GOVERNMENT OF INDIA
MINISTRY OF MINES

ISSN 0972-3625

INDIAN MINERALS YEARBOOK 2022

MINERAL REVIEWS

VOLUME III

सतत कार्यरत
ON WITH THE JOB

INDIAN BUREAU OF MINES

Government of India
Ministry of Mines
Indian Bureau of Mines

INDIAN MINERALS YEARBOOK 2022

VOLUME - III
MINERAL REVIEWS

Issued by
Controller General
Indian Bureau of Mines
NAGPUR

OCTOBER, 2024

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PREFACE

Indian Minerals Yearbook–2022 (IMYB–2022) is the 61st Edition in its Series and comprises three Volumes. This book titled 'Mineral Reviews' is the third Volume and it contains 31 Reviews of important minerals produced in the country which are arranged in an alphabetical sequence. Each Review provides valuable insights on resource/reserve positions; production, stock & prices, mining, marketing & transport; usage & specifications; trade policy; world review; foreign trade; and future outlook of the minerals. The data coverage of this Edition, i.e., IMYB–2022 pertains to the year 2021-22.

This Edition of IMYB, i.e., IMYB–2022, in departure from the earlier editions and in consequence of the notifications of the Government of India declaring 31 major minerals as minor minerals, has a single consolidated chapter dedicated to Minor Minerals which includes 22 sub-chapters on various minor minerals produced in the country. Many minerals which hitherto were covered as individual Mineral Review after the realignment of chapters have been consolidated into a single Review on Minor Minerals.

Be that as it may, attempts nevertheless have been made to comprehensively cover the various minerals explored and extracted in India at the micro-level with inclusions of all recent updates. It has been our continuous endeavour to improve upon the coverage of the Yearbook and to present a complete perspective of all domains that have relevance to minerals and metals to the fullest extent possible.

This year there has been a transformational change in the aesthetics especially in the get-up and layout of the book. Refreshing changes in terms of colour- scheme and presentation of content have been effectvated with a belief that these would engage the attention of the readers. Additioned features by way of presentation of tables, illustration (both pictorial & graphical) along with highlight-jottings are expected to add value to the book.

This Yearbook is the outcome of the joint efforts of the Bureau's Mineral Economics Division and Mining & Mineral Statistics Division. While preparing this Volume, relevant inputs have been drawn from the reports of various Divisions of IBM. Various survey reports/annual reports, technical journals, periodicals of various organisations, including the affirmative responses received from the Mineral Industry on statutory and non-statutory basis, have also been referred and information from related websites too were resourced and incorporated wherever necessary, during the compilation & formulation of this Volume.

The Bureau is indebted to Central and State Government Departments, Public Sector Undertakings, Public and Private Companies and Research Organisations, Mineral-Based Industries & Associations concerned with mines, minerals and mineral-based industries for their support & cooperation in lending and sharing information. It is firmly believed that this Edition of Indian Minerals Yearbook, i.e., IMYB–2022 is in the lines of its predecessors and will serve the interest of all its referring/reading clientele who in the past have reposed such unshakable faith in the authenticity of the data/information published in the Series.

Nagpur
Date: . . 2024

(Sanjay Lohiya)
IAS
Additional Secretary &
Controller General (In-charge)
Indian Bureau of Mines

Volume- III

MINERAL REVIEWS

Contents

EXPLANATORY NOTES AND SOURCES

The statistics presented in this publication are in metric units and the prices quoted are in the Indian currency unless otherwise stated.

The stage of measurement of quantity is normally the mine output which refers to the form in which the minerals are extracted. It also includes the usual processing operations done at the mine site to render the ore marketable. Exceptions to the above definition are gold and silver for which the metal output is considered, and for copper, lead & zinc, the concentrates.

The value of the mineral is reckoned in terms of the Ex-Mine Price which represents the sale value of the mineral at the mine site. The value of production of minerals is calculated by multiplying in each case the quantity of production and pit's mouth value per unit as furnished by the mine owners in the returns under MCDR 1988 in all cases except captive mines where the value is calculated on the basis of the cost of production. In case of fuel minerals, the production value figures in respect of coal & lignite are supplied by the Office of the Coal Controller, Kolkata, on annual basis. Regarding petroleum and natural gas (utilised), value published by the National Accounts Division, Central Statistical Office, is used. Value of sulphur produced as by-product from fertilizer plants and oil refineries is not included in the value of mineral production. The value of non-ferrous metals is furnished by the respective units. The export valuation is on the basis of free on board (f.o.b.) inclusive of export duty, wherever such duty is levied. The basis of valuation of imports is the cost, insurance and freight (c.i.f.) value.

Break-ups may not add to total in some tables due to rounding-off.

Sources

The statistical data presented in this publication have been taken from a large number of sources as listed below:

Minerals other than fuels, atomic minerals and 'minor minerals'

The basic data relating to major minerals except coal, petroleum and natural gas are collected by IBM under Rule 45 of the MCDR, 1988 framed under the Mines and Minerals (Development and Regulation) Act, 1957. These Rules cover all the States and Union Territories of the Indian Union and apply to all minerals except i) petroleum and natural gas, ii) coal, lignite and sand for stowing, iii) minor minerals, and iv) any mineral declared as prescribed substance by Atomic Energy Act, 1962. Data on sulphur are collected from fertilizer plants and oil refineries.

Ilmenite, rutile, monazite, rare earths and zircon

Indian Rare Earths Ltd; Kerala Minerals and Metals Ltd; Department of Atomic Energy, Mumbai, and Private Sector producers and processors.

Fossil fuel

a) Coal and lignite	Coal Controller, Kolkata and the Coal Directory of India.
b) Crude oil and natural gas	i) Economics and Statistics Division of the Ministry of Petroleum & Natural Gas, Government of India, New Delhi, and
	ii) Indian Petroleum & Natural Gas Statistics, Ministry of Petroleum & Natural Gas, Government of India.
	iii) Basic Statistics on Petroleum & Natural Gas, Ministry of Petroleum & Natural Gas, Government of India.
	iv) National Accounts Division, Central Statistical Office, Ministry of Statistics and Programme Implementation, Government of India

Minor minerals

Respective State Governments. 'Minor minerals' are defined in Clause (e) of Section 3 of the Mines and Minerals (Development and Regulation) Act, 1957. The current list of 'minor minerals' includes minerals, such as, building stones, gravel, ordinary earth, ordinary clay, ordinary sand other than sand used for prescribed purposes (i.e. used for other than refractory, ceramics, metallurgical, stowing in coal mines and optical purposes, and in manufacture of silvicrete cement, sodium silicate, pottery and glass), boulder, shingle, chalcedony or impure quartz pebbles (used for ball mill purposes or filling for boreholes or for decorative purposes in buildings), limeshell, kankar, and limestone used in kilns for manufacture of lime used as building material, murrum, brick earth, fuller's earth, bentonite, road metal, rehmatti, slate and shale used for building material, stones used for household utensils, marble, quartzite and sandstone when used for purpose of building or for making road metals and household utensils and saltpetre. In addition to the minerals already declared, 31 more minerals have been declared minor minerals vide Notification S.O 423(E), dated 10th February, 2015, namely, (i) Agate, (ii) Ball Clay, (iii) Barytes, (iv) Calcareous Sand, (v) Calcite, (vi) Chalk, (vii) China clay, (viii) Clay

(Others), (ix) Corundum, (x) Diaspore, (xi) Dolomite, (xii) Dunite or Pyroxenite, (xiii) Felsite, (xiv) Felspar, (xv) Fireclay, (xvi) Fuschite Quartzite, (xvii) Gypsum, (xviii) Jasper, (xix) Kaolin, (xx) Laterite, (xxi) Limekankar, (xxii) Mica, (xxiii) Ochre, (xxiv) Pyrophyllite, (xxv) Quartz, (xxvi) Quartzite, (xxvii) Sand (Others), (xxviii) Shale, (xxix) Silica Sand, (xxx) Slate and (xxxi) Steatite or Talc or Soapstone.

Trade statistics

Monthly Statistics of the Foreign Trade of India, issued by the DGCI&S, Kolkata

Prices

a) Minerals	i)	Principal producers and exporters
	ii)	Coal Controller, Kolkata
	iii)	Industrial Minerals (UK)
	iv)	Basic Statistics on Indian Petroleum & Natural Gas, Ministry of Petroleum & Natural Gas, Government of India.
	v)	DGCI&S, Kolkata (Import Value)
b) Metals	i)	Producers and exporters
	ii)	Reserve Bank of India Bulletin
	iii)	World Metal Statistics (WBMS)
	iv)	London Metal Exchange (Website)
	v)	Minerals & Metals Review (Monthly/Yearly)
World information & statistics	i)	Mineral Commodity Summaries (USGS)
	ii)	World Mineral Production (BGS)
	iii)	Minerals Yearbook (USGS)
	iv)	World Metal Statistics (WBMS)
	v)	Mineral Industry Surveys (USGS)
	vi)	Canadian Minerals Yearbook

Minerals Consumption	Data obtained on statutory and non-statutory basis from industrial units consuming minerals/ores. Data have also been obtained in some cases from Central Government Ministries. The consumption indicated relates to the number of reporting units in the organised sector only. Estimated consumption data is based on statistical norms in vogue.
from National	Reserves/resources of minerals in India have been taken from National Mineral Inventory prepared by IBM as per UNFC system. The source of information for the world resources of minerals is given against each mineral.
Port facilities	Annual Report of the Ministry of Shipping, Indian Ports Association, Major and Minor Port Authorities and exporters of minerals.
Research and Development	IBM's Ore Processing Laboratory, National Laboratories under the Council of Scientific & Industrial Research, and Ore Dressing Division of BARC and R&D laboratories in the Public/Private Sector.

Besides, Annual Reports of various Ministries of Government of India, Annual Reports, Brochures and Websites of Public Sector undertakings and private companies, Bulletins concerned with minerals and mineral-based industries, etc. were also referred.

Information /data Liability Disclaimer

The reviews as presented in the Indian Minerals Yearbook are the product of the concerted efforts of in-house authors. In preparation of manuscripts, the authors resourced data/information from various sources, such as, published information on the internet, various publications, Annual reports etc. Major chunks of information have actually been collated internally from the different Divisions of Indian Bureau of Mines which regularly and routinely are in the cycle of gathering data /information through correspondences.

All these sourced information/data that get included in the General/Mineral Reviews are subjected to analyses, interpretations and sometimes extrapolations in the case of paucity of data.There have been instances when the data have been used 'as it is' hence it is recommeneded that the readers apply discretion in discerning the data for their further utilisation for general or scientific purposes.

Indian Bureau of Mines while processing of the sourced data/information undertakes its best efforts to ensure accuracy and to verify that the data published have been selected on the basis of thorough scientific judgement. However, IBM would make no warranties to that effect, and shall not be liable for any consequent damage that may result from errors or omissions in the database contained there in.

ABBREVIATIONS

The abbreviations and symbols/units used in the Publication are as follows:

AMD	Atomic Minerals Directorate for Exploration and Research
APMDC	Andhra Pradesh Mineral Development Corp. Ltd
BALCO	Bharat Aluminium Company Ltd
BARC	Bhabha Atomic Research Centre
BGML	Bharat Gold Mines Limited
BGS	British Geological Survey, UK
BIS	Bureau of Indian Standards
BISAG	Bhaskaracharya Institute of Space Applications & Geo-Informatics
BOT	Build, Operate, Transfer
BSMDC	Bihar State Mineral Development Corp. Ltd
CAPEXIL	Chemical and Allied Export Promotion Council
CBM	Coal Bed Methane
CCI	Cement Corporation of India Ltd
c.i.f.	Cost, Insurance and Freight
CMDC	Chhattisgarh Mineral Development Corporation
CMPDI	Central Mine Planning & Design Institute
CSO	Central Statistical Office
DAE	Department of Atomic Energy
DES	Directorate of Economics & Statistics
DGCI&S	Director General of Commercial Intelligence and Statistics
DGH	Directorate General of Hydrocarbons
DGM	Directorate of Geology and Mining
DGPS	Differential Global Positioning System
DMG	Directorate of Mining and Geology
DMF	District Mineral Foundation
EEZ	Exclusive Economic Zone
EU	European Union
FDI	Foreign Direct Investment
FIMI	Federation of Indian Mineral Industries
f.o.b.	free on board
f.o.b.t.	free on board trimmed
f.o.r.	free on rail
GMDC	Gujarat Mineral Development Corp. Ltd
GSI	Geological Survey of India
GVA	Gross Value Added
HCL	Hindustan Copper Ltd
HGML	Hutti Gold Mines Co. Ltd
Hindalco	Hindalco Industries Ltd
HZL	Hindustan Zinc Ltd
IBM	Indian Bureau of Mines
IMMT	Institute of Minerals & Materials Technology (Formerly RRL, Bhubaneswar)
IREL	Indian Rare Earths Ltd
ISRO	Indian Space Research Organisation
JPC	Joint Plant Committee
JV	Joint Venture
KCC	Khetri Copper Complex
KMML	Kerala Minerals & Metals Ltd
LAPL	Large Area Prospecting Licence
LME	London Metal Exchange
MALCO	Madras Aluminium Company Ltd
M(A)R	The Mineral (Auction) Rules
MCDR	Mineral Conservation and Development Rules
M(EMC)R	The Minerals (Evidence of Mineral Contents) Rules
MCR	Mineral Concession Rules
MECL	Mineral Exploration Corporation Ltd
ML	Mining Lease
MMDR Act	Mines & Minerals (Development & Regulation) Act
MMTC	Minerals and Metals Trading Corp. Ltd
MoEFCC	Ministry of Environment, Forest and Climate Change
MoU	Memorandum of Understanding
MSS	Mining Surveillance System
MTS	Mining Tenement System
MSTC	Metal Scrap Trade Corp. Ltd
NA	Not Available
NAS	Not Available Separately
NALCO	National Aluminium Co. Ltd
NCMT	National Centre of Mineral Targeting
ND	Not Determined
NELP	New Exploration Licensing Policy
NES	Not Elsewhere Stated
NFL	National Fertilizers Ltd
NLC	Neyveli Lignite Corporation Ltd
NMDC	National Mineral Development Corp. Ltd
NMET	National Mineral Exploration Trust
NMEP	National Mineral Exploration Policy
NMI	National Mineral Inventory
NML	National Metallurgical Laboratory
NRSC	National Remote Sensing Centre
NTPC	National Thermal Power Corp. Ltd
NQ	Not Quoted
N/v	Near Village/s
OIL	Oil India Ltd
OMC	Orissa Mining Corporation Ltd
ONGC	Oil and Natural Gas Corporation Ltd

PMKKKY	Pradhan Mantri Khanij Kshetra Kalyan Yojana
PL	Prospecting Licence
PPP	Public Private Partnership
RP	Reconnaissance Permit
RRL	Regional Research Laboratory
RSMML	Rajasthan State Mines and Minerals Ltd
SAIL	Steel Authority of India Ltd
SBICAP	SBI Capital Markets Limited
SCCL	Singareni Collieries Company Ltd
SDF	Sustainable Development Framework
SEZ	Special Economic Zone
SMC	Sikkim Mining Corporation Ltd
STD	Standard (Code of UNFC)
TAMIN	Tamil Nadu Minerals Ltd
TAMRA T	ransparency, Auction Monitoring and Resource Augmentation
TERI	The Energy and Resources Institute
tpd	tonnes per day tpy tonnes per year
TSL	Tata Steel Ltd (formerly Tata Iron and Steel Co. Ltd)
TW	Territorial Waters
UAE	United Arab Emirates
UK	United Kingdom
UNFC	United Nations Framework Classification
USA	United States of America
USGS	United States Geological Survey
UT	Union Territory
VE	Visual Estimate
VISL	Visvesvaraya Iron & Steel Ltd
w.e.f.	with effect from
(e)	Estimated
(P)	Provisional
(R)	Revised
(U)	Under reference
--	Nil
++	Negligible

UNITS UNITS

cm	centimetre
m	metre
mm	millimetre
cu m	cubic metre
'000 cu m	thousand cubic metres
m cu m	million cubic metres
sq m	square metre
km	kilometre
ha	hectare
sq km	square kilometre
t	tonne
'000	tonnes thousand tonnes
lkm	line kilometre
ct	carat
g	gram
kg	kilogram
₹	Indian rupees
₹ '000	thousand rupees
kWh	kilowatt-hour
s	second

Conversion Table

Troy oz	31.1035 g
kg	2.2046 lb
tonne	Metric ton of 2,204.6 lb
ton	Long ton of 2,240 lb
cwt	112 lb
foot	0.3048 m
Crore	Ten million
Lakh	Hundred thousand

Classification of Reserves/Resources of Various Minerals as per United Nations Framework Classification (UNFC) System

The classification of reserves/ resources of various minerals based on UNFC system were first prepared by IBM as on 1.4.2000 and later, as on 1.4.2005. Reserves/resources are furnished mineralwise in State Reviews and gradewise and statewise in Mineral Reviews. Quinquennially updated resources for 43 minerals as on 1.4.2010 and for 70 minerals as on 1.4.2015 have been included in this Edition of Indian Minerals Yearbook in State Reviews and Mineral Reviews. The process for updating the National Mineral Inventory as on 1.4.2020 for 46 minerals is currently in progress. The amendment to Mineral Conservation & Development Rules,1988 vide Gazette Notification No.185 dated 17.4.2003 makes it statutory for all non-coal major mineral mine-owners to report their reserves data as per UNFC and for Mining Lease applications to submit mining plans accordingly. Detailed guidelines, definitions, etc. concerning UNFC were issued by IBM on 3 June 2003 and published in the edition of Mineral Conservation & Development Rules, 1988.

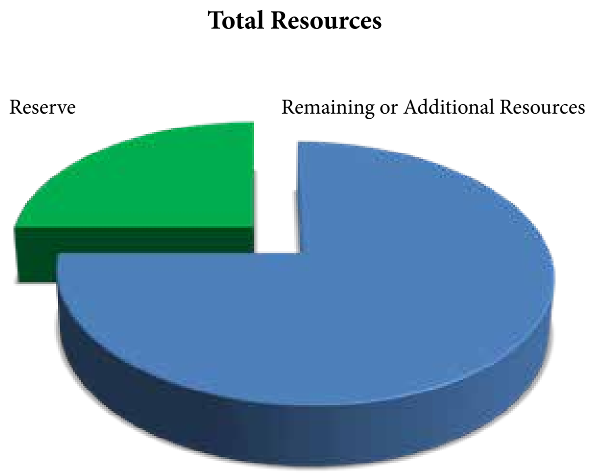
The UNFC consists of a three-dimensional system with the following three axes : Geological Assessment, Feasibility Assessment and Economic Viability. The process of geological assessment is generally conducted in stages of increasing details. The typical successive stages of geological investigation, i.e., reconnaissance, prospecting, general exploration and detailed exploration, generate resource data with a clearly defined degree of geological assurance.

These four stages are, therefore, used as geological assessment categories in the classification. Feasibility assessment studies form an essential part of the process of assessing a mining project. The typical successive stages of feasibility assessment, i.e., geological study as initial stage followed by prefeasibility study and feasibility study/mining report are well-defined. The degree of economic viability (economic or sub-economic) is assessed in the course of prefeasibility and feasibility studies. A prefeasibility study provides a preliminary assessment with a lower level of accuracy as compared to that of a feasibility study which assess the economic viability in detail.

It is a three-digit-code-based system, the economic viability axis representing the first digit, the feasibility axis, the second digit and the geologic axis, the third digit. The three categories of economic viability have codes 1, 2 and 3 in decreasing order. Similarly, the three categories of feasibility study have also codes 1, 2 and 3 while the four stages of geological assessment are represented by 4 codes, i.e., 1 (detailed exploration), 2 (general exploration), 3 (prospecting) and 4 (reconnaissance). Thus, the highest category of resources under UNFC system will have the code (111) and lowest category, the code (334). The various terms used in this classification and their definitions in brief are as follows:

Total Mineral Resources

Reserve plus Additional or Remaining Resource comprise the Total Resource, or Total Resource minus Reserve gives the Remaining Resource.



Diagramatic Representation of Reserve and Resource

A. Mineral Reserve

Economically mineable part of measured and/or indicated mineral resource.

(i) Proved Mineral Reserves (111)
Economically mineable part of Measured Mineral Resource.

(ii) Probable Mineral Reserves (121 & 122)

Economically mineable part of indicated or in some cases, a measured mineral resource.

B. Mineral Resource

A Mineral Resource (Remaining or Additional Resource) is the balance of the Total Mineral Resources that have not been identified as Mineral Reserve.

(i) Measured Mineral Resource (331)

That part of mineral resource for which tonnage, density, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence, i.e., based on detailed exploration.

(ii) Indicated Mineral Resource (332)

Tonnage, density, shape, physical characteristics grade and mineral content can be estimated with reasonable level of confidence based on exploration, sampling and testing information, location of borehole, pits etc.

(iii) Inferred Mineral Resource (333)

Tonnage, grade and mineral content can be estimated with low level of confidence inferred from geological evidence.

(iv) Reconnaissance Mineral Resource (334)

Estimates based on regional geological studies and mapping, airborne and indirect methods, preliminary field inspections as well as geological inference and extrapolation.

(v) Prefeasibility Mineral Resource (221 and 222)

That part of an indicated and in some circumstances measured mineral resource that has been shown by prefeasibility study as not economically mineable or can become economically viable subject to changes in technological, economic, environmental and/or other relevant conditions.

(vi) Feasibility Mineral Resource (211)

That part of measured mineral resource, which after feasibility study has been found to be economically not mineable.

Definition of Uneconomic Occurrence

Materials of estimated quantity, that are too low in grade or for other reasons are not considered potentially economic. Thus, Uneconomic Occurrence is not part of a mineral resource. If quantity and quality are considered worthy of reporting, it should be recognised that an Uneconomic Occurrence cannot be exploited without major technological and/or economic changes, which are not currently available.

Mineral Occurrence

A mineral occurrence is an indication of mineralisation that is worthy of further investigation. The term mineral occurrence does not imply any measure of volume/tonnage or grade/quality and is thus not part of a mineral resource

1. Apatite and Rock Phosphate

311.25
(million tonnes) Total reserves/resources of rock phosphate have been established as on 1st April 2020

1,395
(thousand tonnes) Production of phosphorite/rock phosphate have been reported in 2021-22

540
(tonnes) of rock phosphate were exported in 2021-22

9.66
(million tonnes) of rock phosphate were imported in 2021-22

Apatite is a group of phosphate minerals named by German Geologist Abraham Werner in 1786. It is the most abundant crystalline phosphate mineral found as an accessory mineral in practically all kinds of igneous rocks. Sometimes, it is concentrated in pegmatites, metallic veins and magmatic deposits. It also occurs in metamorphic rocks and as a secondary mineral in phosphatic rocks of sedimentary origin. It is a group of phosphate minerals, usually referring to hydroxy apatite, fluorapatite and chlorapatite. Fluorapatite $Ca_5(PO_4)_3F$ is the most common variety of apatite and also a secondary source of fluorine. Collophane ($Ca_3P_2O_8$) is apparently a cryptocrystalline or amorphous calcium phosphate complex. Rock phosphates or phosphorites are sedimentary phosphatic deposits comprising fine-grained mixture of various calcium phosphates, most important being hydroxylapatite, carbonateapatite, fluorapatite and their solid solutions. The majority of phosphate production in the world is derived from phosphate rocks (phosphorite) containing one or more phosphatic minerals, usually calcium phosphate of sufficient purity and quantity to permit its use directly or after concentration in manufacturing commercial products.

Phosphate rock is also the source of by-product fluorine. Apatite & rock phosphate containing 3 to 4% CaF_2 are useful for recovery of fluorite. Hydrofluoro-silicic acid is recovered as by-product from phosphoric acid plants during processing of rock phosphate. Phosphate rocks are also considered as a significant and secondary resource of uranium.

India is deficient in Apatite & Rock Phosphate availability. In case of apatite, the country is fully dependent upon imports, while the Rock Phosphate production is only from two States, namely, Rajasthan and Madhya Pradesh.

RESERVES/RESOURCES

Apatite

The total Reserves/Resources of apatite as per NMI data, based on UNFC system as on 1.4.2020 has been placed at 21.11 million tonnes. Out of these resources, the Reserves are placed at 0.03 million tonnes, while 21.08 million tonnes are placed under Remaining Resources category. Of the total reserves/resources, West Bengal accounts for the bulk of 50%, followed by Jharkhand (34%) and Meghalaya (6%). The remaining 10% resources are located in Rajasthan, Andhra Pradesh, Gujarat and Tamil Nadu. Gradewise, soil reclamation grade accounts for 45% followed by beneficiable grade (32%), Low/Non-beneficiable grade (15%) and remaining Blendable, Unclassified & Not-known grades (7%). The resources of Chemical Fertilizer grade are about one per cent (Table-1).

Table – 1 : Reserves/Resources of Apatite as on 1.4.2020

(By Grades/States)

(In tonnes)

State/Grade	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility		Pre-feasibility	Measured	Indicated	Inferred	Reconna-issance	Total	Reso-urces
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**27715**	**–**	**1680**	**29395**	**499149**	**–**	**–**	**2281521**	**11481250**	**5801338**	**1017646**	**21080904**	**21110299**
By Grades													
Chemical Fertilizer	27715	–	1680	29395	–	–	–	30000	–	200163	–	230163	259558
Soil Reclamation	–	–	–	–	236502	–	–	2233500	6243000	800000	–	9513002	9513002
Low/Non-beneficiable	–	–	–	–	–	–	–	3360	2363000	50000	666646	3083006	3083006
Beneficiable	–	–	–	–	–	–	–	12477	1875250	4561175	351000	6799902	6799902
Blendable	–	–	–	–	262647	–	–	2184	–	–	–	264831	264831
Unclassified	–	–	–	–	–	–	–	–	1000000	–	–	1000000	1000000
Not-known	–	–	–	–	–	–	–	–	–	190000	–	190000	190000
By States													
Andhra Pradesh	27715	–	1680	29395	–	–	–	–	–	200163	–	200163	229558
Gujarat	–	–	–	–	–	–	–	–	–	–	351000	351000	351000
Jharkhand	–	–	–	–	–	–	–	2110000	1620000	3540000	–	7270000	7270000
Meghalaya	–	–	–	–	–	–	–	–	–	1300000	–	1300000	1300000
Rajasthan	–	–	–	–	–	–	–	51521	1016000	–	–	1067521	1067521
Tamil Nadu	–	–	–	–	–	–	–	–	–	240000	–	240000	240000
West Bengal	–	–	–	–	499149	–	–	120000	8845250	521175	666646	10652220	10652220

Figures rounded off

Rock Phosphate

The total reserves/resources of rock phosphate as per NMI data, based on UNFC system as on 1.4.2020 has been placed at 311.25 million tonnes. Out of these, the reserves constitute only 30.87 million tonnes while 280.38 million tonnes are under Remaining Resources category. Of the total reserves/ resources, 34% are in Jharkhand, 30% in Rajasthan, 19% in Madhya Pradesh, 8% each in Uttar Pradesh & Uttarakhand, respectively. Meagre quantities of resources are also located in Gujarat and Meghalaya. Gradewise, Low-grade account for 37%, followed by Beneficiable (22%), Soil Reclamation (15%) Blendable (10%), Chemical Fertilizer (9%) and remaining Unclassified and Not-known grades (about 7%) (Table-2).

Table – 2 : Reserves/Resources of Rock Phosphate as on 1.4.2020(P)

(By Grades/States)

(In tonnes)

State/Grade	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility		Pre-feasibility	Measured	Indicated	Inferred	Reconna-issance	Total	Reso-urces
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**27103158**	**-**	**3772935**	**30876093**	**13669080**	**29796846**	**34526541**	**2879833**	**3539750**	**186657066**	**9308275**	**280377392**	**311253485**
By Grades													
Chemical Fertilizer	22177450	-	264965	22442415	-	1877652	1856628	-	-	2271077	-	6005357	28447772
Blendable	-	-	-	-	9384650	1660000	8349933	13333	-	12991513	-	32399429	32399429
Soil Reclamation	-	-	-	-	705867	12015437	16512812	700000	30000	16887166	-	46851282	46851282
Beneficiable	4925708	-	1053166	5978874	3578563	14243757	6976076	2166500	2769750	25288989	6650750	61674385	67653259
Low grade	-	-	-	-	-	-	-	-	-	115547549	-	115547549	115547549
Unclassified	-	-	2454804	2454804	-	-	831092	-	740000	10095773	2657525	14324390	16779194
Not-known	-	-	-	-	-	-	-	-	-	3575000	-	3575000	3575000
By States													
Gujarat	-	-	-	-	-	-	-	-	-	314820	-	314820	314820
Jharkhand	-	-	-	-	-	-	-	-	-	107370000	-	107370000	107370000
Madhya Pradesh	5258158	-	3772935	9031093	6460616	15688511	13880230	-	2730000	10615956	50625	49425938	58457031
Meghalaya	-	-	-	-	-	-	-	-	-	1311035	-	1311035	1311035
Rajasthan	21845000	-	-	21845000	4144961	13675437	15793355	119833	69750	28942783	9257650	72003769	93848769
Uttar Pradesh	-	-	-	-	-	432898	3118586	-	740000	21481960	-	25773444	25773444
Uttarakhand	-	-	-	-	3063503	-	1734370	2760000	-	16620513	-	24178386	24178386

Figures rounded off

EXPLORATION & DEVELOPMENT

Exploration and development details, if any, are covered in the Review on " Exploration & Development" under "General Reviews".

PRODUCTION & STOCKS

Apatite

No production of apatite was reported since 2017-18 (Table-3).

Table – 3 : Production of Apatite, 2020-21 & 2021-22

(By Sectors/States/Districts/Grades)

(Quantity in tonnes; Value in ₹ '000)

State/District	No. of mines	2020-21		No. of mines	2021-22 (P)	
		Quantity	Value		Quantity	Value
India	-	-	-	-	-	-
Public sector	-	-	-	-	-	-
Private sector	-	-	-	-	-	-
Andhra Pradesh	-	-	-	-	-	-
Visakhapatnam	-	-	-	-	-	-
West Bengal	-	-	-	-	-	-
Purulia	-	-	-	-	-	-

The mine-head closing stocks at the end of 2021- 22 was 6,306 tonnes same as in 2020-21 (Table-4). The average daily labour employed in apatite mines during 2021-22 was nil as same as in the previous year.

Table – 4 : Mine-head Closing Stocks of Apatite, 2020-21 & 2021-22

(By States/Grades)

(In tonnes)

State	2020-21	2021-22 (P)
India	**6306**	**6306**
Andhra Pradesh	-	-
West Bengal	6306	6306

Phosphorite/Rock Phosphate

The total production of phosphorite/rock phosphate is 1,395 thousand tonnes in 2021-22 which decreased by 4% as compared to that in the previous year (Tables-5 to 7).

Table – 5 : Principal Producers of Phosphorite/Rock Phosphate, 2021-22

Name and address of producer	Location of mine	
	State	District
Rajasthan State Mines & Minerals Ltd,C-89-/90, Janpath Lal, Kothi Scheme,Jaipur-302 015, Rajasthan.	Rajasthan	Udaipur
Khajuraho Stones (India) Pvt. Ltd,Sagar Road Dhadari,Chhatarpur-471 001,Madhya Pradesh.	Madhya Pradesh	Chhatarpur
M.P. State Mining Corporation Ltd, Prayas Bhavan Block No 1(A)Second Floor , Jail Road, Arera Hills,Bhopal,	Madhya Pradesh	Jhabua

Table – 6 : Production of Phosphorite/Rock Phosphate, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**1400189**	**4731313**	**1455829**	**4694525**	**1395079**	**7616476**
Madhya Pradesh	99960	94304	97880	92007	113730	111398
Rajasthan	1300229	4637009	1357949	4602518	1281349	7505078

Table – 7 : Production of Phosphorite/Rock Phosphate, 2020-21 & 2021-22

(By Sectors/States/Districts/Grades)

(Quantity in tonnes; Value in ₹ '000)

State/District	2020-21							2021-22 (P)						
	No.of mines	Grade: P_2O_5 content				Total		No.of mines	Grade: P_2O_5 content				Total	
		Above 30%	Above 25-30%	Above 20-25%	Up to 20%	Qty	Value		Above 30%	Above 25-30%	Above 20-25%	Up to 20%	Qty	Value
India	**6**	**194629**	**552577**	**-**	**708623**	**1455829**	**4694525**	**7**	**250616**	**429719**	**-**	**714744**	**1395079**	**7616476**
Public Sector	5	194629	552577	-	610743	1357949	4602518	6	250616	429719	-	615214	1295549	7522918
Private Sector	1	-	-	-	97880	97880	92007	1	-	-	-	99530	99530	93558
Madhya Pradesh	**5**	**-**	**-**	**-**	**97880**	**97880**	**92007**	**6**	**-**	**-**	**-**	**113730**	**113730**	**111398**
Chhatarpur	2	-	-	-	97880	97880	92007	2	-	-	-	99530	99530	93558
Jhabua	2	-	-	-	-	-	-	3	-	-	-	14200	14200	17840
Sagar	1	-	-	-	-	-	-	1	-	-	-	-	-	-
Rajasthan	**1**	**194629**	**552577**	**-**	**610743**	**1357949**	**4602518**	**1**	**250616**	**429719**	**-**	**601014**	**1281349**	**7505078**
Udaipur	1	194629	552577	-	610743	1357949	4602518	1	250616	429719	-	601014	1281349	7505078

There were 7 reporting mines in 2021-22 as compared to 6 in 2020-21. Rajasthan continued to be the principal producing state contributing 92% of the total production and the remaining 8% was contributed by Madhya Pradesh. The mine-head closing stocks of phosphorite/ rock phosphate in the year 2021-22 was 2,278 thousand tonnes as compared to 2,322 thousand tonnes in 2020-21 (Table-8).

Table –8: Mine-head Closing Stocks of Phosphorite/Rock Phosphate, 2020-21 & 2021-22

(By States/Grades)

(In tonnes)

State	2020-21					2021-22 (P)				
	Grade: P_2O_5 content					Grade: P_2O_5 content				
	Above 30%	Above 25-30%	Above 20-25%	Up to 20%	Total	Above 30%	Above 25-30%	Above 20-25%	Up to 20%	Total
India	**353080**	**342076**	**79148**	**1548092**	**2322396**	**322903**	**355188**	**79067**	**1520400**	**2277558**
Madhya Pradesh	-	1377	3756	62727	67860	-	1377	3675	77166	82218
Rajasthan	353080	340699	75392	1485365	2254536	322903	353811	75392	1443234	2195340

The average daily labour employed in phosphorite/ rock phosphate mines in 2021-22 was 700 as against 951 in the previous year.

MINING AND MARKETING

Apatite mining is confined to Visakhapatnam district, Andhra Pradesh and in Purulia district, West Bengal. In apatite mine of Andhra Phosphate (Pvt.) Ltd, manual mining was carried out by developing benches along the strike length, following the dip of ore body, and by lateral developments of levels along the strike. A mineral treatment plant at Srungavarapukota, about 20 km from the apatite mine has two disintegration units of 15 hp and 50 hp that operate from two separate sheds. Apatite after disintegration is screened to 40 mesh, 60 mesh and 100 mesh. The screened material of right size is packed in quantities of 50 kg each in polythene-lined gunny bags and are despatched for sale to buyers through Srungavarapukota railway station.

West Bengal Mineral Development & Trading Corporation (WBMDTC) operates the only apatite mine in West Bengal which is located at Beldih. The mine is operated by using opencast mining method with the deployment of HEMM like JCB excavator, jackhammer drills, air compressor, tippers, etc. The mine has a production capacity of about 15,000 tonnes of in situ ore per annum. Half of the low-grade ore (10-12% P_2O_5) is blended with available high-grade ore (>22% P_2O_5) manually to produce additional quantity of saleable ore (18-20% P_2O_5). The desired grade (18-20% P_2O_5) of apatite ore is ground to 100 mesh and sold in the local market for direct application in the name of "PURULIA PHOS". However, no production was reported since 2017-18.

In the case of rock phosphate, the phosphorite/ rock phosphate mine in India was reported from Six State Public Sector mines. Of these, Chhatarpur and Jhabua districts of Madhya Pradesh have one and three mines respectively and Sagar district has one mine, while Udaipur district of Rajasthan has one mine. The one mine under the Private Sector is also located in Chhatarpur district, Madhya Pradesh.

The Meghnagar mine in Jhabua district and Hirapur mine in Chhatarpur and Sagar districts of Madhya Pradesh are worked by opencast method and both the mines are operated by Madhya Pradesh State Mining Corporation Ltd. Compressed-air jackhammers are deployed for drilling. The present run-of-mine capacity of Jhabua mine is 1,50,000 tonnes per year. The production of Meghnagar Mine is used in Fertilizer Industries and Phosphorus Industries. The BRP plant at Hirapur mine is operated by Madhya Bharat Agro Industries Ltd. The processed ore from the plant is predominantly sold to manufacturers of phosphatic fertilizers and chemicals. Some parts of the ore are also internally consumed for fertilizer production.

In Rajasthan, the ore body at Jhamarkotra mine of M/s RSMML extends over a strike length of 10 km and the average width of phosphate bed is about 15 m with an average inclination of about 550 from the vertical. The height of the bench is maintained up to 10 m. Shovels (6.1 cu. m) and dumpers (85 tonnes) are used for removal of ore and overburden. The mine has an annual rock handling capacity of about 20 million tonnes. The thin and sharply dipping ore body results in long and narrow pits with great depth extension which leads to very high stripping ratio (about 1:10) with high lead distance and lift for waste and mineral. An effective dewatering scheme was implemented to tackle ground water problem. The working levels are kept dry by continuous pumping of ground water through tube- wells constructed on periphery of the pit limit. The beneficiation plant of RSMML at Jhamarkotra has 9 lakh tpy capacity to treat run-of-mine low-grade ore, with an average 16 % P_2O_5. Production fro Jhamarkotra mine is despatched to many phosphatic fertilizer and chemical manufacturers from Udaipur and Umra railway stations which are located at 18 km and 25 km, respectively, away from the mine. RSMML has put up a beneficiation plant for processing of 9 lakh MT of low-grade phosphate ore per annum.

RSMML produces the following products:

1) (+) 30% P_2O_5 crushed -1/2" size high-grade rock phosphate (for SSP manufacturing units).

2) 31.5% P_2O_5 high-grade rock phosphate Chips (for DAP/Phos Acid manufacturing units).

3)18% P_2O_5 ground low-grade beneficiated rock phosphate (RAJPHOS) (direct application to acidic soils).

4)=31.54% P_2O_5 - BRP Grade (for SSP & DCP Manufacturing units, PROM, etc.)

RSMML was unable to market its low-grade rock phosphate (trade name-Rajphos) till 2005-06 because of its high R_2O_3 content which could neither be blended nor beneficiated. However, during recent years, this grade of rock phosphate has found takers especially, fertilizer manufacturers.

INDUSTRY

As per Ministry of Chemicals and Fertilizers Department of Fertilizers Annual Report 2021-22, presently, there are about 33 large size urea, 21 DAP and complex fertilizers, and 2 ammonium sulphate plants. Among the major fertilizer products, the estimated production of urea during the year 2021- 22 would be 26.374 million tonnes (6.488 million tonnes from Public Sector, 6.762 million tonnes from Cooperative Sector and 13.124 million tonnes from Private Sector), Diammonium Phosphate (DAP) 3.968 million tonnes (2.287 million tonnes from Cooperative Sector and 1.681 million tonnes from Private Sector), complex fertilizers 9.374 million tonnes (1.437 million tonnes from Public Sector, 2.095 million tonnes from Cooperative Sector and 5.842 million tonnes from Private Sector).

The major phosphatic fertilizer plants in Public Sector are Fertilizers and Chemicals (Travancore) Ltd (FACT) at Udyogamandal, Kochi (Kerala); Rashtriya Chemicals and Fertilizer Ltd (RCF) at Trombay, Mumbai (Maharashtra); Madras Fertilizer Limited at Chennai (Tamil Nadu); Brahmaputra Valley Fertilizers Corporation Ltd (BVFCL) at Namrup (Assam); National Fertilizers Ltd (NFL) at Noida (U.P.); FCI Aravalli Gypsum and Minerals India Ltd (FAGMIL) at Jodhpur (Rajasthan); Projects and Development India Limited (PDIL) at Noida (U.P.); Fertilizer Corporation of India Limited (FCIL) in New Delhi; and Hindustan Fertilizer Corporation Ltd (HFCL) in New Delhi.

The plants in Private Sector are Gujarat State Fertilizer Company Ltd (GSFC) at Vadodara (Gujarat); Zuari Agro Chemicals Ltd in Goa; Mangalore Chemicals and Fertilizers Ltd at Mangaluru (Karnataka); Gujarat Narmada Valley Fertilizers & Chemicals Ltd (GNFC) at Bharuch (Gujarat); Nagarjuna Fertilizer and Chemicals Ltd (NFCL) at Kakinada (Hyderabad); Chambal Fertilizers and Chemicals (CFCL) at Gadepan (Rajasthan); Tata Chemicals Ltd (TCL) at Bardala (Uttar Pradesh); Kanpur Fertilizer and Cements Ltd (KFCL) at Kanpur (Uttar Pradesh); Indo-Gulf Fertilizers Limited at Jagdishpur Uttar Pradesh, etc.

The plants in the Co-operative Sector that manufacture phosphatic fertilizer are Indian Farmers Fertilizer Co-operative Ltd (IFFCO) at Kandla (Gujarat) and Krishak Bharti Cooperative Ltd (KRIBCHO) at Surat (Gujarat). The 2 plants of IFFCO are in Gujarat (Kalol and Kandla), 2 in Uttar Pradesh (Phulpur and Aonla) and one in Odisha (Paradeep).

Besides, RSMML has a beneficiation plant in Jhamarkotra in Rajasthan, while Krishna Phoschem Ltd has set up a 600 tpd rock phosphate beneficiation plant at Meghnagar in Jhabua district of Madhya Pradesh. The Company has long-term tie-up with Madhya Pradesh State Mining Corporation Ltd.

The other associate industries on rock phosphate include Coimbatore Pioneer Fertilizer Ltd and Rashtriya Chemicals & Fertilizers Ltd, Mumbai which have domestic plants that recover by-product fluorine from rock phosphate in the form of hydrofluorosilicic acid, sodium silico-fluoride; and aluminium fluoride. Department of Atomic Energy has issued sanctions for establishment of 2 units for recovery of uranium from rock phosphatic sources and these are Rashtriya Chemicals & Fertilizers, Mumbai in association with Heavy Water Board (HWB); and SPIC, Thoothukudi in association with IREL.

RCF is also setting up a rapidwall plant for manufacture of unique building material using phospho-gypsum as a raw material which is the by-product of phosphoric acid plant. The project is estimated to cost ₹ 75 crore.

Red phosphorus is manufactured mainly by United Phosphorus Ltd. Red phosphorus is consumed in Matches Industry. It also has applications as fumigant in Agriculture Industry and as flame retardant.

Joint Ventures Abroad

India's dependency on import at present is to the extent of 25% of our requirements of Urea, 90% in case of phosphates either as raw material or finished fertilizers (DAP/MAP/TSP) and 100% in case of potash.

The Government has been encouraging Indian companies to establish joint ventures abroad in countries which are rich in fertilizer resources for production facilities with buy back arrangements and to enter into long-term agreement for supply of fertilizers and fertilizer inputs to India. The Department of Fertilizers has undertaken joint ventures abroad with 5 countries in the previous years. Although during the year 2021-22, no joint venture with any country was signed, a number of major developments took place with the following countries:

Nepal

Memorandum of Understanding between the Government of India and the Government of Nepal on the supply of Urea and DAP to Nepal from India under Government to Government Arrangement has been approved by the Cabinet. MoU is to be signed shortly.

Russia

To explore the possibility of long term agreement between both the countries and to discuss the terms & conditions of arriving at a mutually long term agreement for supply of fertilizers to India, VC meetings were held between both the sides on 21 June, 2021, 4 August, 2021, 09 September, 2021 and 30th December, 2021. An agreement of Intent has been signed between Indian PSUs and Russian Company, Phosagro on 21.09.21 for supply of 2,50,000 LMT of four types of fertilizers from Russia to India during the year 2022 and options for further engagements for mutual cooperation are being explored.

Saudi Arabia

Several rounds of meetings were held between Indian companies along with officials from DoF and Saudi Companies SABIC and MAADEN on 1st July, 2021, 6th July, 2021 and 5th August, 2021 in coordination with Indian Embassy to Saudi Arabia for arriving at a mutually long-term agreement between Indian and Saudi Arabian Companies for collaboration in the fertilizer sector. Further, engagements for mutual cooperation are being explored.

Morocco

Meetings were held between Indian Companies along with officials from DoF and OCP, Morocco with the constitution of a joint committee/ expert committee.

Canada

A meeting was held between Secretary (Fertilizers) and India's High Commissioner to Canada on 17.12.2021 which was attended by representative of Indian companies importing Potash from Canada. The matter is being pursued with State Government of Gujarat to pursue the case of mining in Canada by GSFC.

Iran

Discussions are being held and follow up actions are taken with Ambassador, Embassy of the Islamic Republic of Iran to strengthen the collaboration and establish a long-term relationship between both the countries for procurement of fertilizers, specifically urea and ammonia from Iran.

RESEARCH AND DEVELOPMENT

RSMML has developed the organic fertilizer called Phosphate Rich Organic Manure (PROM) by using high-grade rock phosphate with farmyard waste and other organic matter. The field trials conducted through different agricultural unversities in the country have shown that the agronomic efficacy of this new P-fertilizer is higher than that of the complex phosphatic fertilizers available in the market today. 'PROM' is suitable to neutral and alkaline soils, which will prove to be a boon to the Indian farmers. RSMML with the help of GSFC is making efforts for utilisation of secondary ore accumulated at Jhamarkotra mine either through beneficiation route or its direct conversion into phosphoric acid.

1. R&D efforts in the following areas strengthened the Company's operation through technology absorption, adaptations & innovation:

a) Productivity studies of HEMM at Jhamarkotra Mines.

b) Beneficiation of secondary rock phosphate.

2. Benefits derived as a result of the above R&D:

a) Strengthening of market share.

b) Converting waste into useful product.

c) Conservation of Mineral.

d) Future plan of action-Energy efficient process.

3. The Company has developed the low cost organic fertilizer "PROM".

4. Two patents have been filed by the Company jointly with MLS University, Udaipur, which got approved under the title i) "process for making slow release phosphate fertiliser". ii) "An eco-friendly process for making EPSOM and Gypsum".

5. The Company has introduced 30% crushed Rock phosphate replacing 31.5% CRP, which has improved mineral conservation.

6. Benefits derived as a result of the above efforts are product improvement, cost reduction, product development, import substitution, etc.

Above efforts helped in satisfying the consumer needs as well as business requirements by introducing new products.

ENVIRONMENTAL CONCERNS

There are apparent concerns regarding phospho-gypsum which is formed as a by-product during manufacturing of phosphoric acid. It contains about 1% PO , 1% F and 10-30 times more radon, none of which is desirable. Environment Protection Agency (EPA) of USA stipulated in 1989 that phospho- gypsum is unsuitable for sale as common gypsum. Production of each tonne of P_2O_5 yields about five tonnes of phosphogypsum. EPA has prescribed stringent measures for storage, transport and disposal of phosphogypsum. In India, however, by- product phospho-gypsum is used widely in cement manufacture.

The use of phosphate also falls under scrutiny. Much attention has been paid to its role in stimulating the growth of algae and other organisms in surface water, the process known as eutrophication. This process is deleterious because it causes blooms of algae which consume dissolved oxygen in lakes and even in shallow, isolated arms of the ocean. Phosphate fertilizers are probably not the only cause of phosphate- induced eutrophication. Another concern is fertilizer phosphate does not leach readily from soil. One of the best ways to remove this phosphate is through the addition of lime which causes precipitation of apatite. However, this procedure, being relatively costly, has not been applied widely. Other application where the use of phosphate has been discouraged is in manufacturing of detergents

USES

Most of the phosphate rock mined throughout the world is used to produce phosphate fertilizer. It is also used as animal feed supplements. Elemental phosphorus and phosphoric chemicals derived from phosphate rocks find application in detergents, insecticides, pharmaceutical products, soft drink, tooth paste, glass, photographic films, matches, fire -works, military smoke screens, incendiary bombs, etc.

Transparent specimens of apatite with vivid green, blue, yellow or pink colour and excellent clarity are often cut into faceted gemstone. Along with other phosphates, apatites are also a proposed host material for storage of nuclear waste.

SPECIFICATIONS

Elemental Phosphorus and Phosphoric Acid

BIS has prescirbed the IS:11224-1985, reaffirmed 2010 specifications for rock phosphate required for the manufacture of elemental phosphorus (Type-I) and phosphoric acid (Type-II).

Single Superphosphate

The P_2O_5 content in rock phosphate for manufacturing single superphosphate should be minimum 31%. Silica up to 8% can be tolerated. Iron and alumina, i.e., R_2O_3 should not be more than 3.5%. Higher R_2O_3 may tend reversion of available P_2O_5 (water soluble P_2O_5). Carbonate up to 5% will improve the reactivity of rock phosphate by increasing the reaction temperature and making the mass porous.

Direct Application of Rock Phosphate as Fertilizer

In India, the finely-ground rock phosphate containing 16% P_2O^5 is used for direct application to the soil for soil amendment. This application is dependent upon the structure and chemical composition of the rock. Direct application is suited mostly for pastures and forage crops and for acidic soils. According to PPCL the following specifications are considered for utilising any rock phosphate as phosphatic fertilizer for direct application in acidic soils.

1. Absolute citrate solubility index 7% (max.)
2. Apatite to carbonate ratio 0.035 CO_2% : P^2O_5%
3. Origin of rock phosphate Sedimentary
4. Mesh size 100
5. Hydroxyl ion in crystal lattice 2 is higher indicating substitution of OH for PO_4 :H_2O
6. Grade of rock phosphate powder 16% P_2O_5 citrate soluble fraction
7. Iron as Fe_2O_3 ^{5}%
8. CaO to P_2O_5 ratio 1:8

The use of rock phosphate for direct application as fertilizer depends on its level of solubility in acidic soil.

CONSUMPTION

The apparent consumption of apatite and rock phosphate in 2021-22 was about 11million tonnes as against the 9 million tonnes during preceding year, i.e., increased by about 20 % in 2021-22.3

POLICY

Imports of natural calcium phosphates (including apatite), natural aluminium-calcium phosphates and phosphatic chalk are allowed 'free' under Heading No. 2510 as per the Import Policy ITC(HS) 2022. All chemical fertilizers except urea continue to be decontrolled. The Government of India has been implementing a scheme of concession fixing indicative maximum retail price (MRP) for enabling sales of decontrolled phosphatic and potassic fertilizers at reasonable prices

In case of Phosphate Fertilizer Industry, the scarcity of domestic raw material constrains the attainment of self-sufficiency in the country. A policy has, therefore, been adopted which involves the following three options:

1. domestic production based on indigenous imported rock phosphate and imported sulphur.
2. domestic production based on imported intermediates, viz, phosphoric acid.
3. imports of finished fertilizers.

The Government of India notified new Urea Policy extended for the period 01.6.2015 to 30.9.2020 for existing gas-based urea manufacturing units. Thereafter the target energy norms of NUP-2015 have been enforced on these urea units from 1st October 2020.

WORLD REVIEW

The world reserves of phosphate rock are about 72 billion tonnes, located mainly in Morocco (69%), Egypt (4%), Tunisia, Algeria & China (3 % each). The remaining 18% is located in other countries (Table - 9).

The world production of phosphate rock is 222 million tonnes in 2021 which is same as of previous year. China (39%), Morocco (17%), USA (10%), Russia (6%), and Peru & Jordan (5% each) have been the major producers (Table-10).

Table – 9: World Reserves of Phosphate Rock

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total (rounded)	**72000000**
Algeria	2200000
Australia5	1100000
Brazil	1600000
China6	1900000
Egypt	2800000
Finland	1000000
India*	46000
Israel	60000
Jordan	1000000
Kazakhstan	260000
Mexico	30000
Morocco	50000000
Peru	210000
Russia	600000
Saudi Arabia	1400000
Senegal	50000
South Africa	1600000
Togo	30000
Tunisia	2500000
Turkey	50000
USA	1000000
Uzbekistan	100000
Vietnam	30000
Other countries	2600000

Source: USGS, Mineral Commodity Summaries2023

5:For Australia, Joint Ore Reserves Committee compliant or equivalent reserves were 124 million tonnes.

6:Production data for large mines only, as reported by the National Bureau of Statistics of China.

**India's total reserves/ resources of rock phoshate as per National Mineral Inventory as on 1.4.2020 are 311.25 million*

Table – 10 : World Production of Phosphate Rock

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
World:Total (rounded off)	**226000**	**222000**	**222000**
China	93324	88000e	86000e
Morocco	35300	40700	38122
USA	23300	23500	22000e
Russia	13800	13800	13800e
Peru	11091	8594	10776
Jordan	9223	8938	10015
Saudi Arabia	5716	8000	8400
Brazil (d)	4700	5500	5500e
Tunisia	4109	3194	3726
Other countries	25193	21781	23217

Source : BGS, World Mineral Production, 2017-21.

d: Including beneficiated and directly shipped material.

Figures Rounded off ; e :- Estimated

To provide a generalised view of the development in various countries the country wise description as sourced from the latest available publication of Minerals Yearbook 'USGS' 2018 is furnished below:

Brazil

Mosaic completed its acquisition of Vale Fertilizantes S.A. on January 8, 2018. Included in the purchase were five phosphate rock mines in Brazil, with a total annual production capacity of 5 Mt, and the Vale stake in the Miski Mayo Mine joint-venture phosphate rock mine in Peru, which gave Mosaic 75% ownership of the mine. Mitsui & Co. Ltd. owned the other 25% of the joint venture. The purchase also included two phosphoric acid plants and four processed fertilizer plants, the only potash mine in Brazil, and the Kronau, Saskatchewan, Canada, potash project.

Saudi Arabia

Ma'aden Phosphate Co. (MPC) began commercial production of DAP at the Wa'ad Al Shammal phosphate project, which included the Umm Wu'al phosphate mine on the Al Khabra deposit. The facility had been running on a trial basis since mid-2017 as it ramped up to full capacity. The project was a joint venture among MPC (60%), Mosaic (25%), and Saudi Arabian Basic Industries Corp. (15%). The project included the phosphate rock mine and beneficiation plant and production facilities for phosphoric acid, ammonium phosphates, animal feed, purified phosphoric acid, sodium tripolyphosphate, and sulfuric acid. The phosphate products would be sent by rail to Ras Al Khair to be processed into fertilizers. Existing fertilizer plants would be expanded at Ras Al Khair as part of this project. Production capacities were rated at 5.3 million metric tons per year (Mt/yr) of phosphate concentrate, 1.5 Mt/yr of phosphoric acid, and 3.5 Mt/yr of phosphate fertilizers. MPC announced it planned to expand Wa'ad Al Shammal to double the current capacities. The new phase of the project was planned to begin operations in 2024.

Syria

Production of phosphate rock continued in 2018 , under the control of Russia's JSC Stroytransgaz, which was given a 50-year contract by the Government of Syria to operate the mine. The phosphate mine in the Homs region had been closed since 2016, when an insurgent militant group took control of the region. The Government of Syria regained control of the area in late 2017, allowing for mining to resume. No reports of production tonnage were available as of mid-2019

FOREIGN TRADE

Exports

In 2021-22 , exports of rock phosphate decreased by 35 % to 540 tonnes from 825 tonnes in the previous year. Exports of phosphatic fertilizers at 428 tonnes in 2021-22 increased by 11% from 385 tonnes in the preceding year. The exports of phosphoric acid increased manifold to 9,187 tonnes in 2021-22 from 460 tonnes in the previous year. Export of elemental phosphorus increased by 8% to 627 tonnes from 583 tonnes in the preceding year. Rock phosphate was exported mainly to Bangladesh (44%), Nepal (36%), Oman & USA (8% each), Malaysia (3%) and Uganda (1%). Elemental phosphorus was also mainly exported to USA (19%) , Chile (13%) and Russia (11%). In 2021-22, exports of phosphatic fertilizers were mainly to Nepal (90%), Jordan (5%) and Indonesia (4%), while phosphoric acid was mainly exported to Bangladesh (54%), UAE (18%), Kenya (5%), Singapore (4%) and Netherland. & Nepal (3% each), (Tables- 11 to 16).

Table – 11: Exports of Rock Phosphate

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All countries	**825**	**5602**	**540**	**11316**
USA	102	1923	41	8314
Nepal	89	630	192	1989
Oman	-	-	42	555
Bangladesh	255	204	240	238
Malaysia	274	2040	17	127
Uganda	4	14	8	88
Sri Lanka	-	-	++	4
Bulgaria	-	-	++	1
Bhutan	72	473	-	-
UK	22	272	-	-
Other countries	7	46	-	-

Figures rounded off

Table – 12 : Exports of Rock Phosphate (Ground)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**436**	**4291**	**328**	**2409**
USA	102	1923	29	830
Nepal	60	328	++	659
Oman	--	--	42	555
Bangladesh	--	--	240	238
Malaysia	274	2040	17	127

Figures rounded off

Table – 13: Exports of Rock Phosphate (Unground)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All countries	**389**	**1311**	**212**	**8907**
USA	-	-	12	7484
Nepal	29	302	192	1330
Uganda	4	14	8	88
Sri Lanka	-	-		++
Bulgaria	-	-	++	1
Bhutan	72	473	--	--
UK	22	272	--	--
Bangladesh	255	204	--	--
Kenya	6	22	--	--
New Zealand	1	16	--	--
Other countries	++	8	++	++

Figures rounded off

Table – 14: Exports of Phosphorus (Elemental)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**583**	**246040**	**627**	**362922**
USA	144	56670	121	63141
Chile	16	7477	81	46074
Argentina	5	2379	46	35237
Russia	68	23136	68	35063
Brazil	40	18141	41	22150
Indonesia	33	15015	29	20069
South Africa	14	5642	28	18351
Mexico	7	2932	22	18081
Canada	14	5562	28	17254
Egypt	33	13921	28	16451
Other countries	209	95165	135	71051

Figures rounded off

Table – 15: Exports of Phosphatic Fertilizers

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**385**	**15631**	**428**	**16776**
Indonesia	-	-	18	10005
Nepal	130	4231	387	4225
Jordan	-	-	20	1304
Australia	-	-	2	737
Denmark	-	-	++	371
Kenya	7	1722	1	128
Argentina[a]	-	-	++	3
Bhutan	-	-	++	3
Korea, Rep. of	36	4004	-	-
Sri Lanka	190	3060	-	-
Other countries	22	2614	-	-

Figures rounded off

Table – 16: Exports of Phosphoric Acid

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**460**	**50475**	**9187**	**1228169**
Bangladesh	22	2672	4985	580681
UAE	74	6559	1677	237433
Netherlands	-	-	302	72809
Kenya	29	2034	438	55738
Singapore	69	6830	322	47903
Belgium	++	60	118	40005
Nepal	54	4612	287	37931
Korea, Rep. of	-	-	179	30570
Qatar	10	1427	195	26948
Cote D' Ivoire	-	-	101	14561
Other countries	202	26281	583	83590

Figures rounded off

Imports

Imports of rock phosphate increased by 24% to 9.66 million tonnes in 2021-22 from 7.78 million tonnes in the previous year. Imports were mainly from Jordan (43%), Morocco (21%), Egypt (13%) and Togo (9%). Imports of elemental phosphorus increased by 24% to 52,577 tonnes in 2021-22 from 42,551 tonnes in the previous year. The imports of elemental phosphorus were mainly from Vietnam (82%) and Russia (16%). During 2021-22, meagre amount of phosphatic fertilizers were imported. Imports of phosphoric acid sharply increased by 156% to 6.44 million tonnes in 2021- 22 from 2.51 million tonnes in the previous year. The imports of phosphoric acid were mainly from Morocco (78%), Jordan (9%) and Senegal (7%) (Tables- 17 to 22).

Table –17 : Imports of Rock Phosphate

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**7781423**	**53709109**	**9659818**	**104667349**
Jordan	3016512	21316732	4147424	43813672
Morocco	1964608	17290552	2068626	26044201
Togo	784085	5466808	854324	10740853
Egypt	1725014	8042720	1231647	10277522
Algeria	31500	184139	577953	5181858
UAE	237540	1275558	278700	2771080
Nauru	--	--	138679	1734347
Senegal	1	3	118574	1368732
Peru	--	--	60499	671058
Hong Kong	152	5262	53500	629036
Other countries	22011	127335	129892	1434990

Figures rounded off

Table – 18: Imports of Rock Phosphate (Ground)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**3673367**	**27621345**	**4667997**	**52941744**
Morocco	1959208	17262394	2058477	25953219
Togo	727418	4965344	653034	7588430
Jordan	205881	1377926	608058	6386315
Algeria	31500	184139	519634	4738823
Egypt	489772	2424762	340973	3024696
UAE	237540	1275558	268700	2709580
Senegal	--	--	118574	1368730
South Africa	--	--	30279	472556
Cyprus	21800	121894	43500	382312
Nauru	--	--	26766	316576
Other countries	248	9328	2	507

Figures rounded off

Table – 19 : Imports of Rock Phosphate (Unground)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**4108056**	**26087764**	**4991821**	**51725605**
Jordan	2810631	19938806	3539366	37427357
Egypt	1235242	5617958	890674	7252826
Togo	56667	501464	201290	3152423
Nauru	--	--	111913	1417771
Peru	--	--	60499	671058

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
Hong Kong	--	--	53500	629036
Singapore	--	--	53010	557430
Algeria	--	--	58319	443035
Morocco	5400	28158	10149	90982
UAE	--	--	10000	61500
Other countries	116	1378	3101	22187

Figures rounded off

Table – 20 : Imports of Phosphorus (Elemental)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**42551**	**8199312**	**52577**	**17336452**
Vietnam	32059	6159010	42902	15277341
Russia	9523	1841954	8482	1785140
Kazakhstan	965	196481	1193	273796
USA	++	52	++	127
China	—	—	++	28
Germany	++	11	++	16
UK	++	5	++	4
Philippines	4	1799	—	—

Figures rounded off

Table – 21: Imports of Phosphoric Acid

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2514246**	**124688967**	**6442448**	**186191658**
Morocco	986637	48714772	5016629	60025398
Jordan	620569	30712792	553667	49133247
Senegal	489173	23937276	441862	39782034
Tunisia	119301	5887970	196072	16398721
USA	71003	3271520	84027	7822928
Vietnam	50127	2910996	38129	3358237
Philippines	28056	1466382	38645	3145389
South Africa	50794	2604320	27387	2217515
Egypt	30817	1476012	16320	1761674
UAE	29629	1474299	8850	742008
Other countries	38140	2232628	20860	1804507

Figures rounded off

Table – 22: Imports of Phosphatic Fertilizers

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**51**	**++**	**245**
Ukraine	++	11	++	245
Korea, Rep. of	++	40	-	-

Figures rounded off

FUTURE OUTLOOK

There is no substitute for phosphorus in agriculture. The country is deficient in all fertilizer minerals. The reserves/ resources of chemical and fertilizer grades apatite and rock phosphate in India are very limited. Therefore, detailed exploration is necessary for conversion of remaining resources into reserves. Secondly, the search for apatite and rock phosphate may have to be intensified in Andhra Pradesh, Rajasthan, Madhya Pradesh, Jharkhand, Tamil Nadu, Meghalaya, Gujarat, Uttar Pradesh, Uttarakhand, West Bengal, etc. Till the domestic resources of these two minerals are improved, the country has no alternative but to depend on imports. Concerted efforts should be made by way of constituting consortia of public- private companies to acquire assets abroad specifically in countries like Uzbekistan, Jordan, etc. Strengthening ties with mineral-rich countries and provinces with functional and specific MoUs and utilisation of IMG mechanism to align domestic stakeholders with MoUs is required. A very small requirement of raw material for phosphate fertilizer production is met through indigenous sources. The major requirement is met through imports in the form of rock phosphate, phosphoric acid and direct fertilizers.Private Sector participation in rock phosphate mining needs to be promoted in order to make available the ab ove two mine rals to re duce import dependence for promotion of fertilizers for Agricultural Sector.

Demand for phosphatic fertilizer is expected to increase gradually in tandem with the growth in population and corresponding increase in food require me nts. T he Government has been encouraging Indian Companies to establish joint venture abroad in countries which are rich in fertilizer resources.

In India, most of the existing phosphatic fertilizer and phosphoric acid plants have been designed for high-grade imported rock phosphate, mainly from Morocco and Jordan. The Indian deposits on the other hand, are of low-grade variety. Therefore, the fertilizer and phosphoric acid plants that are likely to be set up as replacement of the existing plants may have to be designed to accept indigenous ores as feed. In addition, beneficiation of domestic low-grade ores would be a step in the right direction and should be promoted persuasively.

2. Asbestos

22.90	1,906	4,37,511
(million tonnes) Total reserves/ resources of asbestos in the country as on 1st April 2020	(tonnes) of asbestos were exported in 2021-22	(tonnes) of asbestos were imported in 2021-22

Asbestos is a group of six naturally occurring fibrous silicate minerals. The physical properties, besides fibrous character, such as, fineness, flexibility, tensile strength & length of fibres, infusibility, low heat conductivity and high resistance to electricity & sound as also to corrosion by acids, make asbestos commercially important. Commercial asbestos is classified into two main mineralogical groups: serpentine asbestos or chrysotile asbestos and amphibole asbestos. The latter includes asbestos minerals, such as, tremolite, actinolite, anthophyllite, amosite and crocidolite. Commercially, chrysotile asbestos is far superior in physical properties, and hence, more valuable than amphibole asbestos.

India's asbestos requirement is met through imports from Russia, Brazil, Kazakhstan, Hungary and Poland.

RESERVES/RESOURCES

As per NMI database, based on UNFC system, the total reserves/resources of asbestos in the country as on 1.4.2020 has been placed at 22.90 million tonnes. A total of 22.90 million tonnes of asbestos are placed under Remaining Resources. Out of the total resources, Rajasthan accounts for 13.61 million tonnes (59%) and Karnataka 8.28 million tonnes (36%). The remaining five per cent resources are estimated in States of Andhra Pradesh, Jharkhand, Odisha and Uttarakhand (Table-1).

Table – 1 : Reserves/Resources of Asbestos as on 1.4.2020 (P)

(By Grades/States)

(In tonnes)

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**-**	**-**	**-**	**-**	**2488022**	**3113446**	**4062376**	**100687**	**2527959**	**10557777**	**57800**	**22908067**	**22908067**
By Grades													
Chrysotile	-	-	-	-	684838	39126	16553	2885	17660	70843	-	831905	831905
Amosite	-	-	-	-	-	-	-	-	3987	4459680	-	4463667	4463667
Tremolite	-	-	-	-	-	94768	116516	-	2426700	1562125	-	4200109	4200109
Chrysotile mixed													
with others	-	-	-	-	-	3871	18309	-	-	336	-	22516	22516
Mixed Amphibole	-	-	-	-	1743560	2642595	3745856	87802	42101	4121718	-	12383632	12383632
Actinolite	-	-	-	-	-	-	-	-	311	34000	-	34311	34311
Anthophyllite	-	-	-	-	-	-	-	-	-	20000	-	20000	20000
Others	-	-	-	-	-	332459	99675	-	-	-	-	432134	432134
Not-known	-	-	-	-	59623	627	65467	-	-	279574	57800	463091	463091
Unclassified	-	-	-	-	1	-	-	10000	37200	9500	-	56701	56701
By States													
Andhra Pradesh	-	-	-	-	684839	39126	16553	-	1541	55936	-	797995	797995
Jharkhand	-	-	-	-	-	3871	18309	2885	5769	124059	-	154893	154893
Karnataka	-	-	-	-	-	-	-	-	2441037	5841420	-	8282457	8282457
Odisha	-	-	-	-	-	-	-	10000	37200	9500	-	56700	56700
Rajasthan	-	-	-	-	1803183	3070449	4027514	87802	42101	4526861	57800	13615710	13615710
Uttarakhand	-	-	-	-	-	-	-	-	311	-	-	311	311

Figures rounded off

Table-2 summarises the mineralogical varieties of asbestos occurring in various parts of the country.

Table – 2 : Occurrences of Asbestos in India

State	District	Mineralogical variety
Andhra Pradesh	Anantapur Cuddapah	Chrysotile
Jharkhand	Singhbhum (East) Singhbhum (West)	Chrysotile, tremolite, chrysotile mixed with other minerals
Karnataka	Chikkamagaluru	Amosite
	Hassan	Anthophyllite
	Mandya	Mixed amphibole minerals
	Mysuru	Chrysotile
	Shivamogga	Amosite
Odisha	Kendujhar	-
Rajasthan	Ajmer	Mixed amphibole minerals
	Bhilwara	-do-
	Dungarpur	-do-
	Pali	Tremolite, chrysotile mixed with other amphibole minerals
	Rajsamand	Tremolite, actinolite and mixed amphibole minerals
	Udaipur	Chrysotile, tremolite and mixed amphibole minerals
Uttarakhand	Chamoli	Others

PRODUCTION

No production of asbestos was reported in 2021-22 as well as in the previous year and there were no reporting mines in 2021-22 as well as in preceding year.

Similarly, the mine-head closing stocks of asbestos also remained 'Nil' for the year 2021-22 as well as in the preceding year 2020-21. The average daily employment of labour for both the years was 'Nil.'

MINING & MILLING3

Presently, there is no working asbestos mine in India. The usual method of mining chrysotile in Pulivendla Tehsil, Cuddapah district, Andhra Pradesh, was by opening an incline along the dip varying from 20^0 to 25^0, keeping the trap as floor and limestone as roof. Two or threesuchinclines were converted into a regular underground mine by developing levels and winzes, connecting them and adopting board-and-pillar system of development. In almost all the mines, operations like blasting, hole drilling, hoisting, pumping and ventilation were mechanised.

The run-of-mine was subjected to manual sorting of asbestos-bearing rock (ABR). ABR was then hand-combed for chipping off the asbestos-bearing portion in small pieces of about 2.5 cm for producing asbestos concentrates. From ABR, the serpentine was removed as a waste. The asbestos concentrate was fed manually into hopper of a hammer mill. In hammer mill, asbestos and other minerals were separated and then fed to double-deck screen having 10 to 40 mesh sieves. The screening gives three fractions: (a) oversize, (b) middling and (c) tailing.

Tailing was taken as a waste which generally did not contain appreciable quantity of asbestos. The oversize was recycled in the hammer mill, and the middling fibre was sucked up by a cyclone and collected.

GRADING & MARKETING

Small fibres recovered through milling pro cess account for nearly a two-third production. The general grading system adopted is as follows:

Grade	Fibre Size	Method
Grade - As	45 mm and above	Hand-sorted
Grade - A	Between 25 and 45 mm	
Grade - B	Between 12 and 25 mm	
Grade - C	Above 16 mesh	Mill-processed
Grade - D3	24 mesh	
Grade - D4	40 mesh	
Grade - D6	60 mesh	

Note: Producers of amphibole asbestos sell their output as crude or fluff and powder.

CLASSIFICATIONS

Various classifications of chrysotile asbestos followed in India are based, by and large, on fibre length:

(1) Grade A or

A Special - 25.4 mm fibres or larger

As 1 - 25.4 mm and larger fibres but brittle compared to As or A Special

A- 19.05 to 25.4 mm fibres

A1 - 19.05 to 25.4 mm fibres but brittle compared to A

A2 - 19.05 to 25.4 mm fibres but brittle compared to A1

Grade B -6.35 to 19.05 mm fibres

B1- 6.35 to 19.05 mm fibres but brittle compared to B

B2- 6.35 to 19.05 mm fibres but brittle compared to B1

C- Below 6.35 mm fibres

(2)Grade A Special - Above 31.5 mm

A	- Between 19 and 31.5 mm
B	- Between 6.3 and 19 mm
C	- Below 6.3 mm including powder
D	- Dust

3) Quebe standard asbestost esting machine classification of chrysotile asbestos according to groups is given below:

Crude Asbestos		
Group No. 1	Crude No. 1	Consists basically of crude, 3/4 inch and longer staple
Group No. 2	Crude No. 2	Consists basically of crude, 3/8 to 3/4 inch staple.

Milled Asbestos	
Standard designation of grade	**Guaranteed minimum spinning test**
Group No. 3 (spinning fibres)	
3 D	10.5-3.9-1.3-0.3
3 z	0-8-6-2
Group No. 4 (shingle fibres)	
4 D	0-7-6-3
4 Z	0-1.5-9.5-5
Group No. 5 (paper fibres)	
5 D	0-0.5-10.5-5
5 R	0-0-10-6
Group No. 6 (waste)	
6 D	0-0-7-9
Group No. 7 (shorts or refuse)	
7 D	0-0-8-11
7 W	0-0-0-16
Group No. 7 (floats)*	
7 RF	No test
7 TF	No test
Group No. 8 (sand & gravel)	
8 S	Less than 50 lb per cu. ft loose measure
8 T	Less than 75 lb per cu. ft loose measure.
Group No. 9 (gravel & stone)	
9 T	More than 75 lb cu. ft loose measure

** The suffix 'F' designates 'floats' in the case of 7R and 7T grades.*

USES

Industrial use of asbestos is linked with the type of asbestos. Chrysotile asbestos, being more fibrous and possessing better tensile strength than amphibole variety is used in the manufacture of asbestos fabrics, cement sheets, pipes and allied products. It is also used in brake linings, insulation and fireproof clothing. Short fibres are used with cement as binders for manufacturing asbestos- cement products. Amphibole asbestos generally finds use in heat insulation and treatment of acids . Anthophyllite and tremolite fibres, although of good length, are too weak and brittle to be spun. They are, therefore, used for boiler lagging, hardsetting magnesia composition and as a filler in asbestos paints and various asbestos-moulded articles.

SUBSTITUTION

Materials substituted for asbestos include calcium silicate, carbon fibres, fibres of cellulose, ceramic, glass & steel, wollastonite and several organicfibres like aramid, polyethylene, polypropylene and polytetrafluoroethylene. Where reinforcement properties of fibres are not required, several non-fibrous minerals are also considered for possible substitution. However, no single substitution is found to be as versatile or as cost-effective as asbestos.

ENVIRONMENTAL IMPACT OF ASBESTOS

Asbestos used as a part of construction material due to flame retardant quality, poses major risk to human health and environment. Asbestos has been linked in number of serious medical conditions. These include the lungs and respiratory problems because asbestos is made of tiny fibres that when released into the air and prolonged breathing of air laden with asbestos dust can settle inside the lungs and irritate the tissues in the chest cavities. Mesothelioma is a rare form of cancer of the lungs and digestive tract which is most commonly caused by exposure to asbestos mixed air. Besides health hazards, asbestos also has negative impact on the environment. A study presented in 2006 at the International Conference on Health, the Environment and Justice found that asbestos dust can easily travel through the air and into the water supply. It can also settle on the surface of the soil instead of getting absorbed into the ground, which means that it can still get picked up by the wind and inhaledinto human respiratory system.

However, as per the report of the 'Asbestos Cement Products Manufactures' Association' in India, only chrysotile (white) asbestos fibre is used for the manufacture of asbestos-cement sheets and asbestos-cement pipes which contain a very small quantity of chrysotile fibre (only 8–10%). The other raw materials used are cement 45%, fly ash 30-35% and wood pulp. The asbestos fibres are firmly locked-in or encapsulated within the cement matrix during manufacture so that fibres cannot be emitted into the atmosphere under normal use and thus, pose no health risk to the general public or environment. Several studies abroad have concluded that use of chrysotile in the manufacture of Asbestos Cement Products under controlled conditions is safe for the workers, environment and the general public.

TRADE POLICY & LEGISLATION

No restrictions have been imposed on exports of asbestos in the Foreign Trade Policy, 2015-20. As per the prevailing Foreign Trade Policy, asbestos under Heading 2524 can be imported freely with the exception of amosite which is restricted. However, the imports of crocidolite, actinolite, anthophyllite, amosite and tremolite are restricted in terms of Interim Prior Informed Consent (PIC) Procedure of Rotterdam Convention for Hazardous Chemicals and Pesticides.

Ministry of Environment and Forest, vide Notification dated 13.10.1998 , under Sections 3(1) and 6(2) (d) of Environment (Protection) Act, 1986 and Rule 13 of Environment (Protection) Rules, 1986, has prohibited the imports of waste asbestos (dust and fibre), on account of it being a hazardous waste detrimental to human health and environment.

WORLD REVIEW

Large reserves are located mainly in Kazakhstan, Zimbabwe, Russia, China, Brazil and USA. Reliable evaluations of global asbestos resources have not been published recently, and available information was insufficient to make accurate estimates for many countries. However, world resources are large and more than adequate to meet anticipated demand in the foreseeable future. Resources in the United States are composed mostly of short-fiber asbestos for which use in asbestos-based products is more limited than long-fiber asbestos. In 2021, the world production of asbestos increased by 9% to 1,200 thousand tonnes in 2021 as compared to 1,100 thousand tonnes in preceding year. Russia was the leading producer with 700 thousand tonnes, followed by Kazakhstan (250 thousand tonnes), China (120 thousand tonnes) and Brazil (100 thousand tonnes) (Tables-3 and 4).

Table – 3 : World Reserves of Asbestos

(By Principal Countries)

(In million tonnes)

Country	Reserves
World: Total	**Large**
Brazil	11
China	15
Kazakhstan	Large
Russia	110
USA	Small
Zimbabwe	Large

Source: USGS, Mineral Commodity Summaries, 2023.

** India's total reserves/resources of asbestos as per NMI database, based on UNFC system, as on 1.04.2020 have been estimated at 22.90 million tonnes.*

Table – 4 : World Production of Asbestos

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
World Total	**1200**	**1100**	**1200**
Brazil	12	77	100[e]
China	150[e]	120[e]	120[e]
Colombia	-	-	-
Kazakhstan	211	227	250
Russia	790	720[e]	700[e]

Source: BGS, World Mineral Production, 2017-2021.

(e) : Estimated.

To provide generalised view of the development in various countries, the country wise description sourced from latest available publication of USGS, Mineral Year Book, 2019 is detailed below:

Brazil

The Supreme Federal Court of Brazil (STF) enacted a comprehensive national ban on asbe stos in November 2017, extending a prohibition that was limited to the State of Rio de Janeiro to the entire country. Eternit S.A., the only asbestos producer in Brazil, disputed the national nature of the ban and considered asbestos to be legal in those States without explicit laws that disallowed its mining and use. A judicial injunction allowed the company to continue operating its mine in the State of Goias until February 2019, when production ceased. In April, Eternit petitioned the STF to allow asbestos ore stockpiles to be processed for sale to foreign markets. In July, the State of Goias passed a law that authorized the extraction and processing of asbestos in the State for export purposes, generating immediate legal challenges. By year end 2019, the STF had not issued a ruling on the constitutionality of the Goias law, and Eternit had not restarted operations.

Colombia

The Government of Colombia enacted legislation to prohibit the mining, export, production, sale, and use of asbestos beginning 2021. Domestic companies that used asbestos to manufacture products would be exempt from the ban for 5 years.

Zimbabwe

At the former Mashaba Mine, which closed in 2007, Shabanie Mashaba Mine Holdings began producing asbestos from tailings and was working to dewater the mining shafts and procure equipment to restart underground production.

FOREIGN TRADE

Exports

Exports of asbestos increased to 1,906 tonnes in 2021-22 as compared to 299 tonnes in the previous year. Exports were mainly to Bangladesh. Exports of asbestos (fibre products) were at 49,044 tonnes in 2021-22 as compared to 41,739 tonnes in the previous year. Exports were mainly to USA (33%), UAE (7%), Egypt (6%), Brazil (5%) and Indonesia, Kenya, & Canada, (3% each). Exports of asbestos (chrysotile) were at 1,905 tonnes during the year 2021-22 as compared to 275 tonnes in the preceding year. Exports of asbestos (others) decreased to 01 tonnes during the year 2021-22 as compared to 24 tonnes in the preceding year. Exports of asbestos-cement products were 1,16,492 tonnes in 2021-22 as compared to 89833 tonnes in the preceding year. Exports of asbestos-cement products were mainly to UAE (29%), Qatar (23%), Nepal (21%) and UK (12%) (Tables-5 to 9).

Table – 5 : Exports of Asbestos

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**299**	**11991**	**1906**	**68026**
Bangladesh	275	11887	1906	68000
Uganda	--	--	++	26
Nepal	24	54	++	++
Kenya	++	42	--	--
Cote D' Ivoire	++	8	--	--

Figures rounded off

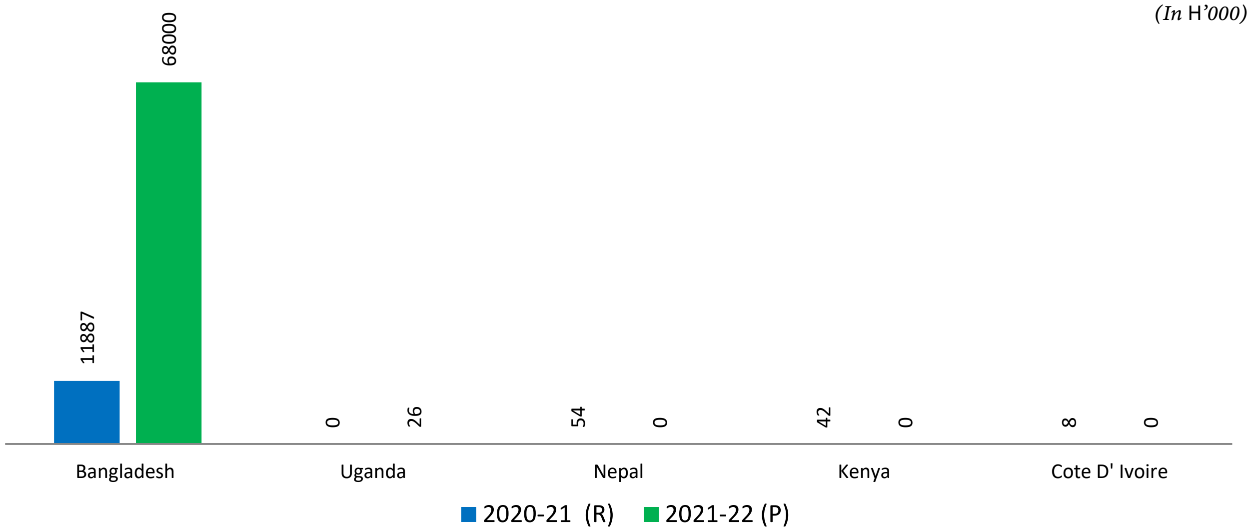


Fig. 1: Countrywise Value of Exports of Asbestos

Table – 6 : Exports of Asbestos (Fibre Products)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**41739**	**5548536**	**49044**	**6902347**
USA	13407	1834003	16223	2155064
Brazil	817	262332	2364	489080
U A E	3355	388212	3385	402632
Nepal	1076	151558	751	216908
Egypt	2244	179241	2762	212397
Russia	276	60510	856	189110
Indonesia	955	101843	1574	183692
Kenya	1440	133834	1412	175061
Turkey	464	131610	593	170571
Canada	1149	160061	1343	163853
Other Countries	16556	2145332	17781	2543979

Figures rounded off

Table – 7 : Exports of Asbestos (Chrysotile)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**275**	**11895**	**1905**	**67961**
Bangladesh	275	11887	1905	67961
Cote D' Ivoire	++	8	--	--

Figures rounded off

Table – 8 : Exports of Asbestos (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**24**	**96**	**1**	**65**
Bangladesh	--	--	1	39
Uganda	--	--	++	26
Nepal	24	54	++	++
Kenya	++	42	--	--

Figures rounded off

Table – 9 : Exports of Asbestos Cement Products

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**89833**	**1444464**	**116492**	**1876220**
Nepal	20814	323160	24363	486952
UAE	27254	389165	33988	446358
Qatar	18132	283356	26692	372451
UK	6398	128380	13474	238312
South Africa	3319	55863	2803	48462
Oman	2577	41041	2881	41930
Maldives	1313	27240	1856	33858
Somalia	504	10326	1493	29620
Iraq	527	8322	1511	24134
Ghana	668	11090	1013	17336
Other Countries	8327	166521	6418	136807

Figures rounded off

Imports

Imports of asbestos were 4,37,511 tonnes in 2021-22 increased by 42% as against 3,08,506 tonnes in the previous year. Almost entire import was that of chrysotile asbestos except only 534 tonnes import was in the form of Asbestos (others). Imports of asbestos were mainly from Russia (52%), Brazil (35%), Kazakhstan (6%), Hungary (4%) and Poland (2%). A total of 20,721 tonnes asbestos-cement products were also imported in 2021-22 as against 19,306 tonnes in the previous year. Imports were mainly from Thailand (91%) and Indonesia (5%). Imports of asbestos fibre products were 3,353 tonnes during the year 2021-22 as compared to 2,309 tonnes in previous year. Imports of asbestos fibre products were mainly from China (30%), Denmark (24%), Japan (14%) UK(10%), Germany (9%) and USA (4%). (Tables-10 to 14).

Table – 10 : Imports of Asbestos

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**308506**	**11851124**	**437511**	**16631390**
Russia	195419	7749132	228529	8952770
Brazil	72385	2454931	151277	5408508
Kazakhstan	10105	379339	25168	935189
Hungary	16549	688296	16515	726658
Poland	9614	348194	10302	333479
South Africa	2816	169062	2718	152208
USA	240	18102	2407	102007
Hong Kong	--	--	338	12970
Singapore	136	4864	68	2381
China	1017	33651	67	2302
Other countries	225	5553	122	2918

Figures rounded off

(In ₹'000)

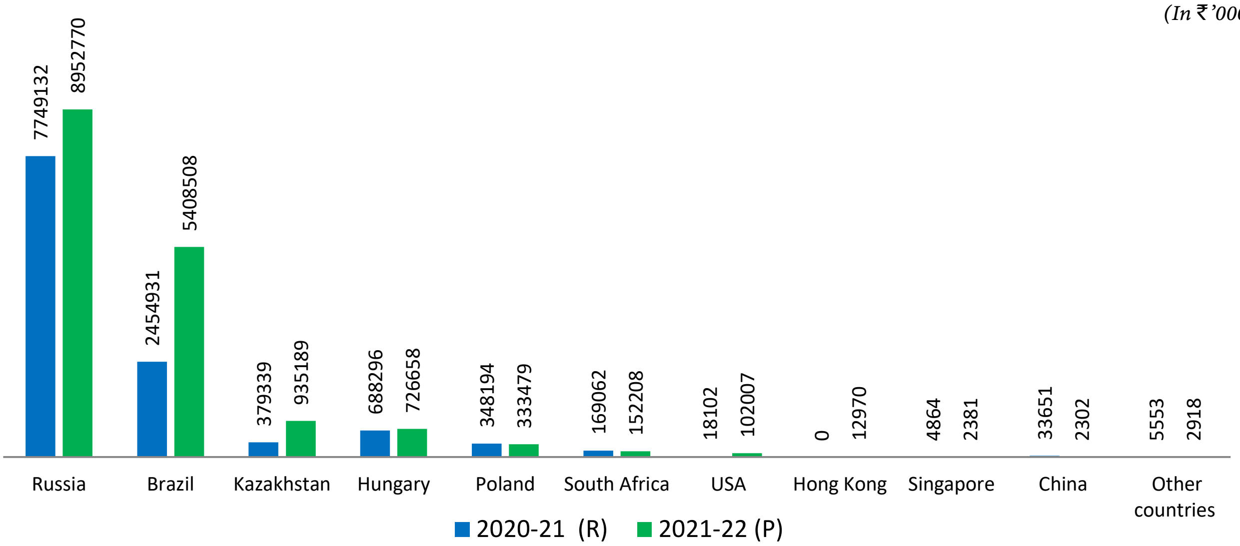


Fig-5: Countrywise Value of Imports (in ₹'000) of Asbestos

Table – 11 : Imports of Asbestos (Chrysotile)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**308100**	**11840174**	**436977**	**16613219**
Russia	195419	7749132	228529	8952770
Brazil	72385	2454931	151232	5406513
Kazakhstan	10105	379339	25168	935189
Hungary	16549	688296	16515	726658
Poland	9344	338450	9867	317968
South Africa	2816	169062	2718	152208
USA	240	18102	2407	102007
Hong Kong	--	--	338	12970
Singapore	136	4864	68	2381
China	1016	33621	67	2302
Other Countries	90	4377	68	2253

Figures rounded off

Table – 12 : Imports of Asbestos (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**406**	**10950**	**534**	**18171**
Poland	270	9744	435	15511
Brazil	--	--	45	1995
Turkey	135	1176	54	597
Japan	--	--	++	68
China	1	30	--	--

Figures rounded off

Table – 13 : Imports of Asbestos Cement Products

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**19306**	**466845**	**20721**	**590388**
Thailand	17629	373669	18816	458621
Germany	2	14552	35	29064
Indonesia	1185	36903	994	24449
USA	24	18133	25	19339
China	202	8747	251	18343
Mexico	119	3924	218	8155
Canada	—	—	144	7183
Poland	—	—	39	5296
UK	—	—	40	5280
Turkey	22	6063	19	5244
Other Countries	123	4854	140	9414

Figures rounded off

Table – 14 : Imports of Asbestos Fibre Products

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2309**	**2750723**	**3353**	**3130952**
Japan	589	1251083	474	1399517
Denmark	667	526425	803	684867
Germany	93	182431	295	228687
China	510	183946	1013	218759
USA	150	198495	150	185401
UK	65	68067	339	84795
Korea	76	110737	57	82633
France	30	32344	73	49001
Czech Republic	11	23847	36	48758
Hungary	3	17392	34	34627
Other Countries	115	155956	79	113907

FUTURE OUTLOOK

Consumption of asbestos minerals in India & other countries of the world will decline steadily in near future due to liability issues associated with asbestos use, leading to the displacement of asbestos from traditional domestic markets by substitutes, alternative materials and technological advancement. While the economic impact of asbestos mining in India is minimal, mining operations do adversely affect human and environmental health. Globally, asbestos- cement products are expected to continue to be the leading market for asbestos. India's imports of chrysotile asbestos too have been showing significant growth.

As per USGS report, Domestic use of unmanufactured asbestos fiber has declined significantly since the 1970s and will likely remain steady or continue to decrease over the long term as alternative materials and (or) new technologies displace it from the chloralkali production process. The trajectory of world production in the coming years will depend on the outcome of the asbestos ban in Brazil and the restart of mining in Zimbabwe. However, significant global demand for asbestos products is expected to continue in several regions of the world, particularly for cement pipe, roofing sheets, and other construction materials in Asia.

3. Bauxite

4,958

(million tonnes) Total reserves/ resources of bauxite were established in the country as on April 2020

22,494

(thousand tonnes) Production of bauxite were reported in 2021-22

378

(thousand tonnes) of bauxite were exported in 2021-22

3,009

(thousand tonnes) of bauxite were imported in 2021-22

Bauxite is basically an aluminous rock that contains hydrated aluminium oxide as main constituent and iron oxide, silica & titania as minor constituents present in varying proportions. Hydrated aluminium oxides present in the bauxite ore are diaspore and boehmite, $Al_2O_3.H_2O$ (Al_2O_3:85%; Al:45%); gibbsite or hydrargillite, $Al_2O_3.3H_2O$ (Al_2O_3: 65.4%; Al:34.6%), and bauxite (containing colloidal alumina hydrogel), $Al_2O_3.2H_2O$ (Al_2O_3:73.9%; Al:39.1%). The iron oxide in bauxite ore is present as haematite or goethite; silica as clay; and free quartz & titania as leucoxene or rutile. Bauxite is the principal ore of aluminium which is one of the most important non-ferrous metals used in the modern industry. It is also an essential ore for Refractory and Chemical industries.

RESERVES/RESOURCES

Reserves/Resources of bauxite in the country as on 1.4.2020, as per NMI database, based on UNFC system have been placed at 4,958 million tonnes. These resources include 646 million tonnes Reserves and 4311 million tonnes. Remaining Resources. The country is endowed with huge quantities metallurgical grade bauxite. By grades, about 79% resources are of Metallurgical grade (I, II & Mixed). The resources of Refractory and Chemical grades are limited and together account for about 4 %. By States, Odisha alone accounts for 41% of country's resources of bauxite followed by Chhattisgarh 20%, Andhra Pradesh (12%), Gujarat (8%), Jharkhand (6%), Maharashtra (5%) and Madhya Pradesh (4%). Major bauxite resources are concentrated in the East Coast bauxite deposits in Odisha and Andhra Pradesh (Table-1).

Table – 1 : Reserves/Resources of Bauxite as on 1.4.2020 (P)

(By Grades/States)

(In '000tonnes)

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**560865**	**15553**	**70076**	**646493**	**268398**	**128409**	**316835**	**526286**	**843058**	**2044653**	**184116**	**4311754**	**4958248**
By Grades													
Chemical	5454	480	706	6639	1936	4819	528	2877	182	5063	-	15405	22044
Refractory	30120	437	11806	42363	5705	8788	46667	6737	184	31999	628	100709	143072
Chemical/Refractory	1301	120	154	1575	6037	3202	793	3378	216	11161	-	24786	26362
Mixed with others													
Metallurgical-1	468244	9495	29788	507527	164431	44265	188496	390814	427586	1410328	19573	2645493	3153020
Metallurgical-2	27772	986	8342	37100	25714	21567	37982	19638	138352	334894	7640	585786	622886
Metallurgical mixed	6443	310	2030	8783	8463	5085	7378	58958	11308	38329	16846	146366	155149
Low Grade	7920	2673	16056	26649	22851	4619	17908	24414	211839	151151	88692	521473	548122
Beneficiable	832	-	-	832	-	756	-	-	34424	4610	39260	79050	79883
Mixed grade Excluding Chem./Refrac.	7503	561	339	8403	22017	12399	7563	6839	4370	13387	-	66576	74979
Abrasive	-	-	-	-	264	740	123	92	56	961	840	3076	3076
Others	3192	-	855	4047	5971	137	8754	11999	5600	9250	1545	43257	47304
Unclassified	2084	491	-	2576	4303	22033	643	535	8940	12093	8954	57500	60076
Not-known	-	-	-	-	706	-	-	5	-	21427	138	22276	22276
By States													
Andhra Pradesh	-	-	-	-	-	-	-	188971	138120	288176	-	615267	615267
Bihar	-	-	-	-	-	-	-	-	-	4114	-	4114	4114
Chhattisgarh	19202	1073	3420	23695	14306	4727	46620	37763	75682	771015	18747	968860	992555
Goa	7963	-	1650	9613	5222	1097	8195	6820	-	36910	-	58244	67857
Gujarat	83448	2005	15777	101230	86746	41434	21913	29145	22107	82774	11678	295797	397027
Jammu & Kashmir	-	-	-	-	-	-	-	1323	182	1220	-	2725	2725
Jharkhand	29524	731	9717	39972	25895	7647	14969	25962	63224	70527	41050	249272	289244
Karnataka	126	194	4887	5207	2468	864	88	82	2220	35520	-	41242	46449
Kerala	-	-	-	-	29	-	24	2037	14637	2722	-	19449	19449

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
Madhya Pradesh	13584	631	4349	18564	20389	13358	7138	22060	54577	50172	-	167695	186259
Maharashtra	18833	3573	16065	38472	15794	1981	21023	38931	32875	83354	-	193958	232430
Meghalaya	-	-	-	-	-	-	-	-	-	4300	-	4300	4300
Odisha	388184	7346	14210	409740	97550	56160	193301	161842	428849	596940	112642	1647284	2057024
Rajasthan	-	-	-	-	-	-	-	-	-	528	-	528	528
Tamil Nadu	-	-	-	-	-	1141	3564	960	10084	8363	-	24112	24112
Uttar Pradesh	-	-	-	-	-	-	-	10390	500	8018	-	18908	18908

Figures rounded off

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION & STOCKS

The production of bauxite at 22,494 thousand tonnes in 2021-22 increased by about 10 % as compared to that of the previous year.

There were 126 reporting mines in 2021-22 as against 134 in the previous year. Besides, produc- tion of bauxite was reported as an associated min- eral by 9 mines during the year. In all, 55 producers reported production of bauxite in 2021-22. Out of these, ten principal producers having 41 mines contributed about 91.40% of the total production.

NALCO is the leading producer of bauxite and contributed 33% of the total production. The share of Public Sector mines was about 49% of the total production in 2021-22, as against 52% in the previous year.

About 80% of the total production of bauxite was of 40-45% Al_2O_3 grade followed by 11% of Cement grade, 6% of 45% to 50% Al_2O_3 grade, 1% by refrac- tory grade and the remaining production was reported in grades (below 40% grade, Abrasive grade & Chemical grade) during the year 2021-22. Odisha emerged as the leading producing State accounting for about 73% of the total production during 2021-22 (Tables -2 to 5).

Table – 2 : Principal Producers of Bauxite, 2021-22

Name & address of producers	Location of mine	
	State	District
National Aluminium Co.Ltd, NALCO Bhawan, Bhubaneswar-751 061, Odisha.	Odisha	Koraput
Utkal Alumina International Ltd, J-6, Jayadev-Vihar,Bhubaneswar-751 013, Odisha.	Odisha	Raygada
Odisha Mining Corporation Ltd. OMC House, Unit-V, Post Box No. 34, Bhubaneswar- 751 001, Odisha .	Odisha	Koraput
Hindalco Industries Ltd, Ahura Centre, Ist Floor, B-Wing, Mahakali Caves Road, Andheri (East), Mumbai-400 093, Maharashtra.	Chhattisgarh Jharkhand Maharashtra	Surguja Gumla Latehar Lohardaga Kolhapur
Mr.Sanjay Kumar Trikamlal Shah 2,Arbudan agar -1 Ratnakar Mata Kapadwanj Kheda - 386720, Gujarat.	Gujarat	Kheda
Gujarat Mineral Development Corporation Ltd, Khanij Bhavan, 132 Feet Ring Road, Near University Ground, Vastrapur, Ahmedabad -380 052, Gujarat.	Gujarat	Devbhoomi-Dwarka Kutch
Minerals & Minerals Ltd, Court Road, Lohardaga-835 302, Jharkhand.	Jharkhand	Lohardaga Gumla
Infrastructue Logistics Pvt. Ltd., 205, 2nd floor, Kamat Metropolis-I,St Inez, Goa North Goa -403004, Goa	Maharashtra	Ratnagiri
Alimiya Imamali Saiyad, FF/16, Samruddhi Complex, Near L.I.C. Office, Himmatnagar, Dist, Sabarkantha-383 001, Gujarat.	Gujarat	Sabarkantha
Smt P. H. Joshi 216, Shivam Complex, Opp. Hetarth party plot, Sola sciemce city Road Gujarat-388225, Ahmedabad	Gujarat	Kheda

Table – 3 : Production of Bauxite, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**21825227**	**16299333**	**20380548**	**16793448**	**22493947**	**24767048**
Chhattisgarh	1565307	1609377	716296	751459	968247	1085795
Gujarat	2076329	1439889	1497716	1198490	2018309	1683681
Jharkhand	1418793	1400830	1497472	1607332	1808725	2334128
Madhya Pradesh	685929	546953	632385	479818	608925	493590
Maharashtra	595562	401196	471068	332108	640345	390285
Odisha	15483307	10901088	15565611	12424241	16449396	18779569

(Quantity in tonnes)

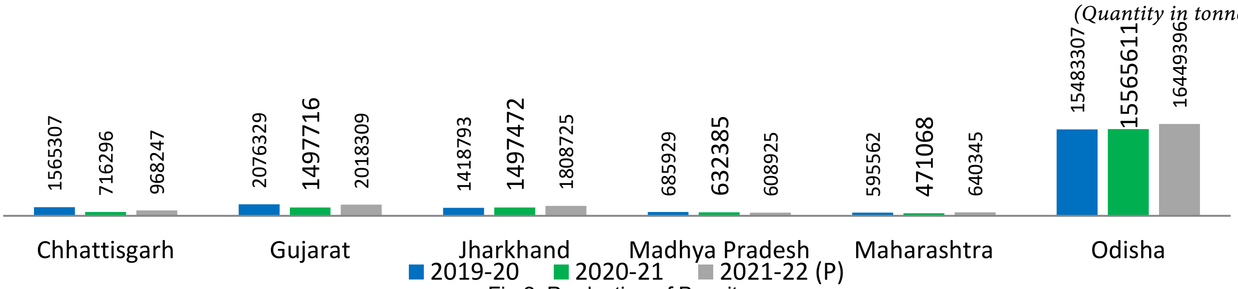


Fig 2: Production of Bauxite

State/District	For use in Alumina & Aluminium extraction : Al2O3 content							For use other than Alumina & Aluminum extraction				Total	
	No. of Mines	60% & above	55– 60%	50–55%	45– 50%	40– 45%	Below 40%	Cement	Abrasive	Refractory	Chemical	Quantity	Value

Table – 4 (A) : Gradewise Production of Bauxite, 2020-21 (P)

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	For use in Alumina & Aluminium extraction : Al2O3 content							For use other than Alumina & Aluminum extraction				Total	
	No. of Mines	60% & above	55– 60%	50–55%	45– 50%	40– 45%	Below 40%	Cement	Abrasive	Refractory	Chemical	Quantity	Value
India	**134(7)**	**-**	**-**	**-**	**877407**	**17056794**	**150114**	**1941472**	**89821**	**130735**	**134205**	**20380548**	**16793448**
Public Sector	20	-	-	-	-	10484896	750	15465	-	60697	113815	10675623	9440515
Private Sector	114(7)	-	-	-	877407	6571898	149364	1926007	89821	70038	20390	9704925	7352933
Chhattisgarh	**14**	**-**	**-**	**-**	**446215**	**270081**	**-**	**-**	**-**	**-**	**-**	**716296**	**751459**
Kabirdham	2	-	-	-	-	575	-	-	-	-	-	575	582
Kondagaon	2*	-	-	-	-	-	-	-	-	-	-	-	-
Surguja	10	-	-	-	446215	269506	-	-	-	-	-	715721	750877
Gujarat	**63**	**-**	**-**	**-**	**-**	**51506**	**750**	**1172536**	**89821**	**69288**	**113815**	**1497716**	**1198490**
Amreli	1	-	-	-	-	-	-	500	-	-	-	500	422
Devbhoomi Dwarka	34	-	-	-	-	51506	-	170578	87877	48211	-	358172	307280
Kheda	10	-	-	-	-	-	-	457090	269	-	-	457359	367809
Kutch	9	-	-	-	-	-	750	-	-	19087	113815	133652	151416
Porbandar	5	-	-	-	-	-	-	257225	1675	1990	-	260890	195283
Sabarkantha	4	-	-	-	-	-	-	287143	-	-	-	287143	176280
Jharkhand	**19**	**-**	**-**	**-**	**392196**	**1055260**	**-**	**-**	**-**	**50016**	**-**	**1497472**	**1607332**
Gumla	13	-	-	-	392196	486185	-	-	-	50016	-	928397	1027353
Lohardaga	6	-	-	-	-	569075	-	-	-	-	-	569075	579979
Madhya Pradesh	**21(7)**	**-**	**-**	**-**	**-**	**68100**	**-**	**532464**	**-**	**11431**	**20390**	**632385**	**479818**
Anuppur	1	-	-	-	-	-	-	44547	-	-	-	44547	31495
Jabalpur	2(1)	-	-	-	-	-	-	106442	-	-	2500	108942	74143
Katni	9(3)	-	-	-	-	-	-	272860	-	-	-	272860	196924
Rewa	1	-	-	-	-	-	-	12255	-	-	-	12255	10417
Satna	3(3)	-	-	-	-	-	-	8995	-	4046	17890	30931	32579
Shahdol	2	-	-	-	-	68100	-	65115	-	-	-	133215	93695
Sidhi	3	-	-	-	-	-	-	22250	-	7385	-	29635	40565

State/District	For use in Alumina & Aluminium extraction : Al2O3 content							For use other than Alumina & Aluminum extraction				Total	
	No. of Mines	60% & above	55– 60%	50–55%	45– 50%	40– 45%	Below 40%	Cement	Abrasive	Refractory	Chemical	Quantity	Value
Maharashtra	**12**	**-**	**-**	**-**	**38996**	**195600**	**-**	**236472**	**-**	**-**	**-**	**471068**	**332108**
Kolhapur	6	-	-	-	38996	195600	-	-	-	-	-	234596	223798
Raigad	3	-	-	-	-	-	-	97894	-	-	-	97894	53156
Ratnagiri	3	-	-	-	-	-	-	138578	-	-	-	138578	55154
Odisha	**5**	**-**	**-**	**-**	**-**	**15416247**	**149364**	**-**	**-**	**-**	**-**	**15565611**	**12424241**
Koraput	3	-	-	-	-	10383785	-	-	-	-	-	10383785	9102691
Raygada	1	-	-	-	-	5032462	149364	-	-	-	-	5181826	3321550
Sundargarh	1*	-	-	-	-	-	-	-	-	-	-	-	-

*Figures in parentheses indicate number of associated mines. * Only labour reported.*

Table – 4 (B) : Gradewise Production of Bauxite, 2021-22 (P)

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	For use in Alumina & Aluminium extraction : Al²O³ content							For use other than Alumina & Aluminum extraction				Total	
	No. of Mines	60% & above	55– 60%	50–55%	45– 50%	40– 45%	Below 40%	Cement	Abrasive	Refractory	Chemical	Quantity	Value
India	**126(9)**	**-**	**-**	**-**	**1377785**	**18042239**	**75187**	**2496196**	**86184**	**263739**	**152617**	**22493947**	**24767048**
Public Sector	19	-	-	-	80589	10590726	-	115960	113	126309	152387	11066084	14876391
Private Sector	107(9)	-	-	-	1297196	7451513	75187	2380236	86071	137430	230	11427863	9890657
Chhattisgarh	**13**	**-**	**-**	**-**	**802000**	**166247**	**-**	**-**	**-**	**-**	**-**	**968247**	**1085795**
Kabirdham	2	-	-	-	-	127	-	-	-	-	-	127	83
Kondagaon	2*	-	-	-	-	-	-	-	-	-	-	-	-
Surguja	9	-	-	-	802000	166120	-	-	-	-	-	968120	1085712
Gujarat	**58**	**-**	**-**	**-**	**80589**	**-**	**-**	**1522811**	**86184**	**176338**	**152387**	**2018309**	**1683681**
Amreli	-	-	-	-	-	-	-	-	-	-	-	-	-
Devbhoomi Dwarka	34	-	-	-	80589	-	-	292986	86184	95201	-	554960	482210
Kheda	9	-	-	-	-	-	-	790176	-	-	-	790176	561814
Kutch	9	-	-	-	-	-	-	-	-	80037	152387	232424	357859
Porbandar	3	-	-	-	-	-	-	181600	-	1100	-	182700	108629

State/District	For use in Alumina & Aluminium extraction : Al^2O^3 content							For use other than Alumina & Aluminum extraction				Total	
	No. of Mines	60% & above	55– 60%	50–55%	45– 50%	40– 45%	Below 40%	Cement	Abrasive	Refractory	Chemical	Quantity	Value
Sabarkantha	3	-	-	-	-	-	-	258049	-	-	-	258049	173169
Jharkhand	**19**	**-**	**-**	**-**	**456196**	**1300383**	**-**	**-**	**-**	**52146**	**-**	**1808725**	**2334128**
Gumla	13	-	-	-	456196	619590	-	-	-	52146	-	1127932	1457176
Lohardaga	6	-	-	-	-	680793	-	-	-	-	-	680793	876952
Madhya Pradesh	**18(9)**	**-**	**-**	**-**	**-**	**-**	**-**	**573440**	**-**	**35255**	**230**	**608925**	**493590**
Anuppur	-	-	-	-	-	-	-	-	-	-	-	-	-
Jabalpur	2(2)	-	-	-	-	-	-	127030	-	-	-	127030	80972
Katni	7(3)	-	-	-	-	-	-	249775	-	-	-	249775	177478
Rewa	1	-	-	-	-	-	-	13620	-	-	-	13620	11348
Satna	3(4)	-	-	-	-	-	-	27140	-	8011	230	35381	47488
Shahdol	2	-	-	-	-	-	-	130743	-	-	-	130743	81803
Sidhi	3	-	-	-	-	-	-	25132	-	27244	-	52376	94501
Maharashtra	**12**	**-**	**-**	**-**	**39000**	**201400**	**-**	**399945**	**-**	**-**	**-**	**640345**	**390285**
Kolhapur	6	-	-	-	39000	201400	-	-	-	-	-	240400	210678
Raigad	3	-	-	-	-	-	-	97880	-	-	-	97880	44046
Ratnagiri	3	-	-	-	-	-	-	302065	-	-	-	302065	135561
Odisha	**6**	**-**	**-**	**-**	**-**	**16374209**	**75187**	**-**	**-**	**-**	**-**	**16449396**	**18779569**
Koraput	4	-	-	-	-	10450506	-	-	-	-	-	10450506	14142591
Raygada	1	-	-	-	-	5923703	75187	-	-	-	-	5998890	4636978
Sundargarh	1*	-	-	-	-	-	-	-	-	-	-	-	-

*Figures in parentheses indicate number of associated mines. * Only labour reported.*

Table – 5 : Production of Bauxite, 2020-21 and 2021-22

(By Frequency Groups)

(Quantity in tonnes)

Production group	No. of mines		Production for the group		Percentage to total production		Cumulative percentage	
	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)
Total	**134(7)**	**126(9)**	**20380548**	**22493947**	**100**	**100**	**-**	**-**
Up to 1000	57(1)	45(1)	4013	2230	0.02	0.01	0.02	0.01
1001 – 3000	5(1)	6(1)	10556	11814	0.05	0.05	0.07	0.06
3001 – 5000	3	3	12290	11308	0.06	0.05	0.13	0.11
5001 – 10000	6	6(1)	42665	54197	0.21	0.24	0.34	0.35
10001 – 25000	16(2)	16(3)	279588	318923	1.37	1.43	1.71	1.78
25001 – 50000	18	15(2)	728459	661668	3.57	2.94	5.28	4.72
50001 and above	29(3)	35(1)	19302977	21433807	94.71	95.28	100	100

Figures in parentheses indicate number of associated mines

Mine- head closing stocks of bauxite in 2021-22 were 17,285 thousand tonnes as compared to 17,116 thousand tonnes in the previous year. About 84% of the total stock was held in Gujarat at the end of the year (Tables- 6 'A' & 6 'B'). The average daily employment of labour in bauxite mines was 5,015 in 2021-22 as against 5,041 in the previous

Table – 6 (A) : Mine-head Closing Stocks of Bauxite, 2020-21

(By States & Grades)

(Quantity in tonnes)

State	For use in Alumina & Aluminium metal Extraction $Al^{2}O^{3}$ Content						For use other than Alumina & Aluminium metal extraction				
	60% & above	55–60%	50–55%	45–50%	40–45%	Below 40%	Cement	Abrasive	Refra-ctory	Chemical	Total
India	**-**	**-**	**-**	**640750**	**2423793**	**215398**	**12862061**	**418588**	**395172**	**159947**	**17115710**
Chhattisgarh	-	-	-	19719	31090	-	-	94	1255	1261	53419
Gujarat	-	-	-	499725	461173	46523	11783532	418494	372010	128741	13710198
Jharkhand	-	-	-	22328	85037	12878	7	-	-	-	120250
Karnataka	-	-	-	-	-	-	9000	-	-	-	9000
Madhya Pradesh	-	-	-	3999	51720	33122	602827	-	21908	29945	743521
Maharashtra	-	-	-	81790	197495	111702	466695	-	-	-	857682
Odisha	-	-	-	13189	1597278	11172	-	-	-	-	1621639

Table – 6 (B) : Mine-head Closing Stocks of Bauxite, 2021-22 (P)

(By States & Grades)

State	For use in Alumina & Aluminium metal Extraction Al2O3 Content						For use other than Alumina & Aluminium metal extraction				
	60% & above	55–60%	50–55%	45–50%	40–45%	Below 40%	Cement	Abrasive	Refra-ctory	Chemical	Total
India	**-**	**-**	**-**	**100444**	**1729610**	**478873**	**13972363**	**507393**	**346032**	**149957**	**17284672**
Chhattisgarh	-	-	-	24563	105930	690	-	95	1255	1261	133794
Gujarat	-	-	-	9171	450174	46501	13108616	507298	319239	118043	14559042
Jharkhand	-	-	-	28798	158097	12858	-	-	-	-	199753
Karnataka	-	-	-	-	-	-	9000	-	-	-	9000
Madhya Pradesh	-	-	-	-	552	297039	465100	-	25538	30653	818882
Maharashtra	-	-	-	24723	125867	111649	389647	-	-	-	651886
Odisha	-	-	-	13189	888990	10136	-	-	-	-	912315

MINING & TRANSPORT

The mining of bauxite is carried out by opencast method. The mines are classified in the following three categories depending upon the level of mechanisation:

(i) Manually operated mines

(ii) Semi-mechanised mines

(iii) Mechanised mines

Manually Operated Mines

Many bauxite mines are small and produce less than 10,000 tpy. The entire work of overburden removal, extraction of bauxite and loading of bauxite on to trucks is carried out manually and the bauxite is transported to respective railway siding or plants by road.

Semi-mechanised Mines

In semi-mechanised mines, mining operations are carried out by jack hammer drilling and normally ANFO mixture is used as an explosive for blasting in mineralised zone as well as in overburden, if required. Loading of mineral on to trucks or dumpers is done by payloaders or manually. Since bauxite occurs as small lenses or pockets or boulders or as segregations in murrum and laterite, it is difficult to mechanise the mining operations

Mechanised Mines

Mechanised mining operations are carried out in a few captive mines of the alumina/aluminium plants. These mines use Rock breakers for loosening the overburden, compressed-air drills for drilling blastholes. Sometimes, compressed- air jack hammer drills are also used for drilling blastholes for secondary blasting of boulders and also for toe drilling in irregular bauxite faces caused due to improper fragmentation of bauxite. The blasted overburden/ore materials are handled and transported separately by using shovels or excavators and trucks/ dumpers. Separate benches are maintained for overburden and ores. The height of benches in ore varies from 1.5 to 7.5 m.Tippers for hauling of OB to the waste dump and bull dozer for leveling the dumped material, bauxite excavation through drilling, blasting and sizing through crusher and loading into the trucks for transportation to plants etc. Computerised mine planning, use of mobile crusher, simultaneous land reclamation, restricting operations to small portions of mining area at a time, etc. have greatly helped in conserving energy and faster land rehabilitation.

CONSUMPTION

In 2021-22, the apparent consumption of Bauxite was about 24.95 million tonnes as against 21.35 million tonnes during preceding year, which has been a increase about 16.90 %. The sources of supply of Bauxite to Alumina plants is given under Table-7.

Table – 7 : Domestic Sources of Supplies of Bauxite to Alumina Plants

Producer	Plant	Source of supply
NALCO	Damanjodi, Koraput (Odisha)	Captive mines at Panchpatmali Hills, Koraput distt. Odisha.
BALCO	Korba (Chhattisgarh)	Captive mines in Surguja & Bodai-Daldali in Kabirdham (Kawardha) distt. Chhattisgarh.
Hindalco Industries	Renukoot (Uttar Pradesh)	Captive mines in Shahdol distt. Madhya Pradesh; Gumla & Lohardaga distts. Jharkhand and Surguja distt. in Chhattisgarh. Also other suppliers include suppliers from Odisha, Madhya Pradesh and Jharkhand; Katni Bauxite Pvt. Ltd, Satna, Laxmidasji Ramji, Katni; and Minerals & Minerals Corp., Gujarat.
	Belagavi (Karnataka), Muri, Ranchi (Jharkhand)	Captive mines in Chandgad & Durgmanwadi, Kolhapur distt. Maharashtra and Lohardaga distt. in Jharkhand. Udgiri, Gudeghar, Kolhapur distt., Maharashtra and Bhoomi Resources Pvt Ltd, Maharashtra.
Utkal Alumina	Odisha	Baphlimali bauxite mine (Odisha)
Vedanta Aluminium	Lanjigarh (Odisha)	Supplier from Gujarat, BALCO, Bagmar Bauxite Indus- tries Pvt Ltd, Chhattisgarh; LDR, M.P. and abroad.

USES & SPECIFICATIONS

Bauxite is primarily used to produce alumina through the Bayer process. Aluminium Industry normally uses bauxite containing minimum 40% Al_2O_3. However, slightly inferior grades with a suitable blend are also used depending upon other characteristics, such as, solubility in caustic soda and absence of silica. The BIS has specified IS:5953-1985(Reaffirmed 2008 & 2014) specifications for metallurgical grade bauxite. Details of the industries are provided in a separate Review 'Aluminium and Alumina'.

In Steel Industry, bauxite is used as a slag corrector in place of fluorite and generally bauxite, containing 45 to 54% Al_2O_3 and 5% SiO_2 (max.) is consumed. Size preference is 25 to 125 mm with a tolerance of 5% (max.) for -25 mm & +100 mm fractions. BIS has prescribed the specifications of bauxite 'IS : 10817-1984 (Reaffirmed in 2020) for Refractory Industry. The IS specifications of bauxite for consumption in Chemical and Petroleum industries are given in 'IS : 3605-1984 (Reaffirmed 2020) Apart from the chemical specifications, the physical requirements are that the material passing through 90-micron IS sieve but retained on 212- micron IS sieve should be 90% maximum; that passing through 300-micron IS sieve shall be 1% by mass maximum; and that passing through 212- micron IS sieve but retained on 300-micron IS sieve should be 10% maximum.

The other specifications laid down by BIS are 'IS:8228-1976 (Reaffirmed 2020)' for bauxite sand and 'IS:8988-1978 (Reaffirmed 2019)' for bauxite powder for foundry washes.

As per Ministry of Mines Notification dated 25th April 2018, the threshold value of bauxite mineral has been classified into the following two categories:

(i) For Aluminous laterite: Al2O3– 20% (min.)

(ii) For Bauxite: Al^2O^3– 30% (min.) and SiO^2 (Total) –7% (max.)

SUBSTITUTION

There is no substitute for bauxite as source for aluminium metal extraction carried out on a large scale. However, calcined clay can be substituted for refractory bauxite but only with reduction in time and stock resistance. Sillimanite, alumina, silicon carbide, magnesite–chromite and carbon–magnesite refractories are the other alternatives for high-alumina material but these would entail higher cost. Silicon carbide and diamonds can substitute for fused aluminium oxide in abrasive use but these would entail again at higher cost. Synthetic mullite is a probable substitute for bauxite-based refractories.

Silicon carbide and alumina–zirconia are costlier substitutes for bauxite-based abrasives. The raw material like alunite, anorthosite, coal wastes and oil shales are other potential sources of alumina. The extraction, however, would require new plants with different technology. These non-bauxitic materials could satisfy the demand for primary metal, refractories, aluminium chemicals and abrasives.

TRADE POLICY

As per the Foreign Trade Policy 2015-2020 and policy on export and import, imports of aluminium ores and concentrates including natural bauxite, calcined and activated bauxite and others are permitted free. There are no policy restrictions on the export of bauxite.

WORLD REVIEW

The world bauxite reserves are estimated at 31 billion tonnes and are located mainly in Guinea (24%), Vietnam (19%), Australia (16%), Brazil (9%), Jamaica (6%) , Indonesia (3%), China,India & Russia (2% each). Countrywise reserves of bauxite are furnished in Table-8.

Table – 8 : World Reserves of Bauxite

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total (rounded off)	**31000000**
Guinea	7400000
Vietnam	5800000
Australia	5100000a
Brazil	2700000
Jamaica	2000000
Indonesia	1000000
China	710000
India*	660000
Russia	500000
Saudi Arabia	180000
Kazakhstan	160000
United States	20000
Other countries	5100000

Source: USGS, Mineral Commodity Summaries, 2023.

(a) For Australia, joint Ore Reserves Committee - compliant reserves were 1.7 billion tons.

** As on 1.4.2020, as per NMI database, based on UNFC system Reserves/Resources of bauxite in India have been placed at 4958 million tonnes.*

The world production of bauxite decreased by 2% to 343 million tonnes in 2021 as compared to 349 million tonnes in preceding year. Australia continued to be the major producer and accounted for about 30% share in the total production, followed by Guinea (26%), China (12%), Brazil (11%), Indonesia & India (6% each) (Table-9).

Table – 9 : World Production of Bauxite 2019 to 2021

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
World: Total (rounded off)	**329600**	**349000**	**342600**
Australia	105544	103627	103266
Brazil	31938	32898	36000e
Chinae	42000	42000	40000
Guinea [(a)]	70173	87766	87439
India*[(b)]	22073	19700e	19700[e]
Indonesia	16593	25860	21500
Jamaica	9022	7616	5937
kazakhstan	4118	4058	4370[e]

Country	2019	2020	2021
Russia	5574	5570	5679
Saudi Arabia	5127	5227	5488
Other countries	17502	14721	13236

Source: BGS World Mineral Production, 2017-2021.

(e) Estimated

(a) No adjustment has been made for moisture content

(b) Years ended 31 March following that stated.

**India's production of bauxite during 2019-20, 2020-21 and 2021-22 was 21.82 million tonnes, 20.38 million tonnes and 22.49 million tonnes, respectively.*

(In '000 tonnes)

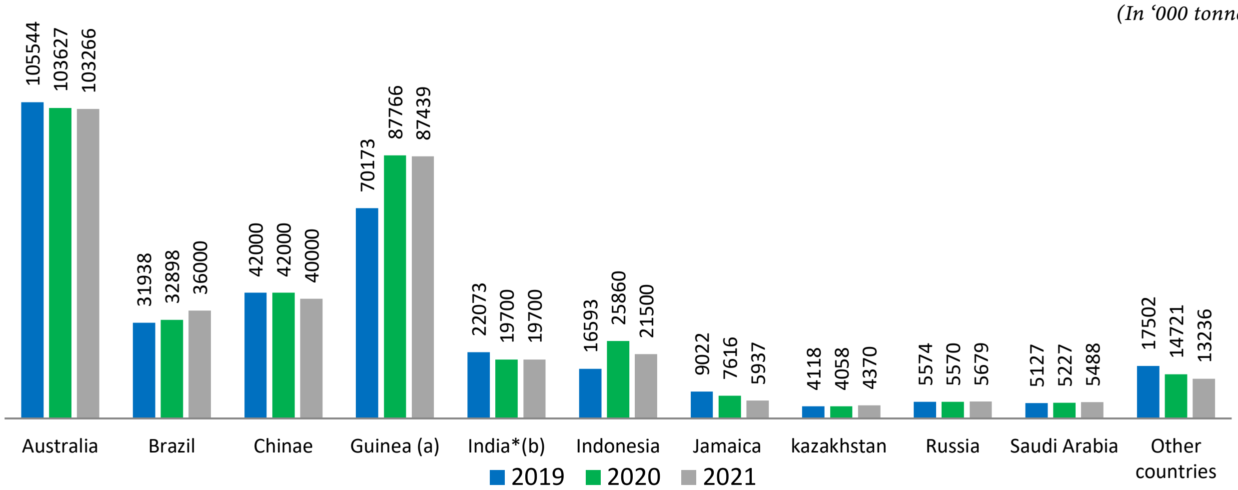


Fig 3: Countrywise Production of Bauxite

To provide generalised view of the development in various countries the country wise description sourced from latest available publication of USGS, Mineral Year Book, 2018 is detailed below:

Australia

The Huntly Mine capacity was 26 Mt/yr and the Willowdale Mine capacity was 10 Mt/yr. The mines and refineries were operated by Alcoa (60%) as part of its joint venture with Alumina Ltd (40%). Rio Tinto plc continued construction of the Amrun Mine in Queensland and made the first shipment of bauxite from the mine.

Brazil

An expansion project, started in 2016, was completed at the Juruti Mine, increasing capacity to 6.5 Mt/yr from 5.7 Mt/yr. The mine was a joint ven ture of Alcoa (60%) and Alumina Ltd. (40%).

Canada

Orbite Technologies Inc. was repairing equipment that failed during trial production from its high-purity alumina refinery in Cap-Chat, Quebec.

China

The increased production in China was attributed to production from new capacity and restarts of capacity at several refineries that had been temporarily shut down to comply with environmental regulations. Alumina capacity at yearend 2018 was estimated to be 83.4 Mt/ yr, a 3% increase from 81 Mt/yr at yearend 2017. Approximately 73.5 Mt/yr of capacity was in use at year end. Although new capacity was added, some startups were delayed until permits were issued and because of limited bauxite supplies at some refineries in the northern part of the country. Many of the new alumina refineries under construction or planned for construction were located in port cities rather than adjacent to inland bauxite deposits. Stricter enforcement of environmental regulations and decreasing quality of bauxite reserves discouraged new refineries in many inland cities while availability of abundant bauxite imports made port locations more attractive.

The Government of China ordered alumina refineries and aluminum smelters in certain regions to shut down 30% of capacity from November 15, 2017, until March 15, 2018. The order to shut down capacity cited environmental concerns about pollution produced by refineries, smelters and power plants during the winter. Refineries and smelters in 31 cities, mainly in the Central and Eastern Provinces, were affected by the order. When the restrictions expired, some of the capacity affected by the policy was restarted. The Government instituted a similar shutdown from October 1, 2018, to March 31, 2019, to reduce pollution during the winter, requiring alumina refineries and aluminum smelters in 26 cities to close 30% of their capacity.

Indonesia

The Government of Indonesia issued export licenses to PT Aneka Tambang Tbk (Antam) and PT Bintan Alumina Indonesia Ltd. (Bintan) so that they could use proceeds of bauxite sales to finance construction of alumina refineries. The permit system was scheduled to end in 2023. Antam completed a bankable feasibility study for a 1-Mt/ yr alumina refinery in Me mpawa h, We st Kalimantan Province, with PT Indonesia Asahan Aluminium Ltd (Inalum). Bintan was a joint venture among Shandong Nanshan Aluminum Co. Ltd (China) (9 4 %) , Re dstone Alumina International Pte. (Australia) (5 %), and PT Makhota Karya Utama (1 %). A construction schedule was not available.

FOREIGN TRADE

Exports

In 2021-22, exports of bauxite increased by 57 % to 378 thousand tonnes from 241 thousand tonnes in the previous year. Exports were mainly to Nepal (53%), Oman (16%), Kuwait & Qatar (13% each) and Slovenia (4%). Exports of bauxite other (aluminium ores & concentrate) increased by 56% to 276 thousand tonnes from 177 thousand tonnes in the previous year. Exports were mainly to Nepal (61%), Oman (22%) and Qatar (17%). Export of bauxite (aluminium & concentrate) also increased by 60% to 102 thousand tonnes during 2021-22 from 64 thousand tonnes in the preceding year. Exports were mainly to Kuwait (50%), Nepal (30%), Slovenia (14%), Saudi Arabia (2%) and France (1%). (Tables-10 to 12).

Table – 10: Exports of Bauxite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**240841**	**951442**	**378081**	**1005256**
Nepal	158165	331823	199669	397096
Slovenia	11407	178458	14754	250302
Kuwait	380	7681	50650	100735
Oman	54703	123786	59539	96788
Qatar	300	8085	47298	62563
Nigeria	75	1844	883	27269
Saudi Arabia	750	6660	1887	16845
France	1191	18222	1049	16153
Australia	714	14989	528	13824
Malaysia	500	10701	270	5608
Other Countries	12656	249193	1554	18073

Figures rounded off

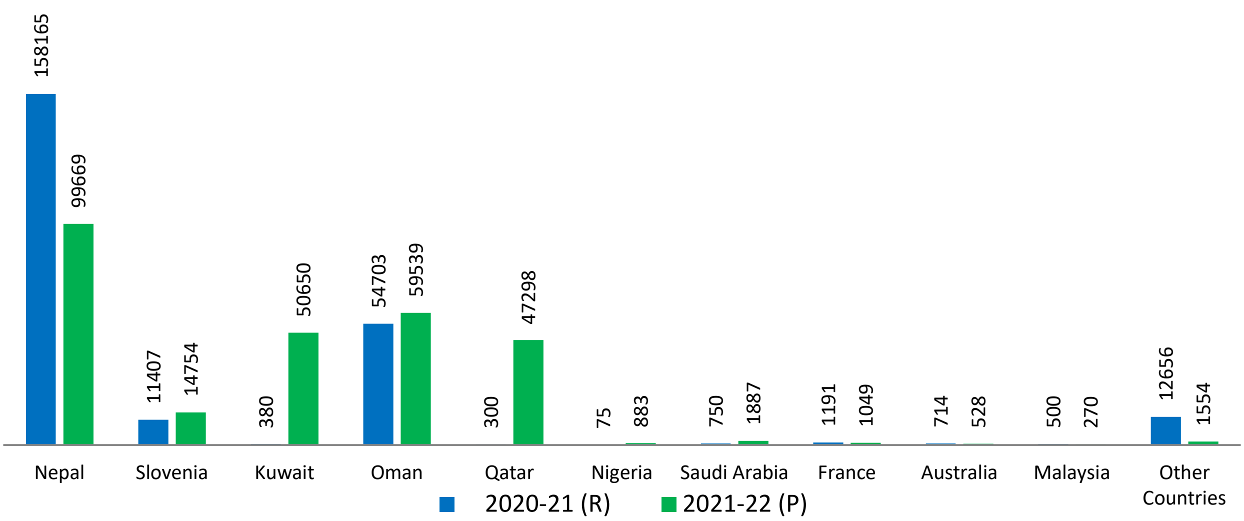


Fig 4: Countrywise Export of Bauxite

Table – 11 : Exports of Bauxite: Other Aluminium Ores & Concentrates

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**176955**	**389007**	**276039**	**506683**
Nepal	122172	264087	168792	340162
Oman	54690	123435	59539	96788
Qatar	--	--	47295	62447
Nigeria	--	--	118	3150
Bangladesh	--	--	151	1993
Saudi Arabia	--	--	100	776
Egypt	--	--	27	665
Netherlands	--	--	1	267
BahOrain	--	--	1	151
U A E	1	28	5	147
Other Countries	12656	249193	1554	18073

Figures rounded off

Table – 12 : Exports of Bauxite: (Aluminium & Concentrates)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**63886**	**562435**	**102042**	**498573**
Slovenia	11407	178458	14754	250302
Kuwait	380	7681	50650	100735
Nepal	35993	67736	30877	56934
Nigeria	75	1844	765	24119
France	1191	18222	1049	6153
Saudi Arabia	750	6660	1787	16069
Australia	714	14989	528	13824
Malaysia	500	10701	270	5608
Italy	1583	36292	208	3344
Korea	3243	11881	820	2786
Other Countries	8050	207971	334	8699

Figures rounded off

Imports

Imports of bauxite slightly decreased by 1 % to 3,009 thousand tonnes during 2021-22 from 3,034 thousand tonnes in the previous year. Imports were mainly from Guinea (95%) and China (3%). Imports of bauxite other (aluminium ores & concentrates) increased by 48% to 492 tonnes during 2021-22 from 333 tonnes in the previous year. Imports were mainly from Turkey (66%), China & Sri Lanka (13% each) and USA (4%). Imports of bauxite (aluminium & concentrates) slightly decreased by 1% to 3,009 thousand tonnes during 2021-22 f rom 3034 thousand tonnes in the preceding year. Imports were mainly from Guinea (95%) and China (3%) (Tables-13 to 15).

Table – 13: Imports of Bauxite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**3034041**	**13709540**	**3009079**	**18963241**
Guinea	2931220	11040863	2857828	15185138
China	86044	2371446	78724	2513910
Guyana	8324	98512	34877	513532

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
Hong Kong	5516	124781	14362	352361
Bolivia	--	--	10000	154300
Trinidad	--	--	8793	129187
Singapore	1175	34591	1075	48924
U S A	245	3806	1952	30680
Netherlands	294	13528	286	14265
U K	221	6073	179	6056
Other Countries	1002	15940	1003	14888

Figures rounded off

Table – 14: Imports of Bauxite:Other Aluminium Ores & Concentrates

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**333**	**8419**	**492**	**17181**
Turkey	160	3424	324	4616
USA	++	126	19	4719
Sri Lanka	--	--	63	3221
China	47	1119	64	1434
Netherlands	8	622	17	1434
UK	5	889	4	1058
Thailand	--	--	1	675
France	--	--	++	22
Ireland	--	--	++	1
Singapore	--	--	++	1
Other Countries	113	2239	--	--

Figures rounded off

Table – 15 : Imports of Bauxite: Aluminium & Concentrates

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**3033708**	**13701121**	**3008587**	**18946060**
Guinea	2931220	11040863	2857828	15185138
China	85997	2370327	78660	2512476
Guyana	8324	98512	34877	513532
Hong Kong	5516	124781	14362	352361
Bolivia	--	--	10000	154300
Trinidad	--	--	8793	129187
Singapore	1175	34591	1075	48923
U S A	245	3680	1933	25961
Netherlands	286	12906	269	12831
U K	216	5184	175	4998
Other Countries	729	10277	615	6353

Figures rounded off

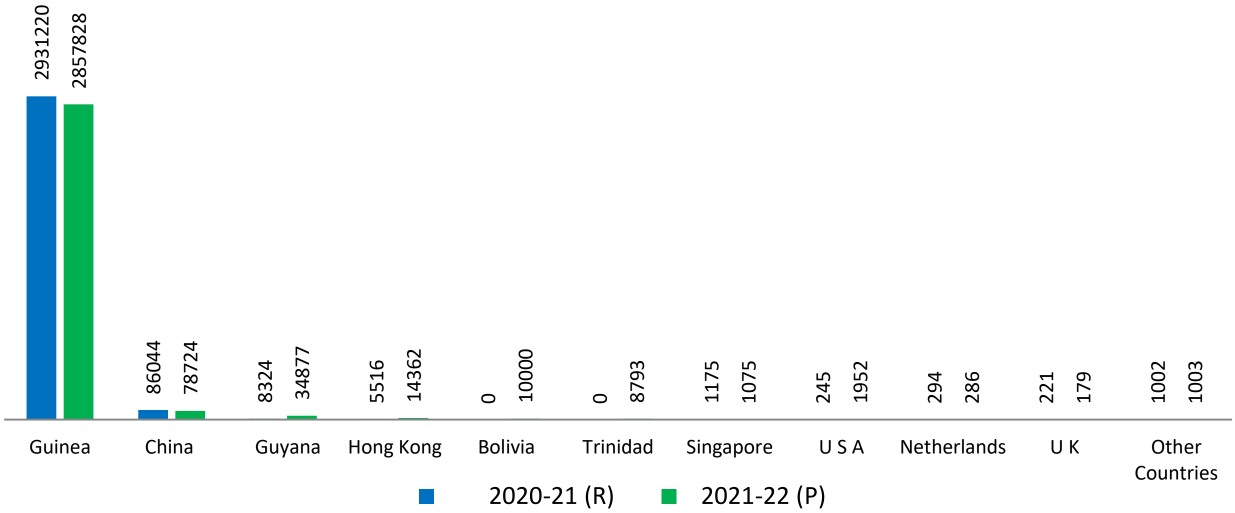


Fig 5: Countrywise Import of Bauxite

FUTURE OUTLOOK

The total resources of bauxite that comprise various grades, as found to occur in the country as on 1.4.2020, are estimated at 4,958 million tonnes. The resources of Metallurgical grade bauxite are adequate while those of the Chemical and Refractory grade bauxite are relatively limited considering the future requirements.India's strength in aluminium is production is due to its rich reserve of bauxite, a core resources used in production of aluminium. As per provision made in Mineral (Auction) Rule 2015, a total of 32 bauxite blocks (including blocks of Bauxite and other associated minerals) were auctioned till 22nd Sept. 2023 in the State of Maharashtra (8 blocks) and Madhya Pradesh (8 block), Gujarat (07 blocks), Chhatisgarh (05 blocks), Odisha (03 blocks) and Jharkhand (01 block).

As per the FITCH Report, the production of bauxite is estimated to grow to 50.7 million tonnes by 2027. Aluminium Industry is one of the leading segments of the Indian economy and is expected to play a significant role in the country's future growth. Apart from its potentially large growing market, India is endowed with large deposits of high-quality bauxite ore, resources for power generation (coal) and formidable pool of manpower – both skilled and unskilled. Indian Aluminium Industry is forging ahead with rapid expansion in both primary metal and downstream sectors.

The demand for aluminium is expected to move upward with shifting demand of consumers towards electric vehicles. Also, the recyclable nature of the metal puts up with goal of reducing carbon emission of many countries. The demand for aluminium will be supported from sectors like aviation, construction, renewable energy production, consumer goods, defence etc.

4. Boron Minerals

74,204
(tonnes) Total reserves/resources of borax were estimated as on 1st April 2020

2,23,368
(tonnes) of borax were imported in 2021-22

4,725
(tonnes) of borax were exported in 2021-22

Boron minerals occur mostly as borates which are deposited from volcanic gases or hot springs near volcanic activities. The deposits, predominantly of borax and sassolite are formed as a result of drying up of shallow saline and alkaline tertiary lakes called 'Playa'. The principal boron minerals are borax-hydrated sodium borate ($Na_2O.2B_2O_3.10H_2O$), kernite (rasorite)-hydrated sodium borate ($Na_2O._2B_2O_3.4H_2O$), colemanite-hydrated calcium borate ($Ca_2B_6O_{11}.5H_2O$) and ulexite-hydrated sodium calcium borate ($NaCaB_5O_9.8H_2O$). Besides, the above four boron minerals of commercial importance, two minerals, viz., sassolite (H_3BO_3)–the natural boric acid and boracite ($Mg_3B_7O_{13}Cl$) are less important.

Borax is, presently, not produced in India. However, it was obtained since ancient times from the lakes in Jammu & Kashmir in India. The domestic requirements of boron minerals are met solely through imports of crude borate which is refined in the country for producing borax and boric acid.

RESERVES/RESOURCES

Economically viable deposits of borax have not been established in the country so far. The only deposit of little economic significance is reported from Puga Valley in Leh district, Jammu & Kashmir. As per NMI data, based on UNFC system, the total reserves/resources of borax as on 1.4.2020, has been estimated at 74,204 tonnes in Jammu & Kashmir. All resources are of Reconnaissance category viz., UNFC Code 334. Occurrences are also reported from Surendranagar district, Gujarat and Jaipur district, Rajasthan (Table-1).

Table – 1 : Reserves/Resources of Borax as on 1.4.2020 (P)

(By Grades/States)

(In tonnes)

Grade/State	Reserves	Remaining Resources						Total
	Total	Pre-feasibility	Measured	Indicated	Inferred	Reconnaissance	Total	Resources
	(A)	STD221	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**-**	**-**	**-**	**-**	**-**	**74204**	**74204**	**74204**
By Grades								
Unclassified	-	-	-	-	-	74204	74204	74204
By States								
Jammu & Kashmir	-	-	-	-	-	74204	74204	74204

Figures rounded off.

USES

Glass and porcelain industries are the major consumers of borax and boric acid. It is an essential component of heat-resisting boro-silicate glass, glass fibres and industrial & optical glass. In glass, enamels and ceramics, it controls thermal expansion, improves durability, assists melting processes and adds to inorganic colours and decorations

Borax is used in medicine (boric powder), leather processing, adhesive, corrosion inhibition, ferrous wire manufacture, flame-proofing and timber preservation.

Borax is used as a flux in brazing, welding, soldering and in the manufacture of artificial gems like, cubic boron nitride, (commercially called 'Borazon') which is equal to diamond in hardness and boron carbide, titanium boride and tungsten boride which are next to diamond in hardness.

Its easy solubility and property to soften hard water find applications in soaps, cleaners & detergents and for water treatment. Its mild alkalinity and germicidal nature, enable its use in manufacturing toothpastes and mouth washes. Borax is used as an antiseptic and emulsifying agent in Cosmetics Industry. As a decolourising agent, it is used in Vanaspati Industry. In Textile Industry, borax is used as a decolourising agent as well as for maintaining the alkalinity of solutions used for producing rayons. It prevents mould formation in citrus fruits. In agriculture, borax is used as an essential plant nutrient.

Boron compounds are used for fertilizers, algicides, herbicides and insecticides. Borax and boric acid are used in fire-retardant treatment and as food grain preservative, respectively.

Borate ester is used as dehydrating agent, special solvent and catalyst in Chemical Industry. In nuclear reactor, boron acts as neutron absorber. " Boron neutron capture therapy", a form of radiochemotherapy, is becoming increasingly important for treatment of certain forms of cancers and boron neutron capture synovectomy for treatment of arthritis.

Borates are consumed mainly in glass fibre for insulations and textile-grade fibre. They are also used as anti-knock agents in gasoline. Diborane (gas), pentaborane (liquid) and decaborane (solid) are potential jet and rocket engine fuels. Boron hydride also has potential value as rocket fuel. The high energy fuel value imparted by the addition of boron compounds has given considerable strategic significance to borates. Another use of borates is the invention of oxgano-sodium borate (liquibor) for use in hydraulic brake fluids.

Boron is an essential plant nutrient and boron compounds, such as, borax and boric acid are used as fertilizers in agriculture, although they are only required in small amounts, with excess being toxic.

SUBSTITUTES

Substitutes in applications, such as, soaps, detergents, enamels and insulations are available. In detergents, boron compounds can be replaced with chlorine and enzymes. Lithium compounds can be used to make enamels and glass products. Insulation substitutes include cellulose, foams and mineral wools. Substitution of borosilicate glass by plastic materials may reduce the use of boron.

Sodium percarbonate can replace borates in detergents and requires lower temperatures to undergo hydrolysis, which is an environmental consideration. Some enamels can use other glass- producing substances, such as, phosphates. In soaps, sodium and potassium salts of fatty acids can act as cleaning and emulsifying agents.

TECHNICAL POSSIBILITIES

A proprietary process called ' Hydrogen on Demand' has been developed using water and sodium borohydride. Hydrogen from the system can be used in fuel cells or internal combustion engines. A longer-life battery based on boron has also been designed. Synthetic diamond containing about 3% boron which is normally a semiconductor becomes superconductor at 4 K. Boron-doped diamond, thus, has numerous possible applications as it can carry electricity without resistance.

Improvements made in evaporating brine solutions are widening the choice of source. Production of boric acid through solution mining of colemanite is a possibility.

ENVIRONMENTAL CONCERNS

Natural borates are not very toxic to animals but can be toxic to plants though low levels of boron are essential for plant life. Boron- hydrogen compounds known as boranes which do not occur in nature are highly toxic and have posed problems in some industrial applications. Environmental concerns have hastened substitution in soaps and detergents. In Europe, borates continue to be listed under hazardous substances and the risk evaluated for their safety under conditions of normal handling and use related to classification and labelling already exists. The US Food and Nutrition Board announced that the essentiality data on boron was adequate to establish a daily tolerable Upper Intake Level for an adult at 20 mg boron.

INDUSTRY

In borax manufacturing process, crude sodium borate is dissolved in water, charged, oxidised, crystallised and centrifuged. Centrifuged material is then dried to get borax decahydrate.

Crude calcium borate lumps are crushed and wet-ground with mother liquor to make slurry. This slurry is decomposed with sulphuric acid to give calcium sulphate and boric acid. Boric acid is separated by filtration, purified, cooled and centrifuged to produce boric acid granules which are powdered as per demand.

Borax Morarji Ltd, Ambernath, Thane district, Maharashtra, is engaged in refining of imported crude borates to produce borax and boric acid. The annual production capacity for all grades of borax and boric acid are 24,000 MT at Dahej, GIDC in the State of Gujarat. Apart from two other producers, National Peroxide Limited (NPL) located at Kalyan district, Maharashtra, is the largest producer of Hydrogen Peroxide in the country.

During the year, the Company completed the expansion of its plant situated at Kalyan which resulted in an increase in the plant rated capacity from 95,000 MT per annum to 1,50,000 MT per annum based on 50% (w/w) Hydrogen Peroxide levels.

NPL is a pioneer in Hydrogen Peroxide Industry in India and has been at the forefront in development of technology, brand image and market share in the country. Indo Borax and Chemical Limited operates borax and boric acid plants at Pithampur, Madhya Pradesh.

Ferroboron is a boron ferroalloy containing 0.2% to 24% boron used primarily to introduce small quantities of boron into speciality steels.

WORLD REVIEW

The world reserves of boron in terms of boric oxide are furnished in Table-2.

Turkey was the leading producer of borates followed by USA, Kazakhstan, Chile, China and Bolivia (Table-3).

Table – 2 : World Reserves of Boron

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World:Total[1]	xx
Turkey, refined borates	1200000
Russia, datolite ore	40000
USA	40000
Chile, ulexite	35000
China, boric oxide equivalent	21000
Peru, crude borates	4000
Argentina, crude ore	NA
Bolivia, ulexite	NA
Germany, compounds	NA

Source: USGS, Mineral Commodity Summaries, 2023.

1: Wold total could not be calculated because reserves are not reported in a consistent manner by all countries.
xx:Not applicable

Table – 3 : World Production of Borates

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
Turkey	8555690	2819111	4057299
USA[a]	1300000	1300000	1300000
Kazakhstan	500000	500000	500000
China[b]	250000	380000	380000
Chile	352255	288103	363032
Bolivia	214500*	258143	312906
Peru	111108	43645	246362
Argentina	181818	134604	130000
Russia*	80000	80000	80000
Iran[c]	2519	1300	1300

Source: BGS, World Mineral Production, 2017-21,

a: Soblor used by producers, b: B_2O_3 equivalent.

**: Estimate, a: Sold or used by producers, b:B_2O_3 equivalent, c: Years ended 20 March following that stated.*

(b) Years ended 31 March following that stated.

To provide a generalised view of the development in various countries, the contrywise description sourced from latest available publication of Minerals Yearbook 'USGS' 2018 has been furnished as below

Turkey

The first known instances of borate mining in Turkey date to Roman times, with borate mining continuing to this day. Approximately 73% of the world's boron reserves are in Turkey, with the Kirka deposit at Eskisehir reported to be the largest tincal deposit in the world. The main borate producing areas of Turkey, all controlled by the state-owned mining company Eti Maden AS, were Bigadic (colemanite and ulexite), Emet (colemanite), Kestelek (colemanite, probertite, and ulexite), and Kirka (tincal). Eti Maden opened warehouses and logistic centers with a company based in Hong Kong to distribute their products from a location closer to the majority of their customer base. Production of refined borates was expected to increase over the coming years owing to investment in new refineries and technologies. Eti Maden continued to invest in the production of boron carbide, boron nitride, and ferroboron owing to their importance in many industries, including the electronics, iron and steel industries. In 2018, Eti Maden and China's Dalian Jinma Boron Technology Group Co., Ltd signed a Memorandum of Understanding to build a boron carbide processing facility in Balikesir. Although this facility will process mostly boron carbide, boron nitride and ferroboron were also projected to be processed. As a result of boron carbide's numerous uses in the defense industry, it was expected to become a significant export for Turkey.

Argentina

Argentina was estimated to be the second-ranked producer of boron minerals in South America in 2018. Borate deposits are located primarily in the Puna region, which includes the northwestern tip of Argentina, the southeastern corner of Peru, the southwestern corner of Bolivia, and the northeastern border of Chile. The principal markets for borates produced in Argentina were throughout South America Borax Argentina S.A. (a subsidiary of Orocobre Ltd.), the country's leading producer of borates, operated the Tincalayu and Sijes Mines, the largest open pit operations in the country, which are 4,100 m (13,500 feet) and 4,540 m (14,900 feet) above sea level, respectively. Record-high production was reported at Borax Argentina's boric acid plant and Tincalayu open pit operation. Tincalayu deposits consisted primarily of borax, with rare occurrences of ulexite and 15 other borates with a reported production of 36,553 tonnes in 2018. Orocobre was reviewing an expansion study for their Tincalayu operation. The expansion could possibly increase Tincalayu's refined-borate-processing capacity from 30,000 metric tonnes per year (tonnes/year) to approximately 120,000 tonnes/year of borax dehydrated equivalent. The expansion review also includes a boric acid plant with a capacity of 40,000 tonnes/year. A project to build a gas pipeline to supply the expanded plant was approved in early 2018. Minera Santa Rita S.R.L.(MSR) operated mines in Catamarca, Jujuy, and Salta Provinces and operated a processing plant in Campo Quijano, which produced granular deca- and pentahydrate borax, technical-grade boric acid powder, and various grades and sizes of natural boron minerals. MSR exported the majority of its mined borates to 28 countries through the Port of Buenos Aires and by land to Brazil.

Chile

Chile was the leading borate compound producer in South America with boric acid production estimated to be 100,000 tonnes and ulexite production estimated to be 600,000 tonnes in 2018. The largest ulexite deposit in the world, Salar de Suirire, was operated by Quiborax SA, a Government entity with reserves estimated to be 1.5 million metric tonnes (Mt). Almost all the material mined at this location was exported in 2018. Quiborax operations have a boric acid production capacity of 36,000 tonnes/year, in addition to 100,000 tonnes/year capacity of borate derived agrochemical products. In May 2018, the 14-year-long dispute between the Bolivian Government and Quiborax came to an end with a ruling in favor of Quiborax. The Bolivian Government must nowpay Quiborax $ 48.6 million for the land seized in 2004 that was used for the company's ulexite mining and revoked mining concessions.

China

China has low-grade boron resources. More than 100 borate deposits occur in 14 Provinces in China. The northeastern Province of Liaoning and the western Province of Qinghai accounted for more than 80% of the resources, mostly in the form of sassolite and tincal. China's boron resources average about 8% B_2O_3 in comparison with reserves from Turkey and the United States, which average from 26% to 31% and 25% to 32% B_2O_3,respectively.

Serbia

Erin Ventures Inc. (Canada) entered into a strategic partnership with a London-based commodity investment company, acquiring funds needed to continue development of the Piskanja Borate Project. Piskanja is a mining region in Serbia approximately 250 km (155 miles) south of Belgrade. The deposit is primarily composed of colemanite and ulexite with estimated reserves of 11.8 Million tonnes. Rio Tinto continued a prefeasibility study in Jadar Valley, in 2018. The deposit contains both boron and lithium ore. Rio Tinto was planning to conduct assessments that will consider the socioeconomic effects of constructing a mine and processing facility on the local communities, in conjunction with environmental assessments.

FOREIGN TRADE

Exports

Exports of borax (total) increased considerably by 57% to 4725 tonnes in 2021-22 from 2,996 tonnes in the previous year. Exports of natural borate in 2021-22 decreased substantially to 44 tonnes from 55 tonnes in the previous year. In 2021-22, exports of sodium borate were at 1,534 tonnes and other borates at 3,147 tonnes. Exports of Borax (total) were mainly to USA (37%), Italy (12%) and Nepal (8%). Exports of boric acid decreased by 29% to 1384 tonnes in 2021-22 from 1,952 tonnes in the previous year. Exports of boric acid were mainly to Nigeria (23%), Nepal (12%) and USA(5%) (Tables- 4 to 9).

Table – 4 : Exports of Boron

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**5**	**525**	**++**	**6093**
USA	++	117	++	5749
Australia	-	-	++	265
Austria	-	-	++	48
Korea, Rep. of	-	-	++	27
Nigeria	-	-	++	4
Turkey	-	-	++	++
Nepal	5	198	-	-
Sudan	++	131	-	-
UK	++	51	-	-
France	++	20	-	-
Other Countries	++	8	-	-

Figures rounded off

Table – 5 : Exports of Borax

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2996**	**414601**	**4725**	**656472**
USA	1391	263087	1775	364542
Italy	304	36116	607	86073
Poland	140	17212	209	32208
Bangladesh	74	15598	255	27515
Nepal	187	9063	404	24618
Spain	-	-	140	20941
Malaysia	75	3524	360	14730
UAE	81	7070	127	12382
Australia	44	5355	144	12347
Saudi Arabia	58	4009	202	10209
Other Countries	642	53567	502	50907

Figures rounded off

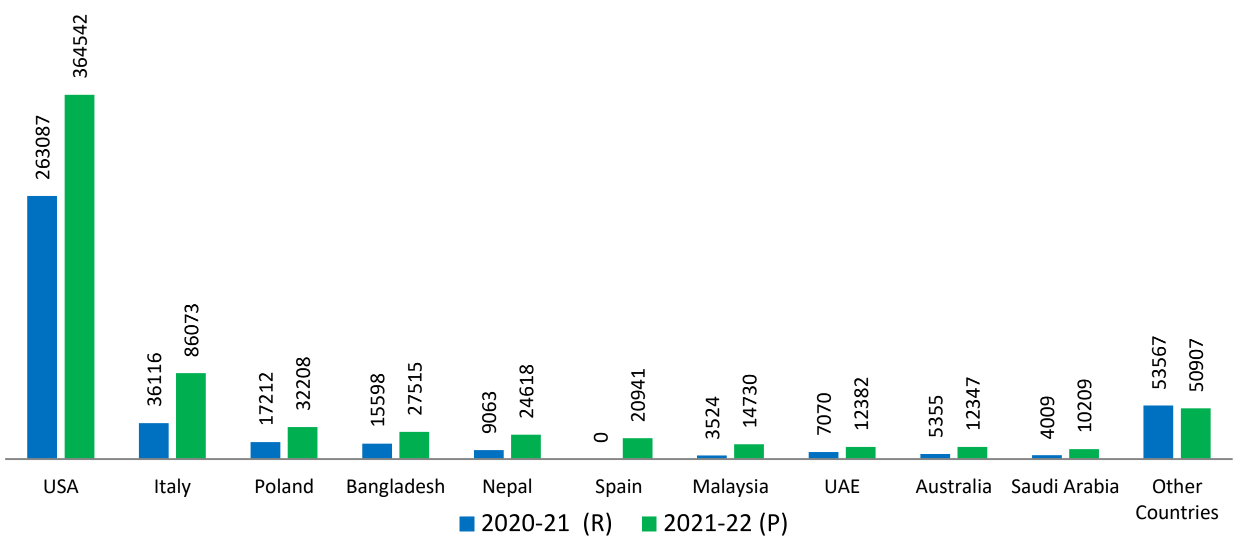


Fig 1: Countrywise Value of Export of Borax

Table – 6 : Exports of Natural Borate

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**55**	**5633**	**44**	**3489**
Nepal	-	-	40	3210
Kuwait	12	753	4	143
U S A	-	-	++	71
Bangladesh	-	-	++	61
UAE	2	360	++	4
Oman	27	2417	-	-
Saudi Arabia	14	2073	-	-
Zambia	++	18	-	-
Nigeria	++	12	-	-

Figures rounded off

Table – 7 : Exports of Sodium Borate

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**741**	**56265**	**1534**	**104106**
U S A	25	21815	38	22962
Nepal	151	6519	294	16839
Malaysia	75	3509	360	14590
Australia	24	1310	144	12325
Saudi Arabia	44	1936	200	9738
Bangladesh	++	149	113	5863
Thailand	-	-	80	4600
UAE	49	1806	81	3651
Myanmar	88	4016	72	3426
Jordan	22	974	59	3325
Other Countries	263	14231	93	6787

Figures rounded off

Table – 8 : Exports of Borax: Other Borates

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2200**	**352703**	**3147**	**548877**
U S A	1366	241272	1737	341509
Italy	304	36116	607	86073
Poland	140	17212	209	32208
Bangladesh	74	15449	142	21591
Spain	-	-	140	20941
UAE	30	4904	46	8727
Oman	37	6904	26	6425
Nepal	36	2544	70	4569
Sri Lanka	22	3319	26	4372
South Africa	33	8130	20	3323
Other Countries	158	16853	124	19139

Figures rounded off

Table – 9 : Exports of Boric Acid

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1952**	**160749**	**1384**	**176162**
Nigeria	326	27384	319	37474
USA	50	9815	83	18999
Nepal	137	10942	162	18122
Ethiopia	19	2090	74	9286
Kenya	26	3054	70	9018
Bangladesh	16	2768	97	8695
Angola	23	2495	51	6255
Uganda	95	9335	43	5499
Congo D.Rep.	36	3533	39	5318
Tanzania Rep	28	2983	36	4782
Other countries	1196	86350	410	52714

Figures rounded off

Imports

Imports of borax (total) increased slightly by 15% to 223368 tonnes in 2021-22 from 194448 tonnes in the previous year. Imports of natural borate also increased by 21% to 101337 tonnes as compared to 83207 tonnes in the previous year. In 2021-22, imports of sodium borate were at 111210 tonnes and other borates 10821 tonnes. Borax (total) was mainlyimported from Turkey (60%), USA (21%), Bolivia (10%), Spain (3%) and China (4%). Imports of boric acid increased to 7412 tonnes in 2021-22 from 6897 tonnes in the previous year. Boric acid was imported mainly from Turkey (61%), Singapore (37%) and China (9%). Import of boron was negligible in both current and the previous year (Tables-10 to 15).

Table – 10 : Imports of Borax

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**194448**	**6337254**	**223368**	**7973967**
Turkey	111804	3426889	134629	4710621
USA	41604	1520214	47329	1769785
Bolivia	15020	235104	22450	423447
Spain	10461	417300	7293	305636
China	1348	158480	1041	127636
Malaysia	7467	252633	3348	123319
Argentina	3628	105296	2834	105537
Singapore	1898	71848	1697	90054
Peru	280	21552	952	79257
UK	220	45089	227	79096
Other countries	718	82849	1568	159579

Figures rounded off

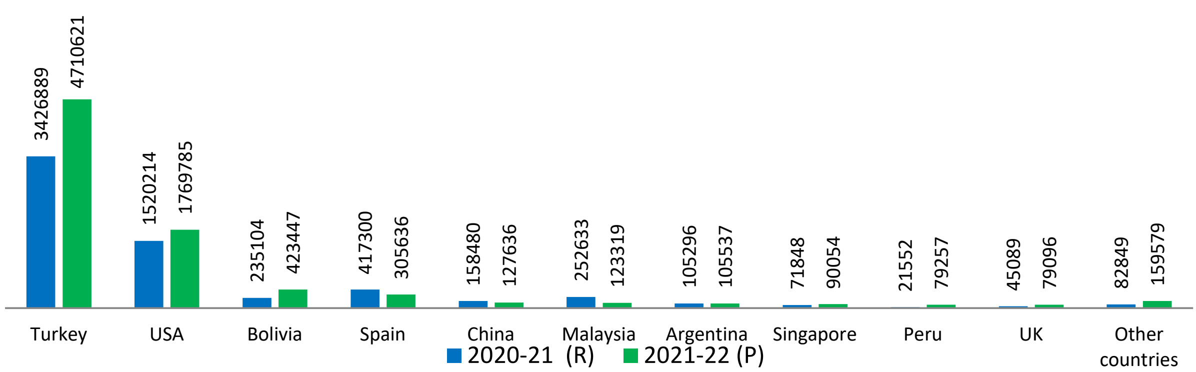


Fig 2: Countrywise Value of Import of Borax

Table – 11 : Imports of Natural Borate

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**83207**	**2113660**	**101337**	**2910832**
Turkey	54464	1379528	69190	2110887
Bolivia	15020	235104	22450	423447
Spain	10443	411949	7277	300454
Argentina	3280	87005	2356	73037
U S A	-	-	16	1491
Montenegro	-	-	22	752
Chile	-	-	26	739
Japan	++	74	++	25

Figures rounded off

Table – 12 : Imports of Borax: Sodium Borates

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**101477**	**3557620**	**111210**	**4188993**
Turkey	52927	1823516	60679	2284456
U S A	39794	1412759	45699	1659784
Malaysia	7392	249124	3348	123319
Netherlands	119	15073	551	41462
China	100	8445	300	28426
Peru	84	6442	224	18944
UAE	15	1271	100	10515
Singapore	719	25498	134	8906
Argentina	216	6727	162	6688
Germany	2	4132	1	4703
Other Countries	109	4633	12	1790

Figures rounded off

Table – 13 : Imports of Borax: Other Borates

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**9764**	**665974**	**10821**	**874142**
Turkey	4413	223845	4760	315278
U S A	1810	107455	1614	108510
China	1248	150035	741	99210
Singapore	1179	46350	1563	81148
U K	120	41847	227	79096
Peru	196	15110	728	60313
Slovenia	109	9186	356	31902
Argentina	132	11564	316	25812
Italy	23	4320	223	23809
Austria	262	23733	143	13923
Other Countries	272	32529	150	35141

Figures rounded off

Table – 14 : Imports of Boric Acid

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**6897**	**313194**	**7412**	**378403**
Turkey	5581	251826	4557	228450
Singapore	1028	45874	2747	142600
China	40	2909	69	4941
USA	98	4924	39	1804
France	++	4	++	390
Germany	++	788	++	218
Peru	150	6814	-	-
Japan	++	50	-	-
Malaysia	++	3	-	-
UK	++	2	-	-
Other Countries	272	32529	150	35141

Figures rounded off

Table – 15 : Imports of Boron

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**1899**	**++**	**2818**
USA	++	124	++	1449
Germany	++	158	++	997
China	++	591	++	340
UK	++	45	++	30
Belgium	++	131	++	2
Hong Kong	++	850	-	-

Figures rounded off

FUTURE OUTLOOK

Consumption of borates is expected to increase, spurred by strong demand in agriculture, ceramic and glass markets in Asia and South America. Continued investment in new refines and technologies and the continued increase in demand were expected to fuel growth in world production for the foreseeable future. In 2013, the European Union (EU) added borates to the Registration, Evaluation, Authorisation and Restrictions of Chemicals (REACH) Restricted Substances List, following an EU study that determined continuous exposure to humans may be harmful. The ruling required detergent makers to decrease their use of boron (Lismore, 2012). Consumption of boron based fertilizers is expected to increase as the demand for food and biofuel cropsis on the rise. Higher crop prices have enabled farmers to invest in advanced farming techniques and higher grade fertilizers.

Consumption of boron nitride is expected to increase owing to the development of high-volume production techniques coupled with the creation of new technologies requiring boron nitride. The properties intrinsic to cubic boron nitride, such as, hardness (second only to diamond), high thermal conductivity, and oxidation resistance, make it an ideal material for a variety of emerging applications. Hexagonal boron nitride is used in producing ceramics, creating intermetallic composites, imparting thermal shock resistance, improving machinability and reducing friction

5. Cement

537
(million tonnes) Total installed capacity of cement plants were reported in 2020-21

0000
(million tonnes) Productionof cement were reported in 2021-22

0,000
(million tonnes) Production of cement were reported in 2021-22

0,000
(million tonnes) of cement were imported in 2021-22

The Cement Industry in India is among the eight core Industries that is vital for economic growth and development. Ever since the Industry was delicensed in 1991, there has been remarkable growth that metamorphosed it to a globally competitive market, making India the second largest producer of cement after China in the world.Cement is the basic building material and is used extensively in housing, industrial sector and infrastructure development. It has become synonymous with construction activi ty and the per capita consumption of cement is accepted as an important indicator of the country's economic growth.

In terms of quality, technology, productivity and efficiency, India compares well with the best in the world. The demand for cement is closely linked to the overall economic growth, particularly the housing and infrastructure sector. The recent government thrust on housing and infrastructure development augurs well for the industry. However, the per capita consumption of cement in India still remains substantially low at about 195 kg when compared with the developed world or world average which stands at about 500 kg. The Indian Cement Industry plays a key role in the national economy, not only by generating substantial re venue fo r State and Centr al Governments but also as a key industry that generates maximum employment directly or indirectly. India has a lot of potential for development in the Infrastructure and Construction Sector and the Cement Sector is poised for a positive growth in the da ys ahea d. Some of the rec ent maj or government initiatives, such as, Housing for all, concrete Highways, Dedicated fright corridors, clean India Mission, ultra Mega power Projects, waterways, development of smart cities are expected to provide a major boost to the sector.

The Department of Industrial Policy and Promotion (DIPP), Ministry of Commerce, Govt. of India publishes data on production and capacity of cement in its Annual Report. As per Annual Report 2021-22, the total installed capacity of cement plants has been placed at 537 million tonnes among which there are about 240 large cement plant and more than350 mini cement plants. During 2021-22, the production of cement was 360.19 million tonnes which showed an increase of 20% as compared to the year 2020-21 which reported a production of 299.94 million tonnes.

Three cement plants, having a total capacity of

1.338 mtpa white cement. Most of these capacities are modern and based on the energy-efficient dry processing technology.

There are as many as 175 plants with over a million tonnes or more capacity. In the Public Sector, however, there is only one Central Public Sector Undertaking i.e., CCI which had 10 units, spread over eight States/Union Territories. Out of these, only three plants, namely, Bokajan, Rajban and Tandur units are operational, the remaining cement plants have shut operations for more than a decade now. There are five large cement plants owned by various State Government Undertakings like Tamil Nadu Cement, Malabar Cements, J&K Ltd and Mawmluh- Cherra Cement Ltd, Shillong, Meghalaya.The company- wise annual installed capacity and production of cement plants during the year 2020-21 in the country is furnished in Table-1. Capacity and production of Cement plants are reflected in Table-2.

Table 1: Company-wise Installed Capacities and Production of Cement Plants, 2020-21

(In million tonnes)

Company/ Plant Name	Capacity	Production
ACC Ltd		
Bargarh, Bargarh, Odisha	2.5	-
Chaibasa, Singhbhum, Jharkhand	1.2	0.95
Chanda, Chandrapur, Maharashtra	3.8	2.63
Damodar (G), Purulia, West Bengal	0.7	0.62
Gagal-I & II, Bilaspur, Himachal Pradesh	4.4	2.94
Jamul, Durg, Chhattisgarh	3	2.27
Kudithini (G), Ballari, Karnataka	3	1.1
Kymore, Katni, Madhya Pradesh	2.72	-
Lakheri, Bundi, Rajasthan	1.5	2.02
Madukkarai, Coimbatore, Tamil Nadu	1	-
Sindri (G), Dhanbad, Jharkhand	3	0.53
Thondebhavi (G), Chikballapur, Karnataka	1.66	-
Tikaria (G), Sultanpur, Uttar Pradesh	2.64	2.67
Vizag (G), Vizag, Andhra Pradesh	0.3	-
Wadi & Wadi New, Wadi, Karnataka	5.45	2.73
ACL, Jaypee Group		
Durga Cement Works, Guntur, Andhra Pradesh	2.31	0.4
Vishaka Cement Works, Vizag, Andhra Pradesh	0.54	-
Ambuja Cement Ltd		
Ambujanagar I & II, Kodinar, Junagadh, Gujarat	5.7	4.06
Bathinda (G), Bhatinda, Punjab	1.2	-
Bhatapara, Raipur, Chhattisgarh	3.5	2.61
Dadri- (G), G B Nagar, Uttar Pradesh	1.5	1.9
Darlaghat, Solan, Solan, Himachal Pradesh	6.8	5.45
Farakka (G), Murshidabad, West Bengal	1.25	1.18
Magdalla (G), Surat, Gujarat	1.56	-
Maratha Cement, Chandrapur, Maharashtra	4.75	3.55
Nalagargh, Solan (G), Solan, Himachal Pradesh	1.5	0.98
Rabriyawas, Pali, Rajasthan	3.6	2.27
Roorkee (G), Haridwar, Uttarakhand	1	0.84
Ropar (G), Ropar, Punjab	3	2.63
Sankrail (G), Howrah, West Bengal	2.4	-
Suli,Rauri Himachal Pradesh	1.6	0.94
Amrit Cement		
Jaintia Hills, Jaintia Hills, Meghalaya	3	-
Andhra Cement Ltd		
Durga Cement Works, Guntur, Andhra Pradesh	2.31	0.37
Anjani Portland Cements		

(Table-1 concld)

Company/ Plant Name	Capacity	Production
Anjani Portland Cements, Nalgonda, Telangana	1.92	0.83
Asian CCPL		
Asian Cement, Solan, Himachal Pradesh	1.3	-
Asian FCPL		
Asian Cement, Patiala, Punjab	1.5	-
Bagalkot Cement & Ind Ltd		
Bagalkot Cement, Bijapur, Karnataka	0.6	-
Barak Valley Cement		
Karimganj, Karimganj, Assam	0.33	-
Bharathi Cement		
Kadapa, Kadapa, Andhra Pradesh	5	3.68
Bhavya Cement		
Bhavya Cement, Guntur, Andhra Pradesh	1.4	0.8
Bheema Cement (Earlier Coromandel Cements)		
Bheema Cement, Nalgonda, Telangana	0.9	-
Binani Cement		
Sikar (G), Sikar, Rajasthan	1.4	2.7
Birla Corp. Ltd		
Chanderia, Chittorgarh, Rajasthan	4	3.57
Durgapur and Durga Hitech Cement (G), Bardhaman, West Bengal	2.3	-
Raebareli (G), Raebareli, Uttar Pradesh	1.3	-
Satna, Satna, Madhya Pradesh	2.2	-
Birla Corp. Ltd (erstwhile Reliance Cement)		
Butibori (G), Nagpur, Maharashtra	0.5	-
Kundanganj (G), Raebareli, Uttar Pradesh	2	-
Maihar, Satna, Madhya Pradesh	3	2.74
BMM Cement, Anantpur, Andhra Pradesh	0.95	0.86
BJCL, Jaypee Group		
Bhilai Jaypee (G), Durg, Chhattisgarh	2.2	-
Bhilai Jaypee, Satna, Madhya Pradesh	1.3	0.8
Burnpur Cement		
Asansol, Burdwan, West Bengal	0.3	-
Patratu, Ramgargh, Jharkhand	0.3	-
C.C.I. Ltd		
Bokajan, Karbi, Assam	0.2	0.1
Rajban, Sirmaur, Himachal Pradesh	0.25	-
Tandur, Rangareddy, Telangana	1	-
Century Cement, Raipur, Chhattisgarh	2.4	1.74
Maihar Cement I & II, Satna, Madhya Pradesh	4.2	3.21
Manikgarh Cement I & II, Chandrapur, Maharashtra	6	3.81
Sonar Bangla (G), Murshidabad, West Bengal	1.5	-
Chettinad Cement		
Ariyalur, Ariyalur, Tamil Nadu	5.5	2.5
Dachepalli works, Guntur, Andhra Pradesh	3.5	0.61
Kallur, Gulbarga, Karnataka	2.5	1.25
Karikkali, Dindigul, Tamil Nadu	4.5	2.24
Puliyur, Karur, Tamil Nadu	1.7	1.01
Dalmia Cement (Bharat) Ltd		
Adhunik Cement Ltd, Jaintia Hills, Meghalaya	1.5	0.9
Ariyalur, Ariyalur, Tamil Nadu	3.4	2.1

(Table-1 concld)

Company/ Plant Name	Capacity	Production
Belagavi, Belagavi, Karnataka	4	1.6
Kadapa, Kadapa, Andhra Pradesh	4	1.84
Dalmiapuram, Trichy, Tamil Nadu	3.4	2.1
Calcom Cement India Ltd, Noagoan, Assam	1.72	-
Dalmia Cement (Bharat) Ltd (erstwhile Jaypee Group)		
Bokaro (G), Bokaro, Jharkhand	2.1	-
DCM Shriram Cement		
Shriram Cement Works, Kota, Rajasthan	0.4	-
Deccan Cement		
Nalgonda, Nalgonda, Telangana	1.8	1.77
Dhandapani Cement Ltd		
Manachanallur, Tamil Nadu	0.02	0.01
ECO Cement		
Durgawati, Bhabhua, Bihar	1	-
Emami Ltd		
Panagarh, Burdwan, West Bengal	2	-
Risda, Baloda Bazaar, Chhattisgarh	3	2.45
Green Valley Industries		
Green Valley Industries, Jowai, Meghalaya	1	-
Grey gold Cement		
Grey gold Cement, Nalgonda, Telangana	0.05	0.04
Gujarat Siddhi Cement Ltd Junagad, Gujarat	2.01	1.15
Heidelberg Cement		
Ammasandra, Tumkur, Karnataka	0.51	-
Imlai (G), Damoh, Madhya Pradesh	3	2.8
Jhansi (G), Jhansi, Uttar Pradesh	2.7	-
Hi-Bond Cement		
Hi-Bond cement, Gondal, Gujarat	1.2	-
Hills Cement Company		
Hills Cement, Jaintia Hills, Meghalaya	1	-
Hemadri Cement Ltd Andhra Pradesh		
Hemadri Cement,Vedadri, Krishna, Andhra Pradesh	0.49	0.23
India Cements Ltd		
Chilamkur Works, Kadapa, Andhra Pradesh	1	0.3
Dalavoi, Ariyalur, Tamil Nadu	2.16	1.3
Malkapur, Rangareddy, Telangana	2.9	1.07
Parli (G), Beed, Maharashtra	1.1	-
Sankaridurg, Salem, Tamil Nadu	1.39	0.65
Sankarnagar, Tirunelveli, Tamil Nadu	2.05	1
Banswara Works, Banswara, Rajasthan	1.8	1.25
Vallur (G), Chennai, Tamil Nadu	1.1	-
Vishnupuram, Nalgonda, Telangana	3.5	1.19
Yerraguntla, Kadapa, Andhra Pradesh	1	0.4
Andaman Nicobar Islands	1.65	0.81
J&K Cement Ltd		
Khrew, Pulwama, J & K	0.4	-
Samba, Jammu, J & K	0.1	-
J.K. Cement Ltd		
Gotan White, Nagaur, Rajasthan	0.61	0.58
Jharli(G), Jhajjar, Haryana	1.5	-

(Table-1 concld)

Company/ Plant Name	Capacity	Production
Mangrol, Chittorgarh, Rajasthan	2.5	1.71
Muddapur, Bagalkot, Karnataka	3	2.02
Nimbahera, Chittorgarh, Rajasthan	3.3	2.12
JAL, Jaypee Group		
Chunar (G), Mirzapur, Uttar Pradesh	2.5	-
Churk, Mirzapur, Uttar Pradesh	1.5	-
Rewa, Rewa, Madhya Pradesh	2.5	-
Sadva Khurd (Blending), Allahabad, Uttar Pradesh	0.6	-
JCCL, Jaypee Group		
Shahabad Cement, Shahabad, Karnataka	1.2	-
JK Lakshmi Cement Ltd		
Durg, Durg, Chhattisgarh	2.4	2.1
Jhajjar (G), Jhajjar, Haryana	1.3	-
Kalol (G), Gandhinagar, Gujarat	1	-
Sirohi, Sirohi, Rajasthan	8.7	3.4
Surat, Surat, Gujarat	1.35	-
JPVL, Jaypee Group		
Jayprakash Power Ventures (G), Singrauli, Madhya Pradesh	2	-
JSPL		
Raigarh, Raigarh, Chhattisgarh	0.85	-
JSW (erstwhile Heidelberg Cement (I) Ltd)		
Dolvi (G), Raigad, Maharashtra	1	-
JSW Cement		
Nandyal, Kurnool, Andhra Pradesh	4.8	1.44
Salboni, P Medinipur, West Bengal	2.4	-
Vijayanagar, Bellary, Karnataka	3.2	-
JUD Cements		
Jaintia Hills, Jaintia Hills, Meghalaya	0.5	-
Kalburgi Cement		
Gulbarga, Gulbarga, Karnataka	3.6	2.07
(formerly Virat Sagar Cement Pvt Ltd)		
Kakatiya Cement & Sugar Ind. Ltd Telangana		
Kakatiya Cement & Sugar Ind. Ltd Telangana	0.3	0.26
Kalyanpur Cement		
Kalyanpur Cement, Rohtas, Bihar	1	-
Kanodia Cement		
Kanodia Cement, Bulandsahar, Uttar Pradesh	0.33	-
Kanodia Infra, Bhabhua, Bihar	1.2	-
KCP Ltd		
Unit II, Jaggayyapeta, Krishna Andhra Pradesh	3.52	2.11
Guntur, Andhra Pradesh	0.82	0.45
Keerthi Industries (Formerly Suvarna Cement)		
Keerthi Industries, Nalgonda, Telangana	0.59	0.51
Kesoram Industries		
Kesoram Cement, Karimnagar, Telangana	1.5	1.09
Vasvadatta Cement, Kalaburagi, Karnataka	8.65	4.23
Khyber Industries (P) Ltd		
Khyber Cement, Srinagar, J & K	0.33	-
KJS Cement		
KJS Cement, Satna, Madhya Pradesh	2.2	1.75

(Table-1 concld)

Company/ Plant Name	Capacity	Production
Nuvoco Vistas Corp Ltd., Lafarge Cement		
Arasmeta, Janjgir, Chhattisgarh	1.8	-
Chittorgarh, Chittorgarh, Rajasthan	2.6	2.08
Jojobera (G), Singhbhum, Jharkhand	4.6	-
Mejia (G), Bankura, West Bengal	1.65	1.54
Sonadih, Raipur, Chhattisgarh	1	0.54
Mawmluh Cherra Cements Ltd		
Mawmluh Cherra Cements Ltd, Garo (east), Meghalaya	0.18	0.01
Maa Chandi Cement		
Bamunara, Burdwan, West Bengal	0.33	-
Malabar Cements		
Cherthala (G), Alappuzha, Kerala	0.2	-
Walayar, Palakkad, Kerala	0.66	0.4
Mancherial Cement		
Mancherial Cement, Adilabad, Telangana	0.33	-
Jalgaon (G), Jalgaon,Maharashtra	2	-
Mangalam Cement Ltd		
Aligarh(G), Aligarh, Uttar Pradesh	0.75	-
Mangalam Cement I & II, Kota, Rajasthan	3.25	2.83
Megha Technical & Engineers Pvt. Ltd		
MTEPL-Lumshong, Jaintia Hills, Meghalaya	0.7	-
Meghalaya Cements Ltd		
Jaintia Hills, Jaintia Hills, Meghalaya	0.86	0.57
Mehta Group		
Gujarat Sidhee Cement, Junagadh, Gujarat	1.2	1.1
Saurashtra Cement, Porbandar, Gujarat	3.06	1.3
Murli Industries		
Murli Cement, Chandrapur, Maharashtra	3	-
My Home Industries Ltd		
Mellacheruvu, Nalgonda, Telangana	3.2	2.04
Mulakalapalli (G), Vizag, Andhra Pradesh	2	-
Ottapidaram,Thoothukudi, Tamil Nadu	1.5	-
NCL Industries		
Kondapalli (G), Krishna, Andhra Pradesh	0.99	-
Simhapuri, Nalgonda, Telangana	2	1.4
Nirma Ltd		
Nirma Cement, Pali, Rajasthan	2.28	1.62
OCL India Ltd		
Bengal Works, Midnapore, West Bengal	1.35	-
Kapilas (G), Cuttack, Odisha	1.35	-
Rajgangpur, Sundargarh, Odisha	4	-
Orient Cement		
Chittapur, Kalaburagi, Karnataka	3	1.99
Devapur, Adilabad, Telangana	5	2.4
Jalgaon (G), Jalgaon, Maharashtra	2	-
Panyam Cement		
Panyam Cement, Kurnool, Andhra Pradesh	1	-
Parasakti Cement		
Parasakti Cement, Guntur, Andhra Pradesh	1.26	0.8
Penna Cement Industries Ltd		

(Table-1 concld)

Company/ Plant Name	Capacity	Production
Boyareddypalli, Anantapur, Andhra Pradesh	2	-
Ganeshpahad, Nalgonda, Telangana	1.2	1.6
Talaricheruvu, Anantapur, Andhra Pradesh	2.2	0.94
Tandur, Rangareddy, Telangana	2	-
Prism Cement Ltd		
Prism Cement-I & II, Satna, Madhya Pradesh	6.6	-
Prism Johnson Ltd		
Karnool, Andhra Pradesh	4.8	-
Purbanchal Cement		
Sonapur, Kamrup, Assam	0.36	-
Rain Cements Ltd		
Kurnool Cem. Plant, Kurnool, Andhra Pradesh	2.77	1.62
Ramapuram Cem. Plant, Nalgonda, Telangana	1.5	0.75
Ramco Cements Ltd		
Alathiyur Works I & II, Perambalur, Tamil Nadu	3.05	1.33
Ariyalur, Perambalur, Tamil Nadu	3.5	2.6
Changelpet (G), Kancheepuram, Tamil Nadu	0.5	-
Jayantipuram, Krishna, Andhra Pradesh	3.85	1.47
Kolaghat (G), P Medinipur, West Bengal	0.95	-
Mathodu, Chitradurga, Karnataka	0.29	-
Ramasamyraja Nagar, Virudhnagar, Tamil Nadu	2	1.67
Salem (G), Salem, Tamil Nadu	1.6	-
Vizag (G), Vizag, Andhra Pradesh	0.95	-
RCCPL Pvt.Ltd,Maihar,Satana	3.6	2.76
RNB Cement		
East Khasi Hills, East Khasi, Meghalaya	0.4	-
Sagar Cement Ltd		
BMM Cement, Anantapur, Andhra Pradesh	1	0.9
Sagar Cements		
Bayyavaram, Vizag, Andhra Pradesh	0.2	-
Mattampally, Nalgonda, Telangana	3.3	1.4
Pedaveedu, Nalgonda, Telangana	0.35	-
Sanghi Industries Ltd		
Sanghi Cement, Kachchh, Gujarat	4.1	2
Saurarashtra Cement		
Porbandar, Gujarat	3	1.39
Shree Cements		
Baloda Bazar, Raipur, Chhattisgarh	3	1.99
Bangur Cement (G), Aurangabad, Bihar	3.6	2
Bangur Cement, Suratgarh, Rajasthan	3.6	2.14
Beawar I & II, Ajmer,Rajasthan Unit-III Andheri Deori	3.6	1.1
Bulandsahar (G), Sikandrabad, Uttar Pradesh	2	2.12
Jaipur (G), Jaipur, Rajasthan	1.5	0.55
Khushkhera (G), Alwar, Rajasthan	3.5	2.5
Karnataka Cement Project, Sedam	3	1.5
Karnataka Cement Project, Gulbarga, Karnataka	3	1.53
Shree Cements		
New Bihar Cement Plant, Aurangabad, Bihar	2	1.56
Ras, Pali, Rajasthan	3	2.8
Roorkee (G), Haridwar, Uttrakhand	1.8	-

(Table-1 concld)

Company/ Plant Name	Capacity	Production
Ras New Cement Unit, Ras Rajasthan	4	2.79
Shree Jharkhand, Saraikela, Jharkhand	2.27	0.57
Suratgarh (G), Sriganganagar, Rajasthan	1.8	0.42
Shree Cements (erstwhile Jaypee Group)		
Panipat (G), Panipat, Haryana	1.5	1.14
Shree Digvijay Cement Co.		
Shree Digvijay-Sikka, Sikka, Gujarat	1.2	1.02
Shristi Cement		
Mangalpur, Burdwan, West Bengal	0.36	-
Sparta Cements & Infra Ltd		
Sparta Cements, Bhuj, Gujarat	1	-
Sri Chakra Cements		
Annamarajupet Grinding Unit (G), Vizianagaram, Andhra Pradesh	0.26	-
Narasimhapuri Cement Unit, Guntur, Andhra Pradesh	0.31	-
Sri JayaJothi Cements Pvt. Ltd		
Sri JayaJothi Cement Plant, Kurnool, Andhra Pradesh	3.2	1.31
Sri Lalita		
Matampally, Nalgonda, Telangana	1	-
Star Cement Ltd		
CMCL-Lumshong, Jaintia Hills, Meghalaya	1	0.8
CMCL-Sonapur (G), Guwahati, Assam	2	-
Swasata Cements Ltd		
Swasata Cements, Purulia, West Bengal	1.5	-
Tamil Nadu Cement		
Alangulam, Virudhunagar, Tamil Nadu	0.29	-
Ariyalur, Ariyalur, Tamil Nadu	0.5	-
Tata Chemicals Limited		
Tata Chemicals Cement Division, Mithapur, Gujarat	0.5	-
Tamil Nadu Newsprint & Papers Limited		
Tamil Nadu Newsprint & Papers Limited	0.33	0.25
The K.C.P. Ltd		
Macherla, Guntur, Andhra Pradesh	0.82	0.3
Muktyala, Krishna, Andhra Pradesh	3.52	1.7
Topcem		
Gauripur, Kamrup, Assam	0.66	-
Udaipur Cement		
Udaipur Cement, Udaipur, Rajasthan	1.6	1.15
UltraTech Cement Ltd		
Aditya, Chittorgarh, Rajasthan	8	4.17
Aligarh(G), Aligarh, Uttar Pradesh	1.3	-
Anantapur, Andhra Pradesh Cement Works	9	3.7
Arakkonam (G), Vellore, Tamil Nadu	1.1	-
Awarpur, Chandrapur, Maharashtra	6	2.34
Bhatinda (G), Bhatinda, Punjab	1.75	-
Dadri (G), G B Nagar, Uttar Pradesh	1.3	-
Dankuni, Hooghly, West Bengal	1.6	-
Dhar, Madhya Pradesh (Nagda)	3.5	2.15
Ginigera (G), Koppal, Karnataka	1.3	-
Gujarat Cement Works, Amreli, Gujarat	6.4	4.8
Hirmi, Raipur, Chhattisgarh	1.9	2.36

(Table-1 concld)

Company/ Plant Name	Capacity	Production
Hotgi, Solapur, Maharashtra	4	2.4
Jafrabad, Amreli, Gujarat	1.45	1.25
Jhajjar (G), Jhajjar, Haryana	1.6	-
Jharsuguda (G), Jharsuguda, Odisha	2.6	-
Kotputli, Jaipur, Rajasthan	4	2.37
Magdalla (G), Surat, Gujarat	0.75	-
Nagpur, Nagpur, Maharashtra	2	-
Panipat(G), Panipat, Haryana	1.3	-
Nathdwara Cement Ltd.,(earlier Binani Cement Sirohi)	4.85	2.69
Patliputra, Patna, Bihar	1.9	-
Rajashree, Kalaburagi, Karnataka	6.1	4.1
Ratnagiri (G), Ratnagiri, Maharashtra	0.48	-
Rawan, Raipur, Chhattisgarh	2.5	2.05
Reddipalayam, Ariyalur, Tamil Nadu	1.4	1.22
Sirohi, Sirohi, Rajasthan	4.85	-
Sewagram, Kachchh, Gujarat	2.4	2.3
Vikram, Neemuch, Madhya Pradesh	3.6	2.1
Wanakbori (G), Kheda, Gujarat	2.4	-
WBCW (G), Burdwan, West Bengal	1.4	-
Bara Allahabad, Uttar Pradesh	4	-
Birla White, Katni, Madhya Pradesh	0.4	0.37
Birla White, Jodhpur, Rajasthan	0.68	0.56
UltraTech Cement Ltd (erstwhile Jaypee Group)		
Ayodhya (G), Ambedkar Nagar, Uttar Pradesh	1	-
Baga, Solan, Himachal Pradesh	2.54	1.17
Bagheri (G & B), Solan, Himachal Pradesh	2	-
Balaji Cement, Krishna, Andhra Pradesh	5	2.9
Bela, Rewa, Madhya Pradesh	2.6	-
Dalla, Sonebhadra, Uttar Pradesh	0.5	0.44
Roorkee (G), Haridwar, Uttarakhand	1.1	-
Sidhi, Sidhi, Madhya Pradesh	3.5	1.59
Sikandrabad, Bulandsahar, Uttar Pradesh	1	-
Vadraj Cement		
Mora, Surat, Gujarat	6	-
Vijay Cements		
Vijay Cements, Trichy, Tamil Nadu	0.1	0.27
Vinay Cement		
Vinay Cement, Dima Hasao, Umrangshu, Assam	1.8	1
Wonder Cement		
Wonder Cement, Chittorgarh, Rajasthan	12	6.26
Zuari Cement Ltd		
Chennai (G), Chennai, Tamil Nadu	0.9	-
Sitapuram, Nalgonda, Telangana	1.4	0.94
Solapur, Solapur, Maharashtra	1.2	-
Yeraguntla, Kadapa, Andhra Pradesh	3.8	2.3

** Survey of Cement Industry and Directory and Annual Return in Form 'M' (Erstwhile Form 'O').*

Table –2: Capacity and Production in Cement Industry, 2020-21 to 2021-22

(In million tonnes)

Year	Annual Capacity	Production
2020-21	537	299.94
2021-22	537	360.19

Source: DIPP, Annual Reports

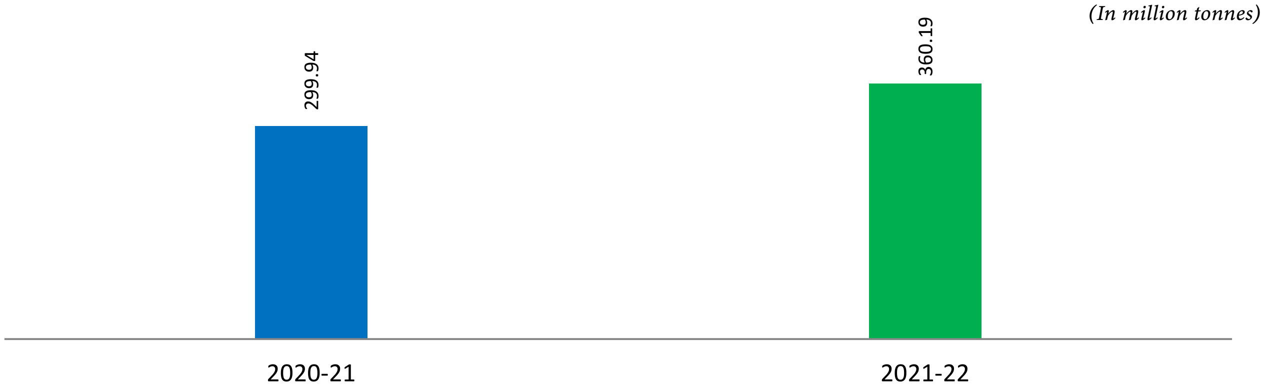


Fig 1: Production of Cement

A large number of mega plants with capacity of one million tonnes and above, possessing the latest technological features like roller process, vertical roller mills, process control equipment and efficient pollution control devices have emerged in different parts of the country. The induction of advanced technology has helped the Industry immensely to conserve energy & fuel and thereby save the raw materials substantially.

India is producing different varieties of cements like Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC), Portland Blast Furnace Slag Cement (PBFSC), Oil-well Cement, Rapid Hardening Portland Cement, Sulphate Resistant Portland Cement (SRPC) and White Cement. BIS covers two types of PPC, viz. IS 1489 (Part1): 1991 (Reaffirmed 2009) Flyash-based and IS 1489 (Part 2):1991(Reaffirmed 2009) Calcined clay-based. PPC is suitable for all general construction, particularly, for marine & hydraulic construction and other mass concrete structures. Portland Slag Cement (PSC)-IS 455:1989 (Reaffirmed 2009) is particularly useful for marine works. BIS specifies three grades of OPC – (i) IS 269:1989 (Reaffirmed 2008), i.e., 33 grade suitable for all general constructions, particularly for masonry and plastering works (ii) IS 8112:1989 (Reaffirmed 2009), i.e., 43 grade is particularly suitable for high strength concrete work, and (iii) IS 12269:1987 (Reaffirmed 2008), i.e., 53 grade suitable for specialised work, such as, precast concrete, prestressed concrete, long span structures/bridges, tall structures, etc.

All these varieties of cement are produced strictly conforming to the BIS specifications for maintaining high quality. The Cement Quality Control Order dated February 2003 issued under the BIS Act ensures quality of cement produced and sold in the market.

Power, coal and freight constitute about 15–20% each of the total production cost of cement while capital cost (interest and depreciation) forms 20–30 per cent. Although the Industry is largely under Private Sector, Government controls more than 40% of the cost. Power, coal and freight costs are all regulated by Government bodies, such as, State Electricity Boards, Coal India Ltd and the Railways

Operating Cost

The cement capacity in the country is mostly concentrated near the main raw material source, i.e., limestone. According to some estimates, around 1.5 tonnes of limestone and 180–250 kg of coal is required to produce a tonne of cement. Cement manufacturing also consume minerals, such as, gypsum, quartz, bauxite, coal, kaolin, and iron ore too in varying amounts. Other important raw material is coal (0.25 tonnes required per tonne of cement). Many cement plants are situated near the coal belts in eastern Madhya Pradesh, primarily due to two reasons, namely, (i) less freight cost incurred to transport coal, and (ii) inability of domestic coal producers to fulfil supply-requirements of cement plants due to fall in production and prioritised supply to power plants. However, limestone reserves have been the primary consideration in choosing the location of plants. Presence of clusters of capacity and high transportation cost make the cement market regional in nature with the producers supplying cement to areas around the location of the plant.

Power is a major parameter that influences the operating cost. Grid power purchased from SEBs is costlier than captive power from coal-based plants by more than 25–30 per cent. Where conditions are favourable, setting up captive wind power farms has become a realistic option for cement plants.

Coal Distribution

Coal, being a low value, bulk product, regional concentration of deposits entails freight costs that constitute a substantial part in the production cost of cement. Though, rail is the predominant form of transport, road transport is commonly used by plants located close to pitheads. The Government in its notification to the Cement Industry has permitted cement plants to operate their own captive coal mines.

Many cement plants have expressed interest in taking up coal blocks on lease and operating the mines for coal. As proposed by the Government, cement is one of the core sectors for which captive mining blocks would be allocated.

Power Availability

The Industry's average energy consumption is estimated to be about 725 kcal/kg clinker thermal energy and 80 kWh/t cement electrical energy. The best thermal and electrical energy consumption presently achieved by the Indian Cement Industry is about 667 kcal/kg clinker and 67 kWh/t cement which are comparable to the best reported figures of 660 kcal/kg clinker and 65 kWh/t cement in a developed country like Japan. Since the controls were lifted, aggregate power requirements have grown rapidly with rising cement capacity without commensurate growth in power generating capacity in the country. To offset the power crisis situation, many cement plants have set-up installations for captive power generation. Further, as part of reform process in Coal Sector, the Government has also permitted 100% FDI in captive coal blocks in Cement Sector along with Power and Steel Sectors to facilitate and augment power availability.

Freight Costs

Logistics in the Cement Sector affect freight costs to a large extent. The basic raw materials for manufacturing cement, such as, limestone and coal are low value high bulk material and, as a result, entail huge freight cost which form the single largest cost component, usually accounting for 33% of the variable costs. During 1990s, the most significant developments were the emergence of big plants and formations of clusters of cement plants. These clusters, typically located far away from the major consumption centres meant that cement has to be transported over very long distances. The Indian Railways transported 137.19 million tonnes cement in 2021-22, an increase from 120.40 million tonnes of cement transported in 2020-21, as a part of revenue earning freight traffic. Alternatively, the cost- conscious manufacturers have attempted to use sea route for transportation as sea route is cost-effective and could benefit coast-based manufacturers. Some cement plants have set-up dedicated jetties for promoting bulk transportation and export.

Cost Control

Cementproducersofthecountryhavecontinuouslyattempted to lower the cost by various methods like:

- improved efficiency by increasing usage of captive power;
- locating units closer to the market place
- increasing production of blended cement;
- availing of various State incentives like sales tax exemption; power tariff; exemption/ concession (Himachal Pradesh and Tamil Nadu);
- conversion from wet to dry process, wherever possible, depending on quality of limestone; and
- enhanced capacities to achieve economy of scale. (Expansion is the preferred route as setting up new plant costs thrice the cost of expansion).

Environment

Ministry of Environment and Forests has notified the emission standards for cement plants in 1987, which were subsequently revised in February, 2006. In India, the permissible stack dust emissions from various sources for existing cement plants is 1.50 mg/Nm and 100 mg/Nm for plants located in critically polluted areas. However, the limit for new plants in our country is 50 mg/Nm which is at par with some of the developed countries. All large plants do have in place necessary air pollution control equipment to control dust emissions. Thermal power stations use bituminous or sub-bituminous coal and produce large volumes of fly ash. Fly ash is a fine powder recovered from gases created by coal- fired electric power generation. These micron sized earth elements consist primarily of silica, alumina and iron. When mixed with lime and water, the fly ash forms a cementitious compound with properties very similar to portland cement. The research outcomes so far have established that low- grade /dolomitic limestone up to 15–20% can be used in the manufacture of cement conforming to 43 grade OPC. Fly ash up to 45% can be used in high volume fly ash cement, thereby, enhancing the fly ash utilisation. The research outcome pursued under Swatchchta Action Plan established that poor quality fly ash can be used up to 40% by activating it through mechanical and chemical routes resulting in additional fly ash utilisation of about 15 million tonnes annually over and above the current quantum of fly ash utlisation limit of 35%. These efforts have certainly impacted the country in a big way by saving it from severe environmental consequences. Industrial wastes, such as, petcoke, tar waste and by-products, such as, red mud from aluminium industries, ferrous and non-ferrous slag from steel & other industries, phospho-chalk & phospho- gypsum from fertilizer industries, lime sludge from paper & sugar industries, carbide sludge from carbide industries, phosphorus furnace slag, etc. are now finding use in the manufacture of cement.

Ready-Mix Concrete

Ready-mix Concrete (RMC) is a relatively nascent market in India. RMC is ready-to-use concrete blend of cement, sand & aggregate and water mixed in convenient proportion. It was first launched in Mumbai a few years ago and is gaining ground in other metros in India. RMC is a corollary to bulk handling and transportation of cement. It has several advantages. It is produced under controlled conditions and hence has consistency in quality and it can be directly powered in the required form which would not only save time but also would improve the quality of construction. Leading companies operating in the RMC market of India include UltraTech Cement Ltd, ACC Ltd, Nuvoco Vistas Corp. Ltd, The India Cement Ltd, Godrej Construction. The Ramco Cement Ltd, etc. Indian RMC market is expected to grow at 9% during 2021–2026.

POLICY

The Export & Import Policy 2015-20, incorporated in the FTP for cement is free. The import of cement viz. portland cement, white cement, aluminous cement, slag cement, super sulphate cement and similar hydraulic cements, whether or not coloured or in the form of clinkers, under ITC (HS) Code 2523 is free.

Development Council for Cement Industry

Development Council for Cement Industry has been set-up under Section 6 of the Industrial (Development & Regulation) Act,1951. The activity of the Council is funded through the cess collected from Cement Manufacturers in terms of the Cement Cess Rules,1993. The Cement Council promotes development of the Cement Industry by funding development projects in areas of base level activities of National Council for Cement & Building Materials and R&D, improving productivity by reducing cost, optimum utilisation of raw materials, modernisation of cement plants, improvement of environment, standardisation and quality control progress, bulk supply and distribution of cement, training and upgradation of skill in Cement Industry.

WORLD REVIEW

The cement production in 2022 was estimated at 4, 100 million tonnes which is constant as compared to preceding year. China (2,100 million tonnes) was the largest producer of cement in the world, contributing about 51 % to the world output, followed by India (370 million tonnes) 9%, Vietnam (120 million tonnes) and USA (95 million tonnes) 2%, each (Table-3).

Table – 3: World Production of Cement
(By Principal Countries)

(In 000 tonnes)

Country	2021	2022
World: Total (rounded)	4,400,000	4,100,000
China	2,400,000	2,100,000
India*	350,000	370,000
Vietnam	110,000	120,000
United States (includes Puerto Rico)	93,000	95,000
Turkey	82,000	85,000
Brazil	66,000	65,000
Indonesia	65,000	64,000
Iran	62,000	62,000
Russia	61,000	62,000
Saudi Arabia	54,000	54,000
Egypt	50,000	51,000
Japan	50,000	50,000
Korea, Rep. of	50,000	50,000
Mexico	52,000	50,000
Other countries	850,000	850,000

Source: USGS, Mineral Commodity Summaries, 2023
** India's production of cement in 2019-20; 2020-21 and 2021-22 was 334.37 million tonnes, 299.94 million tonnes and 360.19 million tonnes, respectively.*

FOREIGN TRADE

Exports

Export of cement (total) decreased by 32% to 1.90 million tonnes in 2021-22 from 2.80 million tonnes in 2020-21. In 2021-22, exports of portland grey cement at 0.99 million tonnes and cement clinker at 0.73 million tonnes. Exports of portland white cement and other cements were 18,285 tonnes and 1,52,375 tonnes, respectively. Exports of cement total in 2021-22 were mainly to Sri Lanka (84%), Nepal (6%), Bangladesh (5%), Maldives (2%) and Mauritius (1%) (Tables - 4 to 8).

Table – 4: Exports of Cement : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2806874**	**8761533**	**1901076**	**6187851**
Sri Lanka	1635909	4602601	1606030	4900914
Nepal	770363	2745464	120476	520795
Bangladesh	151656	376077	97609	250566
Maldives	65156	293991	37976	178735
UAE	4480	107238	2522	67695
Mauritius	30631	138768	11448	65412
Bhutan	27752	134224	6626	43964
Seychelles	3549	13420	10111	40052
Mozambique	93	1371	4625	31059
USA	245	12473	257	15764
Other countries	117040	335906	3396	72895

Figures rounded off

(In tonnes)

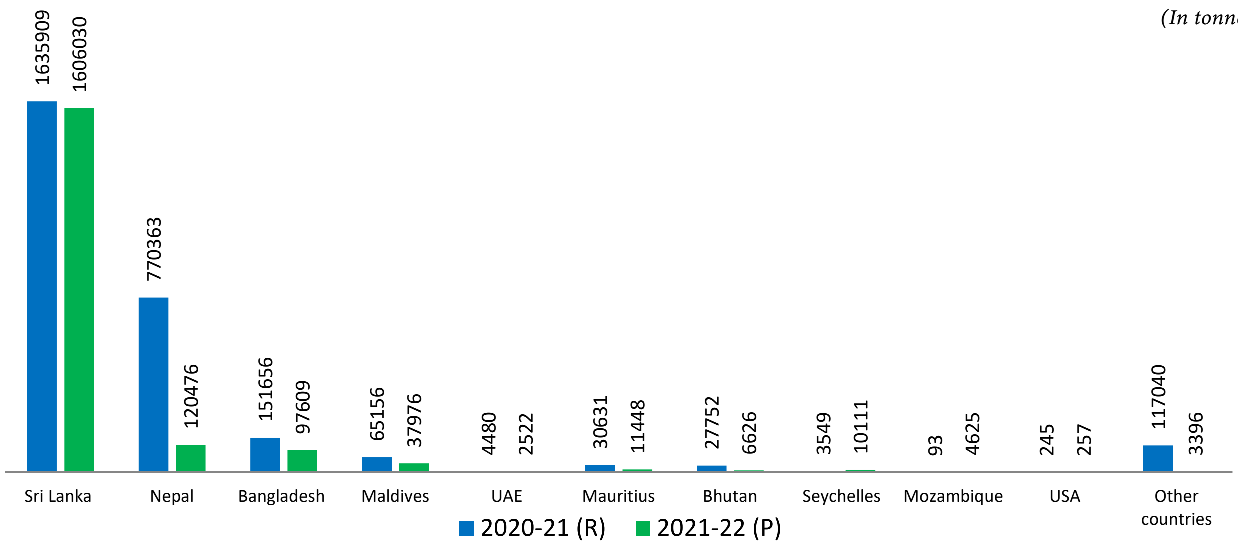


Fig 2: Countrywise Export of Cement

Table – 5: Exports of Cement (Portland Grey)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1528080**	**4528743**	**995557**	**3314929**
Sri Lanka	1422910	4040146	932183	3013319
Maldives	57071	252502	34939	157031
Seychelles	3549	13405	10110	40027
Mauritius	27447	120805	7463	36598
Mozambique	-	-	4554	29844
Nepal	7419	44910	3859	21947
Bhutan	6661	41852	2280	14412
China	192	1730	168	1704
Japan	++	19	1	46
Switzerland	-	-	++	1
Other countries	2831	13374	++	++

Figures rounded off

Table – 6: Exports of Cement (Portland White)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**18384**	**179863**	**18285**	**177863**
Nepal	14085	136320	16030	152705
Qatar	1974	12603	1375	9677
Maldives	50	1989	239	4998
Malawi	159	2107	162	2189
Nigeria	1598	19358	138	2032
Bhutan	88	1146	69	1321
Mozambique	92	1256	70	1166
Tanzania Rep, of	-	-	56	903
Saudi Arabia	10	789	17	778
Medagascar	56	739	56	560
Other countries	272	3556	73	1334

Figures rounded off

Table – 7: Exports of Cement Clinker

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1094051**	**3410629**	**734859**	**1972316**
Sri Lanka	69920	179052	535912	1394878
Nepal	747356	2549445	99199	317394
Bangladesh	151405	374645	97250	246644
Bhutan	20838	89545	2495	13249
Tanzania Rep, of	-	-	2	148
Germany	1	13	1	3
Cote D'Ivoire	104530	217903	-	-
Qatar	1	24	-	-
Seychelles	++	2	-	-

Figures rounded off

Table – 8: Exports of Cement (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**166359**	**642298**	**152375**	**722743**
Sri Lanka	143079	383403	137935	492717
UAE	4480	107205	2522	67689
Mauritius	3130	17273	3985	28812
Nepal	1503	14789	1388	28749
Maldives	8035	39500	2798	16706
USA	245	12473	255	15727
Bhutan	165	1681	1782	14982
Saudi Arabia	245	13986	250	14838
South Africa	76	4605	356	14824
Malaysia	448	9873	400	9094

Figures rounded off

Imports

Imports cement increased marginally in 2021-22 by 14% to 2.02 million tonnes from 2.35 million tonnes in 2020-21. Imports of portland grey cement were 0.34 million tonnes. Similarly, imports of cement clinker were 1.21 million tonnes, other cements 0.29 million tonnes and portland white cement about 0.18 million tonnes. The main suppliers in 2021-22 were Oman (33%), UAE (30%), Iran (14%), Bhutan (11%) and Bangladesh (10%) (Tables- 9 to 13).

Table – 8: Exports of Cement (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**166359**	**642298**	**152375**	**722743**
Sri Lanka	143079	383403	137935	492717
UAE	4480	107205	2522	67689
Mauritius	3130	17273	3985	28812
Nepal	1503	14789	1388	28749
Maldives	8035	39500	2798	16706
USA	245	12473	255	15727
Bhutan	165	1681	1782	14982
Saudi Arabia	245	13986	250	14838
South Africa	76	4605	356	14824
Malaysia	448	9873	400	9094

Figures rounded off

(In tonnes)

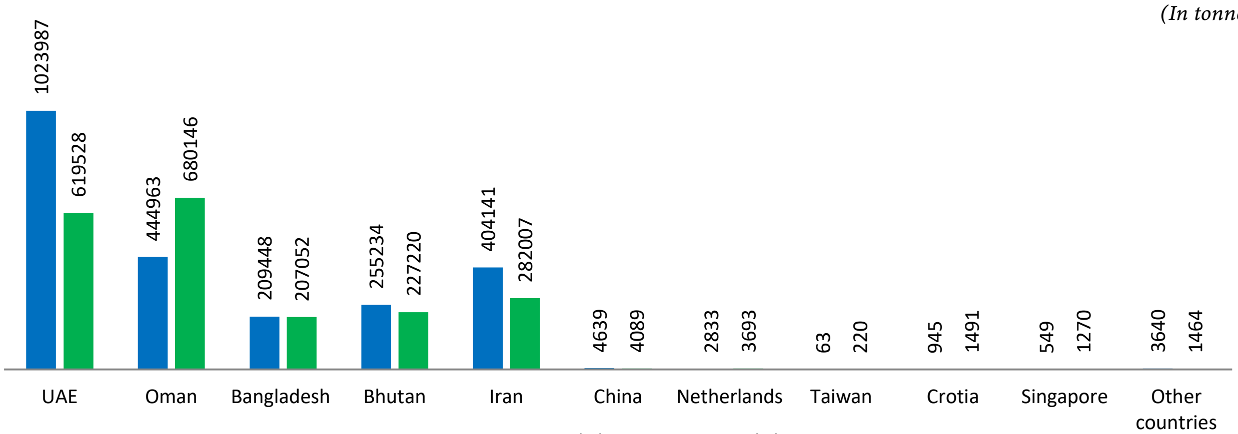


Fig 3: Countrywise Import of Cement

Table – 9: Imports of Cement:Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2350442**	**9302473**	**2028180**	**9220479**
UAE	1023987	4282567	619528	3263557
Oman	444963	1082915	680146	2097490
Bangladesh	209448	1176076	207052	1192902
Bhutan	255234	1171694	227220	1058241
Iran	404141	1013290	282007	879480
China	4639	256239	4089	259775
Netherlands	2833	149272	3693	223253
Taiwan	63	25800	220	88775
Crotia	945	34979	1491	60522
Singapore	549	24687	1270	26542
Other countries	3640	84954	1464	69942

Figures rounded off

Table – 10: Imports of Cement (Portland Grey)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**393659**	**1851543**	**345549**	**1635014**
Bhutan	116445	544386	126541	610254
UAE	184517	824420	127425	588937
Oman	40399	176919	73045	316728
Bangladesh	50622	298557	18532	117931
Spain	++	17	6	952
USA	-	-	++	204
Malaysia	-	-	++	8
Iran	1676	7161	-	-
Singapore	++	75	-	-
Japan	++	8	-	-
Other Countries	++	++	-	-

Figures rounded off

Table – 11: Imports of Cement (Portland White)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**174241**	**1321486**	**187661**	**1473250**
UAE	168352	1283571	187208	1468406
Egypt	420	3658	447	4152
USA	54	467	6	692
Iran	4539	29280	-	-
Oman	794	3921	-	-
Bhutan	81	346	-	-
Spain	1	239	-	-
Malaysia	++	4	-	-
Italy	++	++	-	-

Figures rounded off

Table – 12: Imports of Cement Clinker

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1491411**	**4061781**	**1211789**	**3928839**
Oman	403770	902075	607101	1780761
UAE	628895	1896954	289495	1100896
Iran	397926	976849	282007	879480
Bhutan	58873	244012	31442	122280
China	498	18267	543	24339
Singapore	360	15567	1200	21008
France	-	-	-	53
USA	19	237	1	22
Ukraine	550	4002	-	-
Malaysia	520	3813	-	-
Other countries	++	5	-	-

Figures founded off

Table – 13: Imports of Cement (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**291131**	**2067663**	**283181**	**2183376**
Bangladesh	158826	877519	188520	1074971
Bhutan	79835	382950	69237	325707
China	4141	237972	3546	235436
Netherlands	2833	149272	3693	223253
UAE	42223	277622	15400	105318
Taiwan	63	25800	220	88775
Croatia	945	34979	1491	60522
France	571	24880	517	24563
Korea, Rep. of	322	20013	320	24075
UK	134	12217	104	12003
Other countries	1238	24439	133	8753

Figures founded off

FUTURE OUTLOOK

The primacy of Cement Industry would continue as cement remains paramount for the development of infrastructure all over the world and no other material would possibly substitute it in the near future. Infrastructure upgrade and industrial activity, rural housing and urbanisation and investment in core sectors mainly drive the demand for cement. Some emerging areas for cement demand are concrete roads, concrete canal lining and rural construction (housing). Over 65% demand for cement arises from housing and real estate, 25 % from public infrastructure.

The Government of India has been laying a massive emphasis on infrastructure development, with 100 smart cities, modernisation of 500 cities. Cement concreting of national highways, provision of sanitation facilities, etc. These development projects that are in the pipeline would be the main drivers of growth of Indian Cement Industry.

The country is self-sufficient in terms of cement production. Most of the cement plants in India are operated by state-of-the-art technology and with advanced production facilities. The liberalisation policies for Cement Industry enabled achievement of strong growth in the Cement Sector. The Cement Industry has presently ushered in modifications and upgradation in technology, particularly in the energy conservation front.

As per IBEF India, cement production is expected to rise between 5 and 7% backed by demands from roads, urban infrastructure and commercial real estate segments. Cement consumption is expected to grow at 6.83%. The demand for cement is expected to touch 550–600 million tonnes per annum by 2025.

Reviewing the technology status of the Indian Cement Industry, the Working Group has observed that although the modern cement plants have incorporated the latest technology, yet there is scope for further improvement in the areas of in-pit crushing and conveying, pipe conveyors, co- processing of waste derived/hazardous combustible wastes as fuel, neurofuzzy expert system, cogeneration of power, multi chamber/dome silos, bulk transport of cement, pelletising and shrink wrapping for packing & despatch

6. Chromite

332

(million tonnes) Total reserves/ resources of chromite were estimated as on 1st April 2020

3,786

(thousand tonnes) Production of chromite were reported in 2021-22

2.62

(thousand tonnes) of chromite (total) were exported in2021-22

245.71

(thousand tonnes) of chromite (total) were imported in 2021-22

Chromite is the single commercially viable ore of chromium (Cr) which is chemically known as iron chromium oxide ($FeCr^2O4$). The properties of chromium that make it most versatile and indispensable are its resistance to corrosion, oxidation, wear & galling and enhancement of hardenability. Chromium is an important alloying metal in ferrous metallurgy, perhaps next only to manganese. It is used in the manufacture of alloys along with other metals, such as nickel, cobalt, molybdenum, copper, titanium, zirconium, vanadium, columbium and selenium. Chromium is traded primarily as chromium ore or as an alloy of chromium and iron, namely, ferrochrome or charge chrome. The name of the element is derived from the Greek word 'chrôma', meaning colour, because many of its compounds are intensely coloured. It is a steely-grey, lustrous, hard and brittle metal which takes high polish, resists tarnishing and has a high melting point.

RESERVES/RESOURCES

As per NMI database based on UNFC system, the total reserves/resources of chromite in the country as on 1.4.2020 has been estimated at 332 million tonnes with 79 million tonnes as "Reserves" (24%) and 253 million tonnes as "Remaining Resources" (76%). More than 96% resources of chromite are located in Odisha, mostly in Jajpur, Kendujhar and Dhenkanal districts. Minor deposits are scattered over Manipur, Nagaland, Karnataka, Jharkhand, Maharashtra, Tamil Nadu, Telangana and Andhra Pradesh. Gradewise, Charge chrome grade accounts for 28% resources followed by Beneficiable grade (24%), Ferrochrome grade (17%), Refractory grade (16%) and Unclassified grade (10%). Low, Others, and Not-known grades together account for remaining 4% (Table- 1).

Table – 1 : Reserves/Resources of Apatite as on 1.4.2020

(By Grades/States)

(In tonnes)

State/Grade	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Reso-urces
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**40635**	**15229**	**22672**	**78535**	**52696**	**10545**	**44395**	**1630**	**53008**	**70440**	**20435**	**253150**	**331685**
By Grades													
Refractory	6830	8592	11241	26663	14981	2902	3053	70	430	4238	-	25675	52338
Charge chrome	21426	3130	7340	31896	20723	4651	5205	140	26395	4699	-	61815	93711
Low	4480	-	-	4480	2545	27	-	-	-	3713	-	6284	10764
Beneficiable	7515	3507	4091	15113	11365	2964	14885	1335	14059	20805	-	65413	80526
Ferrochrome	-	-	-	-	1519	-	21083	75	11801	22951	-	57429	57429
Others	-	-	-	-	-	-	-	-	15	-	-	15	15
Unclassified	385	-	-	384	1562	-	169	9	308	13856	19889	35793	36177
Not-known	-	-	-	-	1	1	1	-	-	177	546	725	725
By States													
Andhra Pradesh	-	-	-	-	-	-	-	-	-	-	-	-	-
Jharkhand	-	-	-	-	-	-	-	15	98	623	-	736	736
Karnataka	176	340	323	499	474	378	54	-	20	392	-	1317	1817
Maharashtra	5	48	23	5	5	-	5	43	67	418	-	533	538
Manipur	-	-	-	-	3	21	52	-	504	6077	-	6657	6657
Nagaland	-	-	-	-	-	-	-	-	-	3200	-	3200	3200
Odisha	40453	15229	22349	78031	52215	10146	44289	1565	52304	59284	20435	240237	318269
Tamil Nadu	-	-	-	-	-	-	-	7	-	276	-	282	282
Telangana	-	-	-	-	-	-	-	-	15	171	-	186	186

Figures rounded off

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on Exploration & Development under "General Reviews".

PRODUCTION AND STOCKS

The production of chromite was 3,786 thousand tonnes during 2021-22 which increased by 34% as compared to 2,830 thousand tonnes in the previous year. The number of reporting mines were 20 in 2021-22 as compared to 24 in the preceding year. The share of Public Sector in total production was 31% in 2021-22 as compared to 40% in the previous year. About 17% of the total production was reported from captive mines in the current year as compared to 22% in the previous year. (Figure - 1)

Odisha continued to be the sole producing State for chromite, accounting for the entire production during 2021-22.

Gradewise analysis of production during 2021-22 reveals that about 44% of the total production of chromite accounted for 40%-52% $Cr^{2}O^{3}$ (lumps & fines) followed by 28% accounted for below 40% Cr O (lumps & fines) grade and 27% accounted for 52% & above $Cr^{2}O^{3}$ fines grade.

Mine-head closing stocks of chromite in 2021-22 were 2,988 thousand tonnes as compared to 2,764 thousand tonnes in 2020-21.

The average daily employment of labour in chromite mines during 2021-22 was 4,703 as against 4,289 in the previous year (Tables-2 to 8).

Table – 2 : Principal Producers of Chromite, 2021-22

Name & address of producers	Location of mine	
	State	District
Tata Steel Ltd, Bombay House, 24, Homi Mody Street, Fort, Mumbai – 400 001, Maharashtra.	Odisha	Jajpur
The Odisha Mining Corporation Ltd, 'OMC House', Unit 5, Post Box No. 34, Bhubaneswar – 751 001, Odisha.	Odisha	Jajpur Keonijhar
Indian Metals & Ferro Alloys Ltd, IMFA Building, Bomikhal, P.O.-Rasulgarh, Rasulgarh, Bhubaneswar – 751 010, Odisha.	Odisha	Jajpur
Balasore Alloys Ltd, Balgopalpur, Dist. Balasore - 756 020, Odisha.	Odisha	Jajpur
Ferro Alloys Corporation Ltd., Charge Chrome Plant, D.P.Nagar, Randia, Bhadrak-756135, Odisha.	Odisha	Jajpur

Table – 3 : Production of Chromite, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**3929260**	**32134395**	**2830413**	**21862796**	**3785625**	**47298073**
Odisha	3929260	32134395	2830413	21862796	3785625	47298037

(In tonnes)

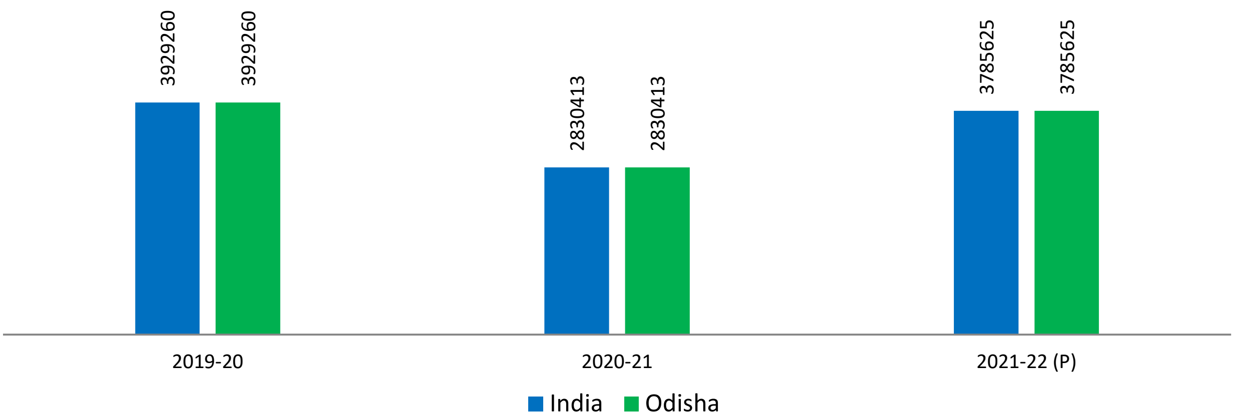


Fig 2: Pr oduction of Chromite

Table – 4 : Gradewise Production of Chromite, 2020-21

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	No. of Mines	Production by Grade: Cr^2O^3 content						Concen trates	Total	
		Below 40%		40–52%		52% & Above			Quantity	Value
		Lumps	Fines	Lumps	Fines	Lumps	Fines			
India	**24**	**71681**	**748478**	**131954**	**2229711**	**-**	**615393**	**33196**	**2830413**	**21862796**
Public sector	8	-	182082	-	732759	-	208901	-	1123742	10511219
Private sector	16	71681	566396	131954	496952	-	406492	33191	1706671	11351577
Karnataka	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Hassan	2*	-	-	-	-	-	-	-	-	-
Odisha	**22**	**71681**	**748478**	**131954**	**1229711**	**-**	**615393**	**33196**	**2830413**	**21862796**
Dhenkanal	3*	-	-	-	-	-	-	-	-	-
Jajpur	16	71681	748478	131954	1229711	-	615393	33196	2830413	21862796
Keonjhar	3*	-	-	-	-	-	-	-	-	-

** Only labour reported*

Table – 5 : Gradewise Production of Chromite, 2021-22(P)

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	No. of Mines	Production by Grade: Cr^2O^3 content						Concen trates	Total	
		Below 40%		40–52%		52% & Above			Quantity	Value
		Lumps	Fines	Lumps	Fines	Lumps	Fines			
India	**20**	**69402**	**991591**	**168510**	**1494730**	**-**	**1004348**	**57044**	**3785625**	**47298073**
Public sector	9	-	159424	-	751176	-	253155	-	1163755	19042093
Private sector	11	69402	832167	168510	743554	-	751193	57044	2621870	28255980
Karnataka	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Hassan	2*	-	-	-	-	-	-	-	-	-
Odisha	**18**	**69402**	**991591**	**168510**	**1494730**	**-**	**1004348**	**57044**	**3785625**	**47298073**
Dhenkanal	3*	-	-	-	-	-	-	-	-	-
Jajpur	14	69402	991591	168510	1494730	-	1004348	57044	3785625	47298073
Kendujhar	1*	-	-	-	-	-	-	-	-	-

** Only labour reported*

Table – 6 : Production of Chromite, 2020-21 and 2021-22

(By Frequency Groups)

(Quantity in tonnes)

Production Group	No. of mines		Production for the group		Percentage to total production		Cumulative percentage	
	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)
Total	**24**	**20**	**2830413**	**3785625**	**100**	**100**	**-**	**-**
Up to 10000	14	10	-	-	-	-	-	-
10001–100000	4	3	233023	150195	8.23	3.97	8323	3.97
100001 – 200000	2	1	307980	163764	10.88	4.33	19.11	8.3
200001 – 300000	2	3	521820	761695	18.44	20.12	37.55	28.42
300001 and above	2	3	1767590	2709971	62.45	71.59	100	100.01

Table – 7 : Mine-head closing stocks of Chromite, 2020-21

(By States/Grades)

(In tonnes)

State	Stocks by Grades: $Cr^{2}O^{3}$ Content							Total
	Below 40%		40–52%		52% & Above		Concentrates	Quantity
	Lumps	Fines	Lumps	Fines	Lumps	Fines		
India	**27423**	**1863074**	**11300**	**590048**	**285**	**244964**	**26814**	**2763908**
Karnataka	1331	-	-	-	-	-	-	1331
Odisha	26092	1863074	11300	590048	285	244964	26814	2762577

Table – 8 : Mine-head Closing Stocks of Chromite, 2021-22

(By States/Grades)

(In tonnes)

State	Stocks by Grades: $Cr^{2}O^{3}$ Content						Concentrates	Total
	Below 40%		40–52%		52% & Above			Quantity
	Lumps	Fines	Lumps	Fines	Lumps	Fines		
India	**2052129**	**24453**	**630594**	**285**	**244124**	**21881**	**2987860**	**3785625**
Karnataka	-	-	303	-	-	-	1341	1163755
Odisha	2052129	24453	630291	285	244124	21881	2986519	2621870

MINING & TRANSPORT

At present, mining operations for chromite are restricted in the Sukinda ultramafic belt, in the Baula Nausahi chromite belt in Odisha and in Hassan district of Karnataka. The method of exploitation of chromite in the areas includes both opencast and underground mining. Chromite outcrops generally are under overburden cover of 3 to 9 m. The overburden is generally soft, consists of aluminous laterite, murrum and laterite except in areas near the base of the Mahagiri Hill. The ore extracted from Kathpal mine and from all the mines in the Baula Nausahi belt is hard and massive. In all other mines, the ore occurs as friable and powdery.

The excavation of overburden in opencast mines is done by digging with shovels. The overburden generated is then loaded and transp orted by trucks & dumpers of 10 & 35 tonnes capacity, respectively. In the case of hard overburden of hard murrum or laterite or serpentinised quartzite etc. drilling and blasting procedures are commonly utilised. Drilling, done with jack hammer, and blasting (with appropriate quantity of explosives) loosen the hard formations which enable removal of overburden. The ores are subsequently excavated, sorted and stacked. In manual mines, ore is extracted manually by using pick axe.

South Kaliapani is the main chrome ore mine of Odisha Mining Corp. Ltd. In South Kaliapani mine, nominal blasting is done to loosen the ore which is then transported to stack yard and sorted manually. The ores for dissemination are transported and stacked separately. OMC is operating a chrome ore Beneficiation plant (COBP) at its South kaliapani lease having capacity 1.5 lakh tonne/year. OMC has decided to go for another COBP of the same capacity. The work is in the final stage of completion of construction. To recover a significant amount of chrome values from the talling of COB plant, OMC conducted a technical plant study through NML. Based on the report of NML, DPR has been prepared and based on the DPR,decision was taken for execution of the project.

Underground mining is practised in four chromite mines viz. , Kathpal mine of M/s FACOR, Nausahi mine of M/s IMFA, Bangur chrome ore mine of Odisha Mining Corp. Ltd and Baula mine of M/s FACOR. The Kathpal chromite mine of M/s FACOR and Mahagiri mine of M/s IMFA are both underground and opencast. Maheswari lode is mined by underground method of mining, whereas Balaji lode is mined by opencast method.

ENVIRONMENT

The major problems associated with chromite mining are the pollution and degradation caused to the environment. The hexavalent chromium, especially in friable ore is the major cause of concern as it is carcinogenic in nature. The hexavalent chromium contamination of water bodies is a major issue that requires concerted attention. Viable treatment methods of pumping water, especially with ferrous sulphate solution, before it being discharged must be rigorously implemented as remedial measure. Ferrous sulphate solution converts the hexavalent into trivalent form which is non-carcinogenic.

Chromium contamination of air also comes from emissions of coal-based power plants and industrial chimneys of iron & steel and ferrochrome industries, from spray paintings, chrome baths, refractory industries and mining of chromite & magnesite. In rural areas, chromium in atmosphere rarely exceeds 1mg/cu.m of air, but in towns with major Iron & Steel Industries the levels may be 1,000 times more.

The inhalation of chromium compounds has been associated with the development of cancer among workers in the Chromite Industry. The relative risk for developing lung cancer has been calculated to be as much as 30 times. There is also evidence for an increased risk of developing nasal, pharyngeal, and gastrointestinal carcinomas. Quantitative epidemiological data were obtained by Mancuso and Hueper (1951), who observed increased occurrence of deaths (18.2%; p<0.01) from respiratory cancer among chromite workers as compared with 1.2% deaths where controls were at place. In a follow-up study conducted when more than 50 % of the cohort died, the observed incidence for lung cancer deaths had increased to approximately 60%.

Protection of environment has become a major issue presently. The major environmental impacts of mining are (i) deforestation (ii) land damage (iii) water pollution and hydrological damage (iv) air pollution (v) noise pollution (vi) ground vibration and fly rock problem (vii) visual impacts, etc.

Deforestation takes place at actual site of an opencast mines and also where mineral and overburden dumps are created or where service buildings and roads are built. Land damage takes place in opencast mining while exposing the mineral and in underground mining due to surface subsidence. In addition, land damage also takes place due to siting of surface dump of mineral, overburden refuse tips and formation of tailing dams.

After enforcement of MCDR,1988 there was afforestation in metalliferous mines in order to stabilise and reduce the impact of mining. IBM did play a major role in the restoration of mine environment . Plantation trees and other afforestation efforts to improve the environment were carried out regularly since 1989-90 and are still in practice.

CONSUMPTION

The consumption of chromite decreased by about 2% to 2.72 million tonnes in 2019-20 from 2.77 million tonnes in 2018 -19 . The most consuming industry was Ferroalloys/Charge chrome Industry (96%). In addition to above, chromite in substantialq uantities is also consumed by small-scale ferrochrome units, information for which is scarce. Besides, nominal consumption is reported by Refractory Industry and a negligible amount by others. Data on consumption of chromite from 2017-18 to 2019-20 is furnished in Table- 9.

Table – 9 : Estimated Consumption* of Chromite 2017-18 to 2019-20

(By Industries)

(In tonnes)

Industry	2017-18	2018-19 (R)	2019-20 (P)
All Industries	**2575200(45)**	**2774800(42)**	**2718900(41)**
Chemical	5000	5100	5300
Concentrates (Chrome ore/ chromite)	60700	112100	99900
Ferroalloys (including Charge chrome)	2499200	2639800	2597500
Refractory (including iron & steel)	9300	16700	15800
Others (*foundry, calcination*)	1000	1100	400

Figures rounded off

** Includes actual reported consumption and/or estimates made wherever required. Owing to Paucity of data, the coverage may not be complete.*

(): Number of plant reported/estimated.

USES

In metallurgy, chromite is mainly used in the manufacture of ferrochrome, silicochrome, charge chrome and chromium metal. Chromium imparts additional strength, hardness and toughness to its alloys. It also shows resistance to corrosion & prevents steel abrasion, reduces oxidation and flow of electricity. Stainless steel, high- speed tool steel and corrosion & heatresistant steel are some of the important varieties of chromium steel.

Ferrochrome is of two types: (i) high-carbon (containing 4–8% carbon) and (ii) low-carbon (containing up to 2% carbon). The amount of chromium used in steel varies with the purpose. Low chromium steels (less than 5% chromium and small amount of nickel) are used in rails, automobiles, armour plates, armour piercing projectiles, etc. Intermediate chromium steels (3–12% Cr) and small amounts of W, Mo or Si are used in high-speed tools, valves for engines and other equipment requiring resistance to abrasion, corrosion and oxidation. Chromium steels include stainless steel (12–18% Cr) and super-stainless steel (12–30% Cr) and 7–10% Ni) which are used for cutlery and cooking utensils, in aircraft & high-speed trains, respectively. Chromium (17%) along with iron (83%) is also used as ferritic stainless steel to manufacture coins.

Chromite is used in Refractory Industry because of its high chemical stability, its high temperature resistance and corrosion resistant properties. Further, its high melting point, ability to withstand sudden temperature changes, its chemically neutral character, moderate thermal expansion and mechanical strength besides abundant availability and reasonable price are added advantages for use in Refractory Industry.

Chromite is used for manufacturing important chro mium compounds like chromates and bichromates of sodium and potassium, chromium pigments like chromic oxide green and chromic acid, which in turn, are used in chromium-plating solution.

Chromium is an essential trace element for human health. However, some of its compounds are highly toxic and carcinogenic. Environment concerns have reduced the use of chromite refractories and chromium chemicals.

SUBSTITUTES

Development of substitutes for chromium tends to be deterred by cost performance or the customer appeal for chromium. There are no substitutes for chromium in stainless steel or superalloys. Boron, manganese, nickel and molybdenum can be substituted in alloy steels and cast irons. Chromium containing scrap can substitute for ferrochromium in some metallurgical uses. Dolomite is an alternative for some refractory bricks. Cadmium yellow is one of the several alternative pigments. However, it is not environmentally acceptable and nickel and zinc are possible substitutes for the protection of decorative coatings.

SPECIFICATIONS

The specifications of chromite vary for different end-use industries. The Cr.Fe ratio is one of the important factors to be considered before deciding the end-use of the mineral. The BIS has specified IS:10818-1984 specifications of chromite for Metallurgical Industries Reaffirmed March 2019. IS: 10819-1999 (First Revision, Reaffirmed in January 2017) for specifications of chromite for Refractory Industry, IS: 4737-1982 (First Revision, Reaffirmed January 2021) for specification of chromite for Chemical Industry and IS : 6788: 1973 (Re-affirmed Feb. 2019) for specification of chromite sand for Foundry Industry.

INDUSTRY

Chromite is mainly used in Metallurgical Industry for manufacture of ferroalloys, e.g., ferrochrome, charge chrome and silicochrome which are used as additives in making stainless steel and special alloy steel. Ferroalloys are the essential ingredients for the production of high quality special alloy steel as well as mild steel. The demand for ferroalloys is associated with the production of alloy steel.

Production of ferrochrome/charge chrome was mainly reported by Ferro Alloys Corp. Ltd, Shri Vasavi Industries Ltd, Balasore Industries Ltd, Tata Steel Ltd, Indian Metals & ferro-Alloys Ltd and Indian Charge-chrome Ltd (merged with Indian Metals & Ferro alloys Ltd in 2006) were amongst the major producers of charge chrome in India. Charge chrome contains 50 to 60 % chromium and 6 to 8 % carbon. Hard lumpy chromite is used for high-carbon ferrochrome while friable ores and fine briquettes are used for low-carbon ferrochrome. Briquette fines along with lumpy ores were also consumed in charge chrome plants.

The production has been at 1.0 to 1.1 million tonnes over the past 4-5 years. India consumes 15-30% of its production and exports the rest to countries like China, South Korea and Japan. The domestic consumption of ferrochrome has not grown for two main reasons except for the top three ferrochrome players IMFA, Tata Steel and Balasore Alloys others are in financial difficulties;

b) Domestic Stainless Steel production which is largely accounted for by the Jindal Stainless Group of late is under severe duress. The Indian Ferrochrome Industry is likely to get consolidated as capacities owned by Rohit Ferro Alloys and FACOR Alloys are to be auctioned through the National Company Law Tribunal (NCLT) shortly. Recently, NCLT released the results of bidding for FACOR's assets.

The important plants which produce chromite based refractories are Tata Steel Ltd (formerly OMC Alloys), Orissa Industries Ltd, Bhilai Refractories Ltd, Burn Standard Co. Ltd, Joglekar Refractories and Ceramics (P) Ltd and Associated Ceramics Ltd.

Ferrochrome when added to steel imparts hardness, strength and augments its stainless characteristics. Carbon content classifies the ferrochrome alloy into high-carbon (6 – 8 %), medium-carbon (3–4%) and low-carbon (1.5–3%), although chromium content in all the three grades is around 60–70 per cent. Around 2.5 tonnes chrome ore with an estimated power consumption of about 4,500 kWh is required to produce one tonne of ferrochrome.

Ferro Alloys Corpn. Ltd, Garividi, Andhra Pradesh; GMR Technologies & Industries Ltd, Srikakulam, Andhra Pradesh; Jindal Steel & Power Ltd, Raigarh, Chhattisgarh; Standard Chrome Ltd, Raigarh, Chhattisgarh; SAL Steel, Kachchh-Bhuj, Gujarat; Balasore Alloys Ltd, Balasore, Odisha; IDCOL Ferro Chrome Plant, Jajpur Road, Odisha; Indian Metals & Ferro Alloys Ltd, Theruballi, Odisha; Jindal Stainless Ltd, Duburi, Odisha; Nava Bharat Ferro Alloys Ltd, Dhenkanal, Odisha; Rawat Ferro Alloys, Cuttack, Odisha; West Bengal; and Sri Vasavi Ind. Ltd, Bishnupur, West Bengal are the major ferrochrome producers in the country. A sizeable quantity of ferrochrome is also produced by units in the Small-scale Sector.

Chromite mine at Sukinda became the first unit to obtain Integrated Management System (IMS) certification (ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007). Tata Steel Ltd, FACOR and Indian Metals & Ferro Alloys Ltd (IMFA), the three major producers of charge chrome in the country have a total capacity of about 1,82,500 tpy. Tata Steel mining Ltd (TSML) has a ferro-chrome plants in Athagarh and Gopalpur in Odisha. TSML scaled up ferro-chrome production to 373 thousand tonnes in 2021-22 from 37 thousand tonnes in 2020-21, while FACOR has a capacity of 65,000 tpy charge chrome at its Randia Plant, Bhadrak district, Odisha. Indian Metals & Ferro Alloys Ltd (IMFA), Cuttack district, Odisha, has an installed capacity of 62,500 tonnes per year.

Vishnu Chemicals Ltd. has plants at Medak, Visakhapatnam (Andhra Pradesh) and Bhilai (Chhattisgarh) which produces chromium products, such as, sodium dichromate (70,000 tonnes per year), basic chromium sulphate, chromicacid (1,000 tonnes per year) and potassium dichromate (1,000 tonnes). There were two producers of chromium chemicals in small quantities in the organised sector, namely, Tamil Nadu Chromates and Chemicals Ltd and Krebs & Cie (India) Pvt. Ltd, Kolkata.

Commercially, chrome ore can be divided into three categories: (i) high-grade, containing >48% chromite, (ii) medium-grade with > 40% chromite and (iii) low-grade containing less than 40% chromite.

Chromium metal and the alloy ferrochromium are commercially produced from chromite by silicothermic or aluminothermic reactions, or by roasting and leaching processes. Chromium metal assumes high value due to its properties, such as, high corrosion resistance and imparting of hardness.

The discovery that steel could be made highly resistant to corrosion and discolouration by adding metallic chromium to form stainless steel led to major developments in the Steel Sector. This application, along with chrome plating (electroplating with chromium) are currently the major commercial use for the element. The element also finds application in the production of chromium compounds, albeit to a minor extent.

The strengthening effect of forming stable metal carbides at the grain boundaries and the strong increase in corrosion resistance has made chromium an important alloying material for steel. The high- speed tool steels contain between 3 and 5 % chromium. Stainless steel, the main corrosion-proof metal alloy is formed when chromium is added to iron in sufficient concentrations usually above 11%. User's specifications of chromite in major consuming industries are furnished in Table-10.

Table – 10 : User's Specifications of Chromite in Major Consuming Industries

Industry/Name and location of plant	Specifications of ore consumed
Ferrochrome/Charge chrome	
Andhra Pradesh/Telangana	
Cronimet Alloys India Ltd,	Lumps : Cr_2O_3 40% to 50%
Ravivalasa, Distt Srikakulam	Fines : Cr_2O_3 40% to 52%
	Concentrates : Cr_2O_3 40%
Ferro-Alloys Corp. Ltd,	Lumps : Cr_2O_3 38% to 40%
Shreeram Nagar, Distt Vizianagaram	Fines : Cr_2O_3 38% to 40%
	Friable : Cr_2O_3 48% to 50%
	Concentrates : Cr_2O_3 48% to 50%
JSL Ltd, (formerly	Lumps : Cr_2O_3 38%
Jindal Stainless Steel Ltd)	Cr:Fe : 2 : 9
Jindal Nagar, Distt Vizianagaram	
Nav Bharat Ventures Ltd,	Lumps: Cr_2O_3 28-42%
Paloncha, Distt Khammam	Fines: Cr_2O_3 48-50%, 52-54%
GMR Technologies & Industries Ltd,	Lumps: Cr_2O_3 38-45%
Ravivalasa, Distt Srikakulam	Fines: Cr_2O_3 45-55 %
VBC Ferro Alloys Ltd,	Lumps: Cr_2O_3 36-52%
Rudragram, Distt Medak, Telangana	
Chhattisgarh	
Jindal Steel & Power Ltd,	Lumps : Cr_2O_3+38%
Raigarh	Cr:Fe : 2 : 9
	Fines : Cr_2O_3+52%, Cr:Fe : 2:6
Deepak Ferro Alloys Ltd,	Lumps : Cr_2O_3 36-40%
Urla, Distt Raipur	Fines : Cr_2O_3 48-52%
Jammu & Kashmir	
Shree Sitaram Industries Pvt. Ltd,	Lumps : Cr_2O_3 40% to 52%
Distt Samba	Fines : Cr_2O_3 40% to +52%,
Odisha	
Balasore Alloys Ltd,	
(formerly Ispat Alloys Ltd)	Lumps : Cr_2O_3 - 40%
Balgopalpur, Distt Balasore	Fines : Cr_2O_3 - 40 to +52%
Ferro Alloys Corp. Ltd,	Lumps : Cr_2O_3 N.A.;
Charge Chrome Division,	Friable : Cr_2O_3 40% & above;
Randia, Distt Bhadrak	Concentrates : N.A.
IDCOL Ferro Chrome & Alloys Ltd,	Cr_2O_3 : 42-52%
Jajpur Road, Distt Cuttack	SiO2 : 6% max.
Indian Metals & Ferro Alloys Ltd,	Lumps: Cr_2O_3 : 40 to >52%
(Formerly, Indian Charge Chrome Ltd)	SiO2 : 15% max.
Choudwar, Distt Cuttack	Fines: 40 to 50% & above
Indian Metals & Ferro Alloys Ltd,	Lumps: Cr_2O_3 : 40 to 52%
Therubali, Distt Raygada	Fines: Cr_2O_3 : 40 to >52%
	Concentrates: N.A.
Tata Steel Ltd,	Cr_2O_3 : 47% min.
(Formerly OMC Alloys Ltd)	Size : 0 to 40 mm
Bamnipal, Distt Keonjhar	
West Bengal	
Rohit Ferro Tech Ltd, (Unit 1)	Lum ps, fines & concentrates
Bishnupur, Distt Bankura	
REFRACTORY	
Chhattisgarh	
SAIL Refractories Unit,	Friable lumps :
Marauda, Distt Durg	Cr_2O_3 : 52 to 54% min. SiO^2 : 5% max.
Vishva Vishal Engineering Ltd, Bhilai, Durg	Cr_2O_3 : 50%, SiO2 : 4.5% max.
	Fe_2O_3 : 8%
Maharashtra	
Joglekar Refractories & Ceramics (P) Ltd,	Lumps Cr_2O_3 44% min. CaO < 2%, Fe_2O_3 < 21%
Rabale, Distt Thane	Imported sand - 30 to +85 mesh, Cr_2O_3 45% min.
	SiO_2 < 1%, Fe_2O_3 < 27%
Odisha	

Industry/Name and location of plant	Specifications of ore consumed
Orissa Industries Ltd,	Cr_2O_3 : 52 to 54%
Lathikata Works,	Fe_2O_3 : 15 to 18% max.
Distt Sundargarh	SiO_2 : 3 to 5%
IFGL Refractories Ltd,	Cr_2O_3 : 55% min. -16 to +22 mesh
Kalunga, Distt Sundargarh	
TRL Krosaki Refractories Ltd,	Cr_2O_3 : 48 to 50% min.
Belpahar, Distt Jharsududa	
Shree Chem Industries (Pvt.) Ltd,	Cr_2O_3 : 54%
Mandiyakudar, Distt Sundargarh	SiO_2 : 5 to 9% min.
Kalinga Ferro Ispat Pvt Ltd,	Fines Cr_2O_3 : 40-52% & above,
Mandia, Distt Jajpur	
Khemka Refractories Pvt. Ltd,	Fines Cr_2O_3 : 52% min.
Kamakhyanagar - 759 018,	
Distt Dhenkanal	
Tamil Nadu	
Burn Standard Co. Ltd,	Cr_2O_3 : 52 to 54% min., SiO^2 : 3 to 5% max.
Salem	Fe_2O_3 : 15 to 18% max.
C. Nataraj Ceramics & Chem. Industry	Lumps, Cr_2O_3 + 44%. Fe_2O_3 -25%
Dalmiapuram, Distt Tiruchirapalli	
West Bengal	
National Refractories,	Cr_2O_3 : 52% min., above fines
P.O. Salampur - 713 357, Distt Burdwan	
CHEMICALS	
Odisha	
Krebs & Cie (India) Ltd,	Cr_2O_3 : 48 to 55%
Kalma, Distt Mayurbhanj	

TRADE POLICY

The Ministry of Commerce and Industry, Department of Commerce had come out with the Foreign Trade Policy (FTP) for the period 2015-2020.

The Central Government amends Export Policy of items under HS code 2610 related to Chrome ore vide notification No. 13/2023 dated 22nd June 2023 is as under;

Tariff Item HS Code	Item Description	Export Policy	Policy Condition	Revised Export Policy	Revised Policy Condition
26100000	(a) Chrome ore lump containing (i) 47% Cr_2O_3 and above	Free	-	Restricted	Export permitted under Authorisation
26100020	(b) Chrome ore lumps containing 40% or more but less than 47% Cr_2O_3	Free	-	Restricted	
26100030	(c) Chrome ore lumps with Cr_2O_3 below 40%	STE	Export through MMTC Limited	Restricted	
26100040	(d) Chrome ore friable and conc. fixes containing 47% Cr_2O_3 and above	STE	Export through MMTC Limited	Restricted	
26100090	(e) Other	STE	Export through MMTC Limited	Restricted	

WORLD REVIEW

World reserves of Shipping-grade chromite are about 560 million tonnes in terms of chromiun content. Countries that possess sizeable quantities of reserves are USA (40%) and South Africa (36%). These two countries together hold about 76% of world's chromite reserves. India possesses 18% while Turkey accounts for 4% of the world reserves of chromite. The available data on world reserves of chromite (Shipping-grade) is furnished in Table-11.

Table – 11 : World Reserves of Chromite (Shipping Grade)**

(By Principal Countries)

(In '000 tonnes of chromium content)

Country	Reserves
World: Total (rounded off)	560000
Kazakhstan	230000
South Africa	200000
India	100000
Turkey	26000
Finland	8300
United States	630
Other countries	NA

*Source: USGS, Mineral Commodity Summaries, 2023 **Shipping grade-Reserves unit are thousand metric tonnes of shipping-grade chromite ore which is deposit quantity and grade normalised to 45% Cr_2O_3except for United States where grade is normalised to 7% Cr_2O_3 and Finland where grade is normalised to 26% Cr_2O_3 NA-Not available.*: Reserves/resources of chromite in the country as on 1.4.2020 asper NMI database based on UNFC system have been placed at 331.69 million tonnes.*

The world mine production of chromite ores & concentrates increased by 18% to 35.03 million tonnes in 2021 from 29.77 million tonnes recorded in the previous year. South Africa was the leading producer contributing about 52% to the total world production followed by Kazakhstan (18%), Turkey (8%), India (7%), Zimbabwe & Finland (3% each) and Russia & Albania (2% each) (Table-12).

Table – 12 : World Mine Production of Chromium Ores and Concentrates

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
World:Total (roundedoff)	**38613047**	**29779224**	**35073322**
South Africa	17664239	13196880	18435250
Kazakhstan	7019000	6327000	6192000
Turkey	3363791	2128669	2779467
India**	3929260	2863869	2560000
Zimbabwe	1550064	1272139	1244300
Finland	1183862	1131336	1141184
Russia	698000	689000	689000
Albania	1288315	626627	650200
Pakistan	467400	404800	467100
Other countries	1449116	1138904	914821

Source: BGS World Mineral Production, 2017-21
***: production of chromite in india 2019-20, 2020-21 and 2021-22 was 3.92 million tonnes, 2.83 million tonnes and 3.78 million tonnes respectively.*
**: Estimate, a: Sold or used by producers, b:B2O3 equivalent, c: Years ended 20 March following that stated.*
(b) Years ended 31 March following that stated.
**India's production of bauxite during 2019-20, 2020-21 and 2021-22 was 21.82 million tonnes, 20.38 million tonnes and 22.49 million tonnes, respectively.*

Upgradation of technology and advan-cement in beneficiation processes, such as, agglomeration of ore, pre-heating and pre-reduction of furnace feed, closed-furnace technology and recovery of chromium from slags have brought about significant changes and are now followed worldwide. For generalised view of the development in various countries, the countrywise description sourced from the latest available publication of USGS 'Mineral Yearbook 2018' chromium (Advance Release) is furnished below:

Albania

Albania produced an estimated 9,60,000 tonnes of chromite ore in 2018 as against 9,50,181 tonnes in 2017. Ferrochromium production was estimated at 60,000 tonnes in 2018 as against 49,000 tonnes in 2017. Chromite ore and ferrochromium production increased in the past several years owing to increased investment in AlbChrome (Tirana), the leading chromite ore and ferrochromium producer in Albania.

Kazakhstan

Kazakhstan produced 66,88,700 tonnes of chromite ore in 2018 as against 63,13,300 tonnes (revised) in 2017 and an estimated 16,00,000 tonnes of ferrochromium in 2018 as compared with 16,40,300 tonnes (revised) in 2017. Kazakhstan was the third-leading producer of chromite ore and ferrochromium in the world.

Finland

Finland's production increased in 2018. The val-ues for production in 2014 through 2017 have been revised and are now about twice as much as previously reported

South Africa

South Africa was the world's leading producer of chromite ore in 2018. South Africa produced 1,76,17,099 tonnes of chromite ore in 2018 compared with 1,65,47,717 tonnes (revised) in 2017 and an estimated 39,00,000 tonnes of ferrochromium in 2018 compared with an estimated 36,00,000 tonnes in 2017. Afarak Group Plc (Finland) announced a transformer failure of a submerged arc furnace that produces ferrochromium in August at its Mogale Alloys processing plant. As a result, Mogale shut down the furnace, and repairs were expected to take up to 14 weeks to complete. Mogale anticipated a 7,000-tonnes/year reduction in ferrochromium capacity and production

Zimbabwe

Zimbabwe produced 8,94,661 tonnes of chromite ore in 2018 as against 6,88,838 tonnes (revised) in 2017 and an estimated 1,80,000 tonnes of ferrochromium in 2018 compared with 1,42,800 tonnes in 2017.

Balasore Alloys Ltd. (India) agreed to acquire a 70% stake in Zimbabwe Alloys Ltd. (ZimAlloys) (Gweru) in January to increase domestic and overseas production capacity. The arrangement was sanctioned by the High Court of Zimbabwe. The investment also settled ZimAlloys' debt of $50 million to creditors. With the debt cleared, ZimAlloys planned to refurbish and restart its blast furnaces within 18 months.

Brazil

Brazil produced an estimated 5,50,000 tonnes of chromite ore in 2018, unchanged from the 2017 revised estimate. Ferrochromium production was 1,75,061 tonnes in 2018 compared with 1,71,531 tonnes in 2017. Companhia de Ferro Ligas da Bahia owned more than 95% of chromite deposits operated in Brazil. Ferbasa invested $2.1 million in its "Hard Lump" project to improve treatment and mining processes in chromite ore production. An investment of $6.1 million was also allocated to machinery and equipment. Ferbasa decided to decrease its sales volume in 2018 compared to sales in 2017 owing to the decrease in the global prices of chromite ore (Companhia de Ferro Ligas da Bahia, 2019).

China

China produced an estimated 30,000 tonnes of chromite ore in 2018, unchanged from the 2017 estimate, and an estimated 52,50,000 tonnes of ferrochromium compared with a revised estimate of 49,40,000 tonnes in 2017. China was the leading producer of ferrochromium in 2018.

In response to requests from the stainless-steel billet and hot-rolled sheet and Coil Industry in China, the Ministry of Commerce of the People's Republic of China announced an investigation into imports of stainless-steel billets and stainless steel hot-rolled coil from the European Union, Indonesia, Japan and the Republic of Korea. The investigation was set to begin on July 23, 2018, and would run for 1 year but could extend into 2020 depending on special circumstances.

FOREIGN TRADE

Exports

Exports of chromite (total) decreased by 8% to 2.62 thousand tonnes in 2021-22 from 2.87 thousand tonnes in the previous year. Out of total chromite exported in 2021-22, the share of chromite concentrate was Negligible while chromite ore (others) accounted for 99%. Exports of chrome ore (others) were almost fully to China in 2021-22. Export of chrome Ore (other) decreased to 2,614 tonnes in 2021-22 from 2,668 tonnes in the preceding year.

In 2021-22, 284 tonnes of chromium & alloys were exported to various countries. Exports of chromium & alloys were mainly to USA (69%), UAE (15%) and Netherlands(7%). The exports of chromium & scrap was negligible. Exports of chromium unwrought (powder) was increased to 284 tonnes in 2021-22 from 158 tonnes in the preceding year (Tables-13 to 20).The details of exports of ferrochrome are furnished in the Review entitled, 'Ferroalloys'.

Table – 13 : Exports of Chromite : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2872**	**71979**	**2625**	**89710**
China	2716	65714	2614	76845
USA	-	-	7	12638
Saudi Arabia	-	-	4	200
Nepal	2	84	++	14
Oman	-	-	++	13
UK	-	-	++	++
Spain	100	4602	-	-
UAE	54	1579	-	-

Figures rounded off

(*In tonnes*)

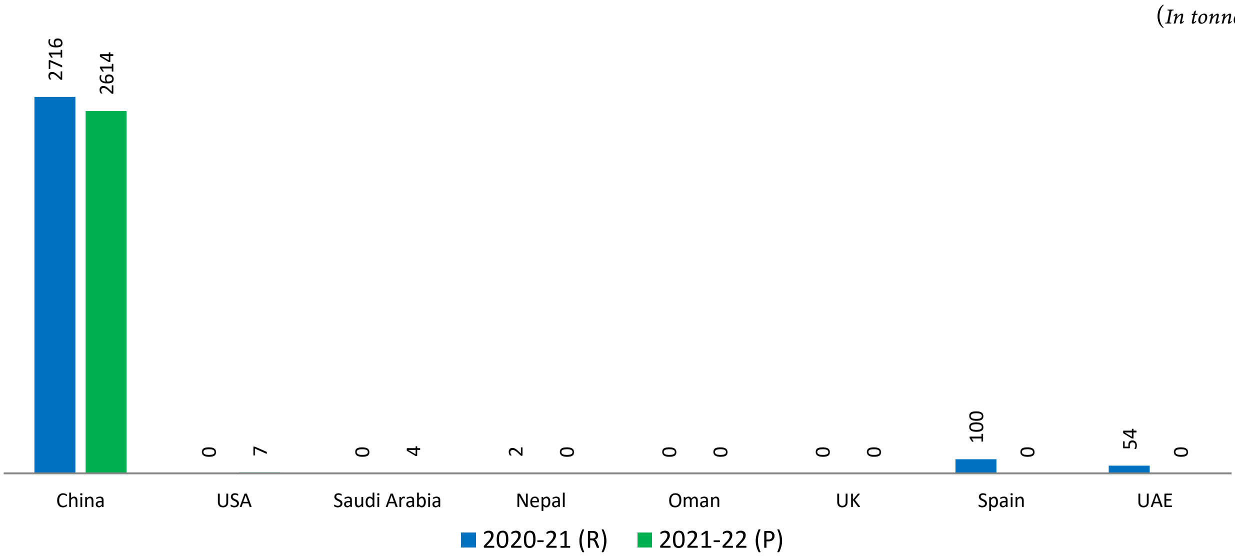


Fig 3: Exports of Chromite

Table – 14 : Exports of Chrome Ore Concentrates

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**204**	**3104**	**-**	**-**
China	204	3104	-	-

Figures rounded off

Table – 15 : Exports of Chrome Ore (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2668**	**68875**	**2614**	**76859**
China	2512	62610	2614	76845
Nepal	2	84	++	14
UK	-	-	++	++
Spain	100	4602	-	-
UAE	54	1579	-	-

Figures rounded off

Table – 16 : Exports of Chrome Ore Lumps

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**-**	**-**	**11**	**12851**
USA	-	-	7	12638
Saudi Arabia	-	-	4	200
Oman	-	-	++	13

Figures rounded off

Table – 17 : Exports of Chromium & Alloys

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**168**	**119489**	**284**	**229068**
USA	136	83691	195	152031
U A E	3	1904	42	37241
Netherlands	-	-	20	17391
Brazil	12	8138	17	14745
Indonesia	1	1298	4	2758
Saudi Arabia	1	61	3	2188
Egypt	1	573	2	1489
Kenya	1	414	1	599
Japan	-	-	++	263
Poland	-	-	++	142
Other countries	13	23410	++	221

Figures rounded off

Table – 18 : Exports of Chromium Articles, Nes

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**10**	**21035**	**++**	**156**
Saudi Arabia	-	-	++	130
Nigeria	-	-	++	22
South Africa	-	-	++	2
Sri Lanka	-	-	++	2
Nepal	10	21000	-	-
Italy	++	34	-	-
Australia	++	1	-	-

Figures rounded off

Table – 19 : Exports of Chromium & Scrap

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**32**	**++**	**265**
Japan	-	-	++	263
Iran	-	-	++	2
Kenya	++	19	-	-
Qatar	++	11	-	-
UAE	++	2	-	-

Figures rounded off

Table – 20: Exports of Chromium Unwrought : Powder

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**158**	**98422**	**284**	**228647**
USA	136	83691	195	152031
U A E	3	1902	42	37241
Netherlands	-	-	20	17391
Brazil	12	8138	17	14745
Indonesia	1	1298	4	2758
Saudi Arabia	1	61	3	2058
Egypt	1	573	2	1489
Kenya	1	395	1	599
Poland	-	-	++	142
Jamaica	-	-	++	78
Other countries	3	2364	++	115

Figures rounded off

Imports

Imports of chromite (total) increased by 57% to 245.71 thousand tonnes in 2021-22 from 156.211 thousand tonnes in the previous year. Imports were mainly from South Africa (71%), Switzerland (19%) and Austria (3%). Out of total quantity of chromite imported in 2021-22, chrome ore lump accounted for 45%, while concentrate and Other forms accounted for 53%. Imports of chrome ore lump were mainly from South Africa (35%), and Switzerland (42%). 93% of the imports of chrome ore concentrate were from South Africa only. Imports of chromium & alloys in 2021-22 were at 1,451 tonnes as compared to 1,329 tonnes in the previous year. Imports of chromium & alloys were mainly from Russia (52%), China (15%) and UK (8%). Imports of chromium & scrap were 102 tonnes in 2021-22 as compared to neglible in 2020- 21 (Tables- 21 to 28).

The import details of ferrochrome are furnished in the Review entitled 'Ferroalloys'.

Table – 21 : Imports of Chromite : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**156211**	**2257733**	**245710**	**4232459**
South Africa	110250	1654869	173586	3192808
Switzerland	6070	87789	45991	606665
Austria	-	-	6155	108338
Singapore	-	-	7684	96931
Turkey	4450	56880	4234	91682
Oman	4319	47871	3218	56133
UAE	561	12416	2384	33439
Monaco	-	-	1952	23690

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
Netherlands	150	7458	318	14372
Germany	2	222	15	1992
Other countries	30409	390228	173	6409

Figures rounded off

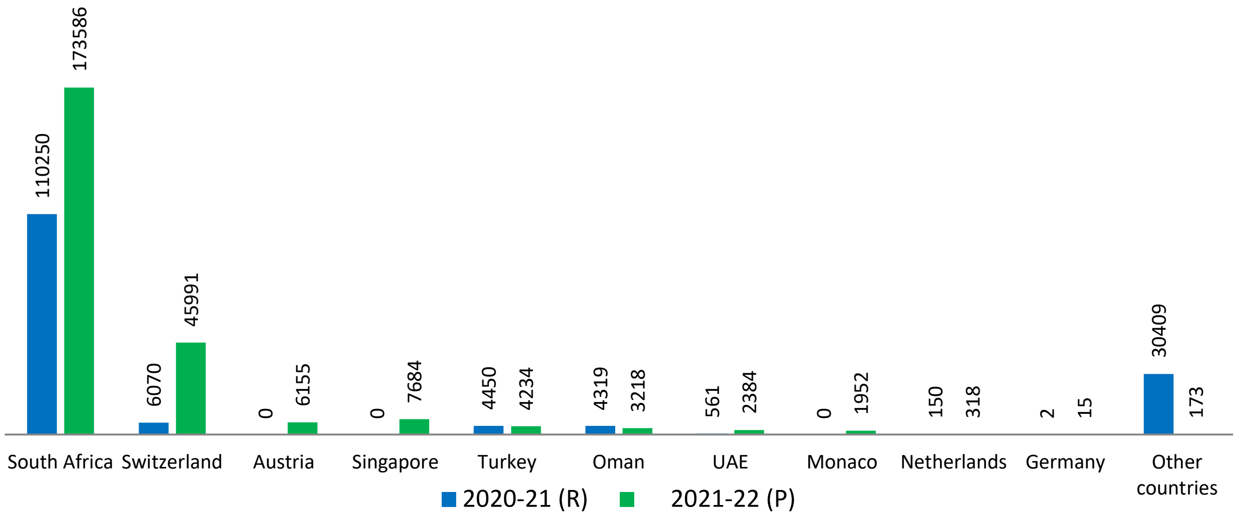


Fig 4: Imports of Chromite

Table – 22 : Imports of Chrome Ore Lump

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**78845**	**1148209**	**110544**	**1809263**
South Africa	33897	570767	39295	800963
Switzerland	6070	87789	45991	606665
Austria	-	-	6155	108338
Singapore	-	-	7684	96931
Turkey	4450	56880	4234	91682
Oman	4319	47871	3218	56133
UAE	-	-	1990	24395
Monaco	-	-	1952	23690
Canada	-	-	25	466
Mozambique	30109	384902	-	-

Figures rounded off

Table – 23 : Imports of Chrome Ore Concentrate

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**4013**	**93937**	**4987**	**126819**
South Africa	3726	89662	4987	126819
Zimbabwe	287	4275	-	-

Figures rounded off

Table – 24 : Imports of Chrome Ore Others

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**73353**	**1015587**	**130179**	**2296377**
South Africa	72627	994440	129304	2265026
Netherlands	150	7458	318	14372
UAE	561	12416	394	9044
Germany	2	222	15	1992
USA	1	319	18	1958S
Saudi Arabia	-	-	81	1896
China	4	247	19	861
France	-	-	20	643
Brazil	8	485	10	585

Figures rounded off

Table – 25 : Imports of Chromium & Alloys

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1329**	**786755**	**1451**	**925819**
Russia	653	309704	747	475349
China	29	12956	219	133952
UK	247	133905	126	80647
Belgium	60	27753	100	67183
Netherlands	293	126282	86	51453
Germany	3	29647	5	45249
France	-	-	20	17149
Latvia	-	-	24	14198
Hong Kong	-	-	43	9614
USA	38	138589	2	9568
Other countries	6	7919	79	21457

Figures rounded off

Table – 26 : Imports of Chromium Unwrought : Powders

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1163**	**650313**	**1263**	**805215**
Russia	593	282628	747	475349
China	9	4062	193	116724
Belgium	60	27753	100	67183
UK	182	82481	91	57395
Netherlands	282	123540	86	51453
France	-	-	20	17149
Latvia	-	-	24	14198
USA	31	123694	2	5231
Germany	++	457	++	446
Singapore	++	76	++	77
Other countries	6	5622	++	10

Figures rounded off

Table – 27 : Imports of Chromium Articles, Nes

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**166**	**135470**	**86**	**94590**
Germany	3	29041	5	41774
UK	65	51424	35	23243
China	20	8894	26	17187
Korea	++	235	20	4492
USA	7	14874	++	3829
Japan	++	306	++	3562
Sweden	++	349	++	454
Thailand	-	-	++	49
Russia	60	27076	-	-
Netherlands	11	2742	-	-
Other countries	++	529	-	-

Figures rounded off

Table – 28: Imports of Chromium & Scrap

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**972**	**102**	**26014**
Hong Kong	-	-	43	9614
Mexico	-	-	39	8414
Japan	-	-	20	4399
Germany	++	149	++	3029
USA	++	21	++	508
China	-	-	++	41
UK	-	-	++	9
Austria	++	800	-	-
Singapore	++	2	-	-

Figures rounded off

FUTURE OUTLOOK

The current status of chromite production and consumption is on anticipated lines, but the consumption could increase enormously in the coming years and the country may have to depend on imports even for the domestic needs of chromite. Depletion of reserves is bound to create a serious problem for the future of the Chromite Industry in the country. An Expert Committee constituted by the Ministry of Steel, Government of India, in its recommendations put forth the need for detailed exploration of chromite in all the potential areas in Odisha, Karnataka and in the ophiolite belt of North-Eastern region with a view to prognosticate resources to a depth of 500 m in Sukinda belt and estimate resources in all other potential areas. Addressing concerns in ferrochrome production which is energy intensive segment is also essential. Setting up of such plant must strike a cost balance between raw materials and electrical energy supply. There are other imminent issues like consistent supply of chrome ore at the right cost, steady power supply and other input materials like low phosporous met coke and good market conditions that need redressal in respect of the continuous and unscrupulous exploitation of chromite.

Adherence to stringent pollution control norms, innovations in the process technology and plant equipment design would become inevitable for the future of the industry.

As per the latest available data, supply of chrome ore is expected to increase at a compound annual growth rate (CAGR) of 2.4 per cent over the 2018 to 2022 period. Demand is expected to increase at a CAGR of 2.9 per cent. This is in comparision with the previous five years, where supply grew at a CAGR of 2.8 per cent and demand at 3.0 per cent modest reflection.

7. Coal & Lignite

778.21

(million tonnes) Production of coal were reported in 2020-21

1.31

(million tonnes) of coal (excl. lignite) were exported in 2021-22

203.64

(million tonnes) of coal (excl. lignite) were imported in 2021-22

361.41

(billion tonnes) total reserves/ resources of coal were estimated as on 1st April 2022

Coal is a fossil fuel. It is a combustible sedimentary, organic rock, which is composed mainly of carbon, hydrogen and oxygen. It is formed from vegetation, which has been consolidated between rock strata and altered by the combined effects of pressure and heat over millions of years to form coal seams.

The build-up of silt and other sediments, together with movements in the earth's crust (known as tectonic movements) buried these swamps and peat bogs, often to great depths causing the plant material to be subjected to high temperatures and pressures. Millions of years of deep burial engendered such physical and chemical changes which transformed the vegetation into peat and then into coal.

The quality of each coal deposit is determined by temperature and pressure and by the length of time in formation, which is referred to as its 'organic maturity'. Initially the peat is converted into lignite or 'brown coal' – these are coal types with low organic maturity. In comparison to other coals, lignite is quite soft and its colour can range from dark black to various shades of brown.

Many more millions of years of continuous effects of temperature and pressure produced further transformation of lignite, progressively increasing its organic maturity into the range known as 'sub- bituminous' coals.

Further chemical and physical changes have caused these coals to become harder and blacker, forming the 'bituminous' or 'hard coals'. Under the right conditions and progressive contrivance of organic maturity, finally results in the formation of anthracite.

Coal is vital for sustainable development. It is the most widely used energy source for electricity generation and an essential input for steel production. Coal is an essential resource for meeting the challenges facing the modern world. In India, coal accounts for around 55% of the country's primary commercial energy. Nearly 72% of the entire power generated in the country is coal based. India has a long history of commercial coal mining since 1774 and nationalisation of coal mines was put to effect on 01.05.1973. As per Integrated Energy Policy Committee of erstwhile Planning Commission, coal will remain India's most important energy source till 2031-32 and possibly beyond.

GEOLOGICAL RESOURCES

Coal

The coal deposits in India primarily are concentrated in the Gondwana sediments occurring mainly in the eastern and central parts of Peninsular India, although Gondwana coal deposits are also found to occur in the north-eastern part of the country mainly in Assam and Sikkim. The Tertiary coal-bearing sediments are found in Assam, Arunachal Pradesh, Nagaland and Meghalaya. As a result of exploration carried out by GSI, CMPDI and other agencies, about 361.411 billion tonnes (including that estimated in Sikkim) of geological coal resources up to 1,200 m depth have been established in the country as on 01.04.2022. Out of these resources, 187.105 (51.77%) billion tonnes are Proved resources, 147.252 (40.74%) billion tonnes are Indicated resources and the remaining about 27.052 (3.66%) billion tonnes are in the Inferred category. Of the total resources, the share of prime-coking coal is 5.318 billion tonnes, medium-coking 28.08 billion tonnes and blendable/semi-coking 1.708 billion tonnes. Share of non-coking coal, including high sulphur (tertiary) is326.306 billion tonnes. State-wise/Coalfield-wise and State-wise/ Type-wise Geological resources of coal as on 01.04.2022 are furnished in Tables-1 & 2, respectively.

Table – 1 : Geological Resources of Coal as on 01.04.2022

(By States/Coalfields)

(In million tonnes)

State/Coalfield	Proved	Indicated	Inferred	Total
All India : Total	**187105**	**147252**	**27054**	**361411**
Gondwana Coalfields*	**186512**	**147131**	**26113**	**359756**
Andhra Pradesh/ Godavari Valley	**921**	**2443**	**778**	**4142**
Assam/Singrimari	**-**	**14**	**-**	**14**
Bihar/Rajmahal	**310**	**4080**	**48**	**4437**
Chhattisgarh	**32053**	**40701**	**1437**	**74192**
Sohagpur	94	10	–	104
Sonhat	365	2304	2	2671
Jhilimili	228	39	–	267
Chirimiri	320	11	31	362
Bisrampur	2014	678	5	2698
East Bisrampur	–	165	–	165
Lakhanpur	456	3	–	459
Panchbahini	–	11	–	11
Hasdeo-Arand	2032	3273	223	5529
Sendurgarh	153	126	–	279
Korba	7055	5763	159	12976
Mand-Raigarh	17978	25307	924	44209
Tatapani-Ramkola	1358	3011	93	4462
Jharkhand	**53245**	**28260**	**5155**	**86660**
Raniganj	1594	445	–	2039
Jharia	16653	2880	–	19533
East Bokaro	3831	3690	762	8284
West Bokaro	3926	1279	17	5218
Ramgarh	937	912	58	1906
North Karanpura	10929	6173	1865	18967
South Karanpura	5614	1312	1143	8070
Aurangabad	352	2142	503	2997
Hutar	191	27	32	250
Daltonganj	84	60	–	144
Deogarh	326	74	–	400

State/Coalfield	Proved	Indicated	Inferred	Total
Rajmahal	8811	9267	774	18852
Madhya Pradesh	**14052**	**12723**	**4142**	**30917**
Johilla	185	263	33	481
Umaria	178	4	–	181
Pench-Kanhan	2112	923	1548	4583
Pathakhera	291	88	68	447
Gurgunda	–	85	53	138
Mohpani	8	–	–	8
Sohagpur	2417	5449	293	8159
Singrauli	8861	5912	2147	16919
Maharashtra	**7984**	**3390**	**1847**	**13221**
Wardha Valley	4928	1856	1441	8225
Kamptee	2046	938	107	3091
Umrer Makardhokra	308	–	161	469
Nand Bander	691	596	118	1405
Bokhara	10	–	20	30
Odisha	**48573**	**34080**	**5452**	**88105**
Ib-River	17134	14621	2228	33982
Talcher	31439	19460	3224	54122
Telangana	**11257**	**8344**	**3433**	**23034**
Godavari Valley	11257	8344	3433	23034
Sikkim/Rangit Valley	**–**	**58**	**43**	**101**
Uttar Pradesh/Singrauli	**884**	**178**	**–**	**1062**
West Bengal	**17234**	**12859**	**3779**	**33871**
Raniganj	16815	6680	2862	26357
Barjora	201	–	–	201
Birbhum	218	6179	901	7298
Darjeeling	–	–	15	15
Tertiary Coalfields	**594**	**121**	**941**	**1656**
Assam	**465**	**57**	**3**	**525**
Singrimari	–	14	–	14
Makum	432	21	–	453
Dilli-Jeypore	32	22	–	54
Mikir Hills	1	–	3	4
Arunachal Pradesh	**31**	**40**	**19**	**90**
Namchik-Namphuk	31	40	13	84
Miao Bum	–	–	6	6
Meghalaya	**89**	**17**	**471**	**576**
West Darangiri	65	–	60	125
East Darangiri	–	–	34	34
Balphakram-Pendenguru	–	–	107	107
Siju	–	–	125	125
Langrin	10	17	106	133
Mawlong Shelia	2	–	4	6
Khasi Hills	–	–	10	10
Bapung	11	–	23	34
Jayanti Hills	–	–	2	2

State/Coalfield	Proved	Indicated	Inferred	Total
Nagaland	**9**	**22**	**448**	**478**
Borjan	6	–	5	10
Jhanzi-Disai	2	22	109	133
Tiensang	1	–	2	3
Tiru Valley	–	–	7	7
Changki	–	–	32	32
DGM	–	–	293	293

Source: Coal Directory of India 2021-22, Coal Controller's Organisation, Kolkata, West Bengal. *
Including Sikkim. Figures rounded off.

(In million tonnes)

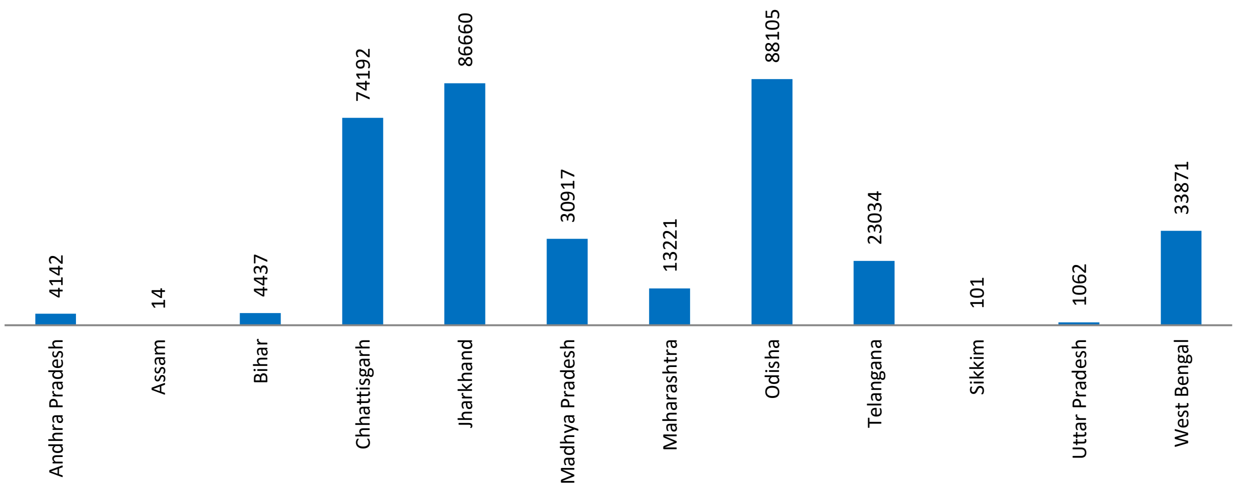


Fig 1: Geological Resources of Coal as on 01.04.2021 (By States/Coalfields)

Table – 2 : Geological Reserves/Resources of Coal as on 01.04.2022

(By States/Types)

(In million tonnes)

State/Type of coal	Proved	Indicated	Inferred	Total
All India : Total	**187105**	**147252**	**27054**	**361411**
Prime-coking	4673	645	–	5318
Medium-coking	15670	10648	1761	28080
Blendable/Semi-coking	530	992	186	1708
Non-coking	165639	134846	24166	324651
High Sulphur	594	121	941	1656
Andhra Pradesh/Non-coking	**921**	**2443**	**778**	**4142**
Arunachal Pradesh	**31**	**40**	**19**	**90**
High sulphur				
Assam	**465**	**57**	**3**	**525**
Semi-coking/Non-coking	–	14	–	14
High sulphur	465	43	3	511
Bihar/Non-coking	**310**	**4080**	**48**	**4437**
Chhattisgarh	**32053**	**40701**	**1437**	**74192**
Semi-coking	71	99	–	170
Non-coking	31983	40602	1437	74022
Jharkhand	**53245**	**28260**	**5155**	**86660**
Prime-coking	4673	645	–	5318
Medium-coking	14765	9088	1489	25342

State/Type of coal	Proved	Indicated	Inferred	Total
Semi-coking	223	472	53	748
Non-coking	33583	18055	3613	55252
Madhya Pradesh	**14052**	**12723**	**4142**	**30917**
Medium-coking	354	1560	273	2187
Non-coking	13697	11163	3869	28729
Maharashtra/Non-coking	**7984**	**3390**	**1847**	**13221**
Meghalaya/High sulphur	**89**	**17**	**471**	**576**
Nagaland/High sulphur	**9**	**22**	**448**	**478**
Odisha/Non-coking	**48573**	**34080**	**5452**	**88105**
Sikkim/Non-coking	**–**	**58**	**43**	**101**
Telangana/Non-coking	**11257**	**8344**	**3433**	**23034**
Uttar Pradesh/Non-coking	**884**	**178**	**–**	**1062**
West Bengal	**17234**	**12859**	**3779**	**33871**
Medium-coking	550	–	–	550
Semi-coking	236	420	133	789
Non-coking	16448	12439	3646	32532

Source: Coal Directory of India 2021-22, Coal Controller's Organisaton, Kolkata.

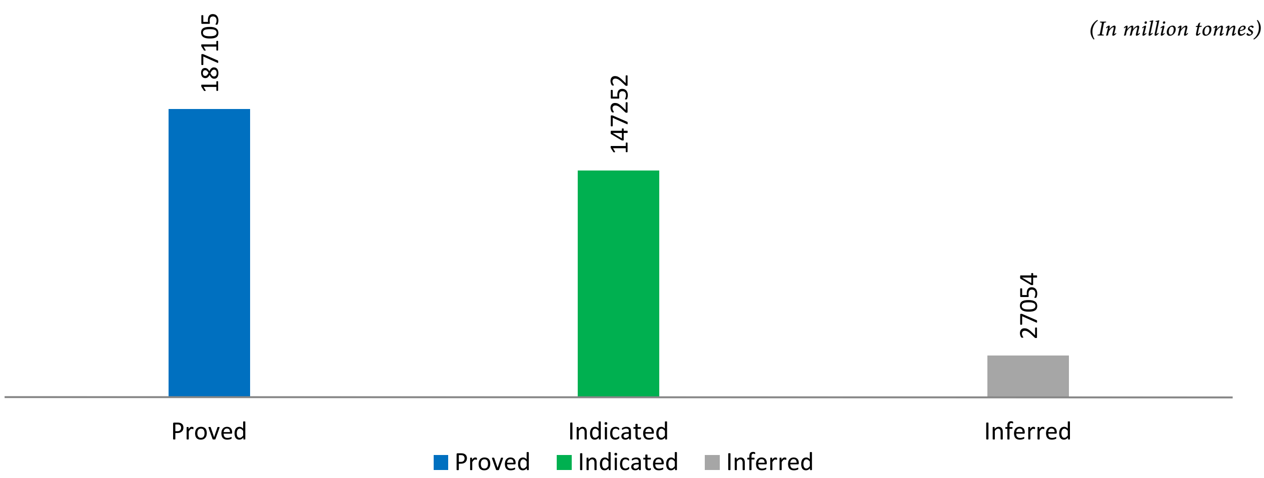


Fig 2: Geological Resources of Coal as on 01.04.2021

Lignite

Indian lignite deposits occur in the Tertiary sediments in the southern and western parts of peninsular shield particularly in Tamil Nadu, Puducherry, Gujarat & Rajasthan also in Jammu & Kashmir and Odisha. The total known geological resources of lignite as on 01.04.2022 is about 46.024 billion tonnes, of which 79.3% resources (about 36.56 billion tonnes) are located in Tamil Nadu, Rajasthan (13.98%) and Gujarat (5.89%). Other States where lignite deposits have been located are West Bengal and Kerala. State-wise/District-wise Geological resources of lignite as on 01.04.2022 are detailed in Table - 3.

Table – 3 : Fieldwise Geological Reserves/Resources of Lignite as on 01.04.2022

(By States/Districts)

(In million tonnes)

State/District	Area/Lignite field	Proved	Indicated	Inferred	Total
All India : Total		**7374.1**	**25721.65**	**13108.41**	**46204.16**
Gujarat		**1278.65**	**283.7**	**1159.7**	**2722.05**
Kachchh	Panandhro & Panandhro Extn., Barkhan Dam, Kaiyari Block-A & B, Mata-No-Madh, Umarsar, Lakhpat-Dhedadi (Punahrajpur), Akrimota, Jhularai-Waghapadar, Hamla-Ratadia & Pranpur.	335.61	56.4	33.09	425.1
Bharuch	Bhuri, Valia, Bhaga, Luna, Pansoli, Nani Pardi, Bhimpur, Rajpardi (GMDC leasehold) by MECL and Rajpardi (CGM) by MECL.	724.76	118.59	491.23	1334.58
Bhavnagar	Kharsalia, Rampur, Hoidad, Bhuteshwar, Surka, etc.	–	–	299.17	299.17
Surat	Tadkeswar, Dungra, East of Kamraj-Vesma, Nani Naroli, Tadkeswar block-Mongrol, Mandvi, Vastan, Ghala, etc.	218.28	108.71	336.21	663.2
Jammu & Kashmir U/T		**–**	**20.25**	**7.3**	**27.55**
Kupwara	Nichahom, Nichahom-Budhasung	–	20.25	7.3	27.55
Kerala		**–**	**–**	**9.65**	**9.65**
Kannur	Madayi, Kadamkottumala, Kayyur and Nileswaram	–	–	9.65	9.65
Odisha		**-**	**-**	**5.93**	**5.93**
Kendujhar	Gandhalpada West	-	-	5.93	5.93
Sundargarh					
Rajasthan		**1168.53**	**3029.78**	**2259.41**	**6457.72**
Bikaner	Palana, Barsinghsar, Gurha East & West, Bholasar, Bithnok Main & East (Extn.), Gadiyala, Girirajsar, Raneri, Mandal Chaman, Hadda, Hadda north & west, Hadla, Badhnu, Hira-ki-Dhani, Chak-Vijaisinghpura, Kuchore (Napasar), Riri, Lalamdesar, Lalamdesar Bada, East of Riri, Bania, Kuchaur-Athuni, Sarupdesar-Palana west, Palana East, Gigasar-Kesardesar, Khar Charan, Ambasar- Gigasar, Girirajsar Extn., Bapeau, Bigga-Abhaysingpura. Diyatra, Pyau, Deshnok-Ramsar-Sinthal, Borana, Bangarsar-Jaimalsar and Kmta-Ki-Basti & South of Bhane-Ka-Gao, etc.	560.3	230.33	309.19	1099.82
Barmer	Kapurdi, Jalipa, Bothia (Jalipa N Ext.), Giral, Jogeswartala, Sonari, Sachcha-Sauda, Bharka, Bothia-Bhakra-Dunga, Sindhari East & West, Kurla, Kurla East, Chokla North, Mahabar-Shivkar, Mithra, Hodu, Nimbalkot, Nimbalkot North, Nagurda, Nagurda (East), Munabao, Kawas Gravity Block, South of Nimbla and Magne-Ki-Dhani.	495.23	2509.46	1555	4559.69
Jaisalmer & Bikaner	Panna & Charanwala	–	–	11.47	11.47
Jaisalmer	Bhanda, Ramgarh & Khuiyala	–	–	70.44	70.44
Jaisalmer & Barmer	Khuri	–	–	13.8	13.8
Jalore	Sewara	–	–	76.08	76.08

State/District	Area/Lignite field	Proved	Indicated	Inferred	Total
Nagaur	Deswal, Gangardi, Indawar, Kaprion-Ki-Dhani, Kasnau-Igiar, Kuchera, Lunsara, Matasukh, Merta Road & Meeranagar, Mokala, Nimbri-Chadawatan and Ucharda,	113	289.49	204.74	607.23
Nagaur & Pali	Phalki, Phalki North and Phalodi	-	0.5	18.69	19.19
Tamil Nadu		**4926.92**	**21981.18**	**9652.62**	**36560.72**
Cuddalore	Neyveli Lignite Corporation (NLC) Leasehold areas, (Mine-I & expansion, Mine-IA, II & expansion, Mine-III, Block B, Mine-I, II & III and river), Devandgudi & areas, South of Vellar (Srimushnam), Veeranam (Lalpettai), Eastern part of NLC leasehold area, Kullanchavadi, Kudikadu, Bhuvanagiri-Kullanchavadi, Eastern part of Neyveli, Bahur*,West of Bahur*of Neyveli Lignite Field.	4022.69	1525.29	1302.23	6850.21
Ariyalur	Meensuruti, Jayamkondamcholapuram, Michaelpatti, & Michaelpatti Extn. of Neyveli Lignite Field	904.23	302.5	512.37	1719.1
Thanjavur &	Mannargudi-Central, Mannargudi-NE	-	17248.06	3123.46	20371.52
Thiruvarur	Mannargudi-NE Extn., Mannargudi SE, Melnattam-Araharam of Mannargudi Lignite Field				
Thanjavur	Cholapuram, Mannargudi-NW & SW, Maharajapuram Orattanadu-Pattukottai, Vadaseri (Orattanadu-Pattukottai), Madukkur-Anaikkadu, Veppanagulam-Kasangadu of Mannargudi Lignite Field	-	2306.17	156.33	2462.5
Thanjavur &	Alangudi, Pandanallur, Kadalangudi, Tirumangaicheri,	-	359.21	926.62	1285.83
Nagapattinam	and Thirumangalam of Mannargudi Lignite Field				
Thiruvarur &	Nachiyarkudi of Mannargudi Lignite Field	-	-	574.05	574.05
Nagapattinam					
Ramanathapuram	Misal, Bogalur, Bogalur (East), Uttarakosamangai & Tiyanur,Kalari North West & East of Ramanathapuram Lignite Field	-	168.83	2072.35	2241.18
Ramnad &	Rajasing Mangalam Pandiyur & Settanur of	-	71.12	985.21	1056.33
Ramanathapuram	Ramanathapuram Lignite Field				
Sivaganga					
Puducherry U/T	**Bahur & West of Bahur of Neyveli Lignite Field**	**-**	**405.61**	**11**	**416.61**
West Bengal		**-**	**1.13**	**2.8**	**3.93**
Bardhaman	Rakshitpur, Gaurangapur-Bankati	-	0.29	1.82	2.11
Birbhum	Mahalla, Dhobbanpur & Djara	-	0.84	0.98	1.82

Source: Coal Directory of India 2021-22, Coal Controller's Organisation, Kolkata and Geological Survey of India.

** Both blocks cover parts of Tamil Nadu and Puducherry.*

EXPLORATION & DEVELOPMENT

Exploration and development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews" i.e, Vol. I of the titl e.

PRODUCTION AND STOCKS

COAL

Production

The total production of coal reported in 2021-22 was 778.21 million tonnes which increased by around 9% in comparison to that of the previous year. Odisha is the largest coal producing State with a share of about 24% followed by Chhattisgarh and Madhya Pradesh having contribution of 20% and 18% respectively in the national output. Statewise production is furnished in Table-4.

Table – 4 : Production of Coal, 2019-20 to 2021-22

(By Sectors/States)

(Quantity in '000 tonnes)

State/UT	2019-20	2020-21	2021-22 (P)
India	**730874**	**716083**	**778210**
Public Sector	**698224**	**685950**	**747441**
Private Sector	**32650**	**30133**	**30769**
Assam	517	36	28
Chhattisgarh	157745	158410	154120
Jammu & Kashmir	14	10	11
Jharkhand	131763	119295	130105
Maharashtra	54746	47435	56528
Meghalaya	0	0	0
Madhya Pradesh	125726	132531	137975
Odisha	143016	154151	185068
Telangana	65703	52603	67233
Uttar Pradesh	18030	17016	18073
West Bengal	33614	34596	29069

Source: Coal Directory of India, 2021-22.

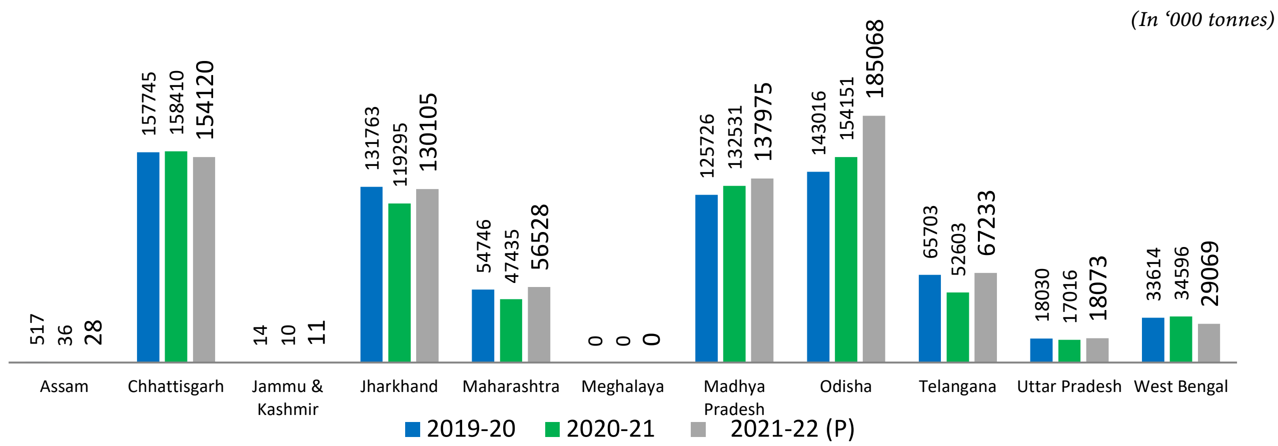


Fig 4: Stateswise Production of Coal

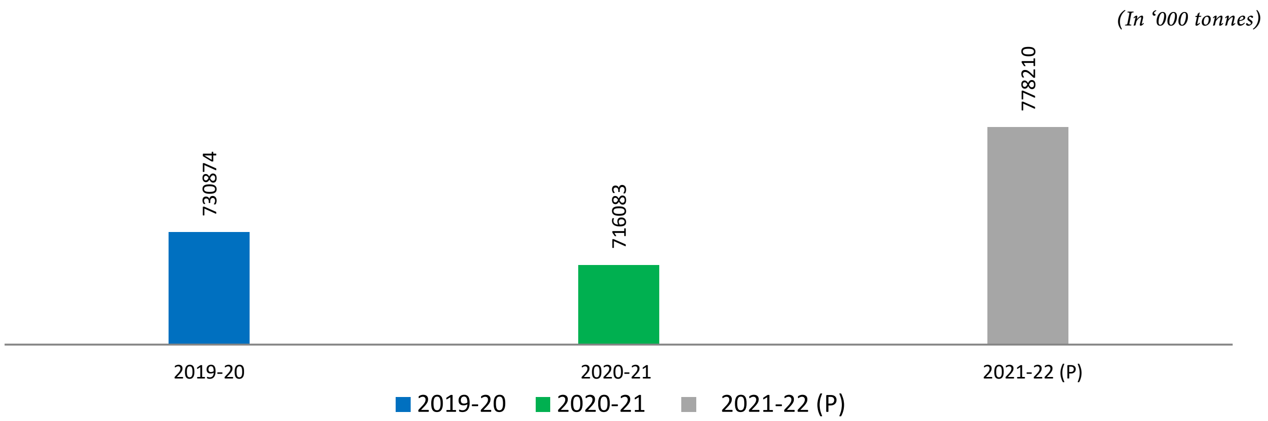


Fig 5: Coal Production (Total)

Next in order of share in the total production were Jharkhand (16.71%), Telangana (8.64%), Maharashtra (7.26%), West Bengal (3.74%) and Uttar Pradesh (2.32%). Small quantity of coal production was reported by Assam and Union Territory of Jammu & Kashmir. During the year 2021-22 coal mining was confined mainly to the Public Sector that contributed about 96%. The remaining 4% was contributed by the Private Sector. A total of 533 coal mines (as on 31.03.2022) in India reported production in 2021-22. Out of these, Jharkhand accounted for 171 mines while Madhya Pradesh 79, Chhattisgarh 77 West Bengal 72, Maharashtra 57, Telangana 46 and Odisha 21. The remaining 10 mines were from Assam, Union Territory of Jammu & Kashmir and Uttar Pradesh (Table - 5).

Table – 5 : Number of Coal Mines, 2020-21 & 2021-22 (P)

(By States)

(No. of Mines)

State	No. of Mines	
	2020-21	2021-22 (P)
India	**442**	**533**
Arunachal Pradesh	**0**	**0**
Assam	**3**	**3**
Chhattisgarh	53	77
Jammu & Kashmir	2	2
Jharkhand	113	171
Madhya Pradesh	61	79
Maharashtra	54	57
Meghalaya	0	NA
Odisha	31	21
Uttar Pradesh	5	5
Telangana	48	46
West Bengal	72	72

During the year 2021-22 coal mining was confined mainly to t he Public Sector that contributed about 96%. In the year 2021-22, out of the total reported production of coal, 6% was coking coal and the rest 94% was non-coking coal. The bulk of the coking coal production, i.e., about 91% was reported from the Public Sector.

Grade-wise analysis of coking coal in 2021-22 revealed that Washery Grade IV had the maximum share at 50% followed by Washery Grade V (39%), Washery Grade II (5%) and Washery Grade III (3%). The remaining 3% production of coking coal was of Semi-coking Grade, Washery Grade I & VI and Steel Grade I & II. Out of the total production of coking coal in India, bulk quantity, i.e., 99% was produced in Jharkhand (51.219 million tonnes). The remaining 1% was contributed by Chhattisgarh, Madhya Pradesh and West Bengal collectively (Tables-6 & 7).

Table –6: Production of Coking Coal, 2020-21

(By States and Grades)

(In '000 tonnes)

State	All-Grades	ST-I	ST-II	W-I	W-II	W-III	W-IV	W-V	W-V1	SC
India	**44787**	**1**	**8**	**202**	**2365**	**1820**	**26943**	**12798**	**431**	**219**
Chhattisgarh	219	-	-	-	-	-	-	-	-	219
Jharkhand	44387	1	8	202	2365	1820	26762	12798	431	-
Madhya Pradesh	181	-	-	-	-	-	181	-	-	-
West Bengal	-	-	-	-	-	-	-	-	-	-

Source: Coal Directory of India, 2020-21.

Table –7: Production of Coking Coal, 2021-22

(By States and Grades)

(In '000 tonnes)

State	All-Grades	ST-I	ST-II	W-I	W-II	W-III	W-IV	W-V	W-V1	SC
India	**51702**	**225**	**-**	**234**	**2501**	**1539**	**25740**	**20171**	**1292**	**-**
Chhattisgarh	225	225	-	-	-	-	-	-	-	-
Jharkhand	51219	-	-	234	2401	1539	25582	20171	1292	-
Madhya Pradesh	158	-	-	-	-	-	158	-	-	-
West Bengal	100	-	-	-	100	-	-	-	-	-

Source: Coal Directory of India, 2021-22, Coal Controller's Organisation, Kolkata.

During 2021-22, except for a nominal quantity around (4%), the balance production of non-coking coal (96%) came from the Public Sector. Out of the total production of non-coking coal grades, G11 grade accounted for 31% followed by G13 (14%), G14 (11%), G12 (10.7%), G10 (8.6%), G8 (6.4%), G9 (6%) and G7 (5.5%). The remaining about 6.8% production was accounted for by G1, G2, G3, G5, G6, G15, G16, G17 and UNG grades of non-coking coal. Odisha was the largest producing State. For non-coking coal in 2021-22 which alone accounted for 25.5% of the national output. Next in order were Chhattisgarh with a contribution of (21.2%), Madhya Pradesh (19%), Jharkhand (10.9%), Telangana (9.3%), Maharashtra (7.8%), West Bengal (4%) and Uttar Pradesh (2.5%). Production minor quantities was reported from Assam and Union Territory of Jammu & Kashmir (Tables-8 to 10).

Table – 8: Production of Coal, 2020-21 & 2021-22

(By Grades and Sectors)

(In '000 tonnes)

Grade	2020-21			2021-22 (P)		
	Total	Pub. Sec.	Pvt. Sec.	Total	Pub. Sec.	Pvt. Sec.
All Grades	**716083**	**685950**	**30133**	**778210**	**747441**	**30769**
Coking	**44787**	**38934**	**5853**	**51702**	**47022**	**4680**
Steel-I	1	1	0	225	225	0
Steel -II	8	8	0	0	0	0
Wash-I	202	202	0	234	234	0
Wash -II	2365	1716	649	2500	1901	599
Wash -III	1820	1431	389	1539	1266	273
Wash -IV	26943	22128	4815	25740	21932	3808
Wash-V	12798	12798	0	20172	20172	0
Wash-VI	431	431	0	1292	1292	0
SC-I	219	219	0	0	0	0
SLV1	0	0	0	0	0	0
Mg feed	0	0	0	0	0	0
Non Coking	**671296**	**647016**	**24280**	**726508**	**700419**	**26089**
G1	3	3	0	0	0	0
G2	27	27	0	9	9	0
G3	2681	2681	0	2012	2012	0
G4	14221	14221	0	13049	13049	0
G5	9707	9707	0	8657	8657	0
G6	4252	4206	46	5492	5126	366
G7	37446	37446	0	40742	40209	534
G8	47702	47262	440	46402	46236	166
G9	36723	36723	0	43597	43597	0
G10	69883	59558	10325	62426	53153	9273
G11	194693	181515	13178	223091	209271	13820
G12	73346	73167	179	77626	76926	699
G13	80935	80823	112	100358	99991	367
G14	66297	66297	0	81184	80682	501
G15	26201	26201	0	14047	14047	0
G16	6790	6790	0	7442	7442	0
G17	236	236	0	375	11	363
UNG	153	153	0	-	-	-

Source: 1. Coal Directory of India, 2020-21 & 2021-22, Coal Controller's Organisation, Kolkata.

Note: Meghalaya Coal has not been graded by Coal Controller. For statistical purpose, grade may be treated as 'A'/'B' non-coking coal.

Table – 9 : Production of Non-coking Coal, 2020-21

(By States and Grades)

(In '000 tonnes)

State	Grades																		
	All-Grades	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	UNG
India	**671296**	**3**	**27**	**2681**	**14221**	**9707**	**4252**	**37446**	**47702**	**36723**	**69883**	**194693**	**73346**	**80935**	**66297**	**26201**	**6790**	**236**	**153**
Arunachal Pradesh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Assam	36	3	27	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
Chhattisgarh	158191	-	-	1640	-	1860	945	2601	2212	1561	2379	120900	2039	5899	1093	8272	6790	-	-
Jammu & Kashmir (UT)	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-
Jharkhand	79041	-	-	228	43	1070	669	3396	4865	18491	6638	11939	9795	21907	-	-	-	-	-
Madhya Pradesh	132350	-	-	-	-	436	1335	25073	17696	3840	38692	33426	7825	3929	98	-	-	-	-
Maharashtra	47435	-	-	-	-	-	-	107	696	5377	16058	17635	4645	2917	-	-	-	-	-
Meghalaya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Odisha	154151	-	-	-	-	-	-	-	76	-	-	-	44769	34105	62925	12276	-	-	-
Telangana	52603	-	-	-	-	450	76	3741	5967	6882	3159	8546	3621	11948	2181	5653	-	226	153
Uttar Pradesh	17016	-	-	-	-	-	-	-	14319	572	1957	168	-	-	-	-	-	-	-
West Bengal	30463	-	-	813	14178	5891	1221	2528	1871	-	1000	2079	652	230	-	-	-	-	-

Source: Coal Directory of India, 2020-21, Coal Controllers' Organisation, Kolkata.

Note: Meghalaya coal has not been graded. For statistical purpose grade may be treated as "A"/"B" non-coking coal.

Table- 10: Production of Non-coking Coal, 2021-22

(By States and Grades)

(In '000 tonnes)

State	Grades																	
	All-Grades	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	UNG
India	**726508**	**-**	**9**	**2012**	**13049**	**8657**	**5492**	**40742**	**46402**	**43597**	**62426**	**223091**	**77626**	**100358**	**81184**	**14047**	**7442**	**375**	**-**
Arunachal Pradesh	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Assam	28	-	9	19	-	-	6	-	-	-	-	-	-	-	-	-	-	-	
Chhattisgarh	153893	-	-	1186	102	1326	1063	1378	1847	1195	3004	116355	3100	6045	2082	7406	7442	364	-
Jammu & Kashmir	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-
Jharkhand	78884	-	-	143	88	579	1216	3564	5528	23107	4228	20023	6731	13678	-	-	-	-	-
Madhya Pradesh	137818	-	-	-	-	312	1298	29151	15088	5440	30450	44734	8501	2737	107	-	-	-	-
Maharashtra	56529	-	-	-	-	-	-	88	808	4944	17746	21092	6675	5176	-	-	-	-	-
Meghalaya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Odisha	185069	-	-	-	-	-	-	-	60	49	-	-	51398	57023	76538	1	-	-	-
Telangana	67233	-	-	-	-	675	99	5142	6439	7302	4585	18250	309	15337	2457	6640	-	-	-
Uttar Pradesh	18073	-	-	-	-	-	-	-	14367	1292	2414	-	-	-	-	-	-	-	-
West Bengal	28970	-	-	665	12859	5765	1816	1420	2265	268	-	2637	913	363	-	-	-	-	-

Source: Coal Directory of India, 2021-22, Coal Controller's Organisation, Kolkata.

Note: Meghalaya coal has not been graded. For Statistical purpose grade may be treated as "A"/"B" non-coking coal;

Despatches

Despatches of Raw coal at 819.2 million tonnes in 2021-22 were higher by around 19% as compared to that in the previous year. Odisha was the leading State in the despatches in 2021-22 accounting for 24 % of the total despatches. The States next in the order were Chhattisgarh (20.31%), Jharkhand (16.91%), Madhya Pradesh (14 %), Telangana (8 . 26 %), Maharashtra (7.66%), Uttar Pradesh (5.42%) and West Bengal (3.65%). The remaining very small quantity of despatches were from the Union Territory of Jammu & Kashmir.

During the year 2021-22, statewise analysis revealed that there was increase in the despatches of coal from almost all States, namely, Odisha, Chhattisgarh, Jharkhand, Madhya Pradesh Telangana, Maharashtra, West Bengal and Union Territory of Jammu & Kashmir as against that of the previous year.

Of the total provisional despatches of raw coal effected in 2021-22, a sizeable share of 86% was made to the Electricity Sector (Power utility and Power captive). As much as 1% each to the Sponge Iron Industry and Steel Industry. The remaining 12% was made for other priority sectors including Cement Industry, Fertilizer Industry, Other Basic Metals, Pulp & Paper Chemical, Steel (boilers), Textile & Rayons, Bricks and Others (Tables-11 & 12).

Table – 11: Despatches of Raw Coal,

2020-21& 2021-22

(By States)

(In '000 tonnes)

States	2020-21 (R)	2021-22 (P)
India	**690884**	**819213**
Arunachal Pradesh	-	-
Assam	90	0
Chhattisgarh	146253	166428
Jammu & Kashmir (UT)	8	18
Jharkhand	122238	138560
Madhya Pradesh	105384	115332
Maharashtra	46571	62755
Meghalaya	0	0
Odisha	151911	193638
Telangana	50533	67743
Uttar Pradesh	38355	44804
West Bengal	29541	29935

Source: Coal Directory of India, 2020-21 & 2021-22, Coal Controller's Organisation, Kolkata.

Table –12 : Despatches of Raw Coal,

2020-21 & 2021-22

(By Priorities)

(In '000 tonnes)

Priority	2020-21 (R)	2021-22 (P)
Total	**690884**	**819213**
Power (Utility)	535447	668298
Power (Captive)	45786	36699
Steel	8975	9159
Cement	6754	7306
Sponge Iron	9565	9023
Fertilizers	1527	1111
Pulp & Paper	1045	1244
Other Basic metal	683	2933
Chemical	158	196
Textiles & Rayons	80	80
Bricks	25	23
Others	80839	83141

Source: Coal Directory of India, 2020-21 & 2021-22, Coal Controller's Organisation, Kolkata.

Note: Steel includes direct feed & coking washery for metallurgical use and steel (boilers); Others include non-coking washery and Bricks.

Stocks

The mine-head stocks of coal at the end of the year 2021-22 were 69 million tonnes which was around 37% less than that at the beginning of the year. Similarly, the mine-head stocks of coal at the end of the year 2020-21 were 109.06 million tonnes which increased by 34% from that of the stocks that were available at the beginning of the year. Bulk of the coal stocks (about 99.9%) at the end of the year was accounted for by the mines located in the States of Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Telangana, Uttar Pradesh and West Bengal (Tables-13 & 14)

Table – 13: Mine-head Stocks of Coal, 2020-21

(By States)

(In '000 tonnes)

State	At the beginning of the year	At the end of the year
India	**81432**	**109060**
Arunachal Pradesh	-	-
Assam	54	-
Chhattisgarh	18264	29723
Jammu & Kashmir (UT)	7	9
Jharkhand	17959	19320
Madhya Pradesh	4078	6796
Maharashtra	13673	14533
Odisha	20999	24922
Telangana	3192	5247
Uttar Pradesh	1388	5163
West Bengal	1818	3347

Source: Coal Directory of India, 2021-22.

Table – 14: Mine-head Stocks of Coal, 2021-22 (P)

(By States)

(In '000 tonnes)

State	At the beginning of the year	At the end of the year
India	**109060**	**68901**
Arunachal Pradesh	-	-
Assam	-	28
Chhattisgarh	29723	16890
Jammu & Kashmir (U/T)	9	1
Jharkhand	19320	10799
Madhya Pradesh	6796	6708
Maharashtra	14533	8312
Odisha	24922	17445
Telangana	5247	4726
Uttar Pradesh	5163	1678
West Bengal	3347	2314

Source : Coal Directory of India, 2021-22.

LIGNITE

Production

During the year 2021-22 the reported production of lignite was 47 million tonnes which increased by around 25% in comparison to that of the previous year. The production from Tamil Nadu accounted for around 50 %. The share of Gujarat in lignite production was around 28% and that of Rajasthan was 22% (Table-15).

Out of the total 20 mines that reported lignite production in 2021-22, ten mines are located in Gujarat, seven in Rajasthan and the remaining three in Tamil Nadu (Table-16).

Table – 15 : Production of Lignite, 2019-20 to 2021-22

(By Sectors/States)

(Quantity in '000 tonnes)

State	2019-20	2020-21	2021-22 (P)
India	**42096**	**37895**	**47492**
Public Sector	**41366**	**36903**	**46411**
Private	**730**	**992**	**1081**
Gujarat	10357	10813	13331
Tamil Nadu	23516	18026	23635
Rajasthan	8223	9056	10526

Source: Coal Directory of India, 2021-22, Coal Controller's Organisation, Kolkata.

Table – 16 : Number of Lignite Mines 2021-22

(By States)

State	No. of Mines	
	2020-21	2021-22
India	**20**	**20**
Gujarat	10	10
Rajasthan	7	7
Tamil Nadu	3	3

Source: Coal Directory of India, 2021-22.

Note: No. of mines as on the last day of financial year

Despatches

The quantum of despatches of lignite was 49 million tonnes for the year 2021 - 22 which increased by around 27% as compared to that in the previous year (Table-17).

Table – 17 : Despatches of Lignite

2020-21 &2021-22

(By States)

(In '000 tonnes)

State	2020-21	2021-22 (P)
India	**38492**	**49074**
Gujarat	110819	13385
Rajasthan	9157	10235
Tamil Nadu	18516	25454

Source: Coal Directory of India, 2020-21 & 2021-22.

Stocks

The mine-head stocks of lignite at the end of 2021 - 22 were 3,389 thousand tonnes which decreased by 32% from that of the stocks that were available at the beginning of the year (Table-18).

Table – 18 : Mine-head Stocks of Lignite, 2020-21 & 2021-22

(By States)

(In '000 tonnes)

State	2020-21		2021-22	
	At the beginning of the year	At the end of the year	At the beginning of the year	At the end of the year
India	**5495**	**4981**	**4981**	**3389**
Gujarat	28	103	103	49
Rajasthan	408	307	307	588
Tamil Nadu	5059	4571	4571	2752

Source: Coal Directory of India, 2020-21 & 2021-22

MINING & MARKETING

Coal

Coal mining in the country is carried out by both open-cast and underground methods. Opencast mining contributed 95.50 % of the total provisional production, whereas the rest of the production (4.50%) came from underground mining during 2020-21. Most of the mines are either semi-mechanised or mechanised. The machinery commonly deployed are drill machines, load- haul-dumper (LHD), ventilation fans, pumps for dewatering, haulage for transport, etc. In order to arrest the decline in production from a few underground mines, "mass production technology" by introducing 'continuous miner' is being practised. CIL has planned to introduce 26 nos. of 'continuous miner' in 19 mines and 2 PSLV in 2 mines in the coming 5 years. Modern roof-bolting technology with "flexibolts" up to 5 m length; 'smart bolting' for cost reduction of roof support; and introduction of mechanised roof bolting using hydraulic bolts for difficult roof are new technology absorptions in Indian Underground Coal Mining. Mechanised Long wall mining (long wall powered support) has also been introduced in a limited scale which yields higher output with high percentage recovery (70–80%). In opencast mines, machinery like draglines, dozers, shovels, dumpers and graders are deployed for various operations. CIL has introduced high capacity HEMM's like 42 CuM shovel with 240 tonnes rear dumper in Gevra Expansion, Dipka & Kusmunda open-cast mines.

The latest policy pursued by CIL is to encourage technology upgradation through Global Tender. Global tender approach has been used towards introduction of high productivity with the use of Continuous Miners.

Eastern Coalfields Limited (ECL), Bharat Coking Coal Limited (BCCL), Central Coalfields Limited (CCL), Western Coalfields Limited (WCL), South- Eastern Coalfields Limited (SECL), Mahanadi Coalfields Limited (MCL), Northern Coalfields Limited (NCL) and NEC (North-Eastern Coal field are the 8 subsidiary companies of Coal India Ltd (CIL), a Government of India Undertaking. The coal mines in Assam and its neighbouring areas are controlled directly by CIL under the unit North Eastern Coalfields Ltd (NEC). CMPDIL is a subsidiary of CIL which is engaged in surveying, planning and designing work with a view to optimise coal production.The Singareni Collieries Company Limited (SCCL) is a joint venture between Government of India and Government of Telangana.

BCCL is the major producer of prime-coking coal (raw and washed). Medium-coking coal is also produced in Mohuda and Barakar areas. In addition to production of hard coke and soft coke, BCCL operates a number of sand gathering plants, a network of aerial ropeways for transport of sand and nine coal washeries, namely, Dugda-I, Dugda-II, Bhojudih, Patherdih, Mahuda, Sudamdih, Barora, Moonidih and Madhuband.

CCL operates mines in Bokaro, Ramgarh, Giridih and North & South Karanpura Coalfields in Jharkhand and four coal washeries, namely, Kathara, Swang, Rajrappa and Kedla. Its products included medium-coking coal (raw and washed), non-coking coal, soft coke and hard coke.

WCL operates coal mines located in Pench, Kanhan and Pathakheda Coalfields in Madhya Pradesh and Wardha Valley & Kamptee Coalfields in Maharashtra. This Company largely meets the requirements of thermal power plans and industries in the western region of the country.

ECL covers Raniganj Coalfields in West Bengal and Mugma & Rajmahal Coalfields in Jharkhand. It produces and supplies coal to the local and other industries which require relatively higher grades of coal.

The coalfields of Chhattisgarh, viz, Korba (East & West), Baikunthpur, Chirimiri, Hasdeo, Sohagpur, Jamuna-Kotma and Johilia are under SECL. This subsidiary continued to be the leading producer of CIL.

NEC is responsible for development and production of coal in the North-Eastern States. The present mining activities are confined to Arunachal Pradesh, Assam and Meghalaya. At present, there are 3 Nos.of existing mines, namely, Tirap, Tikale and Tipong. Out of these, Tipong colliery is an underground mine while the remaining colliery chies are openast mines. The area has large proven reserves of low ash, high calorific value coal but because of its high sulphur content, it cannot be used directly as metallurgical coal.

SCCL operates coal mines in Telangana which produces non-coking coal. The coal requirements of consumers in south are mostly met by this Company. SCCL contributes around 9% of the total all India production of coal.

MCL had been incorporated as another subsidiary Company of CIL. Its area of jurisdiction comprises Talcher and Ib Valley Coalfields of Odisha.

NCL covers the entire Singrauli Coalfields situated in Madhya Pradesh and Uttar Pradesh.

Jharkhand State Mineral Development Corporation Ltd (JSMDCL) and Jammu & Kashmir Minerals Ltd (JKML) are State Government Undertakings and Damodar Valley Corporation (DVC) is Central Public Sector Undertaking that are engaged in coal mining. IISCO steel plant of SAIL is the only Public Sector steel unit operating captive mines for coal. Bengal Emta Coal Mines Ltd (BECML), Jindal Steel & Power Ltd (JSPL), Hindalco and Tata Steel are the Companies operating captive mines in the Private Sector.

As on 31.3.2022, there were 533 operating mines for coal in the country out of which 249 were open-cast, while 258 were underground mines. The remaining 26 were mixed collieries. There were 512 Public Sector mines and 21 mines in Private Sector (Table-19). Thrust is given on further increasing production from opencast mines where the gestation period is comparatively shorter. In 2021-22, the share of provisional production of raw coal from opencast mines was 745.027 million tonnes (95.74%) and 33.183 million tonnes (4.26%) from underground mines (Table-20). Production of coal by different mining technologies employed during 2021-22 is furnished in Table-21. The overall Output per Man Shift (OMS) in opencast and underground mines for CIL in 2021-22 was 9.54 tonnes as against 10.32 tonnes in 2020-21. The overall OMS in opencast and underground mines for SCCL was 8.53 tonnes in 2021-22 as against 6.80 tonnes in 2020-21.

Table – 19 : Number* of Coal Mines, 2021-22

(By Sectors/States)

No. of collieries

State	OC	UG	Mixed	Total
All India	**249**	**258**	**26**	**533**
Public Sector	238	250	24	512
Private Sector	11	8	2	21
Arunachal Pradesh	-	-	-	-
Assam	2	1	-	3
Chhattisgarhv	28	46	3	77
Jammu & Kashmir (U/T)	-	2	-	2
Jharkhand	92	66	13	171
Madhya Pradesh	23	54	2	79
Maharashtra	40	17	-	57
Odisha	18	3	-	21
Telangana	21	25	-	46
Uttar Pradesh	5	-	-	5
West Bengal	20	44	8	72

Source: Coal Directory of India, 2021-22, Coal Controller's Organisation, Kolkata.

** Relates to no. of mines as on last day of the financial year (As on 31.3.2022).*

Note: OC - Opencast UG - Underground. U/T - Union Territory

Table – 20 : Production of Raw Coal

(In million tonnes)

Year	Production from open-cast mines (% share)	Production from under-ground mines (% share)	Total production
2018-19	686.214	42.504	728.718
	-94.17%	-5.80%	
2019-20	690.393	40.481	730.874
	-94.46%	-5.54%	
2020-21	683.872	32.211	716.083
	-95.50%	-4.50%	
2021-22	745.027	33.183	778.21
	-95.74%	-4.26%	

Source: Coal Directory of India, 2021-22

Coal Controller's Organisation, Kolkata

Table – 21 : Production of Coal, 2021-22

(By Technology)

(In million tonnes)

Technology adopted	Production	Percentage of total
All India : Total	**778.21**	**100**
Opencast (Total)	**745.027**	**95.74**
Mechanised	745.027	100
Manual	-	-
Underground (Total)	**33.183**	**4.26**
Conventional B&P	0.033	0.1

Technology ado pted	Production	Percentage of total
Mechanised B&P	28.457	85.76
Conventional LW	0.246	0.74
Mechanised LW	2.532	7.63
Other methods	**1.914**	**5.77**

Source: Coal Directory of India, 2021.22,

Coal Controller's Organisation, Kolkata.

Note: B&P - Board-and-pillar; LW - Longwall

Under the Colliery Control Order, 1945, the Central Government was empowered to fix the prices of coal gradewise and collierywise. As per recommendations of the Bureau of Industrial Costs & Prices and the Committee on Integrated Coal Policy, prices of different grades of coal were subjected to deregulation since 22.3.1996, in a phased manner. As the prices of all grades of coking coal got deregulated with effect from 1.4.1996, distribution fell under the purview of CIL/coal companies. The Government of India amended the provisions of Colliery Control Order 1945 and Colliery Control Order 2000 were notified, according to which, the price & distribution of all grades of coal with effect from 1.1.2000 have been deregulated.

Coal movements by coastal shipment to southern and western regions through Haldia, Paradip and Vizag ports continued as usual. Major portion of the despatches was achieved through railways, followed by roads, Merry-Go-Round System, belt conveyor, ropeways and sea route.

Lignite

As on 31.03.2022, the total number of operating lignite mines was 20 and all are worked by opencast method. Out of these, 16 are captive and the remaining four are non-captive. Four mines are owned by Neyveli Lignite Corporation (NLC), six by Gujarat Mineral Development Corporation Ltd (GMDCL), three each by Rajasthan State Mines & Minerals Limited (RSMML) & Gujarat Industries Power Co. Ltd (GIPCL) and one each by Gujarat Heavy Chemicals Ltd (GHCL), Barmer Lignite Mining Company Limited (BLMCL), GPCL & V S Lignite Power Pvt. Ltd (VSLPPL). Sector-wise, seventeen mines are under Public Sector and the remaining three are under Private Sector, i.e., GHCL, GPCL & VSLPPL.

The Neyveli Lignite Mine is the largest open- cast mine in the country with eco- friendly technology. To increase the power demand and to manage both social and environmental externalities, NLC has now diversified into coal mining, coal- based power generation and green energy. NLC operates three opencast mines at Neyveli, Tamilnadu and one opencast mine at Barsingsar, Rajasthan. The present installed capacity in lignite mining of all NLC mines stands at 30.60 MTPA viz. Mine-I with 10.5 MTPA, Mine-IA with 3.0 MTPA, Mine-II with 15.0 MTPA, Barsingsar with 2.1 MTPA Besides, additional planned capacity of lignite mining of 31.55 MTPA viz. Bithnok Lignite Mine (2.25 MTPA), Hadla Mine (1.9 MTPA), Barsingsar expansion (0.40 MTPA), Mine-III project (11.50 MTPA) and South of Vellar & Palayamkottai lignite blocks (11.50 MTPA) is under implementation. The planned capacity of coal mining of 31.00 MTPA viz. Talabira II & III blocks (20.00 MTPA) in the State of Odisha and Pachwara South Coal block (11.00 MTPA) in the State of Jharkhand has been allotted to Neyveli Uttar Pradesh Power Ltd (NUPPL) and is under implementation. The production of lignite for all NLC mines was 251.13 lakh tonnes during 2021-22 which increased by 30% from 192.63 lakh tonnes in the previous year. Due to poor demand on account of pandemic situation and shutdown of few units, Lignite production is restricted accordingly during 2020-21. The NLC's mines are highly mechanised. Presently, these mines are linked to three thermal power stations.

In Power Sector, NLC has added 500 MW Thermal Power and 17.5 MW Renewable power during the year 2020-21 and retired 350 MW of its installed capacity with addition and retirement of unit.

The Corporate Plan Document envisages increase in overall lignite production by 62.15 MTPA, coal production by 31.00 MTPA and power generation up to 21 GW by the year 2025.

Therefore, as on 31.03.2020, the total number of coal blocks that existed was 105. Out of these, 82 blocks were vested/ allotted which accounted for 10,994.79 million tonnes; 11 blocks were under Auction by Competitive Bidding Rules, 2012 with 4,054.84 million tonnes; 8 blocks were that of Custodian with 417.02 million tonnes; and 4 blocks with 2,262.88 million tonnes remained as 'not cancelled' by the Hon'ble Supreme Court.

Up to 2020-21, a total of 126 coal blocks with 21,488.45 million tonnes geological/extractable reserves have been allotted in various States (Table - 22). Of these, 80 coal blocks with 18,853.48 million tonnes are under Public Sector Undertakings (PSU) and the remaining 46 blocks with about 2,634.97 million tonnes are under Private Sector companies. Among these,62 blocks with 14,146.41 million tonnes have been allocated for Power, 26 blocks with 1,018.90 million tonnes for Non-regulated Sector (NRS), 2 blocks with 350.11 million tonnes for Ultra Mega Power Project (UMPP) and 36 blocks with 5,971.33 million tonnes for commercial mining

Table – 22 : Statewise Allotment of Captive Coal Blocks that stand Allocated/Vested/ including Blocks Allotted Under MMDR Act up to 2020-2021 (Except CIL as custodian)

(In million tonnes)

State	No. of blocks	Geological/ extractable Reserves
Coal		
Chhattisgarh	23	4078.24
Jharkhand	36	7027.08
Madhya Pradesh	18	1415.58
Maharashtra	13	370.92
Odisha	19	5472.26
Telangana	2	151.79
West Bengal	15	2972.58
Total	126	21488.45

Source: Coal Directory of India 2020-21, Coal Controller's Organisation, Kolkata.

Note: Extractable reserves (in million tonnes) have been shown against the newly allocated/vested coal blocks as per CM(SP)Act, 2015.

Similarly, up to 31.03.2021, 23 captive lignite blocks stand allocated with 1,555.33 million tonnes geological/ extractable reserves. Of these, 21 blocks with 1,502.87 million tonnnes are under Public Sector Undertakings (State PSU) and the remaining 2 blocks are under Private Sector with 52.46 million tonnes. By sectors, 12 blocks with 1,138.60 million tonnes have been allocated for power generation and 11 blocks with 416.73 million tonnes for commercial end-use. Statewise, 13 lignite blocks with 762.84 million tonnes for Gujarat and 10 blocks with 792.49 million tonnes for Rajasthan have been allocated

FOREIGN COLLABORATION

To meet the country's growing demand for coal, Coal India Limited (CIL) has expressed intent for foreign collaboration with the following objectives:

(a) bringing in proven technologies and advanced man agement skills for running underground (UG) and opencast (OC) mines and in coal preparation;

(b) exploration and exploitation of coal-bed methane, in situ gasification of coal

COAL WASHERIES

Presently, 18 coal washeries (14 in Public Sector and 4 in Private Sector) with 40.02 million tonnes per annum (MTPA) capacity of washed coking coal produced about 4.7 million tonnes of coking coal in 2021-22 out of which about 2.09 million tonnes were produced by the Public Sector and 2.6 million tonnes by Private Sector. Under Public Sector, BCCL operates 9 coking coal washeries (Dugda, Bhojudih, Sudamdih, Moonidih, Mahuda, Madhuban, Dahibari, Patherdih, NLW and TSL washery) CCL operates 4 washeries (Kathara, Swang, Rajrappa and Kedla), and SAIL operates one (Chasnala), whereas 4 washeries (West Bokaro- II , West Bokaro- III , Jamadoba and Bhelatand) are operated by Tata Steel Ltd (TSL) under Private Sector. During 2021-22, 19 coal washeries with 110.88 million tonnes per annum capacity washed non-coking coal of about 24.721 million tonnes . Of these, about 5.510 million tonnes production have been reported under Public Sector and about 19.211 million tonnes under Private Sector. Under Public Sector, 2 non-coking coal washeries (in CCL) were operational, whereas under Private Sector, 17 non-coking coal washeries were in operation.

By and large ash content in raw coal used by washeries varied between 24% and 33%. The ash content in the washed coal and middlings produced by washeries ranged from 19 to 22% and 35 to 40%, respectively. The rejects in most washeries contained over 50% ash.The capacity and production of washed coking/non-coking coal are shown in Tables - 23 to 26

Table – 23 : Production of Washed

Coking Coal, 2020-21 & 2021-22

(Sector-wise/Company-wise)

(In million tonnes)

Country	2020-21	2021-22
All India : Total	**4.422**	**4.701**
Public Sector	**1.303**	**2.088**
BCCL	0.27	1.209
CCL	0.436	0.401

Country	2020-21	2021-22
SAIL	0.597	0.478
Private Sector	3.119	2.613
Tata Steel Ltd	3.119	2.613

Source: Coal Directory of India, 2021-22,

Coal Controller's Organisation, Kolkata.

Table – 24 : Capacity of Washed Coking Coal, 2020-21

(Sector-wise/Company-wise)

(In million tonnes)

Coalfield/Washery	State	Raw Coal Capacity
Grand Total		**40.02**
Public Sector	**Total**	**29.52**
BCCL		**18.13**
Dugda	**Jharkhand**	**2**
Bhojudih	West Bengal	1.7
Sudamdih	Jharkhand	1.6
Moonidih	-do-	1.6
Mahuda	-do-	0.63
Madhuban	-do-	2.5
Dahibari		1.6
Patherdih NLW		5
TSL washery		1.5
CCL		**9.35**
Kathara	Jharkhand	3
Swang	-do-	0.75
Rajrappa	-do-	3
Kedla	-do-	2.6
SAIL		**29.52**
Chasnala	Jharkhand	2.04
Private Sector	**Total**	**10.5**
Tata Steel Ltd		**10.5**
West Bokaro-II	Jharkhand	2.5
West Bokaro-III	-do-	4.5
Jamadoba	-do-	2
Bhelatand	-do-	1.5

Source: Coal Directory of India, 2021-22,

Coal Controller's Organisation, Kolkata (except totals).

Table – 25 : Production of Washed

Non-coking Coal :

2019-20 & 2020-21

(Sector-wise/Company-wise)

(In million tonnes)

Sector/Company	2019-20	2020-21
All India : Total	**41.802**	**24.721**
Public Sector	**6.48**	**5.51**
CCL	6.48	5.51
Private Sector	**35.322**	**19.211**
Adani Enterprises Ltd	11.709	12.17

Sector/Company	2019-20	2020-21
Aryan Coal Beneficiation Pvt. Ltd	18.003	4.444
Aryan Energy Pvt. Ltd	1.426	0.549
Global Coal & Mining Pvt. Ltd	2.79	1.138
Jindal Power Ltd	0.372	0.463
Kartikay Coal Washeries Pvt. Ltd	0.089	0.009
Maruti Clean Coal	0.933	0.438

Source: Coal Directory of India, 2020-21,
Coal Controller's Organisation, Kolkata.

Table – 26 : Capacity of Washed Non-coking Coal, 2020-21

(Sector-wise/Company-wise)

(In '000 tpy)

Washery/Location	Coalfield	State	Raw Coal Capacity
Grand Total			**113600**
Public Sector	**Total**		**11720**
CCL			
East Bokaro Coalfield, Jharkhand			11720
Gidi	East Bokaro	Jharkhand	2500
Piparwar	N. Karanpura	-do-	6500
Kargali	Bokaro	-do-	2720
Private Sector	**Total**		**101880**
Adani Enterprises Ltd			**15000**
AEL	Parsa	Chhattisgarh	15000
Aryan Coal Beneficiation Pvt. Ltd			**60690**
Chakabura	Korba	Chhattisgarh	7500
Dipka	-do-	-do-	14000
Pander Pauni	Ballarpur	Maharashtra	2620
Gevra	Korba	Chhattisgarh	6250
Binjhri	-do-	-do-	4800
Hemgir	Hemgir	Odisha	5000
Ratija	Korba	Chhattisgarh	11000
Talcher	Bharatpur	Odisha	9520
Aryan Energy Pvt. Ltd			**2340**
Talcher	Talcher	Odisha	2340
Global Coal & Mining Pvt. Ltd			**10000**
Ib Valley	Ib Valley	Odisha	3500
Ramagundam	Ramagundam	Telangana	1000
Talcher	Talcher	Odisha	4000
Manuguru	Manuguru	Telangana	1500
Jindal Power Ltd			**4750**
JPL	Raigarh	Chhattisgarh	4750
Kartikay Coal Washeries Pvt. Ltd			**2500**
Wani	Wardha	Maharashtra	2500
Maruti Clean Coal			**6600**
Maruti	-	Chhattisgarh	6600

Source: Coal Directory of India, 2021-22,
Coal Controller's Organisation, Kolkata (except totals).

Import Policy of Coal

The present import policy of coal allows imports to be carried out freely under Open General Licence by the consumers themselves considering their needs. Coking coal is imported by Steel Sector and coke manufacturers mainly on availability and quality consideration. Coal-based power stations and cement plants are also importing non-coking coal on consideration of transport logistics and commercial precedence. In spite of hardening prices of both coking and non-coking coal internationally and increase in ocean freight, large amounts of coal continue to be imported.

FDI Policy

Indian Government permits 100% automatic FDI approval for coal & lignite mining only for captive consumption by power projects, iron & steel and cement units and for other eligible activities subject to the provisions of Coal Mines (Nationalisation) Act, 1973. This is in addition to the existing stipulated policy applied for the Power Sector.

CLASSIFICATION AND GRADES

Indian coal is classified into two main categories, namely, coking and non-coking. Coking coal is a type of coal from which, on carbonisation, coke suitable for use in metallurgical industries, particularly, in Iron and Steel industries can be produced. Parameters determining coking property of coal are coking index, volatile matter (VM %), vitrinite %, crucible swell no., fluidity, reflectance, etc. Although for commercial gradation, ash percentage is the sole criterion, for semi-weakly- coking coal, along with ash percentage, moisture percentage too is considered as an added criterion. For non-coking coal, an empirical formula is used to determine Useful Heat Value (UHV) of coal in kcal/kg.

The classification of coal as per the Ministry of Coal is reflected in Table - 27.

Table – 27 : Classification of Coal

Sl. No	Class	Grade	Grade/Specification
1	**Non-coking coal**	**A**	**Useful Heat Value exceeding 6,200 kcal per kg.**
	produced in all States		
	other than Assam,	**B**	**Useful Heat Value exceeding 5,600 kcal per kg but not exceeding**
	Arunachal Pradesh,		6,200 kcal per kg.
	Meghalaya and		
	Nagaland	C	Useful Heat Value exceeding 4,940 kcal per kg but not exceeding
			5,600 kcal per kg.
		D	**Useful Heat Value exceeding 4,200 kcal per kg but not exceeding**
			4,940 kcal per kg.
		E	Useful Heat Value exceeding 3,360 kcal per kg but not exceeding
			4,200 kcal per kg.
		F	Useful Heat Value exceeding 2,400 kcal per kg but not exceeding
			3,360 kcal per kg.
		G	Useful Heat Value exceeding 1,300 kcal per kg but not exceeding
			2,400 kcal per kg.
2	Non-coking coal	A	Useful Heat Value between 6,200 and 6,299 kcal per kg and
	produced in Arunachal		corresponding ash plus moisture content between 18.85 and 19.57%.
	Pradesh, Assam,		
	Meghalaya and Nagaland	B	Useful Heat Value between 5,600 and 6,199 kcal per kg and
			corresponding ash plus moisture content between 19.58 and 23.91%.
3	Coking coal	Steel Grade I	Ash content not exceeding 15%.
		Steel Grade II	Ash content exceeding 15% but not exceeding 18%.
		Washery Grade I	Ash content exceeding 18% but not exceeding 21% .
		Washery Grade II	Ash content exceeding 21% but not exceeding 24%.

Sl. No	Class	Grade	Grade/Specification
		Washery Grade III	**Ash content exceeding 24% but not exceeding 28%.**
		Washery Grade IV	Ash content exceeding 28% but not exceeding 35%.
		Washery Grade V	**Ash content exceeding 35% but not exceeding 42%.**
		Washery Grade VI	Ash content exceeding 42% but not exceeding 49%.
4	Semi-coking and	Semi-coking Grade I	Ash plus moisture content not exceeding 19%.
	weakly-coking coal	Semi-coking Grade II	Ash plus moisture content exceeding 19% but not exceeding 24%.
5	Hard coke	By-product Premium	Ash content not exceeding 25%.
		By-product Ordinary	Ash content exceeding 25% but not exceeding 30%.
		Beehive Premium	Ash content not exceeding 27%.
		Beehive Superior	Ash content exceeding 27% but not exceeding 31%.
		Beehive Ordinary	Ash content exceeding 31% but not exceeding 36%.

In order to adopt the best international practices, India decided to switch over from the grading based on Useful Heat Value (UHV) to the grading based on Gross Calorific Value (GCV); and, consequently on 16.01.2011 the Ministry of Coal notified the switch over. As per the new system, the following nomenclature has been introduced for gradation of non-coking coal.

Grades	GCV Range (kcal/kg)
G1	GCV exceeding 7,000
G2	GCV exceeding 6,701 but not above 7,000
G3	GCV exceeding 6,401 but not above 6,700
G4	GCV exceeding 6,101 but not above 6,400
G5	GCV exceeding 5,801 but not above 6,100
G6	GCV exceeding 5,501 but not above 5,800
G7	GCV exceeding 5,201 but not above 5,500
G8	GCV exceeding 4,901 but not above 5,200
G9	GCV exceeding 4,601 but not above 4,900
G10	GCV exceeding 4,301 but not above 4,600
G11	GCV exceeding 4,001 but not above 4,300
G12	GCV exceeding 3,700 but not above 4,000
G13	GCV exceeding 3,400 but not above 3,700
G14	GCV exceeding 3,101 but not above 3,400
G15	GCV exceeding 2,801 but not above 3,100
G16	GCV exceeding 2,501 but not above 2,800
G17	GCV exceeding 2,201 but not above 2,500

Based on the GCV ranges of proposed gradation and erstwhile gradation, a Concordance Table has been gene rated for better understanding. However, it may be noted that this concordance does not depict exact one-to-one relation between the two systems.

Old grading based On UHV	New grading based on GCV
A	G1, G2, G3
B	G4, G5
C	G6
D	G7, G8
E	G9, G10
F	G11, G12
G	G13, G14
Non-coking coal Un-graded	G15, G16, G17

"Source: Coal Directory 2019 - 20 , Coal Controller' s Organisation, Kolkata."

CONSUMPTION

Thermal power plants, iron & steel, sponge iron and cement continued to be the major consuming industries for coal in India. Sizeable quantities are also consumed by the railways, collieries and as domestic fuel. Data regarding consumption in these sectors is not available. However, industry- wise despatches of coal during 2019-20, 2020-21 and 2021-22 are provided in Table-28.

Table – 28 : Despatches* of Coal

2019-20 to 2021-22

(By Industries)

(In million tonnes)

Industry	2019-20	2020-21	2021-22 (P)
Total	**707.18**	**690.884**	**819.213**
Electricity	626.15	574.731	704.997
Iron & steel$	11.91	8.975	9.159

Industry	2019-20	2020-21	2021-22 (P)
Sponge iron	10.53	9.565	9.023
Fertilizer	1.76	1.527	1.111
Cement	8.57	6.754	7.306
Others (Chemical, other basic metals, paper & pulp, textile & rayon, bricks, others, etc.)	48.26	82.83	87.617

Source: Coal Directory of India 2021-22.

** Data on consumption is not available.*

$ Includes direct feed, coking washery and steel (boilers).

DEMAND & SUPPLY

To comprehend the requirement of coal in real term, the erstwhile Planning Commission of India did maintain the practice of estimating demand for each year in advance. However, the apparent supply (Despatch + Import – Export) did show variance from the projected estimates. Against the estimated demand of coking coal and non- coking coal, the data on actual despatch, import and export of coal (coking coal and non-coking coal) during 2019-20, 2020-21 and 2021-22 are provided in Table -29.

Table – 29 : Demand-Supply of Coal, 2019-20, 2020-21 and 2021-22

(In million tonnes)

Year	Demand*	Apparent Supply			Total
		Despatch	Import	Export	
2019-20	1000	706.770	248.537	1.029	954.278
2020-21	1085	690.884	215.251	2.945	903.19
2021-22	1142	819.213	208.627	1.316	1026.524

Source: Coal Directory of India 2021-22, Apparent supply= Despatch+Import-Export

**Annual Plan, Ministry of Coal.*

WORLD REVIEW

World proved coal reserves were estimated at 1,074.108 billion tonnes at the end of 2020 of which 753.639 billion tonnes (70%) has been classified as anthracite & bituminous coal and 320.469 billion tonnes (30%) as sub-bituminous coal & lignite. USA has the largest coal reserves with about 23% share of the total world reserves, followed by Russia (15%), Australia (14%) and China (13%) (Table-30) .

Table – 30 : World Proved Coal Reserves at the end of 2020

(By Principal Countries)

(In million tonnes)

Country	Anthracite and bituminous coal	Sub- bituminous coal and lignite	Total
World : Total	**753639**	**320469**	**1074108**
USA	218938	30003	248941
Russia	71719	90447	162166
Australia	73719	76508	150227
China	135069	8128	143197
India*	105979	5073	111052
Indonesia	23141	11728	34869
Germany	-	35900	35900
Ukraine	32039	2336	34375
Poland	22530	5865	28395
Kazakhstan	25605	-	25605
Turkey	550	10975	11525
South Africa	9893	-	9893
Serbia	402	7112	7514
Brazil	1547	5049	6596

Country	Anthracite and bituminous coal	Sub- bituminous coal and lignite	Total
Canada	4346	2236	6582
Colombia	4554	-	4554
Other countries	23608	29109	52717

Source: BP Statistical Review of World Energy, 2021.

* *India's resources of coal as on 1.4.2022 are estimated at about 361.411 billion tonnes to a depth of 1,200 m and those of lignite are estimated at about 46.20 billion tonnes.*

World production of coal and lignite slightly increased from about 7.559 billion tonnes in 2020 to 7.883 billion tonnes in 2021. China continued to be the largest producer of coal & lignite in 2021 with about 50 % share in total world production, followed by India (9 . 0 %), USA (7.88%), Indonesia (7.80%), Australia (6.02%) and Russia (5.48%)

Table – 31 : World Production of Coal and Lignite

(By Principal Countries)

(In million tonnes)

Country	2019	2020	2021
World : Total	**8108**	**7559**	**7883**
Bosnia & Herzegovina			
Brown coal & lignite	13	13	12
Bulgaria			
Lignite	29	29	29
Brown Coal	1	1e	1e
Czech Republic			
Bituminous	3	1	2
Brown coal	37	29	29
Georgia	**15900**	**33134**	**147878**
Germany			
Anthracite & Bituminous	-	-	-
Brown coal	131	107	126
Greece			
Lignite	26	14	12
Poland			
Coking coal	12	12	12
Other bituminous coal	50	42	42
Lignite	52	47	54
Romania			
Anthracite & bituminous	410765	428368	*300000
Lignite	21	15	17
Russia	**439**	**398**	**432**
Serbia			
Bituminous	108000	30000	26000
Lignite (b)	38	39	36
Brown coal	350000	306000	271000
Turkey			
Anthracite	1	1	1
Lignite	92	84	90
United Kingdom			
Anthracite	510000	345000	266000
Bituminous	2	1	788000
South Africa			
Anthracite	3	4	3
Bituminous	251	243	225
USA			

Country	2019	2020	2021
Anthracite	2	2	1
Bituminous	307	215	235
Sub-bituminous	282	222	243
Lignite	48	44	42
Colombia			
Anthracite (d)	127090	231	109798
Coking coal	7	7	7
Other bituminous coal	77	42	48
China	**3846**	**3747**	**3962**
India			
Bituminous (g)	729	716	*676
Lignite (g)	42	36	*34
Indonesia			
Anthracite & Bituminous	616	563	613
Iran (e)	1	1	1
Kazakhstan			
Bituminous	104	104	107
Lignite	5	5	4
Korea, Rep. of			
Anthracite	1	1	897900
Korea, Dem.P.R.of	***18**	***17**	***17**
Kyrgyzstan	**2**	**2**	**2**
Thailand			
Lignite	14	13	14
Vietnam			
Anthracite	47	44	48
Australia			
Bituminous (i)	462	426	432
Brown coal (f)	42	40	42

Source: BGS, World Mineral Production, 2017-2021.

Hard coal – Including anthracite, bituminous &

sub-bituminous coal. Coal- All ranks of coal.

d- excluding production in Kosovo, 1- including sub-bituminous.

**India's production of coal during 2019-20, 2020-21 & 2021-22 was 730.87,716.10 & 778.21 million tonnes, respectively.*

** India's production of lignite during 2019-20, 2020-21 & 2021-22 was 42.09, 37.89 & 47.49 million tonnes, respectively.*

(j) includes sub-bituminous.

(g) year ended 30th June of that stated.

(h) year ended 30th March following that stated.

Global coal demand rebounded strongly in 2021 to 5,640 million tonnes of coal equivalent (Mtce) as economies recovered from the pandemic and coal- fire power generation reached a historic high in 2021. Both China and India have boosted investment in domestic coal production, but global production struggled to keep pace with demand increases, causing coal prices to surge. Russia the world's third-largest coal exporter – and its invasion of Ukraine complicated coal market dynamics and brought additional pressure on prices.

The outlook for coal is heavily dependent on the strength of the world's resolve to address climate change. In the Stated Policies Scenario (STEPS), coal demand declines gradually. In the Announced Pledges Scenario (APS), it declines about 20% below current levels by 2030, and 70% by 2050; coal demand peaked in China in the early 2020s and in India in the late 2020s. In the Net Zero Emissions by 2050 (NZE) Scenario,demand fall by 45% by 2030 and by 90% by 2050.

Coal use in industry is expected to fall by 20% to 2030, in part reflecting an increase in the production of near zero emissions primary steel and near zero emissions clinker for use in cement. In India, coal demand in the STEPS is expected to rise by 25% in 2030. Strong economic growth – the economy is expected to expand by 90% between 2021 and 2030 – will bring with it more demand for coal-fired power generation and in the use of coal to produce iron and steel and cement. Coal-fired power capacity is bound to increase from 240 GW in 2021 to 275 GW in 2030, while there will be limited use of electric arc furnaces in industry. In the APS, coal demand in India would show an increase by just under 15% between 2021 and 2030 , this would reflect increased deployment of renewables, improvements in energy efficiency, and the installation of gas and electricity-based equipment in industry. The increase in coal demand in the Industry Sector is around half of that seen in STEPS, and the increase in the Power Sector is about 20% less. To provide generalised view of the development in various countries, the countrywise description sourced from the latest available publication of USGS is detailed below.

Australia

Queensland remained Australia's leading producer of anthracite and bituminous coal (reported as black coal by Geoscience Australia), accounting for 54% of the country's production in 2017, followed by New South Wales, 44%; Western Australia, 1%; and Tasmania, 0.1%. The BHP Billiton Mitsubishi Alliance (BMA) (owned by BHP Billiton, 50%, and Mitsubishi Corp. of Japan, 50%) was the leading producer of anthracite and bituminous coal in Australia. BMA operated seven mines in Queensland. In March, Cyclone Debbie affected coal operations at multiple mines in the Bowen basin in northern Queensland and caused coal export delays, which led to an increase in global coal prices. The affected mines stockpiled coal while repairs to rail and port infrastructure were completed. The majority of lignite was produced in Victoria and used for domestic energy generation. Loy Yang Power Ltd. operated the Loy Yang Mine, which was Australia's leading lignite mine by capacity. The Hazelwood Mine, which was owned by ENGIE SA of France, and the associated Hazelwood coal-fired powerplant closed in March owing to the powerplant no longer being commercially viable.

China

In 2019, coal production increased by 4.6% to 3.85 Gt. China accounted for 51.7% of the world's coal production (in terms of contained energy) in 2019. China's coal production reached a peak of about 4 Gt in 2013 and had declined since then until 2016 owing to the slowdown in the economy, weak domestic demand, and low prices for coal. Production had gradually increased since 2016 because of increasing demand, the restart of some inactive existing capacity, and the commissioning of new capacities. As of 2019, there were 5,271 coal mines in the country with total production capacity (including capacity under construction) of 5.2 Gt/yr, of which 3.9 Gt/yr capacity was in operation, 1.0 Gt/yr capacity was under construction, and about 300 Mt/yr capacity was inactive. Coal imports in 2019 were 299.7 Mt, which was an increase of 6.6% compared with imports in 2018. China's leading import trade partners (in terms of energy content of imported coal) in 2019 were Indonesia, which supplied 34% of China's coal imports; Australia 32%; Mongolia 16%; Russia 13%; and Canada 2%. Coal exports in 2019 were 6.03 Mt, which was an increase of 22.3% compared with those of 2018. Coal consumption increased by 1.0% in 2019 to 4.0 Gt, of which 2.37 Gt was used for electricity generation; 660 Mt, by the steel industry; 380 Mt, for construction material production; 300 Mt, by the chemical industry; and 320 Mt, for other uses. In 2019, the revenue of the coal industry totaled $360 billion, which was an increase of 3.2% compared with that of 2018, and the profits of these companies totaled $41 billion, which was a decrease of 2.4%

FOREIGN TRADE

Exports

Exports of coal (excl. lignite) decreased substantially by 55% to about 1.31 million tonnes in 2021-22 from 2.94 million tonnes in the previous year. On the other hand, exports of coke increased manifold to 1,299.46 million tonnes in 2021-22 from 207.41 million tonnes in 2020-21. Coal (excluding lignite) was mainly exported to Bangladesh (50%), Nepal (44%) and Bhutan & UAE (3% each). Coke was exported predominantly to Italy (19%), Japan (17%), Vietnam (12%), Brazil (8%), Bhutan & Indonesia (7% each), Malaysia (6%) and Australia , France & Romania (5% each). Exports of lignite were 1 thousand tonnes during the year 2021 - 22 as compared to 2 thousand tonnes during 2020-21. (Tables - 32 to 35).

Table – 32 : Exports of Coal (Excl. Lignite)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2943**	**5736794**	**1314**	**11233701**
Nepal	2200	4294441	575	5456932
Bangladesh	665	738728	656	4951323
Bhutan	48	472514	43	475844
UAE	++	8436	39	298546
Chile	-	-	1	17735
Saudi Arabia	++	5091	++	6623
Thailand	--	-	++	5855
Philippines	--	-	++	4287

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
Srilanka	++	264	++	4031
Nigeria	-	-	++	4010
Other countries	30	217320	++	8515

Figures rounded off

Table – 33 : Exports of Coal, Water Gas, etc.

(Except Gaseous Hydrocarbons)

(By Countries)

Cou ntry	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**-**	**-**	**++**	**2**
Bhutan	-	-	++	2

Figures rounded off

Table – 34 : Exports of Coke

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**207412**	**4771075**	**1299461**	**41017403**
Japan	2	38	225820	8557910
Italy	-	-	249722	7361197
Vietnam	60500	1547731	153000	4828967
Bhutan	62746	1531890	96842	3028825
Brazil	40501	964977	97600	2982790
Australia	-	-	70514	2838090
France	-	-	64000	2824093
Indonesia	14872	365032	88232	2470554
Malaysia	56	1711	74328	2167153
Romania	-	-	60500	1735071
Other countries	28735	359696	118903	2222753

Figures rounded off

Table – 35 : Exports of Coal : Lignite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2**	**234709**	**1**	**203336**
Saudi Arabia	2	159214	1	58654
Singapore	++	22430	++	48589
Oman	++	29999	++	45780
UAE	++	7543	++	13333
Indonesia	++	5422	++	13079
Malaysia	-	-	++	7640
Netherlands	-	-	++	5346
Thailand	++	2547	++	2573
Colombia	-	-	++	1977
Egypt	-	-	++	1655
Other countries	++	7554	++	4710

Figures rounded off

Imports

Imports of coal (excl. lignite) decreased slightly by 3% to 208.64 million tonnes in 2021-22 from 215.26 million tonnes in the previous year. Imports of coke increased slightly by 2% to about 2.50 million tonnes in 2021-22 from about2.46 million tonnes in the previous year. Coal (excl. lignite) was mainly imported from Indonesia (35%), Australia (32%), South Africa (12%), USA (7%), Russia (4%) and Singapore & Mozambique (3% each) whereas coke was imported mainly from Poland (42%), Colombia (18%) & Japan (12%). Imports of lignite remained unchanged in 2021-22 as compared to preceding year. Lignite was imported solely from China. (Tables - 36 to 38).

Table – 36 : Imports of Coal : Lignite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1**	**5746**	**1**	**9495**
China	1	5738	1	8592
USA	-	-	++	901
Germany	-	-	++	2
Ghana	++	8	-	-

Figures rounded off

Table – 37: Imports of Coal (Excl. Lignite)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**215260**	**1160506410**	**208636**	**2288189160**
Australia	54952	426857044	66798	971299396
Indonesia	92535	341262086	72531	488344670
South Africa	31095	142867128	25765	241288992
USA	12203	86477695	14374	167868788
Russia	6748	45686817	8251	118743461
Singapore	4486	28538085	6143	116403819
Mozambique	3570	23492408	6572	75620474
Canada	2963	27359117	2147	34904679
China	25	755889	2616	31774993
Switzerland	1968	11401971	2018	26018652
Other countries	4715	25808170	1421	15921236

Figures rounded off

Table – 38: Imports of Coke

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2463036**	**44821773**	**2501153**	**81047701**
Poland	956636	18379850	1053358	36814753
Colombia	511793	8254215	460962	12558649
Japan	396558	7439354	312603	10220095
Switzerland	212135	3437938	203554	5543786
China	33179	777874	97782	3854328
Indonesia	134664	2877509	87971	3182243
Australia	21519	225853	79299	2607937
Netherlands	-	-	38418	1668713
Russia	118850	2223214	44710	1411611
Korea, Rep. of	-	-	36371	1209220
Other countries	77702	1205966	86125	1976366

Figures rounded off

FUTURE OUTLOOK

Coal is the cornerstone of Indian economy on which modern electricity generation rests. Coal currently supplies around 30% of primary energy and 41% of global electricity generation. The forecast for coal-use is that, it would rise to over 50% by 2030, with developing countries being responsible for 97% of this increase, primarily to meet their futuristic electrification targets. To meet the country's growing demand for coal, foreign collaborations with advanced coal producing countries are also being considered by the Government with an aim to bring in new technologies both in underground and open-cast sectors for efficient management of the Coal Industry along with building adequate support mechanism through comprehensive skill development and training activities.

As per the draft National Energy Policy (NEP), (version as on 27.06.2017) formulated by the NITI Aayog, India Vision 2040 envisages demand-driven provision of energy at affordable prices, high per capita consumption of electricity, access to clean cooking energy & electricity with universal coverage, low emission and security of supply as criteria that would characterise the energy parameters of India in 2040.

The installed coal-based electricity generation capacity is expected to grow to 330- 441 GW by 2040. This is likely to translate into a coal demand of 1.1 to 1.4 billion tonnes. The known levels of proven coal reserves of about 187 billion tonnes as of 01.04.2022 may only be able to support an annual peak production of 1.2 to 1.3 billion tonnes till 2037, with a gradual decrease thereafter. This fact calls for intensifying exploration to enhance the proven coal reserves. Multiple institutions, such as, GSI and CMPDI are responsible for exploration of coal in India. There is a need to synergise the efforts of all these agencies to undertake 100% resource mapping of coal.

India aims to become an advance & developed country in future and for this investing heavily in infrastructure would be an essential imperative. This will boost energy demand for industry and consequently improving electricity production would be high in the agenda. Although India has succeeded in bringing some form of electricity access to almost all of its citizens, the country's per capita power consumption is still low, giving it significant scope to grow. Power generation from renewables is forecasted to expand strongly, with wind capacity doubling and solar photovoltaics (PV) projected to increase fourfold between 2018 and 2024. But that is not enough to prevent coal power generation from increasing by 4.6% per year through 2024. Overall, India's coal demand is expected to grow by more than that of any other country, in absolute terms, over the forecast period.

8. Cryolite

126
(tonnes) of cryolite and chiolite were exported in 2021-22

4,167
(tonnes) of cryolite and chiolite were imported in 2021-22

Cryolite is a double fluoride of sodium and aluminium and has a stoichiometry very near the formula Na_3AIf_6 and a melting point of about 1,010 ^{0}C. It was found to occur in substantial quantities in Ivigtut, Greenland, and was mined extensively there in the early twentieth century, but the mine is now essentially exhausted. Synthetic cryolite can be produced by reacting hydrofluoric acid with an alkaline sodium aluminate solution. It is usually colourless to white, brownish, reddish, brick red colour having vitreous to greasy lusture. cryolite normally is found to occur in coarsely granular masses form having no cleavage. It has a specific gravity of about 2.5 to 3. It has a low index of refraction close to that of water. Synthetic cryolite is used as an electrolyte in the reduction of alumina to aluminium due to non-availability of natural cryolite. Composition and properties of synthetic cryolite are the same as that of natural cryolite, but synthetic cryolite is often deficient in sodium fluoride.

INDUSTRY

Synthetic cryolites are obtained by adopting several processes. The selection of the process depends upon the availability and cost of raw materials. The simplest and most common method of obtaining synthetic cryolite is by reacting hydrofluoric acid with soda ash and alumina hydrate. Hydrofluoric acid is produced by reacting acid-grade fluorspar with sulphuric acid and this process also yields gypsum as by-product. In the secondary reaction between hydrofluoric acid and sodium chloride brine, sodium fluoride and hydrochloric acid are produced. In the primary reaction, dry aluminium hydroxide reacts with hydrofluoric acid to produce aluminium fluoride which reacts with sodium fluoride produced earlier and forms synthetic cryolite.

Besides fluorspar, fluorine gas produced as by- product at plants that produces phosphatic fertilizer and phosphoric acid, has emerged as an important alternative source for hydrofluoric acid and other fluorine chemicals including cryolite and aluminium fluoride. Rock phosphate usually contains 7–8% CaF_2. In terms of fluorine, it works out to 3–4% which is liberated at the time of acidulation of rock phosphate with sulphuric acid. Fluorine combines with silica to form silicon tetrafluoride which when scrubbed with water forms fluorosilicic acid. By recycling, 18–24% fluorosilicic acid is obtained, which serves as a raw material for manufacturing various fluoro-chemicals, including synthetic cryolite. From fluorosilicic acid, fluorine values are precipitated as sodium fluorosilicate by treating it with sodium salts. Sodium fluorosilicate becomes starting point for the production of synthetic cryolite.

For manufacture of synthetic cryolite from sodium fluorosilicate, two routes are generally adopted in the country. In the first route, sodium fluorosilicate is reacted with ammonia and in other route, sodium fluorosilicate is reacted with soda ash

SPECIFICATIONS

The Indian Standard Specifications of cryolite for use in Aluminium Industry defined vide IS - 5893 : 1989 (Second Revision; reaffirmed 2008) are as follows:

Constituents (on dry basis)	Specification
F	53% min.
Na	31 to 34%
Al	13 to 15%
SiO_2	0.20% max.
$Fe2O_3$	0.10% max.
CaF_2	0.06% max.
$Al2O_3$	1.00% max.
SO_3	0.50% max.
$P2O_5$	0.01% max.
Loss on Ignition (LOI)	0.50% max.
NaF/AlF3(by mass)	1.45 max. (ratio required to maintain

Note: i) LOI is to be determined at 550 °C for 60 minutes.

ii) Moisture should not be more than 0.20% when determined at 110+5°C

CONSUMPTION

The consumption of cryolite is nowadays not estimated because many industries prefer the use of synthetic cryolite instead of natural cryolite. However, consumption was reported earlier in bonded abrasives as a filler, insecticides, porcelaneous glass and salts of sodium & aluminium.

USES AND TECHNOLOGY

The commercial application of cryolite is confined mainly to aluminium metallurgy where it is used as an electrolyte in the reduction of alumina to aluminium metal by the Hall-Heroult process. Alumina is a bad conductor of electricity and its melting point is 2,348 °C. It is very expensive to carry out electrolysis at this temperature. To facilitate electrolysis, alumina is dissolved in molten cryolite as it lowers the melting point. Further, addition of certain additives, such as, aluminium fluoride improve the physical and electrical properties of the electrolyte, besides lowering the melting point. The amount that is added is, however, limited as it also causes reduction in electrical conductivity.

Addition of calcium fluoride (CaF_2) further depresses the melting point with less adverse effect on conductivity. In contrast to this advantage, too much CaF_2 raises the density of the melt closer to that of liquid aluminium metal, thus inhibiting the separation of metal from electrolyte. The substituent, sodium fluoride, though is known to improve the density and conductivity, it also affects current efficiency.

A compromise made on all these factors has led to the following general composition of the bath to be in use —80–85% cryolite, 5–7% AlF_3, 5–7% CaF_2, 0–7% LiF and 2–8% Al_2O_3. The electrolyte bath tends to deplete AlF_3 content of cryolite during the process. Hence, the composition of the electrolyte has to be adjusted regularly by addition of AlF^3.

In aluminium refining, high density electrolyte capable of floating aluminium is required. For this purpose, barium fluoride is used to raise density. Aluminium fluoride can be used to improve current efficiency of cryolite bath.

Cryolite is obtained as a by-product during the production of phosphatic fertilizer/phosphoric acid. When utilised in the Aluminium Industry, necessary precautions are observed as even 0.01% P in the electrolyte could cause 1–1.5% reduction in current efficiency in the production process of aluminium.

Other metallurgical uses of cryolite are in aluminising steel, in compounding of welding rod coatings and as fluxes. In glass, cryolite functions as a powerful flux because of its excellent solvent power for oxides of silicon, aluminium & calcium and for its ability to reduce melt viscosity at lower melting temperatures. Cryolite is used as a filler for resin-bonded grinding wheels in Abrasive Industry to impart longer life. Sodium fluoride (NaF) or fluorosilicic acid is also used for this purpose. Cryolite is used in certain nitrocellulose-based gun propellants required in small-calibre weapons, cannons and small & large rockets.

FOREIGN TRADE

Exports

In 2021-22, ex ports of cryolite and chiolite decreased marginally by 15% to 126 tonnes from 149 tonnes in the previous year. USA (60%), Turkey (19%), France (8%), Saudi Arabia (7%), Iraq (3%), Indonesia (2%) and Egypt (<1%) were the main buyers from India in 2021-22 (Table-1).

Table – 1 : Exports of Cryolite and Chiolite
(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**149**	**8467**	**126**	**12127**
USA	20	1206	75	8086
Turkey	81	2536	24	1305
France	10	761	10	840
Indonesia	4	894	3	812
Saudi Arabia	21	1271	9	688
Egypt	1	100	1	226
Iraq	-	-	4	82
Brazil	1	203	++	36
Australia	-	-	++	32
UAE	9	1097	++	20
Other countries	2	399	-	-

Figures rounded off

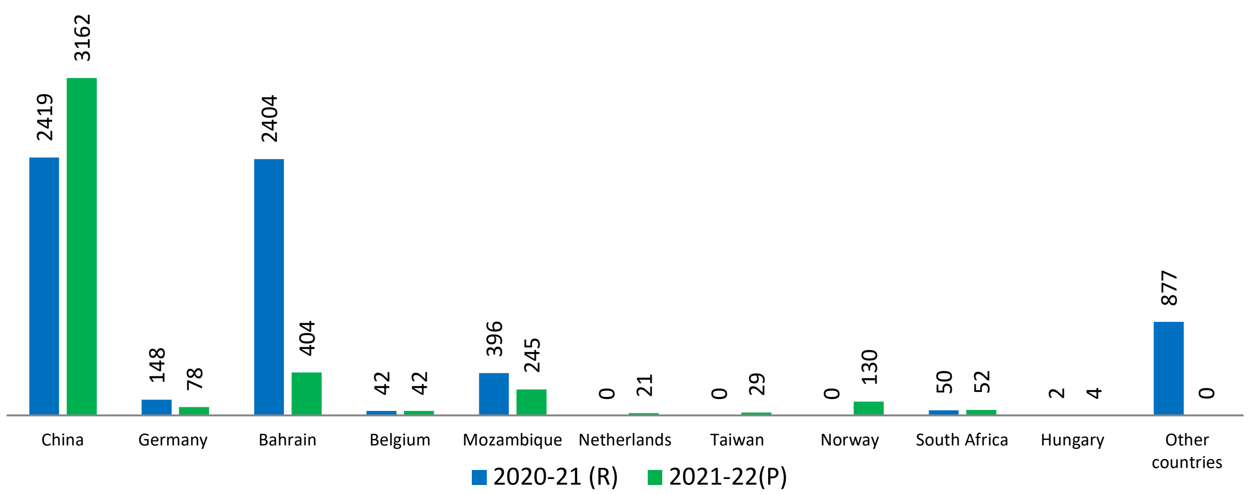


Fig 1: Countrywise Export of Cryolite and Chiolite

Imports

In 2021-22, imports of cryolite and chiolite decreased by 34% to 4,167 tonnes from 6,338 tonnes in the previous year. Imports were mainly from China (76%), Bahrain (10%), Mozambique (6%), Norway (3%), Germany (2%). and Belgium & South Africa (1% each) (Table-2).

Table – 2 : Imports of Cryolite and Chiolite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**6338**	**174382**	**4167**	**152877**
China	2419	104486	3162	122288
Germany	148	15986	78	9012
Bahrain	2404	33317	404	6050
Belgium	42	2814	42	4852
Mozambique	396	5680	245	3507
Netherlands	-	-	21	3266
Taiwan	-	-	29	1770
Norway	-	-	130	1004
South Africa	50	548	52	569
Hungary	2	495	4	557
Other countries	877	11056	++	2

Figures rounded off

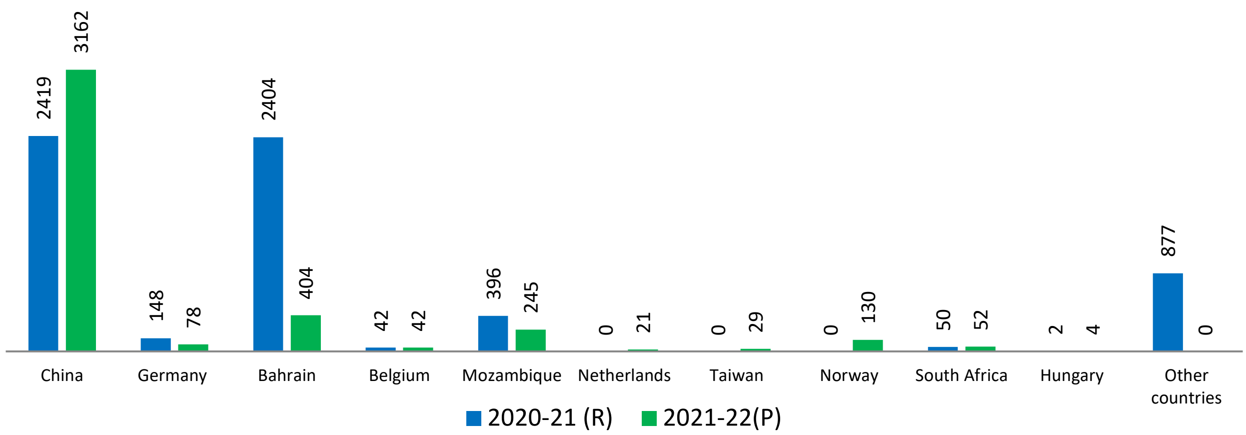


Fig 2: Countrywise Import of Cryolite and Chiolite

FUTURE OUTLOOK

The future of cryolite is dependent upon its use in the Aluminium Industry. Increased usage of aluminium and high performance fluoropolymers in automobiles will drive growth in inorganic and specially fluorochemicals segments. It is learnt that some US firms have registered success in their research and pilot plant tests for the production of aluminium directly from the mineral bauxite without the intermediate process of reduction cell. Viability of this may probably eliminate the use of cryolite in the near future.

9. Diamond

266
(carats) Production of diamond were reported in 2021-22

1,89,365
(crore) Value of Exports of diamond were reported in 2021-22

2,05,638
(crore) Value of Imports of diamond were reported in 2021-22

31.72
(million carats) total reserves/ resources of diamond were estimated as on 1st April 2020

Diamond has been the most valuable among gems for more than 2,000 years. Diamond occurs in two types of deposits, primarily in igneous rocks of basic or ultrabasic composition and in alluvial deposits derived from the primary sources. Its composition is pure carbon and has cubic crystal system and common form octahedron. India is known for its diamond cutting & polishing business especially for small sized diamonds. Most of the world's diamond cutting and polishing business comes to India, particularly to Surat in Gujarat. India depends largely on imports of rough gem diamonds for its Cutting and Polishing Industry as there is no notable production except for two producers in Madhya Pradesh whose limited production is too sparse to meet the Cutting and Polishing Industry's requirements. The cut and polished diamonds are predominantly re-exported.

Diamond has a high refractive index and strong dispersion which gives it exciting brilliance when cut as a faceted stone. Gem diamonds are transparent and colourless or show faint shades of different colours. Flawless stones of good colour are abundantly used in gem trade while off-colour, flawed & defective stones, chips & cuttings as well as small grains & dust are used in many other ways in the industry. Industrial grade diamond, i.e., diamond that does not meet gem quality standards in terms of colour, clarity, size or shape and those that are produced as a by- product of mining gem diamonds continue to be used principally as abrasives in many applications despite their initial cost. Although diamond is more expensive than other abrasive materials, it is more cost-effective in numerous industrial processes because it lasts longer than any other material.

Broadly, industrial diamonds have three varieties viz, 'ballas' which is mass of minute diamond crystals difficult to cleave; 'bort' is yellowish grey to black colour and massive, flawed or irregular in shape and 'carbonado' is black, very hard, opaque and without cleavage.

RESERVES/RESOURCES

Diamond occurrences are reported since prehistoric times in the country. Presently, diamond fields of India are grouped into four regions:

1. South Indian tract of Andhra Pradesh, comprising parts of Anantapur, Kadapa, Guntur, Krishna, Mahabubnagar and Kurnool districts;
2. Central Indian tract of Madhya Pradesh, comprising Panna belt;
3. Behradin–Kodawali area in Raipur district and Tokapal, Dugapal, etc. areas in Bastar district of Chhattisgarh; and
4. Eastern Indian tract mostly of Odisha, lying between Mahanadi and Godavari valleys.

As per the NMI data, based on UNFC system as on 1.4.2020, all India reserves/ resources of diamond have been placed at 31.72 million carats. Out of these, 0.84 million carats are placed under Reserves category and 30.87 million carats under Remaining Resources category. By grades, about 3.32% resources are of Gem variety, 3.45% of Industrial variety and bulk of the resources (93.23%) are placed under Unclassified category. By States, Madhya Pradesh accounts for about 90. 14 % resources followed by Andhra Pradesh 5.74% and Chhattisgarh 4.12% (Table-1).

Table – 1 : Reserves/Resources of Diamond as on 1.4.2020 (P)

(By Grades/States)

(In crorats)

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India:Total	**847400**	**0**	**159**	**847559**	**0**	**0**	**0**	**304601**	**1524317**	**29047514**	**0**	**30876432**	**31723991**
By Grades													
Gem	297692	0	0	297692	0	0	0	158819	1017	596929	0	756765	1054457
Industrial	254559	0	0	254559	0	0	0	41664	223	798936	0	840823	1095382
Unclassified	295149	0	159	295308	0	0	0	104118	1523077	27651649	0	29278844	29574152
By States													
Andhra Pradesh	0	0	0	0	0	0	0	200483	1524317	98155	0	1822955	1822955
Chhattisgarh	0	0	0	0	0	0	0	0	0	1304000	0	1304000	1304000
Madhya Pradesh	847400	0	159	847559	0	0	0	104118	0	27645359	0	27749477	28597036

Figures rounded off

EXPLORATION & DEVELOPMENT

The Exploration & Development details, if any, are covered in the Review on Exploration & Development under "General Reviews".

PRODUCTION & STOCKS

Production of diamond was at 266 carats in 2021-22 as against 13,917 carats in the previous year. There were three reporting mines, both under Public Sector located in district Panna of Madhya Pradesh (Tables- 2 & 3).

Table – 2 : Principal Producers of Diamond, 2021-22

(By Countries)

Name and address of producer	Location of mine	
	State	District
Directorate of Geology & Mining (Diamond Project), Government of Madhya Pradesh, Khanij Bhavan, 29-A, Arera Hills, Bhopal - 462 016, Madhya Pradesh.	Madhya Pradesh	Panna

Table – 3 : Production of Diamond, 2019-20 to 2021-22

(By States)

(Quantity in carats; Value in ₹'000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**28816**	**352472**	**13917**	**147696**	**266**	**18051**
Madhya Pradesh	28816	352472	13917	147696	266	18051

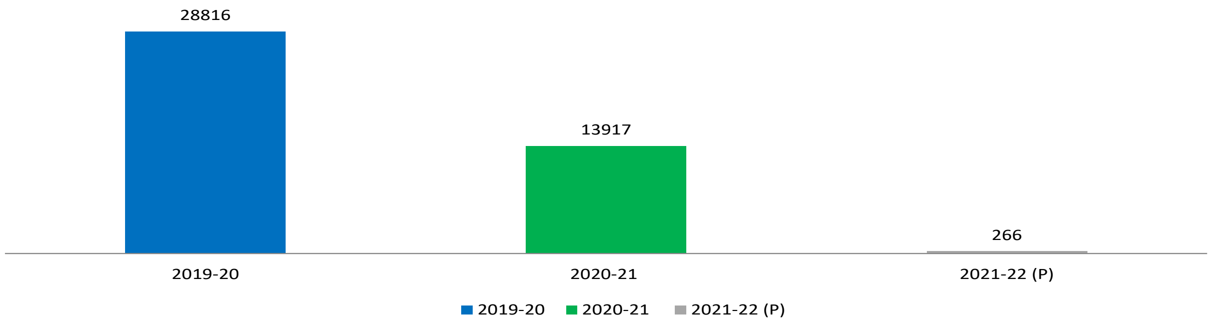


Fig 1: Production of Diamond (in carats)

Out of the total output, Gem variety covering rough & uncut constituted 67% and the remaining 33% was of Industrial grade and other varieties (Table-4).

Table – 4 : Production of Diamond, 2020-21 & 2021-22

(By Sector/State/District/Grades)

(Quantity in carats; Value in ₹'000)

State/ District	2020-21						2021-22 (P)					
	No.of mines	Quantity				Value	No.of mines	Quantity				Value
		Gem (rough & uncut)	Industrial*	other	Total			Gem (rough & uncut)	Industrial*	other	Total	
India	**2**	**5014**	**4580**	**4323**	**13917**	**147696**	**3**	**179**	**42**	**45**	**266**	**18051**
Public Sector	2	5014	4580	4323	13917	147696	3	179	42	45	266	18051
Madhya Pradesh	**2**	**5014**	**4580**	**4323**	**13917**	**147696**	**3**	**179**	**42**	**45**	**266**	**18051**
Panna	2	5014	4580	4323	13917	147696	3	179	42	45	266	18051

** Includes off-colour and dark-brown varieties of diamond.*

Mine-head closing stocks during the year 2021-22 were 78 carats as against 25,329 carats in the previous year (Table-5).

Table – 5 : Mine-head Closing Stocks of Diamond, 2020-21 & 2021-22

(By State)

(In carats)

State	2020-21	2021-22 (P)
India	**25329**	**78**
Madhya Pradesh	25329	78

The average daily employment of labour during 2021-22 was 677 as against 142 in 2020-21.

MINING & PROCESSING

Majhgawan in Madhya Pradesh is a fully mechanised mine operated by National Mineral Development Corporation Ltd. It is worked by opencast method in tuff rock by deploying 4.1 cu. m hydraulic shovel and 40 tonnes dumpers in combination. The mine benches have been designed with a height of about 10 m. A few benches were of 4-5 m in height. Drilling is done by 4-inch diameter drills and charged with slurry explosives, and about 40–50 holes are blasted at a time with delay pattern. The capacity of the mine is about 30,000 carats per year. Diamonds are also recovered from conglomerate and gravel beds at shallow depths by small operations on the basis of annual permits granted by Diamond Officer, Government of Madhya Pradesh. At Majhgawan, kimberlite rock, after mining the ore is stockpiled for weathering action and then is fed to crushing plant. It is processed through Heavy Media Separation System in processing plant for recovery of diamond. Recently, X-ray diamond sorter has been installed for sorting of diamonds from ore and this has increased the recovery of raw diamonds to 98%.

Diamond Mining Factors

Grade

Grade is the weight of diamond expressed as carats per tonne (ct/t) of ore. It varies widely from one mine to another but generally falls somewhere between 0.3 and 1.3 ct/t. One carat is equivalent to 0.2 grams.

Size (weight) of Rough Diamonds in Deposit

Individually, rough diamonds can range from microweight to stones weighing more than 1,000 carats. Depending on the mine, the average size of rough diamond recovered can weigh from 0.01 ct (about 1 mm) to more than 0.7 ct. Many mines in the world show an average of about 0.4 to 0.5 ct per tonne.

INDUSTRY

Indian Diamond Industry enjoys credible standing and reputation in the world market, particularly for small diamonds used in jewellery. Indian diamond manufacturing standards are reckoned as the best in the world. Workmanship & skill of Indian artisans at polishing small diamonds economically and efficiently has been widely acknowledged. Surat in Gujarat is the main centre of the Cutting and Polishing Industry.

The Indian Diamond Industry thrives in the atmosphere of secrecy and informality that envelops the diamond trade and has for long been labeled as an unorganised sector of the economy. However, it resembles a close-knit community composed of thousands of small, medium and large sized CPD (cut and polished diamonds) units and has grown to become one of the highest foreign exchange earners for the country. An in-depth study of the Industry reveals that the so called unorganised sector is in fact highly organised and has great potential to offer useful insights to the field of management in terms of new forms of organising, networking, business processing and conducting international business.

India's predominance as leader in the world market is due to a combination of pragmatic policies of the Government and sustained efforts of exporters. Policy changes, such as, creation of Special Economic Zones (SEZ) is expected to boost the export prospects further. Several diamond polishing companies have already established offices in India for trading in rough & polished diamonds. India obtains rough diamonds from Belgium, UK, Hong Kong, UAE, Israel, etc. Indian diamond traders seek opportunities to establish direct trade ties with mining companies. The expectations of the Indian Diamond Industry are to access rough diamonds at competitive rates directly from the producers to maintain its lead in the world market.

Tripartite MoU among Government of Madhaya Pradesh (MRD, through DGM), MPSMCL & NMDC was signed for geological and geophysical exploration in various Districts of Madhaya Pradesh In this regard, Government of Madhya Pradesh issued Gazette Notifications of 20 diamond prospective blocks which are applied under MoU for exploration and subsequent reservation.

Remote Sensing Studies have been completed in collaboration with NRSC. Chhattarpur-Panna Block 1, Chhattarpur-Panna Block 2 and Damoh Block, Panna (5 Prospective Blocks) and Additional 12 Diamond Blocks.

Several target areas were established after conducting ground magnetic, VLF-EM & Gravity surveys and stream sediment sampling and several additional anomalous areas were demarcated in the diamond blocks by processing the Raw Aeromagnetic Data acquired/provided by GSI in Diamond Blocks.

Forest applications for drilling has been prepared and submitted. The matter is being pursued with Forest Department for obtaining permission for drilling.

Proposals were submitted by NMDC to the Government of Chhattisgarh for Baloda–Belmundi

Diamond Block over an area of 156.80 sq km in Saraipali tehsil, Mahasamund district for reservation under Section 17(A) (2A) of MM (D&R) Amendment Act, 2015 for undertaking prospecting and exploitation operations. Ministry of Mines, Goverment of India vide G.S.R.744(E) dt 14.10.2021 granted reservation of Baloda–Belmundi Diamond Block for PL or ML in favour of NMDC-CMDC limited under Section 17A(1A) of MMDR Act, 1957. NCL vide letter dated 13.01.2022, submitted application to Secretary, MRD, Government of Chhattisgarh for grant of Prospecting Licence for Baloda–Belmundi Diamond Block.

CONSUMPTION

Industrial diamonds are mostly consumed by manufacturers of drill bits, grinding tools and stone cutting & polishing machines and demand of industrial diamonds is mostly met by imports. There are many small-scale sector units that operate in cutting & polishing trade.

SUBSTITUTES

Synthetic Diamond

Today, market for industrial diamond is dominated by synthetic stones, first developed in 1950s. Synthetic diamonds manufactured using high pressure and high temperature methods compete as an abrasive mineral with natural industrial diamonds and also with manufactured materials like silicon carbide (SiC), alumina (Al_2O_3), tungsten carbide (WC) and carbide boron nitrate (CBN). Synthetic diamonds being marketed are mostly 0.6 to 0.8 mm and smaller in size. Synthetic Diamond Abrasives (SDA) are used for sawing, drilling or milling hard stones, concrete aggregate, refractory materials, masonry and asphalt. In general, large crystals are used for cutting softer materials and smaller crystals for tougher jobs. Synthetic diamonds now account for bulk supply of industrial diamonds and are preferred over natural diamonds because their quality can be controlled to suit customer's requirements.

Synthetic diamonds were produced earlier by using graphite with a metal catalyst under very high pressure & temperature.

Of late a new process, such as, Chemical Vapour Deposition (CVD) has been evolved which requires relatively low pressure for production of synthetic diamonds. This process involves depositing tiny crystals of diamond on a film which can be built in complicated shapes and used at desired places or instruments, such as, machine part, heat conductors in micro circuit, shortwave UV, microwave sources and radiation detectors. In future, CVD can be a substitute for silicon in Computer Industry. In USA, developments have taken place in CVD method of growing 100% pure diamond using microwave plasma technology. This method is more economical and also enables production of larger crystals.

TRADE POLICY

Import of diamond under HS Code 7102, Diamonds, whether or not worked, but not mounted or set, fall under 'Free' category as per the Import Policy ITC(HS), 2022 Schedule 1. Foreign Direct Investment (FDI) in diamond mining up to 100% is admissible for automatic approval of Reserve Bank of India.

WORLD REVIEW

The world reserves of industrial diamond are about 1,300 million carats located mainly in Russia (46%), Botswana (23%), Congo (Kinshasa) (12%), South Africa (9%) and Australia (1%). The world reserves of diamond are furnished in Table-6.

Table – 6 : World Reserves of Diamond

(Industrial)

(By Principal Countries)

(In million carats)

Country	Reserves
World : Total (rounded off)	1300
Australia	11a
Botswana	300
Congo (Kinshasa)	150
Russia	600
South Africa	120
USA	NA
Zimbabwe	NA
Other countries	120

Source: Mineral Commodity Summaries,USGS, 2023

a - In Australia, Joint Ore Reserves Committee - compliants reserves were 10 million carats.

(a) For Australia, joint Ore Reserves Committee - compliant reserves were 1.7 billion tons.

The total world production of diamond increased by about 6% from 111.75 million carats in 2020 to 118.03 million carats in 2021.

The principal producers were Russia (33%), Botswana (19%), Canada (15%), Dem. Rep. of Congo (11%), South Africa (8%) and Angola (7%). During the year, increase in diamond production was observed in Russia, Botswana, Canada while decrease in production was observed in Dem. Rep. of Congo (Table-7).

Table – 7 : World Production of Diamond

(By Principal Countries)

(In carats)

Country	2019	2020	2021
World: Total	141649276	111746869	118032675
Russia	45271212	31186551	39116970
Botswana	23687000	16868000	22696000
Canada	18491388	15035711	17353418
Congo, Dem. Rep.	18892000	16560000	12773000
South Africa	7177435	8470840	9723811
Angola	9149746	7734281	8723069
Zimbabwe	2119189	2670458	4224300
Namibia	1745281	1484290	1517525
Sierra Leone	824430	686020	829330
Other countries	14291595	11050718	1075252

Source: BGS World Mineral Production, 2017-2021
Figures rounded off

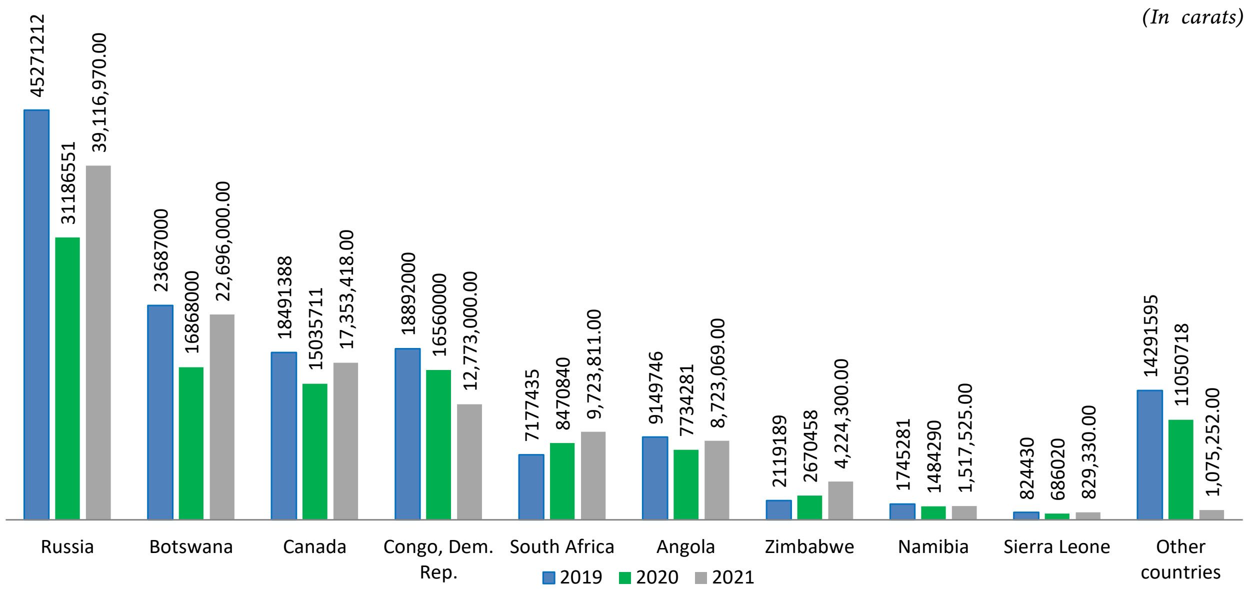


Fig 2: Countrywise Production of Diamond

Natural diamonds are cut in about 52 countries. The major diamond cutting centres in the world are Antwerp in Belgium, Ramat Gan in Israel, New York in USA, Surat in India and Guangzhou & Shenzhen in China.

For a generalised view of the development in various countries, the countrywise description sourced from the latest available publication of Minerals Year- book 'USGS 2018' is furnished below.

Lesotho

The Liqhobong Diamond Mine in the Maluti Mountains of northern Lesotho began ramping up production in late 2016 and had its first full year of commercial production in 2018, when reported production was 8,36,000 carats. The mine was owned by Firestone Diamonds plc (75%) and the Government of Lesotho (25%).

Russia

ALROSA officially commissioned and started mining at the Verkhne-Munskoe Diamond Field in Yakutia on October 31, 2018. Four kimberlite pipes were explored during the last quarter of 2018. ALROSA estimated that the deposit would yield 1.8 million carats of rough diamonds per year, and the estimated reserves of the Verkhne-Munskoe diamond field were sufficient to operate for more than 20 years.

South Africa

De Beers Consolidated Mines Pty. Ltd. safely closed the mine in December 2018, but the South African Department of Mineral Resources continued looking for an operator capable of purchasing the mine. De Beers also operated the Venetia Mine in Limpopo Province, where it was conducting a $2 billion project to take the mine underground and extend its operating life into the 2040.

Exports

Value of exports of diamond increased by 51% to ₹18,93,641 crore in 2021-22 against ₹12,58,209 crore in the previous year. Diamond (mostly cut) alone accounted for almost cent per cent exports in terms of value during this year. The share of industrial diamonds and diamond powder was about ₹ 116 crore and ₹ 29 crore, respectively in 2021-22. Exports were mainly to USA (39%), Hong Kong (25%), Belgium (10%), UAE (8%), Israel (6%) and Thailand (4%) (Tables- 8 to 11).

Table – 8 : Exports of Diamond : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹'000)	Qty (**)	Value (₹'000)
All Countries	**	**1258209200**	**	**1893641728**
USA	**	457334506	**	730165646
Hong Kong	**	428968079	**	480271367
Belgium	**	93205300	**	195508832
UAE	**	82269885	**	147555721
Israel	**	60576761	**	106610481
Thailand	**	43003607	**	79414507
Japan	**	20619224	**	22221449
Botswana	**	9885172	**	17209611
UK	**	7183160	**	14740939
South Africa	**	3172877	**	14582002
Other countries	**	51990629	**	85361173

Figures rounded off

Table – 9 : Exports of Diamond

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (carats)	Value (₹'000)	Qty (carats)	Value (₹'000)
All Countries	**7015880**	**688082**	**12125962**	**1162179**
UAE	888985	246629	2404968	364101
China	625042	119753	744326	251477
Belgium	910757	131789	1757240	239666
Israel	2360952	50514	2758537	94752
USA	532191	57876	676370	69773
Ireland	794330	22380	1439993	37284
U K	812206	21261	1827954	37222
Taiwan	1067	23159	1354	27753
Germany	4777	4377	25017	15626
Russia	50000	874	446000	8164
Other countries	35573	9470	44203	16361

Figures rounded off

*Note:'**'Not additive*

Table – 10 : Exports of Diamond (Mostly Cut)#

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹'000)	Qty (**)	Value (₹'000)
All Countries	**	**1257345848**	**	**1892188684**
USA	**	457215875	**	730021717
Hong Kong	**	428965865	**	480235350
Belgium	**	93050333	**	195229955
UAE	**	82023002	**	147191583
Israel	**	60500703	**	106470422
Thailand	**	43003607	**	79413563
Japan	**	20616732	**	22221449
Botswana	**	9880102	**	17205542
UK	**	7139914	**	14670617
South Africa	**	3172521	**	14581953
Other countries	**	51777194	**	84946533

Figures rounded off

*Note:'**'Not additive*

Table – 11 : Exports of Diamond (Powder)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (TCA)	Value (₹'000)	Qty (TCA)	Value (₹'000)
All Countries	**10628**	**175270**	**13991**	**290865**
USA	4002	60755	3993	74156
Israel	1710	25544	2538	45307
Belgium	716	23178	1471	39211
UK	894	21985	1412	33100
Germany	781	24045	1291	30079
Hong Kong	++	12	3	29420
China	1327	5966	1475	22688
Ireland	231	7428	413	10148
Switzerland	707	1844	1138	3865
Botswana	60	429	53	722
Other countries	200	4084	204	2169

Figures rounded off

Imports

In 2021-22, imports value of diamond increased by about 60% to ₹2,05,638 crore from ₹1,28,351 crore in the previous year. Diamond (mostly cut) shared the bulk, i.e., almost cent per cent of the imports in terms of value. Imports of industrial diamond and diamond powder were about 16.46 million carats and 1,238 million carats, respectively, valued at ₹ 1,078 crore and ₹ 286 crore, respectively. Imports were mainly from UAE (35%), Belgium (21%), USA (20%), Hong Kong (6%), Israel (5%) and South Africa (3%) (Tables-12 to 15).

Table – 12 : Imports of Diamond

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹'000)	Qty (**)	Value (₹'000)
All Countries	**	**1283511854**	**	**2056382187**
UAE	**	367595066	**	712821699
Belgium	**	256742721	**	428174842

Country	2020-21 (R)		2021-22 (P)	
	Qty (TCA)	Value (₹'000)	Qty (TCA)	Value (₹'000)
USA	**	263507101	**	420102490
Hong Kong	**	171122660	**	133013019
Israel	**	46243763	**	96946989
South Africa	**	46613537	**	70089263
Russia	**	50361552	**	60104585
Thailand	**	18361551	**	41225238
Botswana	**	32833354	**	38419662
UK	**	1896882	**	12794236
Other countries	**	28233667	**	42690164

Figures rounded off

Table – 13 : Imports of Diamond

(Industrial)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (carats)	Value (₹'000)	Qty (carats)	Value (₹'000)
All Countries	**8725537**	**4362112**	**16457278**	**10785779**
UAE	6759538	3532523	8105132	6012974
Belgium	752966	301629	4953064	2590443
Russia	423311	343374	1976284	1646523
Hong Kong	78669	63307	397600	252238
Israel	499907	35363	873319	229252
South Africa	187761	81527	103300	30425
UK	9471	1023	36970	17832
Botswana	-	-	4874	2626
Italy	-	-	2635	2375
Ireland	3150	562	4100	1091
Other countries	10764	2804	-	-

Figures rounded off

Table – 14 : Imports of Diamond (Powder)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (TCA)	Value (₹'000)	Qty (TCA)	Value (₹'000)
All Countries	**839962**	**1898403**	**1238216**	**2866544**
China	809594	1645875	1199714	2484163
Ireland	11283	95603	19276	156390
Hong Kong	9914	57581	5234	64074
U S A	3286	40671	5296	63898
Korea, Rep. of	1406	10624	2907	29124
Switzerland	929	17559	1363	26463
Belgium	1660	19964	1934	26299
UK	80	1890	989	5942
UAE	-	-	650	3526
Germany	116	560	585	2819
Other countries	1694	8076	268	3846

Figures rounded off

Table – 15 : Imports of Diamond (Mostly cut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹'000)	Qty (**)	Value (₹0'000)
All Countries	**	**1277251339**	**	**2042729864**
UAE	**	364062543	**	706805199
Belgium	**	256421128	**	425558100
USA	**	263466281	**	420038592
Hong Kong	**	171001772	**	132696707
Israel	**	46208400	**	96717737
South Africa	**	46532010	**	70058838
Russia	**	50018178	**	58458062
Thailand	**	18360627	**	41225238
Botswana	**	32833354	**	38417036
UK	**	1893969	**	12770462
Other countries	**	26453077	**	39983893

Figures rounded off

*Note:'**'Not additive*

FUTURE OUTLOOK

The Diamond Industry in the country currently employs over 8 lakh artisans who are experts in cutting and polishing of small diamonds and are now in a position to process full range of sizes and qualities of gemstones using latest technology. The Chinese Government has begun to initiate multi-billion dollar deals for rough diamonds in exchange for things that China produces like medicines, oils and industrial goods & services. Also, China's investment in Africa is a large threat to the Indian Diamond Cutting and Polishing Industry. There is a growing preference for polishing diamonds in countries where the diamonds are mined, like in Africa. It means that the Indian sector may face problems as India is not a large producer, and depends on import of rough diamonds from Africa. Low profit margins in the cutting and polishing segment have heightened midstream players' interest in synthetic diamonds, but synthetics have to be contented with only limited acceptance among jewellery retailers and end consumers.

With the support in the form of increasing urbanisation, middle-class expansion and appeal as engagement rings, India will emerge as a third largest market for diamond jewellery leaving behind Europe and Japan. Meanwhile, China and the US are expected to remain as the leading diamond jewellery markets.

10. Diatomite

2.89
(million tonnes) total resources of diatomite were estimated as on 01.04.2020

1,964
(tonnes) of diatomite were exported in 2021-22.

1789
(tonnes) of diatomite were imported in 2021-22.

Diatomite is a chalk-like, soft, friable, very- fine-grained siliceous sedimentary rock that is light in colour (white and yellowish) white if pure, commonly buff to grey in situ. It is composed of fossilised remains of unicellular aquatic algae-like plants called diatoms which are both marine & lacustrine in origin. Diatoms are microscopic, single-celled organisms, often appearing as colonial aquatic plants (algae). Diatom cells contain an elaborate internal siliceous skeleton. More than 10,000 living diatom species have been identified, in addition to another 10,000 known diatom fossil forms. Diatomite deposits are the remains from the cell wall of diatoms, which are composed of amorphous hydrous silica. Diatomite has the ability to absorb soluble silica to form a highly porous skeletal framework. The dead remains of these diatoms over the ages have fossilised and formed the deep-bedded deposits in ocean & lake floors. The special properties of diatomite, i.e., light weight (low in density), high porosity and high absorptivity have facilitated its application as filter medium and absorbents. It is chemically inert & highly stable. Diatomite consists of approximately 90 per cent silica and the remainder consists of compounds, such as, aluminium and iron oxides. It is also called 'Kieselguhr'. Diatomaceous earth is a common alternate name, but the term is more appropriate for unconsolidated or less lithified rock of the same origin.

Another lesser known mineral, namely, siliceous earth has many similarities with diatomite in character. Siliceous earth is, however, an inorganic material which has chemical composition of more than 80% of amorphous silica. This amorphous phase is very rare and used widely in industrial-scale because of its high porosity, fine particle size, very low density and its high surface area. Its chemical and physical features are same as diatomites which is also amorphous silica consisting of fossilised remains of diatoms, a type of hard-shelled algae. Siliceous earth differs from diatomite in its origin and seems to be formed from volcanic ash. However, due to she many similarities in both materials, siliceous earth finds similar uses as diatomites and therefore, has been included in the Review.

RESERVES/RESOURCES

The occurrences of diatomite are reported from Gujarat and Rajasthan. As per NMI database, based on UNFC system, the total resources of diatomite as on 1.4.2020 has been estimated at 2.89 million tonnes, all of which fall under Remaining Resources. The resources are distributed in Rajasthan (72%) and Gujarat (28%) (Table-1).

Table – 1: Reserves/Resources of Diatomite as on 1.4.2020(P)

(By Grades/States)

(In '000 tonnes)

Grades/State	Reserves Total (A)	Remaining Resources			Total Resources (A+B)
		Feasibility	Inferred	Total	
		STD211	STD333	(B)	
All India: Total	**–**	**634**	**2251**	**2885**	**2885**
By Grade					
Unclassified	–	634	2251	2885	2885
By States					
Gujarat	–	–	811	811	811
Rajasthan	–	634	1440	2074	2074

Figures rounded off.

PRODUCTION

Diatomite

Production of diatomite has not been reported since 1991-92. Pandava and Khadraliya areas in Bhavnagar district, Gujarat, were the producing areas prior to 1991-92.

Siliceous Earth

The production of siliceous earth was 31,783 tonnes during 2021-22 as against 23,823 tonnes in 2020-21 (Tables- 2 to 4).

There were thirteen reporting mines in the year 2021-22 as against twelve reporting mines in 2020- 21.

Mine-head closing stocks of siliceous earth in the year 2021-22 were 65,918 tonnes (Table-5).

The average daily employment of labour in 2021-22 was 56 as against 48 in the previous year.

Table – 2 : Principal Producers of Siliceous Earth 2021-22

Name & address of producer	Location of mine	
	State	District
Mr. Babu Lal Mali, Akali, Shiv. Barmer - 344701, Rajasthan.	Rajasthan	Barmer
Mr.Narayan Singh Rathore, Chandan Singh ki Dhani, Shiv. Barmer -344 001, Rajasthan	Rajasthan	Barmer
Mr.Ashok Kumar Khatri, Inko ki Pol, Pokaran, Jaisalmer-345 021, Rajasthan.	Rajasthan	Jaisalmer
Mr.Ishwar Singh Rathore, Vill.Jayani,P.O.Kathoti, Jayal,Nagaur-341 001 Rajasthan.	Rajasthan	Jaisalmer

Table – 3 : Production of Siliceous Earth, 2019-20 to 2021-22(P)

(By States)

(Qty in tonnes; Value in ₹'000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**19367**	**11710**	**23823**	**14686**	**31783**	**21209**
Rajasthan	19367	11710	23823	14686	31783	21209

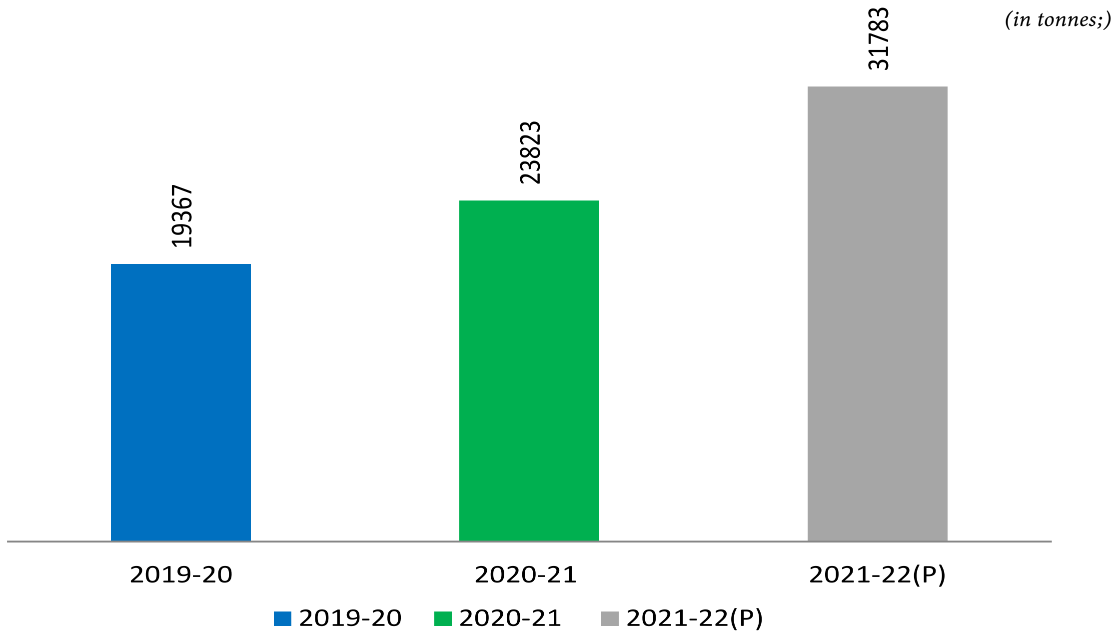


Fig 1: Production of Siliceous Earth

Table – 4 : Production of Siliceous Earth, 2020-21 and 2021-22(P)

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	2020-21			2021-22		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**12**	**23823**	**14686**	**13**	**31783**	**21209**
Private Sector	12	23823	14686	13	31783	21209
Rajasthan	12	23823	14686	13	31783	21209
Barmer	4	9685	6808	6	23630	16976
Jaisalmer	8	14138	787	7	8153	4233

Table – 5 : Mine-head Closing Stocks of Moulding Sand, 2020-21 & 2021-22(P)

(By States)

(In tonnes)

State	2020-21	2021-22(p)
India	**81530**	**65918**
Rajasthan	81530	65918

USES

Diatomite is commonly used after calcination in plate and frame filter units. Processed diatomite finds a wide range of applications due to its properties like porosity, low bulk density, soluble impurities, high absorptive capacity for liquids, large surface area, low thermal conductivity, mild abrasive nature and chemical inertness.

Diatomite is an excellent filtering material for many liquids especially beverages, fruit juices, soft drinks, beer and wine. It is used in chemicals like sodium hydroxide, sulphuric acid and gold salts. Filtration of cooking oils (vegetable and animal) and sugar (cane, beet and corn) is an application where diatomite is predominantly used. It is also used as an absorbent of vegetable oil, polyethylene, rayon liquors and as a flattening agent in paint, plastic, rubber, drugs, toothpaste, polishes and chemicals. Diatomite is utilised for safe handling and storage of hazardous chemicals like sulphuric acid. Besides, diatomite is also used as an abrasive in metal polishing in automobiles and toothpastes; as pozzolanic admixtures in Cement Industry; as animal feed stuff conditioners; and in explosives. It is also used as a coating material in the manufacture of ammonium nitrate fertilizer which is hygroscopic. Diatomite clay is the new revolution in hydroponics. In pharmaceuticals, it is used to filter syrups and other bulk drugs in liquid form. It is used as a facial exfoliator to promote skin health. Research has also shown that food-grade diatomaceous earth may offer positive benefits for controlling cholesterol levels which in turn would improve heart health. The cleaning of grease and oils continued to be the largest end use for diatomite. In Oil Industry, before packing, it is used for filtering oil which not only gives it a shine but also helps in removing any suspended impurity. Wine and beer are filtered through diatomite filters before packing to remove molasses. Filter candles are made from diatomite filter aids for drinking water purification. Processed diatomite granules 15 to 50 mm, are used in denim wash (commonly known as stonewash) to give it shine and design.

Diatomite is also used as caking agent in fertilizers, plastics and as a natural insecticide for organic pest control. Potable water treatment and biological filtration are areas of expansion in diatomite consumption. Siliceous earth is mainly used as filler & filter, heat & sound resistant material and in Ceramic Industry. Filtration and cleaning of vegetable oils and animal fats and manufacturing of medicines are other uses. In advance applications, it is used as carrier for catalyst in chemical processes and for mineral fertilizers & herbicides, pesticides and fungicides. It is also used as raw material for refination and filtration as well as constituent of synthetic molding mass. It is increasingly used for the removal of microbial contaminants, such as, bacteria, protozoa and viruses, from public water systems. Recently, diatomite derived products included filter aids (50 per cent), filters (15 per cent), absorbents (5 per cent), and other minor uses, including specialised pharmaceutical and biomedical applications (less than 1 per cent).

Siliceous earth, on the other hand, is used in powder form which may vary from 80 mesh to 500 mesh powder. It is also used in granule form in some specific operations and in paint, filler, rubber, catalyst, fertilizer, pesticides, agriculture and many other industries.

Diatomite is increasingly used in agriculture segment in fungicides, insecticides and rodenticide owing to its dehydration properties. Other diatomite applications include its use as a growing medium in hydroponic gardens wherein its characteristics, such as, inertness, water holding capability and porosity allows the soil to breathe.

PROCESSING

Diatomite deposits are usually mined as open pit operations. If necessary, the mined crude is dried and crushed. Dried diatomite is collected in cyclones and fed through air separators to remove coarse material and impurities. Calcination and flux calcination are used to thermally volatise organic material and oxidise iron. Calcination is also used to increase diatomic hardness, specific gravity and refractive index. The fusing of small diatomite particles into clusters can also be accomplished through calcination, which results in increased pore size and volume. Diatomite products are sold as various grades of calcined powders.

INDUSTRY

M/s Seema Minerals & Metals, Udaipur, Rajasthan, produces various grades of diatomaceous earth of which some grades are as follows:

- Diatomaceous Earth for insulation in Fire Proof Cabinets and safes.
- Diatomaceous Earth for calcium silicate boards.
- Diatomaceous Earth for water purification.
- Diatomaceous Earth for Animal Feed.
- Diatomaceous Earth for agriculture crops.
- Diatomaceous Earth for filtration.
- Calcined Diatomaceous Earth.
- Diatomaceous Earth Oil absorbents.
- Diatomaceous Earth for insecticides.

SUBSTITUTION

Many materials can be substituted for diatomite. However, the unique properties of diatomite assure its continued use in many applications. Expanded perlite and silica sand compete for filtration. Filters made from manufactured materials, notably ceramic, polymeric, or carbon membrane filters and filters made with cellulose fibers are becoming competitive as filter media. Alternate filler materials include clay, ground limestone, ground mica, ground silica sand, perlite, talc, and vermiculite. For thermal insulation, materials, such as, various clays, exfoliated vermiculite, expanded perlite, mineral wool and special brick can be used. Transportation costs will continue to determine the maximum economic distance that most forms of diatomite may be shipped. Diatomite still remains competitive despite availability of alternative materials. Many alternatives exist for diatomite as a pozzolan, however, its use as an ingredient of portland cement has not diminished but on the cotrary has increased in recent years. The encroachment of natural and synthetic substitute materials into diatomite markets has not been significant.

TRADE POLICY

As per the Foreign Trade Policy, 2015-2020, the imports and the exports of siliceous fossil meals (kieselguhr, tripolite, diatomite) and similar siliceous earth, whether or not calcined under ITC (HS) Code 251200 (25121010, 25120020, 25120030 and 25120090) are free.

WORLD REVIEW

World reserves/resources of crude diatomite are adequate for the foreseeable future. The USA has the largest reserves at 250 million tonnes followed by China with 150 million tonnes,Turkey with 44 million tonnes and Rep. Korea. 2.3 million tonnes. (Table-6). The world diatomite production was 2.2 million tonnes in 2021. The USA dominated the world production by accounting for 38% output which was followed by Turkey (9%) , Mexico (7%), China (6%), Denmark (5%), Peru, Argentina, France (4% each) and Mozambique & Germany (3% each). Production in Denmark was mostly of molar, an impure diatomite containing a large proportion of clay (Table- 7).

Table – 6: World Reserves of Diatomite

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total	**Large**
Argentina	NA
China	150000
Denmark[5] (processed)	NA
France	NA
Germany	NA
Japan	NA
Korea, Rep. of	2300
Mexico	NA
New Zealand	NA
Peru	NA
Russia	NA
Spain	NA
Turkey	44000
USA[1]	250000
Other countries	NA

Source:USGS, Mineral Commodity Summaries,2023

NA - Not available

1 Processed ore sold or used by producers.

5 Include sales of molar production.

Table – 7: World Production of Diatomite

(By Principal Countries)

(In carats)

Country	2019	2020	2021
World: Total	**2100000**	**2100000**	**2200000**
USA[a]	768000	822000	830000(e)
Turkey	220757	100327	207732
Mexico	129274	144105	160956
China[e]	150000	140000	140000
Denmark (Molar)[B]	108750	115000	120625
Peru	91103	85406	94860
Argentina	84610	98575	90000[e]
France[e]	90000	90000	90000
Mozambique	72439	80189	72914
Germany	53802	51511	57719
Other countries	350426	376299	334514

Source: BGS, World Mineral Production, 2017-2021.

(a) Sold or used by producers

(b) Molar is an impure diatomite containing a large proportion of clay

(e) : Estimated

FOREIGN TRADE

Exports

Exports of diatomite decreased drastically by 39% to 1,964 tonnes in 2021-22 from 3,240 tonnes in the previous year. Exports were mainly to Taiwan (37%), Sri Lanka (25%), Mexico (9%), Kuwait (7%), USA (5%), France (4%) and Tanzania (3%) (Table-8).

On the other hand exports of kieselguhr increased marginally by 4% to 28 tonnes in 2021-22 from 27 tonnes in the previous year. Exports were mainly to Switzerland (93%) and China (7%) (Table-9).

Table – 8: Exports of Diatomite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t	Value (₹ '000)
All Countries	**3240**	**69439**	**1964**	**58544**
USA	29	9917	100	13623
Taiwan	1830	25704	731	10248
France	34	4194	77	9950
Sri Lanka	85	1515	482	9583
Tanzania	64	4681	60	3992
Mexico	--	--	179	2901
Kuwait	162	1755	140	1541
Qatar	14	518	24	888
UK	22	694	26	834
Nepal	4	240	12	764
Other countries	996	20221	133	4220

Figures rounded off

(in tonnes;)

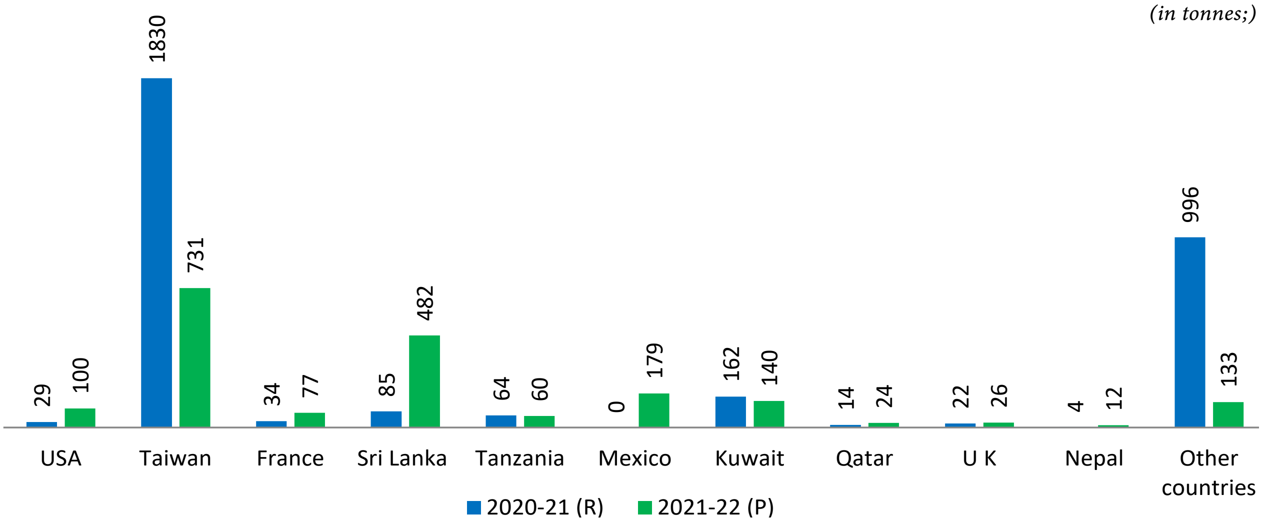


Fig 2: Countrywise Export of Diatomite

Table – 9: Exports of Kieselguhr

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**27**	**917**	**28**	**516**
Switzerland	26	790	26	472
China	++	8	2	39
Philippines	--	--	++	4
Colombia	--	--	++	1
Bangladesh	1	112	--	--
Vietnam	++	4	--	--
Sri Lanka	++	3	--	--

Figures rounded off

Imports

Like exports, imports of diatomite also decreased drastically by 75% to 1,787 tonnes in 2021-22 from 7,099 tonnes in the previous year. Imports were mainly from USA (52%), China (27%), Mexico (13%), Spain & Germany (3% each) (Table-10).

Imports of kieselguhr were negligible in 2021-22 as compared to 10 tonnes in preceding year. Imports of kieselguhr were mainly from UK and Belgiums (Table-11).

Imports of tripoli earth were 19 tonnes in 2021-22 as compared to nil in the previous year. Imports of tripoli earth were from USA (Table-12).

Table – 10 : Imports of Diatomite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t	Value (₹ '000)
All Countries	**7099**	**212766**	**1787**	**94373**
USA	1071	65861	923	45037
China	615	21753	489	22920
Mexico	57	3811	240	14845
Spain	16	2996	55	5099
Germany	-	-	54	4044
Australia	5340	118345	24	1745
France	-	-	2	683

Figures rounded off

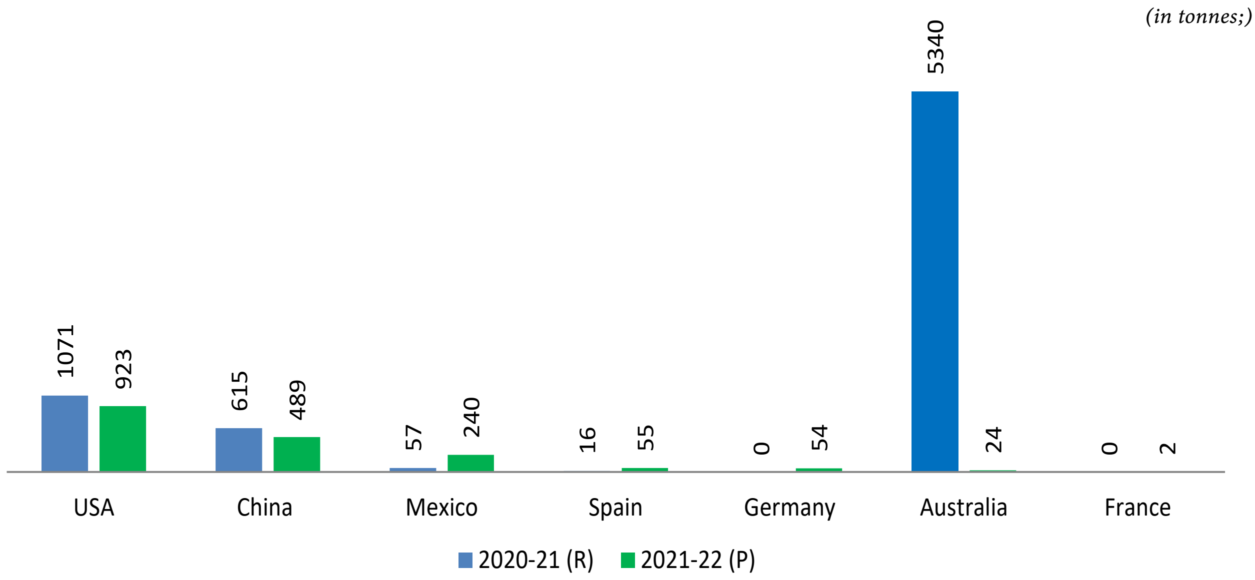


Fig 3: Countrywise Import of Diatomite

Table – 11: Imports of Kieselguhr

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**10**	**1543**	**++**	**64**
UK	++	99	++	59
Belgium	++	4	++	5
France	10	1382	--	--
USA	++	38	--	--
Germany	++	20	--	--

Figures rounded off

Table – 12: Imports of Tripali Earth

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**-**	**-**	**19**	**1174**
USA	-	-	19	1174

Figures rounded off

FUTURE OUTLOOK

Diatomite market is expected to witness substantial growth owing to increasing use in industrial applications including filter aid and filler material. Natural filtering characteristics due to its unique honeycomb structure and its rising use in filtration application as well as food and beverage market are key drivers for the growth of diatomite market.

Filtration market is the largest consumer of diatomite owing to high levels of purifying capabilities. In addition, growing use of diatomite in industries, such as, paints, plastics, insecticides, pharmaceuticals, chemicals, adhesives, sealants, paper etc. is expected to propel market growth over the forecast period. In addition, its use in Plastic Industry as an anti- blocking agent assists in separation of plastic parts during manufacturing and separation of plastic bags. Growing health and safety concerns associated with inhalation of crystalline silica during diatomite processing is expected to affect market growth.

North America accounted for largest market share in terms of demand owing to large amount of diatomite reserves available in the region. In addition, increasing demand from various industrial applications including water treatment, absorbents and crop protection chemicals is expected to augment market growth. United States had the highest demand for diatomite in North America owing to growing demand in manufacturing crop protection and water treatment chemicals. Asia Pacific accounted for second largest market share owing to increasing demand from crop protection chemicals and industrial applications, particularly in China. Further, demand from countries including India, Rep. of Korea, Japan and Australia are expected to provide better opportunity for diatomite market over the forecast period. Europe contributed for a significant share for diatomite owing to increasing demand from crop protection and water treatment particularly in Spain, Germany and United Kingdom. Middle East is expected to witness significant growth owing to increasing use of diatomite in various stages of oil & gas exploration.

The economic stability of diatomite was largely on account of its use as a viable filtration medium. Despite challenging market condition for many industrial commodities, world diatomite production remained stable. The demand for diatomite as filtration medium still remains strong particularly in the filtration of spirit as well as human blood plasma and in other biotechnical applications.

11. Emerald

55,869 (tonnes) Total resources of emerald were estimated as on 1st April 2020	**1,656** (crore) value of emerald (cut & uncut) were imported in 2021-22	**1,081** (crore) value of emerald (cut & uncut) were exported in 2021-22.

Emerald, commonly called as 'Panna' in Hindi, is a variety of mineral beryl and is chemically a complex silicate of aluminium and beryllium ($Be_3Al_2(SiO_3)_6$. The hardness of Emerald is about 7.5 to 8 on Moh's scale. Emeralds are rare & precious gemstones that command immense value on account of their cut, colour, clarity and carat. Beauty, rarity and durability are the main virtues of a gemstone. The cut stones are known as gems, while the uncut ones are gemstones. Emeralds occur in hues varying from yellow-green to blue-green. However, emeralds with unique velvety green colour with high degree of transparency are considered as most precious among gemstones.The rose variety of beryl is called morganite, and the golden yellow variety is termed 'golden beryl'. If the colour is bluish green or blue then it is called 'aquamarine'. When emerald contains chromium as an impurity, it imparts the colour green. Eme ald is generally found at the contact of pegmatites intruding schists, mainly amphibole schists.

RESERVES/RESOURCES

As per NMI data, as on 01.04.2020 based on UNFC system, the total resources of emerald in the country are estimated at 55.87 tonnes. All resources are placed under Reconnaissance category and Unclassified grade resources have been reported in the State of Jharkhand (Table-1).

Occurrences of emerald are also reported from Rajasthan, Odisha and Chhattisgarh. However, resources have not been estimated so far. In Rajasthan, emeralds have been found to occur at a number of places in districts of Rajsamand and Ajmer. In Ajmer-Rajsamand belt of Rajasthan, emerald occurrences are confined to the upper fringes of pegmatites. Emerald deposit is found in the 221 km long belt stretching from Gam Gurha in Rajsamand district to Bubani and Muhami in Ajmer district. Important localities are Rajgarh, Tikhi and Kalaguman (Rajsamand). The occurrences are highly sporadic and variable.

In Odisha, occurrences of emerald are reported from Bira-Mohorajpur belt in district Bolangir. In Chhattisgarh, occurrences of emerald are reported from Deobhog area in Raipur district. Sporadic and irregular crystals of emerald, aquamarine and amethyst are also reported in a few localities in district Coimbatore,Tamil Nadu.

Table – 1 : Reserves/Resources of Emerald as on 1.4.2020 (P))

(By Grades/States)

(In kg)

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111			(A)	STD221			STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	-	-	-	-	-	-	-	-	-	-	**55869**	**55869**	**55869**
By Grade													
Unclassified	-	-	-	-	-	-	-	-	-	-	55869	55869	55869
By State													
Jharkhand	-	-	-	-	-	-	-	-	-	-	55869	55869	55869

Figures rounded off

PRODUCTION

Production of emerald has not been reported since 1983. However, a single lease of 46.32 ha area was granted to M/s Serva Shri Mining & Mineral Industries in district Ajmer, Rajasthan in the year 1998. The mine-head closing stocks of emerald at the end of the years 2020-21 and 2021-22 were 20 kg each (Table-2). The average daily employment was nil in both the years.

Table – 2: Mine-head Stocks of Emerald, 2020-21 & 2021-22 (By State)

(In kg)

State	2020-21	2021-22 (P)
India/ Rajasthan	20	20

MINING AND MARKETING

Mining of emerald was mostly undertaken manually by opencast method. The pits were worked at shallow depths. The stones collected during mining were sorted out according to size, shape and quality. The stones so collected were deposited with the State Government under the supervision of DMG officials and mine owners. Worldwide, crude emerald was sold through public auction from time to time.

The beauty of rough stone is enhanced by skilful cutting and polishing into faceted or rounded form for use in jewellery. The rough stones are sorted out to determine the angles to which facets can be cut. They may be sawed or polished in any direction according to shape, size and colour to be retained. After the shape and size are determined, the next process of 'pre-shaping' is done. The third and important process called 'calibration' gives the pre-shaped stone a definite proportion and size. The process that follows is 'faceting' and 'polishing'. The aim of this process is to achieve maximum internal reflection enhancing the beauty of the stones. Emeralds are generally given a step-cut or cabochon-cut.

India is the leading exporter of cut and polished gems, but continued to depend on raw materials. The Diamond and Gem Development Corporation of India has set up Diamond and Gem Parks for cutting and polishing of gems in different States. Jaipur in Rajasthan is the major centre for processing emeralds. Like diamonds, uncut emerald is imported and part of it is exported after processing. Emerald is next to diamond (uncut) amongst precious and semi- precious stones, being imported and re-exported after cutting and polishing.

Prices are governed by many factors including beauty, clarity, defect, demand, durability and rarity. Prices of precious stones also vary over time.

WORLD REVIEW

World production of emerald is reported mainly from Colombia, Pakistan, Afghanistan, Africa, Nigeria, Mozambique, United States of America, Madagascar, Brazil, Zambia and Zimbabwe.

Afghanistan

Afghanistan' s Panjshir Valley has shown potentiality for commercial emerald production. Emeralds have been found only on the eastern side of the valley, even though the western side has been searched extensively. The emerald mines of Afghanistan are located approximately 70 miles (113 km) north east of Kabul and extend from the village of Khenj to Dest-e-Rewat. The emerald mines are located at elevations between approximately 7,000 and 14,300 ft. (2,135 and 4,270 m) in mountainous terrain on the eastern side of River Panjshir. The Panjshir emerald crystals vary in quality from mine to mine. In general, Panjshir emeralds are mined and marketed in a free-enterprise system.

Madagascar

Madagascar was a globally significant producer of gemstone that included emerald, ruby and sapphire. Emerald was produced from the Kianjavato emerald mines which are located in the rain-forest region of eastern Madagascar, approximately 60 km west of the coastal city of Mananjary. Emeralds are also mined at the Ianapera (Sakalava) emerald deposits in the Ianapera (Janapera) area of Tuléar (Toliara) Province, 350 km east of the town Toliara. Societe Orgaco of France mined the emerald (536 kg Heaven's gift) in matrix at the Morafeno mine near Mananjary and exported it to Reunion.

Pakistan

In Pakistan, the Fizzagat emerald mine is situated near the district headquarters of Mingora in Swat valley.

Brazil

Since the 1970's, Brazil has been consistent source of emerald. Brazilian emerald deposits are found in a typical geological setting with Archean basement and supracrustal, ultramafic and granitoid rocks. Brazil emerald mines are located in the states of Bahia, Minas Gerais and Goias. Brazil's emerald production goes to both domestic cutting and foreign buyers who take the rough back to cutting centres in their own country.

Colombia

In Colombia, the mining activity of emerald has been concentrated in the departments of Cundinamarca and Boyaca, in the denominated East and West emerald belts. Mining districts of Chivor, Gachala and Macanal (Eastern Belt) and Muzo, Coscuez, Penas Blancas, La Palma-Yacoi and La Pita (Western Belt) are located in Colombia. The most representative mines are Muzo, Cunas, Coscuez, La Pita and Chivor.

Zambia

Zambia is one of the world's most significant sources of fine-quality emerald and has been called the second most important producer by value after Colombia. The emerald mines are located in the Kafubu area of central Zambia, about 45 km southwest of the town of Kitwe. The majority of the gems produced in Zambia are found in the Kamakanga and Kagem mines. Both are located in the north-eastern region of the country. Gemfields, the world's biggest emerald miner has found a gem that weighs more than 1 . 1 kg at its mine in Lufwanyama. Earlier 5,655 carat stone was found at the Kagem Mines.

Others

Zimbabwe produces rough emeralds from the Sandawana mine, located in the southwest of the country. In the United States of America, in Beaver County, Utah rare red emeralds are found in the eastern slopes of the Wah Wah Mountains. In Ethiopia, a new deposit of high-quality emeralds has been found in the rural areas of Kenticha and Dermi, in the district Seba Boru. Mining is done through hand tools, without heavy machinery.

FOREIGN TRADE

Exports

In 2021-22, exports of emerald (cut & uncut) by value increased substantially by 103% to ₹ 1,080.89 crore from ₹ 531.67 crore in the previous year. Exports were mainly to USA (31%), Hong Kong (27%), Thailand (12%), France & Italy (5% each) and UAE (4%). Out of the total export value of emerald (cut & uncut), the share of the export value of emerald (cut) was almost 98 percent. The export value of emerald (cut) increased considerably by 101% to ₹ 1059.62 crore in 2021-22 from ₹ 527.09 crore in the preceding year. In terms of quantity, the export of emerald (cut) increased to 5,945 thousand carat in 2021-22 from 4,076 thousand carat in the preceding year. Exports of emerald (cut) were mainly to USA (39%), Hong Kong (20%) , Thailand(16%) and UK (6%). On the other hand, the share of the export value of emerald (uncut) was 2%. In 2021-22, exports of emerald (uncut) by value increased manifold by 365% to ₹ 21.27 crore in 2021-22 from ₹ 4.6 crore in the preceding year. In terms of Value, exportsof emerald (uncut) were mainly to UAE (65%), USA (20%), Hong Kong (6%), and Thailand (5%) (Tables- 3 to 5).

Table – 3: Exports Value of Emerald

(Cut & Uncut): Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**	**5316603**	**	**10808861**
USA	**	1293175	**	3306692
Hong Kong	**	2060857	**	2915677
Thailand	**	561998	**	1249771
France	**	77620	**	588629
Italy	**	314455	**	543945
UAE	**	241815	**	408946
Belgium	**	188189	**	361469
Switzerland	**	59761	**	312073
UK	**	90841	**	244424
Germany	**	44796	**	106956
Other countries	**	383096	**	770279

Figures rounded off

Note: Quantity not given due to partial coverage; value figures, however, have full coverage.

(Value in ₹ '000)

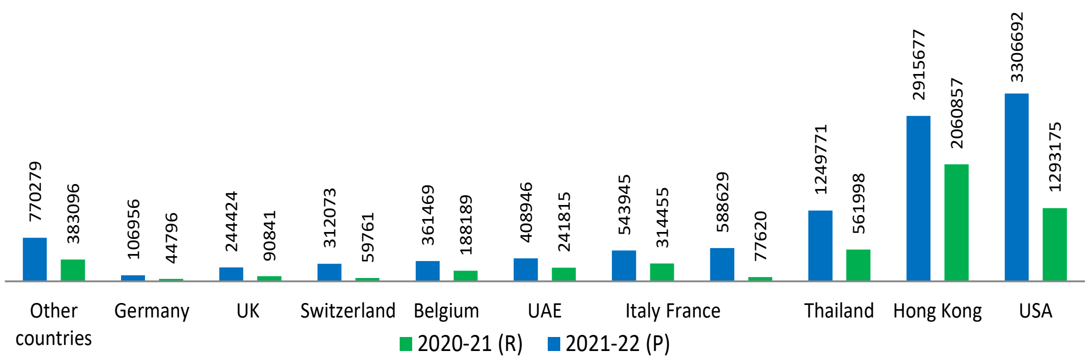


Fig 1: Countywise Exports of Emerald (Cut & Uncut)

Table – 4: Exports of Emerald (Cut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**4076**	**5270862**	**5945**	**10596194**
USA	777	1289117	2337	3263404
Hong Kong	1130	2023042	1199	2903541
Thailand	542	561091	925	1239983
France	7	77580	18	588627
Italy	148	314455	221	543945
Belgium	17	186418	20	356026
Switzerland	2	59761	17	312073
UAE	39	241353	143	271409
UK	1107	90764	368	244314
Germany	34	44796	160	106851
Other countries	273	382485	537	766021

Figures rounded off

(In tonnes)

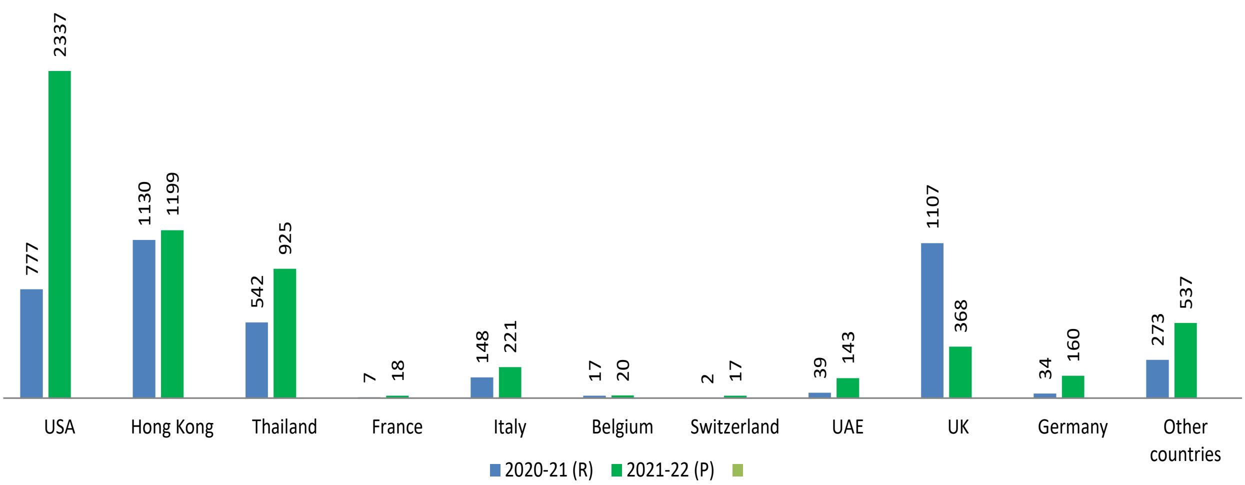


Fig 2: Countrywise Export of Emerald (Cut)

Table – 5: Exports of Emerald (Uncut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**++**	**45741**	**++**	**212667**
UAE	++	462	++	137537
USA	++	4058	++	43288
Hong Kong	++	37815	++	12136
Thailand	++	907	++	9788
Belgium	++	1771	++	5443
China	++	397	++	2591
Australia	++	56	++	995
Japan	++	126	++	281
Singapore	--	--	++	172
Czech Republic	--	--	++	113
Other countries	++	149	++	323

Figures rounded off

(Value in ₹ '000)

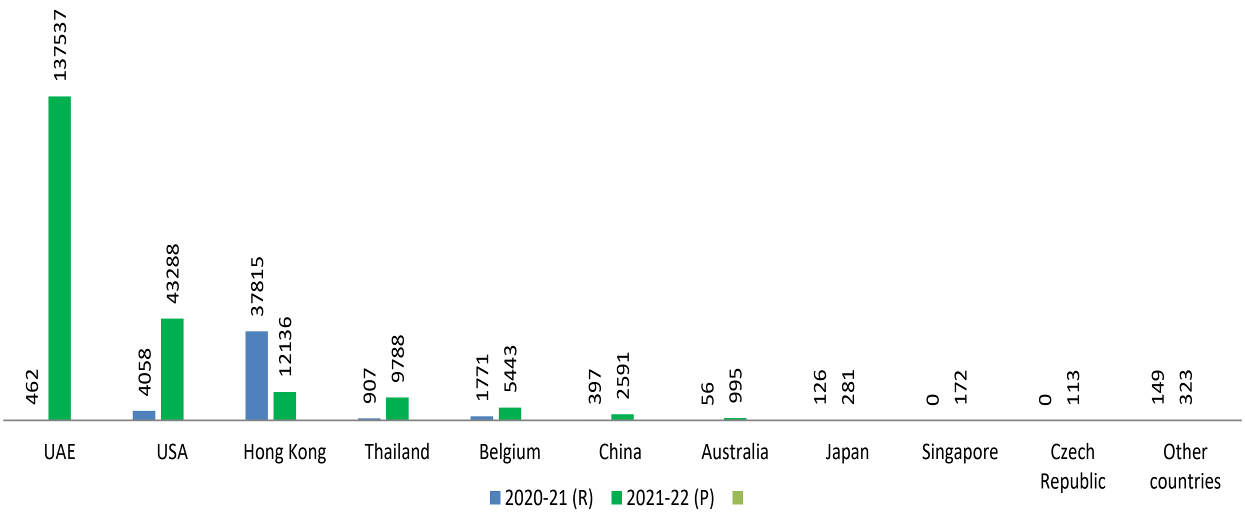


Fig 3: Countrywise Value of Export of Emerald (Uncut)

Imports

In 2021-22, the total imports of emerald (cut and uncut) by value increased by 107% to ₹ 1,656 . 09 crore from ₹ 799.78 cror e in the preceding year. Imports were mainly from Zambia (43%), Hong Kong (18%), UAE (14%) USA (8%), Singapore(4%) and Thailand (3%). Out of the total import value of emerald (cut & uncut), the share of imports value of emerald (cut) was (15%), while the share of imports value of emerald (uncut) was 85%. The imports value of emerald (cut) increased substantially by 88% to ₹ 255.32 crore in 2021-22 as compared decreased by 68 % to 3,174 thousand carat in 2021-22 f rom 9,842 thousand carat in the preceding year. In terms of quantity, imports were mainly from Hong Kong (37%),USA (8%),UAE(7%), and Thailand (6%). However, the import value of emerald (uncut) increased by 111% to ₹ 1,400.78 crore in 2021-22 as compared to ₹ 664 crore in the preceding year. In terms of quantity, the imports of emerald (uncut) also increased by 18% to 58 tonnes in 2021-21 from 49 tonnes in the preceding year. In terms of quantity, imports were mainly from Zambia (53%) and Brazil (28%) (Tables-6 to 8).

Table – 6: Imports of Emerald (Cut & Uncut) : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**	**7997796**	**	**16560915**
Zambia	**	3180916	**	7131002
Hong Kong	**	1483680	**	3034626
UAE	**	1494356	**	2295634
USA	**	578980	**	1375688
Singapore	**	467434	**	592360
Thailand	**	175476	**	422600
Belgium	**	6081	**	346850
Brazil	**	192980	**	286784
France	**	20559	**	254971
Russia	**	134343	**	250676
Other countries	**	262991	**	569724

Figures rounded off

Note: Quantity not given due to partial coverage; value figures, however, have full coverage.

Table – 7: Imports of Emerald (Cut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
USA	**214**	**394861**	**259**	**861348**
Hong Kong	1001	524784	1159	476181
Thailand	98	120151	198	319781
France	++	20559	1	254971
Switzerland	++	27652	2	220884
UAE	325	8502	215	170643
Baha rain Is	--	--	47	68055
Italy	1	30230	2	56114
UK	1	27194	3	48187
Singapore	1	15569	1	17164
Other countries	8201	188264	1287	59881

Figures rounded off

(Value in ₹'000)

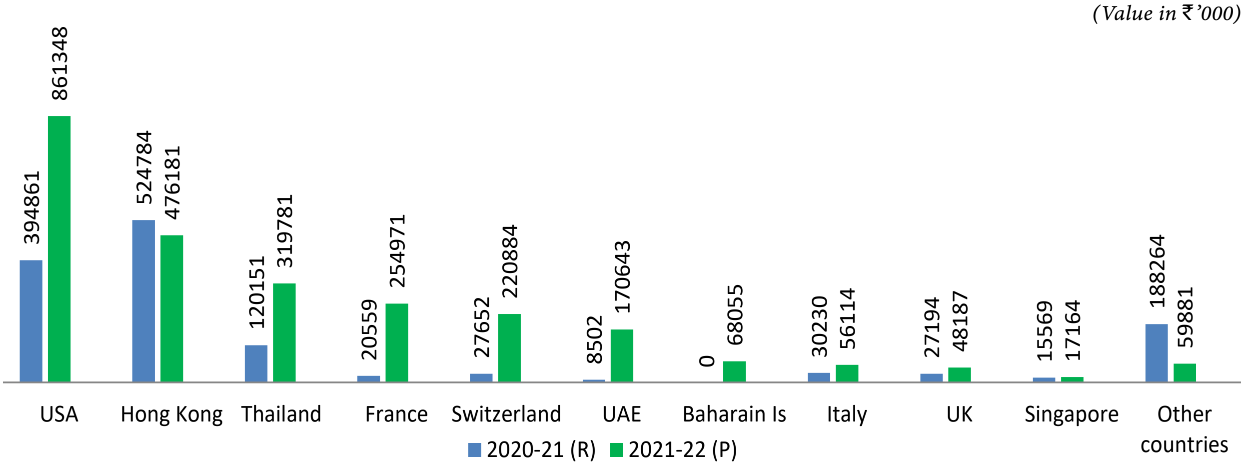


Fig 4: Countrywise Import of Emerald (Cut))

Table – 8: Imports of Emerald (Uncut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**49**	**6640030**	**58**	**14007706**
Zambia	35	3180916	31	7131002
Hong Kong	1	958896	1	2558445
UAE	1	1485854	1	2124991
Singapore	1	451865	++	575196
USA	++	184119	++	514340
Belgium	++	584	++	330619
Brazil	6	189902	16	286746
Russia	2	111853	1	250676
Thailand	++	55325	1	102819
Ethiopia	++	760	1	86982
Other countries	3	19956	6	45890

Figures rounded off

FUTURE OUTLOOK

Gems and Jewellery Export Sector has been contributing about 10%-12% to India's total merchandise exports accounting for the third largest commodity share. As per industry estimates, the sector employs more than 4.64 million employees. The Government of India, along with all the stakeholders of gems and jewellery sector, is well committed towards exports identifying challenges and addressing them with necessary interventions, assisting exporters, especially SME units, and exploring new markets while consolidating existing ones. With a view to strengthen the Gems & Jewellery Industry in the country, the Government has taken a number of steps, such as, establishment of Special Notified Zone (SNZ); announcement of separate ITC HS Code for lab-grown diamonds; introduction of Gold Monetisation Scheme; amendment of wastage and value addition norms for gems and jewellery items; approved scheme for setting up of Common Facility Centres for Gem and Jewellery Sector; and providing financial assistance for participation in international fairs, organising buyer-seller meets etc. under Market Development Assistance (MDA) and Market Access Initiative (MAI) Schemes of the Department of Commerce.

12. Fluorite

20.99
(million tonnes) Total reserves/resources of fluorite have been estimated as on 1st April 2020

1,237
(tonnes) Production of fluorite (graded) were reported in 2021-22

844
(tonnes) of fluorite were exported in 2021-22

2.86
(lakh tonnes) of fluorite were imported in 2021-22

Fluorite is a very popular mineral, and it naturally occurs in all colours of the spectrum. It is one of the most varied coloured mineral in the mineral kingdom. The colours may be very intense and most electric. Pure fluorite is colourless and the colour variations are caused by various impurities. It is a mineral with veritable bouquet of brilliant colours from hallmark colour purple to blue, green, yellow, colourless, brown, pink, black and reddish orange. The rich purple colour is by far the most famous and popular colour. It is an important commercial source of fluorine. Fluorite plays a vital role in the manufacturing Industry. Major consuming industries are chemical, cement, iron & steel, electrode, etc. It is also used in the production of synthetic cryolite without which aluminium extraction is not possible.

Fluorite is commonly deposited by hydrothermal solution sourced from igneous intrusions. The mineralisation occurs as veins or replacement deposits either by the filling of cavities and fissures or by the replacement of the host rock, typically carbonates.

Mainly two grades of fluorite are involved in consumption and trade, namely, the Acid grade (acidspar) containing more than 97% CaF_2 and the Sub-acid grade analysing 97% or less CaF_2. The Sub-acid grade includes Metallurgical (60 to 85% CaF_2) and Ceramic (85 to 95% CaF_2) grades and is commonly known as Metallurgical grade (metspar). Fluorite production in the country is meagre when compared with the world production. In addition to the natural fluorite production, synthetic fluorite is recovered as by-product during uranium processing, petroleum alkylation and stainless pickling. The by-product, fluorosilicic acid, obtained from phosphoric acid plants while processing phosphate rock also supplements fluorite as a source of fluorine.

RESERVES/RESOURCES

As per NMI database, based on the UNFC system, the total reserves/resources of fluorite in the country as on 1.4.2020 has been estimated at 20.99 million tonnes. Out of these, 0.40 million tonnes are placed under Reserves category (of which 0.23 million tonnes are under Proved category and 0.17 million tonnes under Probable category). The Remaining Resources comprise 20.59 million tonnes.

By States, Gujarat accounts for 68% of the total reserves/resources having 14.35 million tonnes, followed by Rajasthan with 5.60 million tonnes (27%), Chhattisgarh 0.54 million tonnes (3 %) and Maharashtra 0.49 million tonnes (2%). Gradewise, the resources are classified into Marketable grade which accounted for 82% of the total resources followed by low grade (15%) and Unclassified grade (2%). Other than these the Grade of around 2 % resources are not known (Table-1).

Table – 1 : Reserves/Resources of Fluorite as on 1.4.2020 (P)

(By Grades/States)

(In tonnes)

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111			(A)	STD221			STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**228393**	**163860**	**11988**	**404241**	**9340556**	**771934**	**768573**	**1727945**	**6239589**	**1578067**	**161575**	**20588239**	**20992480**
By Grades													
Marketable	228393	163860	11988	404241	9313407	586080	384943	14112	5778178	509522	145183	16731425	17135666
Not Known	-	-	-	-	27149	26544	218430	-	-	43542	16392	332057	332057
Low	-	-	-	-	-	3790	9680	1710348	445660	1000003	-	3169481	3169481
Unclassified	-	-	-	-	-	155520	155520	3485	15751	25000	-	355276	355276
By States													
Chhattisgarh	-	-	-	-	65889	153132	9288	185485	5573	126088	-	545455	545455
Gujarat	-	-	-	-	8630000	-	-	-	5723360	1920	-	14355280	14355280
Maharashtra	222282	163860	-	386142	-	-	-	-	-	100000	-	100000	486142
Rajasthan	6111	-	11988	18099	644667	618802	759285	1542460	510656	1350059	161575	5587504	5605603

Figures rounded off

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on Exploration & Development under "General Reviews".

PRODUCTION & STOCKS

The production of fluorite (graded) at 1,237 tonnes in 2021-22 increased by 18 % as compared to that in the previous year.

There were only one reporting mine in 2021-22 as well as in 2020-21. The entire output was reported from a Public Sector mine located in Chandrapur district of Maharashtra owned by Maharashtra State Mining Corporation Ltd.

The mine-head closing stocks of fluorite (graded) was 98,140 tonnes in 2021-22 as against 97,818 tonnes in 2020-21 (Tables-2 to 5).

Table – 2 : Producer of Fluorite 2021-22

Name & address of producer	Location of mine	
	State	District
Maharashtra State Mining Corporation Ltd, Plot No. 7, Ajni Square, Wardha Road, Nagpur-440 015, Maharashtra. Rajasthan.	Maharashtra	Chandrapur

Table – 3 : Production of Fluorite (Graded), 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**1315**	**8844**	**1052**	**8018**	**1237**	**8831**
Maharashtra	1315	8844	1052	8018	1237	8831

Table – 4 : Production of Fluorite 2020-21 & 2021-22

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	2019-20			2020-21		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**1**	**1052**	**8018**	**1**	**1237**	**8831**
Public Sector	1	1052	8018	1	1237	8831
Maharashtra	1	1052	8018	1	1237	8831
Chandrapur	1	1052	8018	1	1237	8831

(In tonnes)

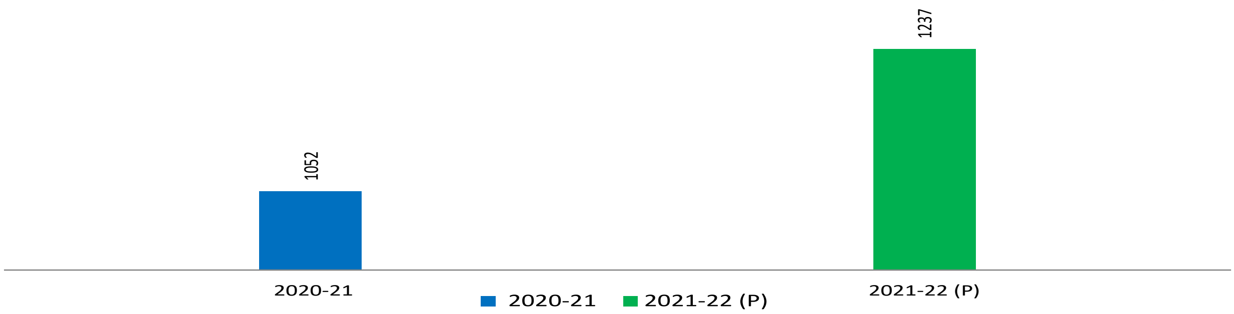


Fig 1: Production of Fluorite in India

Table – 5 : Mine-head Closing Stocks of Fluorite, 2020-21 & 2021-22

(By State)

(In tonnes)

State	2020-21	2021-22 (P)
India	**97818**	**98140**
Gujarat	84372	84371
Maharashtra	13446	13769

The average daily labour employed in fluorite mines in 2021-22 was 42 against 46 in the previous year.

The domestic price of fluorite is furnished in the General Review on 'Prices'.

MINING

Maharashtra State Mining Corporation (MSMC) operates Dongargaon fluorite mines in District Chandrapur, Maharashtra. Mining is carried out by semi-mechanised opencast method. The run-of-mine is hand sorted for marketing of fluorite (graded).

BENEFICIATION

Fluorspar is beneficiated by hand sorting followed by gravity concentration methods, such as, heavy media, jigs and tables in order to separate calcite and silicate mineral impurities. Low-grade fluorite produced is used after beneficiation in the industries. GMDC has a beneficiation plant of 500 tpd capacity located at Kadipani to produce Acid grade (96% CaF^2) and Metallurgical grade (90% CaF_2) fluorite by upgrading the low-grade fluorspar ore from 23–25% CaF_2 by flotation method. Besides, it has facility to produce MFC & MET grade powder analysing 75 to 85% CaF & 85 to 92.5% CaF , respectively and other products, such as, starch briquettes (81% CaF2min) and silicate briquettes (79% CaF_2min.).

CONSUMPTION

The apparent consumption of fluorite was about 2,86,295 tonnes in 2021-22, as against the 2,21,083 tonnes in 2020-21.

SPECIFICATIONS

BIS has prescribed IS: 8587-1993 (First Revision, reaffirmed 2011) for Acid grade fluorite for use in Chemical industries, and IS: 4574-1989 (Second Revision, reaffirmed 2008) for fluorite in Metallurgical industries.

USES

Acid grade fluorite is used as a feedstock in the manufacture of hydrofluoric acid (HF) and to produce aluminium fluoride (AlF_3). The major use of HF is for the production of a wide range of fluorocarbon chemicals, including hydrofluorocarbons (HFC_s) hy drochlorofluoro carbons ($HCFC_s$), and fluoropolymers. But, owing to environmental concerns, part of chlorofluorocarbons (CFC_s) are replaced by $HCFC_s$. HF is used in the manufacture of uranium tetrafluoride, an important ingredient used for producing nuclear fuel and fission explosives. It is also used in stainless pickling, petroleum alkylation, glass etching, oil & gas well treatment and as etcher/cleaner in Electronic Industry.

HF is used in the manufacture of a host of fluorine chemicals used in dielectrics, metallurgy, wood preservatives, herbicides, mouthwashes, decay-preventing dentifrices, plastics and water fluoridation.

AlF_3 manufactured from Acid grade fluorite is used as a flux in electrolytic recovery of aluminium. On an average, worldwide consumption of fluorides is about 21 kg for every tonne of aluminium produced. This ranged from 10 to 12 kg per tonne in a modern pre-baked aluminium smelter and about 40 kg in an old Soderberg smelter without scrubber.

Ceramic grade fluorite containing 85 to 95% CaF_2 is used in Ceramic Industry as a flux and as an opacifier in the production of flat glass, white or opal glass and enamels. The addition of 10–30% Ceramic grade fluorspar to glass makes it opaque, white and opalescent. It is also used in the manufacture of magnesium, some manganese chemicals and welding rod coating

Metallurgical grade fluorite is used primarily as fluxing agent by Steel Industry. It is added to slag to make it more reactive through increased fluidity. Fluorite of different grades is used in the manufacture of aluminium, cement and glass fibres. It is also used in the melt shop by Foundry Industry.

INDUSTRY

Manyfluorine based chemicals like hydrofluoric acid, aluminium fluoride, cryolite, sodium silicofluoride and hydrofluorosilicic acid are produced by Chemical and Fertilizer industries in the country.

In addition to material produced indigenously, substantial quantity of high- grade fluorite was also imported to meet the demand of the fluorine- based Chemical Industries

The Tanfac Industries Ltd is a Joint Sector Company of Tami Nadu Industrial Development Corporation (TIDCO) and Aditya Birla Group at Cuddalore, Tamil Nadu. It is engaged in the manufacture of fluorine chemicals, such as, aluminium fluoride, anhydrous hydrofluoric acid, sodium silicofluoride, ammonium bifluoride, potassium fluoride, and various other fluorine-based chemicals.

Navin Fluorine International Ltd (NFIL) is an Indian manufacturers of speciality fluorochemicals. It belongs to the Padmanabh Mafatlal Group – one of India's oldest industrial houses. Established in 1967, NFIL operates one of the largest integrated fluorochemicals complexes in India with manufacturing locations at Surat and Dahej in Western India and Dewas in Central India.The Company produces a number of fluorine chemicals, namely, hydrofluoric acid, cryolite,aluminium fluoride and various other organic and inorganic fluorine- based chemicals.

Apatite and rock phosphate containing 3 to 4% CaF^2 was another useful source for recovery of fluorine.

SUBSTITUTES

Olivine or dolomitic limestone can be used as substitute for fluorite in Iron & Steel industry. The by-product fluorosilicic acid from phosphoric acid production could also be used as a substitute in aluminium fluoride production.

ENVIRONMENT

Fluorine attracts environmental concern. Use of fluorine in drinking water has begun to wane. Fluorine is toxic in high concentration but beneficial in low concentration. Although fluorine has been under attack ever since its use in water in 1949, the only significant health problem with which it has been linked was 'Fluorosis', a disease that involves health defects and bone lesions. This problem is caused by concentration of fluoride that is much higher than the permissible levels in municipal water supplies. As per Indian Standards, the permissible limit of fluoride in the drinking water is 1.5 mg/l. "Defluoridisation by adsorption" is a common economical and efficient method for removal of excess fluoride from drinking water. Electrolytic precipitation based on use of aluminium salts and by electrochemical route, etc. are the other few methods used for defluoridisation.

Fluorine is at the centre of controversy over chlorofluorocarbons (CFCs), which causes depletion of atmospheric ozone layer that protects the earth from ultraviolet radiation, a major cause of skin cancer. The hydrofluorocarbon (HFC) and hydrochlorofluorocarbon (HCFC) compounds, which have been developed as an alternative to CFC, require more hydrofluoric acid than CFC and are expected to boost fluorite consumption. These greenhouse gases are being phased out in stages. It is reported that even if CFC emission is stopped, the present level of these gases may take up to ten years to reach the upper atmosphere where they could persist for a century or more.

According to United Nations Environment Programme (UNEP), an international agreement to curtail i llegal trade in CFC and other ozone depleting c hemic a l s c ame into effect on 10th November 1999. The agreement, which was authorised through an amendment to the Montreal Protocol in 1997 , requires nations to create licensing system for international sales of ozone depleting chemicals. Further, as a part of the Montreal Protocol, 129 nations agreed on a three- year funding package to enable developing countries to continue their efforts to phase out CFC and other ozone depleting chemicals. Accordingly, the Fund's Executive Committee approved major agreements with China and India to finance the shutdown of CFC production facilities in the two countries during the next ten years.

The United Nations Environment Programme (UNEP) has prepared a Montreal Protocol Handbook that provides additional detail and explanation of the provisions. CIESIN's Thematic Guide on Ozone Depletion and Global Environmental Change presents an in-depth look at causes, human and environmental effects, and policy responses to stratospheric ozone depletion.

The use of the low global warming Potential (GWP) hydyrofluroolefins refrigerant HFO-1234 yf is suggested as a preferred replacement of HFC- 134a by both the U.S. Environmetal protection Agency and the EU. Daimler in Europe has opted for CO_2 based air conditioning refrigerant in its 2017 Mercedes E and S class cars.

WORLD REVIEW

The world total reserves of fluorite / fluorspar were at 260 million tonnes.World reserves are concentrated mainly in Mexico (26%), China (19%), South Africa (16%), Mongolia (8%) and Spain (4%) (Table- 6).

World production of fluorite / fluorspar in 2021 decreased marginally by 6 % to 7.80 million tonnes as compared to 8.30 million tonnes in the previous year (Table-7). China (69%), Mexico (13%), South Africa (5%) Vietnam & Spain (3% each) and Mongolia (2%) were the principal producing countries of fluorite / fluorspar in 2021.

Table – 6 : World Reserves of Fluorspar

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total (rounded)	**260000**
Canada	NA
China	49000
Germany	NA
Iran	3400
Mexico	68000
Kazakhstan	NA
Mongolia	22000
Morocco	NA
Pakistan	NA
South Africa	41000
Spain	10000
USA	4000
Vietnam	5000
Other countries	55000

Source: USGS, Mineral Commodity Summaries,2023
Note : Reserves for China and Morocco were revised based on company and Govt. reports.

Table – 7 : World Production of Fluorite

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
World Total	**7400000**	**8300000**	**7800000**
China(e)	4300000	5400000	5400000
Mexico	1931532	1571269	1007118
South Africa	210000	320000	420000(e)
Vietnam	238003	219920	215027
Spain	145185	185958	214587
Mongolia	156100	127300	118300
Iran(c)	49705	116159	116000(e)

Country	2019	2020	2021
Kazakhstan	87800	77000	77000(e)
Morocco	73240	70000(e)	70000(e)
Germany	79959	64933	56632
Other countries	91148	121536	114495

Source : BGS, World Mineral Production, 2017-21
(e) Estimated
c) Years ended 20 March following that stated

To provide generalised view of the development in various countries, the countrywise description as sourced from the latest available publication of Minerals Yearbook 'USGS 2018' is furnished below :

Canada

In August 2018, Canada Fluorspar (NL) Inc. (St. Lawrence, Newfoundland and Labrador) made its first shipment acid-grade concentrate from its St. Lawrence Fluorspar project. The company was ramping up production using ore that had been stockpiled during open pit mine development.

China

China is the world's leading producer and consumer of AlF3, fluorspar, fluorocarbons (feedstock and non-feedstock), and HF. Throughout the 1990s, China was the leading global fluorspar exporter. However, for the past two decades, Government policy evolved to discourage exports in favor of development of downstream consuming industries and increased vertical integration. In 2017, the Government declared fluorspar to be a strategic mineral and was prioritized for stricter controls on the use of mineral resources, establishment of key targets for financial investment, and increased monitoring to support Government initiatives. In December 2018, the Fluorite Industry Development Association of China was established in Beijing to facilitate development and standardisation within the fluorspar industry .

Kenya

On April 1, 2018, control of Kenya Fluorspar Co.'s assets in the Kerio Valley reverted to the Government after the company opted not to renew its 20-year lease. Operations at the mine and its processing plant were idled in 2016.

Mongolia

Increased production in Mongolia was attributed to a large increase in China's imports beginning in the second half of the year. Although Mongolia has been known to produce acid-grade fluorspar, many plants produced lower grade flotation concentrate that did not meet the specifications required by most leading acid-grade consumers.

The Government of Mongolia has encouraged investment in the mining sector to support economic growth.

Morocco

GFL GM Fluorspar SA began production of acid- grade fluorspar from a new mine in Taourirt. The operation was established as a joint venture between Gujarat Fluorochemicals Ltd. (India) and Global Mines sarl (Morocco). Concentrate from the 40,000- t/yr operation would be exported through the Port of Nador, primarily to Gujarat's HF operations in India and fluorochemical producers in Europe.

South Africa

Sephaku Flouride Ltd. continued to develop its Nokeng Fluorspar Mine (Nokeng) and milling project in Rust de Winter, Gauteng Province. Nokeng is in the Bushveld Complex directly south of the Minersa Group's Vergenoeg Mine, the country's only operational fluorspar mine. Open pits would be developed at two of three fluorspar-haematite deposits that compose the Nokeng Fluorspar Mine— the Outwash Fan, with an average ore grade of 22.7% CaF_2, and Plattekop, with an average ore grade of 38.2% CaF_2.

Vietnam

Nui Phao Mining Co. Ltd. (Masan Resources Corp.) produced 238,702 t of acid-grade fluorspar concentrate from its Nui Phao polymetallic mine in Thai Nguyen Province, a slight increase compared with production in 2017. The company has reported increased production of fluorspar each year since the mine went into operation in 2014, which it attributed to the implementation of successive capital upgrades to increase ore throughput and enhance recovery rates, particularly in the tungsten- and fluorspar-processing circuits. Fluorspar recovery increased by 4% in 2018, despite a 2% decrease in mill feed grades.

FOREIGN TRADE

Exports

Exports of fluorite increased by 78% to 844 tonnes in 2021-22 from 474 tonnes in the previous year. Exports were mainly to Indonesia (40%), Bangladesh (32%), Saudi Arabia (6%), Brazil (5%) and Ethiopia, Kenya, Philippines & Jordan (3% each) . While, exports of aluminium fluoride decreased by 52% to 984 tonnes in 2021-22 as compared to 2,045 tonnes in the previous year. Exports were mainly to UAE (51%), Turkey (39%) and Japan (10%). Exports of hydrofluoric acid decreased by 31% to 1,325 tonnes in 2021-22 as compared to 1,931 tonnes in the preceding year (Tables- 8 to 10).

Table – 8 : Exports of Fluorite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**474**	**22436**	**844**	**43463**
Indonesia	249	13604	335	20073
Bangladesh	20	570	274	8932
Saudi Arabia	--	--	47	3194
Brazil	17	1218	44	3070
Ethiopia	--	--	25	1430
Kenya	9	197	23	1410
Philippines	44	2297	22	1231
Jordan	28	1069	25	1222
Tanzania	4	199	15	772
Qatar	21	1099	11	697
Other countries	82	2183	23	1432

Figures rounded off

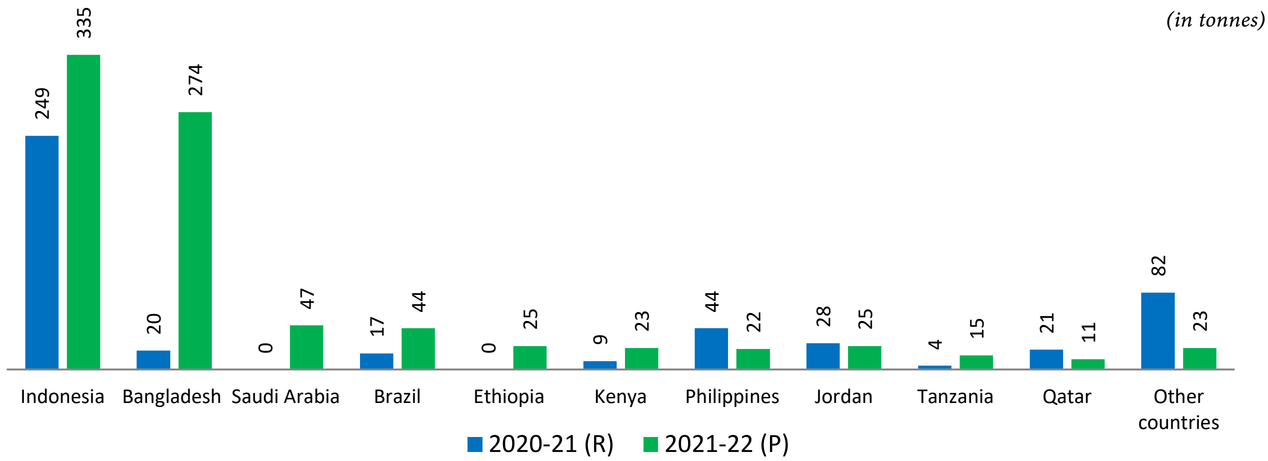


Fig 2: Countrywise Export of Fluorite

Table – 9 : Exports of Aluminium Fluoride

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2045**	**187158**	**984**	**24720**
UAE	1800	170576	500	9216
Turkey	100	1245	383	3462
Japan	120	13790	100	11766
Germany	++	9	++	128
Australia	--	--	1	84
Belgium	++	120	++	60
Malaysia	--	--	++	4
South Africa	24	1277	--	--
UK	1	135	--	--
Kuwait	++	6	--	--
Other countries	++	++	--	--

Figures rounded off

Table – 10 : Exports of Hydrofluoric Acid

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1931**	**164258**	**1325**	**132129**
Thailand	489	56720	472	58196
Saudi Arabia	202	22211	345	27899
USA	544	36901	195	16708
Japan	87	6720	53	5922
Indonesia	18	1554	53	4507
Turkey	348	18792	54	4337
Singapore	36	7998	17	4019
UAE	8	596	30	3236
Spain	23	1918	22	1709
Australia	91	4186	38	1558
Other countries	85	6662	46	4038

Figures rounded off

Imports

Imports of fluorite increased by 30% to 2,86,224 tonnes in 2021-22 as compared to 2,20,573 tonnes in the previous year. Imports were mainly from South Africa (68%), Thailand (8%) and Luxembourg, Vietnam, China, Canada & Morocco (4% each). Imports of aluminium fluoride, however, increased substantially by 21% to 74,348 tonnes in 2021-22 from 61,225 tonnes in the previous year. Imports were mainly from Mexico (20%), China (17%), Qatar (16%), Italy (14%), UAE (11%), Bahrain & Croatia (7% each) and Lithuania &Jordan (3% each).While imports of hydrofluoric acid decreased by 46% to 1,122 tonnes in 2021-22 from 2,095 tonnes in the preceding year. Imports were mainly from Taiwan (65%), China (19%) and Sri lanka (16%) (Tables -11 to 13) .

Table – 11 : Imports of Fluorite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**220573**	**6090596**	**286224**	**7792038**
South Africa	141117	3858569	194063	4875662
Thailand	27492	696512	23585	601868
Luxembourg	492	14479	12502	429968
Vietnam	16980	540087	11659	420973
China	14089	433550	10271	419020
Canada	4015	119504	10333	334965
Morocco	3127	94265	10455	313367
Netherlands	1100	33761	3654	118161
Belgium	598	15495	2764	90498
Hong Kong	3680	102833	2347	74673
Other countries	7883	181541	4591	112883

Figures rounded off

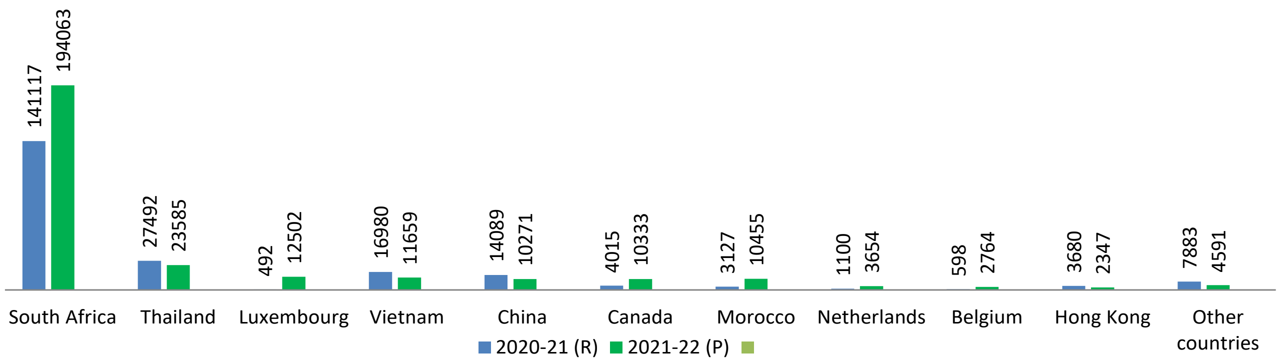


Fig 3: Countrywise Import of Fluorite

Table – 12 : Imports of Hydrofluoric Acid

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2095**	**177923**	**1122**	**133130**
Taiwan	167	12173	724	68597
China	1016	86508	211	33726
Sri Lanka	487	38386	178	22473
UK	--	--	5	5037
Germany	424	40235	4	2746
Spain	++	134	++	252
USA	++	307	++	136
Sweden	--	--	++	97
France	--	--	++	34
Belgium	++	78	++	32
Other countries	1	102	--	--

Figures rounded off

Table – 13 : Imports of Aluminium Fluoride

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**61225**	**4805867**	**74348**	**5287781**
Mexico	7000	576887	14625	1273267
China	22846	2014359	12793	1317137
Qatar	7496	94853	12084	139754
Italy	13284	1156118	10638	1101739
UAE	5324	494244	8343	904470
Bahrain	--	--	5276	61767
Croatia	--	--	5022	60796
Lithuania	600	42817	2500	188104
Jordan	1020	74328	2051	167209
Indonesia	1140	103653	560	46715
Other countries	2515	248608	456	26823

Figures rounded off

FUTURE OUTLOOK

The major driving factors for fluorite market are the growing Chemical Industry and increasing use of fluorite in Cement, Iron & Steel, Glass Industries. The Chemical Industry and Glass Industry account for the major share of the fluorite demand globally. As per TANFAC Annual Report 2021-22, Global Fluorochemical market is estimated around US$ 20 billion and expected to grow at a CAGR of 5.2% and reach USD 26 billion by 2026 with Asia Pacific region expected to account for significant share of the global market. In India, the market growth of fluorochemicals is driven by downstream sectors like Automobile, Air Conditioning, Refrigeration, Construction, Cold Storage and Pharma / Life Science segments. Life Science segment has emerged one of the key drivers over the years. India is expected to become 4th largest chemical producer in the world by 2030, benefitting from rising export opportunities, stability of prices, faster end user industry growth and low penetration of specialty chemicals. The Chemical Industry of India is a major industry in the Indian economy and as of 2022, contributes 7% of the country's Gross Domestic Product (GDP). India is the world's sixth largest producer of chemicals and the third largest in Asia, as of 2022. As on 01.04.2020, the resources of fluorite in India are 20.99 million tonnes which is considered to be limited. Hence, to meet the requirements, the domestic Chemical Industry will have to depend (both qualitatively and quantitatively) on imported fluorite in the coming years, both for direct use and for blending with the domestic Acid grade fluorite.

13. Garnet

8.60
(million tonnes) Total reserves of garnet (including proved and probablecategories) were estimated as on 1st April 2020

8,182
(tonnes) Production of garnet(abrasive) were reported in 2021-22

81,270
(tonnes) of abrasive garnet were exported in 2021-22

140
(tonnes) of abrasive garnet were imported in 2021-22

Garnet is the collective name for a group of minerals which crystalise in cubic system with different chemical composition. The principal members of the Garnet group are Almandine (Fe-Al), Pyrope (Mg-Al), Spessartine (Mn-Al), Grossularite (Ca-Al), Andradite (Ca-Fe) and Uvarovite (Ca-Cr). Almandine is hardest amongst all varieties and is often used for abrasive purpose. Garnet is dense & hard with sharp angular chisel-edged fracture, containing small amounts of free silica and exhibits high resistance to physical and chemical attacks. It is used both as semi- precious stone and as an abrasive. The hardness of garnet varies from 6.5 to 7.5 on Mohs scale. This allows it to be used as an effective abrasive

RESERVES / RESOURCES

In India, garnet deposits suitable for use in Abrasive Industry occur in Andhra Pradesh, Chhattisgarh, Jharkha nd, Kerala , Odisha, Rajasthan, Tamil Nadu and Telangana. Gem variety of garnet occurs in Ajmer, Bhilwara, Jhunjhunu, Sikar and Tonk districts, Rajasthan; Nellore and Srikakulam districts, Andhra Pradesh; Khammam district, Telangana and Coimbatore, Ramanathapuram, Tirunelveli, Kanyakumari, Tiruchirappalli and Tiruvarur districts, Tamil Nadu. Garnet is found to occur in beach sands along with ilmenite, rutile, sillimanite, etc. in the States of Kerala, Odisha and Tamil Nadu.

The total reserves/resources of garnet in India as on 1.4.2020, as per UNFC system has been placed at 56.01 million tonnes of which Reserves under Proved and Probable categories together constituted 8.60 million tonnes. Of the total resources, about 20.87 million tonnes are of Abrasive grade, whereas resources of Semiprecious grade are mere 8,468 tonnes. Tamil Nadu alone accounted for about 46 % of the total resources followed by Andhra Pradesh (31%), Odisha (17%) and Telangana (3%). The remaining States together shared less than 3% (Table- 1).

Table – 1 : Reserves/Resources of Garnet as on 1.4.2020 (P)

(By Grades/States)

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111	STD121	STD122	(A)	STD21	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**8539521**	**50946**	**5**	**8590472**	**1835546**	**1624128**	**4622014**	**138905**	**10226601**	**28066885**	**902574**	**47416654**	**56007126**
By Grades													
Gem	-	-	1	1	5847	16279	23919	0	0	110	4	46158	46160
Abrasive	8486371	50920	4	8537296	1705715	1526269	4568321	102866	15602	3514907	902570	12336249	20873545
Semi-precious	612	26	-	637	2093	132	1630	39	1249	2688	-	7831	8468
Others	-	-	-	-	9051	36358	-	-	-	215573	-	260982	260982
Unclassified	52538	-	-	52538	85485	43806	394	36000	10208995	23951287	-	34325967	34378505
Not-known	-	-	-	-	27355	1284	27750	-	756	382321	-	439466	439466
By States													
Andhra Pradesh	-	-	-	-	1196087	237025	1359988	18	8800000	5674011	-	17267129	17267129
Chhattisgarh	-	-	-	-	-	-	-	-	-	28800	-	28800	28800
Jharkhand	-	-	-	-	-	-	88303	-	-	21768	-	110071	110071
Kerala	-	-	-	-	-	-	45797	100874	-	52190	-	198861	198861
Odisha	8330045	-	1	8330046	5	-	1	-	-	348001	-	1177318	9507364
Rajasthan	156938	50946	4	207888	310712	191094	33115	2013	17606	215120	73263	842923	1050811
Tamil Nadu	52538	-	-	52538	266555	1153976	3094811	36000	1408995	19871019	-	25831356	25883894
Telangana	-	-	-	-	62187	42033	-	-	-	1855976	-	1960196	1960196

Figures rounded off

EXPLORATION & DEVELOPMENT

The details about the exploration and development, if any, are covered in the Review on "Exploration and Development" under "General Reviews".

PRODUCTION AND STOCKS

Garnet (Abrasive)

Production of garnet (abrasive) is at 8,182 tonnes during 2021-22 compared to 7,114 tonnes in the preceeding year. Similarly, there were only 6 reporting mines during 2021-22 as against 9 mines reported in the year 2020-21. Three principal producer accounted for about 87% of the total production during the year.

Like previous year the share of Public Sector in the total output was nil in 2021-22 as same in the previous year. Similarly, the share of Private Sector in the total output was cent per cent in 2021-22 as same in the preceding year.

In 2021-22 , like that of previous year, production was reported only from the State of Rajasthan, i.e., five principal producers from Rajasthan accounted for about cent percent of the total output during the current year (Tables-2 to 4).

Table – 2 : Principal Producers of Garnet (Abrasive), 2021-22

Name & address of producer	Location of mine	
	State	District
AKD Gem Garnet Mines, F-203, Near Mahapragya Circle, Azad Nagar, Bhilwara - 311 001, Rajasthan.	Rajasthan	Bhilwara
Arun Bagdiya,C/o,Shri Ramdev Bagdiya,Resi No-110,Kendriya Vihar, Sector-8,Bidyadhar Nagar, Jaipur-302039, Rajasthan.	Rajasthan	Ajmer
Ummed Singh Ranawat, Vill-Basda,P.O.Gundali Bhilwara-311001, Rajasthan.	Rajasthan	Bhilwara

**Producing as an associated mineral with sillimanite.*

Table – 3 : Production of Garnet (Abrasive) 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**568**	**1775**	**7114**	**26378**	**8182**	**29880**
Andhra Pradesh	-	-	-	-	-	-
Odisha	-	-	-	-	-	
Rajasthan	568	1775	7114	26378	8182	29880
Tamil Nadu	-	-	-	-	-	-

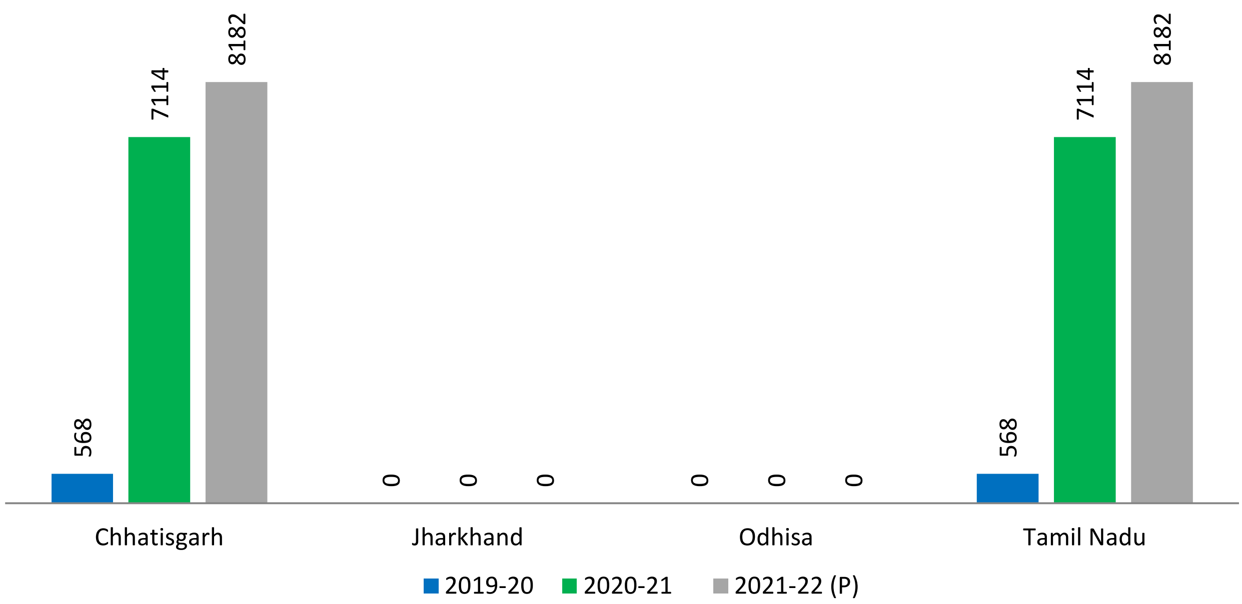


Fig 1: Production of Garnet (Abrasive) (In tonnes) in India

Table – 4 : Production of Garnet (Abrasive), 2020-21 & 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20			2020-21		
	No. of Mines	Quantity	Value	No. of MInes	Quantity	Value
India	**9**	**7114**	**26378**	**6**	**8182**	**29880**
Public sector	-	-	-	-	-	-
Private sector	9	7114	26378	6	8182	29880
Rajasthan	**7**	**7114**	**26378**	**5**	**8182**	**29880**
Ajmer	3	2367	7017	2	2316	6783
Bhilwara	3	4741	19332	2	5850	23042
Tonk	1	6	29	1	16	55
Tamil Nadu	**2**	**-**	**-**	**1**	**-**	**-**
Tiruchirapalli	2	-	-	1	-	-

Note-The main reason for decrease in number of mines is classification of some Garnet producing mines, such as BSM mines in Andhra Pradesh, Odisha and Tamil Nadu. Earlier, these mines were considered under Garnet (Abrasive) as a part of MCDR mineral as there was no seperate classification of Beach Sand Minerals (BSM) and Non-Beach Sand Minerals (Non-BSM).

Mine-head closing stocks of garnet (abrasive) for the year 2021-22 were 2,682 tonnes as against 3832 tonnes in the previous year (Table -5). The average daily employment of labour during 2021- 22 was 42 as against 66 in the previous year.

Table – 5 : Mine-head Closing Stocks of Garnet (Abrasive) 2020-21 & 2021-22

(By Stats)

(In '000 tonnes)

State	2020-21	2021-22 (P)
India	3832	2682
Andhra Pradesh	326	-
Odisha	-	-
Rajasthan	2864	2616
Tamil Nadu	642	66

Garnet (Gem)

No production of garnet (gem) was reported since 2018-19.

USES & CONSUMPTION

The most important industrial use of garnet in the form of garnet sand is as an abrasive. About 90% production of abrasive garnet is used for manufacturing of garnet-coated papers, clothes and discs. Garnet-coated abrasives are used in the form of belts, covers for drums, discs or as small sheets. It is used for cleaning spark plugs, paints, polishing and grinding of plate-glass. The remaining 10% output is used in the form of loose grains for surfacing and polishing soft stones (marble, slate, soapstone, etc.). Clear, flawless and rich-coloured crystals of garnet are used as semi-precious stones. The principal variety among them are pyrope, deep-crimson almandine, orange-yellow grossularite, etc. Other uses are in Electronic and Television Industry for polishing glass and TV tubes. Garnet granules are used in 'abrasive blasting' commonly called 'sand blasting' in order to smoothen, clean and remove oxidation products from metals, stone and other material. MMTC's specifications of garnet sand used for sand blasting/jet cutting/other uses for exports to USA, Europe, Middle East and Taiwan are as follows: Al O : 20.8 to 21.2%, Bulk density; 2.17 kg/ m3, Hardness in Mohs scale should be 7.5 to 8. Water jet cutting machines generally use finely- ground 80-120 mesh size garnet as cutting medium with high pressure water. Owing to its inertness to a wide range of chemicals and relatively high specific gravity, it is used as filter medium for water and other liquids.

SUBSTITUTES

Other natural and manufactured abrasives can substitute to some extent for all major end uses of garnet. In many cases, however, using the substitutes would entail sacrifices in quality or cost. Fused aluminum oxide and staurolite compete with garnet as a sandblasting material. Ilmenite, magnetite and plastics compete as filtration media. Corundum, diamond and fused aluminum oxide compete for lens grinding and for many lapping operations. Emery is a substitute in nonskid surfaces. Fused aluminum oxide, quartz sand and silicon carbide compete for the finishing of plastics, wood furniture and other products.

WORLD REVIEW

Garnet group of minerals are found throughout the world in metamorphic, igneous and sedimentary rocks.

World resources of garnet are large and occur in a wide variety of rocks, particularly, gneisses and schists. Garnet also occurs in contact- metamorphic deposits in crystalline limestones, pegmatites, serpentinites and in vein deposits. In addition, alluvial garnet is present in many heavy-mineral sand and gravel deposits throughout the world. Large domestic resources of garnet also are concentrated in coarsely-crystalline gneiss near North Creek, NY; other significant domestic resources of garnet occur in Idaho, Maine, Montana, New Hampshire, North Carolina, and

Oregon. In addition to those in the United States, major garnet deposits exist in Australia, Canada, China, India and South Africa, where they are mined for foreign and domestic markets; deposits in Russia and Turkey also have been mined in recent years, primarily for internal markets. Additional garnet resources are in Chile, Czech Republic, Pakistan, Spain, Thailand and Ukraine; small mining operations have been reported in most of these countries.

In 2022, Australia produced about 38% of total global production of garnet (Industrial), followed by China (31%), South Africa (15%), USA (8%) and the remaining 8 % was contributed by other countries. Russia and Turkey are also mining garnet for domestic markets. Garnet is also mined in Canada, Chile, Czech Republic, Pakistan, South Africa, Spain, Thailand and Ukraine. Worldwide the end uses of garnet and market shares are: abrasive blasting media 30%, abrasive grains for water jet cutting 35%, water filtration 20%, abrasive powder 10% and other end uses 5 per cent.

The world reserves/resources and production of industrial garnet are furnished in (Tables- 6 and 7).

Table – 6 : World Reserves of Garnet (Industrial)

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total (rounded)	**Moderate to Large**
India	13,000,000
United Stated	5,000,000
China	2,200,000
Australia	Moderate to Large
South Africa	NA
Other countries	6,500,000

Source: USGS, Mineral Commodity Summaries,2023

** In India as per NMI data based on UNFC system the total reserves/resources of garnet as on 1.4.2020 are estimated at 56.01 million tonnes.*

Table – 7 : World Production of Garnet (Industrial)

(By Principal Countries)

(In '000 tonnes)

Country	2021	2022
World:Total (rounded)	**925000**	**980000**
Australia	321000	370000
China	310000	310000
South Africa	140000	150000
United States	81700	76000
India	12000	15000
Other countries	60000	60000

Source: USGS, Mineral Commodity Summaries 2023,

Note : Figures are rounded off

** India's production of garnet (abrasive) during 2019-20, 2020-21, and 2021-22 was at 568 tonnes,and 8182 tonnes respectively.*

FOREIGN TRADE

Exports

In 2021 -22, exports of abrasive garnet increased drastically by 3% to 81,270 tonnes from 76,799 tonnes in the previous year. Exports were mainly to UAE (35%), USA (19%), Malaysia (6%) Thailand (5%) and Saudi Arabia (5%). Exports in terms of value in respect of cut & uncut garnet variety increased drastically by 35% to 37.84 crore in 2021-22 from 28.08 crore in the previous year. In terms of value, exports were mainly to Thailand (30%), Hong Kong (18%), USA (15%), Japan (6%) and Armenia (5%).

Out of the total exports in terms of value of cut & uncut garnet in 2021-22, cut variety of garnet accounted for 95 % share and the remaining 5% was contributed by the uncut garnet. In terms of value, of exports cut variety were mainly to Thailand (31%),USA (16%), Hong Kong (15 %) , Japan (6 %) & Armenia(6 %) . Similarly, exports of uncut garnet were mainly to Hong Kong (100%), (Tables- 8 to 11).

Table -8 : Exports of Garnet (Abrasive)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**76799**	**1265586**	**81270**	**1433741**
UAE	9184	157482	28448	490465
USA	19989	308885	15383	317258
Malaysia	7057	113156	5005	80339
Thailand	1618	29610	4116	71145
Saudi Arabia	6540	116809	4050	70796
Qatar	2986	52016	2931	50204
Kuwait	3472	53941	2904	47549
Italy	5208	91648	2380	44063
Canada	3325	57665	2119	37611
Oman	2688	46263	2156	36806
Other countries	14732	238111	11778	187505

Figures rounded off

(in tonnes)

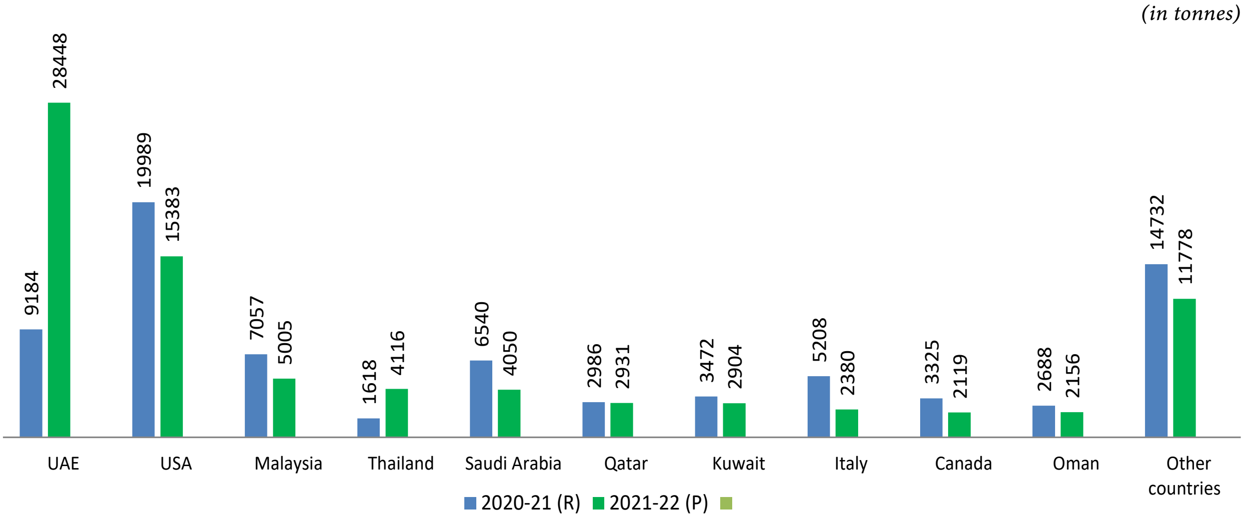


Table- 9 : Exports of Garnet (Cut & Uncut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**	**280824**	**	**378455**
Thailand	**	79120	**	112575
Hong Kong	**	69715	**	69441
USA	**	47384	**	58670
Japan	**	13710	**	24271
Armenia	**	7682	**	20890
Russia	**	4015	**	14862
Italy	**	4082	**	14754
UK	**	18439	**	12531
Germany	**	6396	**	11356
Australia	**	3772	**	10060
Other countries	**	26509	**	29045

*Note : ** - Not additive. The total may not tally.*

Figures rounded off

Table – 10 : Exports of Garnet (Cut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**76049**	**260630**	**12258**	**359152**
Thailand	1473	74972	20811	111039
USA	2398	46737	4073	57467
Hong Kong	1502	55990	1573	53690
Japan	350	13673	437	24255
Armenia	109	7682	317	20890
Russia	92	4015	277	14862
Italy	104	4082	170	14754
UK	1647	18157	488	11979
Germany	277	6396	486	11321
Australia	66440	3715	9	10056
Other countries	1657	25211	2377	28839

Figures rounded off

Table – 11 : Exports of Garnet (Uncut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (**)	Value (₹ '000)	Qty (**)	Value (₹ '000)
All Countries	**111**	**20194**	**29**	**19303**
Hong Kong	84	13725	29	15751
Thailand	++	4118	-	1536
USA	++	612	-	1203
UK	++	282	-	552
China	27	1240	-	173
Germany	-	-	-	35
Ireland	-	-	-	27
Japan	++	32	-	16
Australia	++	52	-	4
Mexico	-	-	-	3
Other countries	++	58	-	3

Figures rounded off

Imports

In 2021-22, imports of abrasive garnet decreased marginally by 60% to 140 tonnes from 345 tonnes in the previous year. Imports were from UAE (82%) and Kenya (18%). Imports in terms of value in respect of cut & uncut garnet variety increased drastically by 88% to 18.35 crore in 2021-22 from 9.73 crore in the previous year. In terms of value, imports were mainly from Kenya (24%), Thailand (21%), Hong Kong (18%),Tanzania (15%) Sri Lanka (6%), & USA (5%).

Out of the total imports in terms of value of cut & uncut garnet in 2021-22, uncut variety of garnet accounted for 77% share and the remaining 23% was contributed by the cut garnet. In terms of quantity, imports of uncut variety were mainly from Madagascar (43%) and Tanzania (21%). Similarly, imports of cut garnet were mainly from Sri Lanka (57%) and USA (15%) (Tables-12 to 15).

Table – 12 : Imports of Garnet (Abrasive)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**345**	**14712**	**140**	**1789**
UAE	104	1978	115	1545
Kenya	-	-	25	244
UK	241	12734	-	-

Figures rounded off

Table- 13: Imports of Garnet (Cut & Uncut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**	**97335**	**	**183591**
Kenya	**	10668	**	44520
Thailand	**	24582	**	38413
Hong Kong	**	22559	**	34614
Tanzania	**	6826	**	28232
Sri Lanka	**	9393	**	11559
USA	**	11447	**	8765
South Africa	**	-	**	8562
Nigeria	**	1330	**	2043
Germany	**	524	**	2039
Madagascar	**	165	**	1880
Other countries	**	9841	**	2964

*Note : ** - Not additive. The total may not tally.*
Figures rounded off

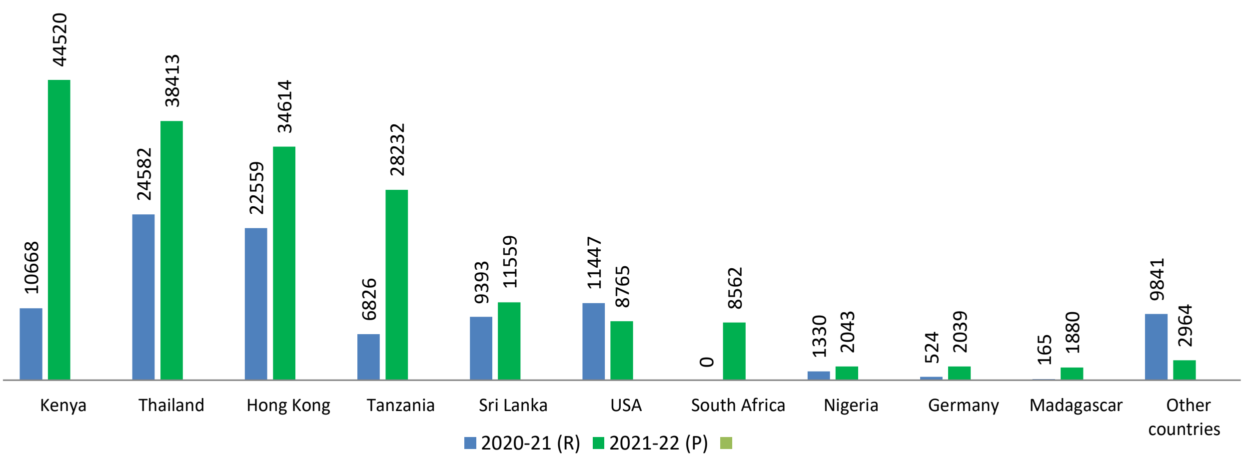


Fig 4: Country-wise Exports of Garnet (Cut & Uncut)

Table – 14 : Imports of Garnet (Cut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1437**	**32565**	**1299**	**42311**
Hong Kong	669	6260	175	13712
Sri Lanka	622	9393	749	11559
Thailand	105	7548	116	7519
USA	22	2809	188	6094
Germany	1	512	47	1186
Canada	++	36	12	1092
Japan	++	2	12	748
Switzerland	-	-	++	207
Madagascar	-	-	++	69
UAE	-	-	++	52
Other countries	18	6005	++	73

Figures rounded off

Table – 15 : Imports of Garnet (Uncut)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**11**	**64770**	**23**	**141280**
Kenya	++	10668	1	44483
Thailand	1	17034	1	30894
Tanzania	1	3773	5	28232
Hong Kong	1	16299	1	20902
South Africa	-	-	3	8562
USA	++	8638	++	2671
Nigeria	1	1330	1	2043
Madagascar	++	165	10	1811
Germany	++	12	++	853
Zambia	1	1351	++	296
Other countries	6	5500	1	533

Figures rounded off

FUTURE OUTLOOK

Garnet has a wide range of applications, such as, in production of abrasives, sand blasting, water filtration materials, abrasive blasting media and water-jet cutting. Garnet is expected to continue replacing silica sand blasting media, owing to latter's associated occupational health risks. Moreover, garnet is safer for the environment and cheaper to dispose of after recycling. Hence, the worldwide demand for garnet is expected to increase, especially for waterjet cutting and for abrasive blasting media. China and India are expected to steadily increase garnet production and will become significant garnet sources for other countries. The garnet market is very competitive. To increase profitability and remain competitive with imported material, production may be restricted to only high-grade garnet ores as a by-product of other saleable mineral products that occur with garnet, such as, kyanite, marble, metallic ores, mica minerals, sillimanite, staurolite or wollastonite.

14. Graphite

211.62

(million tonnes) Total reserves/resources of graphite were estimated as on 1st April 2020

57,264

(tonnes) Production of graphite were reported in 2021-22

764

(tonnes) of graphite (natural) were exported in 2021-22

54,047

(tonnes) of graphite (natural) were imported in 2021-22

Graphite, also known as plumbago or blacklead or mineral carbon, is a stable form of naturally occurring carbon. Structurally, graphite is known to crystaelise in hexagonal system and occurs in layered & lamellar form with grey-to-black metallic lustre and a greasy feel. Na tural graphite is categorised into two commercial varieties (i) crystalline (flaky) graphite and (ii) amorphous graphite. Both flaky and amorphous varieties of graphite are produced in India. The quality of graphite depends upon its physical qualities and carbon content. Besides natural graphite, there is synthetic or artificial graphite which is manufactured on a large-scale in electric furnaces, using anthracite or petroleum coke as raw feed.

RESERVES / RESOURCES

Graphite occurrences are reported from various States but the deposits of economic importance are located in Chhattisgarh, Jharkhand, Odisha and Tamil Nadu.

As per NMI database, based on the UNFC system, the total reserves/resources of graphite as on 1.4.2020 have been placed at about 211.62 million tonnes, out of which 8.56 million tonnes are in the Reserves category and 203.6 million tonnes are placed under Remaining Resources category. Resources containing +40% fixed carbon constitute about 2.91 million tonnes and resources analysing 10–40% fixed carbon constitute 43.98 million tonnes. The balance 164.73 million tonnes fall under Benificiable 'Others', 'Unclassified' and 'Not-known' grades. Arunachal Pradesh accounts for 36% of the total resources which is followed by Jammu & Kashmir (29%), Jharkhand (9%), Madhya Pradesh (5%), Odisha (9%), and Tamil Nadu (4%). However, in terms of reserves, Tamil Nadu has the leading share of about 36% followed by Jharkhand (30%) and Odisha (33%) of the total reserves (Table-1).

Table – 1 : Reserves/Resources of Graphite as on 1.4.2020 (P)

(By Grades/States)

(in tonnes)

Grade/State	Reserves				Remaining Resources								Total Resources
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	
	STD111	STD121	STD122	(A)	STD221	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**4386467**	**-**	**4176944**	**8563411**	**7964326**	**3461288**	**6166401**	**796464**	**10679490**	**31827080**	**142165128**	**203060176**	**211623587**
By Grades													
+ 40% F.C.	1121513	-	266338	1387851	327513	39106	315485	338686	263391	243723	-	1527904	2915755
10-40% F.C.	3264954	-	3910606	7175560	6461456	3199689	3337518	408852	2810895	17699258	2891244	36808911	43984471
Benificiable	-	-	-	-	48639	-	733621	-	-	11070	-	793330	793330
Others	-	-	-	-	511778	30600	1211011	-	6526906	6767064	4106000	19153359	19153359
Unclassified	-	-	-		614940	191893	536585	9090	7253	5876995	62249569	69486325	69486325
Not-known	-	-	-	-	-	-	32181	39836	1071045	1228970	72918315	75290347	75290347
By States													
Andhra Pradesh	-	-	-	-	-	-	1135	-	1122	1136018	-	1138275	1138275
Arunachal Pradesh	-	-	-	-	-	-	-	-	-	3200000	73118257	76318257	76318257
Chhattisgarh	5282	-	-	5282	-	1330	-	-	-	-	-	1330	6612
Gujarat	-	-	-	-	-	-	-	-	2520805	835000	-	3355805	3355805
Jammu & Kashmir	-	-	-	-	-	-	-	-	-	1059520	61681035	62740555	62740555
Jharkhand	2091442	-	512637	2604079	1341224	491883	3020107	60607	5167431	6639828	681208	17402288	20006367
Karnataka	-	-	-	-	203673	30600	48821	-	41605	667933	-	992632	992632
Kerala	-	-	15443	15443	-	8376	-	-	1088550	322606	-	1419532	1434975
Madhya Pradesh	-	-	-	-	-	-	-	-	-	6254000	6386000	12640000	12640000
Maharashtra	-	-	-	-	-	-	-	-	-	1160000	-	1160000	1160000
Odisha	-	-	2838414	2838414	6371790	2889564	2927932	696021	838841	3119932	298628	17142707	19981121
Rajasthan	-	-	-	-	47600	-	165920	-	250000	1450034	-	1913554	1913554
Tamil Nadu	2289743	-	810450	3100193	39	39535	2486	29136	647500	5886390	-	6605086	9705279
Telangana	-	-	-	-	-	-	-	-	123636	95818	-	219455	219455
Uttarakhand	-	-	-	-	-	-	-	10700	-	-	-	10700	10700

Figures rounded off

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on Exploration & Development under "General Review".

PRODUCTION AND STOCKS

Production of graphite at about 57,264 tonnes in 2021-22 increased by 61% as compared to that in the preceding year.

There were 11 reporting mines in 2021-22 as compared to 13 in the previous year. Five principle producers accounted for 96% during the year.

About 88% of the total production in 2021-22 was accrued from three mines, each producing more than 5,000 tonnes annually, while 12% was contributed by eight mines in the production range of 1,000 to 5,000 tonnes per annum.

Tamil Nadu was the leading producing State contributing 63% to the total output during 2021- 22, followed by Odisha.

Mine-head closing stock in the year 2021-22 was 1,76,601 tonnes as against 1,82,564 tonnes in the previous year. The average daily employment of labour during 2021-22 was 93 against 167 in the preceding year (Tables- 2 to 6).

Table – 2: Principal Producers of Graphite, 2021-22

Name & address of producer	Location of mine	
	State	District
Tamil Nadu Minerals Limited. 31, Kamarajar Salaitwad House, Chepauk, Chennai - 600005, Tamil Nadu .	Tamil Nadu	Sivaganga
Sibanana Pradhan A 19, Trishna Residency Phase 3, KIIT College Road, Patia, Bhubaneshwar - 751024, Odisha.	Odisha	Rayagada
Pradhan Industries House No 1, Telengana Bazar, Cuttack Sadar - 753009, Odisha	Odisha	Rayagada
Antaryami Mishra. Thikadarpara, Nuapara, Balangir- 767001, Odisha.	Odisha	Balangir

Table – 3: Production of Graphite, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**34674**	**55908**	**35386**	**87147**	**57264**	**95192**
Chhattisgarh	908	409	1701	2041	-	-
Jharkhand	21202	20661	5962	6069	21	23
Odisha	12564	34838	17697	46633	21029	63519
Tamil Nadu	-	-	10026	32404	36214	31650

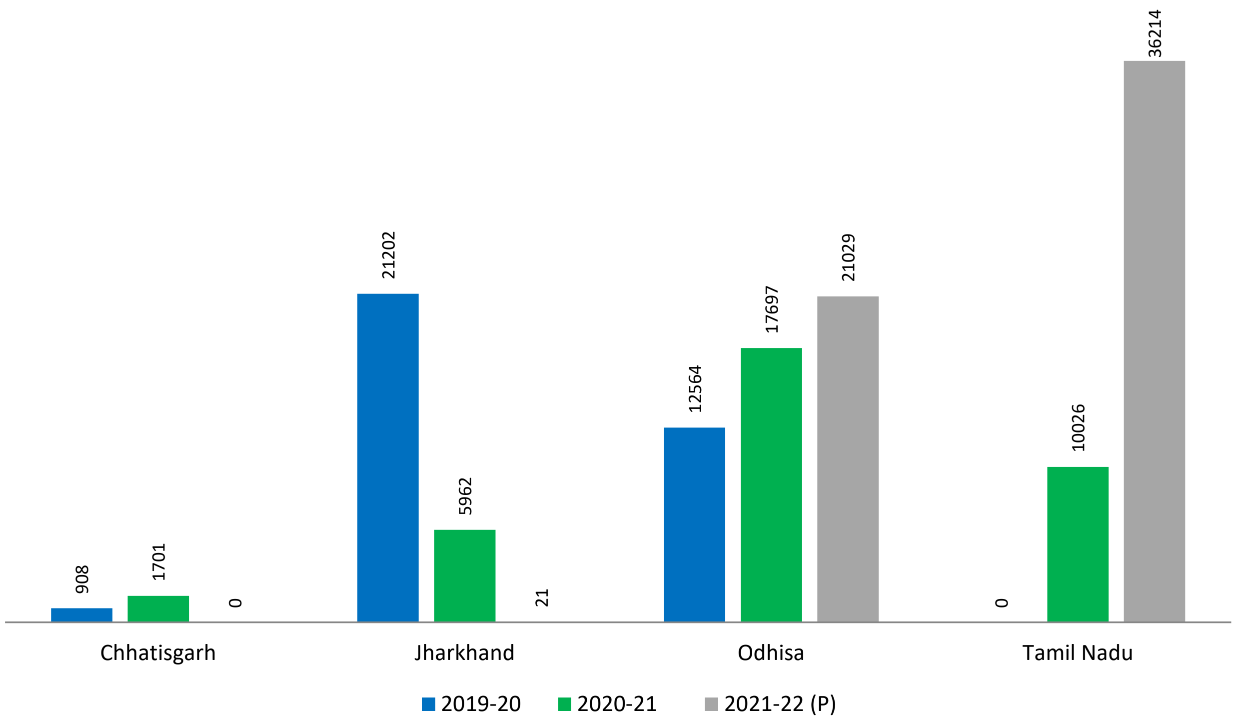


Fig 1: Production of Garphite in India

Table – 4: Production of Graphite, 2020-21 and 2021-22

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	2020-21						2021-22 (P)					
	No. of Mines	Grade: Fixed Carbon content			Total		No. of Mines	Grade: Fixed Carbon content			Total	
		80% or more	40% or more but less than 80%	Less than 40%	Qty.	Value		80% or more	40% or more but less than 80%	Less than 40%	Qty.	Value
India	**13**	**822**	**472**	**34092**	**35386**	**87147**	**11**	**1043**	**1130**	**55091**	**57264**	**95192**
Public Sector	**1**	**-**	**-**	**10026**	**10026**	**32404**	**1**	**-**	**-**	**36214**	**36214**	**31650**
Private Sector	**12**	**822**	**472**	**24066**	**25360**	**54743**	**10**	**1043**	**1130**	**18877**	**21050**	**63543**
Chhattisgarh	**1**		**-**	**1701**	**1701**	**2041**	**1**	**-**	**-**	**-**	**-**	**-**
Surguja	1	-	-	1701	1701	2041	1	-	-	-	-	-
Jharkhand	**3**	**-**	**-**	**5962**	**5962**	**6069**	**1**	**-**	**-**	**21**	**21**	**23**
Latehar	1	-	-	3259	3259	3178	-	-	-	-	-	-
Palamu	2	-	-	2703	2703	2891	1	-	-	21	21	23
Karnataka	**2***	**-**	**-**	**-**	**-**	**-**	**2***	**-**	**-**	**-**	**-**	**-**
Mysuree	2*	-	-	-	-	-	2*	-	-	-	-	-
Odisha	**6**	**822**	**472**	**16403**	**17697**	**46633**	**6**	**1043**	**1130**	**18856**	**21029**	**63519**
Nawapara	2	-	-	11464	11464	11900	2	-	-	2333	2333	2423
Raygada	3	822	472	19	1313	29911	3	1043	1130	14112	16285	58481
Balangir	1		-	4920	4920	4822	1	-	-	2411	2411	2615
Tamil Nadu	**1**	**-**	**-**	**10026**	**10026**	**32404**	**1**	**-**	**-**	**36214**	**36214**	**31650**
Sivaganga	1	-	-	10026	10026	32404	1	-	-	36214	36214	31650

Table – 5 : Production of Graphite, 2020-21 & 2021-22

(By Frequency Groups)

(Qty in tonnes)

Production group	No. of Mines		Production for the group		Percentage in total production		Percentage Percentage	
	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)
India	**13**	**11**	**35386**	**77264**	**100**	**100**	**-**	**-**
Up to 1000	5	5	307	624	0.87	1.09	0.87	1.09
1001 to 2000	2	1	2995	1730	8.46	3.02	9.33	4.11
2001 to 5000	4	2	14314	4584	40.45	8.46	49.78	12.12
5001 to 10000	1	2	7744	14112	21.88	24.64	71.66	36.76
Above 10000	1	1	10026	36214	28.33	63.24	100	100

Table – 6: Mine-head Closing Stocks of Graphite, 2020-21 & 2021-22

(By States/Grades)

(In tonnes)

S tate/District	2020-21				2021-22 (P)			
	Grade: Fixed Carbon content				Grade: Fixed Carbon content			
	80% or more	40% or more but less than	Less than 40%	Total	80% or more	40% or more but less than	Less than 40%	Total
India	**86**	**105**	**182373**	**179191**	**86**	**159**	**176393**	**176601**
Chattisgarh	-	-	6308	6308	-	-	6308	6308
Jharkhand	-	-	11989	11989	-	-	8681	8681
Karnataka	-	-	1742	1742	-	-	1742	1742
Kerala	-	-	-	-	-	-	-	
Odisha	86	105	3711	3902	49	159	15038	15246
Tamil Nadu	-	-	158623	158623	-	-	144624	144624

MINING & MARKETING

Graphite mines, barring a few underground mines, are mostly small and opencast. Active mining centres of graphite are in Palamu district in Jharkhand; Nawapara & Balangir districts in Odisha; and Madurai & Sivagangai districts in Tamil Nadu. Disseminated deposits of flaky graphite containing 5 to 20% Fixed Carbon (F.C.) are found in Palamu district of Jharkhand. In Odisha, areas in and around Balangir are the chief mining centres where several graphite grades are produced. At Balangir, a few opencast workings are deeper than 45 m from surface and the r.o.m. from such mines generally contains 10 to 20% F.C. Sargipalli underground mine in Sambalpur district, operated by M/s T.P. Mineral Industries (TPMI), produced graphite that analysed up to 40% F.C. in the past. Water seepage beyond 6 m depth is the main problem faced by almost all mine owners in Odisha.

Graphite of Balangir district is utilised mostly by the Graphite Crucible Industry. The technological changes in recent years have considerably reduced the use of graphite as a lubricant. However, recycled graphite is still used in production of clay bonded graphite crucibles.

The Sivagangai graphite is of flaky variety with 14% average Fixed Carbon (F.C.) used in the manufacture of refractory bricks, expanded graphite, crucibles and carbon brushes. It is being mined by opencast mining method.The mined graphite is subjected to size reduction by crushing, grinding, flotation and dewatering to upgrade the graphite concentrate from other gangue minerals.

Mining is considered to be easy and safe as regards graphite deposits in view of their comparatively soft nature and presence of hard rocks on either side. In order to expose graphite deposit, thickness of 1 to 2 meters of top lateritic soil is dozed out using dozer or removed by excavator and loaded through dumper and transported to separate dump yard located in non-mineralised zone in the lease area. The graphite ore obtained usually is transported to stock yard for blending. In stock yard, both high- grade and low-grade ores are stacked separately. Depending on plant requirements, blending work is carried out and blended ore is despatched for consumption.

Tamil Nadu Minerals Ltd (TAMIN) has over 600 acres of graphite-bearing areas in Pudupatti, Kumaripatti and Senthiudayanathapuram of Sivaganga district, Tamil Nadu.

BENEFICIATION

During graphite beneficiation one of the challenges is to maximise the recovery of flaky graphite from low grade graphite ore without breaking the flakes of graphite. This is because flaky graphite has a huge industrial demand due to its distinct properties such as excellent lubricity and higher thermal conductivity.

Graphite occurs generally admixed with country rocks, and hence, it requires beneficiation for obtaining desired grade for various end-uses. Processes for graphite beneficiation depend upon nature and association of gangue minerals present. The common processes adopted are washing, sorting, tabling, acid leaching and froth flotation. Amongst these, froth flotation process is used widely as it helps in producing a fairly high-grade graphite concentrate. Sometimes, beneficiated concentrate is further enriched by chemical treatment (acid leaching, chlorination, etc.) to obtain a very high-grade concentrate containing 98 to 99% F.C.

Prominent beneficiation plants for graphite in India are Chota Nagpur Graphite Industries and Carbon & Graphite Products, Daltonganj; Agrawal Graphite Industries, Gandhamardhan Graphite Udyog and T. P. Minerals Private Limited, Sambalpur; Tamil Nadu Minerals Ltd (TAMIN), Sivagangai, etc.

The ROM, containing an average of about 10% F.C. has to be invariably beneficiated before marketing. Indigenously fabricated equipment is used generally to upgrade the ROM to produce marketable grade graphite which contains normally 70 to 80% F.C. About 92% F.C. product has been obtained by many producers after repeated cycles of beneficiation. A few plant owners have claimed to have obtained product containing as high as 95% F.C.

Beneficiation plants in Odisha seem to have been designed for treating +10% F.C. graphite (ROM). In practice, it is seen that lower grade graphite having +5% F.C. is blended with higher grades to meet the requirements of beneficiation plant, i.e., +10% F.C. Thus, low-grade ore analysing +5% F.C. also gets used.

Tamil Nadu Minerals Ltd (TAMIN) produces flaky graphite from a mine in Sivagangai district in Tamil Nadu. The beneficiation plant located adjacent to the mine site is designed to produce 8,400 tpy of natural graphite concentrate containing 96% F.C. with 92% recovery from ROM.

USES & SPECIFICATIONS

Traditional uses of graphite are in crucibles, foundries, pencils, etc. More sophisticated applications of graphite are in refractories that are used in the manufacture of steel, cement and glass, expanded graphite-based sealing gaskets, graphitised grease, braid, brushes, brake lining, etc. It is also used for speciality applications, such as, in the Nuclear Industry, soil conditioners and graphite foils, which is used for sealing in the Chemical and Petrochemical industries as well as in the Energy, Engineering and Automotive industries. It is also used in minor amounts as a vital additive for producing foundry coatings to prevent fusion of liquid metal with sand at the mould or core face. Such coatings are either applied by spraying or painting in the form of suspension or by dusting or by rubbing as dry powders. Graphite used for coating is of high quality which does not peel off as flakes on drying and imparts a smooth surface to the casting. Graphite, a major additive to many coating systems, is known for its multifarious functions, such as, refractory, lubricant, thermal conductor, electrical conductor, UV shield, electromagnetic pulse shield, corrosion shield and pigment. It is also used as moderator in nuclear reactors and in Lithium-ion (Li-ion) batteries which is used in the electric vehicles, that require high purity flake graphite in their anode material. Li-ion battery anode are typically made of graphite, which can absorb and hold the lithium ions between the layers in its atomic structure, while at the same time conducting electric charge.

The BIS has prescribed the following specifications of graphite for use in various industries:

IS: 11321-1985 (Reaffirmed 2019) - graphite for use in Graphite Crucible Industry;

IS:1305-1984 (Reaffirmed 2022) - graphite for use in foundry coatings;

IS: 14852-2000 (Reaffirmed 2022) - flaky graphite for Refractory Industry;

IS: 495-1967 (First Revision, Reaffirmed 2018) - graphite flakes for lubricants;

IS: 62-2006 (Reaffirmed 2021) - graphite for paints; and

IS: 2079-2022 - graphite for pencil slips.

The specifications of graphite adopted for various industrial purposes are detailed as below:

Specifications of Graphite

End product	Percentage of graphite used	Quality of the graphite used	
		Fixed Carbon (F.C.)	Size (micron)
Mag-Carb refractories	12	87–90%	150–710
Alumina-Carb (graphitised) alumina refractories	8–10	85% min.	150–500
Clay-bonded crucibles	60 –65	80%	–20 to + 100
Silicon carbide crucibles	35	80–89%	150
Expanded (or flexible) graphite foils and products	100	90% min.	250–1800

based thereon (e.g. sealing	+99%)		
gaskets in refineries, fuel			
pumps, automobiles)			
Pencils	50–60	+95–98%	50 max
Brake-linings	1-15	98% min.	75 max.
Foundry	–	40-70%	53-75
Batteries			
a)	Dry cells	–	75 max.
b)	Alkaline	–	75 max.
Brushes	–	Usually 99%	Usually less than53
Lubricants	–	98– 99%	53–106
Sintered products	–	98– 99%	5
(e.g. clog wheels)			
Paint	Up to 75	50-55%	Amorphous
			75% min.
Braid used for sealing	40-50	95% min.	– (e.g. in ship)
Graphitised grease	–	99%	38 max
(used in seamless steel			

CONSUMPTION

As per the information received from various graphite consuming units and estimates, the apprent consumption of various grades of graphite during 2021-22 was 1,10,547 tonnes which increased by 48% as compared to 74,823 tonnes in the previous year.

SUBSTITUTION

In principle, it is possible to substitute graphite by either synthetic graphite, produced primarily from high carbon precursors, such as, petroleum coke and coal tar pitch (e.g. in batteries or for increasing the carbon in steel) or by replacing the product as in the case of pencils or by other compounds as in high temperature applications (e.g. refractories). In the later case, it is difficult to fully substitute graphite as it is tough to replicate the same level of performance that graphite provides.

There is a limit to how much charge graphite can store and lithium moves relatively slowly through graphite. Therefore, while considering the improvement required for large scale EV, tin and silicon may be the future competitor because of higher charge capacity and also tin conducts lithium- ion faster.

WORLD REVIEW

The world resources of graphite are believed to exceed 800 million tonnes of recoverable graphite. However, world reserves of graphite have been placed at 320 million tonnes of which Turkey accounts for 28% followed by China (23%), Brazil (22%), Madagascar & Mozambique (8% each), Tanzania (5%), India & Uzbekisthan (2% each) and Mexico & Dem. P. R. of Korea (1% each) (Table-7).

Table–7: World Reserves of Graphite (Natural)

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total (rounded off)	**320000000**
USA	(4)
Austria	(4)
Brazil	74000000
Canada	(4)
China	52000000
Germany	(4)
India*	8000000
Korea, Dem.P.R. of	2000000
Korea, Rep. of	1,800,000
Madagascar	26000000
Mexico	3100000
Mozambique	25000000
Norway	600000
Russia	14000000
Sri Lanka	Nov-06
Tanzania	18000000
Turkey	90000000
Ukraine	(4)
Uzbekistan	7600000
Vietnam	(4)

Source: USGS Mineral Commodity Summaries, 2022

**India's reserves of graphite as per NMI database, based on UNFC system as on 1.4.2020 have been placed at about 8,563 thousand tonnes.*

Austria, Canada, Germany, Pakistan, Russia, Ukraine, United States and Vietnam are included in world total.

World production of graphite was 1.12 million tonnes in 2020 as compared to 1.39 million tonnes in 2019. Austria was the leading producer, with a share of about 58% which is followed by Brazil (8%), Canada (4%), Madagascar (5%) and Dem. P.R of Korea (4%) (Table-8).

Table – 8 : World Production of Graphite

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
World Total	**1100000**	**1100000**	**1300000**
(Rounded off)			
China[d]	*700000	*762000	820000
Madagascar	45106	61405	98000
Brazil	*96000	*95000	95000
Mozambique	113803	18159	77116

Korea,Dem.P.R.of	40000	*30000	40000
Turkey	9990	15205	28336
India [(a)(e)]	31991	30168	*27900
Russia	18000	25000	*27000
Norway	*9600	*9000	9000
Canada	11000	8841	7706
Other countries	41699	38941	40159

Source: BGS World Mineral Production, 2016-20,

a: Crude

b: Material

c: Years ended 31 March following that stated

d: Including flake graphite

f: Years ended 30 june of that stated

h:Export

j:Sales

India's productiom of graphite during 2018-19, 2019-20 and 2020-21 was at 39 thousand tonnes, 34 thousand tonnes and 30 thousand tonnes, respectively.

A generalised view of the development in various countries with countrywise description sourced from latest available publication of minerals yearbook 'USGS 2018' is furnished below

Brazil

Brazil had estimated production of 95,000 t of marketable natural graphite. Nacional de Grafite Ltda. was the only producer of natural flake graphite in Brazil from mines and plants at three sites in the State of Minas Gerais. Highgrade crystalline flake graphite projects were being developed in Brazil with at least two companies conducting or considering graphite exploration and development.

Canada

Canada had two active open pit mines with combined production of 40,000 t of natural flake graphite. About 80% of the production came from the Lac des Iles flake graphite mine in Quebec, operated by Imerys Graphite & Carbon, and approximately 20% came from the Black Crystal flake graphite quarry in British Columbia, owned by Eagle Graphite Corp. In recent years, many potential graphite producers were exploring and developing flake graphite projects in Canada. Exploration was focused primarily on properties in Ontario and Quebec, but other graphite exploration projects were underway in British Columbia

FOREIGN TRADE

Exports

In 2021-22, exports of graphite (natural) increased by 7% to 764 tonnes as compared to 716 tonnes in the previous year. Graphite (natural) was exported mainly to Tanzania (25%), Nepal (15%), Malaysia (11%), and UAE (10%).

The exports of graphite (artificial) increased by 29% to 28,218 tonnes in 2021-22 from 21,744 tonnes in the previous year. Graphite (artificial) was exported mainly to Germany (30%), U S A (5%), Bhutan (20%), UAE (9%), and Kuwait (5%).

China

China was the world's leading producer, exporter, and consumer of natural and synthetic graphite. China was also estimated to have the largest natural graphite resources in the world. China produced 6,93,000 t of natural graphite, of which an estimated 4,16,000 t was flake graphite and the remainder was amorphous graphite; this was about 62% of the total global production. The increased demand was due to China shifting to higher levels of crude steel production using electric arc furnace technology, which relies on graphite electrodes. China was the world's leading producer of synthetic graphite and accounted for nearly 50% of global synthetic graphite production. Most of this output was in the form of synthetic graphite electrodes for export.

Mozambique

Mozambique had been the focus for several natural flake graphite development projects in recent years. The planned production capacity for the country far exceeded that of any global production operation and projections for Mozambique's emerging graphite mining sector continued to increase. During 2018, Mozambique was the world's second leading graphite producer with an estimated production of 1,04,000 t of crystalline flake graphite. Production of natural flake graphite in Mozambique resulted from foreign investment. The largest known graphite deposit in the world was the nearby Balama deposit owned by Syrah Resources Ltd. (Australia), also in the Cabo Delgado Province. Resources at Balama were estimated to be 1.1 billion metric tons, which was more natural graphite than that contained in all other known deposits in the world combined. Production at the project began in December 2017, and output was expected to rise rapidly in coming years as production ramped up.

Tanzania

Tanzania produced an estimated 150 t of crystalline flake graphite. Several natural flake graphite deposits were being explored in Tanzania. Discovery Africa Ltd. (Australia), through its Tanzania Graphite project, discovered a very large high-grade flake graphite deposit in southern Tanzania. The company executed a memorandum of agreement for the acquisition of up to 80% of Hatua Resources Ltd., which held four exploration licenses in the region. Assessment and sampling of graphitic schist outcrops in all four locations graded up to 49.9% total graphitic carbon. The average samples within the licenses exhibited 15.3% total graphitic carbon.

The exports of graphite crucibles increased to 416 tonnes in 2020-21 from 20 tonnes in the preceding year, while those of silicon carbide crucibles also increased to 30137 tonnes in 2021- 22 from 3728 tonnes in the previous year. Graphite crucibles were mainly exported to Taiwan (32%), Netherlands (13%) and Rwanda (10%). Silicon carbide crucibles were exported mainly to UAE (14%), Turkey (6%), South Africa (4%). Exports of graphite bricks and shapes decreased by 59 tonnes in 2021 - 22 from 515 tonnes in the preceding year. Graphite bricks and shapes were mainly exported to Ethiopia (72%), UAE (7%), and Jordan (2%) (Tables - 9 to 13).

Table – 9 : Exports of Graphite (Natural)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**716**	**42994**	**764**	**46963**
Tanzania	185	8683	325	15745
Malaysia	81	4470	106	5470
China	15	962	48	3390
UAE	77	4379	43	2344
USA	10	594	32	2342
Mauritania	12	602	35	1769
Kenya	24	1047	3	1688
Saudi Arabia	1	43	15	1453
Bangladesh	40	2389	12	1391
Mauritius	3	87	9	1071
Other countries	268	19738	136	10300

Figures rounded off

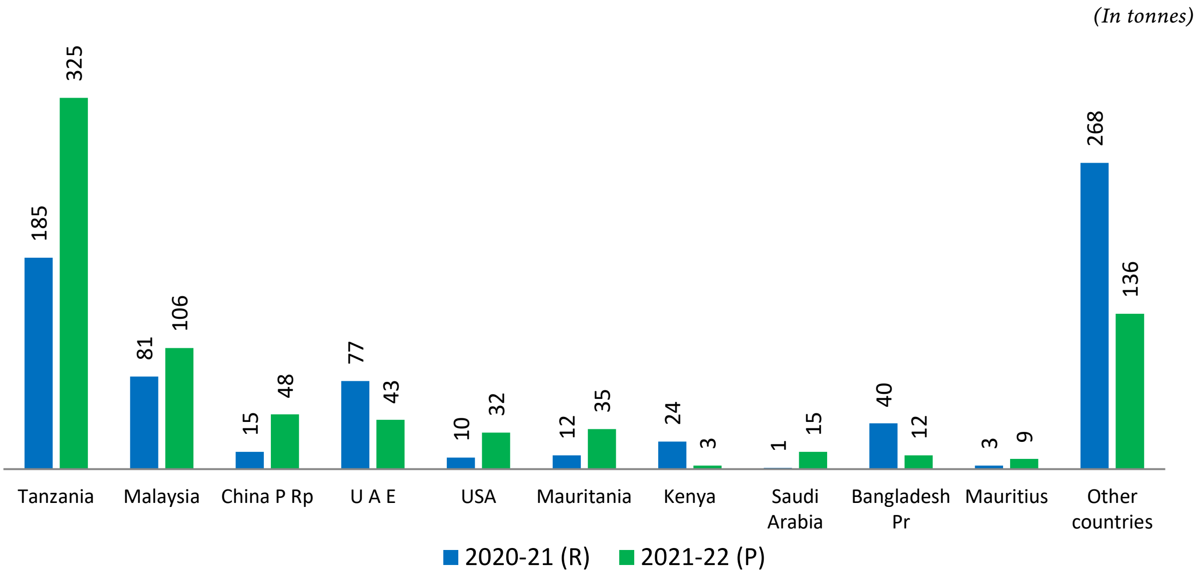


Fig 2: Countrywise Exports of Graphite (Natural)

Table – 10: Exports of Graphite (Artificial)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**21744**	**2820004**	**28218**	**4090984**
Germany	7684	1531046	8418	1822595
USA	760	236726	1402	441165
Bhutan	4364	170055	5539	312029
Saudi Arabia	231	54641	2058	198248
Turkey	120	61497	89	187488
UAE	2011	153408	2454	172937
Bangladesh	1548	54222	2030	112322
Kuwait	1397	75080	1297	86159
Oman	1192	61639	1288	85480
Belgium	75	40903	186	78255
Other countries	2362	380787	3457	594306

Figures rounded off

Table– 11 : Exports of Graphite Bricks & Shapes

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**515**	**8408**	**59**	**4099**
Bangladesh	-	-	7	1491
Jordan	14	1220	11	839
Taiwan	2	46	27	562
Sri Lanka	++	60	1	497
Nigeria	-	-	1	294
Mauritius	-	-	8	261
Guinea	-	-	3	73
Saudi Arabia	3	218	1	71
Mexico	++	7	++	11
Ethiopia	373	3271	-	-
Other countries	123	3586	-	-

Figures rounded off

Table– 12 : Exports of Graphite Crucibles

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**20**	**2256**	**416**	**28081**
Taiwan	-	-	135	8145
Netherlands	-	-	58	6059
Rwanda	-	-	40	3637

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
UK	++	81	21	2666
Zimbabwe	-	-	60	1825
Iraq	-	-	20	1690
USA	8	139	44	1141
Mali	-	-	5	873
Congo	-	-	8	765
Bangladesh	-	-	15	544
Other countries	12	2036	10	736

Figures rounded off

Table – 13 : Exports of Silicon Carbide Crucibles

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**3728**	**624851**	**30137**	**888930**
UAE	534	115347	8293	134771
USA	116	45080	190	80777
Turkey	238	70602	12151	78610
South Africa	142	59960	148	65352
Germany	88	26113	162	55149
Egypt	141	34186	209	53270
Korea, Rep of	94	35173	128	49817
Thailand	136	33512	200	48547
UK	92	19465	227	36816
Colombia	14	4967	4540	35452
Other countries	2133	180446	3889	250369

Figures rounded off

Imports

Imports of graphite (natural) increased by 34% to 54,047 tonnes in 2021-22 from 40,153 tonnes in the preceding year. Graphite (natural) was imported mainly from China (41%), Madagascar (38%), and Mozambique (16%) .

Imports of graphite (artificial) increased by 39% to 75,657 tonnes in 2021-22 from 54,327 tonnes in the previous year. Imports of graphite (artificial) were mainly from China (47%), Germany (9% each), Poland (9%) and remaining 35% share was contributed by other countries.

Imports of graphite bricks and shapes drastically increased to 2,00,053 tonnes in 2021-22 from 5,430 tonnes in the preceding year. Imports of graphite bricks and shapes were mainly from Belgium (99%) followed by China and remaining share was contributed by USA & Japan. Imports of graphite crucibles drastically dccreased to 296 tonnes in 2021- 22 from 906 tonnes in the preceding year. China was the main supplier country. Imports of silicon carbide crucibles increased to 918 tonnes in 2021-22 from 386 tonnes in the previous year. Imports were mainly from China (97%), Germany (2%) and Netherlands (Tables - 14 to 18).

Table – 14 : Imports of Graphite (Natural)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**40153**	**1808218**	**54047**	**2651642**
Madagascar	9437	544250	20850	1095472
China	21800	799903	22171	962376
Mozambique	3644	133914	8716	301619
Germany	223	61892	284	64377
USA	244	51868	335	59757
Brazil	160	11957	412	29127
UK	91	8846	214	22396
Austria	272	21823	258	21001
Japan	23	7039	42	17255
Sweden	20	5469	52	15746
Other countries	4239	161257	713	62516

Figures rounded off

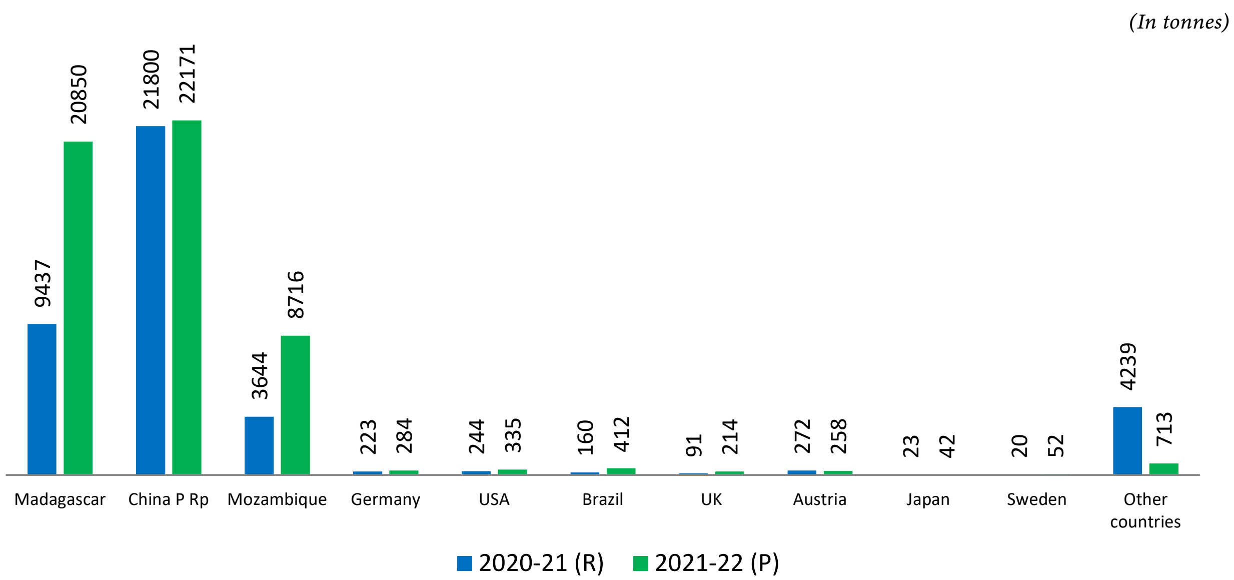


Fig 3: Countrywise Imports of Graphite (Natural)

Table – 15 : Imports of Graphite (Artificial)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**54327**	**5422418**	**75657**	**8125841**
China	25414	1996380	32787	3538380
Germany	4789	1345986	3517	1028785
UK	1473	217548	3517	1008912
Norway	4506	253365	4780	345371
USA	846	220126	7128	344737
Netherlands	221	78416	729	227358
Japan	377	184622	664	222071
France	1858	287110	1106	211871
Poland	5214	398786	1990	207385
Belgium	147	75903	829	129338
Other countries	9482	364176	21302	861033

Figures rounded off

Table – 16 : Imports of Graphite Bricks & Shapes

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**5430**	**21390**	**200053**	**23733**
China	90	11574	39	15453
USA	3440	7545	14	8259
Belgium	++	8	200000	21
Japan	1900	2263	-	-

Figures rounded off

Table – 17 : Imports of Graphite Crucibles

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**906**	**50672**	**296**	**38483**
China	312	42252	266	34727
Germany	-	-	30	2631
Italy	551	2199	++	1025
Japan	++	++	++	100
Hong kong	2	5820	-	-
Canada	++	209	-	-
Korea, Rep. of	1	189	-	-
USA	40	3	-	-

Figures rounded off

Table – 18 : Imports of Silicon Carbide Crucibles

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**386**	**70638**	**918**	**135424**
China	319	55172	892	117199
Germany	26	8518	14	7141
Netherlands	-	-	6	4901
USA	25	3903	2	2161
Japan	5	1076	++	1361
Canada	++	263	2	1101
Czech Republic	++	836	2	1038
Belgium	9	616	++	255
Italy	1	34	++	225
Poland	-	-	++	36
Other countries	1	220	++	6

Figures rounded off

FUTURE OUTLOOK

Worldwide demand for combined natural and synthetic graphite is expected to rise along with improvements in the global economic conditions. Demand is also expected to augment further with the development of non-carbon energy applications, such as, batteries used in electric vehicles, electric devices and energy storage devices that use graphite. The graphite reserves having +40% Fixed Carbon are rather limited in the country. Detailed exploration of graphite deposits in Odisha, Jharkhand, Jammu & Kashmir and Kerala should be carried out. Cost-effective beneficiation technologies for low- grade graphite ore need to be developed. Silicon carbide- graphite crucibles are being diversified and manufactured to improve upon the use of inferior grade material with less quantity and at the same time ensuring longer life of crucible.

Of late, a few emerging & important specialised applications of exfoliated graphite have been reported especially in the manufacture of sealings, gaskets, braids and brushes. New products of synthetic graphite, such as, graphite fibres/ropes and graphite insulation blankets have been introduced.In the world scenario, there seems to be a rapid diversification in respect of potential large- volume end-use for natural graphite, such as, in heat sinks, also called spreader shield, which is a graphite foil material that conducts heat only in two directions. It has thermal conductivity above aluminium and almost equal to copper. These are used for dissipating heat in laptop computers, flat-panel displays, wireless phones, digital video cameras, etc. Such emerging & high growth applications of graphite are certainly causing noticeable impacts on the demand & consumption patterns within the country & globally.

The demand for high purity graphite is increasing exponentially due to increase in the demand of lithium-ion batteries for electric vehicles, laptops, smartphones, home/ business applications and traditional uses for expanded graphite foils are also the potential areas that are expected to be major drivers for graphite consumption. It represents 23% of global flake graphite demand. The demand for graphite in the Battery segment is forecasted to double in the next six years. Graphite is mentioned in Part D of the First Schedule to the MMDR Act for critical & strategic minerals which is essential for our country's economic development and national security.

15. Ilmenite & Rutile

351
(thousand tonnes) Total reserves/ resources of ilmenite wereestimated as on 1st April 2020

70.22
(million tonnes) of titanium ores & conc. were exported in 2021-22

1,11,653
(tonnes) of titanium ores & conc. were imported in 2021-22

India is endowed with large resources of heavy minerals which occur mainly along coastal stretches of the country and also in inland placers. Heavy mineral sands comprise a group of seven minerals, viz, ilmenite, leucoxene (brown ilmenite), rutile, zircon, sillimanite, garnet and monazite. Ilmenite ($FeO.TiO_2$) and rutile (TiO_2) are the two chief minerals of titanium. Titanium dioxide occurs in polymorphic forms as rutile, anatase (octahedrite) and brookite. Though brookite is not found on a large-scale in nature, it is an alteration product of other titanium minerals. Leucoxene is an alteration product of ilmenite and is usually found associated with ilmenite.

RESERVES / RESOURCES

Ilmenite and rutile along with other heavy minerals are important constituents of beach sand deposits found right from Saurashtra coast (Gujarat) in the west to Digha coast, West Bengal in the east. These minerals are concentrated in five well-defined zones:

* Over a stretch of 22 km between Neendakara and Kayamkulam, Kollam district, Kerala (known as ' Chavara' deposit after the main mining centre).
* Over a stretch of 6 km from the mouth of River Valliyar to Colachal, Manavalakurichi and little beyond in Kanyakumari district, Tamil Nadu (known as MK deposit).
* On Chatrapur coast stretching to about 18 km between Rushikulya river mouth and Gopalpur lighthouse with an average width of 1.4 km in Ganjam district, Odisha (known as 'OSCOM' deposit after IREL's Orissa Sands Coplex).
* Brahmagiri deposit stretches for 30 km from Girala nala to Village Bhabunia with an average width of 1.91 km in Puri district, Odisha.
* Bhavanapadu coast between Nilarevu and Sandipeta with 25 km length and 700 m average width in Srikakulam district, Andhra Pradesh.

The AMD of the Department of Atomic Energy has been carrying out exploration of these mineral deposits. Of the total coastal length of 5,921 km spread in Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra, Goa, Gujarat and West Bengal about 451 km, 1,873 km, and 112 km have been covered by detailed exploration, general exploration and preliminary exploration, respectively. A coastal length of 2,272 km have not been covered due to various reasons viz., mangrove, port activity etc., leaving an unexplored coastal length of 1,214 km. The distribution of area coverage (sq km) in different geological domains are Beach & Dune (1845), Inland Sand Body (180), Terrace sediments (368), River Channel (32), Inland alluvium (646) and Lake & Sea Beds (38). The ilmenite resource estimation for the areas explored up to March, 2020 has been completed and the resources are up from 629.57 million tonnes (including leucoxene) in the year 2016 to 687.57 million tonnes in the year 2020. The resources include Measured, Indicated and Inferred categories. Though, the latest state-wise / deposit-wise details are not available, the state-wise/ deposit-wise details as received from DAE vide letter dated 26.07.2018 are furnished in Tables-1 & 1A.

Table – 1 : Ilmenite Reserves, Resources/ Deposits in India

(In million tonnes)

State/Deposit	Ilmenite reserves
Andhra Pradesh	
1. Bhavanapadu	10.18
2. Kakinada (Phase I-VIII)	13.81
3. Kalingapatnam	7.03
4. Narasapur	2.92
5. Nizampatnam	19.26
6. Srikurman (South)	8.6
7. Visakhapatnam (Bhimunipatnam)	2.88
8. Amalapuram (Phase I-IV)	4.72
9. Pandurangapuram-Voderevu (Bapatla-Chirala coast)	10.38
10. Vetapalem Coast (Chirala coast)	5.31
Kerala	
1. Chavara Barrier beach	13.17
2. Chavara Eastern Extension (Phase-I)	17.02
3. Chavara Eastern Extension (Phase-II)	49.26
4. Trikkunnapuzha-Thotapally Beach & Eastern Extension	9.5
5. Alapuzha-Kochi	5.88
Maharashtra	
Ratnagiri	3.68
Munge-Achra-Malvan	1.12
Vijayadura-Mithbav	0.7
Gujarat	
Moti Daman-Umbrat coast	2.77
Odisha	
1. Brahmagiri (Phase I-V and NW extension)	86.04
2. Chatrapur	26.72
3. Gopalpur	6.42
Tamil Nadu	
1. Kudiraimozhi	22.86
2. Ovari-Periyatalai-Manapadu (Teri)	24.01
3. Sattankulam Teris	41.26
4. Cuddalore-Pudupattuchavadi (beach sand)	4.67
5. Vayakallur (beach sand)	4.52
6. Manavalakurichi (beach sand)	3.07
7. Midalam	1.64

Source: As per letter received from Department of Atomic Energy, Mumbai dated 26/07/2018

Table – 1 A : Reserves/Resources of Ilmenite and Rutile

(In million tonnes)

State	Total in situ #
Ilmenite* : Total	629.57
Andhra Pradesh	156.17
Jharkhand	0.73
Gujarat	2.77
Kerala	144.02
Maharashtra	5.5
Odisha	150.62
Tamil Nadu	167.7
West Bengal	2.06
Rutile : Total	**33.95**
Andhra Pradesh	10.55
Jharkhand	0.01
Gujarat	0.02
Kerala	8.74
Maharashtra	0.01
Odisha	6.58
Tamil Nadu	7.85
West Bengal	0.19

Source: As per letter received from Department of Atomic Energy, Mumbai dated 26/07/2018. The resources of beach sand minerals (BSM) viz. Ilmenite, Rutile, Zircon, Garnet, leucoxene, monazite and Sillimanite were last updated in the year 2016 by AMD.
#Inclusive of Indicated, Inferred and Speculative categories.
**Including leucoxene.*

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on "Exploration and Development" under "General Reviews".

PRODUCTION AND PRICES

Ilmenite

The production of Ilmenite at 391 thousand tonnes in 2021-22 increased by 11% as compared to that in the preceding year. Odisha was the leading producer of Ilmenite during the year under review, contributing 60% of the total production followed by Kerala (28%) and Tamil Nadu (12%).

Rutile

The production of Rutile at 13 thousand tonnes in 2021-22 increased by 4% as compared to that in the previous year. Odisha was the leading producer of Rutile accounting for 67% of the total production followed by Kerala (21%) and Tamil Nadu (12%) .

Table – 2 : Production of Ilmenite and Rutile

(By States)

(In tonnes)

State	2019-20	2020-21	2021-22* (P)
ILMENITE			
India : Total	**350535**	**351387**	**390638**
Kerala	75593	88110	110654
Odisha	241009	230040	234132
Tamil Nadu	33933	33237	45852
RUTILE			
India : Total	**13102**	**12845**	**13283**
Kerala	8669	2197	2790
Odisha	3257	9409	8856
Tamil Nadu	1176	1239	1637

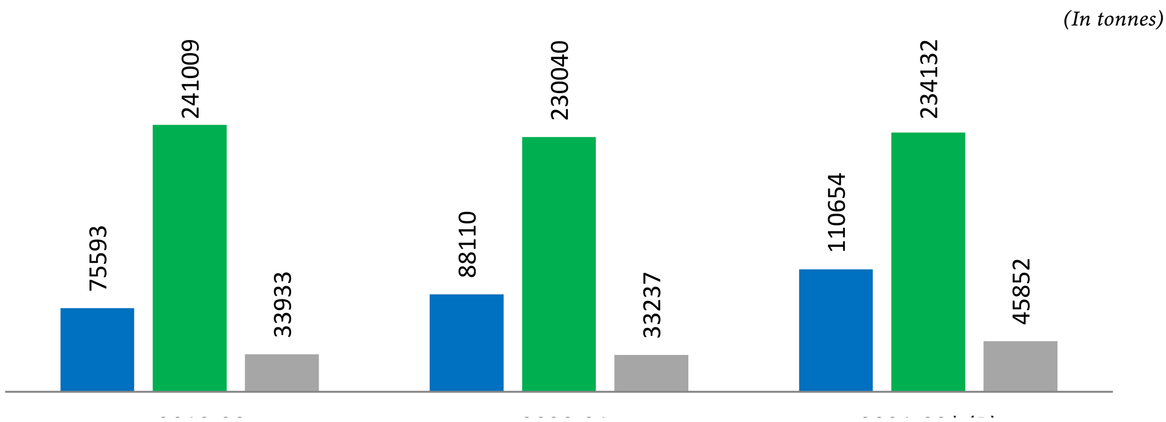


Fig 1: Statewise Production of Ilmenite in India

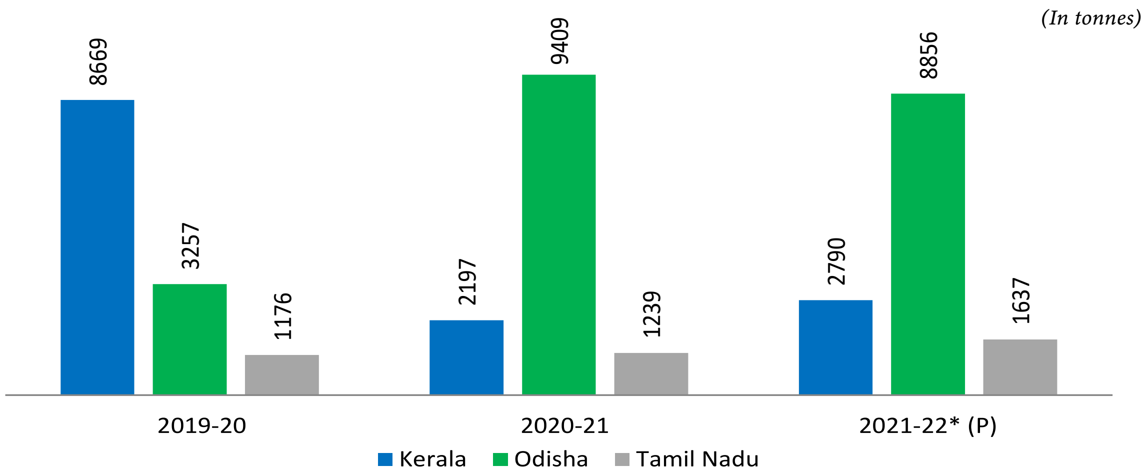


Fig 1: Statewise Production of Ilmenite in India

Table – 3 : Prices of Rutile
2017-18 to 2019-20

(₹ per tonne)

Year	Grade	Price	Remarks
IREL			
2017-18**	Q	60748	Ex-works, Bagged
	MK	-	Ex-works, Bagged
	OR	61070	Ex-works, Bagged
2018-19	Q	76995	Ex-works, Bagged
	MK	79627	Ex-works, Bagged
	OR	76798	Ex-works, Bagged
2019-20	Q	92138	Ex-works, Bagged
	MK	93052	Ex-works, Bagged
	OR	92788	Ex-works, Bagged
KMML			
2017-18	-	52083	Average
2018-19	-	66916	Average
2019-20	-	NA	-
V.V. Mineral			
2017-18	-	NA	Average
2018-19	-	NA	-
2019-20	-	-	-

Source: Department of Atomic Energy, Mumbai.
Note: Q: Quilon; MK: Manavalakurichi; OR: Odisha
*** During the financial year 2017-18 MK unit not despatches any material due to non-availability of transport permit.*

Table – 4: Prices of Ilmenite
2017-18 to 2019-20

(₹ per tonne)

Period	Grade	Price	Remarks
IREL			
2017-18**	Q*	11922	Ex-works, loose
	MK*	-	Ex-works, loose
	OR*	11618	Ex-works, loose
2018-19	Q*	12978	Ex-works, loose
	MK*	12667	Ex-works, loose
	OR*	12512	Ex-works, loose
2019-20	Q*	14618	Ex-works, loose
	MK*	14235	Ex-works, loose
	OR*	13167	Ex-works, loose
KMML			
2017-18		NA	
2018-19		NA	
2019-20		NA	
V.V. Mineral			
2017-18	-	-	-
2018-19	-	-	-
2019-20	-	-	-
BMC			
2017-18		NA	
2018-19		NA	
2019-20		NA	
DCW Ltd			

Period	Grade	Price	Remarks
2017-18	-	8423	
2018-19	-	14489	
2019-20	-	15265	

Source: Department of Atomic Energy, Mumbai.

Note: Q: Quilon; MK: Manavalakurichi; OR: Odisha

Ilmenite is usually sold on NAW (naked at works) basis from all production center

: Regular Price

MINING & PROCESSING

A notification dated 27.07.2019, was issued for reserving the prospecting and mining rights of offshore minerals under Offshore Areas Minerals (Development and Regulation) Act, 2002 exclusively to Government and Government owned companies for curbing illegal mining of atomic minerals by private parties. Mining and processing of beach sand is carried out by the IREL, a Government of India Undertaking and KMML, a Kerala State Government Undertaking. Exploitation work of beach sand deposits located at Chavara in Kerala, Gopalpur in Odisha and Manavalakurichi in Tamil Nadu by IREL is under progress.

At IREL, Chavara, Beach Sand was collected over a stretch of 22 km between Neendakara and Kayamkulam in Kerala and was transported to plant site. The unit has adopted wet mining operations involving use of two Dredge and Wet Concentrator (DWC) of 100 tph capacity each to exploit the inland deposits away from the beaches. Chavara ilmenite is the richest in TiO2 content (75.8% TiO2) and has great demand in India and abroad for manufacture of pigments. At Manavalakurichi, the deposit is spread over 300 hectares at Thuthoor-Ezudesam villages, Vilavancode tehsil, district Kanyakumari, Tamil Nadu. All the raw sand required for the mineral separation plant to operate to its full capacity is collected from nearby beaches. Deposits are also exploited by DWC of 100 tph capacity. Manavalakurichi is next to Chavara in terms of TiO2 content which is more than 55%.

The sand deposits of OSCOM at Chatrapur in district Ganjam extend along the coast of Bay of Bengal with an average width of 1.4 km and average depth of 7.5 m. Mining operations involve suction dredging to 6 m depth below water level on a much larger scale (500 tph) augmented by a smaller sized (100 tph) supplementary. The ilmenite from OSCOM is inferior in grade in terms of TiO2 content (50%) in comparison to Chavara and Manavalakurichi. The Synthetic Rutile Plant of OSCOM is presently not working. As a result, the majority of OSCOM ilmenite produced of late is routed to the international market as feedstock for production of both slag grade and anatase grade pigment.

In dry mining, beach washings laden with 40- 70% Heavy Minerals (HM) are collected through front-end loaders and bulldozers for further concentration to 90 % HM at land- based concentrators. Though dry mining is very simple and economical, there is considerable opposition by local people for this form of mining for reasons that removal of sand would expose the land area to sea erosion. Therefore, collection of beach washings has reduced significantly in recent past.

As an alternate approach, IREL has adopted wet mining involving dredging and wet concentration (DWC) from inland areas away from the beach lines. In this mode, an artificial pond is created, the sand bed is cut and the slurry is pumped to spiral concentrator for removal of quartz. Manavalakurichi was the first plant to install a DWC (100 tph) followed by one (500 tph) at OSCOM and two (each 100 tph) at Chavara. The concentrate (90% HM) of beach washing plant from DWC is further upgraded to 97% HM grade at a Concentrate Upgradation Plant (CUP) before sending it to Mineral Separation Plant (MSP).

Execution of Supplimentary Mining Lease deed for OSCOM Mines till a period up to the year 2047 has been completed under the provision of AMCR 2016. Communication on precious area of the Bramhagiri Mineral Sands Deposit in Puri District under AMCR 2016 is in the final stages of issuance by Government of Odisha.

After much persuasion, the precise area communication over an extent of 855 ha out of the identified area of 1,817 ha in Kanyakumari district is also expected to be issued by Government of Tamil Nadu. The Government is showing keen interest in exploiting the resources through a joint venture between IREL and TAMIN, a State PSU. This initiative would be a breather for MK operations as the mineable land within the mining leasehold areas are on the verge of exhaustion. Further, it will also pave way for formation of a new subsidiary of IREL in the same line as that of IREL and IDCOL.

KMML collects seasonal accretions of heavy mineral sand from the beach front. The pit so formed gets filled by fresh accretions of heavy mineral sand. The mineral sand is collected using bulldozers and wheel loaders and transported in tippers to Mineral Separation Plant.

The mineral separation plants use variety of equipment, such as, gravity concentrators, high tension electrostatic separators and magnetic separators. Making use of difference in physical properties like electrical conductivity, magnetic susceptibility and difference in specific gravity, etc., individual minerals like ilmenite, rutile, zircon, sillimanite and garnet are separated. The mined beach sands are pre-concentrated and dried after sieving (30-mesh) to separate the heavies from rejects. The heavy minerals are passed through electrostatic separators where conducting minerals – ilmenite and rutile – are separated from other non-conducting minerals.

Ilmenite and rutile are further subjected to low- intensity magnetic separators where magnetic fraction - ilmenite is separated from rutile. Similarly, non-conducting fractions are subjected to high- intensity magnetic separators where weak magnetic fraction (monazite and garnet) is separated from non- magnetic fraction (zircon and sillimanite). The fractions are further processed on wind tables to separate garnet from monazite and sillimanite from zircon.

Installed capacity and production of ilmenite, rutile and other associated heavy minerals by various separation plants are furnished in Table-5.

Table – 5 : Installed Capacity & Production of

Ilmenite, Rutile and Other Heavy Minerals, 2017-18 to 2019-20

(In tonnes)

Company/ Location	Mineral/ Product	Installed capacity	Production		
			2017-18	2018-19	2019-20
Indian Rare Earths Ltd					
Manavalakurichi,#	Ilmenite	90000	-	25745	320485
Distt Kanyakumari,	Rutile	3500	-	938	11674
Tamil Nadu.	Zircon	10000	-	2190	11490
	Sillimanite	8778	-	-	26052
	Monazite	6000	-	-	69748
	Garnet	10000	-	7425	5034
Chavara,	Ilmenite	200000	43253	48694	
Distt Kollam,	Rutile	11400	1515	1723	
Kerala.	Zircon	17500	2649	3072	
	Rare Earths	4500*	-	-	
	Sillimanite	10000	6826	7953	
Orissa Sands Complex,	Ilmenite	220000	184657	191492	
Distt Ganjam,	Rutile	7400	7860	8384	
Odisha.	Zircon	5000	5696	6694	
	Sillimanite	13000	16698	17930	
	Garnet	20000	34170	31332	
Kerala Minerals & Metals Ltd					
Chavara,	Ilmenite	61600	56757	26140	30009
Distt Kollam.	Rutile	4400	2454	1548	1428
Kerala.	Zircon	6500	4844	4762	4110
	Sillimanite	3600	701	271	1329
V.V. Mineral					
Distt Thoothukudi,	Ilmenite	450000	-	-	
Tamil Nadu.	Rutile	12000	-	-	NA
	Zircon	18000	-	-	
	Zircon-sillimanite	24000	-	-	
Beach Minerals Co. Pvt. Ltd					
Kuttam,	Ilmenite	150000	-	-	
Distt Tirunelveli,					
Tamil Nadu.					
V.V. Titanium Pigments Pvt. Ltd	Titanium	18000	13801	11902	9419
Distt Thoothukudi	Dioxide				
Tamil Nadu.					

Source: Department of Atomic Energy, Mumbai and IREL.
** In terms of rare earths chloride. '-' Not Available # During the year 2017-18, Manavalkurichi Plant was non-operating from Jan 2017 because of non-availability of environmental clearence (EC). V.V.Mineral mine is not in operation since 2017-18.*

INDUSTRY

For manufacturing titanium dioxide pigment, ilmenite is first treated chemically to obtain upgraded ilmenite, commonly called as synthetic rutile. There are two major pigment production processes, namely, chloride process and sulphate process depending on different operating characteristics and feedstock requirements. Plants employing chloride process consume high TiO_2 content feedstocks like synthetic rutile and chloride slag. On the other hand, plants employing the sulphate process use lower-grade ilmenite and sulphate slags.

Ilmenite obtained from Mineral Separation Plant (MSP) is chemically treated to remove impurities, such as, iron to obtain synthetic rutile (90% TiO_2) in Synthetic Rutile Plant (SRP). Indian SRP are based on reduction roasting followed by acid leaching with or without generation of hydrochloric acid. Plants of IREL (OSCOM) and KMML depend on acid regeneration from the leach liquor while those of Cochin Minerals & Rutile Ltd (CMRL) and DCW use fresh acid and recover ferric chloride from the leach liquor for its use in water purification.

At OSCOM plant of IREL, reduction-roasting of ilmenite with coal is followed by leaching with HCL to separate iron as soluble ferrous chloride. The leached ilmenite is calcined to yield synthetic rutile and the acidic leach liquor is treated in an acid regeneration plant to recover HCL for recycling with iron oxide as waste. The unit stopped production in 1997, as it was not viable economically. Against the Request for Proposal floated to set up titanium slag plant under Build-Own-Operate (BOO) model, a CPSE has shown keen interest and based on their request, the due date of submission has been extended. Considering the formidable investment and difficulties in sourcing technology in the field, the progress, though slow is in the right direction.

Environment Clearance for setting up nano titania/ zirconia facilities have been received. However, in consideration of the stringent norms of Zero Effluent Discharge, work has been taken up to use alternate feed material to meet the stipulations. The KMML is manufacturing rutile grade titanium dioxide pigment by chloride route at i ts Sankaramangalam plant near Chavara in Kerala. The project for the production of one lakh tonnes of TiO_2 in a phased manner is under implementation. The Company also has plans to enhance pigment capacity to 60,000 tpy for which detailed project report is under preparation. In 2009, the Company had developed Nano Titanium Dioxide particles on laboratory scale and in July 2011, India's first commercial plant for synthesis of Nano titanium Dioxide was commissioned.

The DCW Ltd procure silmenite from Manavalakurichi which is then roasted with coke fines to convert Fe_2O_3 into FeO_2. The reduced ore is leached with concentrated hydrochloric acid to remove oxides of iron and other metals. The leached ore is washed and calcined to get upgraded ilmenite which contains more than 95% TiO_2. The upgraded ilmenite is micronised to 2 microns by using high-pressure steam. This is marketed as Titox. The liquor from ilmenite leaching process contains fine TiO_2 particles and chlorides. The TiO_2 recovered by filtration & washing in filter process is marketed as Utox. The Company has plans to increase the plant capacity to 48,000 tpy and also to install facilities for the manufacture of ferrite grade iron oxide from the effluent of the ilmenite plant.

Cochin Minerals and Rutile Ltd (CMRL), which began production at its 10,000 tpy synthetic rutile plant in Kerala in 1990 as a 100% EOU, has gradually raised the production capacity to around 45,000 tpy since 2008-09 for exports. It also has ferric chloride & ferrous chloride plants having capacities of 24,000 tpy & 72,000 tpy, respectively.

The Travancore Titanium Products Ltd (TTPL), a Kerala State Government Undertaking, manufactures titanium dioxide pigment by sulphate process at its plant at Kochuveli, Thiruvananthapuram. Ilmenite is reacted with sulphuric acid in digesters and a porous cake is formed. The mass in the solid form is dissolved in dilute sulphuric acid to get titanium in solution as titanium oxysulphate along with other metallic ingredients in ilmenite as their sulphate. The liquor is reduced using scrap iron, when ferric iron gets completely reduced to the ferrous state. The liquor is clarified, concentrated and boiled to precipitate the titanium content as hydrated titania which is then filtered by vacuum filters and calcined. Sulphuric acid required for captive consumption is produced at site using elemental sulphur. Till recently, TTPL was the only unit producing anatase grade titanium dioxide pigment in India. TTPL has capacity to produce 17,000 tpy of titanium dioxide, and with plans to modernise and diversify in stages, the Company has chalked out targets to produce both anatase and rutile grades titanium dioxide pigment.

Tata Steel has proposed a project to produce 1,00,000 tonnes per year titanium dioxide from ilmenite mined from beach sands of Tirunelveli and Thoothukudi districts in southern Tamil Nadu.

Present domestic titanium metal production is negligible. KMML has setup a 500 tpy titanium sponge plant with Defence Metallurgical Research Laboratory (DMRL) technology and first batch of titanium was delivered in September 2011. The plant will be further expanded to 1,000 tpy. IREL is to setup a 10,000 tpy titanium sponge plant at OSCOM for which proposals have been invited on "build, operate and own" basis. Two forward looking MoUs have been entered by IREL, one with UKTMP, Kazakhstan for setting up of facility for production of titanium slag using ilmenite produced from OSCOM mines, while the other one is with Sultanate of Oman for Co-operation in the field of rare earths. Depending upon feasibility, further value addition to TiO_2 pigment and titanium sponge will be taken up, subsequently. Titanium sponge is imported by Mishra Dhatu Nigam Ltd (MIDHANI) for further processing in the country. The available data on plantwise installed capacities of synthetic rutile and TiO_2 pigment are furnished in Table-6.

Table –6 : Installed Capacity of Synthetic Rutile/Titanium dioxide Pigment,

(In tonnes)

Plant	Location	Specification	Installed capacity (tpy)
IREL	Orissa Sands Complex, Distt Ganjam, Odisha.	90.5% TiO_2 (min.)	100000 (Synthetic rutile)
KMML Kerala	Chavara, Distt Kollam,	92-93% TiO_2	55000 (Synthetic rutile) 60000 (TiO2 - Chloride Process)
DCW Ltd	Sahupuram, Distt Thoothukudi, Tamil Nadu.	95% TiO_2	42000 (Synthetic rutile)
CMRL	Edayar, Distt Ernakulam, Kerala.	96.5% TiO_2	50000 (Synthetic rutile)
TTPL	Kochuveli, Distt Thiruvananthapuram, Kerala.	97.5% TiO_2	17000 (TiO2-Sulphate Process)
VVTi Pigments Pvt. Ltd* (formerly Kilburn Chemicals)	Thoothukudi, Tamil Nadu.	98% TiO_2 (min.)	18000 (TiO2- Sulphate Process)
Kolmark Chemicals Ltd	Kalyani, Distt Nadia, West Bengal.	NA	4800 (TiO2- Sulphate Process)

Source: Department of Atomic Energy, Mumbai and individual companies
Note: KMML captively consumes synthetic rutile while CMRL and DCW export synthetic rutile
** Including Kilburn Chemicals*

USES

About 90% of the world's titanium mineral production is used in the manufacturing of white titanium dioxide pigment. The unique combination of superior properties of high refractive index, low specific gravity, high hiding power and opacity and non-toxicity enable titanium dioxide in its application in the manufacture of all types of white and pastle shades of paints, white-walled tyres, glazed papers, plastics, printed fabrics, flooring materials like linoleum, pharmaceuticals, soaps, face powders and other cosmetic products. Besides, its non-toxic nature facilitate its use in cosmetics, pharmaceuticals, and even in foodstuffs as well as in toothpastes. Titanium dioxide is used in the manufacture of many sunscreen lotions and creams because of its non-toxicity and ultraviolet absorption properties. Synthetic rutile is used for coating welding electrodes as flux component and for manufacture of titanium tetrachloride which in turn is used in making titanium sponge. Synthetic rutile is also used as ingredient of special abrasives. Titanium metal is a versatile material with exceptional characteristics. The lightness, strength and durability of the metal make it an essential metal for the Aerospace Industry. It is also used in desalination and power generation plants and corrosive chemical industries because of its inertness and resistance to corrosion and high thermal conductivity. Its non-reactive property makes titanium metal one of the few materials that can be used in the human body for orthopaedic use and in pacemakers.

CONSUMPTION

The ilmenite consumption is placed at 2,25,100 tonnes in 2019-20 which is lower as compared to the previous year. The bulk of ilmenite is consumed by the Chemical Industry (99 %). Moderate proportions are consumed by Welding Electrode Industry. The consumption of rutile in 2018-19 was 10,500 tonnes as compared to 9,700 tonnes in 2017-18. The entire consumption was reported from Electrode Industry since last two years (Table-7).

Table – 7 : Consumption* of Ilmenite and Rutile 2017-18 to 2019-20

(By Industries)

(In '000 tonnes)

Country	2019	2020	2021
Industry	**2017-18**	**2018-19 (R)**	**2019-20 (P)**
Ilmenite			
All Industries	**295000 (36)**	**222900 (36)**	**164800 (26)**
Chemicals	294100	222000	163900
Electrode	800	800	900
Others (Ceramic, Ferroalloys)	100	100	-
Rutile			
All Industries	**9700**	**10500**	**NA**
Electrode	9700	10500	NA
Paint	-	-	NA

Figures rounded off
** Includes actual reported consumption and/or estimates made wherever required.Paucity of data, hence, the coverage may not be complete.*
():Number of plants reported/estimated.

POLICY

A notification dated 27.07.2019, was issued for reserving the prospecting and mining rights of offshore minerals under Offshore Areas Minerals (Development and Regulation) Act, 2002 exclusively to Government and Government owned companies for curbing illegal mining of atomic minerals by private parties. The Government of India had notified in October 1998, a policy on exploitation of beach sand minerals in the country, which inter alia allows participation of the Private Sector with or without foreign companies subject to conditions stipulated. This will encourage further exploitation of mineral deposits through a judicious mix of Public & Private Sector participation including foreign collaboration. The ceiling on FDI on mining of titanium minerals has been raised to 100 percent.

Joint ventures with foreign participation were being pursued by IREL for production of value- added products, keeping in view the Beach Sand Mineral Policy of the Government.

The minerals, ilmenite and rutile, were grouped as 'prescribed substances' as per notifications issued under the Atomic Energy Act, 1962. However, as per the revised list of Prescribed Substances, Prescribed Equipment and Technology notified by Department of Atomic Energy vide S.O.No.61(E), dated 20.1.2006, the titanium ore minerals like ilmenite, rutile and leucoxene have been delisted as prescribed substances by the Department of Atomic Energy subject to the note as below:

"These minerals shall remain prescribed substances only till such time the policy on Exploration of Beach Sand Minerals notified vide Resolution No.8/1(1)/97-PSU/1422, dated 6.10.1998, is adopted/revised/modified by the Ministry of Mines or till 1.1.2007, whichever occurs earlier and shall cease to be so thereafter".

As per notification No 26/2015-2020, the export of Beach Sand Minerals have been brought under State Trading Enterprise (STE) and shall be canalised through Indian Rare Earths Limited (IREL). Beach Sand Minerals, permitted anywhere in the export policy under Sl. No. 98A of Chapter 26 of schedule 2 Export Policy.

As per Gazette Notification No : GSR.134 (E) dated 20.2.2019, the particulars of threshold values for atomic minerals in respect of Beach Sand Minerals (BSM) shall be regulated as Schedule A [Rule 2(1)(m) and Rule 3 (Table7A).

Table - 7 A : Particulars of Threshold Value for Atomic Minerals

[See Rule 2 (1)(m) and Rule 36]

Uranium-bearing tailings left over from ores after extraction of copper and gold, ilmenite and other titanium ores.	60 ppm U3O8 and/or 250 ppm ThO2.
Zirconium-bearing minerals and ores including zircon.	All cases of zirconium-bearing minerals occurring in Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e. the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade. In other cases, zircon containing less than 2,000 ppm of Hafnium.
Beach Sand Minerals, i.e., economic heavy minerals found in the teri or beach sand,which include ilmenite, rutile, leucoxene,garnet, monazite, zircon and sillimanite.	All cases of Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e., the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade.

SUBSTITUTES

There are no cost-effective substitutes for titanium dioxide pigments. Synthetic rutile made from ilmenite can be substituted for natural rutile. Nickel steels, stainless steels and some non-ferrous metal alloys can sometimes replace titanium alloys in industrial uses although at the expense of performance or economics. Tungsten carbide competes with titanium carbide for surface cutting machine tools. Titanium slag competes with ilmenite and rutile.

Environmental awareness indicates that titanium dioxide plants are likely to use chloride technology in future as it produces much less quantity of waste products. Synthetic rutile or slag (made from ilmenite) is likely to be used as feed in increasing amount. There is also a strong pressure to reduce the radioactive content of feedstocks because it affects the marketability of beach sand ilmenite. Titanium alloys could be replaced in aerospace applications by lithium-aluminium alloys or carbon-epoxy composites.

WORLD REVIEW

World resources of anatase, ilmenite and rutile are more than 2 billion tonnes. World reserves of ilmenite are estimated at 700 million tonnes in terms of TiO2 content. Major reserves are in China with 190 million tonnes (29%) followed by Australia with 160 million tonnes (25%), India with 85 million tonnes (13%), Brazil with 43 million tonnes (6%), Norway with 37 million tonnes & South Africa with 35 million tonnes (5% each), Canada with 31 million tonnes & Mozambique with 26 million tonnes (4% each) and Madagascar with 22 million tonnes (3%). The world reserves of rutile are 49 million tonnes in terms of TiO2 content. Major rutile reserves are located in Australia with 31 million tonnes (63%), followed by India with 7.4 million tonnes (15%), South Africa with 6.5 million tonnes (13%) and Ukraine with 2.5 million tonnes (5%). World production of ilmenite and rutile concentrates was 12 million tonnes and 0.60 million tonnes, respectively, in 2022. China and Canada contributed 4.2 million tonnes (33%) and 1.7 million tonnes (13%) of ilmenite production, followed by South Africa with 1 million tonnes and Mozambique with (8%), Ukraine with 0.78 million tonnes (6%).

Australia produced 0.15 million tonnes of rutile, contributing 25% of world rutile output, followed by South Africa with 0.13 million tonnes (22%), Gambia with 0.09 million tonnes (16%), Canada with 0.09 million tonnes(15%), and Madagascar with 0.06 million tonnes (12%). World reserves and production of ilmenite and rutile are furnished in Tables-8 to10.

Table – 8 : World Reserves of Ilmenite and Rutile

(By Principal Countries)

(In '000 tonnes of contained TiO2)

Country	Reserves	
	Ilmenite	Rutile
World: Total (Rounded)	**650,000**	**49000**
China	190,000	-
Australia[(a)]	10,160,000	1,031,000
India	85,000	7,400
Brazil	43000	-
Norway	37000	-
Canada[(d)]	31000	-
South Africa[(d)]	30,000	6,500
Mozambique	26,000	890
Madagascar[(d)]	22,000	520
Ukraine	5900	2500
USA[(b)(c)]	2,000	-9
Kenya	390	170
Vietnam	1600	-
Other countries	26000	NA

Source: USGS, Mineral Commodity Summaries, 2022
a:Joint Ore Reserves Committee- compliant reserves for ilmenite and rutile were estimated to be 38 million and 9.4 million tonnes respectively
b:Rounded to nearest 1,00,000 tonnes to avoid disclosing company proprietary data
c:US rutile reserves data are included with ilmenite.
d: Mine production is primarily used to produce titaniferous slag

Table – 9 : World Production of Ilmenite

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
World: Total (Wt of Conc.)	**12700**	**12200**	**12900**
China	4200	4200	4200
Canada	2100	1900	1700
Mozambique	892	756	1119
South Africa	1100	1020	1000
Ukraine	818	773	780
Senegal	491	505	727
Madagascar	448	499	690
Norway	630	522	671
Australia	596	634	503

Country	2019	2020	2021
Kenya	352	334	345
Other countries	941	934	1123

Source: BGS, World Mineral Production,2016-2020.

**:Estimate*
a:Canada produces some ilmenite which is sold as such and not processed into slag, but tonnages are small
b:It is believed that the majority of this is processed in to slag
c:Years ended 30 June of that stated
d:Years ended 31 March following that stated
m:Including natural rutile

Table – 10 : World Production of Rutile

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
Country	**2019**	**2020**	**2021**
World: Total (wt of conc)	600	600	600
Australia	154	156	150
South Africa	136	116	131
Gambia	115	110	97
Canada	110	86	90
Madagscar	85	72	69
Sierra Leone	10	9	16
Kazakhstan	11	11	11
Mozambique	5	5	11
Senegal	8	5	8
Monzambique	5	6	6
Other countries	1	1	1

Source : BGS, World Mineral Production,2016-2020.
c: Years ended 30 June of that stated.
d: Years ended 31 March following that stated
** : Estimated*

Metal

Commercial production of titanium metal involves the chlorination of titanium-containing mineral concentrates to produce titanium tetrachloride ($TiCl_4$), which is reduced with magnesium (Kroll process) or sodium (Hunter process) to produce a commercially pure form of titanium metal. The metal formed has a porous appearance and is referred to as sponge. Titanium ingot and slab are produced by melting titanium sponge or scrap or a combination of both, usually with various other alloying elements.

Pigment

Global TiO_2 pigment production capacity was estimated to be 5.7 million tonnes per year. TiO_2 pigment produced is categorised by crystal form as either anatase or rutile. Rutile pigment is less reactive with the binders in paint when exposed to sunlight than the anatase pigment and is preferred substance in outdoor paints. Anatase pigment has a bluer tone than rutile, is somewhat softer and is used mainly in indoor paints and in paper manufacturing. Depending

FOREIGN TRADE

Exports

Exports of titanium ores & conc. decreased to 0.22 million tonnes during 2021-22 from 0.25 million tonnes in the preceding year. Exports were mainly to China (35%), Japan (26%), Belgium (14%) Republic of Korea (13%), and Malaysia (2%).

Exports of titanium and alloys (including waste & scrap) were at 106 tonnes, registering an decrease of 36% from 166 tonnes in the previous year. Exports were mainly to Israel (28%), China (18%) and Turkey (7%). Exports of titanium oxide and dioxide (total) increased by 70% to 48,003 tonnes in 2021-22 from 28,419 tonnes in the preceding year. Out of the total exports in 2021-22, those of titanium dioxide were 6049 tonnes and exports of titanium oxides (other than titanium dioxides) were 41954 tonnes (Tables-11 to 18).

Table – 11 : Exports of Titanium Ores & Conc.

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**246534**	**5348323**	**215910**	**6155343**
China	95596	1767412	77066	2179331
Japan	65624	2134372	57056	1529493
Malaysia	22314	504675	4186	403064
Korea, Rep. of	33000	489294	29760	611186
Belguim	30000	452568	30000	564140
UAE	++	2	1	168
Taiwan	-	-	7789	631441
Netherlands	-	-	10000	230296
Uganda	-	-	52	6223
Austria	-	-	++	1

Figures rounded off

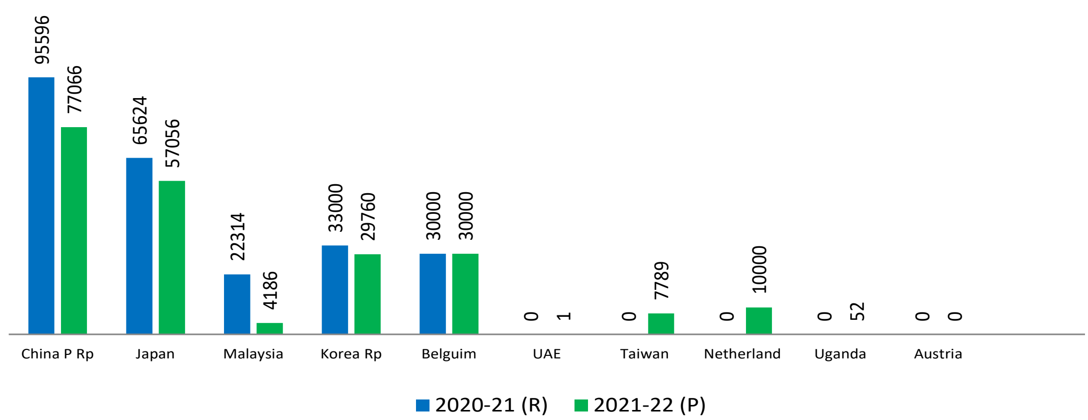


Fig 3: Countrywise Exports of Titanium Ores & Conc.

Table – 12 : Exports of Titanium Ores & Conc. (Ilmenite)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**246534**	**5348321**	**215857**	**6148952**
Japan	65624	2134372	57056	1529493
China	95596	1767412	77066	2179331
Malaysia	22314	504675	4186	403064
Korea, Rep. of	33000	489294	29760	611186
Belgium	30000	452568	30000	564140
Netherlands	-	-	10000	230296
Taiwan	-	-	7789	631441
U Arab Emts	-	-	++	1

Figures rounded off

Table – 13 : Exports of Titanium Ores & Conc. (Rutile)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**2**	**52**	**6239**
UAE	++	2	++	15
Uganda	-	-	52	6223
Austria	-	-	++	1

Figures rounded off

Table – 14 : Exports of Titanium Ores & Conc. (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**-**	**-**	**1**	**152**
UAE	-	-	1	152

Figures rounded off

Table – 15 : Exports of Titanium & Alloys

(Incl. Waste & Scrap)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**166**	**422781**	**106**	**371217**
Philippines	++	30	1	53897
Israel	4	44775	29	46979
Korea, Rep. of	14	14723	4	44775
China	2	6155	20	41062
Turkey	7	124135	9	26095
Germany	2	2367	3	23208
USA	4	17990	2	22101
France	1	13156	1	12374
Finland	3	13780	++	7360
Italy	1	4630	2	6871
Other Countries	128	181040	23	66535

Figures rounded off

Table – 16 : Exports of Titanium Oxide & Dioxide : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**28419**	**2990597**	**48003**	**5320220**
Taiwan	14	2684	16208	1418229
Japan	16183	1513268	2518	438301
USA	2518	438301	3010	768905
China P Rp	5078	352282	7714	596012
Malaysia	1517	101894	3844	352627

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
Italy	1220	241144	984	287687
Spain	140	25477	160	161614
South Africa	80	12620	161	38180
Nepal	152	31846	130	36308
Egypt	178	38318	109	24455
Other Countries	1339	232763	787	217072

Figures rounded off

Table – 17 : Exports of Titanium Dioxide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**6481**	**1152120**	**6049**	**1538174**
USA	2464	432755	3010	768719
Italy	1220	241144	984	287660
Japan	1135	158562	776	139629
Spain	120	24101	160	42042
South Africa	80	12620	155	36058
Nepal	125	27309	125	35070
Egypt	142	22752	109	24455
Bangladesh	44	10214	67	20960
UAE	113	22252	75	20548
Uganda	12	2504	40	14288
Other Countries	1026	197907	548	148745

Figures rounded off

Table – 18 : Exports of Titanium Oxide

(Other than Titanium Dioxide)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**21938**	**1838477**	**41954**	**3782046**
Taiwan	-	-	14872	1413664
Japan	15048	1354706	15432	1278600
China	5026	332038	7714	595959
Malaysia	1515	101371	3844	352627
Spain	20	1376	++	119572
Canada	1	338	20	5035
Netherlands	++	55	++	2851
Nigeria	-	-	24	2646
Tanzani	38	2986	26	2401
South Africa	-	-	6	2122
Other Countries	290	45607	16	6569

Figures rounded off

Imports

Imports of titanium ores & conc. increased drastically by 42% to 1,11,653 tonnes in 2021-22 from 78,747 tonnes in the preceding year. Imports were mainly from Mozambique (51%), Thailand (15%), Netherlands (7%) and Australia (5%).

Imports of titanium and alloys (including waste & scrap) were 4,313 tonnes in 2021-22 as compared to 2,915 tonnes in the previous year. Imports were mainly from China (54%), Russia (11%), USA (6%) and Japan (5%). Imports of titanium oxide and dioxide (total) were 15,233 tonnes in 2021-22 as compared to 13514 tonnes in the preceding year. Imports were mainly from China (32%), Japan (12%), and Rep. of Korea (10%). Bulk of these imports were of titanium dioxide (15,135 tonnes) and titanium oxides (other than titanium oxides) were 98 tonnes in 2020-21 (Tables - 19 to 26).

Table – 19 : Imports of Titanium Ores & Conc. : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**78747**	**3440562**	**111653**	**5292058**
Mozambique	42300	855800	56981	1606498
Australia	2966	252003	5356	572465
China	3188	295112	4656	509355
Thailand	4537	331018	16792	50829
Sri Lanka	2335	189085	2610	361301
Netherlands	6977	204437	8686	268024
Ukraine	1714	164630	3563	258421
UAE	2440	204925	2465	251950
USA	4452	363880	2423	220356
Senegal	2060	152553	1722	161533
Other Countries	5778	427119	6399	573859

Figures rounded off

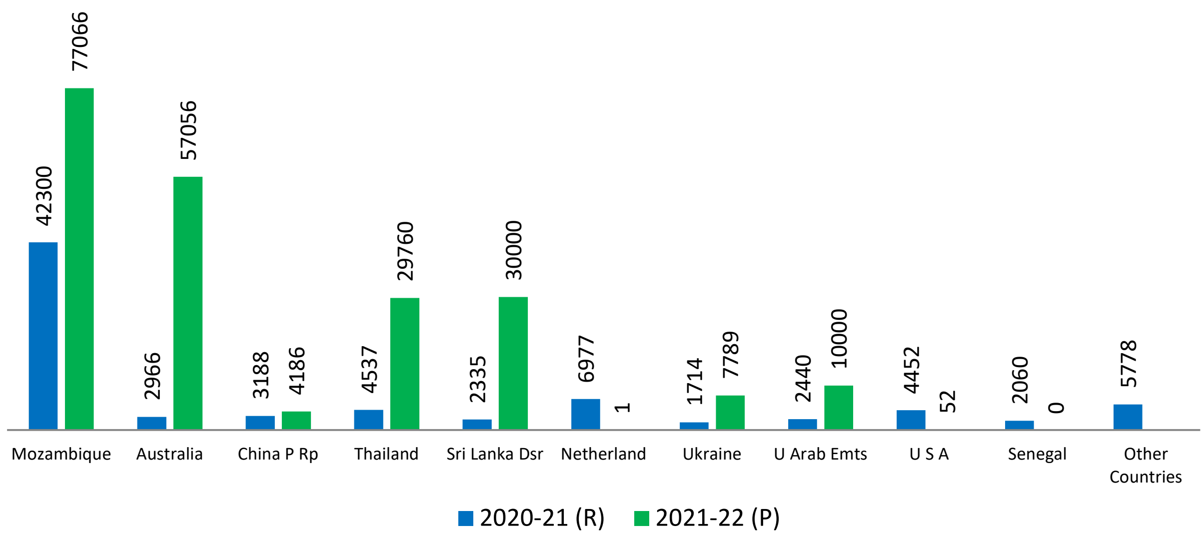


Fig 5: Countrywise Imports of Titanium Ores & Conc. : Total

Table – 20 : Imports of Titanium Ores & Conc. (Ilmenite)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**43894**	**907344**	**77003**	**2326341**
Mozambique	41624	796023	56955	1603973
Thailand	-	-	14940	32272
Sri Lanka	898	69473	1306	224589
UAE	-	-	696	79546
Ukraine	56	1348	1397	42067
Malaysia	946	12893	1461	31875
China	120	6904	1461	31875
Germany	-	-	4	632
New Zealand	-	-	++	23
Vietnam	250	20703	-	-

Figures rounded off

Table – 21 : Imports of Titanium Ores & Conc. (Rutile)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**29562**	**2224774**	**22960**	**2479934**
Australia	1856	164402	4602	495710
China P Rp	2392	225104	3632	400387
USA	4212	347314	2327	213211
Ukraine	1602	157659	1498	173505
Thailand	4537	331018	1852	185575
UAE	2440	204925	1769	172404
Singapore	-	-	1345	148561
Sri Lanka	1124	114540	836	120640
Netherlands	5333	163365	828	100239
South Africa	1636	150260	908	97956
Other Countries	4430	366187	3363	371746

Figures rounded off

Table – 22 : Imports of Titanium Ores & Conc. (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**5291**	**308444**	**11690**	**485783**
Netherland	1644	41072	7858	167785
Vietnam	-	-	20	2297
China	676	63104	780	88053
Australia	1110	87601	754	76755
Senegal	1080	81475	800	74582
Ukraine	56	5623	668	42849
Sri Lanka	313	5072	468	16072
USA	240	16566	96	7145
Malaysia	84	1107	196	4306
UK	88	6801	48	3838
Other Countries	++	23	2	2101

Figures rounded off

Table – 23 : Imports of Titanium & Alloys (Incl. Waste & Scrap)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2915**	**4452214**	**4313**	**6458293**
China	1349	1603114	2343	2732094
USA	129	687730	290	987395
Germany	200	322190	269	633005
Russia	111	109838	477	336476
UK	63	317834	143	475942
Japan	298	357985	233	320664
France	56	151508	34	249094
Belgium	130	179058	56	139444
Italy	62	199958	55	125485
Netherlands	149	154954	101	96557
Other Countries	368	368045	312	36213

Figures rounded off

Table – 24 : Imports of Titanium Oxide & Dioxide : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**13514**	**2579284**	**15233**	**3695149**
China	4359	727242	4838	1055368
Korea, Rep. of	78	939060	4450	1022230
Japan	862	215069	1850	446664
Netherlands	393	114442	1492	441845
Germany	720	217144	768	257108
Belgium	484	128415	453	135595
Hong Kong	452	80621	486	103147
Canada	176	63772	116	39179
USA	++	1444	110	29426
Mexico	40	8937	100	27512
Other Countries	350	83138	570	137075

Figures rounded off

Table – 25 : Imports of Titanium Dioxide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**13389**	**2510726**	**15135**	**3623000**
China	4322	720044	4838	1054969
Korea, Rep. of	393	114442	1476	437507
Netherlands	570	148788	719	202767
Japan	796	177150	1774	404048
Germany	719	202767	763	235700
Belgium	464	123286	453	135450
Hong Kong	452	80621	486	103147
Canada	176	63772	116	39179
USA	++	1254	110	29420
Mexico	40	8937	100	27512
Other countries	349	79496	569	133953

Figures rounded off

Table – 26 : Imports of Titanium Oxide

(Other than Titanium Dioxide)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**125**	**68558**	**98**	**72149**
Japan	66	37919	76	42616
Germany	1	14377	5	21408
Netherlands	-	-	16	4338
France	++	1687	1	2470
China	37	7198	++	399
Singapore	++	54	++	192
Spain	-	-	++	160
Belgium	20	5129	++	145
UK	1	1542	++	115
Korea, Rep. of	++	103	++	115
Other countries	++	549	++	191

Figures rounded off

FUTURE OUTLOOK

As per Technology Vision Document 2035, the demand for titanium in India would be approximately 1,000 tonnes by 2035. The contribution to the demand would be from Space Sector (100 tonnes), General Engineering (50 tonnes), Atomic Energy (125 tonnes), Aeronautical (50 tonnes), Power Generation (150 tonnes), Petroleum Refinery (50 tonnes) and Chemical Industry (475 tonnes).

As per data available, the defence, atomic energy and space research which are critical sectors have been assigned targets to increase communication set-up, safeguard India's security with modern arms, ammunitions & control and to increase power generation by three-fold. For meeting these targets, Indian Engineering Industry will dependent on input materials like titanium sponge. Titanium sponge was not available in India till 2012, the first ever commercially indigenously made Ti-sponge was released as late as 2013 at KMML, Kerala, with the support of ISRO. However, with the successful commissioning of the titanium sponge plant, India has joined the elite club of seven countries capable of producing aerospace-grade titanium sponge. The plant has the basic infrastructure for increasing the capacity to 1,000 tpa in future with sponge to metal yield at 35%, the requirement of titanium sponge on a conservative estimate would be 2,500 tpa for India. The gap, therefore, will remain and would have to be met by import. The plant capacity now will be just sufficient to serve Strategic Industry like the indigenous space & defence programmes.

Titanium Sponge Industry is get to come out of the input of the pandemic as its demand is mainly depend on the aviation sector which is badly affected due to the pendemic restrictions. Global demand growth for TiO_2 is expected to trend with the prospects of economic growth and production of paint, paper and plastics.

Aerospace, defence and industrial uses are expected to strongly influence the consumption of titanium metal in the near future.

The impetus by the Government for renewal energy and infrastructure, however, augurs well for demand for steel and that for IREL's rutile which finds application in production of welding electrodes.

16. Iron Ore

24,057
(million tonnes) Total reserves/ resources of haematite wereestimated as on 1st April 2020

253.97
(million tonnes) Production of iron ore were reported in 2021-22

26.49
(million tonnes) of iron ore were exported in 2021-22

6.68
(million tonnes) of iron ore were imported in 2021-22

Iron & steel is the driving force behind industrial development in any country. The vitality of the Iron & Steel Industry largely influences a country's economic status. The mining of iron ore, an essential raw material for Iron & Steel Industry is arguably of prime importance among all mining activities undertaken by any country. With the total resources of over 35.29 billion tonnes of haematite (Fe_2O_3) and magnetite (Fe_3O_4), India is one of the leading producers of iron ore in the world.

RESERVES / RESOURCES

Haematite and magnetite are the most important iron ores in India. About 79% haematite ore deposits are found in the Eastern Sector (Assam, Bihar, Chhattisgarh, Jharkhand, Odisha & Uttar Pradesh) while about 93% magnetite ore deposits occur in Southern Sector (Andhra Pradesh, Goa, Karnataka, Kerala & Tamil Nadu). Karnataka alone contributes 72% of magnetite deposit in India. Of these, haematite is considered to be superior because of its higher grade. Indian deposits of haematite belong to the Precambrian Iron Ore Series and the ore is within banded iron ore formations occurring as massive, laminated, friable and also in powdery form.

As per NMI database based on UNFC system, the total reserves/resources of haematite as on 1.4.2020 have been estimated at 24,057 million tonnes of which 6,209 million tonnes (25.80%) are under 'Reserves' category and the balance 17,848 million tonnes (74.20%) are under 'Remaining Resources' category. By grades, Lumps constitute about 45% followed by Lumps with Fines (27%), Fines (13%), and the remaining 15 % are Black Iron ore, Beneficiable grade, Others, Unclassified, Not-known Lumps & fines & blue dust unclassified grade. Major reserves/resources of haematite are located in Odisha (9,409 million tonnes or 39%), Jharkhand (4, 710 million tonnes or 20%), Chhattisgarh (4,592 million tonnes or 19%), Karnataka (2,835 million tonnes or 12%) and Goa (1,197 million tonnes or 5%). The balance 5% resources of haematite are spread in Andhra Pradesh, Assam, Bihar, Madhya Pradesh, Maharashtra, Meghalaya, Rajasthan, Telangana and Uttar Pradesh (Table-1).

Table – 1 : Reserves/Resources of Iron Ore (Haematite) as on 1.4.2020

(By Grades/States)

(in '000 tonnes)

Grade/State	Reserves				Remaining Resources								Total Resou - rces
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
ll India : Total	**4559856**	**508158**	**1141020**	**6209034**	**3181005**	**2404790**	**2005363**	**1010484**	**1805532**	**4827512**	**2614185**	**17848870**	**24057905**
By Grades													
Lump, high grade	773270	7710	51205	832185	457627	114235	150606	40724	31400	141760	3742	940095	1772279
Lump, medium grade	1066104	59274	307207	1432585	1140155	335227	594409	243736	601353	1180044	93864	4188788	5621372
Lump, low grade	594586	8710	83034	686331	309262	200290	67277	222298	316657	1025039	247723	2388547	3074877
Lump, unclassified grade	194	-	16	210	54880	28	7782	16768	31742	112248	22800	246248	246459
Fines, high grade	146830	-	-	146830	7222	1592	4849	44930	8451	147	-	67192	214022
Fines, medium grade	76699	9401	61729	147829	38835	235664	46988	170724	268811	442248	932	1204201	1352029
Fines, low grade	122319	7765	18216	148301	224999	190987	98102	21053	161961	505004	6212	1208318	1356619
Fines, unclassified grade	300	190	-	490	343	341	-	8734	12610	78658	15200	115885	116375
Lumps & fines high grade	244340	117770	109568	471678	57490	92283	44972	16730	602	154257	112375	478709	950387
Lumps & fines medium grade	675056	92861	248507	1016424	175016	327566	73775	92791	28418	203097	240896	1141559	2157983
Lumps & fines low grade	494490	7347	196706	698544	400738	721773	660343	50884	53254	459916	88688	2435597	3134141
Lumps & fines unclassified	120995	51430	15719	188144	70934	17172	24675	1061	6543	29174	4101	153661	341805
Black iron ore	-	-	-	-	7017	3014	1355	-	1059	6661	-	19106	19106
Beneficiable grade	98514	139886	32121	270521	144495	114029	164994	72012	280639	242950	99318	1118438	1388959
Others	20546	-	3360	23905	15825	8913	16996	-	332	10774	745	53585	77490
Unclassified	68922	3824	13393	86138	57610	19631	39663	5495	1548	53912	152046	329906	416044
Not-known	1330	-	239	1569	621	20000	2992	-	151	180168	1524850	1728782	1730351
Lumps & fines & blue dust													
low grade	-	-	-	-	-	-	410	-	-	1437	0	1847	1847
Lumps & fines &													
blue dust unclassified grade	55361	1990	-	57351	17935	2046	5175	2543	-	16	692	28408	85759

(in '000 tonnes)

Grade/State	Reserves				Remaining Resources								Total Resou - rces
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
By States													
Andhra Pradesh	32893	-	11851	44744	42461	68382	66330	377	5863	144374	23085	350872	395616
Assam	-	-	-	-	-	-	-	-	8600	22290	-	30890	30890
Bihar	-	-	-	-	-	-	-	-	-	55	-	55	55
Chhattisgarh	1289443	99927	204363	1593732	348648	17215	46166	171548	552653	993652	868497	2998379	4592111
Goa	96558	7666	13012	117235	435300	255162	182675	22126	12727	166631	5701	1080322	1197557
Jharkhand	388078	16760	129839	534677	324634	902980	814308	101700	122673	617586	1291588	4175469	4710146
Karnataka	897256	39779	106177	1043212	330334	46621	84816	592180	62882	504234	171714	1792781	2835992
Madhya Pradesh	24363	11326	18440	54129	30076	15080	29885	12613	3993	151523	59700	302870	356999
Maharashtra	9464	2124	3653	15241	1672	6632	9191	81116	95545	59673	32474	286304	301544
Meghalaya	-	-	-	-	-	-	-	-	-	225	-	225	225
Odisha	1817247	328296	653206	2798749	1662944	1068654	770861	28824	925717	2019410	134173	6610582	9409331
Rajasthan	4555	2280	479	7314	3775	3962	1132	-	11510	7776	13	28166	35480
Telangana	-	-	-	-	1162	102	-	-	3370	73754	27240	105627	105627
Uttar Pradesh	-	-	-	-	-	20000	-	-	-	66330	-	86330	86330

figures rounded off

Magnetite is another principal iron ore that also occurs in the form of oxide, either in igneous or metamorphosed banded magnetite-silica formation. As per NMI database based on UNFC system, the total reserves/resources of magnetite as on 1.4.2020 have been estimated at 11,227 million tonnes of which 'Reserves' constitute 202 million tonnes while 11,024 million tonnes are placed under 'Remaining Resources'. Classification on the basis of grades shows that 20% resources are of Metallurgical grade while 80% resources belong to grades that are categorised as Unclassified, Not-known and Coal Washery. The resources of Others and Foundry grades constitute meagre proportions. India's 96.70% magnetite reserves/resources are located in five States, namely, Karnataka (7,802 million tonnes or 69.50%) followed by Andhra Pradesh (1,472 million tonnes or 13.10%), Rajasthan (794 million tonnes or 7.10%), Tamil Nadu (528 million tonnes or 4.70%) and Goa (266 million tonnes or 2.30%). Assam, Bihar, Chhattisgarh, Jharkhand, Kerala, Maharashtra, Meghalaya, Nagaland, Odisha and Telangana together account for the remaining 3.30% resources (Table-2).

Table – 2 : Reserves/Resources of Iron Ore (Magnetite) as on 1.4.2020

(By Grades/States)

(in '000 tonnes)

Grade/State	Reserves				Remaining Resources								Total Resou - rces
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	71930	385	130508	202823	307652	16082	72127	1513168	2036982	6383274	695507	11024791	11227614
By Grades													
Metallurgical	231	65	19	315	165948	24	21583	690596	391192	968646	255	2238244	2238559
Coal washery	35972	-	82706	-118678	-	518	1981	411	318	41545	79596	124368	243045
Foundry	-	-	-	-	330	125	-	-	-	381	-	836	836
Beneficiable	-	-	-	-	-	-	-	-	4016	23602	9180	36798	36798
Others	909	-	443	1351	3796	985	170	-	-	1791	-	6923	8274
Unclassified	34818	320	47341	82479	65421	13720	48387	822161	1641456	5066985	606428	8264559	8347038
Not-known	-	-	-	-	71978	709	6	-	-	280324	48	353064	353064
By States													
Andhra Pradesh	-	-	-	-	114210	-	-	13800	1266666	68527	9180	1472383	1472383
Assam	-	-	-	-	-	-	-	-	-	15380	-	15380	15380
Bihar	-	-	-	-	-	-	-	-	48850	589	-	49439	49439
Chhattisgarh	29319	-	46557	75876	12263	-	17782	-	-	-	-	30045	105921
Goa	4364	-	626	4990	59509	14516	33512	-	-	151811	1997	261345	266336
Jharkhand	-	-	-	-	-	518	1986	411	3948	3722	82	10667	10667
Karnataka	133	185	-	318	120131	-	18375	1498957	479372	5345018	340000	7801853	7802171
Kerala	-	-	-	-	-	-	-	-	59912	23523	-	83435	83435
Maharashtra	481	65	32	578	329	24	267	-	-	590	-	1210	1788
Meghalaya	-	-	-	-	-	-	-	-	-	3380	-	3380	3380
Nagaland	-	-	-	-	-	-	-	-	5280	-	-	5280	5280
Odisha	-	-	-	-	79	-	120	-	-	43	-	242	242
Rajasthan	376631	136	83294	121060	1131	1023	85	-	3566	588463	79595	673866	794926
Tamil Nadu	-	-	-	-	-	-	-	-	169388	110728	248785	528901	528901
Telangana	-	-	-	-	-	-	-	-	-	71500	15866	87366	87366

Figures rounded off

EXPLORATION & DEVELOPMENT

The Exploration & Development details, if any, are covered in the Review " Exploration & Development" in Volume-I of Indian Minerals Yearbook titled "General Reviews".

PRODUCTION

The production of iron ore constituting lumps, fines and concentrates was at 253.97 million tonnes in the year 2021-22, showing an increase of about 23.86% as compared to that in the preceding year.

There were 245 reporting mines in 2021-22 as against 280 in the previous year. Among them, 43 mines were in the Public Sector and 202 in Private Sector. Besides, production of iron ore was reported as associated mineral by 10 mines in 2021-22 which is one more than that of the year 2020-21. The contribution of Public Sector to the total production was about 39.30% as against about 37.00% in the preceding year. The remaining 60.70% of the production in 2021-22 was from Private Sector. Among 43 iron ore mines in Public Sector, 22 iron ore mines each producing more than one million tonnes annually accounted for about 97.59% of the total output in Public Sector during 2021-22. Out of 202 iron ore mines and 10 associated mines in Private Sector, 39 iron ore mines each producing more than one million tonnes annually accounted for about 84.34% of the total output of Private Sector during the year. Thus, 61 iron ore mines, each producing more than one million tonnes of iron ore annually, contributed about 89.55% of the total output in 2021-22. The captive mines reported production of 96.34 million tonnes comprising about 37.94% of total production and non captive mines reported production of 157.63 million tonnes i.e. about 62.06% during 2021-22. Gradewise analysis of the current year's output reveals that, out of total output of 253.97 million tonnes, iron ore lumps constituted 72.86 million tonnes (i.e., about 28.69%), fines constituted 179.72 million tonnes (i.e., about 70.76%) and concentrates constituted 1.39 million tonnes (i.e., about 0.55%).

Among the States, Odisha recorded the highest production of 136.67 million tonnes, i.e., about 53.82% of the country's production in 2021-22. Chhattisgarh was at the second place with a pro-duction of 41.31 million tonnes, i.e., about 16.27% of the total production followed by Karnataka with a production of 40.33 million tonnes, i.e., about 15.88% , Jharkhand 24.72 million tonnes, i.e., about 9.74% of the country's production. The remaining 10.90 million tonnes, i.e., 4.29% production was reported from Andhra Pradesh, Madhya Pradesh, Maharashtra and Rajasthan.(Table 3 to 6)

STOCKS AT MINE-HEAD

The mine-head closing stocks of iron ore for the year 2021-22 were 119.19 million tonnes as compared to 121.17 million tonnes in 2020-21 (Tables 7(A) & 7(B)).

Table - 3 :Principal Producers of Iron ore 2021-22

Name & address of producer	Location of mine	
	State	District
National Mineral Development Corporation Ltd 10-3-311/A, Khanij Bhavan, Castle Hills, Masab Tank, Hyderabad –500 028	Chhattisgarh Karnataka	Dantewada Ballari
Steel Authority of India Ltd, Ispat Bhavan, Lodhi Road, New Delhi – 110 003	Chhattisgarh Jharkhand Odisha	Durg Singhbhum (West) Keonjhar, Sundargarh
Tata Steel Ltd, Bombay House, 24, Homi Mody Street, Fort, Mumbai – 440 001, Maharashtra	Jharkhand Odisha	Singhbhum (West) Keonjhar
JSW Steel Ltd, Jsw Centre Bandra Kurla Complex, Bandra (East) - Mumbai-400 051, Maharashtra	Karnataka	Ballari
Rungta Sons (P) Ltd, 8A Express Tower, 42 A-Shakespeare Sarani, Kolkata – 700 017, West Bengal	Jharkhand Odisha	Singhbhum (West) Keonjhar
Odisha Mining Corporation Ltd, OMC House, Unit-5, P.B. No.34 Distt Khurda, Bhubaneswar-751 001, Odisha	Odisha	Keonjhar Sundargarh
Sarda Mines (P) Ltd, Room No. 64, 6th Floor, Circular Court, 8-AJC Bose Road, Kolkata- 700 017, West Bengal	Odisha	Keonjhar
Essel Mining & Industries Ltd, Industry House, 18th Floor, 10 Camac street, Kolkata-700 017, West Bengal.	Odisha	Sundargarh Keonjhar
Vedanta Ltd, Sesa Ghor, EDC complex, Patto, Panaji, Tisavadi-403 001, Goa	Karnataka	Chitradurga
ArcelorMittal India Pvt. Ltd, Office No.126 101-104, GCP Business Centre Opp. Memnagar Fire Station, Vijay Cross Road, Memnagar, Ahmedabad-380014 Gujarat	Odisha	Keonjhar
Mysore Minerals Limited, A Block, 5th floor, Santhinagar, Bengaluru – 560 027, Karnataka	Karnataka	Ballari
Jindal Steel & Power Ltd, O.P. Jindal Marg, Delhi Road, Hissar - 125 005, Haryana	Odisha	Sundargarh
Serajuddin & Co, P-16, Bentink Street, Kolkata- 700069, West Bengal	Odisha	Keonjhar
Sri Kumaraswamy Minerals Exporters, No. 24, 2nd Link Road, Parvathi Nagar, Ballari- 583102, Karnataka	Karnataka	Ballari

Name & address of producer	Location of mine	
	State	District
Geetarani Mohanty, 380, Bomikhal, Cuttack- Puri Road, Bhubaneswar- 751010, Odisha	Odisha	Sundargarh
Tata Steel Long Products Ltd., (West) Mangal Kalash, 2A, Shakespear Sarani, Kolkata- 700017	Jharkhand	Singhbhum
Narbheram Power and Steel Pvt Ltd., Avani Signature91a/1, 6th Floor, Park Street, Kolkata- 700016, West Bengal	Odisha	Keonjhar
Godawari Power & Ispat Ltd., Plot No. 428/1, Phase-1, Industrial Area, Siltara Dharsiwa, Raipur- 493111, Chhattisgarh	Chhattisgarh	Rajnandgaon
Arcelor Mittal Nippon Steel India Li., 27 km, Surat Hazira Roadhazira, Chouryasi, Surat- 394270, Gujarat	Odisha	Sundargarh
Prabodh Mohanty, Weighbridge Road, Post Box No. 21, Barbil- 758035, Odisha	Odisha	Sundargarh

Table – 4 : Production of Iron Ore, 2019-20 to 2021-22

(By States)

(Quantity in '000 tonnes; Value in ₹ '000)

States		2019-20		2020-21		2021-22 (P)	
		Qty	Value	Qty	Value	Qty	Value
India	**Total**	**244083**	**496430578**	**205041**	**527292469**	**253973**	**963813280**
	Lumps	76012	195781171	61917	198763643	72864	361924390
	Fines	166889	296322689	141934	323013422	179716	594861827
	Concentrates	1182	4326718	1190	5515404	1393	7027063
Andhra Pradesh	**Total**	**825**	**613393**	**349**	**260233**	**312**	**230684**
	Lumps	508	424030	213	181601	189	159196
	Fines	317	189363	136	78632	123	71488
Chhattisgarh	**Total**	**34728**	**99153323**	**36839**	**132201316**	**41313**	**218099187**
	Lumps	12191	38230890	12710	52033594	14545	88248035
	Fines	22537	60922433	24129	80167722	26768	129851152
Goa	**Total**	**-**	**-**	**1003**	**897737**	**-**	**-**
	Lumps	-	-	331	333817	-	-
	Fines	-	-	672	563920	-	-
	Concentrates	-	-	-	-	-	-
Jharkhand	**Total**	**25015**	**29411760**	**21434**	**28520399**	**24728**	**55467888**
	Lumps	6954	9627055	4827	7279890	5680	13943382
	Fines	18061	19784705	16607	21240509	19048	41524506
Karnataka	**Total**	**31392**	**67326043**	**34500**	**94390860**	**40332**	**158769382**
	Lumps	9248	25077852	10108	36892352	11707	57861464
	Fines	22144	42248191	24392	57498508	28625	100907918
Madhya Pradesh	**Total**	**3343**	**1729068**	**4094**	**2146870**	**7399**	**4667940**
	Lumps	1467	687760	859	463231	1197	778188
	Fines	1876	1041308	3235	1683140	6202	3889752
	Concentrates	-	-	-	499	-	
Maharashtra	**Total**	**1131**	**1340244**	**1249**	**1732866**	**1958**	**6471874**
	Lumps	93	197711	113	253928	751	4237390
	Fines	1038	1142533	1136	1478938	1207	2234484

(Quantity in '000 tonnes; Value in ₹'000)

States		2019-20		2020-21		2021-22 (P)	
		Qty (t)	Value(₹'000)	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
Odisha	**Total**	**146637**	**293179734**	**104485**	**262035370**	**136696**	**514531737**
	Lumps	45363	121484813	32699	101296238	38660	196606783
	Fines	100916	170994093	71626	160300893	97740	316379535
	Concentrates	358	700828	160	438239	296	1545419
Rajasthan	**Total**	**1012**	**3677013**	**1088**	**5106818**	**1235**	**5574588**
	Lumps	188	51060	57	28992	135	89952
	Fines	++	63	1	1160	3	2992
	Concentrates	824	3625890	1030	5076666	1097	5481644
Telangana	**Total**	**-**	**-**	**-**	**-**	**-**	**-**
	Lumps	-	-	-	-	-	-
	Fines	-	-	-	-	-	-

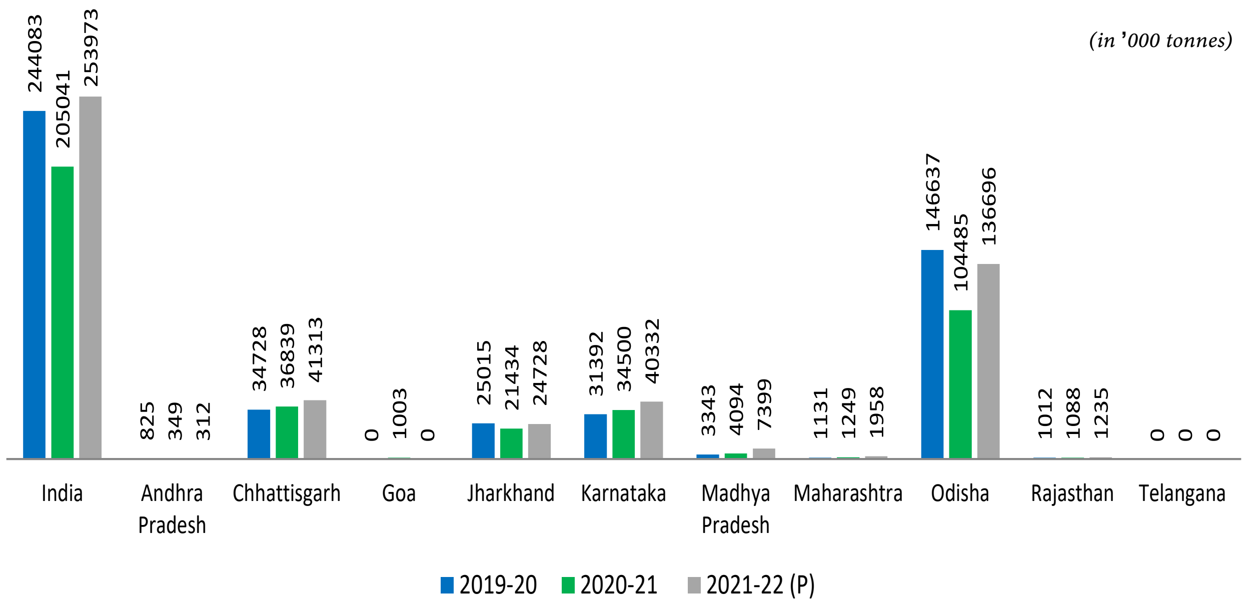


Fig 1: Statewise Production of Iron ore

Table – 5 (B) : Production of Iron Ore, 2021-22

(Quantity in '000 tonnes; Value in ₹'000)

State/ District	Lumps									Fines											
	No. of mines	Below 55% Fe	55%-below 58% Fe	58%-below 60% Fe	60%-below 62% Fe	62%-below 65% Fe	65% Fe & above	Total		Below 55% Fe	55%-below 58% Fe	58%-below 60% Fe	60%-below 62% Fe	62%-below 65% Fe	65% Fe & above	Total		Concentrates		Total	
								Qty	Value							Qty	Value	Qty	Value	Qty	Value
India	**245(10)**	**5902**	**2820**	**9215**	**10707**	**26985**	**17235**	**72864**	**361924390**	**19343**	**25007**	**19490**	**44118**	**48140**	**23618**	**179716**	**594861827**	**1393**	**7027063**	**253973**	**963813280**
Public Sector	43	121	268	1053	5113	18263	9838	34656	200526074	282	2670	4191	27182	26242	4586	65153	272667286	-	-	99809	473193360
Private Sector	202(10)	5781	2552	8162	5594	8722	7397	38208	161398316	19061	22337	15299	16936	21898	19032	114563	322194541	1393	7027063	154164	490619920
Andhra Pradesh	**13**	**189**	-	-	-	-	-	**189**	**159196**	**123**	-	-	-	-	-	**123**	**71488**	-	-	**312**	**230684**
Anantapur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuddapah	4	160	-	-	-	-	-	160	132962	107	-	-	-	-	-	107	60898	-	-	267	193860
Krishna	1	-	-	-	-	-	-	-	-	++	-	-	-	-	-	++	23	-	-	++	23
Kurnool	7	29	-	-	-	-	-	29	26234	16	-	-	-	-	-	16	10567	-	-	45	36801
Nellore	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prakasam	1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chhattisgarh	**21**	**352**	**255**	**279**	**725**	**3393**	**9541**	**14545**	**88248035**	**1174**	**1453**	**780**	**4183**	**14044**	**5134**	**26768**	**129851152**	-	-	**41313**	**218099187**
Dantewara	7	-	-	13	-	181	9539	9733	80274985	4	6	119	1444	12895	4405	18873	115887818	-	-	28606	196162803
Durg	4	21	85	113	614	3110	-	3943	6409250	27	420	104	2263	1148	-	3962	6472702	-	-	7905	12881952
Kanker	6	113	105	94	107	102	-	521	822059	1063	964	533	468	-	729	3757	7109529	-	-	4278	7931588
Narayanpur	2	-	-	42	-	-	2	44	99274	14	10	-	-	-	-	24	42966	-	-	68	142240
Rajnandgaon	2	218	65	17	4	-	-	304	642467	66	53	24	8	1	-	152	338137	-	-	456	980604
Goa	**27**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Goa	9*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
South Goa	18*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jharkhand	**16**	**35**	**87**	**897**	**2264**	**849**	**1548**	**5680**	**13943382**	**77**	**788**	**1678**	**5631**	**2365**	**8509**	**19048**	**41524506**	-	-	**24728**	**55467888**
Singhbhum (West)	16	35	87	897	2264	849	1548	5680	13943382	77	788	1678	5631	2365	8509	19048	41524506	-	-	24728	55467888
Karnataka	**56(1)**	**2351**	**794**	**2247**	**2519**	**3377**	**419**	**11707**	**57861464**	**4895**	**7830**	**5849**	**3805**	**5285**	**961**	**28625**	**100907918**	-	-	**40332**	**158769382**
Bagalkot	2	161	-	-	-	-	-	161	513978	106	-	-	-	-	-	106	225879	-	-	267	739857
Bellary	48	2021	699	1581	2199	3206	419	10125	49325500	4162	3055	4702	3800	5285	961	21965	81277171	-	-	32090	130602671
Chitradurga	5	169	87	666	320	171	-	1413	7983648	614	4775	1147	5	-	-	6541	19384745	-	-	7954	27368393
Tumkur	1(1)	-	8	-	-	-	-	8	38338	13	-	-	-	-	-	13	20123	-	-	21	58461

(Quantity in '000 tonnes; Value in ₹'000)

State/ District	Lumps									Fines								Concentrates		Total	
	No. of mines	Below 55% Fe	55%- below 58%	58%- below 60%	60%- below 62%	62%- below 65%	65% Fe & above	Total Qty	Total Value	Below 55% Fe	55%- below 58%	58%- below 60%	60%- below 62%	62%- below 65%	65% Fe & above	Total Qty	Total Value	Qty	Value	Qty	Value
Madhya Pradesh	**23(8)**	**1192**	**5**	**-**	**-**	**-**	**-**	**1197**	**778188**	**6054**	**139**	**-**	**9**	**-**	**-**	**6202**	**3889752**	**-**	**-**	**7399**	**4667940**
Balaghat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chhatarpur	1	80	-	-	-	-	-	80	39214	22	-	-	-	-	-	22	11040	-	-	102	50254
Gwalior	1	-	-	-	-	-	-	-	-	121	-	-	-	-	-	121	60803	-	-	121	60803
Jabalpur	20(8)	1053	5	-	-	-	-	1058	666480	5888	139	-	9	-	-	6036	3799295	-	-	7094	4465775
Sagar	1	59	-	-	-	-	-	59	72494	23	-	-	-	-	-	23	18614	-	-	82	91108
Maharashtra	**11**	**65**	**54**	**54**	**23**	**555**	**-**	**751**	**4237390**	**560**	**181**	**126**	**264**	**76**	**-**	**1207**	**2234484**	**-**	**-**	**1958**	**6471874**
Chandrapur	1	10	7	6	3	-	-	26	76148	23	7	11	-	-	-	41	76900	-	-	67	153048
Gadchiroli	1	-	-	4	20	555	-	579	3810495	-	-	-	264	76	-	340	1231368	-	-	919	5041863
Gondia	3	11	-	-	-	-	-	11	20570	6	-	-	-	-	-	6	3560	-	-	17	24130
Sindhudurg	6	44	47	44	-	-	-	135	330177	531	174	115	-	-	-	820	922656	-	-	955	1252833
Odisha	**68(1)**	**1588**	**1620**	**5738**	**5176**	**18811**	**5727**	**38660**	**196606783**	**6457**	**14616**	**11057**	**30226**	**26370**	**9014**	**97740**	**316379535**	**296**	**1545419**	**136696**	**514531737**
Keonjhar	39	1106	865	2976	1660	13421	5461	25489	125614399	2921	7114	6389	19940	15365	8929	60658	183508182	-	-	86147	309122581
Mayurbhanj	3	257	209	3	9	42	8	528	2102992	1062	-	9	19	4	12	1106	1702339	-	-	1634	3805331
Sundargarh	26(1)	225	546	2759	3507	5348	258	12643	68889392	2474	7502	4659	10267	11001	73	35976	131169014	296	1545419	48915	201603825
Rajasthan	**10**	**130**	**5**	**-**	**-**	**-**	**-**	**135**	**89952**	**3**	**-**	**-**	**-**	**-**	**-**	**3**	**2992**	**1097**	**5481644**	**1235**	**5574588**
Bhilwara	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1097	5481644	1097	5481644
Jaipur	3	59	-	-	-	-	-	59	18221	1	-	-	-	-	-	1	826	-	-	60	19047
Jhunjhunu	3	28	-	-	-	-	-	28	34521	-	-	-	-	-	-	-	-	-	-	28	34521
Karauli	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sikar	2	43	5	-	-	-	-	48	37210	2	-	-	-	-	-	2	2166	-	-	50	39376
Telangana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Khammam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

++ Negligible, Only labour reported, ( ) : No. of mines reported as associated mineral.*

Table – 5 (B) : Production of Iron Ore, 2021-22

(Quantity in '000 tonnes; Value in ₹'000)

State/ District	No. of mines	Lumps								Fines								Concentrates		Total	
		Below 55% Fe	55%- below 58% Fe	58%- below 60% Fe	60%- below 62% Fe	62%- below 65% Fe	65% Fe & above	Total Qty	Total Value	Below 55% Fe	55%- below 58% Fe	58%- below 60% Fe	60%- below 62% Fe	62%- below 65% Fe	65% Fe & above	Total Qty	Total Value	Qty	Value	Qty	Value
India	**280(9)**	**3736**	**1981**	**6062**	**9278**	**24757**	**16103**	**61917**	**198763643**	**11453**	**17969**	**12899**	**30149**	**48813**	**20651**	**141934**	**323013422**	**1190**	**5515404**	**205041**	**527292469**
Public Sector	43	82	154	327	3265	13696	9089	26613	95841017	209	1114	1769	17089	22484	6606	49271	127727896	-	-	75884	223568913
Private Sector	237(9)	3654	1827	5735	6013	11061	7014	35304	102922626	11244	16855	11130	13060	26329	14045	92663	195285526	1190	5515404	129157	303723556
Andhra Pradesh	**14**	**206**	**7**	**-**	**-**	**-**	**-**	**213**	**181601**	**136**	**-**	**-**	**-**	**-**	**-**	**136**	**78632**	**-**	**-**	**349**	**260233**
Anantapur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuddapah	3	200	7	-	-	-	-	207	176226	134	-	-	-	-	-	134	77439	-	-	341	253665
Krishna	1	-	-	-	-	-	-	-	-	++	-	-	-	-	-	++	252	-	-	++	252
Kurnool	9	6	-	-	-	-	-	6	5375	2	-	-	-	-	-	2	941	-	-	8	6316
Nellore	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Prakasam	1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chhattisgarh	**21**	**185**	**378**	**157**	**707**	**2581**	**8702**	**12710**	**52033594**	**744**	**650**	**716**	**3808**	**11320**	**6891**	**24129**	**80167722**	**-**	**-**	**36839**	**132201316**
Dantewara	7	-	-	24	4	21	8667	8716	46782648	-	20	119	1114	9805	6101	17159	70717226	-	-	25875	117499874
Durg	4	29	61	62	565	2501	34	3252	4356798	23	35	-	2115	1515	104	3792	5045162	-	-	7044	9401960
Kanker	6	96	252	53	136	59	1	597	682315	696	530	576	573	-	686	3061	4232182	-	-	3658	4914497
Narayanpur	2	-	-	-	-	-	-	-	196	-	-	-	-	-	-	-	-	-	-	-	196
Rajnandgaon	2	60	65	18	2	-	-	145	211637	25	65	21	6	-	-	117	173152	-	-	262	384789
Goa	**40**	**280**	**47**	**2**	**1**	**1**	**-**	**331**	**333817**	**537**	**99**	**33**	**1**	**2**	**-**	**672**	**563920**	**-**	**-**	**1003**	**897737**
North Goa	14	160	7	2	1	1	-	171	132452	320	29	33	1	2	-	385	315956	-	-	556	448408
South Goa	26	120	40	-	-	-	-	160	201365	217	70	-	-	-	-	287	247964	-	-	447	449329
Jharkhand	**17**	**7**	**5**	**466**	**1560**	**2109**	**680**	**4827**	**7279890**	**107**	**503**	**652**	**5798**	**6888**	**2659**	**16607**	**21240509**	**-**	**-**	**21434**	**28520399**
Singhbhum (West)	17	7	5	466	1560	2109	680	4827	7279890	107	503	652	5798	6888	2659	16607	21240509	-	-	21434	28520399
Karnataka	**65**	**1397**	**918**	**1708**	**1460**	**4314**	**311**	**10108**	**36892352**	**3292**	**5030**	**6452**	**3244**	**5667**	**707**	**24392**	**57498508**	**-**	**-**	**34500**	**94390860**
Bagalkot	3	99	-	-	-	-	-	99	258920	16	-	-	-	-	-	16	16317	-	-	115	275237
Bellary	56	1208	794	1076	1143	4063	311	8595	30054199	2912	2673	3493	3244	5667	707	18696	46949052	-	-	27291	77003251
Chitradurga	6	90	124	632	317	251	-	1414	6579233	364	2357	2959	-	-	-	5680	10533139	-	-	7094	17112372

(Quantity in '000 tonnes; Value in ₹'000)

State/ District	Lumps									Fines								Concentrates		Total	
	No. of mines	Below 55% Fe	55%- below 58%	58%- below 60%	60%- below 62%	62%- below 65%	65% Fe & above	Total		Below 55% Fe	55%- below 58%	58%- below 60%	60%- below 62%	62%- below 65%	65% Fe & above	Total					
								Qty	Value							Qty	Value	Qty	Value	Qty	Value
Tumkur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madhya Pradesh	**21(8)**	**841**	**18**	**-**	**-**	**-**	**-**	**859**	**463231**	**3125**	**110**	**-**	**-**	**-**	**-**	**3235**	**1683140**	**++**	**499**	**4094**	**2146870**
Chhatarpur	1	61	15	-	-	-	-	76	34250	18	-	-	-	-	-	18	8033	-	-	94	42283
Jabalpur	18(8)	772	-	-	-	-	-	772	417143	2864	110	-	-	-	-	2974	1571965	++	499	3746	1989607
Gwalior	1	-	-	-	-	-	-	-	-	232	-	-	-	-	-	232	92969	-	-	232	92969
Sagar	1	8	3	-	-	-	-	11	11838	11	-	-	-	-	-	11	10173	-	-	22	22011
Maharashtra	**11**	**52**	**17**	**44**	**-**	**-**	**-**	**113**	**253928**	**808**	**91**	**237**	**-**	**-**	**-**	**1136**	**1478938**	**-**	**-**	**1249**	**1732866**
Chandrapur	1	-	-	5	-	-	-	5	4587	18	2	3	-	-	-	23	21103	-	-	28	25690
Gadchiroli	1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gondia	3	10	-	-	-	-	-	10	19551	12	-	-	-	-	-	12	6077	-	-	22	25628
Kolhapur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sindhudurg	6	42	17	39	-	-	-	98	229790	778	89	234	-	-	-	1101	1451758	-	-	1199	1681548
Odisha	**82(1)**	**714**	**588**	**3685**	**5550**	**15752**	**6410**	**32699**	**101296238**	**2703**	**11486**	**4809**	**17298**	**24936**	**10394**	**71626**	**160300893**	**160**	**438239**	**104485**	**262035370**
Keonjhar	48	459	207	1608	2116	9712	6103	20205	53656219	693	3458	3828	11956	14603	10390	44928	87436831	-	-	65133	141093050
Mayurbhanj	5	40	29	193	-	64	3	329	1078774	290	9	-	1	27	-	327	309767	-	-	656	1388541
Sundargarh	29(1)	215	352	1884	3434	5976	304	12165	46561245	1720	8019	981	5341	10306	4	26371	72554295	160	438239	38696	119553779
Rajasthan	**9**	**54**	**3**	**-**	**-**	**-**	**-**	**57**	**28992**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1160**	**1030**	**5076666**	**1088**	**5106818**
Bhilwara	2*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1030	5076666	1030	5076666
Jaipur	3	9	-	-	-	-	-	9	2746	-	-	-	-	-	-	-	-	-	-	9	2746
Jhunjhunu	1	11	-	-	-	-	-	11	5616	-	-	-	-	-	-	-	-	-	-	11	5616
Karauli	1*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sikar	2	34	3	-	-	-	-	37	20630	1	-	-	-	-	-	1	1160	-	-	38	21790
Telangana	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Khammam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Warangal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table – 6 : Production of Iron Ore, 2020-21 and 2021-22 (P)

(By Frequency Groups)

Production Group (In tonnes)	No. of mines		Production (In '000 tonnes)		Percentage in total production		Cumulative percentage	
	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)	22020-21	2021-22 (P)
Total	**280(9)**	**245(10)**	**205041**	**253973**	**100**	**100**	**-**	**-**
Up to 50,000	150(7)	109(8)	734	713	0.36	0.28	0.36	0.28
50,001 - 100,000	15	18	1089	1395	0.53	0.55	0.89	0.83
100,001 - 500,000	48(2)	38(2)	11855	9934	5.78	3.91	6.67	4.74
500,001 - 1,000,000	14	19	10040	14498	4.9	5.71	11.57	10.45
1,000,001 -1,500,000	15	16	18492	19613	9.02	7.72	20.59	18.17
1,500,001 - 2,000,000	4	7	6887	12420	3.36	4.89	23.95	23.06
2,000,001 and above	34	38	155944	195400	76.05	76.94	100	100

( ) : No. of mines reported as associated mineral

Table –7 (A) : Mine-head Closing Stocks of Iron Ore, 2020-21

(By States/Grades)

(In '000 tonnes)

State	Lumps							Fines								
	Below 55% Fe	55%- below 58% Fe	58%- below 60% Fe	60%- below 62% Fe	62%- below 65% Fe	65% Fe & above	Total	Below 55% Fe	55%- below 58% Fe	58%- below 60% Fe	60%- below 62% Fe	62%- below 65% Fe	65% Fe & above	Total	Concentrates Total Qty	Total Lumps, & Concen-trate Qty
India	**7508**	**1237**	**2738**	**2466**	**6027**	**2136**	**22112**	**21498**	**45166**	**6072**	**10945**	**12302**	**2762**	**98745**	**313**	**121170**
Andhra Pradesh	481	13	-	++	-	-	494	1092	-	-	1	-	-	1093	-	1587
Chhattisgarh	54	33	103	7	73	670	940	194	65	13	734	941	1090	3037	-	3977
Goa	27	148	11	++	1		187	221	62	++	++	++	-	283	**6**	**476**
Jharkhand	351	408	132	270	257	151	1569	1342	36962	862	1010	1852	119	42147	-	43716
Karnataka	4580	273	586	331	991	100	6861	1950	875	898	591	951	37	5302	-	12163
Madhya Pradesh	845	6	10	17	-	-	878	2777	10	++	-	-	-	2787	++	3665
Maharashtra	56	5	10	1	++	-	72	367	62	8	-	-	-	437	-	509
Odisha	906	351	1886	1840	4705	1215	10903	13542	7130	4291	8609	8558	1516	43646	297	54846

(in '000 tonnes)

State/ District	Lumps									Fines											
	No. of mines	Below 55% Fe	55%- below 58%	58%- below 60%	60%- below 62%	62%- below 65%	65% Fe & above	Total		Below 55% Fe	55%- below 58%	58%- below 60%	60%- below 62%	62%- below 65%	65% Fe & above	Total		Concentrates		Total	
								Qty	Value							Qty	Value	Qty	Value	Qty	Value
Rajasthan		208	++		-	-	-		-	208	13	-		-	-	-	-		13	10	231
Telangana		++	-		-	-	-		-	++	-	-		-	-	-	-		-	-	++

Negligible

Table – 7 (B) : Mine-head Closing Stocks of Iron Ore, 2021-22 (P)

(By States/Grades)

(In '000 tonnes)

State	Lumps							Fines								
	Below 55% Fe	55%- below 58%	58%- below 60%	60%- below 62%	62%- below 65%	65% Fe & above	Total	Below 55% Fe	55%- below 58%	58%- below 60%	60%- below 62%	62%- below 65%	65% Fe & above	Total	Concentrates Total	Total Lumps, & Concen-trate
		Fe	Fe	Fe	Fe				Fe	Fe	Fe	Fe				
India	**8406**	**1737**	**4795**	**3463**	**7124**	**2225**	**27750**	**17802**	**41885**	**4725**	**12665**	**12534**	**1741**	**91352**	**86**	**119188**
Andhra Pradesh	487	6	-	++	-	-	493	1102	-	-	1	-	-	1103	-	1596
Chhattisgarh	3	27	152	14	132	643	971	151	288	19	366	1619	815	3258	-	**4229**
Goa	27	148	11	++	1	-	187	216	62	++	++	++	-	278	5	470
Jharkhand	358	439	118	230	276	85	1506	1337	37560	1323	912	1761	126	43019	-	44525
Karnataka	5201	366	571	557	931	201	7827	2252	734	691	701	1160	113	5651	-	13478
Madhya Pradesh	632	25	10	17	-	-	684	3051	22	4	1	-	-	3078	++	3762
Maharashtra	94	26	13	17	164	-	314	710	66	16	160	57	-	1009	-	1323
Odisha	1321	700	3920	2628	5620	1296	15485	8968	3153	2672	10524	7937	687	33941	70	49496
Rajasthan	283	++	-	-	-	-	283	15	-	-	-	-	-	15	11	309
Telangana	++	-	-	-	-	-	++	-	-	-	-	-	-	-	-	++

++ Negligible , # : under reference

EMPLOYMENT

The average daily employment of labour was 47,063 during 2021-22 as against 42,422 in the preceding year.

MINING, MARKETING & TRANSPORT

Iron ore mining is carried out by opencast method through manual, semi-mechanised and mechanised operations.

The method of mining and deployment of machinery vary from place to place depending upon characteristics of iron ore as per geological set up. Large mechanised mines are mostly in the Public Sector. Manual and semi-mechanised mines are mainly in Private Sector. Some mechanised mines in Jharkhand and Odisha are also operated by the Private Sector.

Manual Mines

Generally, these mines are confined to float ores where mining is done by digging the ore with pick axes, crow bars, chisels and spades. The mined material is screened manually to separate +10 mm float ore which is then stacked separately. The waste is backfilled into the pits. In some reef workings, 35 – 40 mm diameter holes are drilled to 0.6 m depth by hand-held jackhammers at a spacing of about 0.6 m and each hole is charged with 150 –200 g gunpowder or special gelatine cartridges. Blasted tonnage per kg gunpowder is usually 2.5 – 3 tonnes. Blasted ore is manually loaded into trucks for transport to either railway sidings or to buyer's destination directly.

Mechanised Mines

Most of the mechanised mines are captive belongings of different steel plants and have been developed to cater to specific requirements. Mining is done by formation of systematic benches in overburden and ore. The height of the benches normally varies from 10 to 12 m and width up to 20 m in the ore. Drilling holes of 300 mm diameter and till 12 m depth by crawler drills and use of explosives, such as, ANFO, SMS and emulsion explosives for blasting are in practice. Loading is done by earth-moving machinery powered by diesel or electric engines, such as, hydraulic excavators in the range from 1.9 cu. m to 10 cu. m. Ripper dozers and motor graders are also deployed for excavation and levelling purposes.

Mines , where ore is predominantly in powdery form, hydraulic shovels with boom height of around 9 m may be used for excavation and loading. Heavy-duty Ripper-Dozers are preferred for such mining as the ores are soft. Height of the benches is restricted to 7 m for safe and efficient operations. Width of working benches is maintained at more than 15 m and bench slope is maintained at about 80°. The ore produced is transported to short distances by dumpers up to 40 tonnes capacity. For longer distances and barge loading, dumpers/trucks up to 10 tonnes capacity are used. The barges carry the ore to harbours. The ore from the barges is loaded on to ships either through berth or through transshippers.

Almost all the Public Sector mines including Kiriburu, Barsua, Gua, Bailadila, Donimalai, Daitari and Dalli-Rajhara operated by SAIL, NMDC and OMC are fully mechanised. In Private Sector, most of the captive mines are mechanised. Approximately, 90% iron ore production comes from mechanised mines. NMDC operates a couple of large mechanised iron ore mines in the country at Bailadila (Chhattisgarh) and Donimalai (Karnataka). The Company has three highly- mechanised iron ore mine complexes. Two are located in Chhattisgarh and one in Karnataka.

The processing of iron ore in the country involves crushing, screening, washing and in some cases beneficiation and agglomeration. Crushing and screening are adopted mainly for sizing the ore and also for removing the adherent gangue minerals. Dry and wet grinding is also resorted to in some cases.

The lumps and fines of iron ore are marketed after screening and beneficiation. Fines are converted into sinters for use in steel plants while pellets made from concentrates/fines are exported and also are utilised for internal consumption in domestic iron & steel industries.

ENVIRONMENTAL FACTORS

Afforestation, waste dump management, top soil management, management of sub- grade minerals, mechanical beneficiation, dust suppression, monitoring of water & air quality, vibration survey, publicity and propaganda are some common environmental restoration efforts pursued by all mechanised and semi-mechanised iron ore mines. Mining and beneficiation of ores carried out on large-scale cause environmental problems. A specific problem in iron ore mining is the disposal of tailings and other deleterious silica minerals and phosphorous. To safeguard the environment and prevent ecological degradation, thrust has been laid on green belt development, solid waste management, monitoring of liquid & air effluents and other crucial environmental parameters.

Goa region is prone to siltation of agricultural fields, nallahs, riverbeds and creeks due to wash off from iron ore dumps in rainy season. Loss in crop yield and reduction in fish population in streams and navigation difficulties are the problems caused by silting. To overcome these problems, check dams and water filter beds at higher contours have been constructed. Tailing ponds are also being maintained at some mines. Afforestation is the mainstay in reclaiming the mined out areas in Goa. In a few cases, pits are used as water reservoir for pisciculture. But, in early 2018, the apex court had quashed 88 mining leases for violation of mining procedures and asked the State Government of Goa to issue fresh leases instead of renewing existing ones. In February 2021, it will be three years since India's Apex Court stopped iron ore mining in Goa.

In Ballari-Hosapete area, Karnataka, dust concentration (suspended particulate matter) is the main environmental problem. In Bailadila Sector, Chhattisgarh, forest is fairly widespread and dense, supported by good rainfall and rich flora and fauna. The deforestation taking place due to mining and waste dumping needs to be compensated continuously by afforestation at suitable slopes and in township areas. In Jharkhand, afforestation of land is the main recourse adopted for reclamation of degraded lands or improvement in land uses.

INDUSTRY

Iron ore is the basic raw material used for making pig iron, sponge iron and finished steel. The iron ore is used mainly in blast furnaces, mini- blast furnaces (MBF), DRI & sintering and pelletisation plants.

Pelletisation

In general, the pelletisation process involves mixing of iron ore and required limestone with water which later is ground in ball mills to the desired size. The discharged slurry from ball mills is filtered in pressure filters. The filter cake from filters is then mixed with dry-ground coke fines to which bentonite is mixed in suitable proportion to form green pellets in pelletising discs. The coke fines and bentonite are ground separately. The green pellets are then dried, heated and fired in indurating machine to produce iron ore pellets. There is an increasing trend for utilisation of pellets or sinters in the recent years. The use of pellets as feed in the blast furnace has several advantages because of their uniform size, known composition and strength. Iron ore pellet is a kind of agglomerated fines which has better tumbling index as compared to that of parent ore and can be used as a substitute used in blast furnaces in countries where lump ore is not available.

As per the Pellet Manufacturers Association of India the fifty-one pelletisation plants in the country about which information is available, have a total capacity of 136.7 million tonnes per annum. The JSW Steel Ltd has a manufacturing capacity of 17.20 million tonnes of pellets annually at Vijayanagar, Bellary, Karnataka. Amba River Coke Limited, a wholly owned subsidiary Company of JSW Steel, has set up a 12.0 million tpy pellet plant (Dolvi unit 1 and 2) at Dolvi. The pellets produced are primarily supplied to the Dolvi unit of the company. During the year 2021-22, all India production of pellets as per the Pel let Manufacturers Association of India was 77.27 million tonnes.

With a strong belief in prudent forward and backward integrations, JSPL established India's largest 10 MTPA Pelletisation Complex at Barbil, Odisha. The plant includes dry grinding facility that harnesses recuperation type of straight grate technology. The Company's Barbil Plant is India's largest single- location pellet manufacturing facility with 4.5 MTPA Dry Grinding Unit and a 4.5 MTPA Wet Grinding Unit. JSPL pellet plant helps to process low-cost iron ore fines as against expensive lumps , there by handing a cost advantage. Laced with state-of-the art technology backed with proximity to iron-ore access, JSPL's Barbil Plant has emerged as India's largest pellet exporter in recent years.

Arcelor Mittal Nippon Steel India, i.e. , ('AM/ NS India'), (formerly known as Essar Steel was acquired jointly by Arcelor Mittal and Nippon Steel in December 2019) has 8 MTPA iron ore pellet plant in Visakhapatnam, Andhra Pradesh, to cater to the pellet requirements of the HBI plant in Hazira, Gujarat. The plant has an assured supply of high-quality iron ore from the beneficiation plant at Bailadila, Chhattisgarh. The plant is capable of producing both DR and BF grade pellets and is linked to the Visakhapatnam port through conveyors to enable easy material movement in and out of the plant. The plant is located strategically near a deep draft, all-weather port that ensures the movement of large vessels to supply pellets throughout the year to the Hazira steel-making facility. A 6 million tpy pellet plant is located at Paradip in the iron-ore-rich State of Odisha. The plant has an assured supply of high- quality iron ore from the beneficiation plant at Dabuna, Odisha. The Paradip Pellet plant is likely to add another 6 million tpy to its capacity the work towards which is under completion. After completion of this plant AM/NS India's total pelletisation capacity at Paradip would get augmented to 12 million tpy and supported by a 20-million-tonnes pellet-making capability, the Company is on its way to become the largest pellet producer in India.

NMDC has forayed in pellet-making through setting up of a 1.2 MTPA pellet plant at Donimalai. Another 2 MTPA pellet plant is in the process of being set up at Nagarnar, Chhattisgarh.

KIOCL is currently engaged in the business of manufacturing and selling of iron ore pellets. The state-of-the-art pelletisation plant with 3.5 million tpy rated capacity and 0.216 million tpy Blast Furnace Unit is located at Mangaluru. During the year 2019-20, KIOCL Ltd achieved production of 2.210 million tonnes of pellets.

Steel plants are likely to increase usage of pellets in their production process to reduce pollution and increase productivity. Moreover, the forecast of spike in growth in Infrastructure, Real Estate and Automobile Sectors in the ensuing years are expected to augment demand for steel, which in turn would raise the demand and prices of pellets in the near future.

Sintering

In sintering process, iron ore fines, other iron-bearing wastes and coke dust are blended and combusted. The heat fuses the fines into course lumps that can be charged to a blast furnace. There are about thirty-nine sintering plants in the country about which information is available and have a total capacity of about 96.131 million tonnes per annum. Most of the Integrated Steel Plants (ISP) in the country have their own sintering plants. Sinter plants receive raw material mostly from their captive mines. Information on Name Location and installed capacity of pellets and sintering plants are provided in Table-8.

Table – 8 :Name, location and Installed Capacity of Pellets and Sinters Plants

(By Plants)

(In million tonnes)

Name & location of plant	Annual installed capacity
A) Pellet Plants	
1. Amba River Coke Ltd, (A wholly owned subsdiary co. of JSW Steel Ltd), Dolvi, Maharashtra	12
2. Atibir Industries Co. Ltd. Unit-II, Bhorandiha, Jharkhand	0.3
3. Ardent Steel Ltd, Phulj Keonjhar, Odisha	0.8
4. Arya Iron and Steel Company (AISCO) Barbil, Odisha	1.2
5. Pellet Sponge Iron Plant BMM Ispat, Karnataka	2.4
6. Arcelor Mittal Nippon Steel India, Visakhapatnam, Andhra Pradesh	8
7. Arcelor Mittal Nippon, Steel India, Paradip Port,Odisha.	12
8. Godawari Power & Ispat Ltd Siltara, Chhattisgarh	2.7
9. Jindal Steel & Power Ltd, Barbil, Odisha	10
10. Jindal Saw Ltd, Bhilwara, Rajasthan	1.5
11. JSW Steel Ltd, Tornagallu, Toranagally, Ballariy, Karnataka	17.2
12. Jayaswal Neco Industries Ltd, Siltara, Raipur, Chhattisgarh	1.5
13. KIOCL Ltd, Panambur, Mangaluru, Karnataka	3.5
14. Mandovi Pellets Ltd, Near Borim Bridge, Shiroda, Goa – 403 103	1.8
15. Minera Steel & power Private Ltd, Ballari, Karnataka	0.6
16. MSP Steel & Power Ltd, Raigarh, Chhattisgarh	0.9
17. NMDC Ltd, Donimalai, Karnataka.	1.2
18. Orissa Metalics Private Ltd, Paschim Mednapore, West Bengal	3.6
19. Rashmi Metaliks Ltd, Shyamraipur, Gokulpur, West Midnapore, West Bengal	1.2
20. Sarda Energy and Minerals Ltd, Siltara, Mandhar, Raipur, Chhattisgarh	0.8
21. Shri Bajarang Power & Ispat Ltd, Borjhara, Tilda & Gondwara, Raipur, Chhattisgarh	1.4
22. Tata Steel Limited, Jamshedpur, East singbhum, Jharkhand	8
23. Xindia Steels Ltd, Kunikere & Hirebaganal Ginigera, Koppal, Karnataka	0.8
24. Bhushan Power & Steel Ltd Sambalpur, Odisha	3.85
25. Shyam Metalics And Energy Ltd Sambalpur, Sambalpur, Odisha	3
26. MSP Metallics Ltd, Jharsuguda, Odisha	0.6
27. River Pellets Limited, jaipur, Odisha	4
28. Sree Metaliks Ltd-Keonjhar keonjhar, Odisha	0.6

Name & location of plant	Annual installed capacity
29. MSP Sponge Iron Ltd, Keonjhar, Odisha	0.75
30. Rungta Mines, kamanda, Sundergarh, Odisha	3
31. Essel Mining & Industries Lyd. Keonjhar, Odisha	1
32. Shri Jagannath Steels&Power Ltd (KJS Group), Keonjhar, Odisha	1.2
33. Shri Mahavir Ferro Alloys Ltd. Sundergarh, Odisha	1.6
34. MSPL Limited, Koppal, Karnataka	1.2
35. Janki Corpora?on Ltd Bellary, Karnataka	0.6
36. Rashmi Udyog Private Ltd (Rashmi Group), Paschim Midnapur, West Bengal	1.2
37. Orissa Alloy Steel Pvt. Ltd. (Rashmi Group), Kharagpur, West Bengal	3
38. Shakambhari steel, Purulia, West Bengal	2
39. Super Smelters Sponge P Ltd, Jamuria, Paschim Bardhman West Bengal	1.2
40. Bravo Sponge Iron P Ltd Purulia, West Bengal	0.85
41. Shyam Sel And Power Ltd (Jamuria), Paschim Bardhman, West Bengal	3
42. Ankit Metal And Power Ltd. Bankura, West Bengal	0.6
43. Tata Sponge Iron Ltd Main Plant-1& 2, Gamharia, Jharkhand	1.2

Name & location of plant	Annual installed capacity
44. Rungta Mines, Chaliyama, Saraikela Jharkhand	3
45. Amalgam Steel Private Limited (Formerly Adhunik Alloys), Saraikela\ Jharkhand	1.2
46. JSW Ispat Special Products Ltd. (Raigarh), Raigarh, Chhattisgarh	2.2
47. Raipur Power & Steel Durg, Durg, Chhattisgarh	0.6
48. Rashi Steel And Power Ltd, Bilaspur, Chhattisgarh\	0.4
49. Sal Steel Ltd (Shah Alloys Ltd), Gandhinagar, Gujarat	0.6
50. Vinayak Steels Ltd, Mehboobnagar, Telangana	0.07
51. Gullantt Ispat Ltd, Gorakhpur, Uttar Pradesh	0.79
B) Sintering Plant	
1. Atibir Industries Co. Ltd. Unit-II, Bhorandiha, Jharkhand	680
2.Bokaro Steel Plant, Jharkhand	6900
3.Bhilai Steel Plant, Bhilai, Durg, Chhattisgarh.	6334
4.Bhushan Steel Ltd, Dhenkanal, Odisha	6680
5.Durgapur Steel Plant, West Bengal	3009
6.Electrosteel Casting Ltd Khardah, Barrackpore, West Bengal	365
7.Electrosteels Ltd, Siyaljori, Jharkhand	2980

Name & location of plant	Annual installed capacity
8.Gerdau Steel India Ltd, Tadipatri, Anantpur, A.P.	470
9.IISCO Steel Plant, SAIL Burnpur, West Bengal	3880
10.Jayaswal Necco Industries Ltd, Siltara Growth Centre, Raipur-493 221, Chhattisgarh	729
11.Jindal Steel & Power Ltd, Raigarh, Chhattisgarh	2300
12.Jindal Saw Ltd, Mundra, Gujarat	900
13.JSW Steel Ltd, Tornagallu, Toranagallu, Ballari, Karnataka	12950
14.JSW Steel Ltd, Dolvi Works, Raigad, Maharashtra	5400
15.JSW Steel Ltd Salem works, Mkalipatti, Metturdam, Tamil Nadu	1106
16.Jai Balaji Industries Banskopa, West Bengal	608
17.Kalyanigerdua Steels Ltd, formerly sjk steel plant, Jambulapadu, Tadipatri, Andhra Pradesh	500
18.Kirloskar Ferrous Industries Ltd, Bevinahalli, Koppal, Karnataka.	500
19.KIC Metaliks Ltd, Raturia, Angadpur, Durgapur. West Bengal	336
20.Monnet Ispat and Energy Raigarh, Chhattisgarh	962.3
21.Mukund Ltd, M/s Hospet Steel Ltd, Ginigera, Koppal, Karnataka	500

Name & location of plant	Annual installed capacity
22.Neometaliks Ltd, Gopalpur, Durgapur, West Bengal	316
23.Neelachal Ispat Nigam Ltd, Kalinga Nagar, Industrial Complex, Duburi-755 026, Distt Jajpur, Odisha.	1710
24.Rashmi Metaliks Ltd, Shyamraipur, Gokulpur, West Midnapore, West Bengal.	1440
25.RINL, Visakhapatnam Steel Plant No. -1& 2 , Visakhapatnam, Andhra Pradesh	5256
26.RINL, Visakhapatnam Steel Plant No. -3, Andhra Pradesh	3600
27.Rourkela Steel Plant, Odisha	5300
28.SBQ Steel Ltd, Gudur, Nellore, Andhra Pradesh	240
29. Sri Kalahasthi Pipes Ltd, Chitoor, Andhra Pradesh	500
30.SLR Metaliks Ltd, Ballari, Karnataka	350
31.Sesa Goa Ltd, Vedanta Ltd, North Goa	1000
32.Sunflag Iron & Steel Co. Ltd, Warrthy, Bhandara, Maharashtra	450
33.Tata Steel Ltd, Jamshedpur, Jharkhand	8000
34.Tata Metaliks Ltd, Kharagpur, West Bengal	528
35.Tata Steel Ltd,	5750

Name & location of plant	Annual installed capacity
Kalingnagar, Odisha	
36.Usha Martin Ltd (Usha Alloys and Steel Division), Jamshedpur.	715
37.Uttam Galva, Metallics Ltd, Wardha, Maharashtra	887
38.Vedanata Ltd. Amona, Goa	1000
39.Value Added business, Amona, Goa	1000

Pig Iron

Pig iron is one of the basic raw materials required by Foundry and Casting Industry for manufacturing various types of castings for the engineering section. The post-liberalisation regime has witnessed Expression of Interest from a large number of entrepreneurs for setting up mini-blast furnaces for production of hot metal/pig iron. Commissioned pig iron units are mostly of stand-alone type.

The production of pig iron has increased from 1.6 million tonnes in 1991-92 to 5.76 million tonnes in 2021-22. The Private Sector accounted for 89% of the total production of pig iron (5.76 MT) in the country in 2020-21. As per National Steel Policy 2017, the demand for pig iron for merchant use, such as, for castings and supplementary metallic in the electric arc or induction furnaces is projected to increase to 17 million tonnes by 2030- 31.

Sponge iron

India is the world's largest producer of sponge iron or Direct Induced Iron (DRI) with a host of coal-based units located in the mineral-rich States of the country. Over the years, the coal-based route has emerged as a key contributor and accounted for 77% of the total sponge iron production in the country during 2021-22. The growth of Sponge Iron Industry during the last few years in terms of capacity has been substantial. The installed capacity of sponge iron increased from 1.52 million tonnes per annum in 1990-91 to around 47.85 million tonnes in 2019-2020. Production increased from 0.9 million tonnes in 1990-91 to 39.03 million tonnes in 2021-22. As per National Steel Policy 2017, the demand for sponge iron is projected to increase to 80 million tonnes by 2030-31. It is projected that the sponge iron capacity may increase to 114 million tonnes by 2030-31 with around 30% share of gas-based capacities on account of increased environmental considerations and long-term availability of gas.

Sponge iron is a good substitute for scrap which is required by the electric arc furnaces and induction furnaces or mini-steel plants in the country. The availability of indigenous metal scrap is scarce, and therefore, to meet the domestic demand, scrap is usually imported. Sponge iron is a viable alternative for scrap and is produced by direct reduction of high-grade iron ore or pellets to metallic iron ore in solid state by using coal or natural gas as reductant. It is also known as Direct Reduced Iron (DRI) or Hot Briquetted Iron (HBI).

Iron & Steel

The details of the Iron & Steel Industry are provided in the Review on "Iron, Steel & Scrap and Slag".

Ferroalloys

Iron is an important constituent of ferro-alloys, like ferromanganese (high carbon, medium carbon and low carbon), ferrosilicon, ferrochrome (high carbon and low carbon)/charge chrome, ferromolybdenum, ferrovanadium, ferrotungsten, ferro- silicon- magnesium, ferroaluminium, ferro-silicon-zirconium, ferrotitanium, etc. Ferroalloys are used in Steel Industries to impart some special qualities in steel making process.They are consumed in domestic industries and are also exported. The details about the Ferroalloys Industry are provided in the Review on 'Ferroalloys'.

Cement

Iron ore lumps and powder containing +58% Fe are normally used in the Cement Industry as they improve burning properties, impart colour and balance the composition of the mix. Further details about the Cement Industry are provided in the Review on 'Cement'.

USES & SPECIFICATIONS

Iron ore is mainly used for manufacturing pig iron, sponge iron and steel. It is also used in Cement, Coal Washeries, Ferroalloys, Foundry and Glass Industries. The specifications of iron ore consumed by major sponge iron plants are furnished in Table-9.

CONSUMPTION

In 2021-22the apparent consumption of iron ore was about 236 million tonnes, as against 174 million tonnes in the previous your. Plantwise specifications of iron ore in steel plants has been furnished in Table- 10 and Apparent Consumption of iron ore from 2019- 20 to 2021-22 has been provided in Table-11.

Table - 9 : Specifications of Iron Ore Consumed by Major Sponge Iron Plants

Sl. No.	Name of the Plant	Specifications				
		Size	Fe	Al_2O_3 + SiO_2	P	S
1	Orissa Sponge Iron Plant	5– 18 mm	65% min.	4.5% max.	0.03% max.	N. A.
2	Welspun Max Steel Ltd	9– 16 mm	66%	2.6% max.	0.05%	0.01%
3	Sunflag Iron & Steel Ltd	5– 20 mm	67.50%	–	–	–
4	NMDC Ltd (Sponge iron unit)	6– 20 mm	55–58% &	–	–	–
					64–66%	
5	Essar Steel Ltd	10– 40 mm	67%	2.60% max.	0.05%	0.01%
6	Jindal Steel & Power Ltd	10– 30 mm	65% min.	3% max. (SiO_2)	0.05%	–
7	Tata Sponge Iron Ltd	5– 18 mm	65% min.	5% max.	–	–
8	Steel Exchange India Ltd	10– 40 mm	62%	–	–	–
9	Sarda Energy & Minerals Ltd	5– 18 mm	65–66%	–	–	–
10	OCL Iron & Steel Ltd	Sized	62% min.	–	–	–
11	Nalwa Steel & Power Ltd	5– 20 mm	63% min.	–	–	–
12	Shri Bajrang Power & Ispat Ltd	5– 18 mm	64% min.	–	–	–
13	Jai Balaji Industries Ltd	5– 18 mm	65%	5%	0.05%	0.03%
		10– 30 mm	–	–	–	–
		10-150 mm	–	–	–	–

Table – 10 : Specifications of Iron ore

(By Steel Plants)

Steel plant	Specifications
Bokaro Steel Plant, Bokaro, Jharkhand	Lumps: Fe-63.40%, SiO_2:2.25%, Al_2O_3 2.39%, Size: 10-40 mm Fines: Fe - 62.24%, SiO_2 - 3.36%, Al_2O_3 - 3.45%
Durgapur Steel Plant, Durgapur, West Bengal	Lumps : Fe - 62.48%, Al_2O_3 - 2.42% Size: 10-50 mm Fines: Fe - 62.8%, SiO_2 - 2.28%, Size : -10 mm
IISCO Steel Plant, Burnpur, West Bengal	Lumps: Fe - 62.86%, SiO_2 - 2.56%, Al2O3 - 2.56% (max.), Size : -10-40 mm
Bhilai Steel Plant, Chhattisgarh	-
Rourkela Steel Plant SAIL, Rourkela,Odisha	-
JSW Steel Ltd Dolvi Works Raigad, Maharashtra.	-
JSW Steel Ltd Tornagallu, Sandur, Ballari Karnataka	-
JSW Steel Ltd Salem works, Mkalipatti, Metturdam, Tamil Nadu	-
Tata Steel Limited, Jamshedpur	-
RINL Vishakhapatnam Steel Plant, Andhra Pradesh	Lumps : Fe 65.5 % min. SiO_2 2.25 % max., Al_2O_3 2.25 % max. Fines : Fe 64.5 % min. SiO_2 3.00 % max. Al_2O_3 3.00 % max.

Table -11 Apparent Consumption* of Iron Ore 2019-20 to 2021-22

(By Industries)

('000 tonnes)

Industry	2019-20	2020-21 (R)	2021-22 (P)
Production	**244083**	**205041**	**253973**
Imports	1245	766	6683
Opening stocks*	163121	146718	121170
Exports	36625	57723	26494
Closing stocks	146178	121170	119188
Apparent consumption 1+2+3- 4+5	**225646**	**173632**	**236144**

Figures rounded off

** Closing stocks of Preceding year*

TRADE POLICY

To ensure easy availability of raw material in domestic market at reasonable prices, export duty on iron ore is @ 30% for both lumps and fines varieties of 58% Fe content and above. The export duty is @ 0% for both lumps and fines varieties of iron ore less than 58% Fe content. The export duty on iron ore pellets is NIL. Export duty on iron ore originated from NMDC is @ 10% when exported by MMTC Ltd under LTA to Japan and South Korea.

As per the Foreign Trade Policy (FTP) for 2015-20 and the amended Export and Import Policy incorporated in the FTP, the present export policy for iron ore as construed is furnished below in brief. As per the policy, imports of iron ore lumps, fines, concentrates and agglomerated pellets are freely allowed.

HS Code	Item	Export Policy
2601	Iron ore and concentrates, including roasted iron pyrites	Free
260111	Iron ore and concentrates, other than roasted iron pyrites: Non- agglomerated	Free
26011111	60% Fe or more but below 62% Fe	Free
26011112	62% Fe or more but below 65% Fe	Free
26011119	65% Fe and above	Free
26011121	Iron ore lumps (below 60% Fe, including black iron ore containing up to 10 % Mn)–Iron Ore lumps below 55% Fe	Free
26011122	Iron ore lumps (below 60% Fe, including black iron ore containing up to 10 % Mn) – Iron Ore lumps 55% Fe or more but below 58% Fe	Free
2601112 9	Iron ore lumps (below 60% Fe, including black iron ore containing up to 10 % Mn) – Iron Ore lumps 58% Fe or more but below 60% Fe	Free
26011131	Iron ore fines (62% Fe or more)– 62% Fe or more but below 65% Fe	Free
2601113 9	Iron ore fines (below 62% Fe or more)– 65% Fe and above	Free
26011141	Iron ore fines (below 62% Fe) – below 55% Fe	Free
26011142	Iron ore fines (below 62% Fe) –55% Fe or more but below 58% Fe	Free
26011143	Iron ore fines (below 62% Fe) – 58% Fe or more but below 60% Fe	Free
26011149	Iron ore fines (below 62% Fe) – 60% Fe or more but below 62% Fe	Free
26011150	Iron ore concentrates	Free
26011190	Others	
260112	Iron ore and concentrates other than roasted i ron pyrites: Agglomerated	Free
26011210	Iron ore pellets	Free
26011290	Other	Free
26012000	Roasted iron pyrites	Free

Source: ITC(HS), 2018, Schedule 2 Export Policy ; STE: State Trading Enterprise

WORLD REVIEW

The world reserves of crude iron ore are estimated to be around 180 billion tonnes. In terms of iron content, the iron ore reserves are estimated to be around 85 billion tonnes. The world reserves of crude iron ore and iron content by principal countries are furnished in Table - 12.

In 2021, the world production of iron ore was 3,108 million tonnes as against 3,029 million tonnes in the previous year. Australia with 922 million tonnes (30%), China 850 million tonnes (27%), Brazil 431 million tonnes (14%), India 198 million tonnes (6%), Iran 105 million tonnes, Russia 100 million tonnes, Ukraine 79 million tonnes (3%) and South Africa 73 million tonnes, Kazakhstan 73 million tonnes and Canada 57 million tonnes (2% each) were the principal producers. These ten countries accounted for about 93% of the world production of iron ore and the remaining 7% was contributed by other countries. The world production of iron ore is provided in Table-13.

To provide a generalised view of the development in various countries, country-wise description sourced from the latest available publication of Minerals Yearbook 'USGS' 2018 is furnished below.

Australia

Production of iron ore in Australia was 900 million tonnes in 2018, a slight increase from 885 million tonnes in 2017. Three iron-ore mining companies in Australia—BHP Billiton Ltd., Fortescue Metals Group Ltd., and Rio Tinto Ltd.—were among the four leading iron ore producers in the world and accounted for most of the iron ore produced in Australia. BHP Billiton's iron ore production in Australia in fiscal year (FY) 2018, which ended June 30, 2018, was 238 million tonnes, a 3% increase from that of FY 2017. The company reported a decrease in production costs and an increase in seaborne ore prices in FY 2018 compared with those in the FY 2017. In 2018, BHP Billiton planned to improve productivity through transportation improvements at Port Hedland and a dumper car maintenance program to achieve between 241 and 250 million tonnes of iron ore production in FY 2019 . Fortescue's iron ore shipments were 168 million tonnes in FY 2019, a slight decrease from 170 million tonnes in FY 2018. Fortescue approved the $2.6 billion Iron Bridge Magnetite Project to develop 22 million tonnes/yr of 67% concentrates by midyear 2022. The company continued its autonomous haulage truck project, completing conversion to a fully autonomous fleet by midyear 2020. Rio Tinto's share of iron ore production at its operations in Australia was 281 million tonnes in 2018, a 4% increase from 271 million tonnes in 2017. In December 2018, Rio Tinto launched the world's first automated heavy-haul, long-distance rail network. The company approved the Koodaideri Mine Project, a $2.6 billion, 43-million tonnes/yr iron ore mine and processing facility to be completed in late 2021.

Brazil

Production of iron ore in Brazil was 460 million tonnes in 2018, a slight increase from 454 million tonnes in 2017. Vale S.A., leading iron ore producer in Brazil, increased production in 2018 to 385 million tonnes, a 5% increase from 367 million tonnes in 2017, and increased its pellet production in 2018 to 55.3 million tonnes, a 10% increase from 50.3 million tonnes in 2017. In December 2018, Anglo American plc restarted operations at the Minas Rio Mine in Minas Gerais following the March 2018 discovery of leaks in a slurry pipeline that transported ore to a port in Rio de Janeiro. Repairs required the replacement of approximately 4 kilometers (2.5 miles) of pipeline.

China

China produced 335 million tonnes of iron ore in 2018, a 3% decrease from 345 million tonnes in 2017. Increasing demand from steel producers in China for high-grade iron ore blends, primarily originating in Australia and Brazil, were driven by stricter emissions requirements from the

Table – 12 : World Reserves of Iron Ore

(By Principal Countries)

(In million tonnes)

Country	Reserves	
	Crude ore	Iron content
World : Total (rounded off)	**180000**	**85000**
USA	3000	1000
Australia [(a)]	51000	27000
Brazil	34000	15000
Canada	6000	2300
Chile	NA	NA
China	20000	6900
India	5500	3400
Iran	2700	1500
Kazakhstan	2500	900
Mauritania	NA	NA

Country	Reserves	
	Crude ore	Iron content
Mexico	NA	NA
Peru	2600	1200
Russia	29000	14000
South Africa	1000	670
Sweden	1300	600
Turkey	130	38
Ukraine(b)	6500	2300
Other countries	18000	9500

Source: USGS, Mineral Commodity Summaries, 2023.

(a): For Australia Joint Ore Reserves Committee compliant reserves were about 23 billion tonnes for crude ore and 10 billion tonnes for iron content.

(b): For Ukraine, reserves consist of the A and B categories of the Soviet reserves classification system.

** As per UNFC system as on 1.4.2020, India's reserves/resources of Iron ore (Haematite) and Iron ore (Magnetite) were estimated at 24,057 million tonnes and 11,227 million tonnes respectively.*

NA - Not available.

Table – 13 : World Production of Iron Ore

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021 (P)
World: Total	**3056000000**	**3029000000**	**3108000000**
(rounded off)			
Australia	917 045 579	918 063 223	922159323
China	844356000	845000000	850000000
Brazil	396841000	387990000	430550725
India(b)	246081000	204481000	198300000
Iran(c)	91778118	104818915	104900000
Russia	97500 000	100200 000	100600000
Ukraine	76134000	78837700	79000000
South Africa(d)	72430288	55635421	73090918
Kazakhstan	45221900	62865000	64089700
Canada(a)	59013000	60059572	57491803
Other countries	209327314	210997238	227870805

Source: BGS World Mineral Production, 2017-2021.
Note : World Total may not tally as data has been rounded off
(a) Including by-product iron ore.
(b) Years ended 31st March following that stated
(c) Years ended 20th March following that stated
(d) Including by-product magnetite; (e) estimated
** India's production of iron ore in 2019-20, 2020-21 and 2021-22 was 244.08 million tonnes, 205.04 million tonnes and 253.97 million tonnes, respectively.*

FOREIGN TRADE

Exports

Exports of iron ore decreased by 54% to 26.49 million tonnes in 2021-22 from 57.72 million tonnes in the previous year. Exports were mainly to China (83%) and Indonesia (3 %). The total exports of iron ore in 2021-22, in terms of quantity comprised iron ore fines 14.57 million tonnes (55%), iron ore pellets 11.39 million tonnes (43%), iron ore lumps 0.43 million tonnes (2%) and negligible quantity of iron ore non-agglomerated concentrate and iron ore pyrites (Tables- 14 to 19).

Table – 14 : Exports of Iron Ore : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**57723**	**362556021**	**26494**	**241480427**
China	51975	314421802	21861	184557519
Indonesia	594	5375145	912	10908862
Korea, Rep. of	658	5710435	501	7640882
Oman	698	6283030	454	7029303
Italy	++	9	332	4792480
Malaysia	742	6605067	365	4188281
Netherlands	++	2573	236	3391731
Brazil	331	4076384	212	3044805
Poland	73	592883	204	2702460
Germany	++	430	156	2429644
Other Countries	2652	19488263	1261	10794460

Figures rounded off

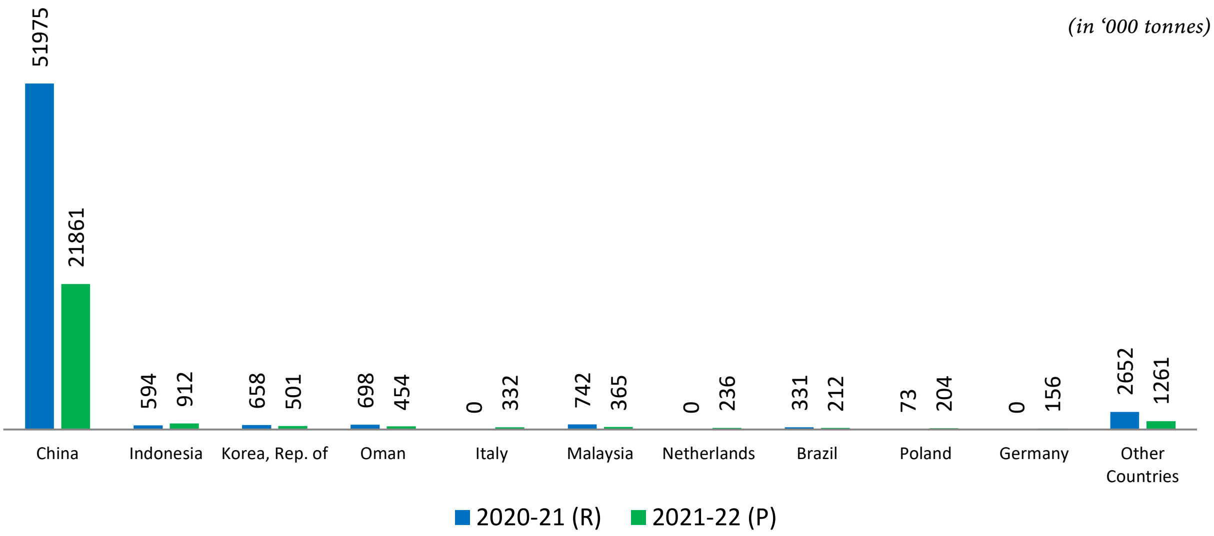


Fig 1: Countrywise Exports of Iron Ore:

Table – 15: Exports of Iron Ore : Lumps

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**2239**	**13118637**	**433**	**1876849**
China	1502	6811960	415	1779342
Singapore	-	-	18	88567
Germany	++	++	++	3599
Congo, D. Rep. of	++	117	++	2850
Tanzania	-	-	++	1912
Australia	++	34	++	355
Nepal	1	732	++	224
Japan	723	6279621	-	-

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
UAE	13	25884	-	-
Ethiopia	++	235	-	-
Other Countries	++	54	-	-

Figures rounded off

Table – 16: Exports of Iron Ore: Fines

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	40661	215190641	14570	83677314
China	38388	200434020	13846	81327260
Qatar	-	-	78	558398
Malaysia	65	234948	81	466654
Japan	1277	8774308	74	366722
Nepal	85	171405	294	260198
Singapore	-	-	46	220237
Indonesia	97	469465	53	197685
UAE	39	118907	50	174887
Kenya	-	-	48	104826
Hungary	-	-	++	395
Other Countries	710	4987588	++	52

Figures rounded off

Table – 17 : Exports of Iron Ore: Pyrites

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	++	46040	++	30702
Netherlands	++	2573	++	4615
Bangladesh	++	2465	++	3187
Turkey	-	-	++	2857
Saudi Arabia	++	5567	++	2855
Korea, Rep. of	++	563	++	2659
Thailand	++	2246	++	2627
Myanmar	-	-	++	2475
Philippines	-	-	++	2439
UAE	++	1585	++	1817
Nigeria	++	492	++	984
Other Countries	++	30549	++	4187

Figures rounded off

Table – 18: Exports of Iron Ore: Concentrates Non-agglomerated

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**363**	**1781069**	**100**	**669724**
China	309	1707189	50	356302
Indonesia	-	-	47	310748
Nepal	9	13018	3	2522
Germany	++	2	++	86
Australia	++	12	++	21
Canada	-	-	++	15
Kenya	1	1329	++	12
France	++	2	++	9
Korea, Rep. of	-	-	++	4
Bhutan	-	-	++	3
Other Countries	44	59517	++	2

Figures rounded off

Table – 19 : Exports of Iron Ore: Pellets

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**14460**	**132419634**	**11391**	**155225838**
China	11776	105457429	7550	101094123
Indonesia	497	4905680	812	10399695
Korea, Rep. of	142	1600668	501	7638219
Oman	698	6283030	454	7029303
Italy	++	9	332	4792480
Malaysia	677	6369416	284	3721001
Netherlands	-	-	236	3387116
Brazil	331	4076384	212	3044805
Poland	73	592883	204	2702460
Germany	++	1	156	2425954
Other Countries	266	3134134	650	8990682

Figures rounded off

Imports

Imports of iron ore increased manifold to 6.68 million tonnes in 2021-22 from 0.76 million tonnes in the previous year. Imports of iron ore were from Brazil (47%), Australia (36%), South Africa (14%) and negligible amount from other countries. The total imports in 2021-22 comprised iron ore fines (61%),non-agglomerated concentrates (22%) and iron ore umps (14%) (Tables-20 to 25).

Table – 20: Imports of Iron Ore: Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**766**	**8445221**	**6683**	**35389345**
Brazil	-	-	3156	16798568
South Africa	166	1793445	928	8854187
Australia	58	593329	2382	7932560
Ukraine	96	853813	152	1283813
Finland	61	461841	61	459404
Turkey	3	36744	2	21446
Croatia	2	20341	1	12082
Russia	1	14161	1	8143
China	++	8650	++	6565
Sweden	++	11707	++	6080
Other Countries	379	4651190	++	6497

Figures rounded off

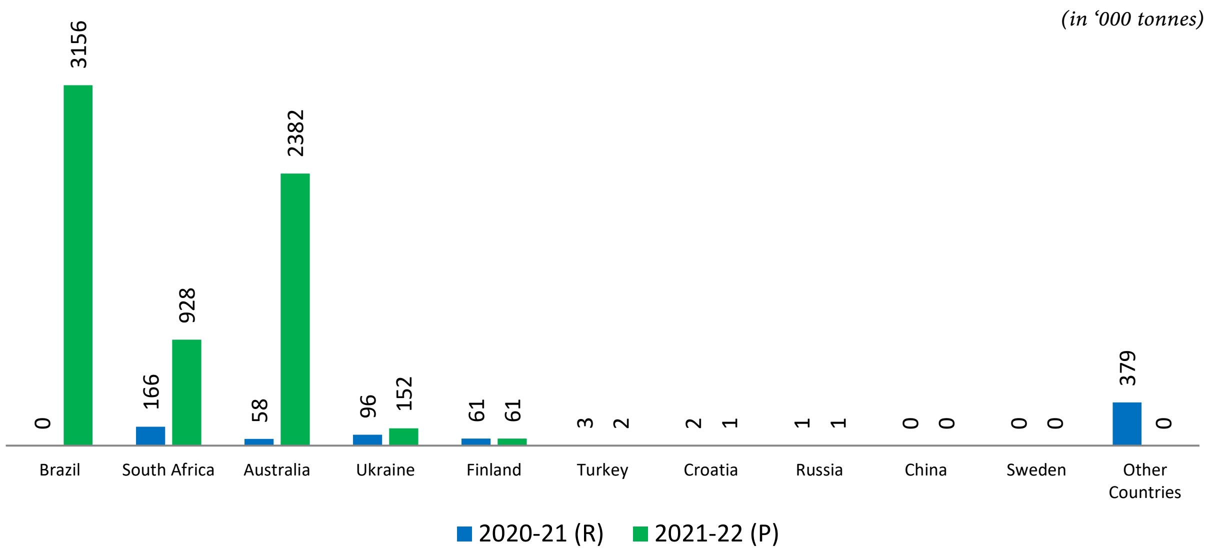


Fig 3: Countrywise Imports of Iron Ore: Total

Table – 21: Imports of Iron Ore Concentrates: Non-agglomerated

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**154**	**1484523**	**1446**	**9469224**
Brazil	-	-	1264	7914628
Ukraine	96	853772	152	1283813
South Africa	-	-	30	263094
Sweden	++	11270	++	5868
USA	++	321	++	1100
UK	++	31	++	369
Germany	-	-	++	204
Canada	-	-	++	140

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
Australia	58	593329	++	6
UAE	-	-	++	2
Other Countries	++	25800	-	-

Figures rounded off

Table – 22: Imports of Iron Ore: Pellets

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	**379**	**4612581**	**170**	**874034**
Brazil	-	-	170	874034
Bahrain	379	4612542	-	-
Ukraine	++	39	-	-

Figures rounded off

Table – 23 : Imports of Iron Ore : Pyrites

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	67	546483	65	512049
Finland	61	461841	61	459404
Turkey	3	36744	2	21446
Croatia	2	20341	1	12082
Russia	1	14161	1	8143
China	++	8601	++	6565
Italy	++	3901	++	3704
USA	++	349	++	698
Oman	-	-	++	7
Malaysia	++	545	-	-

Figures rounded off

Table – 24: Imports of Iron Ore Lumps

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	166	1800782	927	8903226
South Africa	166	1793445	898	8591093
Australia	-	-	29	311671
Sweden	++	437	++	212
Senegal	-	-	++	185
Germany	++	127	++	36
UAE	-	-	++	29
Mozambique	++	6768	-	-
Japan	++	5	-	-

Figures rounded off

Table – 25: Imports of Iron Ore: Fines

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹'000)	Qty ('000 t)	Value (₹'000)
All Countries	++	852	4075	15630812
Brazil	-	-	1722	8009906
Australia	-	-	2353	7620883
USA	-	-	++	23
France	++	850	-	-
Ukraine	++	2	-	-

Figures rounded off

FUTURE OUTLOOK

India is one of the leading producers of iron ore in the world. Among the consuming industries, Cement Industry is the second major consumer of iron ore after Iron & Steel Industry (including Sponge Iron Industry).

The Ministry of Steel under Government of India has introduced the new National Steel Policy, 2017 and with the roll out of the National Steel Policy, 2017 and the DMI & SP policy, it is envisaged that the industry can be steered with appropriate policy support in creating an environment for promoting domestic steel and thereby ensuring a scenario where production meets the anticipated pace of growth in consumption. Thus, the Indian Steel Sector is all set to achieve its vision thereby setting a global benchmark in terms of quality, standards and technology. It is anticipated that crude steel capacity of 300 million tonnes will be required by 2030-31 and to fulfill this capacity, about 437 million tonnes of iron ore is required. However, achieving crude steel capacity up to 300 million tonnes will require extensive mobilisation of natural resources, finances, manpower and infrastructure including land. To address the concerns regarding availability of raw material (iron ore) intensive & deeper exploration would have to be promoted for augmentation of resource base. Eco-friendly viable underground mining techniques for optimal utilisation of magnetite ore deposits locked in Western Ghats would also have to be explored in collaboration with mining research institutes. The Government has already promulgated the Mines and Minerals (Development and Regulation) Amendment Act, 2015 and therein has laid great emphasis on time bound mine development with increased stress on mineral exploration and sustainable mining operations which may support ore output growth.

The Act has brought clarity on mine allocation process (through auction) and procedures for mining lease renewal. The Act, further, provides for reservation of any particular mine for a particular end use and put conditions permitting auction among such eligible endusers. Furtheras per the provision made in Mineral (Avctton)Rules 2015, under the aforesaid Act, a total of 115 mining leases (Ml) and composite licence for iron ore (with blocks of iron ore and other assorted minerals) were auctioned till 28th Dec. 2023 in the States of Andhra Pradesh (5 blocks), Chhattisgarh (10 blocks), Goa (9 blocks), Jharkhand (3 blocks), Karnataka ((29 blocks), Madhya Pradesh (8 blocks), Maharashtra (12 blocks), Odisha (31 blocks), Rajasthan (6 blocks) and Utter Pradesh (2 blocks).

17. Kyanite, Sillimanite and Andalusite

106
(million tonnes) Total reserves/resources of kyanite were estimated as on 1st April 2020

72
(million tonnes) Total reserves/resources of sillimanite were estimated as on 1st April 2020

126
(million tonnes) Total reserves/resources of andalusite were estimated as on 1st April 2020

9,432
(tonnes) Production of kyanite were reported in 2021-22

3,432
(tonnes) Production of sillimanite were reported in 2021-22

1,655
(tonnes) of kyanite were exported in 2021-22

Kyanite, sillimanite and andalusite are unhydrous aluminosilicate minerals that have the same chemical formula Al_2O_3 but differ in crystal structure and physical properties. When calcined at high temperature around 1,350 ^{0}C to 1,380 ^{0}C for kyanite and slightly higher for andalusite and sillimanite, these minerals are converted to mullite, ($3Al_2O_3.2SiO_2$) and silica (SiO_2) which are refractory minerals. Synthetic mullite is made by heating mixtures of alumina and silica or bauxite and kaolin at around 1,550 ^{0}C to 2,000 ^{0}C. Refractories are heat resistant materials used in high temperature applications, such as, furnaces, ladles, kilns, in the metallurgical, glass, chemical, cement and other industries.

The aluminosilicates andalusite, kyanite and sillimanite are metamorphic minerals, which formed in aluminium-rich rocks by orogenic or contact metamorphism. Andalusite is generally preferred to kyanite, because it can be used without calcination, thus saving energy. Most of the world production of andalusite in 2021 originated from France and South Africa.

RESERVES / RESOURCES

Kyanite

The total reserves/resources of kyanite as per NMI database, based on UNFC system as on 1.4.2020 in the country has been placed at 105.68 million tonnes. Out of these resources, only 0.84 million tonnes are Reserves and 104.83 million tonnes are under Remaining Resources. Out of total resources, high and medium-grade resources together account for merely 1.44%, low-grade 8.17%, mixed-grade 0.52%, quartz kyanite rock, kyanite gneiss rock & kyanite schist 88.21% and granular, others & not-known grades 1.63 %. Statewise, share of Telangana is 45.75% of the total resources followed by Andhra Pradesh with 30.28%, Karnataka 12.46% and Jharkhand 7.83%. The remaining 3.69% resources are in Kerala, Maharashtra, Rajasthan, Tamil Nadu and West Bengal collectively (Table-1).

Table – 1 : Reserves/Resources of Kyanite as on 1.4.2020 (P)

(By Grades/States)

(In tonnes)

Grade/States	Reserves				Remaining Resources								Total Resou - rces
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn- aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**3933558**	**331193**	**122314**	**846865**	**1331061**	**940452**	**1864398**	**561680**	**3577402**	**96560462**	**-**	**104835455**	**105682321**
By Grades													
High grade	-	-	-	-	-	4317	21867	-	297827	114689	-	438700	438700
Medium grade	325113	-	43449	368562	34540	-	276651	-	34410	371144	-	716745	1085307
Low grade	66562	992	-	67554	691161	29990	1191151	386247	2214900	4063596	-	8577045	8644599
High & medium mixed	-	-	-	-	-	-	-	-	93640	47750	-	141390	141390
Medium & low mixed	-	-	-	-	-	-	-	-	-	48000	-	48000	48000
High, medium & low mixed	-	-	-	-	13097	89650	10606	-	45000	210025	-	368378	368378
Granular	1620	-	-	1620	578	117	-	700	167000	79434	-	247829	249449
Quartz kyanite rock	-	330202	-	330202	-	816378	38000	-	-	81696358	-	82550736	82880938
Kyanite gneiss rock	-	-	-	-	-	-	-	-	-	5370800	-	5370800	5370800
Kyanite schist	-	-	-	-	-	-	-	-	724625	4250000	-	4974625	4974625
Unclassified	63	-	-	63	-	-	-	-	-	-	-	-	63
Others	-	-	78865	78865	591685	-	326123	-	-	73046	-	990854	1069719
Not-known	-	-	-	-	-	-	-	174733	-	235620	-	410353	410353
By States													
Andhra Pradesh	-	-	-	-	-	-	399	-	-	32003829	-	32004228	32004228
Jharkhand	-	331193	-	331193	1017105	920088	523589	-	1754900	3727685	-	7943367	8274560
Karnataka	181600	-	-	181600	230660	15930	119368	386247	1610502	10628753	-	12991460	13173060
Kerala	-	-	-	-	-	-	-	174733	-	10000	-	184733	184733
Maharashtra	210075	-	122314	332389	69621	4317	1210436	-	45000	1734241	-	3063615	3396004
Rajasthan	-	-	-	-	13097	-	10606	-	-	-	-	23703	23703
Tamil Nadu	1683	-	-	1683	578	117	-	700	167000	79434	-	247829	249512
Telangana	-	-	-	-	-	-	-	-	-	48350000	-	48350000	48350000
West Bengal	-	-	-	-	-	-	-	-	-	26520	-	26520	26520

Figures rounded off

Sillimanite

The total reserves/resources of sillimanite as per NMI database, based on UNFC system in the country as on 1.4.2020 has been placed at 72.26 million tonnes. Out of these resources, 8.26 million tonnes are under Reserves Category, while about 64.00 million tonnes are under the Remaining Resources. Out of total resources, more than 73.89% are granular high-grade, while quartz sillimanite rocks and sillimanite-bearing rocks are about 21 .03 %. Resources of massive sillimanite of all grades are about 4.80%. The resources are located mainly in Odisha (24.49%), Tamil Nadu (24.01%), Uttar Pradesh (15.84%), Andhra Pradesh (15.32%), Kerala (9.58%) and Assam (6.38%). The remaining 4.38% resources are in Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Rajasthan and West Bengal (Table-2).

able – 2 : Reserves/Resources of Sillimanite as on 1.4.2020 (P)

(By Grades/States)

(In tonnes)

Grade/States	Reserves				Remaining Resources								Total Resou - rces
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn- aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**7968445**	**3655**	**290200**	**8262300**	**503301**	**23406**	**20549508**	**4771654**	**17630364**	**16115664**	**4411195**	**64005091**	**72267391**
By Grades													
Massive high grade	91790	3655	68112	163557	-	-	-	-	-	11903	-	11903	175460
Massive medium grade	59084	-	3619	62703	-	4000	-	-	-	29705	-	33705	96408
Massive low grade	38000	-	-	38000	15300	-	519	15000	850000	2258786	-	3139605	3177605
Massive high & medium	-	-	-	-	-	-	-	-	-	19800	-	19800	19800
Massive medium & low	-	-	-	-	-	-	-	-	-	38	-	38	38
Granular high	7776113	-	218469	7994582	404001	8336	20548989	2656654	7430300	13794916	561595	45404791	53399373
Quartz sillimanite rock	-	-	-	-	-	-	-	-	-	-	3748000	3748000	3748000
Sillimanite-bearing rock	-	-	-	-	-	-	-	2100000	9350000	-	-	11450000	11450000
Others	-	-	-	-	-	11070	-	-	-	-	-	11070	11070
Unclassified	3458	-	-	3458	84000	-	-	-	-	-	-	84000	87458
Not-known	-	-	-	-	-	-	-	-	64	516	101600	102180	102180
By States													
Andhra Pradesh	1451556	-	218469	1670025	-	11070	462830	-	7430300	1491539	-	9395739	11065764
Assam	-	-	-	-	-	-	-	-	850000	6700	3748000	4604700	4604700
Jharkhand	-	-	-	-	-	-	-	-	-	83000	-	83000	83000
Karnataka	-	-	-	-	-	-	-	-	-	982725	-	982725	982725
Kerala	553000	-	-	553000	432713	-	-	2564254	-	3369200	-	6366167	6919167
Madhya Pradesh	-	-	-	-	-	-	-	-	-	-	101600	101600	101600

(In '000 tonnes)

Grade/State	Reserves				Remaining Resources								Total Resources
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconnaissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
Maharashtra	174474	3655	3619	181748	15000	-	-	15000	64	516	-	30580	212328
Meghalaya	14400	-	68112	82512	-	-	-	-	-	55807	-	55807	138319
Odisha	5640985	-	-	5640985	-	-	6557013	-	-	4943600	561595	12062208	17703193
Rajasthan	-	-	-	-	300	-	519	-	-	-	-	819	819
Tamil Nadu	134030	-	-	134030	55288	12336	13529146	92400	-	3529577	-	17218747	17352777
Uttar Pradesh	-	-	-	-	-	-	-	2100000	9350000	-	-	11450000	11450000
West Bengal	-	-	-	-	-	-	-	-	-	1653000	-	1653000	1653000

Figures rounded off

Andalusite

The total reserves/resources of andalusite in the country as on 1.4.2020 as per NMI database, based on UNFC system has been placed at 12.60 million tonnes. Most of the resources are of Reconnaissance category located in Uttar Pradesh (Table-3).

Table – 3 : Reserves/ Resources of Andalusite as on 1.4.2020

(By Grades/ States)

(In '000 tonnes)

Grade/State	Total Reserves	Remaining Resources				Total Resources
	Total (A)	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	(A+B)
All India : Total	**-**	**58040**	**56210**	**11800**	**126050**	**126050**
By Grades						
Low	-	58040	56210	11800	126050	126050
By States						
Jharkhand	-	-	-	11800	11800	11800
Uttar Pradesh	-	58040	56210	-	114250	114250

Figures rounded off

EXPLORATION & DEVELOPMENT

Details of exploration & development, if any, are covered in the Review of "Exploration & Development" under "General Reviews".

PRODUCTION & STOCKS

Kyanite

The production of kyanite was 9,432 tonnes in 2021-22, which is increased by 92% as compared to 4,925 tonnes in the previous year. There were 5 reporting mines in 2021-22 against 4 reporting mines in the previous year. Three principal producers contributed the entire production of kyanite during the year.

In 2021-22, 9,432 tonnes, i.e., total production of kyanite was of grade below 40% Al_2O_3. About 54% of the total production was reported by the Private Sector (Tables-4 to 6).

Mine-head closing stocks of kyanite for 2021-22 were 13,745 tonnes as against 11,265 tonnes in 2020-21 (Table-7).

The average daily employment of labour was 89 in 2021-22 as against 61 in the preceding year.

Table – 4 : Principal Producers of Kyanite, 2021-22

Name & address of producer	Location of mine	
	State	District
Mohammad Akram Rasheed, 3 Marcha Halli, H.D.Kote Mysore-571 125. Karnataka	Karnataka	Mysore
JSMDC LTD Khanij Bikash Nigam, Nepal House Area Doranda, Ranchi- 834 002, Jharkhand.	Jharkhand	East Singhbhum
Maharashtra State Mining Corporation Ltd., Plot No. 7, Ajani Chowk, Wardha Road, Nagpur - 440 015, Maharashtra.	Maharashtra	Bhandara

Table – 5 : Production of Kyanite, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**3498**	**12728**	**4925**	**9251**	**9432**	**17578**
Jharkhand	-	-	-	-	2899	5417
Karnataka	400	880	3780	7397	5075	9084
Maharashtra	3098	11848	1145	1854	1458	3077

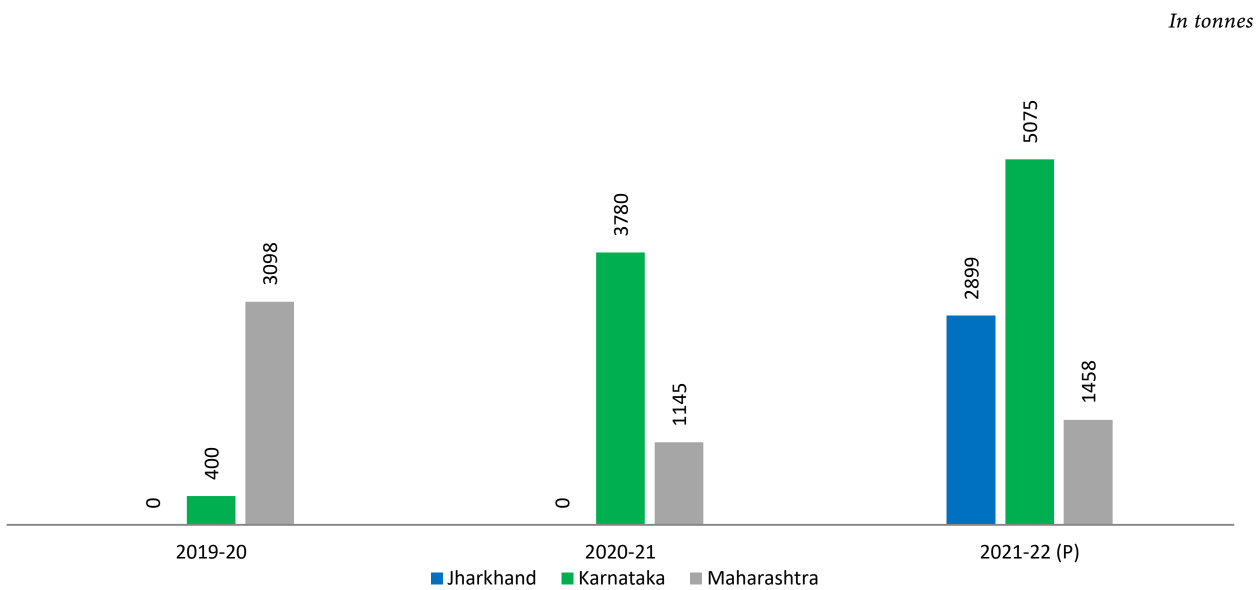


Fig 1: Production of Kyanite in India

Table – 6 : Production of Kyanite, 2020-21 and 2021-22

(By Sectors/States/Districts/Grades)

(Quantity in tonnes; Value in ₹ '000)

State/District	2020-21					2021-22 (P)				
	Quantity					Quantity				
	No. of mines	40% Al_2O_3 & above	Below 40% Al_2O_3	Total	Value	No. of mines	40% Al_2O_3 & above	Below 40% Al_2O_3	Total	Value
India	**4**	**605**	**4320**	**4925**	**9251**	**5**	**-**	**9432**	**9432**	**17578**
Public sector	1	-	540	540	1136	2	-	4357	4357	8494
Private sector	3	605	3780	4385	8115	3	-	5075	5075	9084
Jharkhand	-	-	-	-	-	1	-	2899	2899	5417
Singhbhum East	-	-	-	-	-	1	-	2899	2899	5417
Karnataka	1	-	3780	3780	7397	1	-	5075	5075	9084
Mysuru	1	-	3780	3780	7397	1	-	5075	5075	9084
Maharashtra	3	605	540	1145	1854	3	-	1458	1458	3077
Bhandara	3	605	540	1145	1854	3	-	1458	1458	3077

Table – 7 : Mine-head Closing Stocks of Kyanite, 2020-21 & 2021-22

(By States/Grades)

(Qty in tonnes)

State	2020-21			2021-22 (P)		
	40% Al_2O_3 & above	Below 40% Al_2O_3	Total	40% Al_2O_3 & above	Below 40% Al_2O_3	Total
India	**1647**	**9618**	**11265**	**321**	**13424**	**13745**
Jharkhand	1326	1	1327	-	790	790
Karnataka	-	9440	9440	-	11789	11789
Maharashtra	321	177	498	321	845	1166

Sillimanite

The production of sillimanite at 3,432 tonnes in 2021-22 decreased by 69% as compared to 11,110 tonnes in the previous year. There were 2 mines which reported production of sillimanite as an associated mineral with kyanite during the year 2021- 22 (Tables-8, 9 & 10).

The whole production of sillimanite was reported by Private Sector during the year 2021-22. Maharashtra is the only State which contributed cent per cent production of sillimanite during the year 2021-22.

Mine-head closing stocks for the year 2021- 22 were 2,920 tonnes as against 1,463 tonnes in the previous year (Table - 11).

Table – 8 : Principal Producers of Sillimanite, 2021-22

Name & address of producer	Location of mine	
	State	District
*Dighori Kyanite Mine, Apna Nagar, Tkiya Ward, Nagpur Road Bhandara, Bhandara-441 904, Maharashtra.	Maharashtra	Bhandara
*Pavri Kyanite Mines, A/1, Indrasagar, Ravindranath Tagore Road, Civil Lines, Nagpur- 440 001, Maharashtra.	Maharashtra	Bhandara

** Producing as an associated mineral with kyanite*

Table – 9 : Production of Sillimanite, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**13221**	**37903**	**11110**	**13987**	**3432**	**7973**
Andhra Pradesh	-	-	-	-	-	-
Kerala	-	-	-	-	-	-
Maharashtra	13221	37903	11110	13987	3432	7973
Meghalaya	-	-	-	-	-	-
Odisha	-	-	-	-	-	-

Note: The main reason for decrease in number of mines is classification of some sillimanite producing mines, as BSM mines in Andhra Pradesh, Kerala and Tamil Nadu. Earlier, these mines were considered under sillimanite mineral as a part of MCDR mineral as there was no separate classification of Beach Sand Minerals (BSM) and Non-Beach Sand Minerals (Non-BSM).

In tonnes

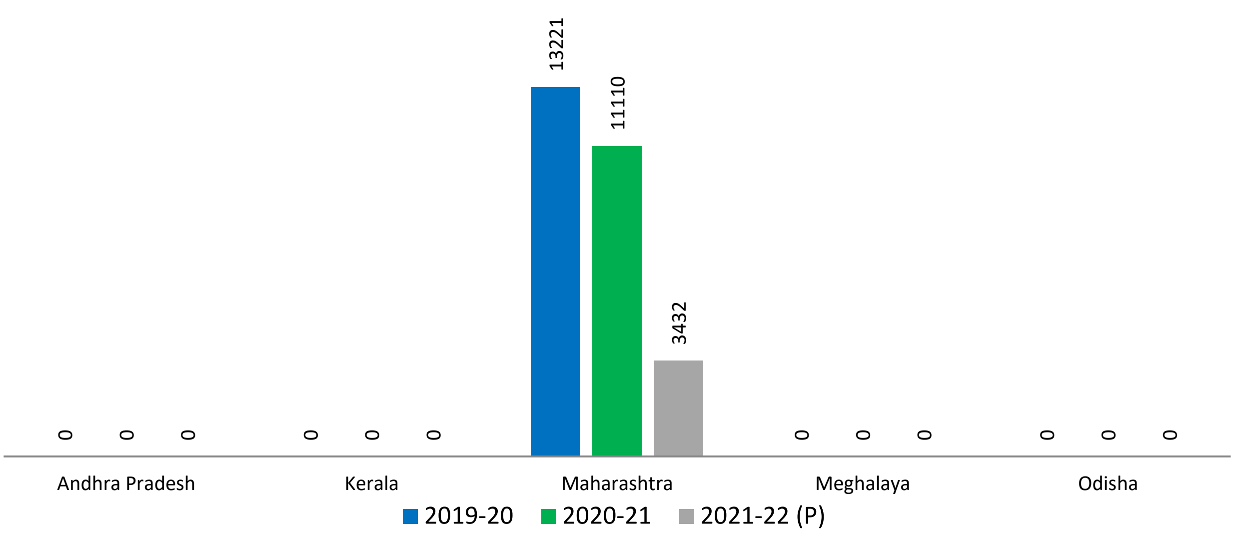


Fig 2: Production of Sillimanite in India

Table – 10 : Production of Sillimanite, 2020-21 & 2021-22

(By Sectors/States/Districts)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**1(2)**	**11110**	**13987**	**(2)**	**3432**	**7973**
Public sector	1	-	-	-	-	-
Private sector	(2)	11110	13987	(2)	3432	7973
Andhra Pradesh	-	-	-	-	-	-
Srikakulam	-	-	-	-	-	-
Kerala	-	-	-	-	-	-
Kollam	-	-	-	-	-	-
Maharashtra	1(2)	11110	13987	(2)	3432	7973
Bhandara	1(2)	11110	13987	(2)	3432	7973
Meghalaya	-	-	-	-	-	-
Khasi Hills West	-	-	-	-	-	-
Odisha	-	-	-	-	-	-
Ganjam	-	-	-	-	-	-

Figures in parentheses indicate the number of associated mines with kyanite

Note: The main reason for decrease in number of mines is classification of some sillimanite producing mines as BSM mines in Andhra Pradesh, Kerala and Tamil Nadu. Earlier, these mines were considered under sillimanite mineral as a part of MCDR mineral as there was no separate classification of Beach Sand Minerals (BSM) and Non-Beach Sand Minerals (Non-BSM).

Table – 11: Mine-head Closing Stocks of Sillimanite, 2020-21 & 2021-22

(By States)

(In tonnes)

Country	2020-21 (R)	2021-22 (P)
India	**1463**	**2920**
Andhra Pradesh	-	-
Kerala	-	-
Meghalaya	188	188
Maharashtra	1275	2732
Odisha	-	-

Andalusite

There was no production of andalusite reported since 1988.

MINING & MARKETING

Kyanite

Kyanite mines are worked by opencast manual as well as semi-mechanised methods. Generally, the mineral is marketed under three grades: 60% Al_2O_3 and above, 50-60% Al_2O_3 and less than 50% Al_2O_3. These three grades are used in the manufacture of refractories.

Sillimanite

Sillimanite mines are also worked by opencast method. Pohra mine of Maharashtra State Mining Corporation Ltd is semi-mechanised.

USES

Kyanite, sillimanite and andalusite are mainly used in refractories and ceramic products because of their ability to form mullite phase at high temperature. Mullite is an essential component of high-alumina refractories forming the inner lining of furnaces and high temperature vessels widely used in the production of metals, ceramics, glass and cement. These are used in manufacturing refractory products like dense bricks, insulating bricks, monolithic & castables. Sillimanite refractory bricks are extensively used in steel and glass industries and also in ceramics, cement kilns, heat treatment furnaces and petrochemical industries.

SPECIFICATIONS

BIS has prescribed IS:14301-1995 (reaffirmed in 2011) for kyanite used in Refractory Industry. There are two grades, i.e., Grade-1 and Grade-2. Composition of kyanite under this specification is Al_2O_3 58% min. Grade-1 and 54% min. for Grade-2; Fe_2O_3 1.50% max., K_2O + Na_2O 1% max.; other constituents would be for as agreed between the supplier and pur chaser. P yro metric Co ne Equivalent (PCE) specified would have to be not less than 36 for Grade-1 and 35 for Grade-2. Size of the material is 50 to 150 mm or 10 to 50 mm. BIS has laid down IS:14302-1995 (reaffirmed in 2011) in respect of beach sand sillimanite for use in Refractory Industry, while IS:2045-1962 in respect of natural sillimanite blocks for glass melting tanks furnaces has been withdrawn.

CONSUMPTION

Kyanite & Sillimanite

The apparent availability of kyanite and sillimanite during 2021-22 is 9,445 & 1,113 tonnes, respectively (Table-12).

Table – 12 : Apparent Availability of Kyanite and Sillimanite for Domestic Consumption (Based on Production, Imports and Exports)

(Quantity in tonnes)

Minerals	Kyanite 2021-22	Sillimanite 2021-22 (P)
I) Total Production	**9432**	**3432**
II) Total Imports	1668	801
III) Total Exports	1655	3120
IV) Apparent Availability	9445	1113

WORLD REVIEW

World reserve of kyanite and related minerals is large in the USA. Andalusite is limited to only a few countries. The main producer and exporter of andalusite is South Africa and Peru while USA and India are the main producers of kyanite. India is the leading producer of sillimanite. World production of kyanite and related minerals is indicated in Table-13.

Table – 13 : World Production of Minerals (Kyanite, Sillimanite & Andalusite)

(By Principal Countries)

(In tonnes)

Country	2019	2020	2021
France			
Andalusite [(a)]	68000	65000	65000
India*			
Kyanite[(C)]	3497	4925	4480
Sillimanite [(C)]	13236	11110	11900
Madagascar	1	-	-
Nepal			
Kyanite [(d)]	1	-	-
South Africa			
Andalusite	190000	180000	190000
USA			
Kyanite [(b)]	91300	67100	81000

Source: BGS World Mineral Production, 2017-2021, BGS.
(a) May Include other sillimanite minerals.
(b) Including related minerals.
(c) Years ended 31st March following that stated.
(d) Years ending 15th July of that stated.
(e) Estimated.
**India's production during 2019-20, 2020 -21 and 2021-22 in respect of kyanite is 3,498 tonnes, 4,925 tonnes & 9,320 tonnes respectively and in respect of sillimanite is 13,221 tonnes, 11,110 tonnes & 3,432 tonnes respectively.*

The availability of inexpensive refractory-grade bauxite from China served to increase demand for refractories from alternative raw material, such as, andalusite. Demand for refractories in iron and steel production is expected to have larger increases in countries with higher growth rates in steel production. Increased demand also is anticipated for refractories used for producing other metals and in the industrial mineral market because of increasing production of cement, ceramics, glass, and other mineral products.

FOREIGN TRADE

Exports

Exports of kyanite during 2021-22 at 1,655 tonnes increased manifold by 557% from 252 tonnes in the previous year. Exports were mainly to UAE (82%), Sri Lanka (6%) and Greece & Turkey (3% each). Exports of sillimanite decreased by 38% to 3,120 tonnes in 2021-22 from 4,998 tonnes in the previous year. Sillimanite was exported mainly to China (83%), Japan (10%), Nepal (4%) and Malaysia (3%). Exports of less than 1% were to Thailand, USA and Angola. Exports of andalusite during 2021-22 increased by 100% to 18 tonnes from 9 tonnes in the previous year. Andalusite was exported solely to UAE (100%) (Tables - 14 to 16).

Table – 14: Exports of Kyanite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty ('000 t)	Value (₹ '000)	Qty ('000 t)	Value (₹ '000)
All Countries	252	9033	1655	15376
UAE	12	404	1353	11164
Sri Lanka	-	-	100	1271
Turkey	-	-	46	1234
Greece	216	4871	48	933
Saudi Arabia	10	153	35	365
Nigeria	-	-	52	195
Sudan	-	-	2	131
Zambia	-	-	4	47
Cameroon	-	-	15	36
Bhutan	4	3500	-	-
Other countries	10	105	-	-

Figures rounded off

(In tonnes)

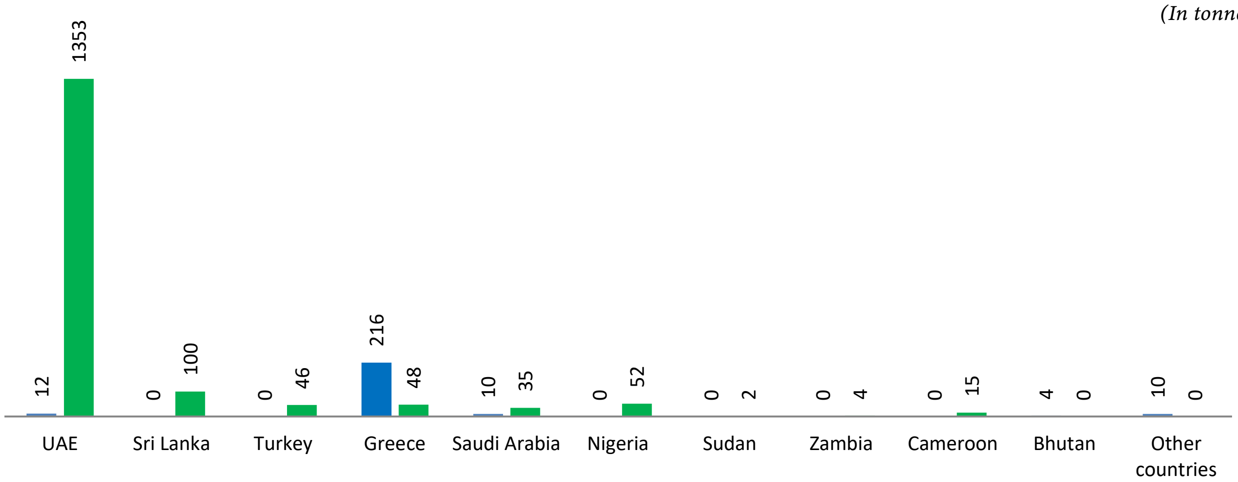


Fig 3: Countrywise Exports of Kyanite

Table – 15: Exports of Sillimanite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**4998**	**94359**	**3120**	**64355**
China	4004	72772	2576	50244
Japan	378	12700	314	10405
Malaysia	298	5399	84	1664
Nepal	235	1296	116	1234
Thailand	50	990	25	525
USA	1	62	1	202
Angola	-	-	4	25
Germany	++	2	++	24
Canada	++	10	++	15
UK	++	22	++	9
Other countries	32	1106	++	8

Figures rounded off

(In tonnes)

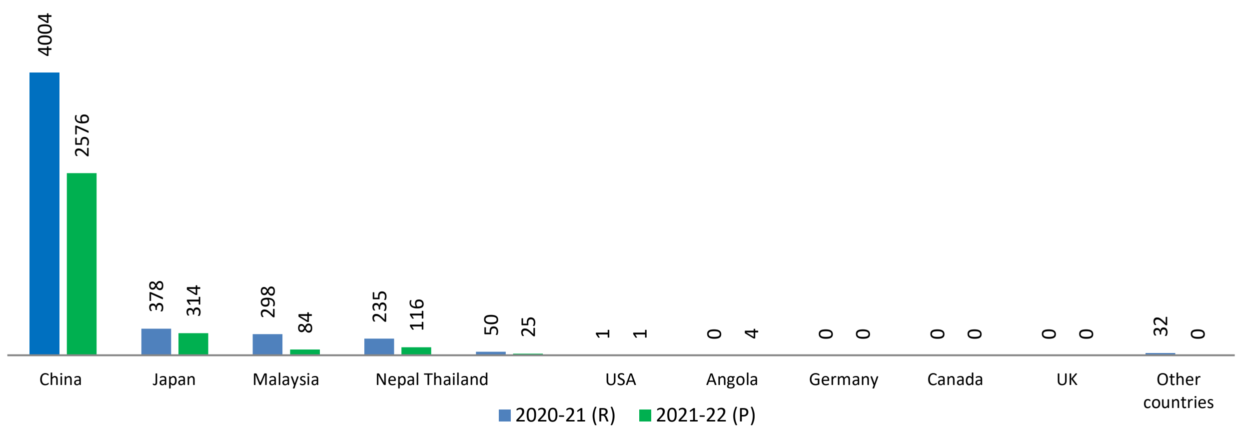


Fig 4: Countrywise Exports of Sillimanite

Table – 16: Exports of Andalusite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**9**	**476**	**18**	**1233**
UAE	9	476	18	1233

Figures rounded off

(In tonnes)

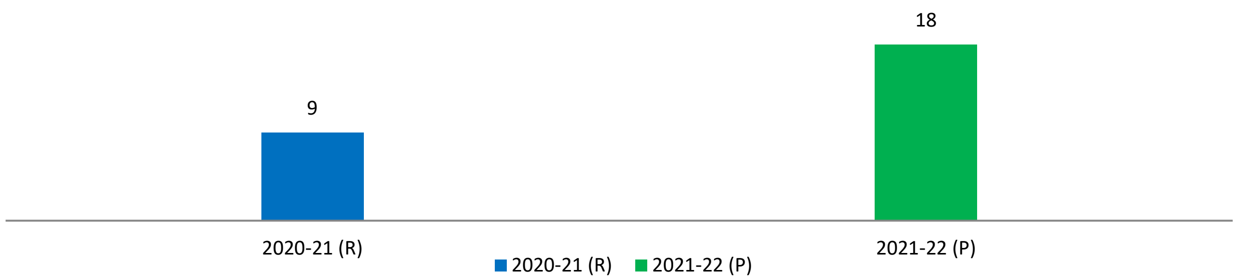


Fig 5: Countrywise Exports of Andalusite

Imports

In 2021-22, imports of kyanite were at 1,668 tonnes as against 1,238 tonnes in the previous year registering an increase of 35%. Imports of sillimanite were at 801 tonnes which also increased by 32% during 2021-22 as compared to 606 tonnes in the previous year. Imports of andalusite at 10,419 tonnes decreased by 32% during 2021-22 from that of the previous year. The imports of kyanite were mainly from USA (78%) and China (22%). UAE (48%), Hong Kong (26%) & Ukraine (20 %), were the main suppliers of sillimanite while South Africa (79%), France (19%) were the main suppliers of andalusite in 2021-22 (Tables - 17 to 19).

Table – 17: Imports of Kyanite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1238**	**42080**	**1668**	**53418**
USA	985	36136	1298	49554
China	180	3823	370	3864
South Africa	54	1442	-	-
UAE	10	282	-	-
Australia	4	228	-	-
Malaysia	5	169	-	-

Figures rounded off

(In tonnes)

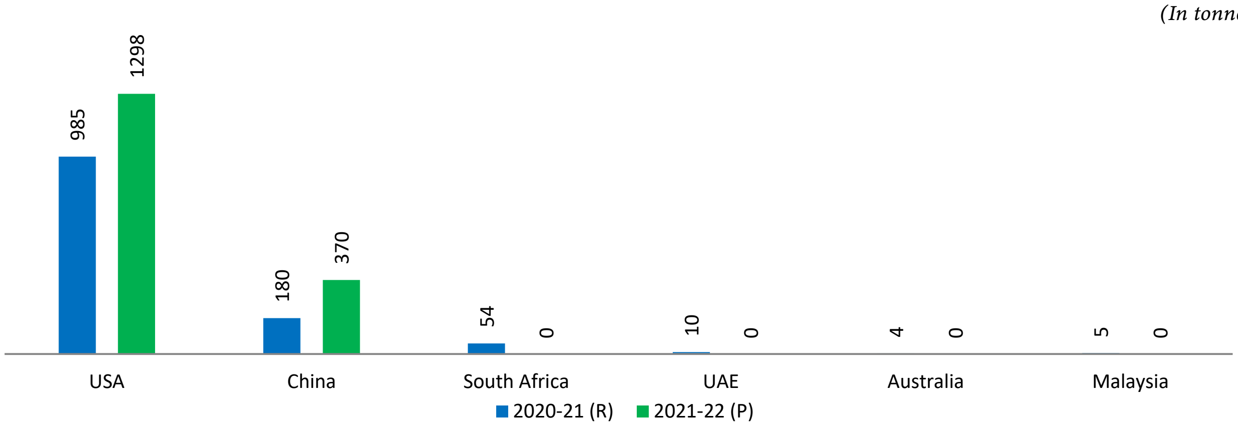


Fig 6: Countrywise Im ports of Kyanite in India

Table – 18 : Imports of Sillimanite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
HongKong	**200**	**3890**	**210**	**4918**
Ukraine	405	7080	160	3518
UAE	-	-	383	3374
USA	++	341	41	946
Spain	-	-	1	687
China	++	80	3	265
Poland	-	-	3	204
Germany	-	-	++	58
Belgium	-	-	++	2
Japan	1	147	-	-
Other countries	++	33	-	-

Figures rounded off

(In tonnes)

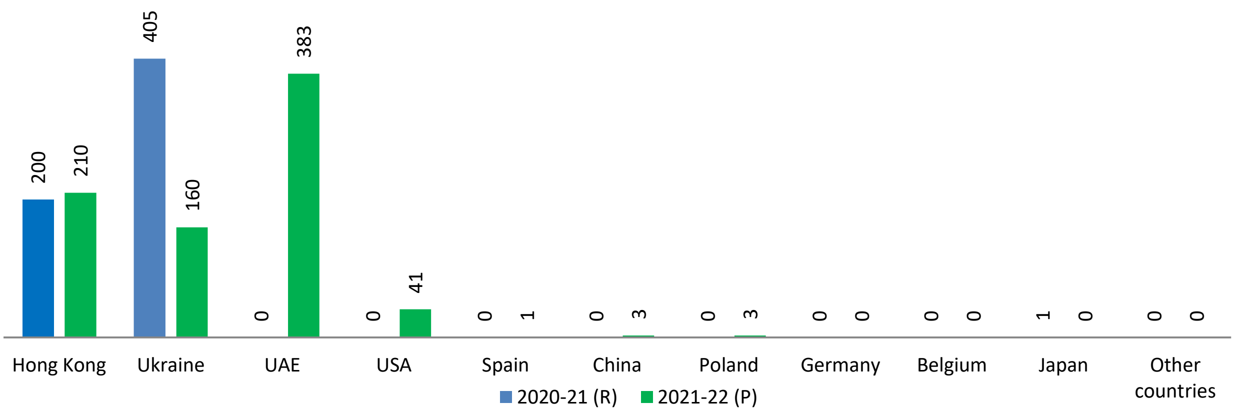


Fig 7: Countrywise Imports of Sillimanite in India

Table – 19 : Imports of Andalusite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**15217**	**428831**	**10419**	**344730**
South Africa	11762	323009	8191	252706
France	3291	100507	1992	81675
USA	150	4534	160	6001
Spain	-	-	48	3657
Ukraine	-	-	28	681
China	++	71	++	10
UAE	14	643	-	-
UK	++	67	-	-

Figures rounded off

(In tonnes)

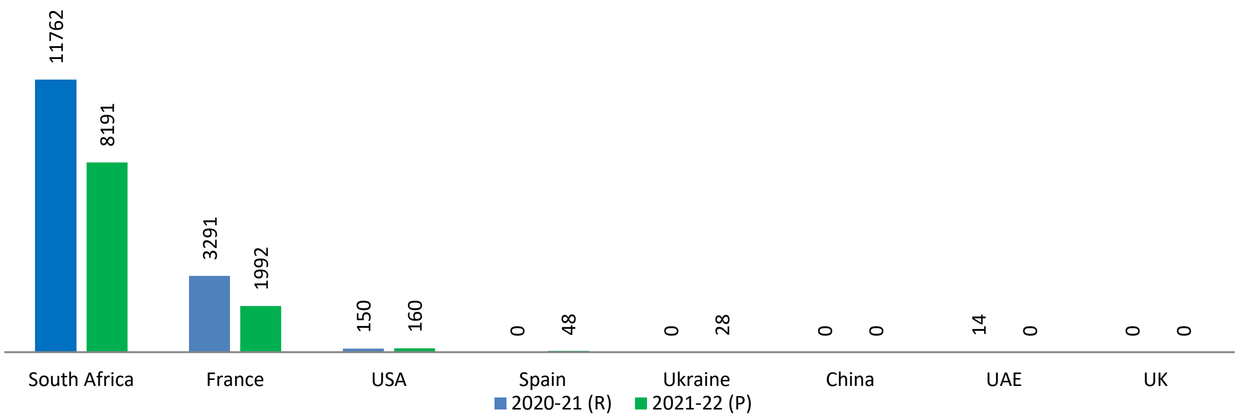


Fig 8: Countrywise Imports of Andalusite in India

FUTURE OUTLOOK

The demand for high quality raw and calcined sillimanite minerals is closely linked to the need for high performance refractories with increased operational lifespans. As the predominant consumer of refractory products, the Steel Manufacturing Industry provides a reliable market indicator of the demand for sillimanite minerals

The Asia-Pacific region remains the largest market for refractories. The production of sillimanite is likely to increase in the coming years to meet the demand. China will remain the leading market on global front. Demand for refractory minerals in India is likely to scale up in commensurate with steel production which is also likely to show an increasing trend.

18. Limestone & Other Calcareous Materials

2.28
(million tonnes) resources were estimated as per NMI database

392
(million tonnes) Production of limestone werre reported in 2021-22.

12.16
(million tonnes) of limestone were exported in 2021-22.

27.58
(million tonnes) of limestone were imported in 2021-22.

Limestone is a sedimentary rock composed mainly of calcium carbonate ($CaCO_3$) in the form of the mineral calcite. About 10 % of sedimentary rocks are limestone and most cave systems are through limestone bedrock. The two most important constituents of Limestone are calcite and dolomite. Limestone often contains magnesium carbonate, either as dolomite $CaMg (CO_3)_2$ or magnesite ($MgCO_3$) mixed with calcite. Such rocks are termed as 'dolomitic' or 'magnesian' imestone. Limestone altered by dynamic or contact meta morphism become coarsely crystalline and are referred to as 'marble' and 'crystalline limestone'.

Other common varieties of limestone are 'marl', 'oolite' (oolitic limestone), shelly limestone, algal limestone, coral limestone, pisolitic limestone, crinoidal limestone, travertine, onyx, hydraulic limestone, lithographic limestone, etc. However, the limestone which is used by industries in bulk quantity is a bedded type sedimentary limestone.

Other calcareous material used by industry are 'limeshell', the thick calcareous shells of molluscs deposited in the form of beds as well as present in ancient lakes and shallow seas. "Marl", a lime-rich mud contains variable amounts of clays and silt.

A limestone rock which separates well along the stratification into a few centimetres thick slab is termed 'flagstone'. The dimensional limestone is used for building and ornamental stone

RESERVES / RESOURCES

The total reserves/resources of limestone of all categories and grades as per NMI database based on UNFC system as on 1.4.2020 has been estimated at 2,27,589 million tonnes, of which 19,028 million tonnes (8%) are placed under Reserves category and 208,560 million tonnes (92%) are under Remaining Resources category. Karnataka is the leading State having 24% of the total resources followed by Andhra Pradesh (13%), Rajasthan (12%), Gujarat (10%), Meghalaya (10%), Telangana (7%), Chhattisgarh (5%) and Madhya Pradesh (4%). The remaining 15% is shared by other states. Grade-wise, Cement grade (Portland) has leading share of about 68% followed by Unclassified grades (11%) and BF grade (6%). The remaining 15% is shared by various other grades [Table-1 (A)].

Table – 1(A) : Reserves/Resources of Limestone as on 01.04.2020 (P)

(By Grades/States)

(In '000 tonnes)

Grade/State	Reserves				Remaining Resources								Total Resou - rces
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India: Total	**14701910**	**1065305**	**3261256**	**19028470**	**7665106**	**6442697**	**9261072**	**7528921**	**32250068**		**9579524**	**208560789**	**227589259**
By Grades													
Chemical	146938	24096	83801	254835	193447	136909	614181	49055	1852736	2334325	17172	5197825	5452660
S.M.S.(O.H.)	84202	544	18824	103570	37598	347821	750421	473258	872586	2351376	12338	4845398	4948968
S.M.S.(L.D.)	27026	64	289	27379	4535	107078	11723	6933	218226	240547	2202	591243	618622
S.M.S.(O.H. & L.D.													
mixed)	143912	-	-	143912	-	-	-	-	69460	167182	-	236642	380554
B.F.	447043	17379	282224	746646	236231	423320	345685	513408	941805	10947453	18551	13426453	14173099
S.M.S. & B.F. mixed	5579	6543	9459	21580	18093	15425	99785	1 5303	139338	712250	240733	1240926	1262506
Cement (portland)	13072953	940605	2699398	16712957	6584396	5046475	6977585	5557939	17983254	89232763	8258746	139641159	156354115
Cement (white)	27140	-	866	28006	2132	7949	3629	-	27225	5862	-	46798	74804
Cement (portland													
& white)	29172	-	26239	55411	14126	7694	67824	338670	60000	516850	39000	1044164	1099575
Cement (blendable													
beneficiable)	479513	3638	105356	588507	284744	204927	198066	75132	2699758	3432109	156607	7051343	7639850
B.F. & cement mixed	6583	-	13281	19864	36032	26131	35249	485	479069	40442	-	617408	637273
S.M.S., chemical													
& paper	182	-	-	182	1732	2174	1329	-	-	1228344	517	1234096	1234278
Paper	53899	-	2375	56274	41846	-	3164	125453	27073	643601	-	841137	897411
Blendable (CaO 34-38%)	-	-	-	-	6641	6730	2762	39760	310215	113006	404770	883884	883884
Others	43886	2312	2516	48714	34178	32246	35476	64646	558849	2687647	27316	3440357	3489071
Unclassified	105382	54583	5127	165092	116840	65050	94908	224091	5666344	19835715	380040	26382988	26548080
Not-known	28500	15540	11502	55542	52535	12767	19286	44789	344129	1343930	21532	1838969	1894511
By States													
Andhra Pradesh	2815170	2133	439387	3256690	1302360	404217	1164592	115264	2129536	1866740	3399422	26582132	29838822
Arunachal Pradesh	-	-	-	-	-	-	-	-	49220	433575	1	482796	482796
Assam	23442	-	164687	188130	170039	27593	100319	67000	39859	1278730	-	1683540	1871670

Grade/State	Reserves				Remaining Resources								Total Resources
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconnaissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
Bihar	11807	-	-	11807	3388	2558	1675	67926	135740	772343	10558	994188	1005995
Chhattisgarh	1364595	65530	56227	1486351	1658144	903350	298720	1456579	1778018	5630057	-	11724867	13211218
Daman & Diu	-	-	-	-	-	-	-	-	-	128670	-	128670	128670
Gujarat	722663	115984	64467	903115	507311	254583	176439	79919	2593098	18317659	160	21929169	22832284
Haryana	-	-	-	-	1425	15507	3382	-	2200	52163	-	74677	74677
Himachal Pradesh	696165	249863	75984	1022012	78403	653158	21105	1529950	5079	3295168	14271	5597134	6619146
*Jammu & Kashmir	156757	15852	12881	185490	122422	45566	58608	67456	26704	1703261	218054	2242071	2427561
Jharkhand	6780	3512	395	10687	74071	50565	11535	91922	13220	356962	11803	610078	620765
Karnataka	1766001	2013	503208	2271221	584131	522239	778646	1776165	15091800	35135248	11008	53899236	56170457
Kerala	10475	-	65	10540	123286	103	-	21161	2888	36622	-	184059	194599
Madhya Pradesh	1252455	128972	311004	1692431	772476	342790	1119260	498580	791417	4128019	308205	7960747	9653178
Maharashtra	528636	137773	34940	701349	765567	235543	126780	69286	681879	1220928	7060	3107044	3808392
Manipur	-	-	-	-	-	-	-	10197	2138	33718	-	46053	46053
Meghalaya	133298	50979	66766	251043	57639	104791	16452	697286	4167752	17819716	720309	23583945	23834988
Nagaland	-	-	-	-	825	-	-	-	1005500	745875	-	1752200	1752200
Odisha	388084	67346	13150	468580	156898	456006	260485	139924	239877	435449	38785	1727424	2196004
Puducherry	-	-	-	-	-	-	-	4433	4333	6966	-	15732	15732
Rajasthan	3299838	220062	1284254	4804154	454148	1838217	4541298	441902	2261727	12946106	1673697	24157095	28961249
Sikkim	-	-	-	-	-	-	-	-	-	2380	-	2380	2380
Tamil Nadu	537272	3836	5915	547024	317801	239742	120594	95885	114647	687457	900	1577025	2124049
Telangana	984751	1450	227926	1214127	509737	142386	299243	118735	893077	11342869	3132280	16438327	17652454
Uttar Pradesh	3720	-	-	3720	-	111910	101510	142763	40000	43540	-	439723	443443
Uttarakhand	-	-	-	-	5035	91872	60429	29486	164879	1191059	33011	1575771	1575771
West Bengal	-	-	-	-	-	-	-	7104	15482	22120	-	44706	44706

Figures rounded off

** Notified as Union Territory and is to be known as Union Territory of Jammu & kashmir comprising the territory of the existing State of Jammu & Kashmir (Gazette Notification No. 53, New Delhi, Friday, August 9, 2019)*

The total reserves/resources of marl of all categories and grades as per NMI database based on UNFC system as on 1.4.2020 has been estimated in Gujarat at 99.20 million tonnes of which 68.15 million tonnes (69 %) are under Reserves category and 31.05 million tonnes (31%) are under Remaining Resources category [Table- 1 (B)].

Table – 1 (B) : Reserves/Resources of Marl as on 01.04.2020

(By Grades/States)

(In tonnes)

Grade/State	Reserves				Remaining Resources								Total Resou - rces
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**50825000**	**17210000**	**110000**	**68145000**	**26474477**	**4189000**	**-**	**-**	**-**	**390000**	**-**	**31053477**	**99198477**
By Grade													
Unclassified	50825000	17210000	110000	68145000	26474477	4189000	-	-	-	390000	-	31053477	99198477
By State													
Gujarat	50825000	17210000	110000	68145000	26474477	4189000		-	-	390000	-	31053477	99198477

Figures rounded off

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION AND STOCKS

Limestone

The production of limestone in 2021-22 at 393 million tonnes increased by about 12.50% as compared to that of the previous year.

There were 689 reporting mines in 2021-22 as against 665 during the previous year. Thirty six mines, each producing more than 3 million tonnes per annum contributed 47 percent of the total production of limestone in 2021-22. The share of 21 mines, each in the production range of 2 to 3 million tonnes was 13% of the total production. 20% of the total production was contributed by 54 mines, each producing 1 to 2 million tonnes annually. The remaining 20% of the total production was reported by 578 mines and 7 associated mines during the year. Ten principal producers contributed about 54% of the total production. About 2.87% of the production was reported by Public Sector mines as against 2.48% in the previous year.

About 97% of the total production of limestone during 2021-22 was of Cement grade and remaining 3% by other grades (Tables-2 to 6).

Table – 2 : Principal Producers of Limestone, 2021-22

Name & address of producers	Location of mine	
	State	District
UltraTech Cement Ltd,	Andhra Pradesh	Kurnool
'B' Wing, Ahura Centre,	Chhattisgarh	Baloda Bazar
2nd Floor, Mahakali Caves Road,		Raipur
Andheri (E)	Gujarat	Amreli
Mumbai-400 093,		Bhavnagar
Maharashtra	Himachal Pradesh	Solan
	Karnataka	Gulbarga
	Madhya Pradesh	Dhar
		Neemuch
		Rewa
		Satna
		Sidhi
		katni
	Maharashtra	Chandrapur
	Rajasthan	Chittorgarh
		Jaipur
		Nagaur
		Pali
	Tamil Nadu	Ariyalur
		Perambalur
	Uttar Pradesh	Sonbhadra
Shree Cement Ltd,	Andra Pradesh	Guntur
Post Box No. 33,	Chattisgarh	Raipur
Bangur Nagar,	Karnataka	Gulbarga
Beawar – 305 901,	Rajasthan	Ajmer
Rajasthan.		Jhunjhunu
		Pali
Ambuja Cement Ltd,	Chhattisgarh	Baloda Bazar
Elegant Business Park,		Raipur
MIDC Cross Road B	Gujarat	Junagadh
Off Andheri Kurla Road,	Himachal Pradesh	Solan
Andheri-(East),	Maharashtra	Chandrapur
Mumbai - 400 059	Rajasthan	Nagpur
Maharashtra		Pali

Name & address of producers	Location of mine	
	State	District
The ACC Ltd, Cement House, 121, Maharshi Karve Road, Mumbai – 400 020, Maharashtra	Chhattisgarh Himachal Pradesh Jharkhand Karnataka Madhya Pradesh Maharashtra Odisha Rajasthan	Bilaspur Durg Bilaspur Singhbhum (W) Gulbarga Katni Yavatmal Bargarh Bundi
Dalmia Cement (Bharat) Ltd, Dalmiapuram, Main Road, Thiruchirapalli-621 651, Kallakudi Lalgudi, Tamil Nadu	Andhra Pradesh Karnataka Meghalaya Madhya Pradesh Odisha Tamil Nadu	Cuddapah Belgaum Jaintia Hills Satna Sundargarh Ariyalur Tiruchirapalli
J.K.Cement Ltd. Kamla Tower, Kanpur-208 001 Uttar Pradesh	Karnataka Rajasthan	Bagalkot Chittorgarh Nagaur
The Ramco Cement Ltd, 5th Floor, Auras Corporate Centre,98-A, Dr Radhakrishanan Salai, Mylapore,Chennai.- 600 004, Tamil Nadu	Andhra Pradesh Karnataka Tamil Nadu	Krishna Kurnool Chitradurga Ariyalur Perambalur Thoothukudi Virudhunagar Ariyalur
J.K. Lakshmi Cement Ltd, 4th Floor, Nehru House 4, Bahadur Sah Zafar Marg, New Delhi-110 002	Chhattisgarh Rajasthan	Durg Siroho
Chettinad Cement Corporation Ltd, House of Chettinad Raniseethai Hall, 5th Floor 603, Anna Salai Chennai-600006	Andra Pradesh Karnataka Tamil Nadu	Guntur Gulbarga Ariyalur Dindigul Karur Perambalur
Wonder Cement Limited., 17, Old Fetahpura Near Seva Mandir Udaipur-313004 Rasthan--313004	Rajasthan	Chittorgarh

Table – 3 : Production of Limestone, 2019-20 to 2021-22

(By States)

(Quantity in '000 tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**359464**	**88890081**	**349120**	**86484948**	**392760**	**97349550**
Andhra Pradesh	42532	9267248	41148	8685149	50260	10444417
Assam	1552	500950	1552	469810	1681	537696
Bihar	556	263446	1000	301961	987	367151
Chhattisgarh	42699	10200663	40378	10139974	41888	11009962
Gujarat	22868	5204303	22227	5080904	23543	4959400
Himachal Pradesh	12527	2746801	12018	2618878	13710	2966412
Jammu & Kashmir*	959	280284	1175	300656	1156	354825
Jharkhand	785	339164	324	233245	72	35005
Karnataka	34165	6672035	33188	6095069	39405	7611350
Kerala	398	342144	376	331191	379	345424
Madhya Pradesh	47118	12332360	46099	12879609	50140	14782552
Maharashtra	14614	3475512	13943	3476065	15757	3869717
Meghalaya	7248	2988280	6029	2689713	6399	2872708
Odisha	5627	1848621	7186	2118507	7059	2410646
Rajasthan	72390	19094468	74266	19449722	87679	22220563
Tamil Nadu	24461	7151088	21144	5813723	21334	6265788
Telangana	26161	5249950	24493	4904676	28502	5620487
Uttar Pradesh	2804	932764	2574	896096	2809	675447

**Formed a new Union Territory to be known as the Union Territory of Jammu and Kashmir comprising the territory of the existing state of Jammu & Kashmir vide Gazette Notification No. 53, New Delhi, Friday, August 9, 2019/Shravana 18,1941 (SAKA).*

Table – 4 : Production of Limestone, 2020-21 and 2021- 22 (by Freguency Groups)

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

Production group (In tonnes)	No.of mines		Production for the group ('000 tonnes)		Percentage in total production		Cumulative percentage	
	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2019-20	2020-21 (P)
All Groups	**665(4)**	**689(5)**	**349120**	**392760**	**100**	**100**	**-**	**-**
Up to 10000	226(3)	230(4)	332	343	0.1	0.09	0.01	0.09
10001-50000	108	102	3037	2951	0.87	0.75	0.97	0.84
50001-100000	61	79	4445	5750	1.27	1.46	2.24	2.3
100001-200000	52(1)	48(1)	7602	7305	2.18	1.86	4.42	4.16
200001-300000	31	26	7827	6512	2.24	1.66	6.66	5.82
300001-400000	23	20	8011	7278	2.29	1.85	8.95	7.67
400001-500000	15	24	6996	10880	2	2.77	10.95	10.44
500001-600000	8	9	4468	5061	1.28	1.29	12.23	11.73
600001-700000	8	13	5312	8525	1.52	2.17	13.75	13.9
700001-800000	9	10	6831	7643	1.96	1.95	15.71	15.85
800001-900000	11	8	9526	6722	2.73	1.71	18.44	17.56
900001-1000000	11	9	10551	8767	3.02	2.23	21.46	19.79
1000001-2000000	49	54	68520	78795	19.63	20.06	41.09	39.85
2000001-3000000	27	21	67999	52717	19.48	13.42	60.57	53.27
3000001 & above	26	36	137663	183511	39.43	46.73	100	100

Figure in parenthesis indicates mines of chalk, dolomite & shale with limestone as an associate mineral.

Table –5 : Production of Limestone, 2020-21 & 2021-22

(By Sectors/States/Districts/Grades)

(Qty in '000 tonnes; Value in ₹ '000)

State/District	2020-21						2021-22 (P)					
	No. of mines	Grades LD, SMS & BF			Total		No. of mines	Grades LD, SMS & BF			Total	
		Cement	BF	Chemical	Qty	Value		Cement	BF	Chemical	Qty	Value
India	**665(6)**	**339449**	**7174**	**2497**	**349120**	**86484948**	**689(7)**	**381294**	**9347**	**2119**	**392760**	**97349550**
Public Sector	**24**	**5409**	**3259**	**-**	**8668**	**3509259**	**19**	**6999**	**4272**	**-**	**11271**	**5007428**
Private Sector	**641(6)**	**334040**	**3915**	**2497**	**340452**	**82975689**	**670(7)**	**374295**	**5075**	**2119**	**381489**	**92342122**
Andhra Pradesh	**68(1)**	**40665**	**483**	**-**	**41148**	**8685149**	**72(1)**	**49685**	**575**	**-**	**50260**	**10444417**
Anantapur	8	4339	15	-	4354	860178	9	5192	9	-	5201	982310
Cuddapah	6	10301	-	-	10301	2051805	6	12103	-	-	12103	2476086
Guntur	13	4360	-	-	4360	831792	12	5424	-	-	5424	1067576
Krishna	10	9627	236	-	9863	2590794	10	11921	300	-	12221	3016235
Kurnool	31(1)	12038	232	-	12270	2350580	35(1)	15045	266	-	15311	2902210
Assam	**2**	**1552**	**-**	**-**	**1552**	**469810**	**2**	**1681**	**-**	**-**	**1681**	**537696**
Karbi Anglong	1	131	-	-	131	44867	1	188	-	-	188	64063
North Cachar Hills	1	1421	-	-	1421	424943	1	1493	-	-	1493	473633
Bihar	**1**	**1000**	**-**	**-**	**1000**	**301961**	**1**	**987**	**-**	**-**	**987**	**367151**
Rohtas	1	1000	-	-	1000	301961	1	987	-	-	987	367151
Chhattisgarh	**57**	**39925**	**453**	**-**	**40378**	**10139974**	**68**	**40983**	**905**	**-**	**41888**	**11009962**
Baloda Bazar	3	5919	-	-	5919	1246777	4	7161	-	-	7161	1627249
Bastar	10	35	++	-	35	12658	10	2	++	-	2	823
Bilaspur	2	130	240	-	370	165784	3	232	627	-	859	342913
Durg	21	6858	213	-	7071	1925455	30	7014	278	-	7292	2162587
Janjgir-Champa	2	1464	-	-	1464	445670	2	1604	-	-	1604	478941
Kabirdham	1	20	-	-	20	12811	1	30	-	-	30	19051
Raipur	18	25499	-	-	25499	6330819	18	24940	-	-	24940	6378398
Gujarat	**91(1)**	**19945**	**-**	**2282**	**22227**	**5080904**	**85(3)**	**21765**	**-**	**1778**	**23543**	**4959400**
Amreli	2	3597	-	-	3597	763013	4	3611	-	-	3611	708884
Bhavnagar	2	210	-	-	210	72145	2	53	-	-	53	12422
Jamnagar	16	2040	-	267	2307	501474	20	1960	-	217	2177	481522
Junagarh	35	6460	-	953	7413	1678614	29	8075	-	868	8943	1900510
Kutch	3	5385	-	-	5385	1164058	3	5906	-	-	5906	1127687

State/District	2020-21						2021-22 (P)					
	No. of mines	Grades LD, SMS & BF			Total		No. of mines	Grades LD, SMS & BF			Total	
		Cement	BF	Chemical	Qty	Value		Cement	BF	Chemical	Qty	Value
Porbandar	30(1)	1884	-	1062	2946	793850	23(3)	1924	-	693	2617	636787
Rajkot	2	99	-	-	99	18825	3	28	-	-	28	12629
Surat	1	270	-	-	270	88925	1	208	-	-	208	79009
Himachal Pradesh	**22**	**11888**	**130**	**-**	**12018**	**2618878**	**23**	**13623**	**87**	**-**	**13710**	**2966412**
Bilaspur	1	3085	-	-	3085	579895	1	4145	-	-	4145	852101
Sirmour	19	657	130	-	787	338730	20	854	87	-	941	384175
Solan	2	8146	-	-	8146	1700253	2	8624	-	-	8624	1730136
Jammu & Kashmir	**18**	**1175**	**-**	**-**	**1175**	**300656**	**16**	**1156**	**-**	**-**	**1156**	**354825**
Anantnag	8	-	-	-	-		7	-	-	-	-	-
Pulwama	7	646	-	-	646	147919	6	614	-	-	614	145080
Srinagar	3	529	-	-	529	152737	3	542	-	-	542	209745
Jharkhand	**4**	**324**	**-**	**-**	**324**	**233245**	**4**	**72**	**-**	**-**	**72**	**35005**
Ranchi	2*	-	-	-	-	-	2*	++	-	-	-	++
Singhbhum (West)	2	324	-	-	324	233245	2	72	-	-	72	35005
Karnataka	**54(1)**	**32835**	**353**	**-**	**33188**	**6095069**	**54**	**39035**	**370**	**-**	**39405**	**7611350**
Bagalkot	37	2919	325	-	3244	830920	34	3299	349	-	3648	978723
Belgaum	4	1858	28	-	1886	434104	6	2326	21	-	2347	541057
Chitradurga	1*	-	-	-	-	-	1*	-	-	-	-	-
Gulbarga	10(1)	28058	-	-	28058	4830045	11	33410	-	-	33410	6091570
Shimoga	1*	-	-	-	-	-	1*	-	-	-	-	-
Tumkur	1*	-	-	-	-	-	1*	-	-	-	-	-
Kerala	**1**	**376**	**-**	**-**	**376**	**331191**	**1**	**379**	**-**	**-**	**379**	**345424**
Palakkad	1	376	-	-	376	331191	1	379	-	-	379	345424
Madhya Pradesh	**144(3)**	**42308**	**3689**	**102**	**46099**	**12879609**	**168(3)**	**45364**	**4684**	**92**	**50140**	**14782552**
Damoh	1	3858	-	-	3858	883581	1	3883	-	-	3883	870234
Dhar	6	2819	-	-	2819	522457	13	3741	-	-	3741	706242
Jabalpur	1	-	29	-	29	11051	1	-	2	-	2	1317
Katni	52(3)	3665	2895	102	6662	2129731	59(3)	4377	3647	92	8116	2761570
Narasinhapur	1	-	28	-	28	5314	1	-	80	-	80	56859
Neemuch	3	3887	-	-	3887	695347	5	4178	-	-	4178	894048
Panna							1*	++			++	199

State/District	2020-21						2021-22 (P)					
	No. of mines	Grades LD, SMS & BF			Total		No. of mines	Grades LD, SMS & BF			Total	
		Cement	BF	Chemical	Qty	Value		Cement	BF	Chemical	Qty	Value
Rewa	10	3847	2	-	3849	1478513	10	3813	1	-	3814	1431710
Satna	66	21986	735	-	22721	6291250	73	23187	954	-	24141	6929425
Sidhi	4	2246	-	-	2246	862365	4	2185	-	-	2185	1130948
Maharashtra	**17**	**13943**	**++**	**++**	**13943**	**3476065**	**20**	**15757**	**++**	**-**	**15757**	**3869717**
Chandrapur	5	10888	-	-	10888	2591866	7	11493	-	-	11493	2474836
Yavatmal	12	3055	++	-	3055	884199	13	4264	++	-	4264	1394881
Meghalaya	**19**	**6029**	**-**	**-**	**6029**	**2689713**	**16**	**6399**	**-**	**-**	**6399**	**2872708**
Jaintia Hills	16	3796	-	-	3796	1169489	14	3922	-	-	3922	1170179
Khasi Hills East	3	2233	-	-	2233	1520224	2	2477	-	-	2477	1702529
Odisha	**7**	**7186**	**+**	**-**	**7186**	**2118507**	**7**	**6993**	**66**	**-**	**7059**	**2410646**
Bargarh	1	841	-	-	841	435886	1	958	-	-	958	514376
Koraput	1	172	-	-	172	51704	1	183	-	-	183	55058
Sundargarh	5	6173	18	-	6173	1630917	5	5852	66	-	5918	1841212
Rajasthan	**39**	**72125**	**2028**	**113**	**74266**	**19449722**	**41**	**84729**	**2638**	**249**	**87679**	**22220563**
Ajmer	2	2341	-	-	2341	550969	2	2337	-	-	2337	606728
Banswara	1	1084	-	-	1084	254656	1	1277	-	-	1277	301582
Bundi	1	1041	-	-	1041	299886	1	1071	-	-	1071	369064
Chittorgarh	11	29173	-	-	29173	7503303	11	34240	-	-	34240	8029329
Jaipur	1	3901	-	-	3901	1283521	1	4697	-	-	4697	1424535
Jaisalmer	2	589	2028	-	2617	1249027	2	1065	2638	-	3703	2035163
Jhunjhunu	1	-	-	-	-	-	1*	++	-	-	-	120
Kota	1	2578	-	-	2578	641856	1	3169	-	-	3169	798599
Nagaur	7	1157	-	113	1270	566906	9	3488	-	249	3737	1283422
Pali	6	18310	-	-	18310	3781328	6	19130	-	-	19130	4096204
Sikar	1*	++	-	-	-	47	1	2	-	-	2	913
Sirohi	3	10425	-	-	10425	2929091	3	12438	-	-	12438	2798957
Udaipur	2	1526	-	-	1526	389132	2	1878	-	-	1878	475884
Tamil Nadu	**89**	**21107**	**37**	**-**	**21144**	**5813723**	**78**	**21313**	**21**	**-**	**21313**	**6265788**
Ariyalur	38	11288	37	-	11325	2747043	37	11419	21	-	11419	2955836
Coimbatore	4		-	-					-	-		
Dindigul	4	2544	-	-	2544	713104	4	2490	-	-	2490	825475

State/District	2020-21						2021-22 (P)					
	No. of mines	Grades LD, SMS & BF			Total		No. of mines	Grades LD, SMS & BF			Total	
		Cement	BF	Chemical	Qty	Value		Cement	BF	Chemical	Qty	Value
Karur	1	529	-	-	529	149645	1	633	-	-	633	218485
Perambalur	17	2576	-	-	2576	706756	16	2207	-	-	2207	652706
Salem	3	479	-	-	479	237120	3	524	-	-	524	162005
Thoothukudi												
(Tuticorin)	4	1070	-	-	1070	575739	5	1091	-	-	1091	584904
Tiruchirapalli	9	2317	-	-	2317	525936	9	2501	-	-	2501	585054
Tirunelveli	3	-	-	-	-	-	2	160	-	-	160	127493
Virudhunagar	6	304	-	-	304	158380	1	288	-	-	288	149830
Telangana	**30**	**24493**	**-**	**-**	**24493**	**4904676**	**31**	**28502**	**-**	**-**	**28502**	**5620487**
Adilabad	2	2950	-	-	2950	583275	3	3480	-	-	3480	748259
Karimnagar	2	957	-	-	957	347573	2	1300	-	-	1300	541750
Nalgonda	22	16676	-	-	16676	3220595	22	18715	-	-	18715	3379762
Rangareddy	4	3910	-	-	3910	753233	4	5007	-	-	5007	950716
Uttar Pradesh	**2**	**2574**	**-**	**-**	**2574**	**896096**	**2**	**2809**	**-**	**-**	**2809**	**675447**
Sonbhadra	2	2574	-	-	2574	896096	2	2809	-	-	2809	675447

Table – 6 : Mine-head Closing Stocks of Limestone, 2020-21 & 2021-22

(By States/Grades)

(In '000 tonnes)

State	2020-21				2021-22 (P)			
	Grades				Grades			
	Cement	LD, SMS & BF	Chemical	Total	Cement	LD, SMS	Chemical & BF	Total
India	19788	2919	1488	24195	22658	3257	1327	27242
Andhra Pradesh	302	105	6	413	227	114	-	341
Assam	21	-	-	21	21	-	-	21
Chhattisgarh	2498	146	-	2644	2381	328	-	2709
Gujarat	1239	-	1348	2587	1529	-	1240	2769
Himachal Pradesh	188	49	-	237	517	13	-	530
Jammu & Kashmir*	226	-	-	226	82	-	-	82
Jharkhand	16	-	-	16	16	++	-	16
Karnataka	2698	628	-	3326	3112	554	-	3666
Kerala	1	-	-	1	1	-	-	1
Madhya Pradesh	4769	1230	51	6050	5484	1585	23	7092
Maharashtra	83	6	++	89	677	1	-	678
Meghalaya	132	-	-	132	71	-	-	71
Odisha	310	413	-	723	408	475	-	883
Rajasthan	5979	221	83	6283	6859	78	64	7001
Tamil Nadu	899	121	++	1020	916	109	++	1025
Telangana	427	-	-	427	357	-	-	357

++: Negligible

**Formed a new Union Territory to be known as the Union Territory of Jammu and Kashmir comprising the territory of the existing state of Jammu & Kashmir vide Gazette Notification No. 53, New Delhi, Friday, August 9, 2019/Shravana 18, 1941 (SAKA).*

Rajasthan was the leading producing State accounting for (22%) of the total production of limestone, followed by Madhya Pradesh and Andhra Pradesh (13%), Chhattisgarh (11%), Karnataka (10%), Telangana (7%) , Tamil Nadu (5%), Gujarat (6%) and the remaining 13% was contributed by Assam, Bihar, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Kerala, Maharashtra, Meghalaya, Odisha and Uttar Pradesh.

Mine-head closing stocks of limestone for the year 2020-21 was 24.19 million tonnes and for the year 2021-22 was 27.24 million tonnes.

Average daily labour employment in limestone mines in 2021-22 was 19,464 as against 20,470 in the previous year.

Limeshell

The production of limeshell is nil during 2021-22 compared to 4600 tonnes in the preceding year.

There were nil reporting mines in 2021-22 as compared to 2 reporting mines in 2020-21.

Mine-head closing stocks of limeshell in the year 2021-22 was 591 tonnes as against 608 tonnes in the previous year.

The average daily employment of labour during the year 2021-22 was nil as against 244 in the previous year (Tables-7 to 9).

Table – 7 : Production of Limeshell, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**4600**	**18730**	**-**	**-**	**100**	**220**
Karnataka		3051	-	-	100	220
Kerala	3538	15679	-	-	-	-

Table – 8 : Production of Limeshell, 2020-21 & 2021-22

(By Sectors/States/Districts)

(Quantity in tonnes; Value in ₹ '000)

State/District	2019-20		2020-21		2021-22 (P)	
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**-**	**-**	**-**	**1**	**100**	**220**
Public sector	-	-	-	-	-	-
Private sector	-	-	-	1	100	220
Karnataka	**-**	**-**	**-**	**1**	**100**	**220**
Uttara Kannada	-	-	-	1	100	220
Kerala	**-**	**-**	**-**	**-**	**-**	**-**

Table – 9 : Mine-head Closing Stocks of Limeshell, 2020-21 & 2021-22

(By States)

State	2020-21	2021-22 (P)
India	**608**	**591**
Karnataka	608	591

Marl

Production of marl during 2021-22 was 1,853 thousand tonnes as compared to 2,216 thousand tonnes in the preceding year. The entire production of marl was reported as an associated mineral with limestone in both the years. There were 9 associate mines reporting production of marl during 2021-22 as compared to 8 associate mines in the previous year. The entire production was reported by Private Sector mines. Entire production of marl during 2021-22 was reported from Gujarat and Tamil Nadu. Mine-head closing stock at the end of 2021-22 was 468 thousand tonnes as against 600 thousand tonnes in the previous year (Tables-10 to 13).

Table – 10 : Principal Producers of Marl, 2021-22

Name & address of producers	Location of mine	
	State	District
*The Ramco cements Ltd, 3rd floor, Auras corporate, Centre-98A, Dr. Radhakrishanan, Salai, Malypore Chennai-600 004	Tamil Nadu	Aryalur
*Ultra Tech Cement Ltd, B-Wing, 2nd Floor, Ahura Centre, Mahakali Caves Road, Andheri (E), Mumbai– 400 093.	Gujarat	Amreli
*Saurashtra Cement Ltd, N.K. Mehta International House,178, Backbay Reclamation, Mumbai-400 020.	Gujarat	Porbandar
*Chettinad Cement Corpn. Ltd, 4th floor, Rani Seethai Hall Building, 603, Anna Salai Chennai-600 006	Tamil Nadu	Aryalur
*Gujrat Sidhee Cement Ltd, N.K. Mehta International House, 178, Backbay Reclamation, Mumbai-400 020.	Gujarat	Jamnagar

**Producing as an associated mineral with limestone*

Table – 11 : Production of Marl, 2019-20 to 2021-22(p)

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**2148854**	**412463**	**2216414**	**417184**	**1853481**	**326498**
Gujarat	1646104	318711	1300333	243556	900560	133211
Tamil Nadu	502750	93752	916081	173628	952921	193287

Table – 12 : Production of Marl, 2020-21 and 2021-22

(By Sector/States/Districts)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**-9**	**2216414**	**417184**	**-8**	**1853481**	**326498**
Private Sector	-9	2216414	417184	-8	1853481	326498
Gujarat	**-5**	**1300333**	**243556**	**-4**	**900560**	**133211**
Amreli	-2	1211651	228179	-2	532155	97161
Jamnagar	-1	23049	2789	-1	-	-
Junagadh	-1	15733	3257	-1	39130	8391
Porbandar	-1	49900	9331	-1	329275	27659
Tamil Nadu	**-4**	**916081**	**173628**	**-4**	**952921**	**193287**
Ariyalur	-4	916081	173628	-4	952921	193287

Figures in parentheses indicate associated mines with limestone

Table – 13 : Mine-head Closing Stocks of Marl, 2020-21 & 2021-22

(By States)

(Qty in tonnes)

State	2020-21	2021-22 (P)
India	**600254**	**468771**
Gujarat	381309	262383
Tamil Nadu	218945	206388

MINING & MARKETING

In India, limestone mines are worked by opencast method. Captive mines are mechanised and supply feed to cement and iron & steel units. Some mines have well-laid road-cum-rail routes. The large mines are developed by forming benches in overburden and limestone bed. The face length, width and height of the benches correspond to the mining machinery deployed and production schedule. Heavy earth-moving machinery like 3.3 to 4 cu.m capacity hydraulic excavators in combination with 10-35 tonnes dumpers are normally used. Other mines are mainly worked by semi-mechanised and manual opencast mining methods. As per MCDR reports, drilling is done by Jack hammer & Wagon drill and blasting is done by ANFO, Slurry explosives, emulsion explosives etc.

Limestone production from Kurnool, Andhra Pradesh and from Adilabad in Telangana is used in paper mills, sugar, cement and steel plants. Tile, mossaic, chip and polished stonemakers also use limestone.

Limestone produced in Bihar is supplied mainly to cement plants, foundries and lime kiln units.

In Raipur and Durg districts of Chhattisgarh, the limestone produced is suitable for Iron & Steel Industry. The Bhilai Steel Plant fulfills its requirements of limestone from Nandini mines in Durg district. The Cement-grade limestone is also produced in the region and there is large cluster of cement plants in and around Raipur.

Limestone produced in Gujarat is consumed mainly in cement and chemical industries and also in textile, foundries and steel plants. The dolomitic limestone in Gujarat is used for making slabs and tiles.

Limestone produced in Himachal Pradesh is supplied to cement plants, paper industry, sugar mills and lime kilns. The limestone production from Bilaspur district is despatched to fertilizer unit of National Fertilizers Ltd (NFL) at Naya Nangal.

Limestone produced in Jammu & Kashmir is suitable for cement manufacturing.

In Karnataka, limestone is supplied generally to paper mills and cement plants. However, limestone of Kalaburagi district, commonly known as 'Shahabad stones', is used as flagstone or flooring stones.

Limestone from Madhya Pradesh is used in cement, sugar, paper, steel and lime industries.

In Maharashtra, apart from cement and sugar industries, limestone is used in Ferromanganese Industry as flux and also in Tanning Industry.

Limestone mined in Rajasthan is consumed in captive cement plants on a large scale. Limestone of Nagaur district is utilised as feed for white cement plants as well as in steel plants as low silica SMS grade flux and in Chemical Industry. Crystalline limestone of Rajasthan is widely known as a decorative ornamental stone. The limestone worked in Bundi district and Raghunathgarh in Jaipur district is an excellent flagstone which find use as paving stone.

The limestone produced in Dehradun-Garhwal areas of Uttarakhand was supplied to Sugar, Paper, Steel, Glass, Chemical and Cement Industries in the past.

Limestone in Tamil Nadu is consumed by various industries like Cement, Steel, Paper, Foundry, Fertilizer and Chemicals.

Limeshell from Kerala is used mainly in Chemical, Cement and White cement Industries. It is also used in the manufacture of polyfibre and in Tanning Industry.

USES

Limestone used for industrial purpose falls under 'major mineral', while the use of limestone in lime kilns and for building purposes comes under 'minor mineral' as per Mines and Minerals (Development and Regulation) Act, 1957.

The threshold value of limestone as per the revised Notification issued by IBM vide No.C- 284/3/CMG/2017 dated 25th April 2018 is CaO 34% (min.) and MgO 5% (max.).

The principal use of limestone is in the Cement Industry. Other important uses are as raw material in the manufacture of quicklime (calcium oxide), slaked lime (calcium hydroxide) and mortar. Pulverised limestone is used as a soil conditioner to neutralise acidic soils (agricultural lime). It is used in sculptures because of its suitability for carving. It is often found in medicines and cosmetics. In some circumstances, limestone is used for glass making.

As a reagent in fuel-gas desulphurisation, it reacts with sulphur dioxide which enables air pollution control. It can suppress methane explosions in underground coal mines. It is added to toothpaste, paper, plastic, paint, tiles and other materials as both white pigment and cheap filler. In blast furnaces, limestone binds with silica and other impurities and facilitates their removal from iron.

Lime is prepared by heating limestone in kilns up to 1,000 ^{o}C. The CO released is effluxed and 'quicklime' (CaO) formed remains as hard white lumps. This when slaked with water and mixed with sand, forms mortar or plaster. Commonly, the commercial lime is prepared as dry hydrated lime $Ca(OH)_2$ by adding to quicklime the right amount of water (18 parts to 56 parts of CaO). The value of lime for most purposes depends upon its CaO (or CaO + MgO) content.

The manufacture of metallic calcium is one of the latest uses of lime. Calcium is used in reducing organic compounds, desulphurising petroleum, debismuthising lead production of hard lead alloys and calcium-silicon alloys, and in the manufacture of calcium hydride which is further used as an efficient hydrogen carrier.

Limeshell is used mainly in Chemical and White Cement Industries. It is also used in the manufacture of polyfibre and in Tanning Industry. Marl is used as lithographic stone.

SPECIFICATIONS

Cement Industry

Cement is a binder, a substance used in construction that sets, hardens and adheres to other materials. Cement used in construction is usually inorganic, often lime or calcium silicate based. Magnesia, sulphur and phosphorus are regarded as deleterious elements. As per end use grade classification of IBM, it is mentioned that as reported by Cement Manufactures Association, limestone containing CaO 44 to 52% and MgO not more than 3.5% should be classified under Portland Cement. Limestone containing 38-44% CaO and up to 5% MgO should be placed under Blendable/Beneficiable Cement. Limestone containing CaO 48% (min.) should be placed under White Cement. The broad chemical specifications of Cement grade limestone (r.o.m.) for cement manufacture suggested by the National Council for Cement and Building Materials, New Delhi, are specified in Table-14.

Table – 14 : Broad Chemical Specifications of Cement Grade (Run-of-Mine) Limeston(Clause 6.1.1)

Oxide component/ Other Constituents	Acceptable range for manufacture of Ordinary Portland Cement (33, 43 & 53 Grade) (per cent)	Limiting values taking into consideration other types of cements, scope of beneficiation and blending (per cent)
CaO	44-52	40 (min.)
MgO	3.5 (max.)	5.0 (max.)
SiO_2	To satisfy LSF, silica	–
Al_2O_3	Modules and alumina	–

Oxide component/ Other Constituents	Acceptable range for manufacture of Ordinary Portland Cement (33, 43 & 53 Grade) (per cent)	Limiting values taking into consideration other types of cements, scope of beneficiation and blending (per cent)
Fe_2O_3	Modules	–
TiO_2	<0.5	<1.0
Mn_2O_3	<0.5	<1.0
R2O ($Na_2O + K_2O$)	<0.6	<1.0
Total S as SO_3	<0.6	<0.8
P_2O_5	<0.6	<1.0
Cl	<0.015	<0.05
Free silica	<8.0	<10.0

Iron & Steel Industry

In Iron & Steel Industry, limestone is used both in blast furnace and steel melting shop as a flux after calcining. It is also added as flux in self-fluxing iron ore sinters. It has two basic functions in steel making, first to lower the temperature of melting and second, to form calcium silicate which comes out as a slag, as it combines with silica in iron ore.

For use in the blast furnace, the calcium carbonate ($CaCO_3$) content in limestone should not be usually less than 90 per cent. The combined SiO_2 and $Al2O_3$ should not exceed 6% though up to 11.5% is allowed, MgO should be within 4% and sulphur & phosphorus as low as possible.

In Steel Melting Shop (SMS), insolubles in limestone should not exceed more than 4 per cent. Good fluxing limestone should naturally be low in acid constituents like silica, alumina, sulphur and phosphorus. Limestone should be dense, massive, preferably fine-grained, compact and non-fritting on burning.

BIS has prescribed specifications for Flux grade limestone for use in steel plants as per IS : 10345 - 2004 (Second Revision; Reaffirmed 2023).

Glass Industry

Glass Industry requires high calcium limestone (94.5% $CaCO_3$) and 97.5% of combined $CaCO_3$ and $MgCO_3$. Iron and other colouring matters are regarded as objectionable and $Fe2O_3$ should be up to 0.20% (max.). For colourless glass, limestone should contain 98.5% $CaCO_3$ (min.), iron content as $Fe2O_3$ should not be more than 0.04%; and for bottle glass, $Fe2O_3$ up to 0.05% is used. The BIS specifications (IS : 997 - 1973),
First Amendment (Reaffirmed Oct. 2022) for limestone for use in Glass Industry are as follows:

Silica as SiO_2	2.5%
Total iron (Fe_2O_3)	
a) Calcite or marble	0.05%
b) Limestone	0.10%
c) Dolomitic limestone or dolomite	0.15%
Lime (as CaO)	53.0%
Total lime and magnesia (as CaO + MgO)	54.50%

Chemical Industry

The calcium carbide manufacturers generally prefer lime containing 95% CaO (min.) with limitations of not more than 3% SiO_2, not more than 0.95% phosphorus and other impurities not exceeding more than 2%. For the manufacture of bleaching powder, lime containing 95% and above CaO is required. The total $Fe_2O_3 + Al_2O_3 + MnO_2$ should be less than 2%; MgO should be below 2%; and SiO_2 less than 1.5%. Bleaching powder is prepared by absorption of chlorine by dry hydrated lime. The hydrated lime should not contain more than 2% excess water. Iron and manganese oxides lead to unsuitability of the product and iron oxides tend to discolour the bleached material. Magnesia renders the bleaching powder hygroscopic. Silica and clay impede solution and settling of bleaching powder.

BIS has prescribed specification for limestone for use in Chemical Industry as per IS: 3204:1978 (First revision, March, 2020).

Sugar Industry

In Sugar Industry, lime is used for clarification of cane and beet juice, viz, removing the impurities from the juice and also for precipitating sugar from impurities. Milk of lime 1% in volume of cane juice is added to pre-heated juice. Limestone used in Sugar Industry must be high in active lime (CaO 80% min.), but low in iron, alumina and silica. Magnesia should be less than one per cent. Excess silica is undesirable because it separates as a gelatinous precipitate which covers the sugar crystals and retards their growth and filtration. Magnesia is objectionable because magnesium carbonate is soluble in sugar juice. Presence of iron tends to colour the finished product.

Fertilizer Industry

Limestone is used only as carrier in the manufacture of calcium ammonium nitrate fertilizer. For this purpose, limestone should contain $MgCO_3$+$CaCO_3$ 85% (min.), SiO_2 5% (max.) and acid insolubles 14% (max.).

Foundry Industry

The chemical requirements of limestone for use in foundries as per BIS specification (IS : 4140 -1978) have been withdrawn.

INDUSTRY & CONSUMPTION

Limestone comprises 95% of core raw material for cement production. As per report of Mines & Minerals- CMA India, around 180-250 kg of coal and about 1.5 tonnes of limestone is required to produce one tonne of cement.

India was the second largest cement producing country in the world after China. The total installed capacity of cement in 2019-20 was thus about 537 million tpy against 532.16 million tpy in the preceding year. Besides, there are three white cement plants having a total 9,90,000 tpy capacity. The total production of cement reached 334.37 million tonnes in 2019-20 registering a negative growth of about 0.87% over that of the preceding year.

In 2019-20, the total cosumption of limestone, as reported by different industries was 328.62 million tonnes which decreased marginally by 5.41% from 347.42 million tonnes in the preceding year. Cement was the major consuming Industry accounting for 308.66 million tonne (94%) consumption, followed by Iron & Steel 12.68 million tonne (4%) and Chemical 5.29 million tonne (2%). Negligible consumption was reported by aluminium, sugar & other industries etc. Consumption of limestone from 2017-18 to 2019-20 is furnished in Table - 15.

Table - 15 : Consumption* of Limestone, 2017-18 to 2019-20

(By Industries)

(in tonnes)

Industry	2017-18	2018-19 (R)	2019-20 (P)
All Industries	**313767100 (216)**	**347421600 (217)**	**328619800 (208)**
Aluminium/Alumina	126100	67200	57800
Cement	295644300	327466600	308659600
Chemical	5116100	5162200	5293100
Iron & Steel	11135600	12723600	12680700
Sugar(c)	780000	858000	648000
Others**	965000	1144000	1280600

Figures rounded off.

** Includes actual reported consumption and/or estimates made wherever required. Due to paucity of data, coverage may not be complete.*
*** Includes, Alloy steel, calcination, ceramic, electrodes, oil well drilling, refractory, petroleum refining, sponge iron fertilizers, ferroalloys, foundry, glass, paper, metallurgy & thermal power.*
( ) Parenthesis indicates total no. of plants

FOREIGN TRADE

Exports

Exports of limestone increased by 245% to 12.16 million tonnes in 2021-22 from 3.53 million tonnes in the previous year. Limestone in bulk was exported mainly to Bangladesh (99%) and Nepal (1%). On the other hand, during the same period, exports of chalk increased moderately by 2% to 1129 tonnes from 1,104 tonnes in the previous year. Chalk was exported mainly to Nepal (92%), Bangladesh (3%), Congo (2%) and EGYPT (2%).

Exports of bleaching powder increased by 44% at 30,919 tonnes in 2021-22 as compared to 21,509 tonnes in the previous year. Bleaching powder was exported mainly to Bangladesh (84%), Sri Lanka and Nepal (4%) besides other countries.

In 2021-22, about 787 tonnes of calcium carbide was also exported as against 129 tonnes in the previous year registering a massive increase of 510 %. Exports were mainly to Bangladesh (89%) and Nepal (7%). (Tables-16 to 19).Exports

Table – 16 : Exports of Limestone

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**3528973**	**42939083**	**12160342**	**4551537**
Bangladesh	3447674	41950799	12112717	3474832
USA	7481	175659	5607	607975
Nepal	17098	106929	17272	105575
UK	31871	379721	6187	93047
Ireland	6136	77425	3049	40362
Korea, Rep. of	3308	34268	3416	30926
China	364	5791	1499	28727
Belgium	1670	21699	2129	24420
UAE	741	21454	641	22522
Ghana	891	9873	1093	14705
Other countries	11739	155465	6732	108446

Figures rounded off

(In tonnes)

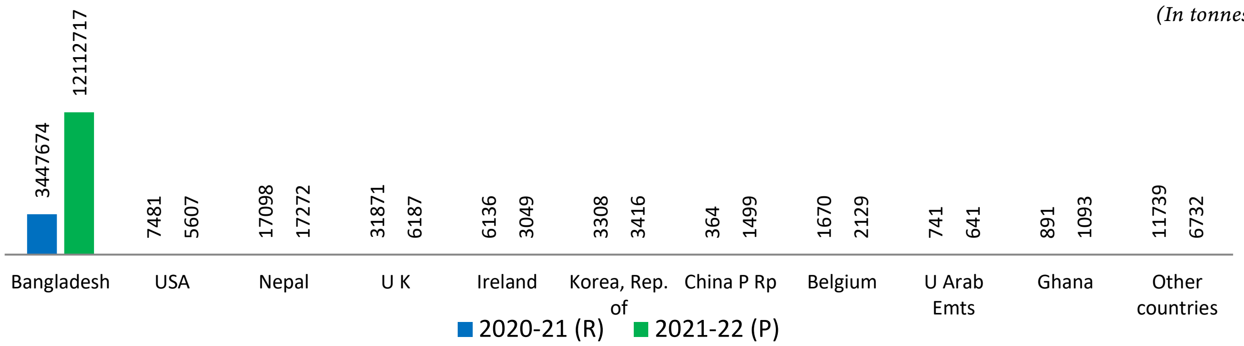


Fig 1: Countrywise Export of Limestone

Table – 17 : Exports of Chalk

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1104**	**6155**	**1129**	**7557**
Nepal	936	4281	1039	5628
Congo D. Rep.	++	5	21	645
Egypt	47	495	28	451
Bangladesh	1	10	33	292
Bhutan	1	12	2	149
Canada	--	--	++	126
Gambia	++	4	4	77
USA	4	25	++	44
Maldives	1	11	++	38
UAE	25	449	1	21
Other countries	89	863	1	86

Figures rounded off

Table – 18 : Exports of Bleaching Powder

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**21509**	**734237**	**30919**	**931596**
Bangladesh	15834	468720	26059	697795
USA	814	71779	732	65150
Sri Lanka	1615	52816	1228	44202
Vietnam	639	40912	355	23880
Nepal	1160	23736	1374	23553
UAE	69	2778	244	21504
Malaysia	484	19394	357	18041
Israel	24	1747	105	10312
Ethiopia	166	6127	133	4647
Egypt	--	--	40	3336
Other countries	704	46228	292	19176

Figures rounded off

Table – 19: Exports of Calcium Carbide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**129**	**11213**	**787**	**97371**
Bangladesh	82	6221	701	89402
Nepal	--	--	48	3202
Djibouti	--	--	22	2360
Bhutan	47	4706	16	2059
Germany	++	30	++	319
Singapore	++	45	++	29
USA	++	109	++	--
Mozambique	++	72	++	--
Saudi Arabia	++	24	--	--
Tanzania	++	4	--	--
Other countries	++	2	--	--

Figures rounded off

Imports

Imports of limestone increased moderately by 21% to 27.58 million tonnes in 2021-22 from 22.79 million tonnes in the previous year. On the other hand , imports of chalk in 2021-22 drastically decreased by 3% to 64 tonnes as against 66 tonnes in the previous year. Limestone was imported mainly from UAE (88%), Oman (8%), Vietnam (2%) and Malaysia (1%), while chalk was imported mainly from France (93%) & Italy (6%).

Imports of calcium carbide decreased marginally by 33% to 22,008 tonnes in 2021-22 from 32,665 tonnes in the previous year. Calcium carbide was imported mainly from China (79%) and Indonesia (20%).The imports of bleaching powder during 2021- 22 decreased by 8% to 31 tonnes as against 34 tonnes in the previous year. Imports were mainly from USA (97%) and Argentina (3%) (Tables-20 to 23).

Table – 20 : Imports of Limestone

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
UAE	**18835897**	**23618001**	**24281405**	**39309027**
Oman	2623396	4505778	2337928	4191555
Malaysia	635579	2739907	648596	3627260
Vietnam	489553	1172453	114659	747183
Egypt	52930	209827	91165	376224
China	7070	120656	7563	244462
Thailand	14338	163346	7952	181001
Philippines	66950	129086	44000	118475
U K	2578	54269	3002	70607
Jordan	--	--	13968	52611
Other countries	69510	198436	32529	96245

Figures rounded off

Table –21 : Imports of Chalk

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**66**	**2661**	**64**	**2197**
France	40	1110	60	1719
Italy	4	381	4	376
Seychelles	--	--	++	53
China	4	182	++	30
USA	--	--	++	17

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
UK	++	1	++	2
Belgium	10	583	--	--
Taiwan	++	179	--	--
Germany	8	167	--	--
Vietnam	++	58	--	--
Other countries				

Figures rounded off

Table – 22 : Imports of Calcium Carbide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	32665	1774852	22008	1576090
China	29248	1580788	17400	1274224
Indonesia	3384	193334	4590	299912
USA	--	--	18	1954
Dominica	33	730	--	--

Figures rounded off

Table – 23 : Imports of Bleaching Powder

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**34**	**5524**	**31**	**6228**
USA	28	3656	30	4824
Argentina	4	1714	1	1400
Japan	2	129	++	4
Switzerland	++	22	--	--
Germany	++	3	--	--

Figures rounded off

FUTURE OUTLOOK

India has huge resources of limestone distributed over different parts of the country. It is comfortably placed in terms of annual capacity and production of cement. Cement-grade limestone occurs in all the limestone-bearing areas, while SMS, BF and Chemical-grade limestones occur in selective areas. Concerted efforts to locate SMS and BF grade limestone along with Cement-grade limestone are imperative to meet the growing demand.

The demand of raw materials for cement, such as, limestone and gypsum is expected to cause disruptive growth in the next few decades. The second largest Cement Industry in the world, the Indian Cement Industry, is expected to grow to an extent of 550 million tonnes per annum of capacity by FY2025.

The demand for paper in India is expected to rise at a healthy rate mainly due to the Packaging Industry and the increasing number of schools. The increasing number of construction projects is expected to lead to a thriving Building and Construction Industry in India. This is expected to contribute 10% to the GDP of India. Also with rising growth in Indian pharmaceutical and Food & Beverage industries, the consumption of calcium carbonate (limestone) in India is expected to increase.

India's domestic demand is being fulfilled as per the Government of India's new policy of allotment of mining blocks through auctioning. Up to 2022-23, a total of 241 blocks were auctioned. Out of these 241 blocks, 74 blocks were limestone blocks.

19. Magnesite

459
(million tonnes) Total reserves/ resources of magnesite were estimated as on 1st April 2020

1,34,495
(tonnes) Production of magnesite were reported in 2021-22.

5,384
(tonnes) of magnesite were exported in 2021-22

5,10,898
(tonnes) of magnesite were imported in 2021-22

Magnesite ($MgCO_3$) is a carbonate of magnesium. It is usually found repeated as an alteration product of serpentine ultramafic rocks and other magnesiumrich rock types formed by replacement of dolomite and dolomitic limestone, as bedded deposits and as irregular veins. Magnesite deposits in India, generally occur as crystalline mass, amorphous and massive. Calcium and silica are the most common impurities found in magnesite along with Fe_2O_3 and Al_2O_3. It is a very important mineral for the manufacture of basic refractories, which could be largely used in the Steel Industry. In commerce, the term 'magnesite' refers not only to the mineral, but also to many products, obtained by calcining the natural carbonate, e.g., caustic magnesite (magnesia obtained by calcining crude magnesite at comparatively low temperatures, 700 to 1,000 o C, and retaining 2 to 7% CO as carbonate) and dead-burnt or refractory magnesite (magnesia obtained by calcining magnesite at high temperatures, 1,500 to 1,800oC, usually containing less than 0.5% CO_2). Pure magnesite calcined at still higher temperatures (1,600–1,800^{0}C) to expel carbon dioxide completely is termed as 'periclase' (MgO) in the trade. The dead burnt magnesite and fused magnesia are used in Refractory Industry to manufacture various refractory products. The caustic magnesia or low calcined magnesite is used as animal feed stuff and in the manufacture of oxichloride cement. The Refractory Industry is the major consumer of magnesite.

RESERVES / RESOURCES

The total reserves/resources of magnesite as per NMI database, based on UNFC system, as on 1.4.2020 is about 459 million tonnes of which Reserves and Remaining Resources are 66 million tonnes and 393 million tonnes, respectively. Substantial quantities of resources are established in Uttarakhand (52%), followed by Tamil Nadu (34%) and Rajasthan (12%). Resources are also located in Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka and Kerala.

Occurrences of magnesite in Tamil Nadu are low in lime and high in silica, whereas those of Uttarakhand are high in lime and low in silica. The Gradewise and Statewise reserves and resources of magnesite are furnished in Table - 1.

Table – 1 : Reserves/Resources of Magnesite as on 1.4.2020

(By Grades/States)

(In '000 tonnes)

Grade/State	Reserves				Remaining Resources								Total Resources
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn-aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**57934**	**6354**	**1782**	**66070**	**80983**	**24858**	**40132**	**59010**	**59652**	**128104**	**309**	**393047**	**459118**
By Grades													
High Grade	-	-	-	-	3277	27	1	2	-	28	-	3336	3336
Medium Grade	55835	6354	1659	63849	75554	21443	5363	64	109	4436	-	106968	170818
Beneficiable/Low	2032	-	122	2154	886	1154	1446	648	31558	117580	264	153537	155691
High & Medium Mixed	-	-	-	-	6	173	2059	-	-	100	-	2339	2339
Medium & Low Mixed	-	-	-	-	-	429	29237	58271	27766	207	-	115910	115910
Others	6	-	-	6	1260	1448	2025	24	-	2501	-	7258	7264
Unclassified	-	-	-	-	-	-	-	-	-	83	-	83	83
Not-known	60	-	-	60	-	184	-	-	219	3170	45	3617	3677
By States													
Andhra Pradesh	-	-	-	-	-	-	-	-	-	80	-	80	80
Himachal Pradesh	-	-	-	-	-	-	-	-	-	298	-	298	298
Jammu & Kashmir	-	-	-	-	3210	740	-	-	-	150	45	4145	4145
Karnataka	997	30	-	1027	802	247	270	88	10	2834	264	4516	5543
Kerala	-	-	-	-	-	-	-	2	-	38	-	40	40
Rajasthan	-	-	-	-	1030	1574	2045	-	149	49293	-	54091	54091
Tamil Nadu	48760	6324	-	55084	71885	21695	3944	17	737	2124	-	100402	155486
Uttarakhand	8177	-	1782	9959	4056	602	33873	58902	58756	73287	-	229476	239434

Figures rounded off

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on Exploration & Development under "General Review".

PRODUCTION

Production of magnesite in 2021-22 was 1,13,495 tonnes increased by 52% as compared to 74661 tonnes in the previous year. There were 10 reporting mines in 2021-22 as against 12 reporting mines in 2020-21. Five principal producers accounted. for about 98% of the total output during the year 2021-22. Out oftotal production, about 54% of magnesite was contributed by the Public Sector and the remaining 46% by Private Sector during 2021-22.

Tamil Nadu is the major producing State with maximum contribution of 71% to the total output during 2021-22 followed by Uttarakhand and Karnataka.

Mine-head closing stocks of magnesite for the year 2021-22 was 54 thousand tonnes as against 67 thousand tonnes in the previous year.

The average daily employment of labour in magnesite mines during the year 2021-22 was 638 as against 642 in the previous year (Tables- 2 to 5).

Table-2: Principal Producers of Magnesite, 2021-22

Name & address of producers	Location of mine	
	State	District
Almora Magnesite Ltd, Village Matela, P.O. Billori, Distt Bageshwar-263 630, Uttarakhand.	Uttarakhand	Bageshwar
S. Sundararajan, 5/22-A, Periyakollapatti Kannankuruchi, Post – Gorimedu, Distt Salem -636 008, Tamil Nadu.	Tamil Nadu	Salem
India Magnesia Product Limited, No. 11/239, Ramakrishna Road, Balaji Towers, 3rd floor, Distt Salem – 636 007, Tamil Nadu.	Tamil Nadu	Salem
N. Rajashekar Talooru Magnasite Mines Talooru Magnasite Mine, Taloor village, Jayapura Hobli, Mysore-571311, Karnataka.	Karnataka	Mysore
Tamil Nadu Magnesite Limited 5/53, Omalur Main Road Jagirammapalayam, Salem-636 302, Tamil Nadu.	Tamil Nadu	Salem

Table – 3: Production of Magnesite, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**102554**	**351947**	**74661**	**314676**	**113495**	**450169**
Karnataka	7198	48309	6611	39237	7057	50138
Tamil Nadu	51147	222293	43613	227494	81012	350856
Uttarakhand	44209	81345	24437	47945	25426	49175

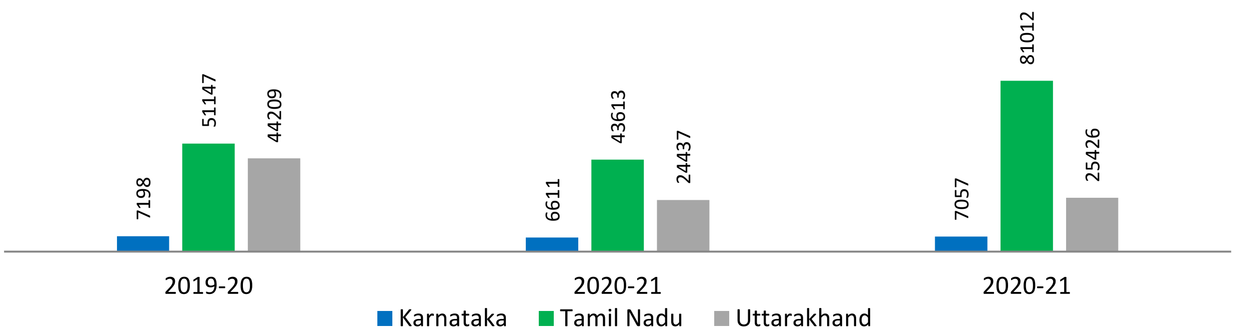


Fig 1 : Statewise Production of Magnesite

Table – 4: Production of Magnesite, 2020-21 and 2021-22

(By Sectors/States/Districts)

(Quantity in tonnes; Value in ₹ '000)

State/District	2020-21			2021-22 (P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**12**	**74661**	**314676**	**10**	**113495**	**450169**
Public Sector	6	30621	115818	5	61322	185659
Private Sector	6	44040	198858	5	52173	264510
Jammu & Kashmir	**1***	**-**	**-**	**-**	**-**	**-**
Udhampur	1*	-	-	-	-	-
Karnataka	**4**	**6611**	**39237**	**3**	**7057**	**50138**
Mysore	4	6611	39237	3	7057	50138
Tamil Nadu	**5**	**43613**	**227494**	**5**	**81012**	**350856**
Salem	5	43613	227494	5	81012	350856
Uttarakhand	**2**	**24437**	**47945**	**1**	**25426**	**49175**
Bageshwar	1	24437	47945	1	25426	49175
Pithoragarh	1	-	-	-	-	
Rajasthan	**-**	**-**	**-**	**1***	**-**	**-**
Pali	-	-	-	1*	-	-

** Only Labour reported*

Table-5: Mine-head Closing Stocks of Magnesite, 2020-21 & 2021-22

(By States)

(In tonnes)

State	2020-21	2021-22 (P)
India	**67330**	**54446**
Jharkhand	1012	-
Karnataka	6223	1786
Rajasthan	30	30
Tamil Nadu	53533	48607
Uttarakhand	6532	4023

MINING AND MARKETING

Magnesite is being worked by open-cast method by developing benches. In Salem area (Tamil Nadu), magnesite is found chiefly as encrustations, veins and stringers in ultrabasic rocks like dunite and peridotite. Stringers and veins occur irregularly in fractures of rocks giving rise to different patterns. Veins are broken and magnesite is sorted out manually. Major magnesite producing mines in Salem area belong to Tamil Nadu Magnesite Ltd (TANMAG a State Government Undertaking), Ponkumar Magnesite Mines, Mysore Minerals, Dalmia Magnesite Corporation (a Private Sector Enterprise) and SAIL Refractory Co. Ltd (a Central Government Undertaking).

These mines are semi-mechanised as well as mechanised and uses compressors, wagon drills, jackhammers, power shovels, loaders, dumpers, dozers and pumps in their mining operations. Normally, Ammonium Nitrate Fuel Oil (ANFO) Mixture with high explosives as booster is used for blasting.

The hand-picked crude magnesite is further subjected to sorting and dressing in the dressing yard. Magnesite lumps which are not considered fit for dressing (containing 10 to 20% silica) constitute 2 to 6% of the run-of-mine. These lumps are hand- picked and stacked separately as rejects. The remaining material is further dressed to obtain usable magnesite containing less than 3% silica. The usable magnesite hardly constitutes 4 to 8% of blasted rocks even though run-of-mine contains 20 to 30% magnesite. In Uttarakhand, Almora Magnesite Ltd and N.B. Minerals Corporation are the important producers having mines in Bageshwar and Nainital districts, respectively. Magnesite is marketed generally after calcination, that is, after converting it into lightly calcined or caustic magnesite and dead- burnt variety.

USES AND SPECIFICATIONS

The major proportion (about 98%) of magnesite mined is used for conversion into calcined form which finds many applications. The other industries where raw magnestite is used are mosaic tiles, electrodes, chemicals and manufacture of magnesium metal. Magnesite is also used in fertilizers and by Food Processing Industry. As per the Industries Department, Govt. of Tamil Nadu, Policy Note 2016-17, about 2.7 tonnes of raw magnesite and 220 litres of furnace oil is required to produce one tonne of Dead Burnt Magnesite (DBM). Raw magnesite is dead-burnt for making basic refractory bricks, basic refractory mortars, ramming mass, tar/pitch impregnated magnesite, magnesia-carbon bricks, slide-gate plates and other refractories. As per the Industries Department, Govt. of Tamil Nadu, Policy Note 2016-17, about 2.7 tonnes of raw magnesite and 140 litres of furnace oil are required to produce one tonne of Caustic Calcined Magnesite (CCM). Caustic Calcined Magnesite is used in manufacturing sorel cement (magnesium oxychloride), castable refractories and extraction of magnesium metal. It is also the source material for manufacture of magnesium compounds like magnesium sulphate (Epsom salt) and other salts used in Paper and Pharmaceutical Industries. In Paper Industry, magnesium bisulphate produced from magnesite is used as cooking liquor for preparing pulp. It is also used in Textile, Rubber, Glass, Ceramic Industries and as animal feed stuff. Fused magnesia finds application as insulating material in tubular heating elements in Electrical Industry and refractory brick linings in steel furnaces.

Refractory Industry

Refractory Industry is one of the major consumers of magnesite in India. In the manufacture of refractories, deleterious constituents are SiO_2, CaO, Fe_2O_3 and Al_2O_3. The permissible limits for these constituents are governed by its end-use. The refractory bricks are made from Dead Burnt Magnesite by judicious blending of different types of raw magnesite before dead-burning or of different qualities of Dead Burnt Magnesite prior to brick making.

Indian steel plants use domestic DBM bricks containing up to 5% silica and 2.5% maximum CaO. By and large, Indian refractory makers prefer magnesite for making high-grade DBM containing MgO 45.5% (min.), SiO_2 (max.). 2.5% (max.) and CaO 1.5%

Chemical Industry

The BIS has prescribed specification - IS : 3607- 1979, First Revision, Reaffirmed 2010, for magnesite to be used in Chemical Industry.

CONSUMPTION

The apparent consumption of Magnesite in 2021-22 was about 0.63 million tonnes as against the 0.43 million tonnes during preceding year, i.e., increased by about 47 % in 2021-22.

The BIS has prescribed the IS specification (14303-1995, Reaffirmed 2011) for magnesite for use in Refractory Industry.

INDUSTRY

Dead Burnt Magnesite (DBM)

Raw magnesite when calcined at temperatures in the range of 1,660–1,800 °C in the rotary kiln, carbon dioxide gets expelled completely and a dense product 'Dead Burnt Magnesite' is obtained. Dead Burnt Magnesite refers to the magnesite that is chemically unreactive or 'dead', therefore, enabling it to be used in brick making or monolithic hearths without undue difficulty arising out of hydration or shrinkage.

Caustic Calcined Magnesite (CCM)

Low calcined magnesite also known as Caustic Calcined Magnesite is obtained by calcining magnesite in a shaft or rotary kiln at temperature ranging between 800°C and 1,000°C. The incomplete dissociation causes retention of 8 to 10% carbon dioxide as carbonate. Low calcined magnesia when mixed with water forms a feebly plastic paste. Industries like paper, rubber, ceramic, asbestos products, glass, etc. use caustic magnesia.

Fused Magnesia

Fused magnesia is produced by the fusion of the high-grade magnesite in Higgin's or electric arc tilt furnaces between 2,500 oC and 3,000 oC. It is resistant to the action of molten metals, basic slags and fluxes and high temperatures. It is used in the form of moulded vessels and as compressed material for covering resistant elements of the furnaces used in the melting of lead, tin, etc.

As per the available information, presently there are seven major plants that manufacture Dead Burnt Magnesite, while there are four plants that produce calcined magnesite and one that produces fused magnesia (Table-6).

Table -6: Manufacturing Plants of Dead Burnt Magnesite (DBM), Calcined Magnesite, etc.

Name of the plant	Location	Installed capacity (tpy)
Tamil Nadu Magnesite Ltd (TANMAG)	Salem, Tamil Nadu	30,000 (DBM) 19,500 (calcined magnesite)
Ramakrishna Magnesite Mines (Two Units)	-do-	21,600 (calcined magnesite)
SAIL Refractory Co. Ltd	-do-	54,000 (DBM)
(Formerly, Burn Standard Co.Ltd)		18,000 (calcined magnesite)
Dalmia Magnesite Corporation	-do-	72,000 (DBM)
Sri Ponkumar Magnesite Ltd	-do-	26,500 (DBM)
Almora Magnesite Ltd	Bageshwar, Uttarakhand	24,000 (DBM)
Minerals & Refractories	Haldwani,Uttarakhand	3,000 (DBM)
Hansaflon Plastochem Ltd	NA	1,500 (Fused

By- product magnesium carbonate and other magnesium salts were also produced during salt manufacturing from sea water. Dalmia Magnesite Corporation and Tamil Nadu Magnesite Ltd are the major producers of DBM and caustic calcined grades.

Sea Water Magnesia (SWM)

Sea water or lake bitterns is an alternative source to obtain magnesia by chemical reaction. Key raw materials required other than sea water are dolomite or limestone, fresh water and sulphuric acid. The magnesia content of sea water is about 0.2%, and even by enrichment with dolomite, around 300 kilograms sea water need to be processed to obtain one kilogram of magnesia. The sea water magnesia can be used to manufacture Dead Burnt Magnesite, caustic magnesia and other magnesium compounds.

Marine By-products

Carbonates, chlorides and sulphates of magnesium are obtained as by-products in the production of common salt by solar evaporation. The production is normally reported from the salt pans in Jamnagar–Gandhidham, Gujarat.

Magnesium Metal

Magnesium metal is a fairly strong, silvery-white, light-weight metal (about one-third lighter than aluminium). It is traditionally produced in ingot form of approximately 7 kg each with purity close to 99.9%. Its chief applications are, in die casting (alloyed with zinc), to remove sulphur in the production of iron and steel, for production of titanium in the Kroll process. The other application field of magnesium is in electronic devices. Defence equipment and nuclear reactor materials also consume magnesium.

Magnesium technology and its commercial production in India are still at its infancy. India has developed silico-thermic reduction process as well as fused salt electrolytic process, with capacity of 600 t/year for each process. However, the cost of production is very high as compared to the landed cost of imported magnesium metal. Hence, its production has been stopped by one of the companies. The production is only about 15–20% of the rated capacity.

TRADE POLICY

As per import policy of ITC (HS) 2022 in schedule-1 and export policy of ITC (HS) 2022 schedule-2 , Natural magnesium carbonate (Magnesite); fused magnesia,dead-burned (Sintered) Magnesia, whether or not containing small qualities of other oxides added before sintering; other magnesium oxide,whether or not pure are allowed freely widthout restrictions.

WORLD REVIEW

The world reserves of magnesite were 6,800 million tonnes in terms of magnesium oxide content, excluding large resources of magnesium-bearing substitutes, such as, dolomite, brucite and olivine. Further, magnesium compounds could be recovered economically from well & lake brines and from sea water. Out of the total world reserves, the major share was that of Russia (34%) followed by China (8%), Slovakia (5%), Australia & Greece (4% each) and Brazil (3%) (Table-7).

Table – 7: World Reserves of Magnesite

(By Principal Countries)

(In '000 tonnes of magnesium oxide (MgO) content)

Country	Reserves
World : Total (rounded off)	**6800000**
Australia	290000*
Austria	49000
Brazil	200000
Canada	NA
China	580000
Greece	280000
India	82000
Iran	12000
Russia	2300000
Slovakia	370000
Spain	35000
Turkey	110000
USA	35000
Other countries	2500000

Source: USGS, Mineral Commodity Summaries, 2023

**For Australia, Joint Ore Reserves Committee-compliant or equivalent reserves were 37 million tonnes*

The world production of magnesite was at 34.30 million tonnes in 2021. China continued to be the leading producer accounting for about 61% production, followed by Australia (8%), Russia (7%) and Brazil & Turkey (6% each). The world production of magnesite is furnished in Table-8.

Table–8: World Production of Magnesite

(By Principal Countries)

(In tonnes)

Country	2019	2020	2021
World Total (rounded off)	**30300000**	**29700000**	**34300000**
China[e]	19000000	19000000	21000000
Australia[d]	433712	820057	2735767[e]
Russia[e]	2600000	2600000	2600000
Brazil[C]	2962000	1993600	2000000[e]
Turkey	1496081	1560818	1927280
Austria	691909	816370	844226
Spain	634580	626055	703834
Slovakia	615200	516900	576700
Greece	365792	275100	309600
Other countries	1496834	1488921	1637562

Source: BGS, World Mineral Production, 2017-21.
e: Estimated

c: Including beneficiated and directly shipped material

d: Year ended 31 March following that stated

China, Australia, Russia, Brazil and Turkey had the largest magnesite production capacity and accounted for about 88% of the total world production.

To provide a generalised view of the development in various countries, the country-wise description sourced from the latest available publication of magnesium Compound Minerals Yearbook 'USGS' 2018 is furnished below.

Australia

Archer Exploration Ltd. announced the sale of the Leigh Creek magnesite project for $2 million to Australian Consolidated Venture Capital Pty., Ltd. The project is located approximately 500 kilometers north of Adelaide, South Australia. Archer had sought to produce dead-burned and caustic-calcined magnesia from magnesite ore, but its inability to secure long-term access to a kiln was cited as the reason to sell the property.

Canada

West High Yield Resources Inc. continued an environmental study and a mine permit application for its proposed Record Ridge project in British Columbia. The company planned to build a mine and processing facility to produce magnesia from a serpentine deposit.

China

The enforcement of environmental regulations by the Government of China in 2017 brought about the temporary closure of 80% to 90% of magnesia production capacity in China's major magnesia- producing region. The government of Haicheng, within Liaoning Province, took ownership and consolidated 42 magnesia companies into the Liaoning Magnesite Mining Company. The newly formed company controlled government permits and activities including mining, processing, sales, and trade. The consolidation provided the local government with the means to direct sustainable growth for the magnesia market within the region. The plant included a dolomite mine and production facilities. Haicheng Guotian Mining Co., Ltd., Refratechnik Holding GmbH, and Yingkou Jinlong Refractories Group Co., Ltd. formed a joint venture to produce high-grade caustic-calcined magnesia and dead-burned magnesia.

FOREIGN TRADE

Exports

The exports of magnesite decreased by 2% to 5,384 tonnes in 2021-22 from 5,477 tonnes in the preceding year. Exports were mainly to Malaysia (34%), Bangladesh (16%), Thailand (7%), Singapore & Ethiopia (6% each) and UAE (5%) . Out of the total exports in 2021-22, those of fused magnesia were at only 2 tonnes as compared to 41 tonnes in the preceding year; non-calcined magnesite were at 436 tonnes as compared to 220 tonnes; other magnesite 2,735 tonnes as compared to 3,468 tonnes; and magnesium oxide 1,886 tonnes as compared to 1,646 tonnes in the preceding year. Exports of Unwrought Magnesium and Waste & Scrap of Magnesium were at 6,997 tonnes in the year 2021-22 as compared to 1,249 tonnes in the preceding year. Exports were mainly to USA (44%), Turkey (20%), Netherlands (12%), Brazil (7%) and UAE (4%). The total exports of magnesium powder and flakes was 1 tonne in 2021-22 which was the same as preceding year. The exports of Magnesium & alloys wrought was 132 tonnes in 2021-22 as compared to negligible in the preceding year (Table-9 to 21)

Table – 9 : Exports of Magnesite : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**5477**	**171020**	**5384**	**173809**
Bangladesh	731	24355	857	36145
Thailand	201	11300	378	21512
Malaysia	2502	22498	1809	19347
Singapore	367	19322	318	14831
UK	105	27574	45	12431
Ethiopia	67	2224	313	9854
UAE	247	3368	294	9781
China	293	29547	152	7038
Egypt	5	1218	12	4734
Djibouti	24	789	130	4552
Other countries	935	28825	1076	33584

Figures rounded off

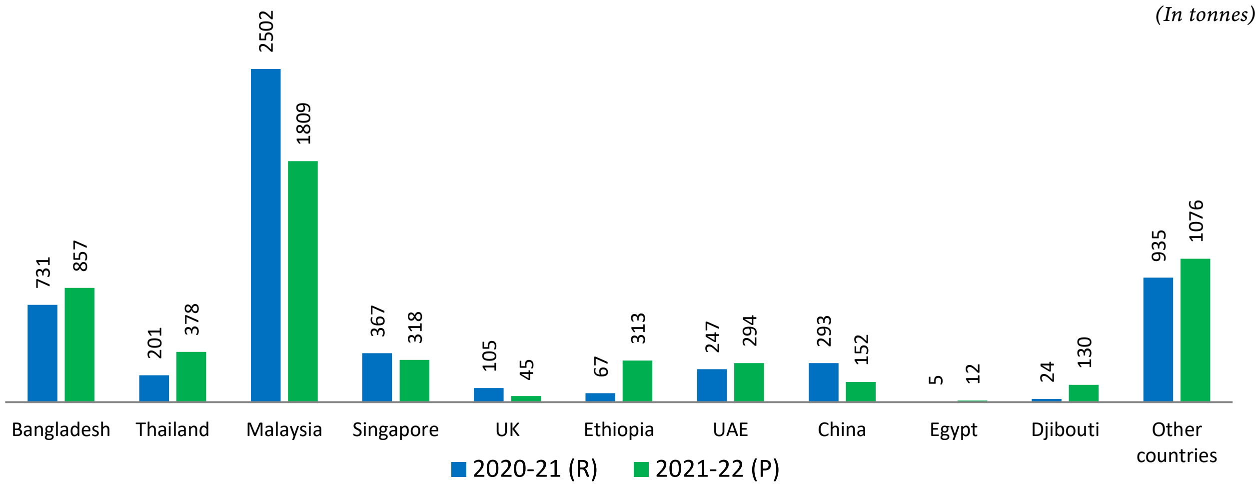


Fig 2:Countrywise of Exports of Magnesite

Table – 10: Exports of Magnesia (Fused)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**41**	**863**	**2**	**585**
UAE	++	130	++	372
Sri Lanka	++	1	2	137
Qatar	-	-	++	14
Zimbabwe	-	-	++	11
Germany	-	-	++	10
South Africa	-	-	++	10
Peru	-	-	++	8
Singapore	++	11	++	7
USA	++	++	++	7
Sudan	-	-	++	4
Other countries	41	721	++	5

Figures rounded off

Table–11: Exports of Magnesite (Calcined)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**100**	**2102**	**117**	**5014**
Cameroon	-	-	54	2120
Nepal	2	45	26	861
Australia	19	653	18	776
Nigeria	68	859	7	404
Vietnam	5	193	9	372
Korea	-	-	++	249
USA	1	144	1	88
Spain	2	99	1	77
Turkey	3	109	1	45
Malawi	-	-	++	22

Figures rounded off

Table – 12: Exports of Magnesite: Dead Burnt Magnesite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2**	**93**	**208**	**6829**
UAE	-	-	144	4333
Oman	-	-	16	833
Bangladesh	-	-	16	584
Indonesia	-	-	20	508
Australia	2	79	7	300
Senegal	-	-	4	171
Malaysia	-	-	1	100
France	++	9	-	-
Nepal	++	5	-	-

Figures rounded off

Table–13: Exports of Magnesite (Non-calcined)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**220**	**5202**	**436**	**11483**
Bangladesh	193	3597	294	5639
UAE	-	-	3	2395
Kenya	++	16	80	1638
Ethiopia	-	-	54	1584
Sudan	-	-	4	101
Nigeria	-	-	1	100
Nepal	++	4	++	23
UK	++	7	++	3
Turkey	-	-	++	++
Djibouti	24	789	-	-
Other countries	3	789	-	-

Figures rounded off

Table – 14: Exports of Magnesium Oxide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1646**	**119899**	**1886**	**110791**
Bangladesh	193	11473	277	22479
Thailand	166	10683	354	20500
Singapore	367	19311	313	14528
UK	105	27567	45	12428
Ethiopia	61	2155	259	8270
China	293	29547	152	7038
Djibouti	-	-	130	4552
Egypt	5	1170	8	3356
Netherlands	100	2089	75	2622
Taiwan	11	625	43	1688
Other countries	345	15279	230	13330

Figures rounded off

Table – 15: Exports of Magnesium and Articles thereof, including waste and scrap

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1266**	**143710**	**7269**	**1314210**
USA	332	43330	3208	564272
Turkey	410	30172	1428	151302
Netherlands	182	19689	873	174376
Brazil	++	125	619	118590
UAE	21	4497	309	141441
Germany	3	4344	251	38703
Italy	-	-	210	24929
Korea, Rep. of	++	40	159	20119
Australia	++	187	2	30475
Nepal	10	7133	50	20917
Other Countries	308	34193	160	29086

Figures rounded off

Table-16: Exports of Magnesium Powders and Flakes

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1**	**522**	**1**	**1405**
Malaysia	++	195	1	1111
Brazil	-	-	++	103
Japan	-	-	++	87
South Africa	-	-	++	25
UK	-	-	++	22
Yemen Republc	-	-	++	20
Bangladesh	-	-	++	13
Singapore	++	10	++	8
Mexico	-	-	++	7
Egypt	-	-	++	3
Other Countries	1	317	++	6

Figures rounded off

Table – 17: Exports of Magnesite (Other)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**3468**	**42861**	**2735**	**39107**
Malaysia	2502	22498	1808	19213
Bangladesh	345	9285	270	7443
Vietnam	-	-	270	2446
Nepal	138	1154	57	1874
UAE	245	2923	121	1521
Kenya	++	95	76	1473
Egypt	++	48	4	1378
USA	1	1081	++	1184
Thailand	35	617	24	1010
Myanmar	-	-	96	823
Other countries	202	5160	9	742

Figures rounded off

Table-18: Exports of Magnesium & Alloys Wrought

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**585**	**132**	**50929**
USA	++	242	102	22504
Nepal	-	-	29	14027
Australia	-	-	1	13683
UK	++	262	++	516
Belgium	-	-	++	49
Poland	-	-	++	42
UAE	-	-	++	27
France	-	-	++	26
Korea, Rep. of	-	-	++	24
Germany	-	-	++	21
Other Countries	++	81	++	10

Figures rounded off

Table-19: Exports of Magnesium & Alloys NES

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**585**	**132**	**50929**
USA	++	242	102	22504
Nepal	-	-	29	14027
Australia	-	-	1	13683
UK	++	262	++	516
Belgium	-	-	++	49
Poland	-	-	++	42
UAE	-	-	++	27
France	-	-	++	26
Korea, Rep. of	-	-	++	24
Germany	-	-	++	21
Other Countries	++	81	++	10

Figures rounded off

Table-20: Exports of Magnesium Wire

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**986**	**++**	**679**
Australia	++	167	++	364
Germany	-	-	++	171
Malaysia	-	-	++	124
South Africa	++	11	++	11
UAE	-	-	++	6
Nepal	-	-	++	2
Zambia	-	-	++	1
USA	++	568	-	-
Saudi Arabia	++	216	-	-
Israel	++	12	-	-
Other Countries	++	12	-	-

Figures rounded off

Table-21: Exports of Unwrought Magnesium and Waste & Scrap of Magnesium

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1249**	**129904**	**6997**	**1217881**
USA	322	39658	3106	541721
Netherlands	182	19652	873	174376
Turkey	410	30172	1428	151301
UAE	21	4497	309	141408
Brazil	++	125	502	90936
Germany	-	-	251	31926
Italy	-	-	210	24929
Korea, Rep. of	-	-	159	20054
Australia	++	16	1	16428
Slovenia	250	17128	100	7273
Other Countries	64	18656	58	17529

Imports

The imports of magnesite (total) increased by 40% to 5,10,898 tonnes in 2021-22 from 3,64,577 tonnes in the preceding year. Imports were mainly from China (48%), UAE (28%), Turkey (10%), Australia (6%) and Saudi Arabia. (4%). Out of the total imports in 2021-22, those of fused magnesia were at 42,306 tonnes as compared to 25,215 tonnes in the preceding year; non-calcined magnesite were at 1,36,894 tonnes as compared to 57,993 tonnes; other magnesite 49,392 tonnes as compared to 25,379 tonnes; magnesium oxide 67,331 tonnes as compared to 63,442 tonnes; and Dead burnt magnesite were at 1,70,744 tonnes as compared to 1,33,034 tonnes in the preceding year. Imports of Unwrought Magnesium and Waste & Scrap of Magnesium were at 21,966 tonnes as compared to 17,692 tonnes in the preceding year. Imports were mainly from China (88%) and Hong Kong (8%). The total imports of magnesite powder and flakes in the year 2021-22 was at 1,737 tonnes as compared to 2,657 tonnes in the preceding year. The imports of magnesium & alloys wrought were at 234 tonnes during 2021-22 as compared to 278 tonnes in the preceding year (Tables-22 to 32).

Table – 22: Imports of Magnesite : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All countries	**364577**	**7657838**	**510898**	**13106490**
China	221089	4071438	243309	7987513
Australia	25781	1140647	30489	1548995
Turkey	28264	898836	50385	1383189
UAE	56124	146471	142056	407036
Saudi Arabia	10626	228236	21979	346323
Japan	2545	299721	2205	266456
Netherlands	1384	85953	2770	162528
Israel	904	103896	1147	148430
Germany	387	51772	935	106799
Belgium	116	26328	366	101979
Other Countries	17357	604540	15257	647242

Figures rounded off

(In tonnes)

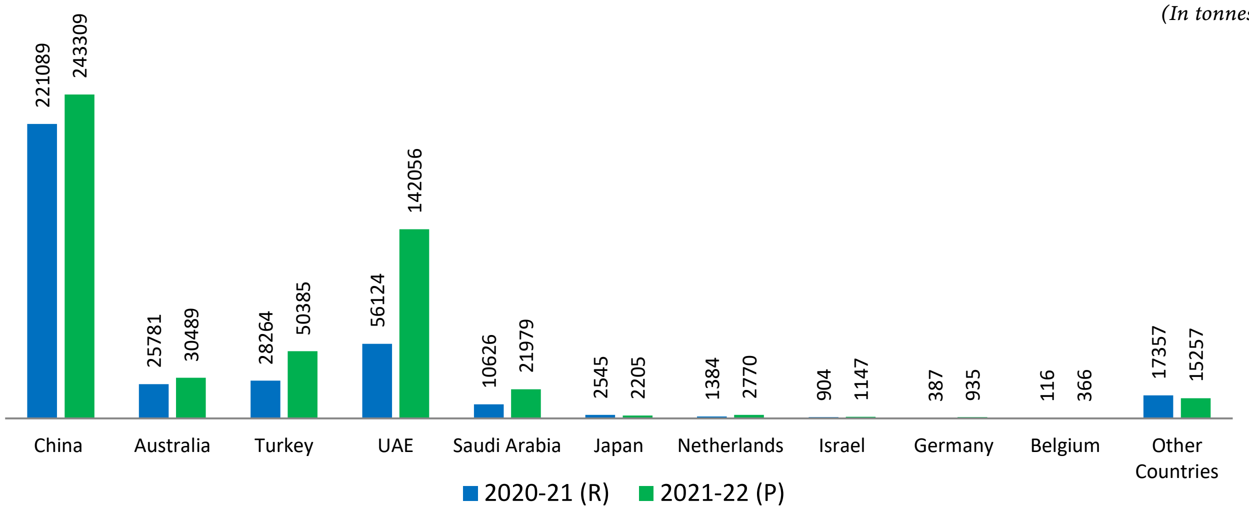


Fig 2:Countrywise of Exports of Magnesite

Table – 23: Imports of Magnesia (Fused)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**25215**	**1135547**	**42306**	**2614441**
China	23796	1033008	40235	2436588
UK	251	36436	262	41205
Japan	-	-	420	27258
Germany	168	14923	93	26921
Greece	192	10301	480	25675
Mexico	60	10094	80	13830
Australia	415	12020	461	11818
Belgium	8	2292	30	10137
Hong Kong	246	10363	92	10105
Russia	60	2620	120	7691
Other countries	19	3492	33	3213

Figures rounded off

Table – 24: Imports of Magnesite (Non-calcined)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**57993**	**159537**	**136894**	**317688**
UAE	49476	100380	128148	260705
Turkey	1545	15323	1948	20605
Saudi Arabia	2227	8543	4477	17352
Oman	825	5029	2078	14803
Japan	6	648	14	1912
Malaysia	2941	20114	223	1584
Israel	-	-	1	426
South Africa	-	-	5	301
China	379	4574	-	-
Iran	550	3116	-	-
Other countries	44	1810	-	-

Figures rounded off

Table–25: Imports of Magnesite (Calcined)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**59515**	**919930**	**44231**	**940743**
China	49453	529490	34950	642450
Saudi Arabia	3219	125976	2514	109802
Turkey	216	13572	4310	96343
Hong Kong	2008	26479	1224	26896
Spain	757	25269	554	18669
Belgium	63	5742	144	13357
Netherlands	100	6882	195	13201
Japan	555	46546	25	6393
USA	-	-	100	6330
Greece	120	4273	60	2363
Other countries	3023	135701	155	4939

Figures rounded off

Table–26: Imports of Magnesite: Dead Burnt Magnesia

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**133034**	**3360002**	**170744**	**5340576**
China	79856	1280794	85758	2249813
Australia	25350	1127409	30028	1537177
Turkey	25620	851761	39582	1197158
Saudi Arabia	494	9021	10270	136939
Netherlands	910	57624	1990	115594
Marshall Island	-	-	1496	29702
USA	101	8881	286	22728
Jordan	243	5729	425	10730
Greece	164	5093	268	8874
Japan	40	2782	120	8812
Other countries	256	10908	521	23049

Figures rounded off

Table–27: Imports of Magnesite (Other)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**25379**	**680448**	**49392**	**1825575**
China	13512	398884	28295	1399711
UAE	6648	46090	11766	91655
Turkey	883	18180	4521	68439
Ireland	1346	58928	1000	60823
Greece	1839	67137	1188	46331
Germany	48	12232	371	36907
Netherlands	350	19218	571	32488
Russia	++	23	559	29282
Japan	393	37216	251	26488
USA	2	558	27	7860
Other countries	358	21982	843	25591

Figures rounded off

Table – 28 : Imports of Unwrought Magnesium and Waste & Scrap of Magnesium

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**17692**	**2839776**	**21966**	**7650925**
China	16603	2666630	19442	7007752
Hong Kong	501	80745	1709	368697
Br Virgn Is	377	57013	394	122044
Singapore	20	3612	218	111790
UAE	160	26769	85	30741
USA	-	-	82	4895
Ghana	-	-	14	1574
Malaysia	-	-	20	1405
Japan	++	300	1	1233
Austria	-	-	1	794
Other Countries	31	4707	++	++

Figures rounded off

Table –29 : Imports of Magnesium Oxide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**63442**	**1402374**	**67331**	**2067467**
China	54093	824688	54071	1258951
Japan	1551	212529	1375	195593
Israel	904	103896	1038	145808
Saudi Arabia	4686	84696	4718	82230
Belgium	44	17890	188	77650
UAE	++	1	2109	51675
USA	304	26992	622	48789
Mexico	531	43110	510	45918
Russia	39	3427	316	38020
Germany	171	24475	256	34096
Other countries	1119	60670	2128	88737

Figures rounded off

Table – 30 : Imports of Magnesium & Alloys:Wrought

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**278**	**85883**	**234**	**103587**
China	113	48769	125	59388
Hong Kong	158	31833	108	40513
UK	-	-	1	3356
USA	-	-	++	330

Figures rounded off

Table – 31 : Imports of Magnesium & Alloys NES

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**5214**	**1195416**	**4908**	**2198220**
China	5115	880335	4751	1702051
Hong Kong	70	229632	101	401683
UK	++	22039	1	38000
Singapore	-	-	48	27412
Macao	9	51643	3	19678
Austria	3	4061	2	3749
Taiwan	++	1605	++	2539
USA	++	9	2	2483
Italy	-	-	++	518
Germany	++	214	++	98
Other Countries	17	5878	++	9

Figures rounded off

Table – 32: Imports of Magnesium Powder & Flakes

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2657**	**482988**	**1737**	**489485**
China	2369	383378	1699	450049
Belgium	57	57052	38	38601
Turkey	149	26023	++	371
Germany	16	4395	++	256
Austria	-	-	++	147
UK	-	-	++	36
USA	++	67	++	25
Russia	66	12039	-	-
Japan	++	26	-	-
UAE	++	8	-	-
Other Countries	-	-	-	-

Figures rounded off

FUTURE OUTLOOK

The Refractory Industry that consumes magnesite to a large extent is experiencing a range of challenges. However, in India, the demand for refractories is not only promising but also encouraging as it rides on the prospects of the Cement and Steel Industries, the growth of which is projected to show an upward trend in the near future. The demand for magnesite is, therefore, likely to grow correspondingly.

As Indian magnesite generally contains either high silica or high lime, the need for beneficiation concomitantly arises.

Beneficiation methods of magnesite at economic cost which could yield high-grade material is probably a viable way to meet the demand for magnesite in the future.

India's Refractory Industry is set to continue its expansion and is likely to benefit from the Government's series of measure spitched specifically to stimulate the infrastructure development in the country. As the demand for magnesite is expected to rise, significant steps to explore and exploit magnesite to meet the future demand would be the right way forward.

As, fused magnesia is expected to contribute high share among all product types of magnesite and thus increase the growth of the market in forecast years. Furthermore, magnesite's use as an additive in the cement industry is majorly driving the growth of the magnesite market.

Increasing use of magnesium oxide in growing demand for magnesite application in wastewater treatment, magnesia-based wallboards, and animal feed and are the key supporter for the positive impact on the growth of magnesite market over the forecast period.

On the other side , envir onmental a nd government regulations implemented on reducing environmental pollution emanating from steel production among other industries are major challenge faced by magnesite manufacturers. Moreover, magnesite substitutes are also hindering the growth of the market in future years.

20. Manganese Ore

503.62
(million tonnes) Total reserves/ resources of manganese ore were estimated as on 1st April 2020

2,696
(thousand tonnes) Production of manganese ore were reported in 2021-22

1,13,606
(tonnes) of manganese ore were exported in 2021-22

6.50
(million tonnes) of manganese ore were imported in 2021-22

Manganese occurs as silvery grey in colour and is very hard and brittle in nature. It is always available in combination with iron, laterite and other minerals. Manganese in alloy form is an essential input in steel making and steel is one of the most important indicators of growth in the industrial economy of any country. In recent years, the trade volume of manganese ore has grown world over. Presently, India is one of the major importers of manganese ore in the world. Manganese ores of major commercial importance are: (i) pyrolusite (MnO_2, Mn about 63.2%); (ii) psilomelane (manganese oxide, containing water and varying amounts of oxides of Ba, K and Na as impurities; Mn commonly 45– 60%);(iii) manganite($Mn_2O_3.H_2O$, Mn about 62.4%); and(iv) braunite ($3Mn_2O_3$, $MnSiO_8$, Mn about 62% and SiO_2 about 10%).

Indian manganese ore deposits occur mainly as metamorphosed bedded sedimentary deposits associated with Gondite Series(Archaeans) of Madhya Pradesh (Balaghat, Chhindwara & Jhabua districts), Maharashtra (Bhandara & Nagpur districts), Gujarat (Panchmahal district), Odisha (Sundargarh district) and with Kodurite Series (Archaeans) of Odisha (Ganjam & Koraput districts) and Andhra Pradesh (Srikakulam & Visakhapatnam districts).

RESERVES/RESOURCES

The total reserves/resources of manganese ore in the country as on 1.04.2020 has been placed at 503.62 million tonnes as per NMI database, based on UNFC system. Out of these, 75.04 million tonnes are categorised as Reserves and the balance 428.58 million tonnes are in the Remaining Resources category. Gradewise, Ferromanganese grade accounts for 8%, Medium grade 7%, BF grade 29% and the remaining 56% are of Mixed, Low, Beneficiable, Others, Unclassified, and Not-known grades including 0.16 million tonnes of Battery/Chemical grade.

Statewise, Odisha tops the total reserves/resources with 34% share followed by Karnataka (24%), Madhya Pradesh (12%), Maharashtra (12%), Goa (7%), Andhra Pradesh (6%) and Jharkhand (3%). Rajasthan, Gujarat, Telangana and West Bengal together shared the remaining 2% resources (Table- 1).

Table – 1 : Reserves/Resources of Manganese Ore as on 01.04.2020 (P)

(By Grades/States)

(In '000 tonnes)

Grade/State	Reserves				Remaining Resources								Total Resou - rces
	Proved	Probable		Total	Feasibility	Pre- feasibility		Measured	Indicated	Inferred	Reconn aissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**61510**	**6081**	**7450**	**75041**	**76106**	**51162**	**80580**	**29600**	**61205**	**117986**	**11944**	**428583**	**503624**
By Grades													
Battery/Chemical	-	-	-	-	4	9	12	4	26	112	–	167	167
Ferromanganese	15011	602	1203	16816	5040	3775	4574	1069	3771	6556	466	25251	42067
Medium	3767	28	55	3850	3871	5182	3860	448	3933	13171	116	30581	34430
BF	7995	892	1006	9892	31427	7102	19447	14391	12904	51139	2135	138545	148437
Mixed	954	75	488	1517	262	654	8259	2024	177	12472	-	23848	25365
Medium & BF mixed	5415	425	367	6207	5123	6817	6805	48	9977	14201	1907	44877	51084
Ferromangane													
Medium & BF mixed	24030	482	-	24512	10480	16598	13844	80	16673	1987	33	59696	84208
Ferromanganese & BF	357	1583	99	2039	256	614	11775	1260	912	4380	-	19197	21236
Low (-)25% Mn	1038	522	711	2271	8474	802	7162	3916	4060	3920	152	28485	30756
Beneficiable	28	1314	1164	2506	1938	315	356	6069	8366	2708	7074	26826	29332
Others	2618	102	1447	4167	5242	5746	1699	207	120	1757	-	14772	18939
Unclassified	297	57	911	1265	3810	3508	2730	84	130	3837	62	14160	15425
Not-Known	-	-	-	-	178	39	59	-	156	1747	-	2178	2178
By States													
Andhra Pradesh	6848	1006	234	8088	1000	718	1990	465	10730	6838	15	21756	29844
Goa	31	-	34	65	14028	1479	9177	48	262	9442	-	34436	34501
Gujarat	695	-	-	695	-	-	-	-	-	2180	-	2180	2875
Jharkhand	132	433	493	1059	1394	1046	5198	-	1395	4658	-	13691	14749
Karnataka	15363	-	101	15464	14723	2373	9604	18700	7306	55471	329	108508	123972
Madhya Pradesh	13551	2230	3777	19558	3830	7037	4212	127	23351	1943	-	40499	60057
Maharashtra	16537	835	361	17733	1891	15354	16304	-	5055	2585	113	41303	59036
Odisha	7535	1511	2423	11469	39091	22916	33968	10260	12219	32657	8947	160058	171528
Rajasthan	568	-	-	568	-	100	-	-	-	1690	-	1790	2359
Telangana	250	66	26	342	150	139	126	-	886	320	2540	4162	4503
West Bengal	-	-	-	-	-	-	-	-	-	200	-	200	200

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION AND STOCKS

The production of manganese ore at 2,696 thousand tonnes during 2021-22 was almost same as compared to the previous year.

There were 127 reporting mines during the year 2021-22 as against 145 in the previous year. Besides, manganese ore production was reported as associate mineral by 14 mines in 2021-22.

In 2021-22, thirty two public sector mines jointly accounted for 46% of the total production. The contribution of captive mines was 11% of the total production.

As per the gradewise composition of production during 2021-22, 69% of the total production was of lower grade (Below 35% Mn), 23% of medium grade (35-46% Mn) and 8% was of higher grade (above 46% Mn). Production of manganese dioxide was at 11,848 tonnes (0.44%) during the year.

Madhya Pradesh is the leading producing State of manganese ore accounting for 31.50% of total production during 2021-22 followed by Maharashtra 27% and Odisha 19% (Tables- 2 to 6).

Table – 2 : Principal Producers of Manganese Ore, 2021-22

Name & address of producers	Location of mine	
	State	District
MOIL Ltd, MOIL Bhavan, 1A- Katol Road, Nagpur- 440 013 Maharashtra	Madhya Pradesh Maharashtra	Balaghat Bhandara Nagpur
The Sandur Manganese & Iron Ores Ltd, Satyalaya. Door No.266 ,(Old no.80), Ward No. 1, Behind Taluk Office, Sandur-583 119, Karnataka.	Karnataka	Bellary
Tata Steel Ltd, Bombay House, 24, Homi Mody Street, Fort, Mumbai- 400 001, Maharashtra	Odisha	Keonjhar
Mr. Debabrata Behera,, 1234/P Govind Prasad, Bomikhal, Rasulgarh, Bhubaneswar-751 010, Odisha	Odisha	Keonjhar
R.B.S.S. Durga Prasad & F.N. Das, Mor Bhavan, Ramdaspeth, Nagpur-440 010, Maharashtra.	Andhra Pradesh	Vizianagaram
S. R. Ferro Alloys, 9, Sidheswar Colony, Distt Jhabua- 457 661. Madhya Pradesh.	Madhya Pradesh	Jhabua
S.K. Sarawagi & Co. Pvt. Ltd, Sarojini Naidu Saranisubham, 5TH floor, Distt - Kolkata-700 017, West Bengal.	Andhra Pradesh	Vizianagaram
M/s. Panaik Minerals Pvt Ltd., Boneikalajoda, Barbil, Keonjhar, Distt.Keonjhar-758 038, Odisha.	Odisha	Sundargarh
Shobha Mineral, 765, Napier Town, Jabalpur Jabalpur-482 001, Madhya Pradesh.	Madhya Pardesh	Jabalpur
M/s.S.S. Enterprises 40APR Society, Katnga, Jabalpur, Jabalpur-482 001, Madhya pradesh	Madhya Pardesh	Jabalpur

Table–3 : Principal Producers of Manganese Dioxide, 2021-22

Name & address of producers	Location of mine	
	State	District
MOIL Ltd, MOIL Bhavan, 1A-Katol Road, Nagpur-440 013, Maharashtra.	Maharashtra	Bhandara

Table – 4 : Production of Manganese Ore, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**2910186**	**18849100**	**2703313**	**17415461**	**2695991**	**22240539**
Andhra Pradesh	330530	1059109	250255	848621	204002	1141924
Jharkhand	4785	36126	-	-	-	-
Karnataka	336745	2194098	371045	2359787	380004	3311881
Madhya Pradesh	962576	6220812	934548	5684482	849221	6831964
Maharashtra	720518	6096443	646513	6485961	731730	8445151
Odisha	537325	3161505	482915	1948077	512591	2421292
Rajasthan	9937	29811	6940	20820	8008	25626
Telangana	7770	51196	11097	67713	10435	62701

(In tonnes)

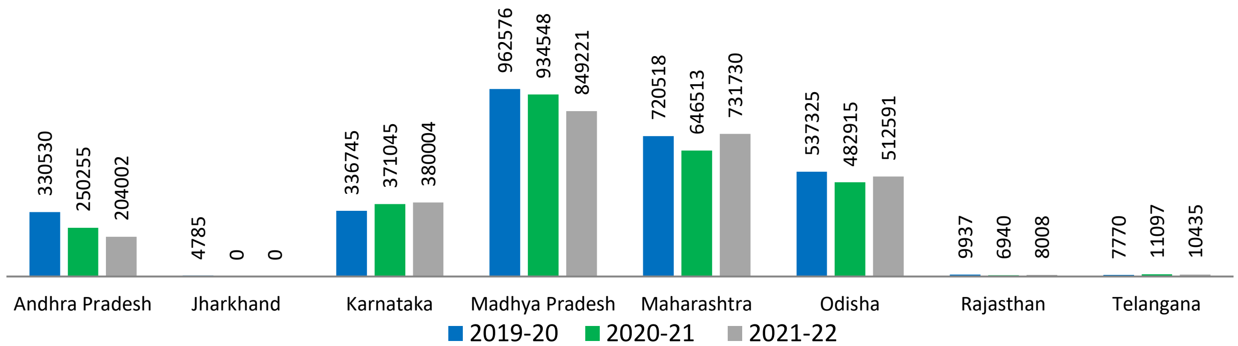


Fig 1: Production of Manganese ore

Table – 5 (A) : Gradewise Production of Manganese Ore, 2020-21

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	No. of mines	MnO_2	Production By Grades: Mn Content				Total	
			46% and above	35% to below 46%	25% to below 35%	below 25%	Quantity	Value
India	**145(13)**	**14219**	**251283**	**564789**	**952900**	**920122**	**2703313**	**17415461**
Public Sector	32	13611	125571	382958	517831	112579	1152550	10667873
Private Sector	113(13)	608	125712	181831	435069	807543	1550763	6747588
Andhra Pradesh	**24**	**-**	**-**	**15140**	**52814**	**182301**	**250255**	**848621**
Vizianagaram	24	-	-	15140	52814	182301	250 255	848621
Goa	**2***	**-**	**-**	**-**	**-**	**-**	**-**	**-**
South Goa	2*	-	-	-	-	-	-	-
Karnataka	9(3)	-	420	51393	162376	156856	371045	2359787
Ballari	1(2)	-	420	51393	153446	84599	289858	2191930
Chitradurga	2	-	-	-	-	18700	18700	33660
Davanagere	4	-	-	-	8870	48740	57610	126211
Tumakuru	2(1)	-	-	-	60	4817	4877	7986
Madhya Pradesh	**47(7)**	**-**	**102651**	**99231**	**374430**	**358236**	**934548**	**5684482**
Balaghat	37	-	102301	96805	323228	129004	651338	5106994
Chhindwara	4	-	350	1954	2492	5199	9995	63153
Jabalpur	5(7)	-	-	-	-	217261	217261	286619
Jhabua	1	-	-	472	48710	6772	55954	227716
Maharashtra	**27**	**13611**	**24468**	**316677**	**247509**	**44248**	**646513**	**6485961**
Bhandara	5	13611	4907	243117	119918	13245	394798	4168317

State/District	No. of mines	MnO_2	Production By Grades: Mn Content				Total	
			46% and above	35% to below 46%	25% to below 35%	below 25%	Quantity	Value
Nagpur	22	-	19561	73560	127591	31003	251715	2317644
Odisha	**29(3)**	**608**	**123744**	**82348**	**98334**	**177881**	**482915**	**1948077**
Keonjhar	17(2)	608	123744	81982	90621	147360	444315	1778205
Raygada	1	-	-	-	544	-	544	5163
Sundargarh	11(1)	-	-	366	7169	30521	38056	164709
Rajasthan	**1**	**-**	**-**	**-**	**6940**	**-**	**6940**	**20820**
Banswara	1	-	-	-	6940	-	6940	20820
Telangana	**6**	**-**	**-**	**-**	**10497**	**600**	**11097**	**67713**
Adilabad	6	-	-	-	10497	600	11097	67713

Figures in parentheses indicate associate mines of iron ore, laterite, limestone and Clay (others)

** Only labour reported.*

Table – 5 (B) : Gradewise Production of Manganese Ore, 2021-22 (P)

(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	No. of mines	MnO_2	roduction By Grades: Mn Content				Total	
			46% and above	35% to below 46%	25% to below 35%	below 25%	Quantity	Value
India	**127(14)**	**11848**	**219170**	**611189**	**1071347**	**782437**	**2695991**	**22240539**
Public Sector	32	11848	138321	405783	601448	81414	1238814	13495771
Private Sector	95(14)	-	80849	205406	469899	701023	1457177	8744768
Andhra Pradesh	**19**	**-**	**-**	**26050**	**48135**	**129817**	**204002**	**1141924**
Vizianagaram	19	-	-	26050	48135	129817	204002	1141924
Goa	**1***	**-**	**-**	**-**	**-**	**-**	**-**	**-**
South Goa	1*	-	-	-	-	-	-	-
Karnataka	**8(3)**	**-**	**-**	**62021**	**199186**	**118797**	**380004**	**3311881**
Ballari	1(2)	-	-	62021	182231	47767	292019	3027081
Chitradurga	1	-	-	-	4200	9300	13500	54286
Davanagere	4	-	-	-	12755	50430	63185	206869
Tumakuru	2(1)	-	-	-	-	11300	11300	23645
Madhya Pradesh	**44(7)**	**-**	**109234**	**107580**	**390397**	**242010**	**849221**	**6831964**
Balaghat	33	-	109234	104812	343141	95726	652913	6115860
Chhindwara	4	-	-	1266	2631	15464	19361	90076
Jabalpur	6(7)	-	-	200	-	127425	127625	362323
Jhabua	1	-	-	1302	44625	3395	49322	263705
Maharashtra	**26**	**11848**	**29465**	**326144**	**320497**	**43776**	**731730**	**8445151**
Bhandara	5	11848	2249	251088	181134	22936	469255	5403710
Nagpur	21	-	27216	75056	139363	20840	262475	3041441
Odisha	**20(4)**	**-**	**80471**	**89394**	**99115**	**243611**	**512591**	**2421292**
Keonjhar	13(3)	-	80471	87025	83980	174094	425570	2054403
Rayagada	1	-	-	-	225	-	225	1865
Sundargarh	6(1)	-	-	2369	14910	69517	86796	365024
Rajasthan	**1**	**-**	**-**	**-**	**8008**	**-**	**8008**	**25626**
Banswara	1	-	-	-	8008	-	8008	25626
Telangana	**8**	**-**	**-**	**-**	**6009**	**4426**	**10435**	**62701**
Adilabad	8	-	-	-	6009	4426	10435	62701

Figures in parentheses indicate associated mines with Clay (others), iron ore, laterite and limestone.

Table – 6 : Production of Manganese Ore, 2020-21 and 2021-22

(By Frequency Groups)

(Quantity in tonnes)

Production	No. of mines		Production		Percentage in total Production		Cumulative percentage	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Total	**145(13)**	**127(14)**	**2703313**	**2695991**	**100**	**-**	**-**	
Up to 1000	66(3)	56(2)	10697	11918	0.4	0.44	0.4	0.44
1001 – 5000	29(2)	23(4)	67522	72789	2.5	2.7	2.9	3.14
5001 – 10000	16(2)	13(2)	131006	112447	4.85	4.17	7.75	7.31
10001 – 20000	10(2)	13(1)	176444	186682	6.53	6.92	14.28	14.23
20001 – 30000	5(2)	2(1)	184198	80942	6.8	3.01	21.08	17.24
30001 – 40000	4	4(2)	135160	202876	5	7.53	26.08	24.77
40001 – 50000	1	3(1)	40557	184442	1.5	6.84	27.58	31.61
50001 and above	14(2)	13(1)	1957729	1843895	72.42	68.39	100	100

Figures in parentheses indicate associated mines of iron ore, laterite, limestone and clay (others).

The mine-head closing stock was 2,830 thousand tonnes for the year 2021-22 as against 2727 thousand tonnes in the previous year [Tables - 7 (A) and 7 (B)].

The average daily employment of labour in man- ganese ore mines was 11,424 in 2021-22 as against 10,191 in the previous year.

Table – 7 (A) : Mine-head Closing Stocks of Manganese Ore, 2020-21

(By States/Grades)

(In tonnes)

State	Grades : Mn content					
	MnO_2	46% and above	35% to below 46%	25% to below 35%	below 25%	Total Quantity
India	**13311**	**23906**	**81029**	**359582**	**2249015**	**2726843**
Andhra Pradesh	-	-	109	40561	39826	80496
Goa	-	-	-	-	-	-
Jharkhand	-	1	-	120	0	121
Karnataka	-	420	8403	67228	236418	312469
Madhya Pradesh	-	12744	27174	44673	814545	899136
Maharashtra	12062	3297	24126	20965	24522	84972
Odisha	1249	7444	21217	180580	1132827	1343317
Rajasthan	-	-	-	5165	-	5165
Telangana	-	-	-	290	877	1167

Table – 7 (B) : Mine-head Closing Stocks of Manganese Ore, 2021-22(P)

(By States/Grades)

(In tonnes)

State	Grades : Mn content					
	MnO_2	46% and above	35% to below 46%	25% to below 35%	below 25%	Total Quantity
India	**10489**	**15746**	**73505**	**382808**	**2347885**	**2830433**
Andhra Pradesh	-	-	2054	41408	41694	85156
Goa	-	-	-	-	-	-
Jharkhand	-	1	-	120	-	121
Karnataka	-	-	6441	85977	232954	325372
Madhya Pradesh	-	10338	18094	42643	852346	923421
Maharashtra	10108	2488	17126	22643	27350	79715
Odisha	381	2919	29790	189310	1192556	1414956
Rajasthan	-	-	-	103	-	103
Telangana	-	-	-	604	985	1589

MINING,PROCESSING, MARKETING & TRANSPORT

Manganese ore mining in the country is carried out by opencast as well as by underground methods. At present, India's largest manganese ore producer MOIL operates its underground and opencast mines located in the Nagpur and Bhandara districts of Maharashtra and Balaghat district of Madhya Pradesh. All these mines are about a century old. The Balaghat Mine is the largest mine of the Company. The mine has now reached a mining depth of about 435 meters from the surface. Dongri Buzurg Mine located in the Bhandara district of Maharashtra is an opencast mine that produces manganese dioxide ore used by dry battery industry. All the underground mines are mechanised or semi-mechanised and adopt cut-and-fill method of stoping. In Kandri mine of MOIL, hydraulic sand stowing has been introduced in place of manual filling system. This system is faster, cheaper and requires less manpower. Conventional timber supports are replaced by cable bolting pre-mining support to increase safety and productivity. In Balaghat underground mechanised mine, overhand flat back cut-and-fill method with rock bolting support and sand stowing is being practised to fill up the voids with a level interval of 30 m and size of stope block as 30 m x 30 m to 60 m x 30 m. Side Dump Loaders (SDL) of 0.66 cu. m bucket capacity were also deployed in underground levels for mechanised loading of run -of- mine (r.o.m.) in stopes. Tyre mounted Rocker shovel was also introduced in Balaghat mine for mechanised loading of ore from ore drive at stripping area. Deepening of high speed vertical shaft up to 750 m in Balaghat, up to 169 m in Chikla mine, up to 245 m in Kandri mine and up to 160 m in Mansar mine of MOIL is in progress. Sinking of high speed vertical shafts up to 160 m, 330 m and 324 m is in progress at Mansar, Gumgaon and Ukwa mines, respectively. The MOIL has set a target to produce 3.50 million tonnes of manganese ore by 2030.

The open-pits are usually worked manually by benching method, using portable compressors, jackhammers and dumper trucks. Tirodi mine of MOIL is worked by opencast mechanised method. Height of the benches in overburden is kept at 7.5 m and that in the ore at 6 m. Drills of 100 mm dia. with 0.9 to 1.7 m^3 capacity of shovels and 20–25 tonnes dumpers are used for production, loading and transport.

The workings vary from shallow depth in lateritoid-type deposits in Odisha, Karnataka and Goa to deep operations in deposits of a more regular nature found in Madhya Pr adesh, Maharashtra and Andhra Pradesh. Bulldozers are used where the overburden is soft. In a few cases, tramways are laid up to the working face and loaded tubs are pushed manually to the dumping ground. In Odisha, Goa and Karnataka, ore is worked by loosening the ground either with crowbars or by blastings. After picking up manganese ore, the waste is removed to the dumping ground. Mining of bedded ore in Madhya Pradesh and Maharashtra is generally carried out by drilling and blasting.

Hand sorting and visual grading are adopted widely to upgrade the ore. Scrubber is also used for washing the ore at some mines. Manual as well as mechanised jigging is done in a few mines.

Most of the producers market manganese ore directly to the industrial units. In a few cases, especially in case of supplies of special type of ore or a semi-processed product, middlemen are found to be involved in marketing. Ore from mines is usually sold to the domestic consumers, either at the rail-head or ex-plant. In cases of Integrated Iron & Steel and Ferromanganese Industry, the units draw their supplies largely from captive mines. However, special ore types for specific purposes are obtained from other producers.

Transport of manganese ore from mines to rail head is generally done by trucks from where it is transported to ports by rail wagons. From the mine of MOIL in Balaghat district, Madhya Pradesh, the ore is transported by aerial ropeways to the loading bins at the rail-heads. Battery loco was introduced for underground transport of r.o.m. tub from ore pass chute to skip bunker. In Goa, ore in bulk is carried by road-cum- river routes up to Mormugao harbour and in a few cases by rail where the mines are close to the railways. The ore loading at river-head into barges is carried out mechanically.

ENVIRONMENTAL PROTECTION

In order to embark upon low-carbon growth trajectory, MOIL has taken up some measures, such as, recycle and reuse of water for beneficiation, construction of strong parapet walls and afforestation in all its mines.

Over the past years, MOIL has set up wind farms and solar power plants, in strategic locations to maximize power generation and have entered into power purchase agreements with governmental bodies. These initiatives have resulted in the production of millions of kilowatt-hours (kWh) of electricity, leading to significant reductions in the carbon emissions.

The MOIL planted saplings across various mines to mitigate the effects of climate change and enhancing local biodiversity. This helps in carbon sequestration and improves the overall health of the surrounding ecosystems.

Manganism-a health condition attributed to manganese poisoning-has been reported to be detected in case of five persons working with BHP Billiton's Metalloys, a manganese alloy plant in South Africa. Manganism shows symptoms similar to Parkinson's disease and psychotic behaviour but conditions of development of the disease are not properly understood.

USES & SPECIFICATIONS

Classification of manganese ore, ferruginous manganese ore, siliceous manganese ore, dioxide manganese ore, and manganiferous iron ore is laid down by BIS vide specification no. IS: 11895- 2006 (Reaffirmed March, 2019). Manganese ore is an important material in iron and steel metallurgy, where it is used both in the ore form and as ferromanganese. Manganese improves strength, toughness, hardness and workability of steel, acts as a deoxidiser and desulphuriser, and also helps in getting ingots free from blowholes. About 90 to 95% world production of manganese ore is used in metallurgy of iron and steel. High amount of phosphoro us makes the manganese ore unsuitable for its metallurgical use, whereas, high phosphorous and high iron contents make it unsuitable for Battery Industry. Manganese has no satisfactory substitute in its major applications. The specifications of manganese ore by different industries are detailed below:

In Iron & Steel Industry, the BIS:11281-2005 (Reaffirmed March, 2021) specification is laid down for manganese ore. However, specifications based on the user industry indicate that normally manganese ore containing 28 to 35% Mn is used. Ore size generally varies from 10 to 40 mm. For other constituents general stipulations are Fe: 16 to 22%, SiO_2 : 2 to 8%, Al_2O_3 : 5 to 8% and P: 0.3% maximum.

For manganese ore used in Ferromanganese Industry, besides manganese content, other important considerations are high manganese to iron ratio and a very low content of deleterious phosphorous. Specifications of manganese ore for production of ferromanganese are prescribed by the Bureau of Indian Standards vide IS: 4763-2006, (Second Revision, Reaffirmed January, 2017). BIS has also laid down the specific ations of manganese ore sinters for blend ing for ferromanganese production vide IS:125961989 (Reaffirmed March, 2019). User's specifications of manganese ore for Ferromanganese/ Silico-manganese industries are furnished in Table-8.

Table – 8 : User's Specifications of Manganese Ore in different Ferromanganese/Silico-manganese Units

Name and location of plant	Specifications of ore consumed
Andhra Pradesh	
Ferro-Alloys Corp. Ltd,	Mn: 70-75%
Shreeram Nagar, Dist. Vizianagram.	C: 6-8%
Nav Bharat Ferro-Alloys Ltd,	Mn: 28-50%, P: 0.1-0.3%, SiO_2: 8-30%
Paloncha, Khammam.	Fe :5-8%
Chhattisgarh	
Sarda Energy & Minerals Ltd	Mn: 28-30% (Low P)
Raipur.	Mn: 37-40%, 42-44%,
	46% (High P)
Monnet Ispat & Energy Ltd,	Mn: 28-46%
Raipur	Fe : 5-16%
	SiO_2: 6-34%
	S & P: 0.05-0.28%
	Size: 0-100% (lumps & fines)
Hira Power & Steel Ltd, Raipur	
i) Jain Carbides & Chemicals Ltd, Raipur (Unit-I).	Mn: 32-35%
ii) Jain Carbides & Chemicals Ltd, Raipur (Unit-II).	Mn: 32-35%
Karnataka	
S. R. Chemicals & Ferro Alloys, Belagavi.	Mn: 38-40%, Fe: 18-23%
Thermit Alloys Ltd, Shivamogga.	Mn: 48-54%
Kerala	
INDSIL Hydro Power and	Fe-Mn ratio 1:3 to
Manganese Ltd,	5% (50%) 1:5 to
Pallatheri,	8% (50%)
Palakkad.	P: 0.05% max.
	Al2O3: 3 to 5% max.
Madhya Pradesh	
MOIL, Ferro-manganese Plant,	Mn: 46-48%
Bharveli, Dist. Balaghat.	
Maharashtra	
Chandrapur Ferro Alloys Ltd,	

Name and location of plant	Specifications of ore consumed
(Formerly Maharashtra Electro-Smelt Ltd)	Mn: 38-46%,
Chandrapur.	Fe: 6-17%
	SiO_2+Al_2O_3: 10-16%
	P: 0.5-0.25% max.
	+100 mm, 10% max.
	+10-100 mm, 80-85% min.
	+5-10 mm, 10% max.
Nagpur Power & Industries Ltd,	Mn: 42-46%,
Nagpur.	Fe: 7-8%,
	SiO_2: 3.6%,
	Al_2O_3: 6-7%,
	P: 0.10-0.12%
	Size: 5-25 mm
Natural Sugar & Allied Ind. Ltd,	Size: 10-80 mm
Sai Nagar Ranjani, Dist. Osmanabad	
Odisha	
Tata Steel Ltd, Joda,	Mn: 43%, min. (for FeMn)
Kendujhar.	36% min. (for SiMn),
	Size: 10-75 mm
	(for FeMn & SiMn)
	Captive Mn Ore Size (mm)
	Below 35% (10-75) + 5%
	35% to 46% (10-75) + 5%
	46% to 49% (10-75) + 5%
	Dioxide + 49% (10-75) + 5%
	MOIL, Mn Ore
	Below 35% (10-75) + 5%
	Imported Mn
	46 to 49% (10-75) + 5%
Tamil Nadu	
Silcal Metallurgical Ltd,	Mn: 35-40% & above
Ramanuja Nagar, Coimbatore.	Size: 35 mm
West Bengal	
Cosmic Ferro Alloys Ltd, Bankura.	Size: 75 mm

Manganese dioxide is used for manufacturing dry cell batteries in which it functions as a depolariser of hydrogen. For use in dry cell battery, BIS has prescribed Specification No. IS:11153-1996 (First Revision, Reaffirmed Sept. 2015) for manganese dioxide. Suitability of ore depends not only on manganese dioxide content but also on its crystallographic structure. Ore having predominant gamma structure is required. The ore must have high manganese dioxide and low iron content, a certain degree of porosity and moderate hardness. It should be free from metallic compounds, such as, copper, nickel, cobalt, arsenic, lead and antimony, which are electronegative to zinc (container). User industry specifications are MnO_2 70% (min.), Fe 6% (max.), moisture 4% (max.), Cu 0.02% (max.) and Ni 0.02% (max.). The size requirement lays down that 90% material should pass through 300 mesh and 100% through 100 mesh. User industry specifications for electrolytic manganese dioxide (EMD) used in dry cell battery are MnO_2 90% (min.), Fe (as oxide) 0.05% (max.), moisture 4% (max.), Pb 0.15% (max.) and pH 4.5 to 5.6. The size requirements are same as those for manganese dioxide ore. Manganese ore is also used in the manufacture of various chemicals, such as, potassium permanganate, hydroquinone, manganese sulphate, manganese chloride, manganese phosphate, etc. In Chemical Industry, generally high-grade material is used for potassium permanganate. Ore containing MnO_2 80% (min.), SiO_2 5% (max.), Fe_2O_3 5% (max.) and 200 to 250 mesh ore size is used. In Glass Industry, ore analysing MnO_2 80% (preferably 86% min.), Fe_2O_3 5% (preferably 0.75% max.), SiO_2 2.8% (max.), Al_2O_3 1.1% (max.), BaO 1.3% (max.), CaO 0.4% (max.) and MgO 0.4% (max.) is consumed.

Requirement of manganese dioxide for Explosive and Pyrotechnic compositions as laid down in IS : 5713-1981 (First Revision, Reaffirmed April 2021) by BIS.

Pyrolusite is used generally to impart glaze to the pottery and to make coloured bricks. It also finds use as driers for oils, varnishes and paints. Manganese sulphide is used in the manufacture of salts and in calico printing. Manganese chloride is used in cotton textile as a bronze dye. Manganese salts are used in photography and in leather and matchbox industries.

CONSUMPTION

The apparent consumption of manganese ore in 2021-22 was about 9 million tonnes as against the 10 million tonnes during preceding year, i.e., decreased by about 11 % in 2021-22.

INDUSTRY

Manganese alloys are the largest produced ferroalloys in the world. For production of one tonne of ferromanganese, about 2.6 tonnes of manganese ore, 0.5 tonne of reductant and 3 MHh of electricity inputs are required. As per Indian Ferro Alloys Producers' Association (IFAPA), the total installed capacity of manganese alloys including ferromanganese/ silicomanganese in the country was estimated to be around 3.16 million tonnes per annum. MOIL has 1,500 tpy Electrolytic Manganese Dioxide (EMD) Plant at Dongri Buzurg mine and . In 2021-22, about 1,202 tonnes of EMD was produced as against 1,070 tonnes in 2020-21. The MOIL has 12,000 tpy Ferromanganese plant in Balaghat. In 2021-22 about 10,245 tonnes of ferro-manganese was produced as compared to 8,851 tonnes in the previous year.

Ferromanganese

The total production of various types of manganese alloys (high-carbon ferromanganese, medium-carbon ferromanganese and low-carbon ferromanganese) was about 5.18 lakh tonnes in 2018-19 as per Monthly Statistics of Mineral Production (March, 2020). Further, production of ferromanganese during 2019-20 to 2021-22 is not available in the source. It is to be noted that the data coverage is partial and does not reflect the actual production.

Silicomanganese

Silicomanganese is a combination of 60-70% Mn, 10-20% silica and about 20% carbon. As per Monthly Statistics of Mineral Production (March, 2022), production of silico-manganese was reported at 3,49,414 tonnes in 2021-22 as compared to 3,29,295 tonnes in 2020-21. It is to be noted that the data coverage is partial and does not reflect the actual production.

The major factor driving the production of manganese alloys is high production growth of low nickel austenitic stainless steel. India is emerging as the largest producer of this steel where manganese is added substituting the expensive nickel.

Iron & Steel

Manganese ore is an important and indispensable input raw material for steel making and steel production and its consumption is among the key indicators of industrial development in any country. Manganese ore in the form of ferro and silicomanganese alloys are the most essential ingredients in the production of steel, both crude and stainless. Iron & Steel Industry was the second major consumer of manganese ore wherein manganese ore is used directly as a blast furnace feed.

Dry Battery

Satisfactory performance of battery is usually the determining factor for use of battery grade manganese ore. Several factors control the suitability of manganese ore for dry-cell manufacture. Dry battery Industry consumes EMD along with natural manganese dioxide ore.

RESEARCH & DEVELOPMENT

The CSIR-Institute of Minerals and Materials Technology, Bhubaneswar, in its Annual Report - 2021-22 has reported about a project for recovery of Mn as EMD from low grade ores and secondaries for energy applications. It is mentioned therein that India's manganese ore deposits are predominantly low grade which constitues > 60% of total reserves and remains under-utilized due to very high iron content. SO_2 is well known reductant for its favourable kinetics in leaching manganese. However, commercial SO_2 (99.9%) are either imported or produced through a concentrator plant,making it energy and cost intensive to implement for the production of Electrolytic Manganese Dioxide (EMD). In the current project, low concentration SO_2 produced from typical sulphur burners,was successfully utilized in reductive acid leaching to recover Mn from low grade ores and ferroalloy slags, instead of concentrated 99% SO_2 gas in a novel approach.

This approach makes concentrated 99% SO_2 redundant in the leaching of Mn. The electrolytic manganese dioxide (EMD) produced subsequent to purification from the leach liquors from ferroalloy slag and low grade ores containing 10-20% Mn was found to satisfy and surpass quality criteria for battary applications as per BIS (IS11153:1996).

As mentioned in the Annual Report 2022-23 of Manganese Ore India Ltd . (MOIL) t he significance of R&D projects of the MOIL are as under :

(A) Mine Ventilation

Studies for ventilation at stope and concreted drive at Beldongri Mine are being carried out by Visvesvaraya National Institute of Technology (VNIT) Nagpur. This will provide a detailed report of pressure, quantity and hygrometric survey of Beldongri Mine and will also include study of the main fans running in the mine. Further, VNIT will also advice MOIL for suitable measures for improvement of ventilation in the existing condition.

(B) Mines Safety - Mining subsidence and patents

1. The work of evaluation of support requirement in stope and stability assessment of drivages at Beldongri Mine has been awarded to Central Institute of Mining and Fuel Research (CIMFR) for working towards enhanced safety parameter and innovation in the field by virtue of scientific studies and their implementation.

2. MOIL has installed ro ck me cha nics instruments in seven underground mine for safety of men and machines in the stopes as per the guideline of DGMS. For the use and implementation of the procured Rock mechanic instruments for mines safety, experts at CSIR- CIMFR have been approached and they have been given the work of instrumentation, installation and interpretation of the strata conditions for a period of one year for the seven underground mines.

(C) R&D Labs

A Rock Mechanics lab has been established at head office to conduct Geo technical studies of various lithology available at all Mines. This will help to know various parameters of rocks which will be useful in preparation of mining plans and method of working for better safety and higher productivity. It helps to generate technical reports for onward submission to regulatory authorities like DGMS, IBM, DGM etc. for safer mining operations with higher productivity.

(D) R&D Studies

1. In accordance with proposal of the Strategic Management Group to have a trial stoping method by sub level stoping to increase the rate of production and safety standards, CSIR- CIMFR has been engaged for "Evaluation of stoping parameters , stope design, and implementation of planned sublevel stoping at Chikla-B section of Chikla Mine" This trial stoping method, if successful and economic, may open new possibilities for MOIL to modify recent stoping methods for better productivity and safety.

2. Modific ation, mechanization and evaluation of Modified Stoping parameters of Cut and Fill Stoping at Ukwa Mine is being carried out by Indian Institute of Technology, Banaras Hindu University (IIT-BHU) to bring about positive changes and transform the age old system of stoping at MOIL Mines.

(E) Exploration

Government of Madhya Pradesh has granted reservation in two districts i.e. in Balaghat and Chhindwara under the tripartite MoU of MOIL with the Government of Madhya Pradesh and MP State Mining Corporation Limited to explore the manganese bearing areas within four districts of Madhya Pradesh viz. Jabalpur, Balaghat, Chhindwara & Jhabua.

SUBSTITUTES

Cost and technology militate against substitution in major applications. However, for economic reasons, there is only limited substitution in minor applications in Chemical and Battery industries. The Steel Industry has, however, made great strides in economising the use of manganese, largely through changes in steel- making techniques.

TECHNICAL POSSIBILITIES

The deep-sea nodules can be a potential resource of manganese in the next decades to come. There is a trend towards using lower grades of ores in ferromanganese production. New steel-making practices and techniques are reducing the amount of manganese consumed in the process. However, counter balancing this to some extent is a trend towards higher manganese specifications for modern steels.

TRADE POLICY

Export Policy

The policy on export as per ITC (HS), 2018 schedule 2 is as follows:

HS Code	Item description	Policy
2602 00	Manganese ores and concentrates including ferruginous Manganese ores and concentrates with Manganese content of 20% or more calculated on the dry wet.	Free

ITC(HS) based Import Policy

As per ITC(HS), 2022 Schedule 1 Import Policy Section V, MINERAL PRODUCTS , Chapter 26 Ores, Slag and Ash, imports of manganese ore and concentrates including ferruginous manganese ores and concentrates containing 20 % or more manganese (calculated on dry weight basis), agglomerated manganese ore sinters, etc. are freely allowed.

WORLD REVIEW

The total world reserves of manganese ore is approximately 1700 million tonnes of metal content which is unevenly distributed (Table-11). Reserves are located in South Africa (38%), China, Australia & Brazil (16% each), Ukraine (8 %), Gabon (3%) and ndia (2%).

World production of manganese ore in 2021 was estimated to be around 56 million tonnes as compared to 50 million tonnes in 2020. South Africa was the leading producer contributing about 34% followed by Gabon (16%), China (12%), Australia (11%),

Ghana (6%), India (4%), Ukraine and Brazil (3% each) and Ivory Coast (2%) (Table-12).

Table – 11 : World Reserves of Manganese Ore

(By Principal Countries)

(In '000 tonnes of metal content)

Country	Reserves
World: Total (rounded off)	**1700000**
Australia[(a)]	270000
Brazil	270000
Myanmar	NA
China	280000
Cote d'Ivoire	NA
Gabon	61000
Georgia	NA
Ghana	13000
India*	34000
Kazakhstan, (concentrate)	5000
Malaysia	NA
Mexico	5000
South Africa	640000
Ukraine, (concentrate)	140000
Vietnam	NA
USA	–
Other countries	Small

Source: *USGS Mineral Commodity Summaries, 2023.*

(a): Joint Ore Reserve Committee compliant reserves were about 135 million tonnes.

NA: Not Available; - : Zero

**: India's total reserves/resources of manganese ore as per NMI database based on UNFC system have been estimated at 503.62 million tonnes as on 1.4.2020.*

Table – 12 : World Production of Manganese Ore

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
World:Total	**57400**	**50400**	**56200**
South Africa	17009	16198	19156
Gabon	7186	8147	9241
China[(e)]	6650	6700	6500
Australia	6649	4752	6285
Ghana	5383	2357	3336
India*[(a)]	2910	2688	2457(e)
Ukraine	1854	1850(e)	1850(e)
Brazil	3726	2385	1775
Ivory Coast	1182	1325	1400(e)
Other countries	4807	4002	4201

Source: *BGS, World Mineral Production, 2017-2021.*

(a): Years ended 31st March following that stated.

(e) : Estimated

FOREIGN TRADE

Exports

Exports of manganese ore (total) increased by 38% to 1,13,606 tonnes in 2021-22 from 82,363 tonnes in 2020-21. Out of the total exports in 2021-22, only 21 tonnes of manganese ore having +46% or more Mn of value ₹ 10,59,000 was exported. Exports of manganese ore (others) were at 70,636 tonnes in 2021-22 as compared to 22,045 tonnes in the preceding year. About 62% of exports of Manganese ore total were to China followed by Indonesia with 22% and UAE with 16%. Exports of manganese oxide decreased by 27% to 21148 tonnes in 2021-22 as against 29,116 tonnes in 2020-21. Manganese dioxide exports in 2021-22 increased by 18% to 5297 tonnes from 4,476 tonnes in 2020-21. In 2021-22, exports of manganese & alloys (including waste & scrap) increased by 31% to 616 tonnes as compared to 469 tonnes in the previous year. Exports of manganese & alloys (wrought & unwrought) in 2021-22 increased by 53% to 288 tonnes as compared to 188 tonnes in the previous year. (Tables- 13 to 26).

Table – 13 : Exports of Manganese Ore : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**82363**	**974940**	**113606**	**588189**
UAE	10050	113362	18363	320917
China	47714	755315	70569	203405
Indonesia	22000	60852	24620	61977
Nepal	3	39	15	906
Bangladesh	23	590	22	667
Germany	-	-	13	257
Tanzania	-	-	4	41
Djibouti	-	-	++	19
Bhutan	2544	44283	-	-
Ethiopia	10	235	-	-
Other countries	19	264	-	-

Figures rounded off

(In tonnes)

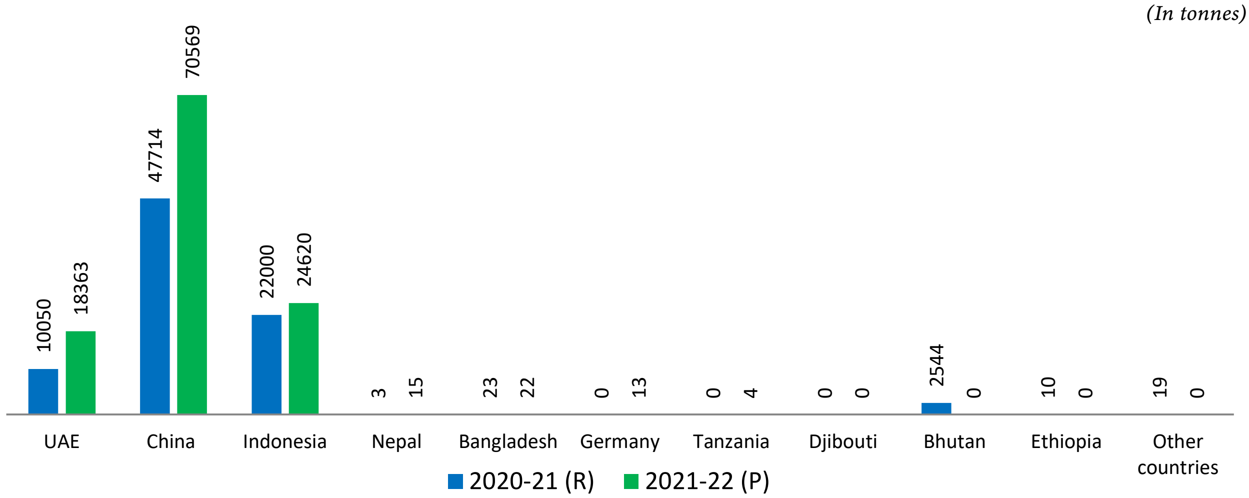


Fig. 2: Countrywise Export of Manganese Ore

Table – 14 : Exports of Manganese Ore (46% or more Mn)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**10**	**330**	**21**	**1059**
Nepal	-	-	15	880
Bangladesh	-	-	6	160
Djibouti	-	-	++	19
Ethiopia	10	235	-	-
Kenya	++	87	-	-
Bhutan	++	8	-	-

Figures rounded off

Table – 15 : Exports of Manganese Ore (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**22045**	**61658**	**70636**	**206256**
China	-	-	70569	203405
Indonesia	22000	60852	50	2527
Germany	-	-	13	257
Tanzania	-	-	4	41
Nepal	3	39	++	26
Bangladesh	23	590	-	-
Sri Lanka	17	150	-	-
Burundi	2	27	-	-

Table – 16: Exports of Manganese Oxide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**29116**	**1357914**	**21148**	**986863**
France	2540	77879	2981	112403
UAE	2548	129789	2266	110738
Indonesia	850	44317	2007	96612
South Africa	27	1505	1613	70554
Vietnam	1785	91663	1408	67281
Russia	944	44763	1269	61125
Turkey	944	49469	1137	54639
Canada	1198	62730	922	49244
Thailand	1152	59102	970	48018
USA	8580	368161	864	41132
Other countries	8548	428536	5711	275117

Figures rounded off

Table – 17: Exports of Manganese Dioxide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**4476**	**227849**	**5297**	**258822**
UAE	2343	118891	2041	99555
Indonesia	29	3574	1208	57569
Netherlands	121	9223	175	13013
Poland	222	14003	198	11608
Turkey	75	5541	143	9996
Ireland	100	7431	125	9587
Bangladesh	168	6503	200	7137
Kenya	267	5122	314	6891
Philippines	45	2482	80	4499
Lithuania	75	4790	75	4167
Other countries	1031	50289	738	34800

Figures rounded off

Table – 18: Exports of Manganese Oxide (Other than Manganese Dioxide)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**24640**	**1130065**	**15851**	**728041**
France	2540	77879	2981	112355
South Africa	-	-	1573	68236
Vietnam	1709	88671	1322	64411
Russia	944	44664	1223	59172
Canada	1175	60835	903	47509
Thailand	1152	59062	960	46352
Turkey	869	43928	994	44643
USA	8521	363677	863	40163
Indonesia	821	40743	799	39043
Australia	780	38520	634	31416
Other countries	6129	312086	3599	174741

Figures rounded off

Table – 19: Exports of Manganese & Alloys (Incl. Waste & Scrap)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	469	375616	616	631089
France	283	270014	435	444943
Korea	12	19625	40	69463
Slovenia	4	7050	10	17225
Italy	3	5590	6	13749
Indonesia	13	4887	17	9159
Brazil	2	1690	14	8155
U S A	++	142	4	7207
Malaysia	14	6433	11	6561
Armania	++	820	4	6435
Romania	3	6233	3	5555
Other countries	135	53132	72	42637

Figures rounded off

Table – 20: Exports of Manganese & Alloys (Wrought/Unwrought)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**188**	**106409**	**288**	**307908**
France	2	997	108	122952
Korea Rep. of	12	19580	40	69463
Slovenia	4	7050	10	17225
Italy	3	5590	6	13749
Indonesia	13	4887	17	9159
Brazil	2	1690	14	8155
US A	++	142	4	7150
Malaysia	14	6433	11	6561
Armenia	++	820	4	6435
Romania	3	6233	3	5555
Other countries	135	52987	71	41504

Figures rounded off

Table - 21 : Exports of Manganese :Wrought

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2**	**688**	**15**	**6909**
UAE	++	54	4	2335
Brazil	1	288	7	2333
Turkey	-	-	2	1338
Malaysia	1	197	1	459
UK	++	89	1	239
Kenya	++	60	++	177
Bangladesh	-	-	++	19
Colombia	-	-	++	9

Figures rounded off

Table - 22: Exports of Manganese & Alloys Unwrought

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**186**	**105721**	**273**	**300999**
France	2	997	108	122952
Korea Rep. of	12	19580	40	69463
Slovenia	4	7050	10	17225
Italy	3	5590	6	13749
Indonesia	13	4887	17	9159
USA	++	142	4	7150
Armenia	++	820	4	6435
Malaysia	13	6236	10	6102
Brazil	1	1402	7	5822
Romania	3	6233	3	5555
Other countries	135	52784	64	37387

Figures rounded off

Table - 23 : Exports of Manganese & Alloys : NES

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**249**	**260113**	**280**	**298469**
France	249	260039	279	297383
Iran	-	-	++	489
Burundi	-	-	1	422
UAE	-	-	++	78
Serbia	++	32	++	58
Nepal	-	-	++	35
Bhutan	++	9	++	4
South Africa	++	33	-	-

Figures rounded off

Table - 24 : Exports of Manganese Ore (35% Or More but Below 46% Mn)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**40108**	**698245**	**18379**	**321424**
UAE	2950	42986	18363	320917
Bangladesh	-	-	16	507
China	34614	610984	-	-
Bhutan	2544	44275	-	-

Figures rounded off

Table – 25 : Exports of Manganese Ore (Ferruginous, 10% or More but Below 30% Mn)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**-**	**-**	**24570**	**59450**
Indonesia	-	-	24570	59450

Figures rounded off

Table – 26 : Exports of Manganese Waste & Scrap

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**32**	**9094**	**48**	**24712**
France	32	8978	48	24608
USA	-	-	++	57
Finland	-	-	++	47
China	++	71	-	-
Korea Rep. of	++	45	-	-

Figures rounded off

Imports

Imports of manganese ore (total) increased rapidly by 60% to 6.50 million tonnes in 2021-22 from 4.05 million tonnes in the previous year. In 2021-22 about 44% of imports of Manganese ore total were to South Africa followed by Gabon (21%), UAE (10%), Australia (8%) and Singapore (6%). Out of the total manganese ore imported, the contribution of manganese ore having +46% Mn was 1,85,816 tonnes (3%), manganese ore having 35-46% Mn was 44,64,163 tonnes (69%), manganese ore having 30 to 35% Mn was 9,29,453 tonnes (14%) and manganese ore (others) was 613709 tonnes (10%). In 2021-22, imports of manganese dioxide were 11268 tonnes. In 2021-22, imports of manganese oxide (Other than Manganese Dioxide) were 17,956 tonnes. During 2021-22, imports of manganese & alloys (including waste and scrap) were 40463 tonnes, out of which manganese & alloys (wrought & unwrought) comprised 39,842 tonnes. Imports of manganese & alloys NES were 621 tonnes during 2021-22. (Tables- 27 to 40).

Table – 27: Imports of Manganese Ore : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**4058590**	**55242138**	**6500149**	**96424799**
South Africa	1754857	19894390	2851947	39684590
Gabon	680154	14231857	1371423	22766318
Australia	594049	8301688	525185	9318282
UAE	271579	2768760	670246	8982902
Singapore	274626	3848144	361419	6085643

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
France	54122	740638	169445	2949149
Brazil	175622	2410870	116332	1981983
Cote d'Ivoire	88229	930035	130809	1843644
China	6961	91530	180050	929402
Hong Kong	67871	816612	56643	764844
Other countries	90520	1207614	66650	1118042

Figures rounded off

(In tonnes)

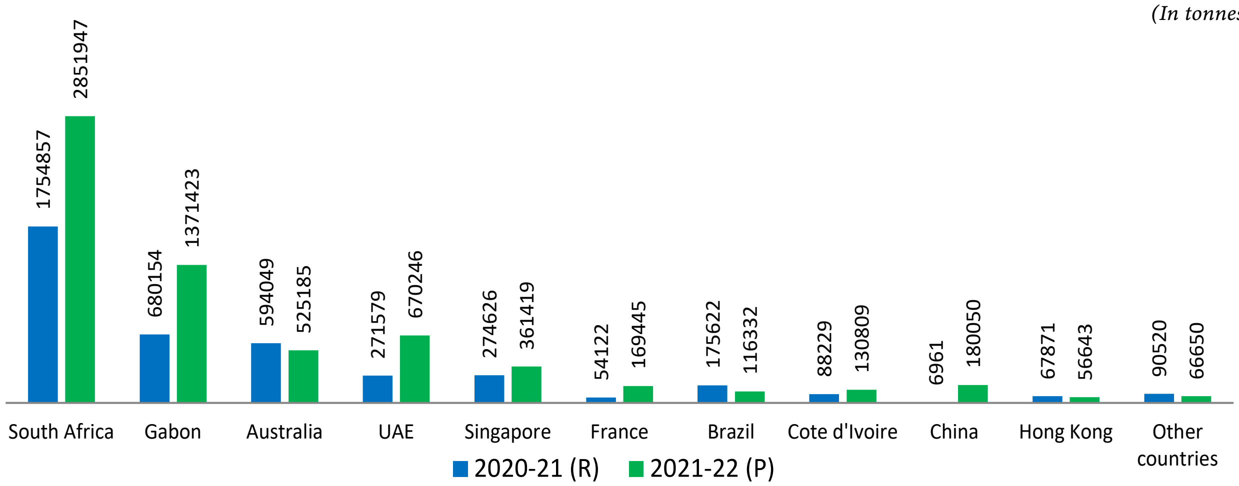


Fig 3: Countrywise Import of Manganese Ore

Table – 28 : Imports of Manganese Ore (46% or more Mn)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**182048**	**3156903**	**185816**	**3797474**
South Africa	86851	1261006	79968	1372767
Cote d'Ivoire	7498	182123	15361	578038
Gabon	44376	868826	18260	371803
Togo	2988	104634	10635	308569
UAE	1674	30651	18776	299148
Tanzania	6699	142804	12882	245260
Brazil	19112	323322	11807	215841
Zambia	8074	126450	8838	164417
China	1675	57809	3935	154284
Singapore	-	-	2611	44872
Other countries	3101	59278	2743	42475

Figures rounded off

Table – 29 : Imports of Manganese Ore (35% or more but below 46% Mn)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2942210**	**39070738**	**4464163**	**69812534**
South Africa	1110682	13627236	1586523	23294128
Gabon	591454	8582003	1066980	18872085
Australia	564638	7842159	525185	9318244
UAE	119220	1523011	347876	5461931

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
Singapore	209991	3021710	319536	5336575
France	54122	740638	169445	2949149
Brazil	138475	1937166	101505	1739842
Cote d' Ivoire	43080	430075	115448	1265606
China	-	-	176115	775118
Hong Kong	58600	726597	40055	578472
Other countries	51948	640143	15495	221384

Figures rounded off

Table – 30 : Imports of Manganese Ore (30% or more but below 35% Mn)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**449497**	**3789163**	**929453**	**9970098**
South Africa	316047	2636360	500060	4878179
Gabon	13727	165331	244564	3024339
UAE	63170	523655	151239	1736259
Hong Kong	6272	51995	15969	175569
Switzerland	5415	48189	9511	77333
Brazil	406	4063	2852	24645
Seychelles	-	-	1644	17667
Kenya	-	-	1905	16654
Tanzania	-	-	691	8744
Oman	-	-	910	8723
Other countries	44460	359570	108	1986

Figures rounded off

Table – 31 : Imports of Manganese Ore (Others)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**316464**	**8006608**	**613709**	**9915315**
South Africa	154548	1718613	504069	8449594
Singapore	57397	770684	39272	704196
Gabon	30597	4615697	41619	498091
UAE	19838	192360	27214	248967
Switzerland	-	-	1314	11979
Brazil	7233	104655	168	1655
Tanzania	-	-	53	645
Zambia	192	2973	++	68
USA	++	143	++	64
Australia	29411	459529	++	38
Other countries	17248	141954	++	18

Figures rounded off

Table – 32 : Imports of Manganese Dioxide

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**12996**	**1016479**	**11268**	**1267664**
China	7569	851348	6935	1071153
Belgium	2906	96802	2948	156270
Peru	1530	38100	995	30035
Australia	437	8731	389	8877
Germany	++	293	1	1121
UK	1	501	++	148
Netherlands	132	7198	++	28
USA	++	151	++	22
Japan	++	43	++	10
UAE	370	9841	--	--
Other countries	51	3471	--	--

Figures rounded off

Table – 33 : Imports of Manganese Oxide (Other than Manganese Dioxide)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**12691**	**548601**	**17956**	**835748**
South Africa	10704	275017	15955	408863
China	692	95792	875	242837
Belgium	631	107854	712	116864
Germany	39	15108	56	21778
UAE	389	39938	43	14922
USA	62	7846	67	10356
Spain	--	--	150	10218
Australia	--	--	47	4535
Italy	25	1763	50	3339
Japan	++	247	1	2014
Other countries	149	5036	++	22

Figures rounded off

Table –34 : Imports of Manganese & Alloys (Incl. Waste & Scrap)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**37247**	**4933243**	**40463**	**12752665**
China	35674	4602138	38617	12027868
Belgium	-	-	235	184760
Hong Kong	554	72961	893	184245
Indonesia	-	-	297	143740
France	125	111625	137	109310
Taiwan	100	11964	96	41921
Korea Rep. of	69	10730	95	28398
Sweden	40	38775	12	12770
UK	++	244	49	10527
UAE	++	7	27	5313
Other countries	685	84799	5	3813

Figures rounded off

Table –35 : Imports of Manganese & Alloys (Wrought/Unwrought)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**36890**	**4838565**	**39842**	**12402477**
China	35391	4566206	38445	11987299
Hong Kong	554	72961	893	184245
Indonesia	-	-	297	143740
Taiwan	100	11964	96	41921
Korea Rep of	69	10730	67	23429
Sweden	40	38775	12	12770
UAE	-	-	27	5312
South Africa	35	8288	5	3661
UK	++	40	++	12
Singapore	625	72940	-	-
Other countries	76	56661	++	88

Figures rounded off

Table –36 : Imports of Manganese (Wrought)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**758**	**96754**	**1915**	**681347**
China	660	83883	1890	676540
Hong Kong	98	12871	25	4807

Figures rounded off

Table –37 : Imports of Manganese & Alloys NES

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**357**	**94678**	**621**	**350188**
Belgium	-	-	235	184760
France	74	58119	137	109310
China	283	35932	172	40569
UK	++	204	49	10515
Korea	-	-	28	4969
USA	++	279	++	48
Germany	++	137	++	16
UAE	++	7	++	1

Figures rounded off

Table – 38 : Imports of Manganese Ore (Ferruginous, 10% or more but Below 30% Mn)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**168371**	**1218726**	**307008**	**2929378**
South Africa	86729	651175	181327	1689922
UAE	67677	499083	125141	1236597
Kenya	-	-	540	2859
Brazil	10396	41664	-	-
Singapore	3569	26804	-	-

Figures rounded off

Table –39 : Imports of Manganese Oxide

(By Countries)

Country	2020-21 (R) Qty (t)	2020-21 (R) Value (₹ '000)	2021-22 (P) Qty (t)	2021-22 (P) Value (₹ '000)
All Countries	**25687**	**1565080**	**29224**	**2103412**
China	8261	947140	7810	1313990
South Africa	10704	275017	15955	408863
Belgium	3537	204656	3660	273134
Peru	1530	38100	995	30035
Germany	39	15401	57	22899
UAE	759	49779	43	14922
Australia	437	8731	436	13412
USA	62	7997	67	10378
Spain	++	6	150	10218
Italy	26	1964	50	3339
Other countries	332	16289	1	2222

Figures rounded off

Table - 40 : Imports of Manganese & Alloys: Unwrought

(By Countries)

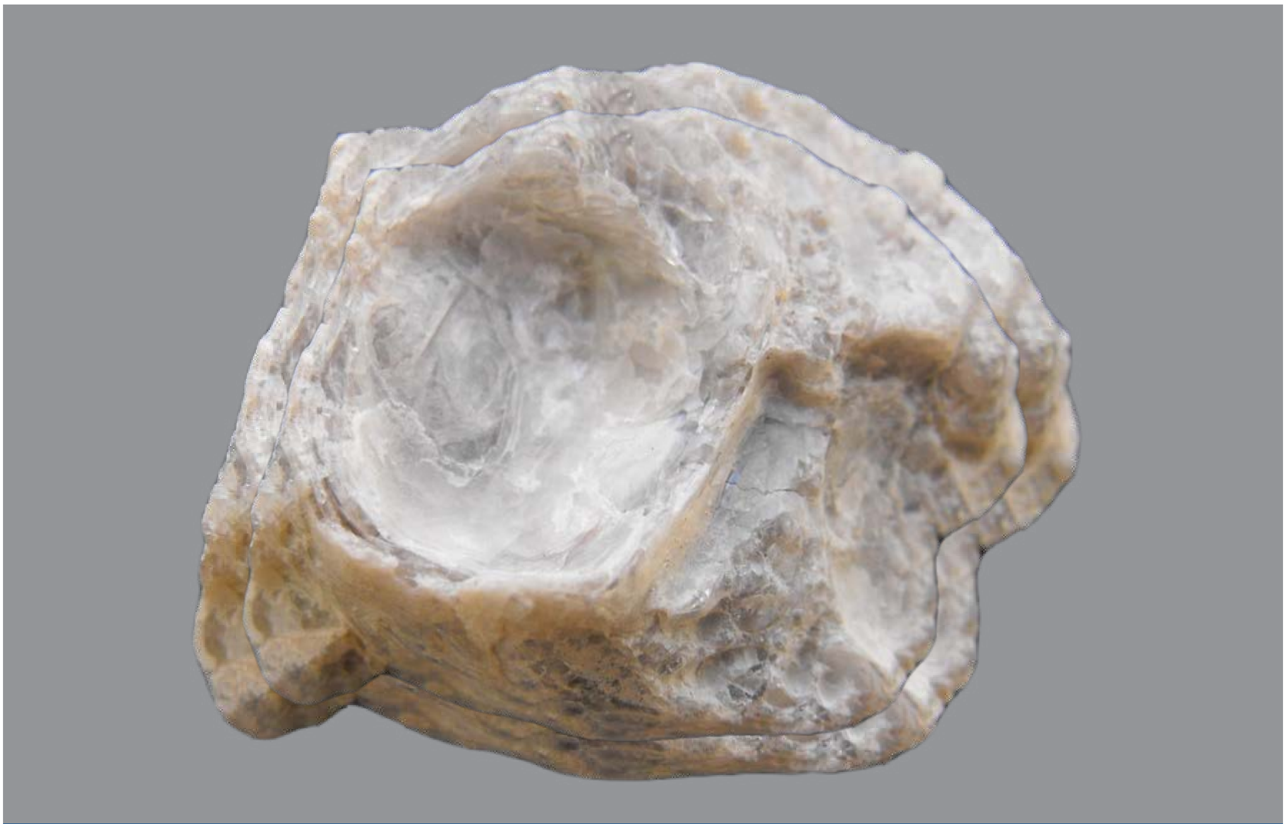
Country	2020-21 (R) Qty (t)	2020-21 (R) Value (₹ '000)	2021-22 (P) Qty (t)	2021-22 (P) Value (₹ '000)
All Countries	**36132**	**4741811**	**37927**	**11721130**
China	34731	4482323	36555	11310759
Hong Kong	456	60090	868	179438
Indonesia	-	-	297	143740
Taiwan	100	11964	96	41921
Korea	69	10730	67	23429
Sweden	40	38775	12	12770
UAE	-	-	27	5312
South Africa	35	8288	5	3661
UK	++	40	++	12
Singapore	625	72940	-	-
Other countries	76	56661	++	88

Figures rounded off

FUTURE OUTLOOK

As per World Steel Association, per capita finished steel consumption in 2022 was 221.8 kg for world while the same for India was 86.7 kg in 2022-23. This difference in the per capita consumption of steel in itself reflects opportunities that are bound to occur for Steel Industry which in turn would positively impact the demand for manganese ore. Production of crude steel is the single most important factor that influences the demand for manganese ore. Steel Industry accounts for approximately 90% of the world demand for manganese. India's crude steel production grew from 89.79 million tonnes in 2015-16 to 120.293 million tonnes in 2021-22.This indicates strong growth of Steel Industry in the country as steel is the principal market accounting for 65 to 70% manganese consumption. The National Steel Policy, which aims to achieve a steel capacity of 300 million tonnes by 2030,with a corresponding demand for approximately 11 million tonnes of manganese ore, offers a promising future. MOIL being India's largest manganese ore producer, accounts for ~45% of the country's production has set a target to produce 3.50 million tonnes of manganese ore by 2030 and the gap in the demand will continue to be filled by imports in years to come.

21. Perlite



2.41

(million tonnes) resources of Perlite have been estimated in India as on 1st April, 2020

Perlite is hydrated, amorphous, siliceous volcanic glass of rhyolitic composition with perlitic texture and pearly lustre. The perlitic texture is often a visible onion peel-like concentric cracking, caused by expansion of the glass upon hydration. It expands in the form of tiny spheres when heated. Colour of crude perlite is light grey to glossy black, whereas the colour of expanded perlite ranges from snowy white to greyish white. It can expand up to 20 times of its original volume at a temperature between 850 °C and 1150 °C. This expansion is due to the presence of 2 to 5% combined water in crude perlite which when heated vaporises to form countless tiny bubbles. Expanded perlite is a white, light weight and durable material that resists decay. Expanded perlite is not only amazingly light weight, but also has exceptional physical properties. Unexpanded (raw) perlite has a bulk density around 1,100 kg/m^3 (1.1 g/cm^3), while typical expanded perlite has a bulk density of about 30–150 kg/m^3.

Perlite is used in industry in both the forms-Crude Perlite and Expanded Perlite. Most perlite is expanded to produce ultra light perlite by heating. Crude perlite is prepared by crushing and screening to various size fractions.

RESERVES/RESOURCES

The only deposit of perlite is located in the Village Patanvav, Rajkot district, Gujarat. It is found to occur in Osam Hill in the form of discontinuous sill. Depending upon the colour, luster and expansion values, the grade of perlite is classified as high, medium and low grade. (i) Perlite which is jet black in colour with glassy luster with expansion values more than 15 to 20 times, is termed as High Grade; (ii) Perlite having black colour, dull luster with mixture of rhyolitic material is termed as Medium Grade; and (iii) Perlite which is black in colour with vitrified, greyish patches and mixture of rhyolitic material is termed as Low Grade.

The total resources of perlite as per NMI database, based on UNFC system as on 1.4.2020 has been estimated at 2.41 million tonnes, out of which 12% are High-Grade, 12% Medium-Grade, 6% Low- Grade and the remaining 70% fall under Unclassified category. The entire resources of perlite are placed under Remaining Resources category (Table -1).

Typical Analysis of Crude Perlite (in percentage)

By Grades	
SiO_2	72–76
Al_2O_3	11 – 17
K_2O	4– 5
Na_2O	2 .9 –4 . 0
CaO	0 .5 –2 . 0
Fe_2O_3	0 .5 –1 . 5
MgO	0 .1 –0 . 5
TiO_2	0.03–0. 20
H_2O	2– 3

Table - 1: Reserves/Resources of Perlite as on 1.4.2020 (P)

(By Grades/States)

(In '000 tonnes)

Grade/State	Reserves	Remaining Resources					Total
	Total	Feasibility	Pre-feasibility		Reconnai ssa nce	Total	Resources
	(A)	STD221	STD331	STD332	STD334	(B)	(A+B)
All India: Total	**0**	**140**	**683**	**595**	**988**	**2406**	**2406**
By Grades							
High	0	19	0	264	0	283	283
Medium	0	79	0	221	0	300	300
Low	0	42	0	110	0	152	152
Unclassified	0	0	683	0	988	1671	1671
By State							
Gujarat	0	140	683	595	988	2406	2406

Figures rounded off.

PRODUCTION AND STOCKS

No production of perlite was reported since 2007-08 and also no stocks were reported during the year 2021-22. However, as per Bulletin of Mining Leases & Prospecting Licences, 2021, one lease having 144.88 Ha area was granted in Rajkot district, Gujarat.

USES

There are different uses of perlite in both crude and expanded form. There are many applications of perlite, such as, producing paint, ceramics, foundry sand, drilling muds, filters, abrasives, matrices for hydroponic plant culturing, for garment washing and loose filling material in insulation and packaging. Usability is mainly controlled by the swelling capacity, which is measured by comparing the bulk density of raw and swelled material. Perlite uses can be grouped under three general categories–construction, horticultural and industrial applications.

Construction Applications

In the construction and manufacturing fields, expanded perlite, on account of i ts acoustic properties, being light weight, fire resistant and an excellent insulator is used in light weight plasters and mortars, insulation, ceiling tiles and as filter aids.

In addition to providing thermal insulation, perlite enhances fire resistance, reduces noise transmission and is resistant to rot, vermin and termites. Perlite is also ideal for insulation against low temperature. When perlite is used as an aggregate in concrete, a light weight, fire resistant, insulating concrete is produced which is ideal for roof decks and other applications. Perlite is also used as an aggregate in portland cement and gypsum plasters (green plaster) for exterior applications and for fire protection of beams and columns. Other construction applications include: light weight curtain/ partition wall, noise reduction, under-floor insulation, chimney lining, paint texturing, ceiling tiles and roof insulation boards. Perlicon is expanded perlite based concrete. The expansion is due to presence of two to six per cent combined water in the crude perlite rock. Demand for good quality expanded perlite in India has been showing an upward trend.

Horticultural Applications

In horticulture, expanded perlite is used throughout the world as a component of soil-less growing mixes, where it provides aeration and optimum moisture retention for superior plant growth. Studies have shown that outstanding yields are achieved with perlite hydroponic systems. Other benefits of perlite in horticulture are its neutral pH value and the fact that it is sterile and weed-free. In addition, its light weight makes it ideal for growing plants in small containers. Besides, perlite is a good carrier for fertilizer, herbicides & pesticides and for pelletising seed. Horticultural perlite is used both by home gardeners as well as commercial growers. Green roofing, where perlite is used as the sole growing medium for plants on roofs, has become a popular trend, and offers a unique sustainable way to insulate a roof while adding foliage to the surface. In greenhouse plantations, landscaping and for in- house plants, use of perlite has shown encouraging results with clean & safe handling. Approximately 10% of annual perlite consumption all over the world is reported under horticultural applications. Perlite can be used by mixing with sand in about 1:1 ratio for better results.

Industrial Applications

Industrial applications of perlite are the most diverse, ranging from high performance fillers for plastics to cements, for petroleum, water and geothermal wells. Other applications include its use as a filter media for pharmaceuticals, food products, chemicals and water for municipal systems and swimming pools.

Perlite finds application additionally as an abrasive in soaps, cleaners and polishes. Its high resistance to heat is taken advantage in manufacturing refractory bricks, high temperature insulation, molten metal topping, light weight fillers, mortars and pipe insulation. Crude perlite is used in retention of heat in Foundry and Ferroalloys Industry. Small quantities of perlite are also used in cryogenic insulation and in ceramics as clay.

SUBSTITUTES

There are a number of materials for construction applications, such as, diatomite, expanded clay, shale, pumice & slag and for horticultural use, vermiculite, coco coir, wood pulp & pumice are alternative soil additives and are sometimes used in conjunction with perlite. These materials can be used in place of perlite without losing any of the benefit that perlite provides. Bentonite and Zeolite are the alternatives in animal feed suppliment.

WORLD REVIEW

Insufficient information is available to make reliable estimates of resources in perlite-producing countries. However, the perlite resources in Greece are 120 million tonnes, China 78 million tonnes, Iran 73 million tonnes, Turkey 57 million tonnes, USA contributed 50 million tonnes and Hungary 49 million tonnes (Table-2).

Asia Pacific is expected to be the fastest growing market for expanded perlite in the next few years. The major reason for this is the growing demand for expanded perlite in developing Asian countries, such as, India, China, Malaysia, Indonesia and Thailand. The major perlite producing countries in the World during 2021 are China 1,500 thousand tonnes, Turkey 1, 429 thousand tonnes, Greece 975 thousand tonnes, USA 860 thousand tonnes and Iran 540 thousand tonnes (Table-3).

As per the Ministry of Commerce under the HS Code: 25301020, the total imports of Perlite during 2019-20, 2020-21 and 2021-22 was 45.72 thousand tonnes and 35.47 thousand tonnes and 48.54 thousand tonnes, respectively.

Table – 2 : World Reserves of Perlite

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total	**NA**
Greece(e)	120000
China(e)	78000
Iran(e)	73000
Turkey(e)	57000
USA	50000
Hungary(e)	49000
Other countries(e)	NA

Source: *USGS Mineral Commodity Summaries, 2023.*

Note: *Sufficient information is not available to make reliable estimates of resources in perlite-producing countries.*

Reserve data for China and Iran were revised based on Government report.

Table – 3 : World Production of Perlite

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
China(e)	1300	1500	1500
Turkey	1174	1146	1429
Greece	719	718	975
USA	629	845	860(e)
Iran(a)	727	541	540(e)
Hungary	77	42	84
Italy(e)	60	60	60
Russia(e)	45	45	45
Slovakia	32	37	35
Georgia	21	32	32
Other Countries	94	57	60

Source: BGS World Mineral Production, 2017-2021.

(a) Year ended 20 March following that stated.

FUTURE OUTLOOK

Perlite is an amorphous volcanic glass. Due to its low bulk density, high heat resistance, low sound transmission, high surface area, low thermal conductivity, chemical inertness and light weight make it more acceptable in industrial applications. Expansion properties from 2 to 20 times of its initial volume in high temperatures, set perlite as a sought after raw material in construction products

Rising construction activities all across the globe and growing application of expanded perlite in various industries including oil & gas are key factors which are anticipated to spur the growth of global perlite market during the near future. The government has planned about 100 smart cities which will invite investment of more than 2 trillion in the coming years which will help attain significant gains to crude perlite market size. Asia Pacific is likely to be the fastest growing market of expanded perlite during the near future owing to high industrialisation and construction activities, rapid urbanisation in emerging Asian economies and growing demand for expanded perlite for gardening purposes in this region.

22. Petroleum and Natural Gas

30
(million tonnes) Production of Crude Oil and Condensate were reported in the country in 2020-21

28,673
(mmscm) production of natural gas were reported in 2020-21

220
(thausand tonnes) of crude petroleum were imported in 2021-22

The domestic production of crude oil and Condenstate which stood at 30.49 million tonnes in 2020-21 decreased by 5.2% as compared to that of the output of the corresponding previous year. The production of natural gas (utilised) also decreased to 28,673 million cu. m (MMSCM) in 2020-21 which is about 8.1% less as against the production in 2019-20. Indian Refinery Industry has done well in establishing itself as a major player globally and has emerged as a refinery hub. India is the second largest refiner in Asia after China and is the fourth largest in the world. The country's refining capacity has touched 249.20 MMTPA as on 01.04.2021. With increase in the domestic refining capacity, which has overtaken domestic consumption, country became a net exporter of petroleum products.

Energy is a key driver of economic growth of any country. Efficient, reliable and affordable energy is essential for sustainable development and inclusive growth of the overall economy of India. India is the third largest energy consumer in the world after China and USA.

India's energy requirement is fulfilled primarily by Coal, Crude Oil, Natural Gas and Renewable Energy. Oil & Gas sector within the energy mix play a predominant role as over one-third of the energy required is met by hydrocarbons. Growing economy and population growth are the main drivers for oil & gas demand, increasing every year. Thus, Oil & Gas will continue to remain important elements for India's energy security and its share in global energy demand is set to almost double to 11% by 2040.

India is set to emerge as one of the primary drivers of growth in oil and gas demand in Asia, despite the pressing Covid-19 challenges. Current hydrocarbon demand is much more than the domestic crude oil and natural gas production. The energy needs of the country are increasing continuously, while the indigenously available energy resources are limited and may not be sufficient in the long run. With the growing energy demands, reliance on imports and limited domestic fossil fuel resources, India needs to plan to either limit its consumption or try to augment production. The country has ambitious plans to increase domestic oil & gas production and exploit all possible forms of energy to the fullest.

India's energy security is primarily about ensuring continuous availability of commercial energy at competitive prices to support its economic growth and meet the lifeline energy needs of households with safe , clean and affordable forms of energy. Oil & Gas sector is pivotal in meeting the energy needs of the nation. To provide renewed impetus to India's upstream Hydrocarbon Sector and usher in favourable policies aligned with the challenging domestic and global energy landscape, Government of India has introduced systemic reforms in the Hydrocarbon Sector, that have ushered consistency, certainty and transparency in the E&P ecosystem.

In the E&P sector, Government's attention has shifted to production enhancement as compared to revenue maximisation, harnessing technological innovation, fostering collaboration and providing a stable and simplified policy and fiscal regime. The path breaking system in the Indian E&P sector clubbed with single window clearance system, strong institutional frameworks, attractive corporate taxes and revitalised regulatory regimes has generated phenomenal investme nt opportunities in India across the entire value chain of E&P, right from greenfield to brownfield.

To meet India's energy security and to reduce the rising import dependence, landmark policy reforms were ushered by the Government in the last 5 years that have elicited universal acclaim and fostered a conducive investment ecosystem in the Oil & Gas Sector. Time is now ripe to steadfastly build upon the policy reforms and work in tandem with the Industry needs.

RESERVES/RESOURCE

As on 1.4.2021, balance recoverable reserves of crude oil were estimated at 587.33 MMT (Million Metric Tons), out of which 325.73 MMT (55%) are in onshore and 261.61 million tonnes (45%) in offshore areas. ONGC (nomination) has the largest share of 71% in reserves of crude oil with OIL (nomination) and PSC regime contributing 13% and 16%, respectively.

The balance recoverable reserves of natural gas as on 01.04.2021 were placed at 1,372.64 billion cu. m, out of which 882.72 billion cum (64%) are in offshore and 492.91 billion cu. m (36%) in onshore areas. PSC regime has the largest share of 50% in natural gas reserves followed by ONGC (nomination) and OIL (nomination) at 40% and 10%, respectively (Table-1).

Table – 1 : Proved and Indicated Balance Recoverable Reserves of Crude Oil and Natural Gas in India as on 1.4.2021(P)

(Crude oil in million tonnes; Natural gas in billion cu. m)

Area	Crude oil	Natural gas
India	**587.33**	**1372.64**
Onshore	325.73	492.91
Andhra Pradesh	7.33	65.5
Arunachal Pradesh	3.64	3.14
Assam	153.05	166.63
Gujarat	115.41	59.79
Jharkhand	-	8.56*
Madhya Pradesh	-	30.88*
Nagaland	2.38	0.09
Rajasthan	34.77	59.06
Tamil Nadu	9.08	37.89
Tripura	0.07	29.18
West Bengal	-	32.19*
Offshore	261.61	882.72
Western offshore	219.27	325.65
Eastern offshore	42.34	557.07

Source: Indian Petroleum and Natural Gas Statistics, 2020-21, Ministry of Petroleum and Natural Gas, Govt. of India.

Note: (i)Proved and Indicated Balance Recoverable Reserves ONGCS contingent Resources (2C) Since 2019.

(ii) Total may not tally due to rounding off.

(iii) Western offshore includes Gujarat offshore.

** Total gas reserves includes CBM reserves CBM Related to Coal-bed Methane.*

EXPLORATION & DEVELOPMENT

The Oil & Natural Gas Corporation (ONGC) and Oil India Limited (OIL), the two National Oil Companies (NOC) and a few Private and Joint Venture companies were engaged in exploration and production activities of oil and natural gas, including coal-bed methane, shale gas/oil, etc. in the country. As on 31.3.2021, there were in all 316 oil/ gas fields including offshore areas under these companies in the country.

Under nomination regime, ONGC's jurisdiction extended to 189 onshore oil/gas fields and 31 offshore oil/ gas fields. Out of the total onshore fields, 77 fields are in Cambay basin (Gujarat); 26 fields in Upper Assam (Assam); 4 fields in Assam & Assam–Arakan (Assam); 4 fields in Jodhpur (Rajasthan); 44 fields in Krishna–Godavari basin (Andhra Pradesh); 25 fields in Cauvery basin (Tamil Nadu); and 9 fields in Assam–Arakan Fold Belt (Tripura). Out of 31 offshore fields, 24 fields in Mumbai, 1 field in Kachchh in the West Coast and 16 offshore fields in Krishna-Godavari (deep) are in East Coast. Besides, OIL was engaged in 19 fields, viz., Upper Assam basin in Assam (14 fields) & Arunachal Pradesh (1 field); Jaisalmer basin (3 fields) & Bikaner– Nagaur basin (1 field) in Rajasthan.

Under PSC and RSC/CBM regime, companies were engaged in 65 onshore oil/ gas fields – Cambay basin in Gujarat (38 fields); Assam– Arakan in Arunachal Pradesh (1 field), Assam (2 fields) & Tripura (2 fields); Krishna–Godavari in Andhra Pradesh (1 field); Jharia & Bokaro in Jharkhand (1 field each) (CBM); Sohagpur in Madhya Pradesh (2 fields) (CBM); Rajasthan (14 fields); Cauvery in Tamil Nadu (2 fields), Raniganj in West Bengal (2 fields) and Bengal in West Bengal (1 field) in onshore areas. In offshore areas, the companies covered 2 fields in Cauvery basin and 7 fields in Krishna–Godavari basin on the East Coast and 3 fields in Cambay basin on the West Coast.

During 2020-21, cumulative 17,051.24 LKM 2D and 1,47,107 SKM 3D seismic data was acquired. Out of which approximately 16,806.42 LKM 2D and 7,281.69 SKM 3D data were acquired. This year 55% of 2D seismic and 68% of 3D seismic data acquisition have been carried out in the offshore basins. A total of 115 exploratory wells (including inland and offshore) amounting to a drilling meterage of 3,44,175 m were drilled. Details of exploratory activities in Nomination, PSC regime & RSC regime in the year 2020-21 are furnished in Table-2.

Table – 2 : Exploratory Efforts in Nomination,PSC and RSC Regime during 2020-21

Subject	Parameter	ONGC (Nomination)	OIL (Nomination)	PSC (Pre-NELP & NELP)	RSC (OALP& DSF)	Total
2D Seismic Data acquired	Onland (GLKM)	244.82	-	-	7502.89	7747.71
	Offshore(GLKM)		-	-	9303.53	9303.53
	Total	**244.82**	**-**	**-**	**16806.415**	**17051.24**
3D Seismic Data acquired	Onland (SKM)	433.05	124.61	250.05	2321.99	3129.71
	Offshore (SKM)	1,272.26			4959.69	6231.95
	Total	**1,705.31**	**124.61**	**250.05**	**7281.69**	**9361.66**
Exploratory well drilled	Onland	61	10	4	1	76
	Offshore	31		8		39
	Total	**92**	**10**	**12**	**1**	**115**
Exploratory Meterage drilled	Onland (1000 m)	176.266	42.811	13.25	1.4	233.744
	Offshore(1000 m)	83.177		27.25		110.31
	Total (1000 m)	**259.443**	**42.811**	**40.5**	**1.4**	**344.175**

Source: India's Hydrocarbon Outlook, 2020-21, Directorate General of Hydrocarbons.

During 2020-21, DGH received a total of 13 discovery notifications of oil and gas from NOC/ PSC/ RSC ope rators , out of these notified discoveries, 3 discoveries were technically accepted. Directorate General of Hydrocarbons (DGH) identified the need of about 48,243 Line kilometer (LKM) 2D seismic data for appraisal for these areas. The project was introduced under broad policy framework of Geo-Scientific Data generation for Hydrocarbons in Indian Sedimentary Basins to appraise the un-appraised onland areas in 26 sedimentary basins and was notified on 20th May 2014. The project is being implemented by National Oil Companies, OIL and ONGC through service providers in North-Eastern states and rest of India respectively. OIL is undertaking seismic data API in Assam shelf & Arakan Basin whereas ONGC carrried out survey work in other basins. As on 31st March 2021, approx. 46,004 LKM of data were acquired which is about 95% of the total target of 48,243 LKM under NSP campaign.

In-Place hydrocarbon volume of 1,159.33 MM T of Oil and Oil Equivalent Gas (O+OEG) have been established by ONGC, OIL and Pvt/JVs under Nomination, PSC and CBM regime. Ultimate reserves established were 4,374.70 MM T O+OEG and accretion in ultimate reserves in the year 2020-21 were 41.61 MMT O+OEG. Balance recoverable reserves were 1,599.69 MMT O+OEG.

During 2020-21, over 4.91 lakh geological surveys have been conducted in India to explore Oil and gas. About 562 wells (of which 79.2% were development wells and 20.8%

exploratory wells) with 12.03 lakh metreage were drilled by Oil and Gas companies during 2020-21.

The details of exploration carried out and discoveries found during the year 2020-21 are covered in General Review on "Exploration & Development".

PRODUCTION

Crude Oil and Condensate

Production of Crude Oil and Condensate in the country was 30.494 million tonnes in 2020-21. It has registered a decrease of 5.20% as compared to that in the previous year. Bulk of the total production, i.e., 76% was shared by the Public Sector companies. Private Sector companies accounted for the remaining 24 per cent (Table-3).

Offshore areas continued to be the largest producer of Crude Oil and Condensate in 2020-21 and had a share of 50.47% in the country's output. Next in order were Rajasthan with a contribution of 19.3%, Gujarat with 15.2% and Assam with 12.8 per cent. The remaining 2.23% of the production was reported by Andhra Pradesh, Tamil Nadu and Arunachal Pradesh.

During 2020-21, the production of Crude Oil and Condensate decreased in Arunachal Pradesh by 3.6%, Tamil Nadu by 1.2% and Gujarat by 1.2% as compared to the previous year. Whereas, there was a decline in production in Andhra Pradesh by 20%, Rajasthan by 11%, Assam by 5% and offshore areas by 4%.

Natural Gas (Utilised)

The production of natural gas (utilised) was 28,673 MMSCM. It decreased by 8.00% in 2020-21 as compared to 31,184 MMSCM in the previous year. Offshore areas continued to be the largest producer of natural gas (utilised) with a share of 64%, followed by Assam (10%), Rajasthan (7%), Tripura (6%), Gujarat (4%), Tamil Nadu (3%) and the remaining 6% of the total production was together contributed by Andhra Pradesh, Arunachal Pradesh, Jharkhand (CBM), Madhya Pradesh (CBM) and West Bengal (CBM). As much as 85% of the total production came from the Public Sector companies whereas the remaining 15% was that of the Private Sector companies during the year 2020-21 (Table-4).

During 2020-21, Statewise analysis revealed that the production of natural gas (utilised) increased in Arunachal Pradesh (24%), Tripura (11%) and Rajasthan (8%) as compared to the previous year. While decline in production was recorded in Jharkhand (CBM) (60%), Tamil Nadu (17%), Gujarat (15%), offshore area (11%), Assam (5%) and Madhya Pradesh (3%) as compared to the previous year.

Table – 3 : Production of Crude Oil and Condensate, 2018-19 to 2020-21 (P)

(By States)

(Quantity in '000 tonnes)

State	2018-19	2019-20 (R)	2020-21 (P)
India	**34203**	**32170**	**30494**
Public Sector	24335	23734	23120
Private Sector	9868	8436	7374
Andhra Pradesh	296	243	195
Arunachal Pradesh	43	56	54
Assam	4309	4093	3902
Gujarat	4626	4707	4651
Rajasthan	7667	6653	5891
Tamil Nadu	395	415	410
West Bengal	--	--	0
Offshore	16867	16003	15391

Source: Indian Petroleum and Natural Gas Statistics, 2019-20 & 2020-2021, Ministry of Petroleum and Natural Gas, Govt. of India.

(In '000 tonnes)

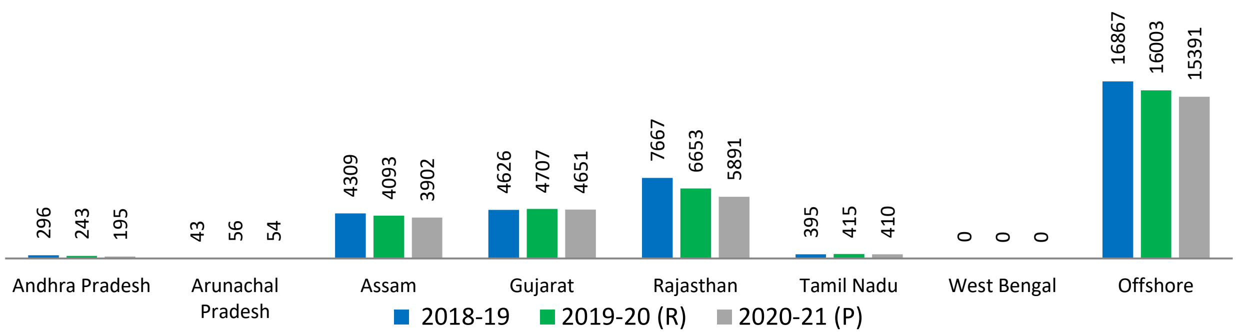


Fig 1: Statewise Production of Crude Oil and Condensate

Table – 4 : Production of Natural Gas (Utilised), 2018-19 to 2020-21 (P)

(By States)

(Quantity in MMSCM)

State	2018-19	2019-20 (R)	2020-21 (P)
India	**32873**	**31184**	**28673**
Public Sector	27396	26414	24352
Private Sector	5477	4770	4321
Andhra Pradesh	1081	912	827
Arunachal Pradesh	28	45	56
Assam	3289	3141	2995
Gujarat	1402	1342	1138
Jharkhand (CBM)**	4	5	2
Madhya Pradesh (CBM)**	357	345	334
Rajasthan	1483	1883	2040
Tamil Nadu	1208	1097	911
Tripura	1554	1473	1634
West Bengal (CBM)**	350	306	307
Offshore	22117	20635	18429

Source: Indian Petroleum and Natural Gas Statistics, 2019-20 & 2020-21, Ministry of Petroleum and Natural Gas, Govt. of India.
*(CBM)**: Coal-bed Methane production*
Note: Total may not tally due to rounding off

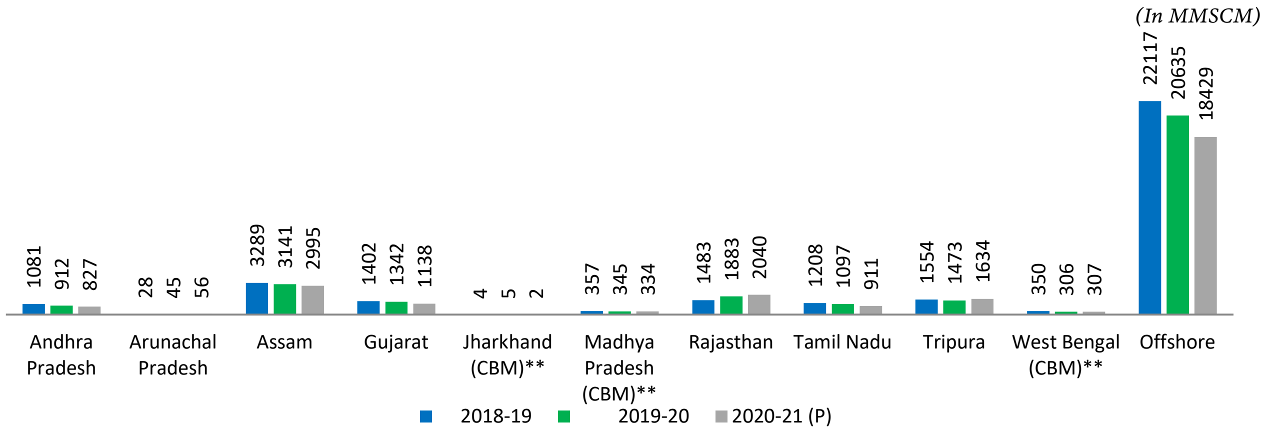


Fig 2: Statewise production of Natural Gas

INDUSTRY

Indian Refinery Industry has done well in establishing itself as a major player globally. India, is the Fourth largest refiner in world and second largest refiner in Asia after China. The operational refining capacity of 23 units in the country which put together touched 249.22 MMTPA in 2020-21. Out of these 23 refineries, 18 are in Public Sector, 3 are in Private Sector and two are Joint Venture. Out of the total refining capacity of 249.22 MMT, 141.92 MMT have been accounted for by the Public Sector, 19.1 MMT by Joint Venture and the balance 88.2 MMT have been reported by the Private Sector. During 2020-21, refinery crude throughput in terms of crude oil processed decreased to 221.77 million tonnes from 254.39 million tonnes in 2019-20 (Table-5). This decrease is attributable to reduced demand caused by the pandemic and lockdown that ensued in the country for several months.

As per annual report of MoPNG for 2020-21, the refining capacity augmentation to the tune of 25.75 million tonnes has been planned by 2022- 23 at brownfield refineries that are IOCL, Barauni (3 MMTPA); IOCL, Guwahati (0.2 MMTPA); IOCL, Bongaigaon (0.35 MMTPA); IOCL, Mathura (1.2 MMTPA); IOCL, Haldia (0.5 MMTPA); IOCL, Koyali (4.3 MMTPA); HPCL Visakhapatnam (6.7 MMTPA); HPCL, Mumbai (2 MM T PA) ; and RIL, DTA, Jamanagar (7.5 MMTPA).

Besides, the Greenfield refinery that is coming up in the near future include HPCL Rajasthan, Refinery Limited (HRRL), Barmer, Rajasthan (9 MMTPA) and Ratnagiri Refinery & Petrochemicals Ltd, Ratnagiri, Maharashtra (60 MMTPA).

The production of petroleum products during 2020-21 at 233.57 million tonnes decreased by 11.2% from 262.94 million tonnes in the year 2019- 20. Production of various petroleum products from refineries and fractionators during 2019-20 to 2020- 21 are provided in Table-6.

Table – 5 : Installed Capacity and Refinery-wise Crude Oil Processed

(In '000 tonnes

Refinery	Annual installed capacity (as on 1.4.2021)	Refinery Crude throughput		
		2018-19	2019-20 (R)	2020-21 (P)
Total	**249200**	**257205**	**254386**	**221773**
Public/Private Sector & Subsidiaries	**141920**	**150976**	**144715**	**127504**
IOCL, Digboi, Assam	650	676	664	605
IOCL, Guwahati, Assam	1000	863	892	849
IOCL, Barauni, Bihar	6000	6661	6516	5469
IOCL, Koyali, Gujarat	13700	13505	13075	11603
IOCL, Haldia, West Bengal	8000	7965	6463	6759
IOCL, Mathura, Uttar Pradesh	8000	9737	8948	8926
IOCL, Bongaigaon, Assam	2350	2513	2045	2450
IOCL, Panipat, Haryana	15000	15281	15038	13181
IOCL, Paradeep, Odisha	15000	14616	15778	12508
BPCL, Mumbai, Maharashtra	12000	14773	15017	12941
BPCL (formerly KRL), Kochi, Kerala	15500	16051	16515	13282
HPCL, Mumbai, Maharashtra	7500	8671	8065	7374
HPCL, Visakhapatnam, Andhra Pradesh	8300	9773	9115	9050
CPCL, Manali, Tamil Nadu	10500	10271	10161	8243
CPCL, Narimanam, Tamil Nadu	1000	423	-	-
Numaligarh Refinery Ltd, Numaligarh, Assam	3000	2900	2383	2707
MRPL, Mangaluru, Karnataka	15000	16231	13953	11475
ONGC, Tatipaka, Andhra Pradesh	70	66	87	81
Joint Venture	**19100**	**18189**	**20155**	**16262**
Bharat Oman Refineries Ltd, Bina@	7800	5716	7913	6190
HPCL Mittal energy Ltd (HMEL), Bathinda#	11300	12473	12242	10072
Private Sector	**88200**	**88041**	**89515**	**78008**
RIL, Jamnagar, Gujarat	33000	31752	33019	34100
RIL, Jamnagar (SEZ), Gujarat	35200	37393	35876	26841
Nyara Energy Ltd (NEL),Vadinar, Gujarat	20000	18896	20620	17067

Source: Indian Petroleum and Natural Gas Statistics, 2020-21, Ministry of Petroleum & Natural Gas, Government of India.
@: Bharat Oman Refineries Ltd (BORL) is a Joint Venture Company promoted by BPCL and Oman Oil Company Ltd (OOCL).
#: HPCL Mittal Energy Ltd is a Joint Venture Company promoted by HPCL and Mittal Energy Investment Pvt. Ltd.
Note: (i) CPCL and BRPL are subsidiaries of IOCL; NRL of BPCL; and MRPL of ONGC.
(ii) Crude throughput in terms of crude oil processed.
(iii) Total may not tally due to rounding off.
(iv) CPCL refinery is under shutdown due to limitation in meeting required product specification.

Table – 6: Production of Petroleum Products from Refineries and Fractionators, 2018-19 to 2020-21 (P)

(In '000 tonnes)

Petroleum Product	2018-19	2019-20	2020-21 (P)
Total Products	**262361**	**262944**	**233513**
LPG	12786	12823	12072
Motor spirit	38039	38616	35779
Naphtha	19786	20679	19403
ATF	15479	15238	7092
Kerosene	4072	3141	2393
HSD	110535	111198	100441
LDO	702	643	729
Furnace oil	9598	8173	6882
LSHS/HHS/RFO	434	437	360

State	2018-19	2019-20 (R)	2020-21 (P)
Lube oils	949	932	1069
Bitumen	5803	5244	5245
Petroleum coke	14676	15528	12655
Paraffin wax	90	96	97
Others	29413	30195	29296

Source: Indian Petroleum & Natural Gas Statistics, 2020-21, Ministry of Petroleum & Natural Gas, Government of India.

Note: (i) Total may not tally due to rounding off.

(ii) Others include Propylene, Solvents, Reformate, MTO, Black Carbon Feed Stock, Sulphur, etc.

CONSUMPTION

The total consumption of petroleum products decreased by 9.26% to 194.295 million tonnes in 2020-21 from 214.127 million tonnes in 2019-20. Increase in consumption was reported in the case of LPG (4.6%), LDO (36%), Lubes/ Greases (6.8%) and Bitumen (11.96%) during 2020-21 as compared to that of the year 2019-20 , whereas, the consumption showed a decline in Fuel Oil (11.36%), Naphtha (1.18%), Furnace Oil (11.9%), ATF (54%), Waxes (20.14%), Petroleum coke (28%), SKO (25%), LSHS (3%) and HSDO (12%) during the same period.

The consumption of various petroleum products from 2018-19 to 2020-21 is furnished in Table-7.

Table – 7 : Consumption of Petroleum Products, 2018-19 to 2020-21 (P)

(In '000 tonnes)

Petroleum Product	2018-19	2019-20	2020-21 (P)
Total	**213216**	**214127**	**194295**
LPG	24907	26330	27558
Motor Spirit	28284	29975	27969
Naphtha	14131	14268	14100
SKO	3459	2397	1798
ATF	8300	7999	3698
HSDO	83528	82602	72713
LDO	598	628	855
Furnace oil (FO)	6195	5912	5208
LSHS	369	390	378
Fuel Oil (FO+LSHS)	6564	6302	5586
Lubes/Greases	3668	3833	4097
Bitumen	6708	6720	7524
Petroleum coke	21346	21708	15605
Waxes	286	278	222
Others	11437	11087	12569

Source: Indian Petroleum & Natural Gas Statistics, 2020-21, Ministry of Petroleum & Natural Gas, Government of India.

Note: (i) Consumption includes sales by oil companies, own consumption & direct private imports.

(ii) Total may not tally due to rounding off.

ALTERNATIVE SOURCES

Conventional or fossil fuels, though being limited, non-renewable and polluting, will continue to play a dominant role in the energy scenario in our country in the next few decades. With the ever-increasing dependence on petroleum imports due to stagnant domestic production and spiralling growth in demand, the Government is encouraging the development of alternative sources of hydrocarbons. The Government has vigorously initiated exploration & development for tapping alternate sources, viz. coal-bed methane, gas hydrates, oil shales, underground coal gasification, etc. in the country.

Coal-bed Methane

Coal-bed Methane (CBM), an eco-friendly natural gas stored in coal seams, is generated during the process of coalification and absorbed into solid matrix of the coal. It is classified as unconventional source of natural gas owing to its nature of occurrence. India, having the fifth largest proven coal reserve in the world, presents a significant opportunity for considering CBM as an alternative source for augmenting India's energy resource, keeping in line with the vision of reducing hydrocarbon import and making India gas-based economy.

The coal and lignite seam contains varying amounts of methane depending on the rank of the carbonaceous matter, the depth of burial and the geotectonic setting of basins. CBM exploration and exploitation has an important bearing on reducing the greenhouse effect. The extraction of CBM, through degassing of the coal seams prior to mining of coal, is a cost-effective means of boosting coal production and maintaining safe methane level in working mines.

In order to harness CBM potential in the country, the Government of India formulated CBM Policy in 1997, wherein CBM being Natural Gas is explored and exploited under the provisions of Oil Fields (Regulation and Development) Act 1948 (ORD Act 1948) and Petroleum & Natural Gas Rules 1959 (P&NG Rules 1959) administered by Ministry of Petroleum & Natural Gas (MoPNG). Various Policy reforms for CBM are discussed in the Chapter ''Policy and Contracts''. As per annual report of Ministry of Petroleum & Natural Gas for 2020-21, the estimated resources of CBM are of the order of 2,600 billion cu. m (91.8 trillion cubic feet) spread over in 11 States in the country.

CBM blocks were offered through international competitive bidding for exploration and production of CBM in the country for the first time in May 2001. Subsequently, there were 3 other bidding rounds in the years 2003, 2005 and 2008, respectively. So far, under the CBM policy, the Government has awarded 33 CBM blocks [including 2 CBM blocks on Nomination basis and 1 block through Foreign Investment Promotion Board (FIPB) route] in four rounds of bidding to National, Private & Joint Venture Companies. These CBM blocks are in the States of Andhra Pradesh, Assam, Chhattisgarh, Gujarat , Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu and West Bengal. The total prognosticated CBM resource for the awarded 33 CBM blocks, is about 62.4 TCF (1,767 BCM), of which, 10.48 TCF (296.9 BCM) has been established as Gas-Inplace (GIP). At present, out of the 33 CBM blocks, 10 are active, 4 of which are in production phase, 4 in development phase and 2 in exploration phase.

Within the next few years, CBM is expected to emerge as a new source of natural gas production in the country. The first commercial production from the CBM blocks commenced in the year 2007 from Raniganj (South) block operated by M/s Great Eastern Energy Corp. Ltd (GEECL). Raniganj (East) Block operated by M/s Essar Oil & Gas Exploration & Production Ltd (EOGEPL) started its commercial production from July 2016. Similarily, Sohagpur (West) operated by M/s Reliance Industries Ltd (RIL) started producing from March 2017 and Bokaro operated by M/s Oil and Natural Gas Ltd (ONGC) from August 2019. In addition to this incidental CBM gas is being produced during testing of CBM wells in Jharia block operated by ONGC and Sohagpur (East), operated by RIL. The cumulative CBM production from these blocks as of FY 2019-20 is 3.7 BCM. The average gas production rate during FY 2019-20 was 1.79 MMSCMD. To date, most of the CBM exploration and production activities in India are pursued by domestic Indian companies.

Gas Hydrates

Gas hydrates are formed when gas and water mixtures are subjected to high pressure and low temperature conditions in the sea, usually in water depths of more than 800 m, within sediments just below the sea bottom. They are also formed in some permafrost region of the world. The gas hydrates also act as a cap under which natural gas can get accumulated. Gas hydrates can be an unconventional energy source of the future.

In India, research and exploratory activities for Gas Hydrate are being steered under National Gas Hydrate Programme (NGHP), technically coordinated by Directorate General of Hydrocarbons (DGH). Under NGHP, various R&D studies are in progress to develop vast resources of gas hydrates in western and eastern offshore and Andaman offshore areas. Two expeditions 01 & 02 have been completed under NGHP

NGHP Expedition-01 exploration programme was carried out in 2006 for mapping gas hydrate zones in Krishna-Godavari, Kerala, Konkan, Mahanadi and Andaman offshore areas. A total of 39 holes drilled at 21 sites and the physical presence of gas hydrate was established predominantly in Krishna–Godavari, Mahanadi and Andaman Basin, but, were non-exploitable with available technologies.

NGHP-02 was conducted successfully in Eastern offshore from 09.03.2015 to 31.07.2015. A total of 42 wells were drilled at 25 sites in Krishna–Godavari and Mahanadi areas in sand reservoirs for Gas Hydrates. NGHP- 02 discovered two distinct Gas hydrate-bearing sand reservoir areas B & C in KG basin, while Area A sand-rich reservoir systems was observed to have limited formation of co ncentrated gas hydrate accumulations whereas in Area-E, the drilled wells indicated the presence of gas hydrate with a combination of fracture/displacement and porefilling type gas hydrate. The results of this expedition were found to be encouraging and further extensive studies are being carried out to assess the gas hydrate resource potential, reservoir characterisation, reservoir delineation & geomechanical modelling for seafloor and wellbore stability & identification of sites for pilot production for testing. KG deep offshore Area B & C were observed to contain gas hydrate accumulations and may be suitable for gas hydrate production. Testing under NGHP Expedition-03 have to be designated.

The challenges faced for commercial exploitation or production of gas from Gas Hydrates are more or less similar all over the world. The planning and execution of NGHP Expedition- 03 were to test the technology and assess the commerciality of Gas Hydrates exploitation in Indian offshore. Atpresent , collation and interpretation of all data is being done to identify sites for pilot production testing. The objective of NGHP Expedition-03 was to carry out pilot production testing at a suitable site identified during the NGHP Expedition-02.

Extracting methane from gas hydrate in marine environments is relatively a new path. Japan has taken a lead in this direction. From the progress being made by the Indian NGHP, steps are underway to mitigate anticipated challenges in the Indian context. The NGHP expeditions are an appropriate line of research investigation which could help the country move forward by harnessing this yet elusive resource.

Shale Oil/Shale Gas

Oil Shales are usually fine-grained sedimentary rocks containing relatively large amounts of organic matter from which significant quantities of shale oil and combustible gas can be extracted by destructive distillation. An oil shale, which has a very high proportion of organic matter in relation to mineral matter, is categorised as coal. Oil shales occur in many parts of the world ranging from small occurrences of little or no economic value to those of enormous size that occupy thousands of square miles and contain many billion barrels of potentially extractable shale oil. Shale Gas/Oil is a form of Natural Gas/Oil that remain unexpelled, unmigrated and entrapped within the pore space and fractures of a source rock (commonly, shale). They are categorised as unconventional resource due to their nature of occurrence and method of extraction. In general, shales have insufficient permeability for fluid flow to a well bore. The shale gas/oil is produced commercially when sufficient fracture conductivity is induced by hydraulic fracturing.

With the continuing decline of petroleum supplies accompanied by increasing costs of petroleum, oil shale presents opportunities for supplying some of the fossil energy needs of the world in the years ahead. Thus, Shale gas can emerge as an important new source of energy in the country. India has several Shale Formations which seem to hold shale gas. The Shale Gas Formations are spread over several sedimentary basins, such as, Gangetic plain, Gujarat, Rajasthan, Andhra Pradesh and other coastal areas in the country including hydrocarbon- bearing ones-Cambay, Assam–Arkan & Damodar Basins which have large shale gas deposits.

In India, a preliminary resource assessment of Shale Gas/Oil was carried out by three different organisations.

(i) ONGC in August, 2013 has estimated Shale Gas resources of 187.5 TCF from 5 sedimentary basins, namely, Cambay, Krishna–Godavari, Cauvery, Ganga and Assam.

(ii) Central Mine Planning and Design Institute (CMPDI) in July, 2013 has estimated Shale Gas resources of 45.8 TCF in Gondwana basin.

(iii) United States Geological Survey (USGS) in January, 2011 estimated Technical RecoverabShale Gas of 6.1 TCF in three basins, namely, Cambay,

Krishna-Godavari (KG) and Cauvery. Again in 2014, it estimated a technical recoverable volume of 62 million barrels of shale oil in Cambay Basin alone.

In order to understand the prospectivity and untap the Shale Gas and Oil resource potential in India, Go I announced a Shale Gas and Oil Exploration Policy on 14th October, 2013 for the National Oil Companies (NOCs), ONGC and OIL. The companies were required to carry out exploration in their PML and ML areas in three phases.

Under the Shale Gas Policy-2013, 50 blocks in 4 basins (Assam, Krishna-Godavari, Cauvery & Cambay) were identified by ONGC and 6 blocks in 2 basins (Jaisalmer and Assam) were identified by OIL in the Phase-I of exploration which ended in April-2017. Till 2019-20, ONGC had drilled a total of 29 wells in 4 basins and OIL has drilled 4 shale wells in 2 basins.

During 2019-20, ONGC drilled two exclusive shale wells (NJSGA in Cambay Basin and MDSGA in KG Basin) and one dual objective well PGAE . At present, a dual objective well, LKEAA in KG Basin is under drilling. Out of the 29 wells completed so far, across four basins viz. Cambay, KG, Cauvery and A&AA Basins, 10 are exclusive wells and 19 are dual objective wells. Indications of presence of shale oil have been recorded in some wells, namely, JMSGA, NSGB and NJSGA in Cambay Basin and WGSGA in KG Basin during activation after hydro-fracturing. In the shale well, NGSGA (Cambay Basin), a zone encountered within the Nawagam Middle Pay (Tight Reservoir) was hydro-fractured and on activation, produced oil. The shale well WGSGA in KG Basin requires further activation whereas another well GNSGC in Cambay Basin is awaiting hydro-fracturing.

During 2019-20 , OIL has completed conventional core analysis of 5 wells, namely, Dandewala-26, Sologuri-2, Matimekhena-5 and South Tinali-5. Final evaluation reports of Jaisalmer PML in Rajasthan and Dibrugarh Extn. PML, Chabua PML, Dumduma PML in Assam incorporating the above conventional core results have been submitted to DGH. Around 17 m of conventional core f rom well Balimara- 6 of Dumduma PML was acquired for prospectivity evaluation of Barail shales. Detail laboratory analysis is currently in progress at M/s Weatherford Laboratories. Two locations have been identified in Jairampur Extn. PEL and Deomali PEL for acquiring conventional core against the target shale of Upper Tikak Parbat and Disang shales for evaluation. Environmental Clearance (EC) is awaited.

Underground Coal Gasification

Underground Coal Gasification (UCG) is a method of converting unworked coal, still in the ground, into a combustible gas which can be used for industrial heating, power generation or the manufacture of hydrogen, synthetic natural gas or diesel fuel. UCG is a new well- pr oven technology of coal extraction that is being investigated and implemented around the world and that avoids most of the challenges of coal mining. With a vast proven reserve of coal, India has the potential to use UCG technology to effectively utilise coal. Development of UCG is envisaged to provide for energy security.

The Government has approved a policy framework on 16.12.2015 for development of Underground Coal Gasification in coal/lignite-bearing areas in the country. A policy, broadly similar to the existing policy for Coal-bed Methane (CBM) development on revenue sharing basis, will be adopted for offering the blocks through competitive bidding. An Inter- Ministerial Committee (IMC) under the Ministry of Coal with members from concerned Ministries will be responsible for identification of the areas, deciding about blocks to be put to bidding or awarding them to PSUs on nomination basis.

ONGC has taken up Vastan Mine block site belonging to Gujarat Industries Power Company Limited (GIPCL) in Naninaroli, Surat district Gujarat as an R&D Pilot Project to establish UCG technology in collaboration with M/s National Mining Research Center–Skochinsky Institute of Mining (NMRC–SIM), Russia. The Agreement of Collaboration (AoC) between ONGC and National Mining Research Center–Skochinsky Institute of Mining (NMRC–SIM), Russia, to co-operate in the Services, Operations, Development and Research related to UCG in India has been renewed up to March 4, 2020. Mining lease with respect to the Vastan Pilot Project has already been awarded to GIPCL.

Moreover, a number of sites have been jointly identifie d by ONGC and Neyveli Lignite Corporation Limited (NLC) for studying their suitability to UCG. These are Tadkeshwar in Gujarat and Hodu- Sindhari & East Kurla in Rajasthan. One more site was jointly identified by ONGC & GMDC viz. Surkha in Bhavnagar district, Gujarat. The data of all the sites have already been analysed and have been found suitable for UCG exploration.

Once the technology is established in India, UCG will emerge as a major clean coal utilisation technology capable of providing significant impact in our country in the near future.

Biofuels

Biofuels seek to provide a higher degree of national energy security in an environment-friendly and sustainable manner by supplementing conventional energy resources, reducing dependence on imported fossil fuels and meeting the energy needs of India's vast population by use of even non-food fee dstocks. The Government has been promoting and encouraging production and use of ethanol derived from molasses and other non- food feedstock for blending with petrol and biodiesel derived from inedible oils, tree borne oil seeds and oil waste for blending with diesel. The Government has notified National Policy on Biofuels 2018 on 8th June, 2018 which is expected to give boost to the biofuel programme of the country. The major features of the Policy are as below:

(i) Categorisation of biofuels as "Basic Biofuels" viz. First Generation (1G) bioethanol & biodiesel and "Advanced Biofuels"— Second Generation (2G) ethanol, bio-CNG etc.

(ii) Expanding the scope of raw material for ethanol production.

(iii) The Policy allows use of surplus food grains for production of ethanol for blending with petrol with the approval of National Biofuel Coordination Committee.

(iv) The Policy indicates a viability gap funding scheme for 2G ethanol Biorefineries.

Ethanol Blended Petrol (EBP) Programme

Ethanol Blended Petrol (EBP) Programme is aimed at achieving multiple outcomes, such as, addressing environmental concerns, reducing import dependency and providing boost to Agriculture Sector. The Government, through Oil Marketing Companies (OMCs), is implementing this programme under which, OMCs sell ethanol blended petrol. The Government, with effect from 01.01.2003, resolved to supply ethanol-blended petrol in nine States and four Union Territories for sale of 5% Ethanol-blended Petrol. This was later increased to 10% w.e.f. 01.10.2008 and extended to 24 States and 5 Union Territories w. e. f. 01.04.2019.

In order to augment the supply of ethanol, the Government on 10th December, 2014, decided to procure ethanol produced from other non-food feed stocks besides molasses, like cellulosic and lignocellulosic materials including petrochemical route. It was also decided to administer the price of ethanol under EBP Programme. Different prices of ethanol have been fixed depending upon the raw material used. The Ethanol Supply Year (ESY) is taken as 1st December to 30th November of the following year so as to align it with the sugarcane crushing season.

From ESY 2018-19, additional sources like B heavy molasses, sugarcane juice, damaged food grains like wheat and r ice unfit for human consumption, surplus food grains and fruit and vegetable wastes have been permitted. During ESY 2018-19, a total of 188.57 crore litres of ethanol were blended in petrol which is the highest quantity in the history of the EBP programme till date, an increase of around 25% over previous year. For ESY 2019-20, the Government has fixed an enhanced remunerative price for ethanol procurement based on raw material utilised. From ESY

2019-20, for the first time sugar and sugar syrup has been allowed for ethanol production to support the industry in liquidating their excess stocks.

The Government in recent years has taken a series of steps to boost the indigenous production of ethanol. These include re-introduction of administered price mechanism, permitting additional feedstock sources for ethanol production, amending Industries (Development & Regulation) Act, 1951 for bringing exclusive control of the Central Government over denatured ethanol, reduction in Goods & Service Tax (GST) rates from 18% to 5% on ethanol utilised under EBP Programme, notifying National Policy on Biofuels-2018 with a target of 20 % ethanol blending by 2030 and an Interest Subvention Scheme for augmentation of ethanol production capacity.

Ethanol meant for EBP Programme is compulsorily denatured in the distillery itself and rendered unfit for human consumption, prior to its dispatch from the distillery. As per Notification of amendment to the Industries (Development and Regulation) Act, 1951 in 2016, the denatured ethanol, which is not meant for human consumption, will be controlled only by the Central Government. Presently, 13 States have already implemented the IDR Act amendment.

Further, MoP&NG has also issued a 'Long Term Ethanol Procurement Policy' under EBP Programme on 11.10.2019 so that the industry can plan towards long-term investments in this Sector. The salient features of this policy are as under:

(i) The ethanol procurement quantity shall be estimated by the OMCs for a period of 5 years and will form part of the procurement tender.

(ii) The annual ex-mill price from sugarcane-based raw materials shall be declared by Government.

(iii) A mechanism will be made by OMCs for change in transportation rates with the change in fuel prices over this long-term contract period.

(iv) Flexibility to introduce any new category of raw material for ethanol procurement.

(v) Mechanism to be available for induction of a new distillery/sugar mill or additional quantity offers by an existing ethanol supplier as well as aprovision for exit by an existing/participating distillery/sugar mill as per ESY in the tender.

A scheme for extending financial assistance to sugar mills through interest subvention for enhancement and augmentation of Ethanol Production capacity has been no t i f i ed by Department of Food and Public Distribution. Under this Scheme, 328 proposals worth ₹ 16,481.67 crore have been accorded in-principle approval which are estimated to add 533 crore litres per annum of ethanol distillation capacity.

With an aim to provide more choices of alternative automotive fuels to consumers, the following approvals have been given by the Government:

(i) Retailing of 100 % Ethanol (E-100) as a transportation fuel on a pilot basis by OMCs at a few retail outlets in areas where ethanol is sufficiently available. After assessment of the economic, operational and developmental aspects of usage of E100 as automotive fuel, the same may be expanded to other outlets.

(ii) Retailing of petrol blended with methanol (M15) as an automotive fuel by Indian Oil Corporation Ltd, at a few outlets in Assam and NE States on a pilot basis. Based on the outcome of this pilot and availability of methanol for blending, the same may be subsequently expanded to other retail outlets.

Second Generation Ethanol

The National Policy on Biofuel announced in 2018 is aimed at accelerated promotion of Biofuels with indicative targets of achieving 20% blending of ethanol in petrol. Therefore, to maximise the production of ethanol in the country for the purpose of blending with petrol, other options/ routes for enhancing ethanol production need to be explored.The Government has already allowed procurement of ethanol produced from other non-food feedstock like cellulosic and lignocellulosic materials, including petrochemical route (known as 2nd generation ethanol). Lignocellulosic biomass is being considered as a prospective source of Second Generation (2G) ethanol for supplementing the rising demand of ethanol for EBP Programme.

Subsequent to opening up of alternate route, i.e., Second Generation (2G) route for ethanol production, Public Sector Oil Marketing Companies are in the process of setting up 12 2G biorefineries and these are at various stages of development. In order to improve the financial viability of the 2G ethanol projects, Government has launched "Pradhan Mantri JIVAN (Jaiv lndhan-Vatavar-an Anukool Fasal Awashesh Nivaran) Yojana" for providing viability gap funding to provide initial thrust to create 2G Ethanol capacity in the country and attract investments in this sector. In this scheme, financial support to twelve Integrated Bioethanol Projects using lignocellulosic biomass & other renewable feedstock with total financial outlay of ₹ 1,969.50 crore for the period 2018-19 to 2023-24 will be provided along with support to ten demo projects for 2G technology.

The foundation stone of Numaligarh Refinery Limited Bio-Refinery Project, a Joint Venture named Assam Bio-refinery Private Limited, was laid on 09.02.2019. Further, the foundation stone of IOCL's Biofuel complex for production of second generation biofuels was also laid at Gorakhpur on 18.09.2019.

Biodiesel Blending Programme

Biodiesel is a mixture of fatty acid easters having properties similar to diesel. It is derived from transesterification process which involves reaction of vegetable/animal fats and oils with alcohol preferably methanol. The properties of biodiesel are such that it can be mixed with any diesel fuel. Experiments for extraction work of biofuel from various plant seeds have been carried out in the country. Of these, Jatropha curcas has been found most suitable for the purpose. The R&D studies indicated that it enhances the life of the engine and results in less pollution.

To encourage production of biodiesel in the country, the Government announced the "Biodiesel Purchase Policy" in 2005 , w. e. f. 01 .01 . 2006 . However, no biodiesel could be procured till 2014. The Government on 16.01.2015 allowed direct sale of biodiesel by manufacturers/ suppliers of biodiesel/their authorised dealers and Joint Ventures (JVs) of OMCs as authorised by MoP&NG to all consumers. On 10.08.2015, the Government allowed sale of biodiesel (B100) by private manufacturers to bulk consumers. Also, retailing of biodiesel blended diesel by Public Sector OMCs was started on the same day. The Government, vide Notification dated 29th June, 2017, has allowed direct sale of Biodiesel (B-100) for blending with High Speed Diesel to all consumers, in accordance with the specified blending limits and the standards specified by the Bureau of Indian Standards.

Ministry of Petroleum & Natural Gas has issued Gazette Notification dated 30.04.2019 regarding 'Guidelines for sale of Biodiesel for blending with High Speed Diesel for transportation purposes- 2019 '. Marketing Division of this Ministry has also issued "The Motor Spirit and High Speed D iesel (Regulatio n of Sup ply, Distribution and Prevention of Malpractices) Amendment Order, 2019 dated 30.05.2019 vide Gazette Notification on 31.05.2019" to incorporate the above guidelines.

During the period April, 2019 to Feb., 2020, 10.13 crore litres of biodiesel has been procured by OMCs for biodiesel blending.

Presently, Biodiesel is mainly being made through imported palm seatrain oil. In order to encourage production of biodiesel from Used Co oking Oil (UCO) , OMCs have floated Expression of lnterest on 10.08.2019, for supply of biodiesel produced from UCO at 100 locations across the country and it was further extended to 200 locations on 10.10.2019. The ex-factory UCO based biodiesel price has been fixed for three years. The price for the first year has been fixed at ₹ 51/litre, for the second year at ₹ 52.7/litre and for the third year a t ₹ 54 . 5 / l i tre. GST and Transportation shall be payable in addition to this price.

POLICIES AND CONTRACTS

One of the landmark outc omes of t he Liberalisation Policy vis-a-vis Petroleum Sector is the impetus for participation of foreign and other Indian Companies in exploration and development activities. The Government further sent signals of encouragement to the National Oil Companies to aggresively pursue oil and gas opportunities overseas.

The New Exploration Licencing Policy (NELP) and the Coal-bed Methane (CBM) Policy were formulated by the Government of India, with Directorate General of Hydrocarbons (DGH) as the nodal agency, during 1997-98 to provide a level playing field to both the Public and Private Sector Companies in exploration and production of hydrocarbons. NELP has steered steadily towards a healthy spirit of competition between National Oil Companies and private companies. The Government had initiated bids under the NELP in February 1999 to accelerate and expand exploration of oil and gas in the country. Under NELP, acreages are offered to the participating comp anies through the process of op en international competitive bidding. The first round of offer of blocks was launched in 1999 and most of the ninth round awards were concluded in 2012. The Government had also formulated a CBM Policy in 1997 and implemented the same in 2000 providing attractive fiscal and contractual framework for exploration and production of CBM.

In order to bridge the gap between energy supply and demand, GoI has adopted multi-pronged strategy for giving momentum to exploration and production (E&P) activities for hydrocarbons in the country. The major steps taken in this regard include offering of exploration blocks in Indian sedimentary basins through NELP; development of alternate sources of hydrocarbon, such as, CBM and Shale Gas; Research & Development for new sources, such as, Gas Hydrate; and carrying out E&P operations in safe and environment-friendly manner.

The Government has issued "Policy Guidelines for Exploration and Exploitation of Shale Gas and Oil on 14th October, 2013. Under this Policy, the right to exploration and exploitation of Shale Gas & Oil will lie with the National Oil Companies (NOCs) holding Petroleum Exploration Licence (PEL)/Petroleum Mining Lease (PML) granted under the nomination regime.

During Pre-NELP era, 28 exploration blocks and 28 small/medium-sized discovered fields were awarded to private companies where ONGC and OIL have the r ights for participation after hydrocarbon discoveries. Under NELP regime, nine rounds of bids have so far been concluded during 1999-2012, in which production sharing contracts for 254 exploration blocks have been awarded and signed. Two DSF bidding rounds have been carried out till date and 53 contract areas have been awarded. Under HELP, four bidding round has been implemented through OALP and received an overwhelming response with 94 blocks getting awarded. As on 01.04.2020, a total of 224 blocks (77 under PSCs and 147 under RSCs) are active comprising 11 Pre-NELP, 21 Small & Medium Size Field PSCs, 45 NELP, 53 Discovered Small field and 94 OALP (under HELP Policy) Blocks. The details of the blocks awarded under various policy/regime are highlighted in Table-8

Table - 8: Status of Exploration Block Awarded

Round	No. of blocks awarded	No. of blocks relinquished	No. of blocks active	Present Area sq.km
NELP-I	24	21	3	231527
NELP-II	23	22	1	267883
NELP-III	23	19	4	204596
NELP-IV	20	17	3	192810
NELP-V	20	16	4	115180
NELP-VI	52	44	8	306426
NELP-VII	41	33	8	112950
NELP-VIII	32	29	3	52573
NELP-IX	19	10	9	26431
Total NELP	254	211	43	1510376
DSF Round-I	30	11	19	777
DSF Round-II	24	5	19	3000
Total DSF	54	16	58	3777
OALP-I	55	-	55	59283
OALP-II	14	-	14	29233
OALP-III	18	-	18	29765
OALP-IV	7	-	7	18510
OALP-V	11	-	11	19789
Total	105	-	94	156580
G. Total	413	227	186	1670733

Source: Indian Statistics 2020-21, Ministry of Petroleum and Natural Gas. Outlook, 2020-21,

The Government's prime objective is to enhance domestic oil & gas production, reduce import dependency and achieve energy security. Therefore, the oil & gas regulatory ecosystem has been overhauled to achieve conducive business environment and to foster investments in the E&P sector. Major policy drives and initiatives have been ushered in by the Government in upstream hydrocarbon segments in India in the last couple of years to provide impetus to the investment climate and to scale up domestic production. The Government has formulated path-breaking policies to revolutionise the E&P sector. Through the various initiatives, the Government envisages to accelerate E&P activities that would provide impetus to expeditious production of oil & gas. Some of the notable policy reforms of recent years have been enumerated below:

1. **Categorises onshore and offshore oil & gasexploration activities as Category B2 for green clearance:** The Ministry of Environment, Forest and Climate Change (MoEF&CC) vide Notification dated 16th January 2020 categorises onshore and offshore oil & gas exploration activities as B2 category for seeking prior Environmental Clearance (EC). As exploration activities in Hydrocarbon sector have been moved from Category A to Category B2, such activities will now require environmental clearance only from the States concerned and will not require preparation of an EIA report or conduct of Public Hearing. However, Development or Production, both on offshore/onshore fields as hydrocarbon blocks, will continue to merit assessment as "Category A".
2. **Self–certification of processes under Production Sharing Contracts (PSC):** Vide Notification dated 28.02.2020, a review of the processes for various approvals and submission of documents for the same under Production Sharing Contracts (PSC) under NELP/Pre-NELP has been undertaken. The documents shall be submitted to DGH and / or Mo PNG. T he Government has reviewed the processes and segregated 37 processes into three categories, viz. (i) 22 Processes where documents shall be accepted on self- Certification basis and no approval is required; (ii) 3 Processes where approval will be deemed on expiry of 30 days of submission of self-certification of documents and (iii) 12 Processes where approvals shall be required under the Act/Rules or Contracts.
3. **Delegating powers to award contract areas to Minister of Petroleum & Natural Gas and Minister of Finance on the recommendations of Empowered Committee of Secretaries (ECS) (Date of Notification:** 29-06-2018): In line with the Government initiative of ease of doing business, the Government has approved delegating of powers to Minister of Petroleum and Natural Gas and Finance Minister to award the Blocks/ Contract Areas to successful bidders under Hydrocarbon Exploration and Licencing Policy (HELP) after International Competitive Bidding (ICB) based on the recommendations of ECS. Under HELP the competitive bidding will be continuous and blocks will be awarded thrice a year.

4. **Exploration and Exploitation of Coal-bed Methane(CBM) from areas under Coal Mining Lease allotted to Coal India Limited (CIL) and its subsidiaries:** The decision is in line with the Government's initiatives of Ease of Doing Business & reducing the hydrocarbon import. The amendment will expedite the exploration and exploitation of CBM, enhance the availability of natural gas and reduce the gap in demand and supply of natural gas. Production of CBM from existing coalfields will further ensure safe mining practices. The increased development activities for exploration and exploitation of CBM gas reserves in-and-around the block will generate economic activities which in turn has potential to crea te emplo yment opp ortunities in CBM operations and in the industries.

The Cabinet Committee on Economic Affairs chaired by the Prime Minister has accorded approval for issuing a notification amending Clause 3(xiii) of the Notification dated 03.11.2015 issued by the Ministry of Petroleum & Natural Gas under Section 12 of the Oil Fields (Regulation and Development) Act, 1948 (ORD Act, 1948). Due to this amendment, relaxation is granted under the Petroleum & Natural Gas Rules 1959 (PNG Rules, 1959) to Coal India Limited (CIL) and i ts subsidiaries for not applying for grant of licence/ lease under the PNG Rules, 1959 for extraction of Coal-bed Methane (CBM) under their Coal-bearing Areas. On 8th May 2018, Ministry of Petroleum & Natural Gas has approved the consolidated terms and conditions for grant of exploration and exploitation rights to Coal India Limited (CIL) and its subsidiaries for CBM. CIL has come out with a tender for carrying out CBM operations in their Jharia and Raniganj Coal Fields.

5. **Policy Framework for Streamlining working of Production Sharing Contracts in respect of Pre–NELP and NELP Blocks :** The policy framework has been notified on 14.08.2018 and includes:

   i) Special dispensation for E&P activities in North Eastern Region (NER) — The Government has extended timelines for exploration and appraisal period in operational blocks of North Eastern region of India considering geographical , environmental and logistical challenges. The exploration period has been increased by two years and appraisal period by one year. Further, to stimulate natural gas production in NER, Government has also allowed marketing including pricing freedom for natural gas to be produced from discoveries which are yet to commence production as on 1st July, 2018.

   ii) Sharing of Royalty and Cess in Pre-NELP Exploration Blocks. The Government has created an enabling framework for sharing of statutory levies including royalty & cess in proportion to the participating interest of the Contractor in Pre- NELP Exploration Blocks and the same has been made cost recoverable with prospective effect.

   iii) Extending tax benefits under Section 42 of Income Tax, 1961 prospectively to operational blocks under Pre-NELP discovered fields for the extended period of contract under PSC extension policy dated 28th March 2016. Section 42 of Income Tax allows the companies to claim 100 % of expenditure incurred under a PSC as tax deductible for computing taxable income in the same year.

   iv) Relaxing the timeline from 7 days to 15 days for giving written notice to notify the occurrence of a Force Majeure event in the PSCs.

6. **Policy Framework for Exploration and Exploitation of Unconventional Hydrocarbons under Existing Production Sharing Contracts (PSCs) Coal-bed Methane (CBM) Contracts and Nomination Fields:** This policy was notified on 20.08.2018 and will enable the realisation of prospective hydrocarbon reserves in the existing Contract Areas which otherwise would remain unexplored and unexploited. With this policy dispensation, new investment in Exploration and Production (E& P) activities and chances offinding new hydroarb on discoveries a nd resultant increased domestic production thereof is expected. This will lead to induction of new, innovative and cutting-edge technology and forging new technological collaboration to exploit unconventional hydrocarbons. As on 31.03.2020, NOC's are carrying out shale Oil/Gas Exploration work in their PEL/PML areas. Operators of blocks Raniganj (South) and RG (East)-CBM-2001/1 have evinced their interest to carry out shale operations in their blocks.

7. **Policy framework to promote and incentivise enhanced recovery methods for Oil and Gas:** The Government notified the Policy on 10th October 2018 with objective to encourage and incentivise additional investments towards adoption of enhanced recovery techniques through fiscal waivers to increase domestic hydrocarb on production. Thepolicy aims at building a supportive ecosystem through academic and research institutes, industry acad emia collaboration and to support and encourage Exploration and Production (E&P) Contractors to deploy ER/IR/UHC Methods/ techniques. Salient Features of the policy are as follows:

   (i) This ER Policy framework is to promote and incentivise Enhanced Recovery (ER)/ Improved Recovery (IR)/ Unconventional Hydrocarbon (UHC) pro duction Methods/ techniques to improve recovery factor of existing hydrocarbons reserves for augmenting domestic production of oil and gas.

   (ii) The ER includes Enhanced Oil Recovery (EOR) and Enhanced Gas Recovery (EGR), Unconventional Hydrocarbon (UHC) production me thod s which include shale oil and gas production, tight oil and gas production, production from oil shale, gas hydrates and heavy oil.

(iii) The policy will be applicable to all contractual regimes and Nomination fields.

(iv) The Policy, having a sunset clause, will be effective for 10 years from the date of its notification. However, the fiscal incentives will be available for a period of 120 months from the date of commencement of production in ER/UHC projects.

(v) In case of IR Projects, the incentives will be available from the date of achievement of the prescribed benchmark.

(vi) The fiscal incentives are extended in form of partial waiver of applicable Cess/Royalty on incremental production resulting from the adoption of ER methods on designated wells.

(vii) An Enhanced Recovery (ER) Committee comprising of representatives of MoPNG, DGH, experts from upstream sector, and academia would monitor and implement the Policy.

(viii) The Policy envisages systemic assessment of every field for its ER potential, appraisal of appropriate ER techniques and fiscal incentives to de-risk the cost involved in ER Projects to make the investment financially viable.

(ix) Mandatory Screening of fields through designated institutions, to be notified by Government, and conducting Pilot-scale studies before actual implementation of ER Project on commercial level.

The implementation of the policy broadly involves 3 major stages screening studies, pilot phase and commercial implementation. The first stage is the screening of ER methods compatible with the field/ reservoir under consideration and selection of the most appropriate ER method accordingly. The second stage is the pilot phase of an ER project which commences after the approval of ER proposals/screening report by DGH. The third stage is the commercial implementation of the ER method by the Operator post a successful pilot phase. Based on this plan for commercial ER implementation, the ER Committee decides upon the quantum of fiscal incentive to be made available to the Operator for the project under the ER Policy.

As on 31.03.2020, a total of 215 commercial fields were screened under the policy. After the first stage screening, the ER screening reports were clubbed field-wise and a total of 72 fields have been deemed to be suitable ER candidate fields. After comprehensive screening studies, a total number of 17 ER proposals have been received in 2019-20 (as on 31st March 2020). Of the 17 ER proposals submitted, 6 proposals have been approved by DGH for next stage

8. **Reforms in Hydrocarbon Exploration and Licencing Policy for enhancing domestic exploration and production of oil and gas:** The Government notified 'Reforms in Exploration and Licencing Policy' on 28th February 2019, with the objective to intensify exploration activities, attract foreign and domestic investment and enhance domestic production. E&P companies under the Reformed Policy will get following exclusive benefits during the contract period:

i) No Revenue Sharing with Government in Category– II & III sedimentary basins except in case of "Windfall Gain";

ii) Royalty concessions for early monetisation and commercial production;

iii) In Category-I, sedimentary basin Revenue share at HRP is capped at 50%;

iv) Simplified contractual terms with emphasis on cutting down approvals of Government/DGH/ Management Committee and expeditious grant of approvals;

v) Empowered Coordination Committee (ECC) under the chairmanship of Cabinet Secretary for expediting process of approvals;

vi) New Dispute Resolution Mechanism for amicable and speedy redressal of contractual dispute.

vii) Electronic Single Window mechanism based on IT workflow and processes for processing of approvals.

The benefits are applicable to OALP Bid Round IV onwards. As on 31.03.2020, 7 Blocks spread over an area of 18,510 sq. km were successfully awarded under OALP Bid Round IV to ONGC. ONGC has committed 1,400 LKM of 2D, 2,450 SKM of 3D and 61 exploratory wells for an investment amount of USD 340.70 million. OALP Bid Round V with 11 Blocks (8 Onland, 1 UltraDeep Water and 2 Shallow Water blocks) on offer spread over an area of 19,800 sq. km is under progress.

9. **Marketing including pricing freedom for gas to be produced from Discoveries in Deepwater (DW), Ultra Deepwater (UDW) and High Pressure-High Temperature areas (HP-HT):** On 10 th March 2016, the Government approved marketing and pricing freedom for Gas discoveries in HP-HT, DW and UDW Reservoirs and details were notified on 21.03.2016. This shall incentivise exploration and production in DW/ UDW/HPHT areas and will unlock huge Hydrocarbon potential. The ceiling gas price is determined (based on alternative fuels) by the Government. Up to 31.03.2020, ONGC has started producing gas from Discoveries in Deepwater, Ultra. Deepwater and High Pressure-High Temperature areas eligible under Notification dated 21.03.2016 from S1-VA field at East Coast from Aug'16. ONGC has also invited tenders for upcoming gas from KG-DWN- 98/2. RIL has also invited tenders for upcoming gas from KG-DWN-98/3.

10. **Policy for the Grant of Extension to the Production Sharing Contracts signed by Government awarding small, medium-sized and discovered fields to private**

Joint Ventures (Date of Notification: 28.03.2016): On 10th March 2016, the Government approved grant of extension to the Production Sharing Contracts for 28 small, medium-sized and discovered fields signed by Government of India and Private JVs. The Policy allows extension for a period of 10 years for both Oil and Gas fields. The Government approved the policy to grant extension for 10 years or economic life of the field, whichever is earlier, to small and medium-sized discovered fields in March, 2016. The Government share of profit Petroleum during the extended period of contract would be 10% higher for these fields. As on 31.03.2020, under this policy, 11 PSCs of Pre-Nelp Discovered Fields have been extended by 10 years and 1 PSC of Pre- Nelp Discovered Field (Hazira) has been extended by 5 years.

11. **New Hydrocarbon Exploration Licencing Policy (HELP) along with Open Acreage Licencing Programme (OALP):** Hydrocarbon Exploration and Licencing Policy (HELP) was launched (Notified on 30.03.2016) with the clear objective of boosting the production of oil & gas in the Indian sedimentary basin. The policy formally put in operation w.e.f. 1st July, 2017 with notification of Open Acreage Licencing Policy (OALP). This policy is based on the new model of Revenue Sharing Contract (RSC) which has replaced the earlier model of Production Sharing Contract (PSC). This policy is a paradigm shift which completely overhauls the regulatory regime for the future Exploration and Production (E&P) activities by reducing the regulatory burden based on the principle of 'Ease of doing business'. Under HELP, Open Acreage Licencing Policy allows the investors to carve out blocks of their choice by assessing E&P data available at NDR & by submitting an Expression of Interest (EoI) throughout the year without waiting for a formal bid round from the Government. These blocks would be subsequently offered through bi-annual formal bidding process . OALP would be manifested through National Data Repository which will provide rapid jump start to E&P activities by providing seamless access to the country's entire G&G data for interpretation and analysis. The Salient Features of HELP are as below:

    i) Unified licence for all types of hydrocarbon viz. conventional oil and gas, coal-bed methane, shale oil, gas hydrates, etc.

    ii) Revenue Sharing Model: Simple, easy to monitor; only two monitoring parameters for the Government revenue & production of the contractor, no cost recovery; no micro-management by the Government; operational freedom to the operator.

    iii) Freedom to carve out blocks under OALP

    iv) Reduced and graded royalty rates. Further, to encourage exploration in deepwater and ultra-deep water areas, the royalty was exempted for first seven years (and subsequently royalty of 5% and 2% will be made applicable in deepwater and ultra-deep water areas, respectively).

    v) Other fiscal incentives viz. exemption of cess on crude oil and custom duty applicable on equipment/ services for exploration and production activities, reduced rate of GST on specified goods being purchased for petroleum operations.

    vi) Full marketing and pricing freedom of gas produced on arm's length basis.

    vii) Extended period for exploration and production, i.e., 8 years for onland/ shallow water and 10 years for deepwater/ frontier areas.

    viii) Pre-determined Liquidated Damages (LDs) for any shortfall in committed work program.

    As on 31.03.2020, since the inception of HELP, four bid rounds have been concluded so far and Fifth Bid Round is ongoing. Under four Bid Rounds, 99 blocks were on offer and 94 exploration blocks covering an area of 1,36,790 sq. km were awarded. Five un-awarded blocks were part of OALP Round- III and in all of them CBM was the focus.

12. **Early Monetisation of CBM:** The policy was notified on 11.04.2017 and it was expected to boost CBM production and generate new avenues of employment and increased investment in CBM blocks. It was also envisaged that 14 CBM blocks which are under relinquishment will be provided an easy exit option under the policy. As on 31.03.2020, after implementation of policy one GSA (Gas Sales Agreement) was signed in Raniganj East CBM Block and exit from 6 CBM Blocks was approved. CBM production during 2019-20 was ~1.80 MMSCMD in the country.

13. **Policy for the Grant of Extension to the Production Sharing Contracts signed by GoI awarding Pre-NELP Exploration Blocks (Date of Notification: 22.03.2017):** This policy enables the contractors to extract not only the remaining reserves but also plan to extract additional reserves by implementing new technologies. The policy will enable acceleration and supplementation of indigenous production of hydrocarbon from existing blocks and will act as a progressive step towards achieving the target of 10% reduction in import of energy by 2021-22. In certain fields, additional recovery of hydrocarbons can be obtained and as such the production would extend beyond the current duration of PSC. The Government share of Profit Petroleum during the extended period of contract would be 10 % higher for these fields, thus bringing additional revenues to the Government. In addition, the policy brings out detailed guidelines regarding grant of extension, criterion forevaluation of request, time frame for consideration of request, duration of extension etc. The extension of these

contracts is expected to bring extra investments in the fields and would generate both direct and indirect employment. The policy aims at bringing out clear terms of extension in fair and transparent manner so that the resources can be expeditiously exploited in the interest of energy security of the country besides improving the investment climate. As on 31.03.2020, out of 10 blocks applicable under the policy, extension of 10 years has been granted to Pre-Nelp Exploration block RJ-ON-90/1, and 6 blocks have more than 2 years for expiry of PSC. One block has been terminated and remaining 2 blocks are under exploration in PSC.

14. **Survey of Un-Appraised Areas of Sedimentary Basins of India (Date of Notification:12.09.2017):** The project was sanctioned to acquire 48,243 Line Kilometer (LKM) 2D seismic data for appraisal of Indian sedimentary basins where limited data is available. The project will be implemented by NOCs, i.e., OIL and ONGC. OIL will conduct survey in North Eastern States while remaining area will be covered by ONGC. Survey work will be carried out in 24 States over a period of 5 years. The timeline to complete the project was June 2020. DGH reviewed the progress of work and construed that reasons for shortfall in completing the project target are inevitable. Due to Covid-19 restrictions and lockdown, MoP&NG has been requested to extend the timeline till June 2021. As on 31.03.2020, cumulative data acquisition by ONGC and OIL was 40,137.40 LKM (98.29%) and 4,637.28 LKM (76.10%) respectively. Processing of 35,431.50 LKM data and interpretation of 22,003.97 LKM data by ONGC have been completed whereas, 3,559.68 LKM data were processed in the case of OIL.

15. **New Domestic Natural Gas Pricing Guidelines, 2014:** In supersession of MoPNG's Gazette Notification no. 22011/3/2012ONG.D.V dated 10.01.2014, the Government of India notified the New Domestic Natural Gas Pricing Guidelines, 2014 on 25.10.2014, effective from 01.11.14. Domestic Natural Gas prices are being determined in accordance with the pricing formula dated 25.10.2014 and notified by MoPNG on half yearly basis. In terms of these guidelines, domestic gas price is determined based on weighted average formula considering (a) annual average prices prevailing at Henry Hub, Alberta Hub, National Balancing Point & Russia and (b) annual volume of natural gas consumed in USA & Mexico, Canada, European Union & Former Soviet Union countries excluding Russia.

16. **Policy framework for relaxations, extension and clarifications at the development and production stage for early monetisation of Hydrocarbon discoveries under PSC regime:** The policy was notified on 10.11.2014 and the salient features of the policy initiative are as under:

    i) Extension of Appraisal period for submission of Declaration of Commerciality (DoC) in respect of Hydrocarbon discovery.

    ii) Extension of time period for submission of Field Development Plan (FDP) after review of DoC by the Management Committee.

    iii) Reduction in Minimum Work Programme (MWP) in case a block or its part is not available for exploration activities consequent to denial of permission by Government Agencies.

    iv) Swapping of 2D and 3D Seismic Minimum Work Programme, on the request of the operator.

    v) In cases where the committed Minimum Work Programme of any exploration phase is not completed, entry into subsequent exploration phases, would be permitted after paying cost of unfinished MWP of previous phases.

    vi) Condoning delays in submission of notice for entering next phase.

    vii) Condoning delays in submission of Annual Work Programme and Budget and the Appraisal work programme.

    viii) Permission for drilling of Appraisal Wells after Submission of DoC.

    ix) Probing additional reservoirs during appraisal programme.

    x) Acce ptance of discoveries for which notification to the Government has not been made and also notification for testing has not been provided as prescribed.

    As on 31.03.2020, over 40 cases have been resolved under this policy. Extension of time period for submission of DoC and FDP were granted in 8 Blocks and 4 Blocks, respectively. Operator allowed to exit in 14 Blocks whereas in 3 Blocks Minimum Work Programme (MWP) Reduction was granted and 2 applications are under consideration. Swapping of 2D and 3D seismic MWP were granted in 7 Blocks. Entry into subsequent exploration phase, after paying cost of unfinished MWP of previous phases was granted in 1 Block. One application was received for condoning delays in submission of notice for entering next phase. Drilling of Appraisal Wells after submission of DoC was granted in 1 Block. Probing of additional reservoirs during appraisal programme was approved in 3 Blocks.

17. **Policyon Testing Requirements for discoveries in NELP Blocks:** The Government of India approved (notified on 13.05.2015) a clear policy on testing requirements for discoveries made under NELP Blocks. The policy settled the long pending issue of about 13 discoveries in five blocks pertaining to ONGC (Seven discoveries) and Reliance Industries (six discoveries). The reform allows the contractors to choose one of the following three options for discoveries which are stuck on account of testing requirement:

(i) Relinquish the blocks

(ii) Develop the discoveries after conducting Drill Stem Test (DST) with 50 per cent cost of DST being disallowed as penalty for not conducting the test on time. The cost recovery for carrying out DST would be capped at US $ 15 million.

(iii) Develop the discoveries without conducting DST in a ring-fenced manner.

As on 31.03.2020, after availing this policy in block KG-DWN-98/3, the Contractor has submitted DOC and FDP for D-29 and D-30 discoveries which got reviewed/approved by MC and currently it is under development. Also under this policy, Contractor has relinquished D- 31 and D-42 discoveries of block KG-DWN-98/3.

18. **Discovered Small Field Policy (Earlier called as Marginal Field Policy) (Date of Notification: 14.10.2015):** To reduce the import dependency of hydrocarbons, to effectively exploit the untapped established reserves and increase indigenous production, the Government approved the Marginal Field Policy (MFP). The Government has attempted to include certain reforms in the hydrocarbon exploration and production management through this policy with sole intention to increase the production at the earliest. The policy was later rectified as Discovered Small Field Policy. The objective of the Discovered Small Field Policy is to bring discovered small fields to production at the earliest to augment the domestic production of oil and gas. For early monetisation of these fields, in September 2015, the Cabinet approved 69 marginal fields for offer under DSF Policy. These contract areas have been awarded under the new regime of Revenue Sharing Model. Award of contract is expected to provide faster development of fields and facilitate production of oil and gas thereby increasing energy security of the country. Under Discovered Small Field Bid Round-I & Round-II, a total of 53 contract areas comprising 100 fields were awarded. Of which, 37 Contract Areas awarded were on-land and 16 remaining Contract Areas were offshore. As on 31.03.2020, Bid Work for 111 wells and anticipated investment under FDPs to the tune of 1,600 million USD are under progress. PML has been granted for 42 contract areas (27 Onland and 15 Shallow water), while for 08 contract areas (Andhra Pradesh-05, Tamil Nadu-02, Arunachal Pradesh-01), it is pending . A total of 23 FDPs have been approved with total Inplace of 154.5 MMtoe and cumulative production of 41.9 MMtoe contribution during field life.

STRATEGIC CRUDE OIL STORAGE

Keeping in view India's high import dependence for oil & gas and country's energy security, MoPNG took up construction of crude oil reserve facilities as a buffer to deal with any situation of supply chain disruption due to external reasons. A Special Purpose Vehicle (SPV) named Indian Strategic Petroleum Reserve Limited (ISPRL), a subsidiary Company of Oil Industry Development Board (OIDB), was created on 16th June, 2004. Under Phase I, three underground rock caverns for Strategic Petroleum Reserve (SPR) with total crude oil storage capacity of 5.33 million tonnes located at Visakhapatnam (1.33 million tonnes), Mangaluru (1.5 million tonnes) and Padur (2.5 million tonnes) have been constructed and were dedicated to the nation on 10th February 2019. The National Oil Company of Abu Dhabi (ADNOC), UAE, has already stored crude oil at its own cost at one of the two cavern of Mangaluru SPRs as per restated agreement signed with ADNOC on 10 th February 2018 . The Indian Strategic Petroleum Reserves Ltd (ISPRL) signed an MoU with Saudi Armaco to explore possibility of filling one cavern at Padur on the sidelines of the PM's visit to Saudi Arabia in October 2019. The total reserve of Phase-I of SPRs is currently estimated to supply approximately 10 days of India's crude requirement.

In order to further augment India's preparedness during emergency oil shortage situation, the Government under Phase-II gave 'In Principle' approval for establishing additional 6.5 MMT Strategic Petroleum Reserves at locations Chandikhol (4 MMT) in Odisha and Padur (2.5 MMT) in Karnataka. The 'In Principal' approval is to take up the project under PPP model to reduce budgetary support of Government of India. On completion of 6.5 MMT storage envisaged in Phase II, there will be an additional storage capacity created to cover another 12 days of crude oil requirement. Thus, the total cover would be approximately 22 days

WORLD REVIEW

The world proved reserves of crude oil and natural gas at the end of 2020 were estimated at 244.4 billion tonnes and 188.1 trillion cu. m, respectively (Tables - 9 & 10). The largest share of reserves of world crude oil is available in Middle East (48.3%) followed by South & Central America (18.7%), North America (14%), CIS (8.4%), Africa (7.2%), Asia Pacific (2.6%) and Europe (0.8%).

Of the total world reserves of natural gas, the largest share is from Middle East (40.3%), CIS (30.1%), Asia Pacific (8.8%), North America (8.1%), Africa (6.9%), South & Central America (4.2%) and Europe (1.7%).

The world production of crude petroleum in 2020 decreased by 7% to 4,126 million tonnes from 4,441 million tonnes in 2019. USA with share of 18% followed by Saudi Arabia (13%), Russia (12%), Iraq, China & Canada (5% each), Brazil & UAE (4% each) and Kuwait & Iran (3% each) were the principal producers of crude petroleum in 2020.

The world production of natural gas decreased to 4,047 billion cu. m in 2020 from 4191 billion cu. m in 2019. USA with share of 23% followed by Russia (17%), Iran (6%), Qatar, China, Canada & Australia (4% each) and Norway & Saudi Arabia (3% each) were the major producers of natural gas in 2020 (Tables-11 & 12).

The world consumption of oil (which includes biogasoline, biodiesel and derivatives of coal & natural gas) in 2020 was estimated as 91,297 thousand of barrel per day, while that of natural gas (excludes natural gas converted to liquid fuels but includes derivatives of coal as well as natural gas consumed in gas-to-liquids transformation) was 3,822.8 billion cu. m. The share of India in the world consumption of oil and natural gas was 5.26% (4,669 thousand of barrels per day) and 1.56% (59.6 billion cu. m), respectively, during 2020 .

Table – 9 : World Proved Reserves of Crude Oil*

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total	244.4
Algeria	1.5
Angola	1.1
Azerbaijan	1
Brazil	1.7
China	3.5
Canada	27.1
Iran	21.7
Iraq	19.6
Kazakhstan	3.9
Kuwait	14
Libya	6.3
Nigeria	5
Norway	1
Qatar	2.6
Russian Federation	14.8
Saudi Arabia	40.9
UAE	13
USA	8.2
Venezuela	48
Other countries	9.5

Source: BP Statistical Review of World Energy, 2021.

** At 2020 end.*

Table– 10 : World Proved Reserves of Natural Gas*

(By Principal Countries)

(In trillion cu. m)

Country	Reserves
World : Total	**188.1**
Algeria	2.3
Australia	2.4
Azerbaijan	2.5
Canada	2.4
China	8.4
Egypt	2.1
India	1.3
Indonesia	1.3
Iran	32.1
Iraq	3.5
Kazakhstan	2.3
Kuwait	1.7
Libya	1.4
Malaysia	0.9
Nigeria	5.5
Norway	1.4
Qatar	24.7
Russian Federation	37.4
Saudi Arabia	6
Turkmenistan	13.6
UAE	5.9

Ukraine	1.1
USA	12.6
Venezuela	6.3
Other countries	9

Source: BP Statistical Review of World Energy, 2021.

** At 2020 end.*

Table – 11 : World Production of Crude Petroleum

(In million tonnes)

Country	2018	2019	2020
World : Total	**4477**	**4441**	**4126**
Algeria	65	64	58
Angola	74	69	65
Argentina	26	26	26
Azerbaijan	39	38	35
Brazil	139	150	158
Canada	228	233	223
China(a)	189	191	190
Colombia	46	47	41
Ecuador	28	29	26
Egypt	33	32	30
India(c)	34	32e	30
Indonesia	39	37	36
Iran	219	158	143
Iraq	227	234	202
Kazakhstan	90	91	86
Kuwait(d)	147	143	130
Mexico	107	99e	99
Nigeria	96	101	87
Norway	91	85	99
Oman	49	48	47
Qatar	80	79	76
Russia	556	561	512
Saudi Arabia(d)	578	557	520
UAE	177	180	166
UK	51	52	49
USA	701	781	747
Venezuela	76	47	27
Other countries	293	278	222

Source: World Mineral Production, 2016-2020.
Note: The figures shown in this table include natural gas liquids.
(a): Including oil from shale and coal.
(c): Years ended 31 March following that stated.
(d):Including shares of production from the Neutral Zone.

Table – 12 : World Production of Natural Gas

(By Principal Countries)

(In billion cu. m)

Country	2018	2019	2020
World: Total	**4039**	**4191**	**4047**
Algeria	94	86	82
Argentina	40	46	42
Australia	131	154	154
Azerbaijan	19	25	26
Bahrain	22	25	25
Bangladesh	27	27	25
Brazil	27	27	25
Canada	157	161	158
China	160	176	176
Egypt	59	65	59
India(d)	32	30	29
Indonesia	73	67	59
Iran	232	241	251
Kazakhstan	55	57	55
Malaysia	66	69	63
Mexico	46	39*	39*
Nigeria	48	46	49
Norway	122	115	112
Oman	35	36	35
Pakistan(c)	41	41	40
Qatar	169	172	171
Russia	726	738	694
Saudi Arabia(e)	112	111	112
Tanzania	59	60	60*
Thailand	37	38	33
Trinidad & Tobago	37	37	31
Turkmenistan	62	63	59
UAE	58	58	55
UK	41	39	39
USA(a)	871	961	948
Uzbekistan	57	57	47
Other countries	324	318	292

Source: World Mineral Production, 2016-2020.
Note: So far as possible the figures in this table exclude flared or reinjected gas.
(a):Dry gas.
(c): Years ended 30 June of that stated.
(d): Years ended 31 March following that stated.
(e): Including one-half of the output of the Neutral Zone.
*: estimated

Exports

Exports of natural gas decreased significantly by 66% to 17,992 tonnes in 2020-21 from 52,408 tonnes in 2019-20. Exports of natural gas were mainly to Nepal (99.9%) (Table -13).

Table – 13 : Export of Natural Gas

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**17992**	**658242**	**3**	**883**
Bhutan	2	299	3	484
U Arab Emts	++	100	++	399
Nepal	17988	65779	--	--
Nigeria	2	46	--	--

Figures rounded off

Imports

Imports of crude petroleum decreased by 15% to 188.182 million tonnes in 2020-21 as compared to 220.870 million tonnes in 2019-20. Imports were mainly from Iraq (26%), Saudi Arabia (18%), UAE and USA (9% each), Nigeria (7%), Kuwait (6%), Mexico (3%) and Oman, Russia & Brazil (2% each). Imports of natural gas Increased marginally by 3% to 25 million tonnes in 2020-21 from 24.41 million tonnes in 2019-20. Main suppliers were Qatar (43%), USA (16%), UAE (14%), Nigeria (7%) , Angola and Oman (4% each), Egypt (3%),(Tables - 14 & 15).

Table – 14 : Import of Petroleum (Crude)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**188182**	**4396561618**	**220034**	**9139168005**
Iraq	43028	951898108	56467	2265536210
Saudi Arabia	34201	795811634	38878	1707845805
UAE	21883	543546952	21664	918227357
USA	15030	396119190	19976	845421712
Nigeria	14220	361689340	14994	641122361
Kuwait	9590	230800971	14228	592834902
Mexico	7343	146424544	7252	254741881
Russia	2760	70008285	4317	184101269
Oman	3267	85023664	6276	269194922
Brazil	3027	68733737	4158	165830985
Other Countries	33833	746505193	31824	1294310601

Figures rounded off

(In tonnes)

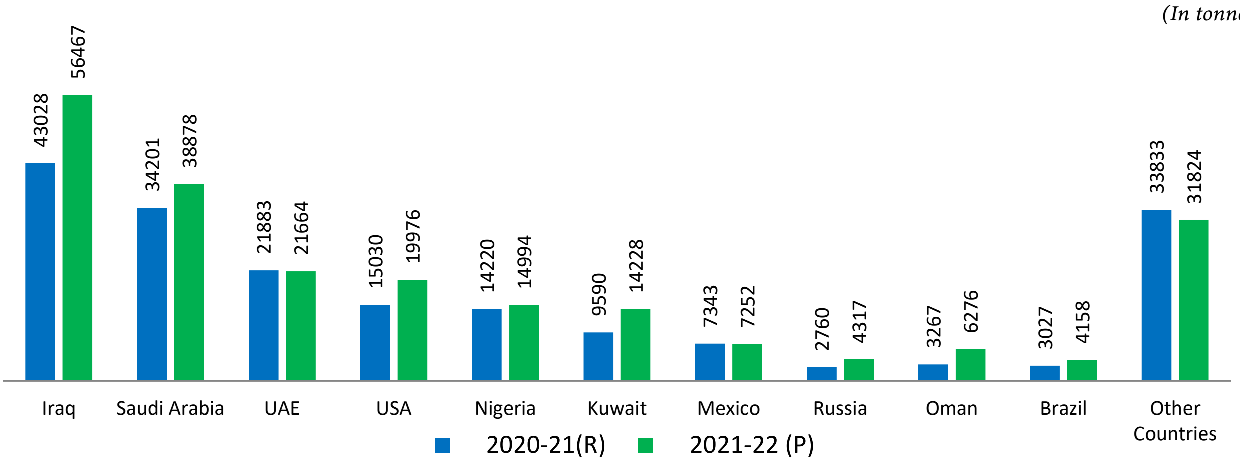


Fig 4: Countrywise Import of Petroleum (Crude)

Table – 15: Import of Natural Gas

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**25054872**	**583289424**	**23417029**	**1005206968**
Qatar	9928514	232229782	10100902	441047128
USA	2903231	82166511	3652704	141562657
UAE	3222307	61110991	3212749	124276361
Nigeria	2153556	47593774	1793215	106236403
Angola	1927953	40107265	996410	45916693
Oman	1502556	34754703	931216	50252252
Cameroon	203350	2797193	337501	9716406
France	475546	13764633	308815	10783085
Egypt	455788	13321517	733197	22514425
Belgium	287728	7266895	210528	9618472
Other Countries	1994343	48176160	1139792	43283086

Figures rounded off

(In tonnes)

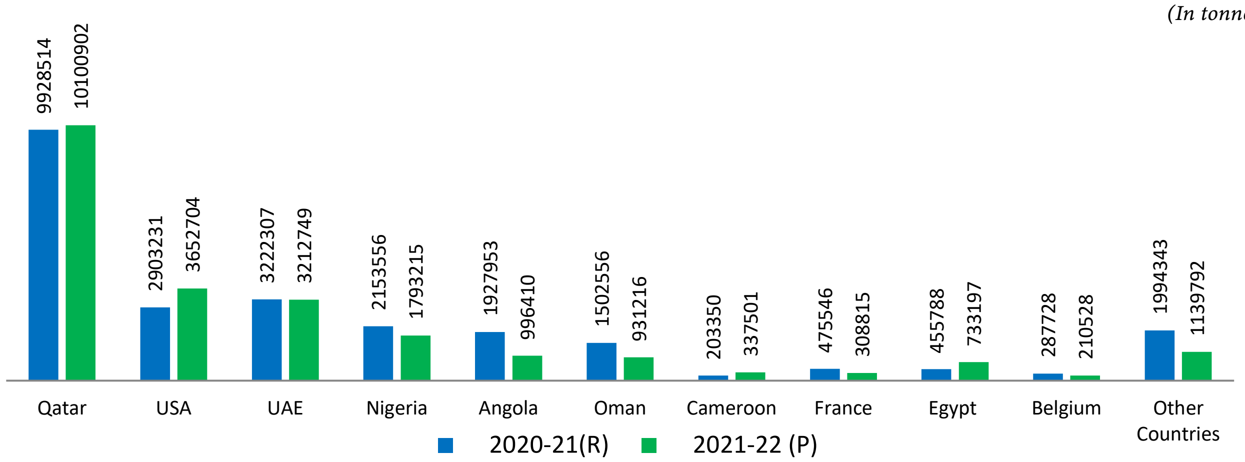


Fig 5: Countrywise Import of Natural Gas

FUTURE OUTLOOK

Energy is considered as one of the key inputs for economic development of any country. India is expected to be one of the fastest growing economies of the world in the near future. With the population anticipated to grow in the future and improvements in socio-economic developments, energy demand is expected to rise consequently. Thus, India will be the biggest contributor to energy growth demand globally in the years to come and hydroca rbons is an important component of India's energy basket in future.

As India moves towards a 5 trillion dollar economy with commensurate energy needs, the criticality of hydrocarbons in meeting this growing energy requirement hardly needs emphasis. Thus, India is set to emerge as one of the primary drivers of growth in oil & gas demand in Asia, despite the pressing Covid-19 challenges. Oil & Gas will continue to remain important elements for India's energy security and its share in global energy demand is set to almost double to 11% by 2040. Further, Government has taken an ambitious target to increase the share of natural gas from the existing 6% to 15% by 2030 to transform India into a gas-based economy.

As per the BP World Energy Outlook 2019, India's primary energy consumption is set to rise from around 754 MMtoe in 2017 to 1,928 MMtoe in 2040 (4.2% CAGR). As per the BP World Energy Outlook 2020, the growth of industrial energy demand would be concentrated in the emerging world (outside of China) – especially, India, rest of Asia and Africa.

In recent years , the Government has committed itself to a number of economic and structural reforms that are aimed at achieving strong growth in GDP over the medium to long term range. The role of renewables in India's energy basket is likely to see a quantum leap in the longer term driven primarily by increasing penetration of renewable energy. Despite the healthy outlook for renewables, the energy mix is still massively dependent on fossil fuels. Within fossil fuels, while the country benefits from abundance of cheap coal, reliance on imports for securing oil & gas requirements is not likely to change anytime soon. The country is deficient in oil resource s and most o f the d ome s t ic requirements are met through imports and this trend is likely to continue in the near future as well.

As per the draft National Energy Policy, 2017 put out by NITI Aayog, it is expected that in the medium term while the share of oil may not come down, share of gas would rise. Based on the present extent of knowledge of the hydrocarbons potential, the said policy anticipates that the production of oil and gas has potentials (ambitious case) to reach 61 Mtoe and 124 BCM by 2040.

As per Annual Report of MoPNG 2019-20, 100% Indian sedimentary area is to be appraised and as of now, only 48% of the basinal areas have been appraised. About 4% sedimentary basinal area has been declared as “NO GO area” by Ministry of Defence/ Ministry of Environment & Forest which remains unapprised. This means, about half of the Indian sedimentary basins have the undiscovered potential of hydrocarbons. Besides, the prognosticated conventional hydrocarbon resources in 26 sedimentary basins of the country have been reassessed or estimated at about 41.87 billion tonnes of oil and oil equivalent of gas (O+OEG), which reflected 49% increase as compared to the earlier estimates of 28.08 billion tonnes. Further, about 74 % of resources, as on 1st April, 2019, are under "yet to discover" category. Out of 10,950 MMT of oil and oil equivalent gas of in-place volumes, the ultimate reserves which can be produced are about 4,259.5 MMT of oil and oil equivalent gas. The balance recoverable reserves are of the order of 1,909 MMT of oil and oil equivalent gas. Thus, Indian sedimentary basins have ample hydrocarbon potential for future exploration and production.

The Hydrocarbon Vision 2030 for Northeast aims at doubling Oil & Gas production by 2030, making clean fuels accessible, fast tracking projects, generating employment opportunities and promoting cooperation with neighbouring countries and targets an investment of ₹ 1.30 lakh crore by 2030.

To exploit the logistical advantage of imported crude supplies, there are potential for capacity expansion and setting up of Greenfield refineries, preferably at coastal locations.

Strategic Petroleum Reserve is estimated to supply approximately 10 days of India’s crude requirement. In order to further augment India’s preparedness during emergency oil shortage situation, the Government under Phase-II gave ‘In Principle’ approval for establishing additional 6.5 MMT Strategic Petroleum Reserves under PPP model. On completion, the total storage capacity would be sufficient to cover approximately 22 days of crude oil requirement. Further, the SPR capacity needs to be augmented on considering the 90-day consumption require ment of strategic and commercial storages.

Apart from the above, Oil India Ltd will concentrate efforts to maintain its position as the l ead ing o per ator in the Northeast by consolidating acreage position through OLAP and intensifying exploration activities both in Mining Leases and Exploration Licences areas. To enhance recovery from the mature fields of Upper Assam, water injection and other IOR/ EOR technologies would have to be adopted which has the ability to l iberate additional production capacity. With the success of Cyclic Steam Stimulation technology in Baghewala Heavy Oil field in Rajasthan, development plans would be implemented to enhance production in an efficient manner. Apart from Northeast and Rajasthan, the Company plans to carry out detailed exploration in Mahanadi Onland, Andaman Offshore and Kerala–Kokan Offshore in quest of establishing hydrocarbon reserves.

Oil India Ltd will continue to pursue acquisition of pro spective overse as E&P opportunities to ensure energy security for the country, to grow by enhancing own E&P portfolio and decrease risks in existing E&P portfolio. In addition to acquisition of conventional assets, OIL would also look towards acquisition of non- conventional assets.

Recently, ONGC reframed Perspective Plan 2030 and approved an Energy Strategy 2040 in April 2019 that outlines strategic growth initiatives across the energy value-chain. The expectation and the strategy for ONGC is to act as the fulcrum around which an ecosystem for thriving Oil & Gas Industry in the country can be created consistent with expectations to reduce import dependence. ONGC has continuously been reviewing its engagements to move up higher in value chain to concentrate on areas where the expected risk-reward payoff offers better business opportunities for growth. ONGC, in its efforts to augment production of oil and gas, is endeavouring to engage all interested players so that the concept of ‘Atmanirbhar Bharat’ remains central to the domestic project execution agenda ONGC has rolled out its separate Gas vertical, which will increase its activities in Gas Sector leveraging on its strong domestic and international presence. It is also taking steps to augment its renewables portfolio. ONGC is also looking into strategic relationships and close alliances with key international players through ONGC Videsh. Intention is to invite foreign participations to explore Category-II and Category- III basins which match size and scale of expectations and portfolio of these large players. ONGC has been aggressively pursuing its deepwater projects in East Coast and couple of shallow water projects in West Coast. ONGC also has plans of acquiring much larger acreage through OALP.

23. Potash

23,091
(million tonnes) of Potash resources established as on 1.4.2020

5,877
(tonnes) of Potash Fertilizer were exported in 2021-22.

3.02
(million tonnes) of Potash Fertilizer were imported in 2020-21.

Potash is an impure combination of potassium carbonate & potassium (K) salts. Over 90% of potash is used as fertilizer and is one of the three primary agricultural nutrients (N-P-K). All commercial potash deposits come originally from evaporite deposits and are often buried deep below the earth's surface.

The principal ore is sylvinite, a mixture of sylvite (KCl) and halite (NaCl). In India, a few deposits of potash mineral are reported from Sidhi district of Madhya Pradesh, Sonbhadra district of Uttar Pradesh, Kaimur district of Bihar and Sawai Madhopur & Karauli districts of Rajasthan. It is in the form of Glauconitic (a potassium-bearing green mica) sandstone. The entire requirement of potash mostly utilised for producing fertilizer products is met through imports.

RESERVES/RESOURCES

As per NMI database, based on UNFC system, the total resources of potash as on 1.4.2020 have been estimated at 23,091 million tonnes, all of which are placed under Remaining Resource category. Rajasthan alone contributes 89% to the total resources, followed by Madhya Pradesh (5%) and Uttar Pradesh (4%) (Table- 1).

Table – 1 : Reserves/Resources of Potash as on 1.4.2020

(By Grades/States)

(In million tonnes)

Grade/state	Reserves Total (A)	Remaining Resources Feasibility STD211	Pre-feasibility STD221	Pre-feasibility STD222	Reconna-issance STD334	Total (B)	Total Resources (A+B)
All India : Total	**0**	**18151**	**4125**	**814**	**23091**	**23091**	**23091**
By Grades							
Glauconite	0	888	1495	766	3149	3149	3149
Polyhalite	0	13985	2179	0	16164	16164	16164
Sylvite	0	2072	452	48	2572	2572	2572
Unclassified	0	1206	0	0	1206	1206	1206
By States							
Madhya Pradesh	0	1206	36	2	1244	1244	1244
Rajasthan	0	16936	3509	127	20572	20572	20572
Uttar Pradesh	0	10	198	685	893	893	893
Bihar	0	0	230	0	230	230	230
Jharkhand	0	0	152	0	152	1	1

Figure rounded off

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on Exploration & Development under "General Reviews".

OCCURRENCES

Glauconitic sandstones/greensands deposits can be used as an alternative indigenous resource for potash. Glauconite is essentially a complex hydrous silicate of iron and potassium chiefly with ferric oxide and partly with ferrous oxide. It contains about 4–7% K_2O.

Major part of these resources are located in Nagaur district of Rajasthan, followed by Panna district, Madhya Pradesh and the balance in Sonbhadra & Chitrakoot districts, Uttar Pradesh. Occurrences of potash are also reported from Tirap district of Arunachal Pradesh; Rohtas district of Bihar; Kachchh district of Gujarat; Rohtak & Sirsa districts of Haryana; Leh district of Jammu & Kashmir; Sidhi district of Madhya Pradesh; Bhatinda district of Punjab; Bhilwara & Nagaur districts of Rajasthan; Tanjavur district of Tamil Nadu and Banda, Chitrakoot, Sonbhadra & Etah districts of Uttar Pradesh.

In Rajasthan, glauconitic sandstones/shales occur in Chittorgarh, Kota, Karauli, Jaisalmer and Barmer districts. In Gujarat, glauconite is found in Ukra Formation at Guneri in Kachchh district. In Himachal Pradesh, glauconite of hydrothermal origin is found in Kumla-Kathwar area of Sirmaur district. In Kerala, glauconite occurs in Quilon Limestone and seabed sediments of Thiruvananthapuram coast.

USES

Potash is the general name given to various inorganic compounds that contain potassium in a water-soluble form. A number of common potassium compounds exist, including potassium carbonate and potassium chloride. Before the industrial era, potash was obtained by leaching wood ashes in a pot (hence the name 'pot-ash').This product was used to manufacture soap, glass, and even gun powder.

Potassium chloride (KCl) is the principal fertilizer product with 60–62% of K_2O equivalent. Other salts that are used as fertilizer and that which are known to improve nutrient value & disease resistance in food crops are potassium sulphate, potassium magnesium sulphate and potassium nitrate. Potassium chloride and potassium nitrate are used in manufacture of glass, ceramics, soap & detergent, dye, synthetic rubber and chemicals. Potassium nitrate is used in explosive manufacture. Potash is also used as a raw material for manufacturing complex fertilizers.

Potash can be used on all plants to boost plant health and nutrition as well as to increase crop yields. While all potash fertilizers contain potassium there are a number of different forms in which it exists. The two most common forms are Muriate of Potash (MOP) and Sulphate of Potash (SOP). Sulphate of Potash (SOP) is a premium potash fertilizer free of chloride (unlike MOP) which is harmful to plants. SOP is used primarily on high value crops, usually leafy plants, fruits and vegetables. MOP is commonly used on carbohydrate type crops, such as, wheat.

CONSUMPTION

As per FAI, the all India consumption of Potassic fertilizer (in K_2O content) was at 2.53 million tonnes during 2021-22, whereas it was 2.02 million tonnes in the previous year.

WORLD REVIEW

The world reserves are estimated at approximately 3,300 million tonnes of K_2O content. Reserves are located mainly in Canada (33%), Belarus (23%), Russia (12%), USA (7%), China (5%), Germany (4%) and Chile (3%) (Table-2).

The world production of potash in 2021 was 45.70 million tonnes in terms of K_2O content as against 44.50 million tonnes in 2020. Canada is the leading producer of potash with 31% share in total production in 2021, followed by Belarus (17%), Russia (16%), China (12%), Germany (6%), Israel (5%), Jordan (3%) and Chile (2%) (Table-3).

Table – 2: World Reserves of Potash

(In '000 tonnes of K_2O content)

Country	Reserves
World: Total (rounded off)	**3300000**
Canada	1100000
Belarus	750000
Russia	400000
United States	220000
China	170000
Germany	150000
Chile	100000
Laos	75000
Spain	68000
Brazil	2300
Other countries	300000

Figures rounded off

Source: Mineral Commodity Summaries, 2023

[1]*Data are rounded to not more than two significant digits to avoid disclosing company proprietary data*

**Israel and Jordan recover potash from the Dead Sea, which contains nearly 2 billion tonnes of potassium chloride*

Table – 3: World Production of Potash

(By Principal Countries)

(In '000 tonnes of K_2O content)

Country	2019	2020	2021
World:Total (rounded off)	**41600**	**44500**	**45700**
Canada (Chloride)	12851	13783	14244
Belarus	7348	7562	7630
Russia (Chloride)	6771	6893	7503
China	5450	6000	6000
Germany (Potassic salts)	2615	2874	2793
Israel (Chloride)	2057	2375	2406
Jordan	1516	1598	1563
Chile (Chloride)	681	951	878
Laos	462	713	818
United Kingdom (Polyhalite)	632	709	789
Other countries	1299	1011	1055

Source: BGS World Mineral Production, 2017-21,

FOREIGN TRADE

Exports

There is no reported production of potash in the country. However, exports of potash fertilizer decreased substantially by 78% to 5,877 tonnes in 2021-22, as compared to 26,583 tonnes during the previous year. Exports were mainly to Serbia (36%) and UAE (23%). Exports of potassium nitrate increased by 11% to 917 tonnes in 2021-22 from 827 tonnes in the previous year. Exports were mainly to USA (37%), Thailand (32%), Indonesia (6%), South Africa (5%) and Egypt (4%) (Tables- 4 & 5).

Table – 4: Exports of Potash Fertilizers

(By Countries)

Country	2020-21(R)		2021-22(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**26583**	**673799**	**5877**	**209314**
Serbia	1040	23810	2106	62860
UAE	1363	27518	1360	48935
Malaysia	12	2877	850	21681
Indonesia	++	6	908	21441
Lebanon	1	134	249	7657
Qatar	++	3	144	7340
Nepal	15494	345727	34	6065
Germany	-	-	1	5646
Czech Rep.	-	-	1	3992
Kenya	53	3626	38	3692
Other countries	8620	270098	186	20005

Figures rounded off

(In tonnes)

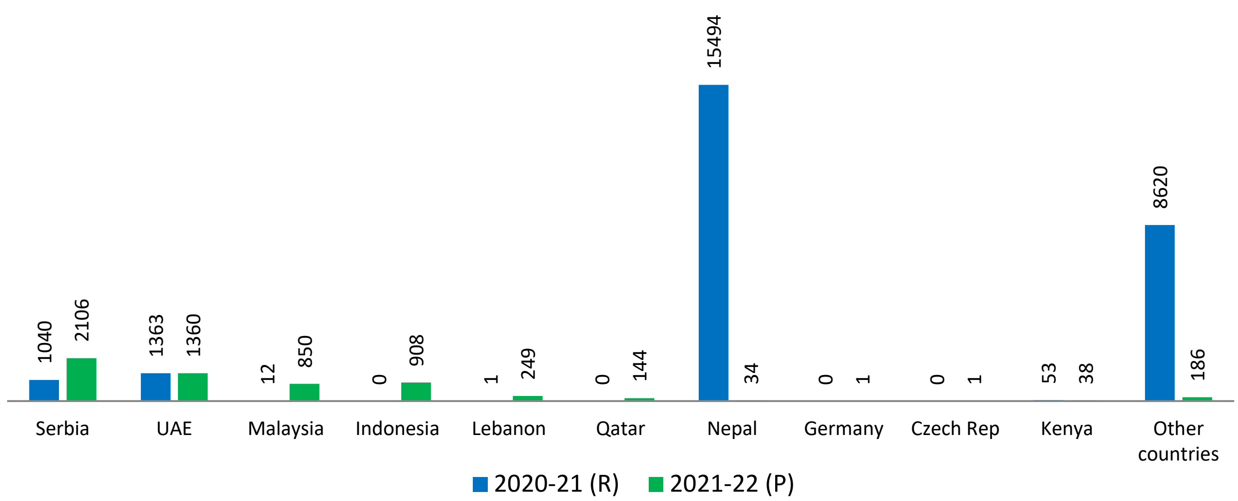


Fig 1: Countrywise Exports of Potash Fertilizers

Table – 5: Exports of Potassium Nitrate

(By Countries)

Country	2020-21(R)		2021-22(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**827**	**165914**	**917**	**187910**
USA	268	71190	336	98194
Thailand	257	38113	290	40260
South Africa	21	5346	49	9649
Indonesia	46	9627	51	8508
Egypt	27	8540	36	6079
Korea, Rep.of	11	1901	25	5608
China	104	16899	29	5176
UAE	42	7655	28	3802
Bangladesh	33	3387	26	3541
Turkey	-	-	24	2733
Other countries	18	3256	23	4360

Figures rounded off

Imports

Like exports, imports of potash fertilizer also decreased by 42% to 3.02 million tonnes during the previous year. Imports were mainly from Belarus (33%), Canada (20%),Israel (17%), Jordan (14%) and Lithuania (9%).

Imports of potassium nitrate increased drastically to 153 tonnes in 2021-22 from 58 tonnes in the previous year. China (86%) and Republic.of Korea (13%) were the main suppliers of potassium nitrate in 2021- 22 (Tables- 6 & 7).

Table – 6 : Imports of Potash Fertilizers

(By Countries)

Country	2020-21(R)		2021-22(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**5250814**	**94059271**	**3020152**	**77176503**
Belarus	922089	16620176	1000208	27164459
Israel	485631	8555193	520802	13825336
Canada	1612329	28597032	615257	13766303
Jordan	629092	11082614	432153	10826541
Lithuania	569610	9768040	280988	6839191
UK	26537	469062	55880	992536
Russia	747928	13133743	54056	976074
Taiwan	21713	724649	14475	599372
Belgium	3941	161200	14690	565383
Germany	198887	3877702	6629	296578
Other countries	33057	1069860	25014	1324730

(In tonnes)

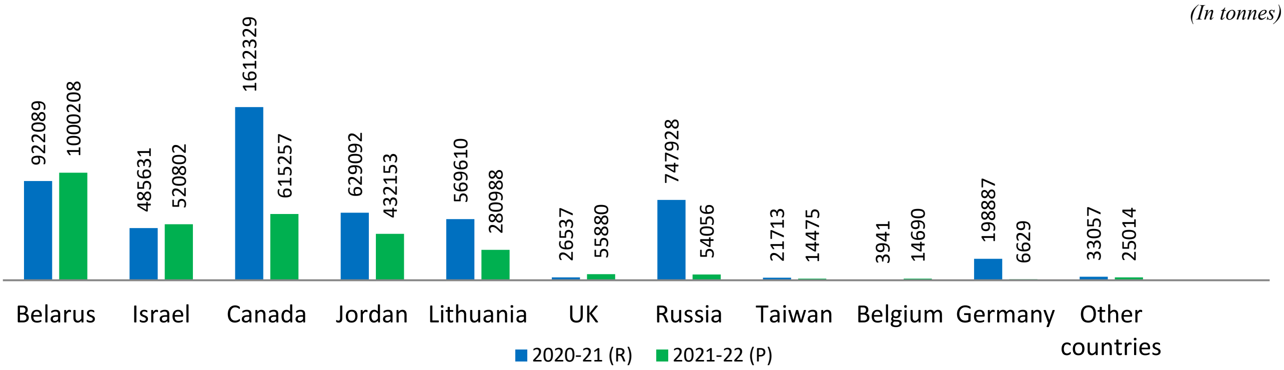


Fig 2: Countrywise Imports of Potash Fertilizers

Table – 7 : Imports of Potassium Nitrate

(By Countries)

Country	2020-21(R)		2021-22(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**58**	**7553**	**153**	**16481**
China	54	3272	131	10193
Korea, Rep.of	-	-	20	5043
Germany	2	2474	++	612
Italy	1	370	1	355
UK	++	5	1	240
USA	1	1234	++	36
France	-	-	++	2
Spain	++	157	-	-
Switzerland	++	41	-	-

FUTURE OUTLOOK

Agriculture is the backbone of India's Economy. However, declining soil fertility impacts on crop productivity. The appropriate application of fertilizer is a key factor in enhancing soil fertility and productivity for overcoming potassium depletion. The market of potash is expected to increase year-on-year globally. The domestic demand is met almost entirely by imports which require a turnaround. and initiatives to promote indigenous mining of potash in India must be encouraged. Prospects of potash mining in India could mitigate the issue of import of the mineral and consequently will have positive impact in the investment opportunities in the sector which in turn could be utilised for the development of mineral wealth. To carry out the feasibility study of solution mining of potash in the State of Rajasthan, a Tripartite agreement between DGM, Rajasthan, RSMML and MECL was signed.

24. Rare Earths

12.73 (million tonnes) estimated resource of monazite in the beach and inland placer deposits as on March, 2021	**3.67** (tonnes) of Rare-earth Metals (scandium & yttrium) were exported in 2020-21	**470.61** (tonnes) of Rare-earth Metals (scandium & yttrium) were imported in 2020-21

The term "rare earth" arises from the minerals from which they were first isolated, which are common oxide-type minerals (earths) found in Gadolinite extracted from one mine in the village of Ytterby, Sweden. However, with the exception of the highly-unstable promethium, rare-earth elements are found in relatively high concentrations in the earth's crust with cerium being 25th most abundant element in the earth's crust at 68 parts per million.

Rare Earths are a group of 17 elements starting with lanthanum in the periodic table of elements and include scandium and yttrium. They are moderately abundant in earth's crust but not concentrated enough to make them economically exploitable. The REEs find key applications in defence, electronics, energy systems etc. For instance, magnets made from rare earths are many times more powerful than conventional ones. Along with energy critical elements (ECE), such as, lithium which has become ubiquitous battery material, REEs have emerged as strategic elements essential for sustainable energy systems.

The Rare-earth Elements (REE) are a collection of 17 elements, namely scandium, yttrium and lanthanides (15 elements in the periodic table with atomic numbers 57 to 71, namely lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb) and lutetium (Lu).

Although these elements tend to occur together, the lanthanide elements are divided into two groups. The light elements are those with atomic numbers 57 to 63 (La, Ce, Pr, Nd, Pm, Sm and Eu) and the heavy elements are those with atomic numbers 64 to 71 (Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu).

REEs are characterised by high density, high melting point, high conductivity and high thermal conductance. A number of rare-earth minerals contain thorium and uranium in variable amounts, but they do not constitute essential components in the composition of the minerals.

The principal sources of REE are bastnaesite (a fluorocarbonate which occurs in carbonatites and related igneous rocks), xenotime (yttrium phosphate) commonly found in mineral sand deposits, loparite which occurs in alkaline igneous rocks and monazite (a phosphate). The rare earths occur in many other minerals and are recoverable as by-products from phosphate rock and from spent uranium leaching. In India, monazite is the principal source of rare earths and thorium. Monazite is a complex phosphate of thorium and Rare-earth minerals [(Ce, La,Nd, Th,Y) PO_4] and this is radio active in nature .

RESERVES/RESOURCES

The mineral monazite is a prescribed substance as per the Notification under the Atomic Energy Act, 1962. AMD has been carrying out its resource evaluation for over six decades. It occurs in association with other heavy minerals, such as, ilmenite, rutile, zircon, etc. in concentrations of 0.4 – 4.3% of total heavies in the beach and inland placer deposits of the country.

The resource estimates of monazite in the beach and inland placer deposits was 12.73 million tonnes as on March, 2021. The statewise breakup of 12.73 million tonnes is given in Table -1.

Table – 1: Resources of Monazite

(In million tonnes)

State	No. of Deposits	Resources*
All India	**130**	**12.73**
Andhra Pradesh	24	3.78
Gujarat	2	0.07
Jharkhand	1	0.21
Kerala	35	1.84
Maharashtra	5	0.004
Odisha	12	3.16
Tamil Nadu	50	2.47
West Bengal	1	1.2

**Inclusive of indicated, inferred and speculative categories.*
Source : Reply of Parliament Question No. 2564 in Rajya Sabha, it was answered on 18.03.2021.

Monazite contained in 130 deposits in the coastal beach placer sands in Kerala, Tamil Nadu, Odisha, Andhra Pradesh, Maharashtra & Gujarat and in the inland alluvium in parts of Jharkhand, West Bengal and Tamil Nadu. The major deposits which contain monazite (thorium and REE ore mineral) are:

1. Chavara barrier beach and Eastern Extension, Kollam district, Kerala
2. Manavalakurichi beach sand deposit, Kanyakumari district, Tamil Nadu
3. Sathankulam Teri sand deposit, Tamil Nadu
4. Ovari Manapadu Teri Sand deposit, Tamil Nadu
5. Navaladi-Ovari Teri Sand deposit, Tamil Nadu
6. Kuduraimoli Teri Sand deposit, Tamil Nadu
7. Bhimunipatnam beach sand deposit, Andhra Pradesh
8. Kandivalasa beach sand deposit, Andhra Pradesh
9. Kalingapatanam beach sand deposit, Andhra Pradesh
10. Srikurmam beach sand deposit, Andhra Pradesh
11. Bhavanapadu beach sand deposit, Andhra Pradesh
12. Gopalpur beach sand deposit, Odisha
13. Chhatrapur beach sand deposit, Odisha
14. Brahmagiri beach sand deposit, Odisha

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are furnished in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION AND PRICES

Indian Rare Earth Limited (IREL), a Mini Ratna Company, is a Government of India Undertaking under the Department of Atomic Energy (DAE) and KMML, a Kerala State Government Undertaking, are actively engaged in mining and processing of beach sand minerals from placer deposits. IREL is the only entity processing monazite to produce Rare-earth (RE) compounds. Some REEs which are available in India such as Lanthanum, Cerium, Neodymium, Praseodymium, Samarium, etc. are in supply surplus while Dysprosium, Terbium, Europium which are classified as HREE are having supply constraint. These HREEs are not available in Indian deposits in extractable quantity. Government is actively engaged in capacity building for consumption of the LREE. The annual installed mining, production and processing capacities are as under:

(i) Mining: 10 million tonnes

(ii) Processing capacity in terms of rare-earth concentrate: 11,200 tonnes

(iii) Refining capacity in terms of Total Rare-earth Oxide (TREO): 5,000 tonnes

(iv) Rare-earth Concentrate Production: 5,040 tonnes

(v) Refining in terms of TREO: 2,000 tonnes (Both Government and Private sector)

As reported by KMML (The Kerala Minerals & Metals Ltd.) monazite is a strategic mineral and cannot be sold in commercial market. Therefore, the prices are not available.

MINING AND PROCESSING

Mining of beach sand is being carried out by IREL and KMML. The installed capacity of monazite (96% pure) separation plant of IREL at Manavalakurichi is 6,000 tpy while that of KMML at Chavara is 240 tpy. Details regarding mining and processing, etc., are provided in the Review on 'Ilmenite and Rutile'.

INDUSTRY

IREL has a plant at Udyogamandal, Aluva, located in Ernakulam district, Kerala, wherein the monazite obtained from Manavalakurichi is chemically treated to separate rare earths in its composite chloride form and thorium as hydroxide upgrade.

IREL has set up a Rare-Earth Extraction plant (REEP) producing mixed Rare-earth chloride (MRCL) Tri-sodium phosphate etc., at its unit in OSCOM Odisha. MRCL produced from the above plant is processed at IREL's plant at Rare Earth Division (RED) in Aluva, Kerala, for producing separated High Pure Rare Earth (HPRE) Oxides/ Compounds.

IREL implemented flow sheet developed by BARC and has produced 50 kg Nuclear Grade Gadolinium Oxide (99.99%). Same can be converted into Gadolinium Nitrate which is used by NPCIL. The Company invited research projects pertaining to products in the value chain of Ilmenite, zircon and rare-earth compounds, improvement in recovery energy efficiency, etc.

IREL is actively pursuing setting up of greenfield operations in Kanyakumari district of Tamil Nadu and Bramhagiri district of Odisha. The proposal for harnessing the beach sand mineral deposits in Tamil Nadu by constituting a Joint Venture Company with the nominated State Government Agency, TAMIN, is under active consideration by the State Government.

Ambadungar RE Project has been initiated to harness the carbonatite deposit explored by AMD in the state of Gujarat. Initially, about 1.55 Ha of the deposit is proposed to be harnessed, which will be further extended based on the exploratory results of AMD. Action has been initiated to establish the technical feasibility and financial viability of the project.

POLICY

In order to safeguard the strategic interest of the nation it is expedient in larger national interest to prohibit the grant of operating rights in terms of any reconnaissance permit exploration licence or production lease of atomic minerals as defined in part-B of the first schedule of the MM(DR) Act, 1957.

A Notification No. S.O.2685 (E) dated 27.07.2019, was issued for reserving the prospecting and mining rights of offshore minerals under Offshore Areas Minerals (Development and Regulation) Act, 2002 exclusively to Government or a Government-owned company or a corporation owned or controlled by the Government.

As per MMDR Act, 1957, Minerals of the "rare earths" group not containing Uranium and Thorium are mentioned in Part D of First Schedule to the Act for Critical & Strategic minerals. As per PIB Press Release dated 28.11.2023 by Ministry of Mines, Criti-cal minerals are essential for our country's economic development and national security. The lack of avail-ability of these minerals or concentration of their extraction or processing in a few countries may lead to supply chain vulnerabilities.

Other minerals under Code 2617 are freely exportable, except those which have been notified as prescribed substances and controlled under Atomic Energy Act 1962.

As per the Foreign Trade Policy, import policy under ITC(HS), 2022 Schedule 1, the import policy on the import of ores & concentrates of rare-earth metals (under HS Code 25309040) are permitted 'freely' whereas as bey the export policy under ITC(HS) 2018 Schedule 2, the export policy on the export of ores and concentrates of rare-earth metals (under HS Code 25309040) are permitted 'freely' .

Export of Beach Sand Minerals have been brought under STE and shall be canalised through Indian Rare Earths Limited (IREL). Beach sand minerals, permitted anywhere in the export policy, will now be regulated in terms of policy under at Sl. No. 98A of Chapter 26 of Schedule 2 of the Export Policy.

As per Gazette Notification No : GSR.134 (E) dated 20.2.2019, the particulars of threshold values for atomic minerals in respect of Beach Sand Minerals (BSM) shall be regulated as Schedule A [Rule 2(1)(m) and Rule 36] (Table-2).

Table - 2 : Particulars of Threshold Value for Atomic Minerals

[See Rule 2(1)(m) and Rule 36]

Uranium-bearing tailings left over from ores after extraction of copper and gold, ilmenite and other titanium ores.	60 ppm U_3O_8 and/or 250 ppm ThO_2.
Zirconium-bearing minerals and ores including zircon.	All cases of zirconium-bearing minerals occurring in Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e., the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade. In other cases, zircon containing less than 2000 ppm of hafnium.
BeachSandMinerals,i.e., economic heavy minerals found in the teri or beachsand,whichincludeilmenite,rutile,leucoxene,garnet,monazite, zircon and sillimanite	All cases of Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e., the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade.

Many projects of IREL have been initiated, such as, capacity expansion of Mineral Separation Plant of OSCOM, Rare Earth Permanent Magnet Plant and Rare Earth Theme Park. Agencies to implement these projects are in place and the projects will be commissioned within the next 2-3 years. New areas of operations, such as, Rare Earths in Ambadungar, Gujarat or Atomic Minerals in Odisha and Tamil Nadu are also in advanced stage of development.

During the year 2020-21, Licence to Operate (LTO) office has been established for centralised monitoring & managing the regulatory compliances required to achieve and sustain the targeted production plans. Centralised monitoring and control of statutory compliances is enabled through database dashboards. Units are sensitised for complying with the statutory requirements at regular intervals. Manavalakurichi and OSCOM units are continuing their operations in a sustainable manner. OSCOM has deposited the statutory fees as desired under Stage-I Forest Clearance towards obtaining the Stage-II Forest Clearance. Chavara Unit is in the final stage of receiving the environment clearances for its mining lease areas. LTO office establishes the processes & tools for proactive information gathering and structuring of regulatory requirements.

Rare Earth Permanent Magnet plant will be set up on BARC campus, Achitapuram, Vizag, for production of Samarium-Cobalt permanent magnet for use in Atomic Energy, Defence and Space sectors. Environment clearance and clearance from Design Safety Review Committee and Safety Committee, BARC for carrying out site activities have been received. Detailed engineering has been completed and appointment of contractor to commence site activities on Engineering Procurement Construction (EPC) model too has been done.

Subsidiary IREL-IDCOL Limited (IIL), the Joint Venture company has been established to harness the beach sand mineral deposit in the state which in turn will widen the footprint of the Company. Ground work towards declaration of the precise area is in the final stages at the State after completion of DGPS survey and preparation of cadastral map. DPR for the project has been prepared. Pre-project activities such as, obtaining environment clearance, preparation of mining plan, etc. necessary for execution of the mining lease deed will be taken up in 2021-22.

USES & CONSUMPTION

The Rare Earth Permanent Magnet (REPM) in Vizag and Rare Earth and Titanium Theme Park (RETTP) in Bhopal have kick started with the funding assistance of Government of India, which will enhance the visibility of IREL in the strategic and niche sector.

Environmental clearance for REPM project has been received from MoEF&CC and M/s MECON Limited, Bengaluru, has been appointed as consulting firm for detailed engineering. As regards RETTP project, lease deed execution towards land has been completed. A Letter of Understanding has been inked with BARC towards developing and transferring laboratory-scale technologies in the value chain of Rare Earths which will be suitably upscaled by IREL to pilot-scale and installed in the theme park.

In addition, IREL has been assigned the responsibility of carrying out civil construction works on behalf of BARC for the 5 million liters per day (MLD) hybrid seawater desalination plant at OSCOM. About 60% construction of plant building has been completed.

Execution of Supplimentary Mining Lease deed for OSCOM Mines till a period up to the year 2047 has been completed under the provisions of AMCR 2016. Communication on precise area of the Bramhagiri Mineral Sands Deposit in Puri district under AMCR, 2016 is in the final stages of issuance by the Government of Odisha.

Rare-earth materials are utilised in a wide range of critical products enabling many emerging green energy technologies, high-tech applications and defence systems, such as, hybrid cars, plug-in- hybrid electric-vehicles (PHEVs), the latest generation of efficient wind power turbines, computer disc drives, missile guidance systems, etc. The lanthanide elements as a group have magnetic, chemical and spectroscopic properties that have led to their application in a wide range of end-uses. Cerium finds application in polishing of glass items like lenses & display screens of cathode-ray tubes, liquid-crystal displays & plasma-display panels, in petrol & diesel fuels as fuel additive and along with lanthanum for replacement of cadmium in red pigments. Mixed salts of the cerium group of elements, other than fluorides, are used in medicine, non-irritating antiseptic dressings, waterproofing agents and fungicides in textile manufacture. The principal uses of commercially pure cerium compounds that are in the form of nitrate is in the manufacture of incandescent gas mantles and cerium compounds as oxide. It also finds usage as a polishing agent of glass. Cerium compounds are also used in ceramic and glass as colouring pigments and also as catalysts in Chemical Industry.

The Department of Atomic Energy (DAE) has accorded in principle approval for futuristic proposal of IREL towards setting up of rare earth theme park which inter alia includes setting up of pilot plants in the value chain of rare earths, skill-cum-enterpreneur development center. This will be a first-of-its kind theme park in the country.

To produce samarium-cobalt (Sm-Co) magnet for meeting national objectives, a Special Purpose Vehicle (SPV) has been formed. Production of Sm-Co metal and magnet is based on technologies developed by BARC, Mumbai & DMRL, Hyderabad. Activities for firming up the investment, plant location etc., are under progress.

Supply of Nuclear Grade Ammonium diuranate (NGADU) from new source, i. e, the newly commissioned monazite processing plant at OSCOM, Odisha has commenced.

Subsequent to identification and development of conditions for dissolution of Rare Earths (REE) from fly ash generated at lignite coal fired thermal power plant at Neyveli, Tamil Nadu, studies were taken up to understand the overall process efficiency and precipitate dissolved rare earths in purified form.

Cerium, lanthanum and neodymium are used as glass additives in optical lenses and display screens, as catalysts in automobiles to reduce sulphur dioxide emission, in multilayer capacitors and along with yttrium in magnesium, aluminium and hydrogen storage alloys. Mischmetal, which is an alloy of cerium with small amounts of other rare-earth metals, is used in lighter flints, for desulphurisation in steel and foundry, and with lanthanum alloys, in batteries and hydrogen storage systems meant for electronics and hybrid cars. Cerium oxide is used in glass polishing industries.

Lanthanum oxide and neodymium compounds are used in special glass manufacture. Lanthanuminds application in X-ray films as phosphors; yttrium in advanced ceramics like nitrides,Y-stabilised ceramics, etc., and gadolinium in magnet alloys. Yttrium, europium and terbium are used as phosphors in displays of computers, TV, etc. and with lanthanum, cerium & gadolinium as phosphors in fluorescent and halogen lamps. Neodymium, samarium, dysprosium, praseodymium and terbium have application as high intensity magnets in electronics, electric motors and audio equipment. Lanthanum, erbium and ytterbium have application in fibre optics and lasers. Lanthanum and yttrium find application in solid oxide fuel cells. Scandium is used mainly in aluminium alloys for sporting goods. Scandium in minor amounts is used in semiconductors and special lighting, including halogen bulbs. Mixed rare-earth products are used as catalysts in petroleum refining and fluid cracking. Neodymium is used in welding in heavy industries and also in MRI scanners. Praseodymium is not a primary element for any specific use, but finds use as a substitute for neodymium in magnets.

Samarium is used essentially for the Sm-Co magnets. Europium is a primary component of phosphorus and is responsible for white light in compact fluoroscent lamps when used with terbium compounds.

Erbium used as fibre optic has emerged in the nineties as a remarkable tool for communication technology through which high quality rapid data in tight pulses can be transferred in speed unthinkable in the past.

The main application for neodymium-iron-boron (Nd-Fe-B) magnets are in automobiles for anti-lock brakes, and in computer hard disk drives, videos, CD-ROMs used in many small-size electronic consumer products, such as, digital cameras, where major advantage is their small sizes. Nickel metal hydride (Ni MH) batteries, containing mischmetal, a mixture of rare-earth compounds, are used mainly in portable electronic equipment, such as, laptops, camcorders and mobile phones. Though, the market for batteries for portable electronic equipment is growing strongly, the Ni MH batteries are increasingly replaced by lithium-ion batteries.

Ground monazite is digested with caustic soda lye to produce trisodium phosphate (TSP) and mixed hydroxide slurry. This slurry is used for production of diverse rare-earth compounds. Elaborate solvent extraction and ion exchange facilities were built to produce individual RE oxides, like oxides of Y, Ce, Nd, Pr and La of specific purities. India is the second largest supplier of yttrium in the world and the maximum production is reported from the plant in Kerala. Uranium values present in monazite which are recovered in the form of nuclear grade ammonium diuranate (ADU) are vital supplement to the indigenous supply of uranium. Thorium is separated in its pure oxalate form. A part of it is taken to OSCOM for further processing by solvent extraction to produce thorium nitrate. A small part of the purified thorium nitrate is converted to nuclear grade thorium oxide powder for supply to Bhabha Atomic Research Centre (BARC) and Nuclear Fuel Complex (NFC) for developing thorium-based fuel for nuclear reactors. IREL has built a large stockpile of impure thorium hydroxide upgrade associated with rare earths and unreacted materials.

Monazite contains about 25.28% P_2O_5 which can be recovered as a by-product for manufacture of fertilizers and production of elemental phosphorus or its salts. Beside, rare earths, thorium is also recovered from monazite. It is a source of atomic energy. An important use of thorium is for addition to tungsten in minute quantity (about 0.75%) to increase the ductility of tungsten wire and thus to facilitate its drawing into filaments used in electric lamps. Metallic thorium is also used in photoelectric cells and X-ray tubes and in certain alloys. Thorium is used as catalytic agent for various processes. Amongst thorium salts, thorium nitrate is used largely in the manufacture of incandescent gas mantles. Mesothorium, the chief radioactive element recovered as a by-product in the chemical treatment of monazite, is marketed usually in the form of its bromide and used in self-luminous paints or enamels. Mesothorium is also used in the treatment of certain types of cancer and skin diseases.

World Review

The total world reserves are estimated at 130 million tonnes of rare-earth oxides equivalent content (REO) of which China alone accounts for 44 million tonnes (34%) followed by Vietnm, Brazil & Russia (16% each) and India (5%) (Table- 3).

China holds the leading position among producers of rare-earth oxides with 348 thousand tonnes. The other major producers are Myanmar, Australia, USA, Russia, India, Vietnam and Malaysia (Table-4).

Table – 3 : World Reserves of Rare Earths

(By Principal Countries)

(In '000 tonnes of REO equivalent content)

Country	Reserves
World: Total (rounded off)	**130,000,000**
USA	2,300,000
Australia[(a)]	104,200,000
Brazil	21,000,000
Burma	NA
Burundi	NA
Canada	830,000
China	44,000,000
Greenland	1,500,000
India	6,900,000
Madagascar	NA
Russia	21,000,000
South Africa	790,000
Tanzania	890,000
Thailand	NA
Vietnam	22,000,000
Other countries	280,000

Source: *USGS, Mineral Commodity Summaries,2023*

a: For Australia, Joint Ore Reserves Committee-complaint or equivalent reserves were 3.0 million tons.

NA - Not available

Table – 4 : World Production of Rare-Earths Oxides

(By Principal Countries)

In tonnes

Country	2019	2020	2021
China[(a)]*	180,000	180,000	348000
Myanmar*	29,000	36,000	35000
USA*	16,800	22,800	25800
Australia[(c)]	19,737	14,562	15970
India[(b)]	4,200	4,200	4200
Madagascar*	2,800	3,200	3500
Russia	2,620	2,663	2276
Vietnam*	1,300	1,000	400
Malaysia	71	14	29

Source: *BGS, World Mineral Production, 2016-21*

*) Estimated

a :Includes production from iron ore extraction, bastnaesite concentrates and ion absorption clays.

b :Year ending 31st March following that stated.

c :Year ending 30th June following that stated.

To provide a generalised view of the development in various countries, the country-wise description sourced from the latest available publication of rare earths in Minerals Yearbook 'USGS' 2018 is furnished below.

Australia

Arafura Resources Ltd continued piloting studies on its Nolan's Bore project in the Northern Territory with the goal of producing rare-earth, phosphate, and uranium products. Alkane Resources Ltd continued the development of its polymetallic Dubbo Zirconia project in New South Wales with planned production of hafnium, niobium, rare-earths, tantalum, and zirconium products. In 2018, Alkane continued test work and sought financing to advance the development of the project. Australian Mines Ltd completed a bankable feasibility study on the Sconi cobalt-nickel-scandium project in northern Queensland. Clean TeQ Holdings Ltd completed a definitive feasibility study for its Sunrise nickel-cobalt-scandium project in New South Wales. Lynas Corp. Ltd, the leading producer of rare-earth mineral concentrates outside of China in 2018, continued to operate its Mt Weld mining operations in Western Australia to support its processing operations in Malaysia. Northern Minerals Ltd continued work to develop the Browns Range project in Western Australia and the Northern Territory. In 2018, the company was commissioning pilot plant operations that included beneficiation through hydrometallurgical extraction. About 2.6 t of mixed rare-earth carbonate was produced and exported to China in the fourth quarter. Platina Resources Ltd completed a definitive feasibility study for its Owendale polymetallic (scandium-cobalt-nickel) project in New South Wales. The Company planned for an initial capacity of 20 t/yr of scandium-oxide equivalent. Scandium International Mining Corp. (Sparks, NV) continued to pursue financing and offtake agreements for its Nyngan scandium project in New South Wales. In 2018, the company was awarded two patents from the United States Patent Office related to its leaching and solvent extraction technology.

Burundi

Rainbow Rare Earths Ltd continued to commission its mining and beneficiation processing operation at its Gakara project in Bujumbura Rural Province.

Canada

Commerce Resources Corp. continued prefeasibility work on its Ashram project in northern Quebec. In 2018 , Commerce Resources was collaborating with Université Laval to conduct process modeling and bench and pilot plant studies. Canada Strategic Metals Inc. merged with Matamec Explorations Inc. and was renamed Quebec Precious Metals Corp. In southwestern Quebec, the new company held joint ownership of the Kipawa project with Investissement Québec and 100% ownership of the Zeus project. In 2018, development activities at both of these adjacent projects were on hold and the company was seeking partners to further develop the projects. Medallion Resources Ltd continued with plans to develop a processing facility to produce mixed rare-earth compounds from monazite. Medallion's proposed facility would purchase monazite by-product from heavy-mineral-sand operations and produce rare-earth compounds. In 2018, the company continued its process of development through collaborations with the Saskatchewan Research Council and Rare Earth Salts Separations and Refining, LLC. Search Minerals Inc. was conducting a drilling programy and environmental assessments on its Foxtrot project in southeastern Labrador. According to the company, most of the rare-earth mineralisation occurred in allanite (a silicate mineral) and fergusonite (an oxide mineral). The project plan was based on a combined open pit and underground mine followed by processing to produce a mixed rare-earth concentrate.

China

China dominated the global production of rare-earth minerals, separated compounds, and metals. China's Ministry of Land and Resources (CMLR) production quotas for rare-earth mine production were 1,20,000 t of REO equivalent, of which 1,00,850 t was for light rare earths and 19,150 t was for medium and heavy rare earths. CMLR classifications for light, medium, and heavy were not defined. The production quotas for smelting and separation were 1,15,000 t. Nearly all mine, smelting, and separation quotas were allocated to the state-owned enterprises. China's exports of rare-earth compounds (HS code 2846) were 45,800 t (gross weight), nearly unchanged compared with those in 2017. The top four destinations of these exports were, in descending order, the United States (31%), Japan (28%), the Netherlands (17%), and the Republic of Korea (6%).

Greenland (Denmark)

Greenland Minerals and Energy Ltd (GMEL) continued work on its polymetallic (REE-uranium-zinc) Kvanefjeld project in southern Greenland. In 2018, the company worked to improve its technical designs and submitted environmental and social impact assessments to the Government of Greenland. GMEL was working with several companies based in China [Baotou Meng Rong Fine Materials Co. Ltd, China Communications Construction Co., and Shenghe Resources Holding Co. Ltd (Shenghe)] and North America on the commercial development of the project. Shenghe was a major shareholder in GMEL.

Kazakhstan

Kazakhstan's National Mining Co. Tau-Ken Samruk JSC acquired the Summit Atom Rare Earth Co. LLP (SARECO) from Kazakhstan's National Atomic Co. Kazatomprom JSC. The SARECO operations in Stepnogorsk were reported to have a capacity of 1,500 t/yr of REO equivalent, although the company described the production as insignificant in 2018. SARECO's REO was a by- product of uranium mining and processing.

Madagascar

In 2018, QIT Madagascar Minerals (QMM) produced 16,000 t of monazite concentrates as a by- product of processing heavy-mineral sands to produce ilmenite and zircon sillimanite concentrates.

Malaysia

Lynas continued to increase production of rare earth compounds at its Lynas Advanced Material Plant (LAMP) near the Port of Kuantan in the State of Pahang. Lynas continued efforts to increase its capacity to produce separated neodymium and praseodymium compounds. In December, Malaysia's Ministry for Energy, Scie nce, Technology, Environment and Climate Change (MESTECC) added preconditions for the LAMP operations licence renewal. The MESTECC preconditions included the removal of residues containing radioactive materials from Malaysia and an action plan for the disposal of "neutralisation underflow" residues.

Philippines

Japan's Sumitomo Metal Mining Co., Ltd (SMM) was preparing to begin commercial-scale production of a scandium intermediate product at its subsidiary Taganito HPAL Nickel Corp. on Palawan Island. The plant was expected to recover up to 7.5 t/yr of scandium-oxide equivalent from a process stream following the leaching of nickel laterite for nickel-cobalt sulphide. Processing of the intermediate product into scandium oxide was performed at SMM's Harima operation in Japan. Russia— PJSC Acron continued to operate a 200-t/yr pilot plant to produce REEs in the form of mixed and separated rare-earth compounds at its Veliky Novgorod facility. The feed for the operation was a by-product apatite mineral concentrate sourced from the company's Oleniy Ruchey phosphate mine in the Murmansk Region. JSC Dalur continued to recover an unknown quantity of scandium-oxide equivalent at the Dalmatovskoye uranium mining and processing operation in the Kurgan Region. In 2018, the company commissioned a pilot plant to produce aluminum-scandium master alloys. United Company RUSAL Plc, one of the world's leading aluminum producers, was conducting pilot-plant studies in the Ural Mountains to recover scandium concentrate from red mud, a residue from the processing of bauxite. RUSAL was reported to have produced scandium oxide with greater than 99% purity.

South Africa

Steenkampskraal Holdings Ltd continued plans to reopen the Steenkampskraal (SKK) monazite mine that was active from 1952 to 1963. The Company expected to produce up to 2,700 t/yr of REO equivalent in mixed carbonates.

Sweden

The Swedish Mines Inspectorate notified Leading Edge Materials Corp. that it had extended the exploration licence for the Norra Karr project in southern Sweden through 2019. In 2018, the Geological Survey of Finland performed a beneficiation study focused on removing iron impurities on bulk samples from Norra Karr. The predominate REE mineralisation was eudialyte. A prefeasibility study was based on production of 5,000 t/yr of mixed REO and a 20 year mine life, using the 0.4%-REO cut-off grade.

Tanzania

Peak Resources Ltd continued the development of its Ngualla project with plans for mining operations in southwest Tanzania.

United Kingdom

In September, Peak Resources was granted an environmental permit for its Teesside extraction and separation operations located in the Wilton industrial area near Middleborough.

FOREIGN TRADE

Exports

Exports of Rare-earth Metals (Scandium & Yttrium) in 2020-21 decreased substantially by 56% to 3.67 tonnes from 8.41 tonnes in the previous year. UAE (87%) and Bhutan (12%) were the main buyers from India (Table-5).

Imports

The imports of Rare-earth Metals (Scandium & Yttrium) in 2020-21 marginally decreased by 0.64% to 470.61 tonnes as compared to 473.64 tonnes in 2019-20. China (95%) and USA (1%) were the main suppliers to India (Table-6).

Table-5 : Exports of Rare-Earth Metals (Scandium & Yttrium)

(By Countries)

Country Name	2021-22(R)		2022-23(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**8.41**	**3990**	**3.67**	**4178**
Bhutan	7.55	3405	0.44	247
Canada	-	-	++	19
China	-	-	0.03	11
Czech Republic	-	-	++	35
Denmark	0.04	41	++	104
Ghana	0.01	3	-	-
Israel	-	-	++	23
Korea, Rep of	0.06	6	-	-
Netherlands	-	-	++	79
UAE	0.75	490	3.2	3659
USA	++	44	-	-

Figures rounded off

(In tonnes)

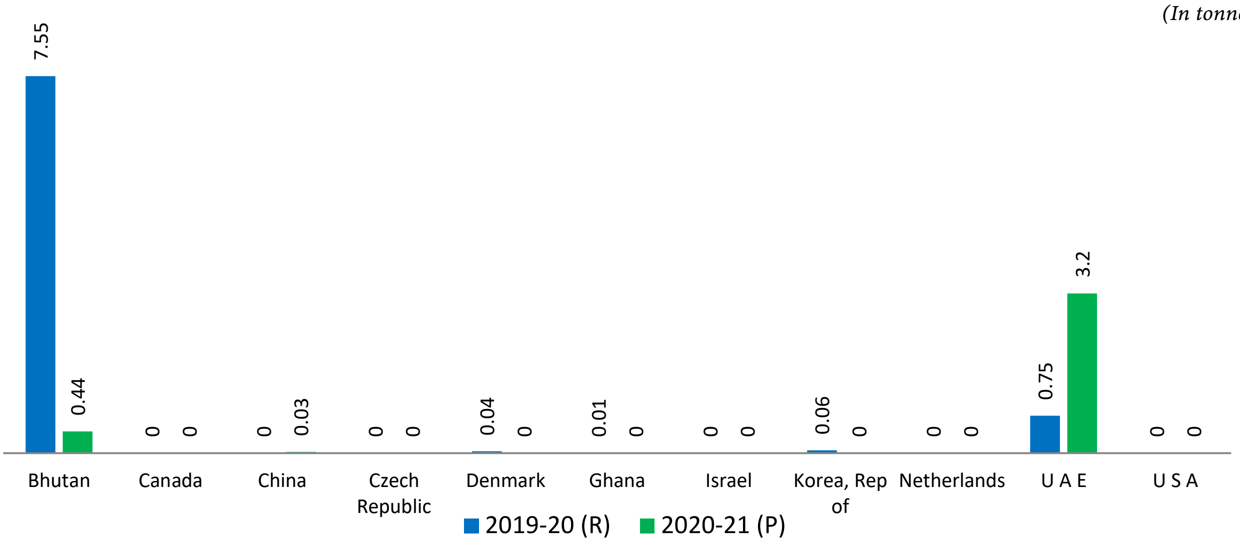


Fig 1: Country-wise Export of Rare-earth Metals (Scandium & Yttrium)

Table-6 : Imports of Rare-Earth Metals (Scandium & Yttrium)

(By Countries)

Country Name	2019-20(R)		2020-21(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**473.64**	**162,305**	**470.61**	**175,172**
Belgium	++	5	++	7
China	437	145,447	444.8	150,440.00
Germany	++	131	++	273
Hong Kong	34	10827	0.05	774
Japan	2	1304	11	8409
Sweden	-	-	10	519
UAE	-	-	0.04	257
UK	0.08	638	0.03	1560
USA	0.56	3954	4.69	12933

Figures rounded off

(In tonnes)

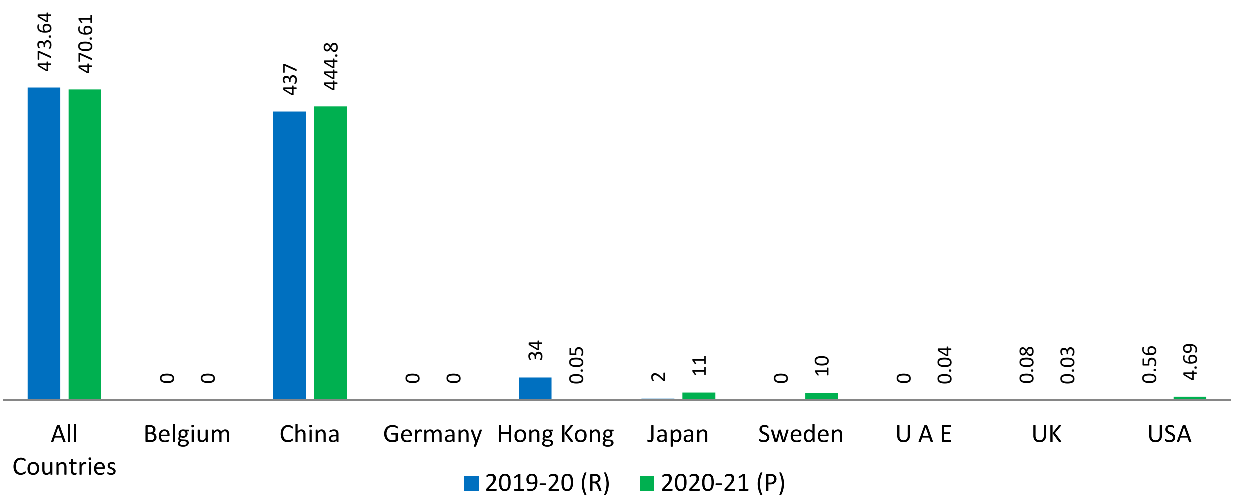


Fig 2: Country-wise Import of Rare-Earth Metals (Scandium & Yttrium)

FUTURE OUTLOOK

Worldwide explorations for economic deposits of REEs and efforts to bring them into production have increased substantially since 2000. Recovery of REEs can be complex because they occur in minerals as a group of similar elements, and at many deposits the REEs are hosted within more than one mineral. The success and timeliness of rare-earth mining projects, and the rare-earth elements industry in general, is difficult to predict and will be continuously monitored and studied by various countries in the world.

As per Roskill report 2021, the global demand of RE is to the tune of 1,31,500 tonnes and the processing capacity is of the order of 1,47,570 tonnes, while as per Argus Report 2021, the global demand of RE is to the tune of 1,59,000 tonnes and the processing capacity is of the order of 1,97,000 tonnes. Hence, as such, there is no supply chain constraint. However, Rare earth comprises of 17 elements and are classified as light RE elements (LREE) and heavy RE elements (HREE). Some REEs which are available in India, such as, Lanthanum, Cerium, Neodymium, Praseodymium, Samarium, etc. are in supply surplus while Dysprosium, Terbium, Europium which are classified as HREE are having supply constraint. These HREE are not available in Indian deposits in extractable quantity. The Government is actively engaged in capacity building for consumption of LREEs.

The RE resources in India are fifth largest in the world. Indian resource is significantly lean with reference to grade and it is tied with radioactivity making the extraction long drawn, complex and expensive. In comparison to China, Indian resources are significantly lean.

Production of RE depends on deposits and end Industry consuming the products. India is one of the pioneers in processing of RE and these capabilities are available in terms of capacity, technology and skill. The Government has targeted increasing REO producing capacity by 3 times by the year 2032. Also, in order to enhance consumption of RE in Indian industries, especially Electric Vehicles, recently Government has announced a PLI scheme vide item No. 6 page 44 of Notification No. S.O. 4632(E) dated 9th November of Ministry of Heavy Industries.

AMD is presently carrying out survey and prospecting operations to augment REE in Barmer district, Rajasthan; Chhota Udaipur district, Gujarat; Cuddalore, Ariyalur, Sivaganga & Madurai districts, Tamil Nadu; and East Singhbhum district, Jharkhand. AMD is carrying out collection of xenotime-bearing polymineral concentrate in the unit established in Jashpur district, Chhattisgarh.

Further, AMD has also been undertaking exploration works to identify additional resources of monazite in the beach sand deposits along coastal tracts in parts of Ganjam and Puri districts, Odisha; Srikakulam district, Andhra Pradesh, Thoothukudi – Kanyakumari – Tirunelveli districts, Tamil Nadu and Kottayam, Ernakulam, Thiruvananthapuram, Kollam and Alapuzha districts, Kerala.

IREL has provision for expanding the capacity of processing rare-earth-mineral to 20,000 tonnes per annum in near future.

The EV car projects which were expected to boost demand for Rare-earth Magnets are likely to be put on a back burner as the industry will take some time to come back on track.

IREL is actively pursuing setting up of greenfield operations in Kanyakumari district of Tamil Nadu and Bramhagiri district of Odisha. The proposal for harnessing the beach sand mineral deposits in Tamil Nadu by constituting a Joint Venture Company with the nominated State Government Agency, TAMIN, is under active consideration by the State Government.

As the country is gearing up towards e-mobility, green energy, e-office and other niche sectors, there is need to secure rare-earth mineral resources in areas beyond the boundaries of the country. Towards the above, IREL has been given the mandate to explore and acquire rare-earth resources abroad towards which activities for constitution of a separate entity under the aegis of the Department have been taken up.

25. Salt

12.78

(million tonnes) Total reserves/resources of rock salt were estimated as on 1st April 2020

286

(tonnes) Production of rock salt were reported in 2021-22

8.86

(million tonnes) of salt were exported in 2021-22

69,549

(tonnes) of salts were imported in 2021-22

Salt is the most significant of all the industrial minerals. Occurrence of rock salt in India is scanty. At the time of Independence, there used to be shortfall in production of salt and the same was met through imports. Since then, India has made tremendous progress in production of salt, achieving self-sufficiency in 1953 and even started exporting salt to other countries.

Common salt, when pure, is mineral halite which is an essential item for human consumption. The per-capita consumption of salt in the country is estimated to be about 14 kg, which includes edible and industrial salt. The current annual requirement of salt in the country is estimated to be 63 lakh tonnes for edible use (including requirement for cattles) and 118 lakh tonnes for industrial use.

"Salt is a Central Subject in the Constitution of India and appears as Item No. 58 in the Union List of the 7th Schedule, which reads:

(a) "Manufacture, Supply and Distribution of salt by Union Agencies; and

(b) "Regulation and control of manufacture, supply and distribution of salt by other agencies".

The Central Government is responsible for controlling and regulating all aspects of the Salt Industry. The Salt Commissioner's Organisation (SCO), Jaipur, Rajasthan, an attached office under the Ministry of Commerce & Industry (Department of Industrial Policy & Promotion), Government of India, is the Authority entrusted with the above task. The SCO is responsible for monitoring the production, distribution, quality, prices, supply and administration of Salt Cess Act, 1953 and the Rules, made thereunder.

RESERVES/RESOURCES

As per NMI database, based on UNFC system, the total reserves/resources of rock salt as on 1.4.2020 has been estimated at 12.78 million tonnes in Mandi, Himachal Pradesh. The entire resources, fall under Remaining Resources category.

PRODUCTION AND STOCKS

Production of Rock-Salt at 286 tonnes in 2021-22 decreased by 41% as compared to that in the preceding year. In the current year, production was reported by a single Public Sector mine from Himachal Pradesh (Table-1,2 and 3).

The mine-head closing stocks at the end of 2021- 22 was 38 tonnes as against 113 tonnes in 2020-21. The average daily labour employed in Rock-Salt mines during 2021-22 was 34 as against 23 in previous year (Table-4).

India is the 3rd largest salt (common) producing country in the world after China & USA with a production of about 266 lakh tonnes dur-ing the year 2021-22.

Production of salt involves extensive use of renewable sources of energy. Weather conditions play an important role in production of salt.

Salt (common) is manufactured mainly by solar evaporation of sea water. Sea salt constitutes about 80% of the total salt produced in the country. Gujarat (86%) was the leading State followed by Rajasthan (6%) and Tamil Nadu (6%) (Table-5). Private Sector contributed significantlly in the production of salt and accounted for 97.12% of the production. Public/Joint Sector contributed 1.11% and the rest was from the Co-operative Sector during 2021-22.

The major by-products recovered in the Salt Industry are gypsum, bromine, magnesium chloride, magnesium sulphate, ammonium bicarbonate, sodash, causticsoda and sodium bicarbonate. The average number of labourers employed in the Salt Industry during 2020-21 and 2021-22 were 91,139 and 77,086 respectively.

Table – 1 : Producers of Rock Salt, 2021-22

Name & address of producers	Location of mine	
	State	District
Hindustan Salt Ltd, B- 427, Pradhan Marg, Malviya Nagar, Jaipur - 302 017, Rajasthan.	Himachal Pradesh	Mandi

Table – 2 : Production of Rock Salt, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

Country/State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**130**	**1447**	**486**	**14239**	**286**	**6125**
Himachal Pradesh	130	1447	486	14239	286	6125

(In tonnes)

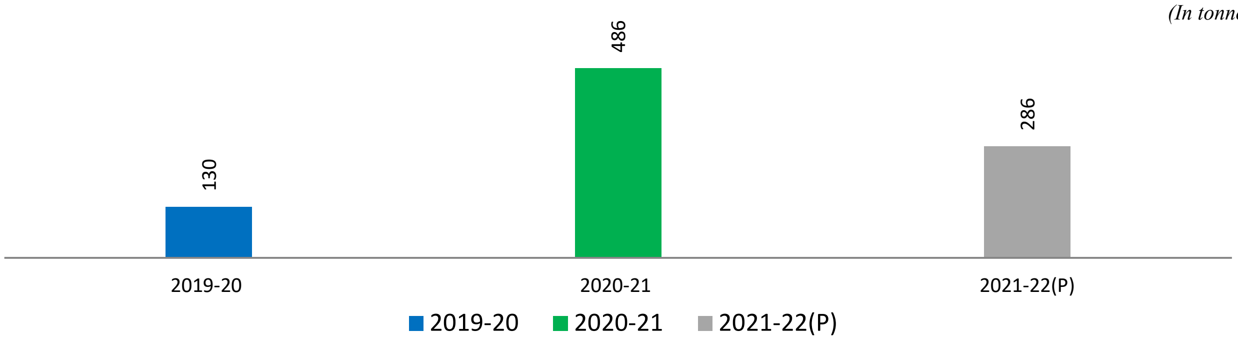


Fig 1: Production of Rock Salt in India

Table – 3 : Production of Rock Salt, 2020-21 and 2021-22

(By Sectors/States/Districts)

(Quantity in tonnes; Value in ₹ '000)

Country/State	2020-21			2021-22(P)		
	No. of Mines	Quantity	Value	No. of Mines	Quantity	Value
India	**1**	**486**	**14239**	**1**	**286**	**6125**
Public Sector	1	486	14239	1	286	6125
Private Sector	-	-	-	-	-	-
Himachal Pradesh/Mandi	**1**	**486**	**14239**	**1**	**286**	**6125**

Table – 4: Mine-head Closing Stocks of Rock Salt, 2020-21 & 2021-22

(By States/Grades)

(in tonnes;)

Country/State	2019-20	2020-21
India	**113**	**38**
Himachal Pradesh	113	38

MINING

In recent development, Drang Mohal (Bhatog) Rock Salt Mine, Village Mohal Bhatog, District Mandi, Himachal Pradesh, of M/s Hindustan Salts has started production and it produced 286 tonnes of rock salt during 2021-22. Mining is carried out by underground semi-mechanised method. The entire mining area is hill (Govt. waste land) region with no forest land cover.

USES

Salt, in addition to its culinary and domestic uses, is also used in meat packing, fish curing & its preservation, dairying, preservation & processing of hides, manufacturing of soaps, detergent & dyestuff, dyeing & finishing of fabrics, refrigeration, glazing earthenware, explosives, leather industries, bakery products, for soil stabilisation, in manufacturing artificial rubber and as wood preservative. In agriculture, salt is used for treating hay and as a fertilizer for certain crops. In countries with cold weather conditions, salt is used in deicing, i.e., removal of snow and ice, from streets and highways.

Industrial Applications

Salt is an important raw material used in Chemical Industry. It is used in the production of basic chemicals like sodium carbonate (soda ash), caustic soda, hydrochloric acid, chlorine, bleaching powders, chlorates, sodium sulphate (salt cake) and sodium metal. These basic chemicals, in turn, are used in the preparation of various end-products, such as, soaps, detergents, chlorinated hydrocarbons and carbon tetrachloride. Other important applications where salt is widely used are in food processing; as freezing- point depressant in refineries & milk supply schemes; treatment of industrial wastes; purification of drinking water; and manufacture of synthetic indigo, explosives, papers, etc.

The rock salt produced from Mandi mines contains 67.81% NaCl which is not suitable for human consumption as the content of sodium chloride is low from the required 96% NaCl necessary for human consumption. However, this salt finds application as essential suppliment in cattle feeds.

Iodised Salt

The SCO is the nodal agency for monitoring the production and quality of iodised salt at the production level and ensuring its equitable distribution in the country. Production of iodised salt continued its progressive trend and the Universal Salt Iodisation (USI), a programme under National Iodine Deficiency Disorder Control Programme (NIDDCP) reached new heights.

Iodised salt is produced by mixing potassium iodate with salt using spray, drip feed, dry mixing and submersion processes. Iodisation of salt is carried out in plants operated by Sambhar Salts Ltd (a subsidiary of Hindustan Salts Ltd), Kharagoda, Gujarat. SCO has facilitated establishment of 518 salt iodisation units including 119 refineries & washeries (152.39 lakh tonnes) with an annual installed capacity of 218.50 lakh tonnes up to March 2022. Production of 67.02 lakh tonnes of iodised salt during 2019-20 and 78.58 lakh tonnes in 2020-21. was reported. During the year 2021-22, the production of refined salt was 55.06 lakh tonnes as compared to 59.11 lakh tonnes during last year 2020-21. The Bureau of Indian Standards (BIS) has revised the specifications of iodised salt and formulated new specifications for refined iodised salt and Vacuum Evaporated iodised salt under IS 7224:2006. BIS has prescribed IS 797:1982 (Reaffirmed 2012) as specification of common salt for chemical industries.

Potassium Iodate Manufacture

Potassium iodate, used for fortifying salt with iodine is produced indigenously, however, iodine, the basic raw material for its production is imported. There are about 13 potassium iodate manufacturing units, registered with the Salt Commissioner.

Table – 5: Statewise Production of Salt (Common), 2021-22

(By States)

(In lakh tonnes)

States	2021-22
India	**266**
Gujarat	227.64
Rajasthan	16.9
Tamil Nadu	17.21
Other	4.24

Source: *Salt Commissioner, Govt. of India, Jaipur, Annual Report, 2021-22*

CONSUMPTION

Salt is extensively used in various industries like Caustic Soda, Soda Ash, Soaps & Detergents, Chemicals, Water softening plants, dyes etc. The Chlor-Alkali Industries, however, are the major consumer of salt. Various industries in the country consumed 108.98 lakh tonnes of salt during the year 2021-22 as against 101.95 lakh tonnes in 2010-21.

TRADE POLICY

Exports of salt have been brought under Open General Licence (OGL) with effect from 25th August, 1987 vide Ministry of Commerce, New Delhi, Export Trade Control Public Notice No. 26-ETC(PN)/87 dated 25th August, 1987. The Ministry of Commerce, Government of India, vide Notification No. 482(E) dated 25th July, 1991 has exempted certain categories of export from compulsory pre-shipment inspection.

As per Foreign Trade Policy (FTP) 2015-2020, exports and imports of rock salt and common salt (including iodised salt) under Heading no. 2501 are allowed as 'Free'.

FOREIGN TRADE

Exports

During 2021-22, the exports of salt (other than common salt) increased by about 7% to about 8.86 million tonnes from about 8.26 million tonnes in the previous year. Exports were mainly to China (29%), Republic of Korea (23%), Japan (13%), Indonesia (8%) and Qatar (7%), & Bangladesh (5%). On the other hand, the exports of salt rock decreased by about 56% to 139.16 thousand tonnes in 2021-22 from 317.3 thousand tonnes in 2020-21. The exports were mainly to Bangladesh (39%), and Republic of Korea (44%). Exports of salt (other) increased by 10% to 8.72 million tonnes during 2021-22 from 7.94 million tonnes in the previous year. Exports were mainly to China (30%), Republic of Korea (23%), Japan (13%) and Qatar (7%) (Tables-6 to 8).

Table – 6: Exports of Salt (Other Than Common Salt)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**8260913**	**10571743**	**8863780**	**13393717**
China	2839885	3092014	2607128	4495218
Korea, Rep. of	1835411	2363062	2091035	2502675
Japan	1105471	1389768	1165266	1388618
Qatar	639399	861159	652400	1001344
Indonesia	460373	576752	728745	885075
Bangladesh	329621	459803	410263	743239
Taiwan	228390	272597	377765	450081
Vietnam	140820	175657	230318	393114
Oman	94719	128460	168527	309456
UAE	118294	158016	92158	220049
Other countries	468530	1094455	340175	1004848

Figures rounded off

Table – 7: Exports of Salt Rock

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**317376**	**489122**	**139164**	**277009**
Bangladesh	260222	360285	53847	94008
UAE	27511	34221	182	6503
Korea, Rep. of	27150	26485	60600	71750
USA	574	15376	164	14243
Singapore	233	8903	140	6180
UK	166	3962	69	4686
Qatar	120	2295	581	3590
Canada	100	3178	145	11782
Nepal	272	2717	545	5223
Kuwait	151	2026	22235	32934
Other countries	877	29674	656	26110

Figures rounded off

(In tonnes)

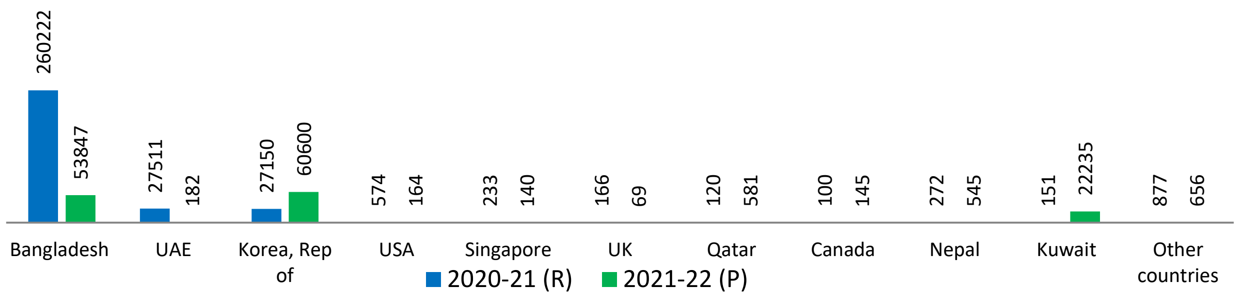


Fig 2: Countrywise Exports of Salt Rock

Table – 8: Exports of Salt (Other)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**7943537**	**10082621**	**8724616**	**13116708**
China	2839883	3091734	2607128	4495025
Korea, Rep. of	1808261	2336577	2030435	2430925
Japan	1105423	1386482	1165245	1386470
Qatar	639279	858864	651819	997754
Indonesia	460373	576752	728745	885075
Taiwan	228390	272597	377764	450010
Vietnam	140820	175657	230148	391730
Oman	94689	127563	168491	308412
Bangladesh	69399	99518	356416	649231
UAE	90783	123795	91976	213546
Other countries	466237	1033082	316449	908530

Figures rounded off

Imports

The imports of salts (other than common salt) decreased by 29% to 69,549 tonnes in 2021-22 from 98,042 tonnes in the previous year. Imports were mainly from Iran(47%), UAE (44%), and China(2%) under Open General Licence (OGL). Similarly, import of salt rock also decreased by 19% to 42,396 tonnes in 2021-22 from 52,651 tonnes in 2020-21. The imports were mainly from UAE (64%), Iran (30%). and Pakistan(4%) On flipside import of salt (other). decreased by 40% to 27,153 tonnes during 2021-22 from 45,391 tonnes in the previous year. The imports were mainly to Iran (75%),UAE (11%),China (4%) and Thailand (3%each) (Tables-9 to 11).

Table – 9: Imports of Salt (other than Common salt)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**98042**	**645494**	**69549**	**512396**
Iran	43373	201965	32983	166575
UAE	43728	195425	30380	200221
USA	260	33875	78	15237
UK	1946	21871	839	12616
Spain	43	21104	67	15679
Thailand	703	20349	870	27008
Germany	684	18554	290	15261
Malaysia	908	18516	285	6249
China	1606	15275	1007	14692
Germany	684	18554	290	15261
Other countries	4780	88625	2729	24159

Figures rounded off

Table – 9: Imports of Salt (other than Common salt)

(By Countries)

Country	2020-21(R)		2021-22(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**98042**	**645494**	**69549**	**512396**
Iran	43373	201965	32983	166575
UAE	43728	195425	30380	200221
USA	260	33875	78	15237
UK	1946	21871	839	12616
Spain	43	21104	67	15679
Thailand	703	20349	870	27008
Germany	684	18554	290	15261
Malaysia	908	18516	285	6249
China	1606	15275	1007	14692
Germany	684	18554	290	15261
Other countries	4780	88625	2729	24159

Figures rounded off

Table – 10: Imports of Salt Rock

(By Countries)

Country	2020-21(R)		2021-22(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**52651**	**252159**	**42396**	**258506**
UAE	33342	139526	27334	176544
Iran	14293	71350	12724	70553
Malaysia	908	18474	285	6218
Pakistan	3514	12678	1632	3287
Germany	459	8461	—	—
Afghanistan	46	638	150	346
Poland	10	259	—	—
U K	++	19	++	2
Egypt	54	198	271	1535
Belgium	++	1	++	21
Other Countries	25	555	++	++

Figures rounded off

(In tonnes)

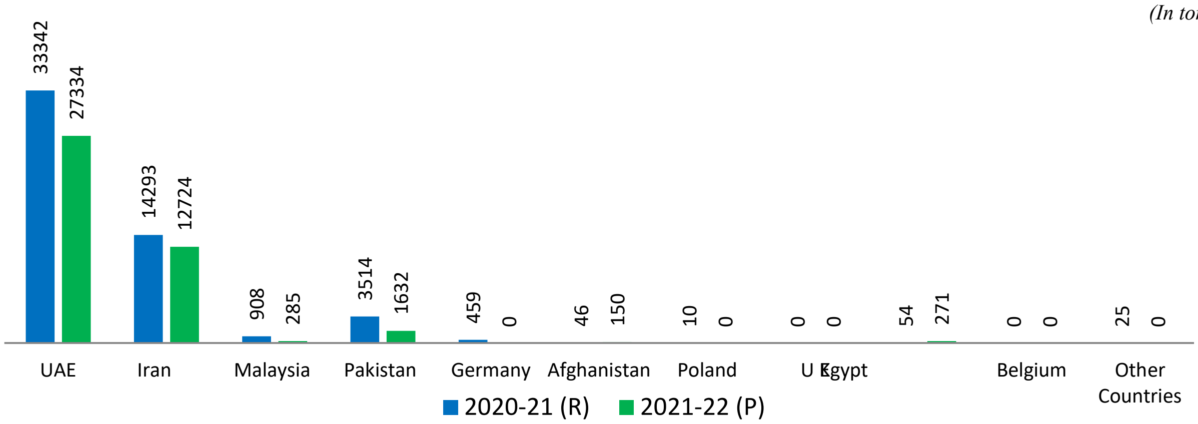


Fig 3: Countrywise Imports of Salt Rock

Table – 11: Imports of Salt (Other)

(By Countries)

Country	2020-21(R)		2021-22(P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	45391	393335	27153	253890
Iran	29080	130615	20259	96022
UAE	10386	55899	3046	23677
China	1606	15275	1007	14692
Netherlands	25	451	246	5055
USA	260	33626	78	15237
UK	1946	21852	839	12614
Spain	43	21068	67	15679
Thailand	703	20349	870	27008
Germany	225	10093	290	15261
France	11	9935	21	14699
Other countries	1106	74172	430	13946

Figures rounded off

FUTURE OUTLOOK

Sambhar Salts Ltd (SSL) approximately produces 2 lakh tonnes of raw salt every year. In addition, approximately 40,000 tonnes of processed salt are also produced. Schemes are also under preparation to enhance further capacity of raw salt production to 10 lakh tonnes per annum.

Hindustan Salt Limited has awarded the longterm contract through open tender for largescale commercial mining of rock salt at Mandi wherein modern Trackless underground mining is proposed to be used to enhance production up to 50,000 MT/annum. This proposal forms a part of Hon'ble PM's vision of Atmanirbhar Bharat wherein it is planned to produce adequate quantity of Himalayan Rock Salt so that complete import of Rock Salt both from Iran and Pakistan gets stopped within 2 years. is also intended to install Salt Refinery for processing of Rock Salt with latest technology as part of the contract.

26. Sulphur and Pyrites

1,674
(million tonnes) Total reserves/ resources of pyrites were estimated as on 1st April 2020

881
(thousand tonnes) Production of sulphur were reported in 2021-22

12,90,620
(tonnes) of sulphur were exported in 2021-22

1.89
(million tonnes) of sulphur were imported in 2021-22

Sulphur is an essential raw material for many chemical industries and is essentially used for the production of sulphuric acid which in turn is used for the production of chemical fertilizers, textiles, dyestuffs, pickling and galvanising of steel, storage batteries, refining of petroleum, explosives and other acids.

In India, presently there are no mineable elemental sulphur reserves. Sulphur combines directly with almost all the elements with the exception of gold, platinum and the noble gases. In its native form, sulphur is a yellow crystalline solid. It can be found as a pure element or as sulphate or sulphide minerals. The crystallography of sulphur is complex. Depending on the specific conditions, the sulphur allotropes form several distinct crystal structures, with rhombic and monoclinic S_8 best known.

Pyrites is naturally occurring mineral comprised of the elements iron and sulphur (FeS_2). It is used for manufacture of sulphuric acid, and as direct feed for soil conditioning. Pyrite is a fairly ubiquitous mineral and it occurs most commonly in sedimentary rocks. Pyrite has a brass yellow colour, brownish black streak, metallic lusture and occurs as cubic crystals. Pyrites includes a range of sulphide materials, such as, marcasite, pyrite and pyrrhotite. Marcasite usually occurs in low temperature metasediments and sedimentary rocks. Pyrrhotite occurs usually in magmatic or contact metasomatic deposits associated with basic igneous rocks and high temperature sulphide veins and isoften nickeliferous. Pyrites was used as a substitute for sulphur in the manufacture of sulphuric acid. However, there was no production of pyrites since 2003.

Native sulphur deposit has been reported in Puga Valley of Leh district in the Union Territory of Jammu & Kashmir. The grade of the deposit ranges from 9 % to 24 % of sulphur. Small occurrences of native sulphur are also reported from Barren Island of Bay of Bengal. Sulphur along with hot springs were reported from various parts of Chamoli, Rudraprayag, Uttarkashi, etc. districts in Garhwal & Kumaun divisions of Uttarakhand. In Andhra Pradesh, native sulphur occurs in granular form with clay and silt in coastal areas of Krishna and East Godavari districts. Occurrences are also reported from Alappuzha district of Kerala and Kangra district of Himachal Pradesh.

Sulphide occurs naturally in mineral ores, oil and coal deposits. Natural waters containing elevated concentrations of hydrogen sulphide are used for therapeutic baths and have been consumed for medical purposes. Hydrogen sulphide (H_2S), which exists as a colourless gas under normal conditions, has a characteristic odour of rotten eggs and occurs naturally in coal, natural gas, oil, volcanic gases and sulphur springs and lakes; H_2S is a central participant in the sulphur cycle, the biogeochemical cycle of sulphur on earth. Sulphides form an indispensable l ink in t he sulphur cycle (the reversible interconversion of sulphide and sulphate) in nature.

Petroleum refineries and gas processing plants extract H_2S when making "clean fuels" and use it as a feed stock to produce sulphur and water. The domestic production of elemental sulphur is limited to by-product recoveries from petroleum refineries and fuel oil used as feedstock for manufacturing fertilizer. Tar sands-natural sand (Oil sands) formations contain about 10% bitumen and with high hydrogen sulphide content.

The sulphide ores contain sulphur and during the production of metal from sulphide ores, sulphur is released as SO_2 which is used to produce sulphuric acid. The sulphuric acid thus produced contains about 32.7% of sulphur and contributes in the industries which otherwise would have used elemental sulphur.

RESERVES/ RESOURCES

The total reserves/ resources of pyrites in the country as per NMI data, based on UNFC system as on 1.4.2020 has been placed at 1,674 million tonnes. There are no reserves and all reso urces are group ed under ' Re maining Resources' category. Out of these, about 27 million tonnes are under Feasibility (STD211) category.

Out of the total resources, Beneficiable grade resources are 62 million tonnes, Low grade 1,555 million tonnes and Soil Reclamation grade resources are about 6 million tonnes. The balance of about 51 million tonnes resources fall under Unclassified/Not- known grades. Major reserves/ resources are located in Bihar (94%) and Rajasthan (5%) (Table - 1).

Table – 1 : Reserves/Resources of Pyrites as on 1.4.2020 (P)

(By Grades/States)

(In '000 tonnes)

Grade/State	Reserves	Remaining Resources						
	Total	Feasibility	Pre-feasibility	Measured	Indicated	Indicated	Total	Total
	(A)	STD221	STD222	STD331	STD332	STD333	(B)	(A+B)
All India : Total	**-**	**27129**	**32597**	**9590**	**77729**	**1527356**	**1674401**	**1674401**
By Grades								
Soil Reclamation	-	-	3000	-	-	3024	6024	6024
Beneficiable	-	27129	29597	-	-	4902	61628	61628
Low	-	-	-	9590	26310	1519430	1555330	1555330
Unclassified	-	-	-	-	51419	-	51419	51419
By States								
Andhra Pradesh	-	-	-	-	-	880	880	880
Bihar	-	13462	9680	-	51419	1500000	1574561	1574561
Himachal Pradesh	-	-	-	-	-	2560	2560	2560
Karnataka	-	-	-	-	-	3000	3000	3000
Rajasthan	-	13667	22917	9590	26310	18392	90876	90876
Tamil Nadu	-	-	-	-	-	24	24	24
West Bengal	-	-	-	-	-	2500	2500	2500

Figures rounded off

Reserves/resources of sulphur (native) have been estimated in the Inferred (STD333) category only. Entire resources are located in Jammu & Kashmir and are placed at 0.21 million tonnes as on 1.4.2020 as per NMI data, based on UNFC System (Table-2).

Table – 2 : Reserves/Resources of Sulphur (Native) as on 1.4.2020 (P)

(By Grades and States)

(In '000 tonnes)

Grade/State	Reserves Total (A)	Remaining Resources Feasibility STD221	Pre-feasibility STD222	Measured STD331	Indicated STD332	Indicated STD333	Total (B)	Total (A+B)
All India : Total	**-**	**-**	**-**	**-**	**-**	**210**	**210**	**210**
By Grades								
Sulphur (Native)	-	-	-	-	-	210	210	210
By States								
Jammu & Kashmir	-	-	-	-	-	210	210	210

Figures rounded off

PRODUCTION

Sulphur (Only relates to Public Sector)

The production of Sulphur recovered as by product from fertilizer plant and oil refineries were 881 thousand tonnes in 2021-22 as against 737 thousand tonnes in the preceding year.

The oil refineries in Public Sector reported production of Sulphur. During the year 2021-22, Indian Oil Corp. Ltd contributed about 72.8% of the total production during the year. Among the States, Odisa accounted for 24% of the total Sulphur production and it was followed by Kerala 21%, Haryana 20%, Gujarat 13%, West Bengal 8%, Uttar Pradesh 7%, Maharashtra 6% and remaining production was contributed by Bihar and Assam.

In addition, refineries of Hindustan Petroleum Corp. Ltd, RIL and Essar Oil also reported recovering of by-product sulphur which in turn is used as feedstock in manufacturing fertilizers and pharmaceuticals. The Vadinar refinery of Essar Oil Ltd is also reported to produce by-product sulphur. In Fertilizer Industry, the sulphuric acid is further used for manufacturing phosphoric acid and single superphosphate (SSP) from rock phosphate (Tables - 3 to 5).

Table - 3 : Principal Producers of By-product Sulphur, 2021-22

Name & address of producer	Location of plant/refinery State	District(s)
Indian oil Corporation Ltd,	Assam	Kamrup Metro,
(Refineries Division),		Tinsukia
Scope Complex, Core-II,		Chirang
7, Institutional Area,	Bihar	Begusarai
Lodhi Road,	Gujarat	Vadodara
New Delhi -110 003.	Haryana	Panipat
	Odisha	Jagatsinghpur
	Uttar Pradesh	Mathura
	West Bengal	Purba Medinipur
Numaligarh Refinery Limited,	Assam	Golaghat
122S, G. S. Road,		
Christanbasti,		
Distt- Guwahati,		
Assam - 781 005.		
Bharat Petroleum Corporation Ltd,	Maharashtra	Mumbai
Bharat Bhavan, 4 & 6,	Kerala	Ernakulam
Currimbhoy Road,		
Ballard Estate,		
Mumbai-400 001,		
Maharashtra		

Note: Sulphur is recovered as by-product from fertilizer plants and oil refineries (excluding units working under Private Sector)

Table – 4 : Production of Sulphur (By-product) 2019-20 to 2021-22

(By States)

(In tonnes)

State	2019-20	2020-21	2021-22 (P)
India	**900942**	**737337**	**880858**
Assam	5955	6447	6545
Bihar	6843	7135	8160
Gujarat	97107	82450	117588
Haryana	170907	138025	178740
Kerala	227253	142166	182352
Maharashtra	55659	41375	53165
Odisha	253697	209387	207831
Uttar Pradesh	47955	54234	60307
West Bengal	35566	56118	66170

(P): Provisional

(In tonnes)

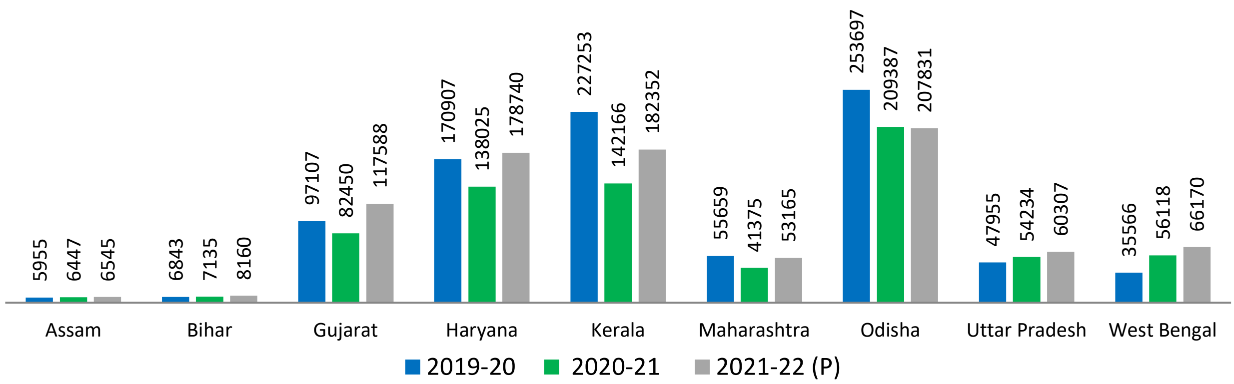


Fig 1: Statewise Production of Sulphur

Table – 5 : Production of Sulphur (By-product) 2020-21 and 2021-22

(By Sectors/States/Districts)

(In tonnes)

State/District	2020-21 (R)		2021-22 (P)	
	No. of units	Quantity	No. of units	Quantity
India/ Public sector	**12**	**737337**	**12**	**880858**
Assam	**4**	**6447**	**4**	**6545**
Chirang	1	1523	1	1678
Tinsukia	1	246	1	169
Kamrup Metro	1	218	1	372
Golaghat	1	4460	1	4326
Bihar/ Begusarai	1	7135	1	8160
Gujarat/ Vadodara	1	82450	1	117588
Haryana/ Panipat	1	138025	1	178740
Kerala/ Ernakulam	1	142166	1	182352
Maharashtra/ Mumbai	1	41375	1	53165
Orissa/ Jagatsinghpur	1	209387	1	207831
Uttar Pradesh/ Mathura	1	54234	1	60307
W. Bengal/ Purba Medinipur	1	56118	1	66170

(P): Provisional

Pyrites

Pyrites Phosphates and Chemicals Ltd (PPCL) had two pyrites production units located at Amjhore (Bihar) and Saladipura (Rajasthan) besides phosphorite division in Dehradun. The Government approved closure and hiving off of these two units in July 2002 and Amjhore unit in June 2003 and since then no activity is reported.

Petroleum Refining

In fossil fuels, sulphur is naturally present as an impurity when fuel is burnt, the sulphur is released as sulphur dioxide Man air pollutant. Hydrodesulfurisation (HDS) is a catalytic chemical process widely used to remove sulphur from natural gas and from refined petroleum products, such as, gasoline or petrol, jet, fuel, kerosene, diesel and fuel oils. Sulphur is a by-product produced in various refineries processing high sulphur crude oil. Sulphur is produced from the sulphur-rich fuel gas as a process to reduce the emission level of sulphur in the atmosphere along with flue gases from the furnaces. Mathura refinery started production of sulphur from beginning itself and sulphur recovery units have been provided in Haldia, Koyali, Panipat, Mathura and Guwahati refineries.Refinery-wise Sulphur (by-product) production capacity of Indian Oil Corporation Ltd is as under.

Unit	Production Capacity ('000 MTPA)
Mathura	48.0
Haldia	24.0
Koyali—	18.0
Panipat	144.0
Barauni	12.0
Guwahati	0.6

Specification of sulphur at Mathura, Panipat, Koyali, Haldia, Barauni & Guwahati refineries is as under:

Property	
Purity	**99.9**
Colour	Yellow
Shape	Lump

USES

Flowers of Sulphur (sublimed sulphur)

Powdered form of sulphur produced by sublimation process that which may contain up to 30% of the amorphous allotrope are generally used in rubber vulcanisation, agricultural dusts, pharmaceutical products and stock feeds.

Sulphur dioxide (SO_2)

Sulphur dioxide is a by-product gas generated during processing of sulphide ores as well from other industries. It is used in many industrial processes such as, chemical preparation, refining, pulp-making and solvent extraction and also is the feed stock to manufacture sulphuric acid. Sulphur dioxide is also used in the preparation and preservation of food because it prevents bacterial growth and browning of fruit.

Sulphuric Acid

Sulphuric acid is a strong mineral acid with the formula H_2SO_4 . It is soluble in water at all concentrations. Sulphuric acid has many appli-cations and is produced in greater amounts than any other chemical besides water. Principal uses include ore processing, fertilizer manufacturing, oil refining, waste water processing and chemical synthesis.

Miscellaneous

One of the direct uses of sulphur is in vulcanisation of rubber. Sulphur is a component of gunpowder. It reacts directly with methane to give carbon disulphide, which is used in the manufacturing of cellophane and rayon.

Elemental sulphur is mainly used as a precursor to other chemicals. Most of the sulphur is converted to sulphuric acid (H_2SO_4), which is of prime importance to the world economy.

The production and consumption of sulphuric acid are an indicator of a nation's industrial development. The principal use of sulphuric acid is in the manufacture of phosphatic fertilizer.

Other applications of sulphuric acid include oil refining, waste water processing and mineral extraction. Sulphur compounds are also used in detergents, fungicides, dyestuffs and agrichemicals. In silver based photography, sodium and ammonium thio-sulphate are used as "fixing agents". Sulphites, derived from burning sulphur, are used to bleach paper. They are also used as preserva-tives in dried fruit and processed fruit products.

Sulphur is used as a light-generating medium in the rare lighting fixtures known as "sulphur lamps". The sulphur lamp is a highly efficient full-spectrum electrodeless lighting system whose light is generated by sulphur plasma that has been excited by microwave radiation.

Nitrogen (N), phosphorus (P) and potassium (K) are critical components of a well-fertilized crop. But to achieve yields and more nutritious foods, crops need sulphur (S). It improves protein and oil percentage in seeds, cereal quality for milling and baking, marketability of dry coconut kernel (copra), quality of tobacco, nutritive value of forages, etc. It is associated with special metabolisms in plant and the structural characteristics of protoplasm. Judicious application in sulphur-deficient soils is a cost-effective way to produce more food and feed.

Concrete binder made with sulphur is an eco- efficient alternative to conventional Portland cement for paving stones, sidewalks and building foundations. In road construction, sulphur technology can replace up to 30 per cent of asphalt binder, a high energy- intensive input in blacktop roads. Sulphur-enhanced roads and parking lots offer a longer life cycle.

INDUSTRY

Coromandel International Ltd, formerly Coromandal Fertilizers Limited (CFL), is a leading manufacturer of a wide range of fertilizers & pesticides. Manufacturing units are located at Vizag, Kakinada and Ennore. The plants have the flexibility to produce 13 products from multiple rock and acid combinations. The environmental concerns have been incorporated in the development of its products and produces Sulphur enhanced fertiliser grades, 24-24-0-8S & 20-20- 0-13S are manufactured.

The present production facility of the Fertilizers and Chemicals Travancore Limited (FACT) includes manufacture of 3,30,000 tonnes per annum. of sulphuric acid in its Cochin Division. During the financial year 2020-21, FACT has started trading of Chemicals including sulphuric acid. Civil foundation work is in progress for construction of two Sulphuric Acid storage tank (5,000 tonnes) at FACT Cochin Division. During the year 2021-22 **Udyogamandal Complex** produced 1,86,192 tonnes of Factomfos, as compared to 2,15,444 tonnes in the previous year. In Cochin Division, during the year 2021-22, the Division produced 2,84,495 tonnes of sulphuric acid as compared to 29,86,620 tonnes in the year 2020-21. Sulphur, araw material for sulphuric acid production whiech is used in fertilizer production is sourced from refineries where it,'s proclvced a by-product from crude processing. At present. the Company has a tie-up with BPCL-Kochi Refinery for sourcing about 60% of its annual requirement minimising import. the Company also import sulphuric acid to meet its requirement for fertiliser production, mainly from Metallurgical Industry, where it is a waste / by-product during processing.

As per the Annual Report 2021-22 of Gujarat State Fertilizers & Chemical Limited, the Company is considering to set up 600 tonnes per day sulphuric acid Plant on LSTK basis at Vadodara Unit. The Company is considering to install 1,800 MTPD Sulphuric Acid Plant at Sikka Unit. To expand GSFC's Agro-product portfolio, the company is considering to enter into organic fertilizers by setting up 2x200 MTPD Phosphate. rich Organic Manure (PROM) plant at Polymer unit by using available existing infrastructure.

HZL produces 98% concentrated sulphuric acid at Chanderia, Debari and Dariba plants in the State of Rajasthan. The production capacity of Dariba plant and Chanderia plant is 0.6 million tonnes annually, while production of Debari plant is 0.3 million tonnes annually. Sulphuric acid is used in production of Single Super Phosphate Fertilizers/ Zinc Sulphate/ Phosphoric Acid/ LABSA for detergent/Chemical Gypsum for Cement Industries/ Metal Industry/Speciality Chemicals/ Dyes etc. for all spectrum of Industries.

TRADE POLICY

Imports of sulphur of all kinds other than sublimed sulphur, precipitated sulphur and colloidal sulphur under Heading No. 2503 are allowed free under the Foreign Trade Policy (FTP), 2015-20. Similarly, the imports of unroasted iron pyrites under Heading No. 2502 are allowed free.

World Review

Of the 14 countries that produced more than 1 million tonnes of sulphur, 12 obtained the majority of their production as recovered elemental sulphur. These 14 countries produced 88% of the total sulphur produced worldwide.

The world Sulphur Industry was composed of two sectors Discretionary and Non.discretionary. In the Discretionary Sector, the mining of sulphur or pyrites is the sole objective; this voluntary production of either sulphur or pyrites (mostly naturally occurring iron sulphide) is based on the mining of discrete deposits, with the objective of obtaining as nearly a complete recovery of the resource as economic conditions permit. In the non.discretionary Sector, sulphur or sulphuric acid is recovered as an involuntary by. product; the quantity of output is subject to demand for the primary product and environmental regulations that limit atmospheric emissions of sulphur compounds irrespective of sulphur demand. Discretionary sources (Frasch, native, and pyrites), once the primary sources of sulphur in all forms, represented only 8% of the sulphur produced worldwide in 2018.

The Frasch process is the term for hot-water mining of native sulphur associated with the caprock of salt domes and in sedimentary deposits In this mining method, the native sulphur is melted underground with superheated water and brought to the surface by compressed air. The United States, where the Frasch process was developed early in the 20th century, was the leading producer of Frasch sulphur until 2000. Poland, with 6,60,000 tonnes, was the only country that produced more than 3,00,000 tonnes of native sulphur by using either the Frasch process or conventional mining methods. Small quantities of native sulphur were produced in Asia, Europe, and South America. The importance of pyrites to the world sulphur supply has significantly decreased. China and Finland were the top producers of sulphur from pyrites with China accounting for 86% of the world pyrite production.

Native sulphur production, including production of Frasch sulphur at Poland's last operating mine, was estimated to be about the same as that in 2017. Recovered elemental sulphur production and by product from metallurgy was slightly higher than that in 2017. Globally, production of sulphur from pyrites was estimated to have been the same as that in 2017. Pyrites is a less attractive alternative to elemental sulphur for sulphuric acid production, primarily because the environmental remediation cost of mining pyrites is high.

Canada

Ranked fifth in the world in sulphur production, Canada was one of the leading sulphur and sulphuric acid exporters. In 2018, sulphur production, in all forms, in Canada was slightly lower than that in 2017. About 80% of Canada's sulphur was recovered at natural gas and oil sands operations in Alberta; some sulphur was recovered from oil sands operations in Saskatchewan, petroleum refineries in other parts of the country, and as byproduct sulphuric acid from metallurgy. Canada's sulphur production was expected to remain stable over the medium term and may increase during the long term as a result of expanded oil sands production.

Environment and Climate Change Canada (2019) published information on Canada's sulphur emissions in 2017, which indicated a 9% decrease from those in 2016 and a 69% decrease from those in 1990. Sulphur emissions in Canada have declined as the result of improved sulphur recovery technology at nonferrous metal smelters but also as a result of reduced emissions from coal-fired, electric-power-generating utilities and plant closures, as well as a reduction in emissions from the petroleum-refining sector. Further decreases in sulphur emissions were achieved through the implementation of low-sulphur fuel standards.

China

China was the leading global producer of sulphur in all forms and the leading producer of pyrites, with about 25% of its sulphur in all forms coming from that source. The country was the leading sulphur importer with a total of about 11 millions tonnes, which was about one- third of global trade. Imports represented 55% to 60% of elemental sulphur consumption in China, the bulk of which was used to manufacture sulphuric acid.

China's Ministry of Transport announced the expansion of its coastal Emission Control Areas to encompass China's entire coastline. Beginning January 1, 2020, all large vessels would be required to burn bunker fuels with 0.5% sulphur content and smaller vessels would be required to use bunker fuels with 10 parts per million sulphur when the vessels were inland waterways. The policy also required seagoing vessels to use bunker fuels with 0.1% sulphur when entering inland waterway areas in China.

Table – 6 : World Production of Sulphur & Pyrites

(By Principal Countries)

In tonnes (sulphur content)

Country	2019	2020	2021
World: Total (Pyrites)	**6400000**	**5900000**	**5600000**
World: Total (Frasch)	**600000**	**400000**	**400000**
World: Total (Recovered)	**78500000**	**72600000**	**71100000**
World: Total (Sulphur ore)	**100000**	**50000**	**50000**
Austria			
Recovered [a]	*44000	*44000	*44000
Belarus			
Recovered [a]	65043	64336	*64000
Belgium(Recovered)[b][a]	*400000	*400000	*400000
Bosnia & Herzegovina			
Recovered	*3700	*3700	*3700
Bulgaria			
Recovered [b]	414503	*420000	*420000
Recovered [a]	*60000	*60000	*60000
Croatia			
(Recovered)[a]	12640	8618	8659
Czech Republic			
(Recovered)[a]	*22000	*25000	*23000
Denmark			
(Recovered)[a]	3554	4140	4090

Country	2019	2020	2021
Finland			
Pyrites	233000	194000	182000
(Recovered)[(b)]	327300	358700	338400
(Recovered)[(a)]	*130000	*120000	*120000
France			
(Recovered)[(a)]	*370000	*370000	*370000
(Recovered)[(c)]	*55000	*55000	*55000
Germany			
(Recovered)[(a)]	460012	353293	382049
(Recovered)[(c)]	280660	213398	235769
Greece			
(Recovered)[(a)]	*330000	*330000	500000
Hungary			
(Recovered)[(a)]	*54000	*54000	*54000
Italy			
(Recovered)[(d)]	550000	*550000	*550000
Lithuania			
(Recovered)[(a)]	86041	71247	72988
Netherlands			
(Recovered)[(b)]	*86000	*90000	*90000
(Recovered)[(a)]	510000	*510000	*500000
Norway			
(Recovered)[(b)]	72900	73187	70948
(Recovered)[(a)]	*22000	*22000	
Poland			
Frasch	568240	422380	449100
(Recovered)[(b)]	*280000	*280000	*280000
(Recovered)[(a)]	25200	24740	24240
Portugal			
(Recovered)	*21000	*21000	*21000
Romania			
(Recovered)	*42000	*42000	*42000
Russia			
Pyrites	*71000	*71000	*71000
(Recovered)[(a)]	*6700000	*6100000	*6400000
(Recovered)[(c)]	*954000	*954000	*954000
Sulphur ore	57427	*28000	*28000
Serbia			
(Recovered)[(b)]	*29400	*29400	*29400
Slovakia			
(Recovered)[(b)]	*4900	*4900	*4900
(Recovered)[(a)]	*85300	*85300	*85300
Sweden			
(Recovered)[(b)]	178401	165500	172700
(Recovered)[(a)]	50021	39085	38248
Turkey			
Pyrites	173731	46408	39681
(Recovered)[(a)(c)]	*72900	*72900	*95300
United Kingdom			
(Recovered)[(a)]	130000	106000	107000
Algeria			

Country	2019	2020	2021
(Recovered)[a]	*10000	*10000	*10000
Egypt			
(Recovered)[a]	*80000	*80000	*8000
Morocco			
(Recovered)	*60000	*60000	*60000
Namibia			
(Recovered)	72923	81500	65500
South Africa			
(Recovered)[b][a]	919624	575491	32044
Zambia			
(Recovered)[b]	960200	*1000000	*1000000
Canada			
(Recovered)[b]	520000	554746	*555000
(Recovered)[a]	6418000	4349262	4329112
Cuba			
(Recovered)	3234	3176	2846
(Recovered)[a]	*20000	*20000	*20000
Mexico			
(Recovered) [b]	*556000	*556000	*556000
(Recovered)[a]	364967	264078	176321
Trinidad & Tobago			
(Recovered)[a]	*10000	*10000	*10000
USA			
(Recovered) [b]	596000	*520000	*600000
(Recovered) [a]	8110000	*7600000	*7500000
Argentina			
(Recoverd) [b]	*20000	*20000	*20000
Brazil			
Pyrites	*20000	*20000	*20000
Recoverd [b]	*292000	*292000	*292000
Recovered [a]	*239000	*239000	*239000
Chile			
(Recovered) [b]	1263119	1476154	1400388
Colombia			
(Recovered) [a]	*7000	*7000	*7000
Ecuador			
(Recovered) [a][e]	*5000	*5000	*5000
Peru			
(Recovered) [d]	*556000	*556000	*556000
Venezuela			
(Recovered) [a]	*155000	*100000	*100000
Bahrain			
(Recovered) [a]	*120000	*120000	*120000
China			
Pyrites	*5900000	*5610000	*5300000
(Recovered)	*11600000	*11390000	*11000000
India			
(Recovered) [b][f]	*1200000	*1200000	*1200000
(Recovered) [a][f]	900942	737337	*723350
Indonesia			
(Recovered) [b]	*160000	*160000	*160000

Country	2019	2020	2021
(Recovered) [(a)]	*120000	*120000	*120000
Iran			
(Recovered) [(d)]	*2200000	*2200000	*1640000
Iraq			
(Recovered) [(a)]	*6792000	*5858000	*5823000
Israel			
(Recovered) [(a)]	70973	45184	43664
Japan			
(Recovered) [(b)]	1629656	1728654	1575032
(Recovered) [(a)]	1629365	1411860	1420094
Jordan			
(Recovered) [(a)]	*490000	*490000	*490000
Kazakhstan			
(Recovered) [(b)]	*604000	*604000	*604000
(Recovered) [(a)]	*2625000	*2484000	*2490000
Korea, Rep. of			
(Recovered) [(b)]	*1078000	*1078000	1078000
(Recovered) [(a)]	1999000	2000000	2000000
Kuwait			
(Recovered) [(a)]	*860000	*780000	*785000
Oman			
(Recovered) [(a)]	*48000	*48000	*48000
Pakistan			
(Sulphur ore)	20715	*20000	19398
Philippines			
Recovered) [(b)]	*169000	*169000	*169000
(Recovered) [(a)]	*2000	*2000	*2000
Qatar			
(Recovered) [(a)]	*1648500	*1593900	*1539700
Saudi Arabia			
(Recovered) [(a)]	*3700000	*3500000	*3400000
Singapore			
(Recovered) [(a)]	*300000	*300000	*300000
Syria			
(Recovered) [(a)]	*1500	*1500	*1500
Taiwan			
(Recovered)	195358	167336	192227
Thailand			
(Recovered) [(a)]	*205000	168526	147669
Turkmenistan			
(Recovered) [(a)]	*363000	*299000	*348000
UAE			
(Recovered) [(a)]	*2523000	*2318000	*2300000
Uzbekistan			
(Recovered) [(b)]	*131000	*131000	*131000
(Recovered) [(a)]	*81000	*61000	*78000
Australia			
(Recovered) [(b)]	*810000	*810000	*810000
(Recovered) [(a)]	*90000	*90000	*90000
New Zealand			
(Recovered) [(a)]	*35000	*35000	*35000

Country	2019	2020	2021

Source: BGS, World Mineral Production, 2017-2021

a: From petroleum refining and/or natural gas

b: From metal sulphide processing

c: Other; d: Sulphur, all forms

e: Including Frasch

f: Years ended 31st March following that stated.

*** India's production of Sulphur (by-product) during 2018-19, 2019-20 and 2020-21,was 8,90,400 tonnes, 9,00,942 tonnes and 7,37,337 tonnes respectively.*

** Estimated*

FOREIGN TRADE

Exports

Exports of sulphur (excluding sublimed, precipitated and colloidal) increased to 12,90,620 tonnes in 2021-22 as compared to 8,02,713 tonnes in the preceding year. Exports were mainly to China (96%), Jordan and Morocco (2% each). On the other hand, exports of sulphur (sublimed, precipitated and colloidal) increased marginally by 12% to 17,607 tonnes in 2021-22 as compared to 15,756 tonnes in the preceding year. Exports were ma inly to USA (15%), Indo nesia & Netherlands (10%each), Brazil & Thailand (8% each) Russia (7%) (Tables-7 to 11). Exports of sulphur (sublimed) increased to 17,607 tonnes in 2021-22 as compared to 15,765 tonnes in 2020-21 and exports of sulphur precipitated were negligible in both the years 2020-21 and 2021-22.

Table – 7 : Exports of Sulphur (Excl. Sublimed, Precipitated & Colloidal) :Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**802713**	**4328627**	**1290620**	**21010530**
China	777803	4142691	1233483	19687695
Jordan	10000	37541	28500	696561
Morocco	-	-	21000	351372
Turkey	126	9396	829	59435
Sri Lanka	1069	18026	1361	39319
Tanzania Rep	183	3394	1068	33377
Nepal	836	12303	764	24554
Djibouti	169	3452	730	21996
Oman	40	1649	1348	16962
UAE	620	28779	209	10599
Other countries	11867	71396	1329	68662

Figures rounded off

(In tonnes)

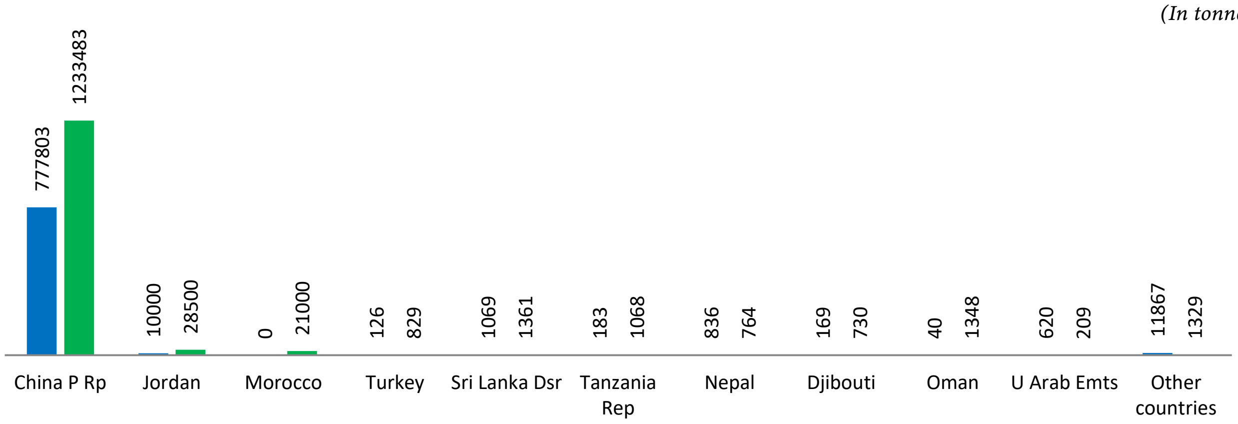


Fig 2: Countrywise Export of Sulphur

Table –8 : Exports of Sulphur (Sublimed, Precipitated & Colloidal) : Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**15756**	**1777105**	**17607**	**1941916**
Netherlands	3367	413979	1699	212919
USA	2475	260094	2667	282792
Brazil	1317	143832	1338	146605
Indonesia	1378	141906	1728	183822
Russia	1237	136992	1230	124625
Thailand	1308	133794	1336	146119
Italy	789	97743	940	107934
South Africa	757	95890	1112	134059
Spain	605	68631	904	88319
Portugal	528	62421	840	99572
Other countries	1995	221823	3813	415150

Figures rounded off

Table – 9: Exports of Sulphur (Colloidal)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**9**	**++**	**9**
Singapore	++	3	++	4
Korea, Rp. of	-	-	++	4
Brunei	-	-	++	1
Spain	++	4	-	-
China	++	1	-	-
Taiwan	++	1	-	-

Figures rounded off

Table – 10 : Exports of Sulphur (Sublimed)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**15754**	**1776553**	**17607**	**1941891**
Netherlands	3367	413979	1699	212919
USA	2475	260094	2667	282792
Brazil	1317	143832	1338	146605
Indonesia	1378	141906	1728	183822
Russia	1237	136992	1230	124625
Thailand	1308	133794	1336	146119
Italy	789	97743	940	107934
South Africa	757	95890	1112	134059
Spain	605	68627	904	88319
Portugal	528	62421	840	99572
Other countries	1993	221275	3813	415125

Figures rounded off

Table-11 : Exports of Sulphur (Precipitated)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**2**	**543**	**++**	**16**
Sri Lanka	++	302	-	-
Haiti	2	239	-	-
Swaziland	++	2	-	-
Ecuador	++	++	-	-
Greece	-	-	++	1
Quatar	-	-	++	3
Egypt	-	-	++	16
UAE	-	-	+	+

Figures rounded off

Imports

Imports of sulphur (excluding sublimed, precipitated and colloidal) increased by 30% to 1.89 million tonnes in 2021-22 from 1.46 million tonnes in the previous year. Imports were mainly from Qatar (32%), UAE (25%), Oman (15%), Saudi Arabia (11%), Kuwait (9%) and Japan & Iraq (2% each). Imports of sulphur (sublimed, precipitated and colloidal) increased by 11% to 959 tonnes in 2021-22 from 862 tonnes in the previous year. Imports were mainly from Taiwan (81%), Malaysia & China (5% each), Germany (4%), and Belgium & Republic of Korea (2% each) (Tables -12 to 16). Imports of sulphur (sublimed) & Precipitated were at 893 tonnes & 39 tonnes. respectively.

Table – 12-: Imports of Sulphur (Excl. Sublimed, Precipitated & Colloidal): Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**1463291**	**10948268**	**1895211**	**35362092**
Qatar	781580	5767576	613000	12587182
UAE	227627	1436414	477998	7701252
Oman	150573	1417055	287017	5282758
Saudi Arabia	71251	519179	210168	3792684
Kuwait	93341	654667	169333	3400845
Japan	44899	319478	47997	947759
Iraq	-	-	39087	659967
Singapore	38195	363098	19499	424202
Bahrain Is	44943	354667	16442	276271
Namibia	-	-	9507	160186
Other countries	10882	116134	5163	128986

Figures rounded off

(In tonnes)

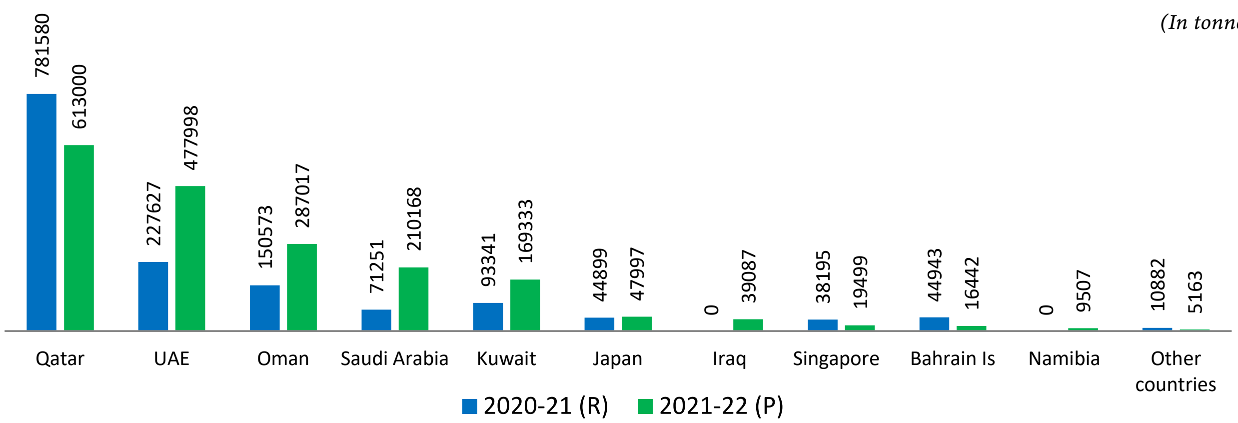


Fig 3: Countrywise Imports of Sulphur

Table – 13: Imports of Sulphur (Sublimed, Precipitated & Colloidal): Total

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**862**	**191861**	**959**	**335922**
Taiwan	345	104365	779	297938
Belgium	9	3541	18	7450
Malaysia	22	2744	48	6832
Korea, Rep. of	95	13776	15	5867
China	50	6633	44	4779
Netherlands	-	-	6	2833
Germany	15	5309	36	5710
Japan	4	1036	5	1837
Vietnam	1	793	2	1641
Indonesia	-	-	6	587
Other countries	321	53664	++	448

Figures rounded off

Table – 14: Imports of Sulphur (Precipitated)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**9**	**1568**	**39**	**6196**
Japan	4	990	3	854
Germany	5	578	36	5273
UK	-	-	++	8
USA	-	-	++	61

Figures rounded off

Table – 15: Imports of Sulphur (Colloidal)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**39**	**8477**	**27**	**10666**
Germany	9	3764	-	-
Belgium	9	3541	18	7450
Korea, Rep. OF	21	905	-	-
USA	++	159	++	1
UK	++	62	++	192
Japan	++	46	++	43
Netherlands	-	-	6	2833
Malaysia	-	-	3	147

Figures rounded off

Table – 16: Imports of Sulphur (Sublimed)

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**814**	**181816**	**893**	**319060**
Taiwan	345	104365	779	297938
Slovenia	321	53018	-	-
Korea, Rep. OF	74	12871	15	5867
China	50	6633	44	4779
Malaysia	22	2744	45	6685
Germany	1	967	++	437
Vietnam	1	793	2	1641
USA	++	425	++	186
Japan	-	-	2	940
Indonesia	-	-	6	587

Figures rounded off

FUTURE OUTLOOK

Worldwide recovered sulphur output is expected to increase as a result of higher sulphur recovery in the Oil and Gas Sector. New sulphur supplies would mostly come from Kuwait, India and Saudi Arabia.

Production from natural gas operations is expected to increase as more natural gas is recovered from shale formations as improved technologies reduce natural gas production costs. By-product sulphuric acid production in the United States has decreased by 36% since 2000. China's smelter acid production has nearly doubled in the past 10 years however, the rate of increase had begun to slow.

China has invested in new copper smelter capacity, Frasch sulphur and pyrites production, however, the production is unlikely to have significant long-term increases. As a reserlt of the continued increase in elemental sulphur recovery and by-product sulphuric acid production for environmental reasons, Discretionary sulphur has become increasingly less important as demonstrated by the lack of expansion in the Frasch Sulphur Industry.

Pyrites, with significant direct production costs, are an even higher cost raw material for sulphuric acid production when the environmental aspects are considered. Discretionary sulphur output is likely to decline. The decrease likely will be pronounced when large operations are closed for economic reasons. For the long term, sulphur and sulphuric acid would will continue to be important in agricultural and industrial applications. Phosphate processing, mainly for agricultural uses, continues to be the dominant use of sulphuric acid (about 60%). Sulphuric acid consvmption expanding in other industrial applications such as titanium dioxide pigment production in China & Europe and for caprolactam (used in the production of nylon 6 fibers manufacturing).

27. Vermiculite

2.36
(million tonnes) Total reserves/ resources of vermiculite have been estimated as on 1st April 2020

3,061 (tonnes) Production of vermiculite were reported in 2021-22

1,263
(tonnes) of vermiculite were exported in 2021-22

1,096
(tonnes) of vermiculite were imported in 2021-22

Vermiculite is a term applied commercially to micaceous minerals (essentially hydrated silicates of Al, Mg and Fe), usually alteration products of biotite or phlogopite micas, formed by the removal of much alkalies and addition of water. Vermiculite differs from mica in its characteristic property, i.e., exfoliation. Crude vermiculite is always exfoliated before use.

RESERVES/RESOURCES

The total reserves/resources of vermiculite as on 1.4.2020 as per NMI data, based on UNFC system, has been placed at 2.36 million tonnes of which about 1.60 million tonnes (68%) are placed under Reserves category and balance 0.77 million tonnes (32%) are placed under Remaining Resources category. Reserves/resources are mainly located in Tamil Nadu that reported 1.86 million tonnes (79%) followed by Andhra Pradesh with 0.20 million tonnes (8%), Karnataka 0.16 million tonnes (7%), Rajasthan 0.01 million tonnes (4%) and Jharkhand 0.03 million tonnes (1%). Nominal resources are located in Gujarat, Madhya Pradesh and West Bengal (Table- 1).

Table - 1: Reserves/Resources of Vermiculite as on 1.4.2020 (P)

(By Grades/States)

(In tonnes)

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India: Total	**1562108**	**-**	**28888**	**1590996**	**76900**	**71397**	**25956**	**9800**	**20179**	**552279**	**8716**	**765227**	**2356223**
By Grades													
Refractory	24514	-	14238	38752	-	-	-	-	-	807	-	807	39559
Unclassified	1537594	-	14650	1552244	76900	71397	25956	9800	20179	551472	8716	764420	2316664
By States													
Andhra Pradesh	45305	-	28888	74193	7349	917	5850	9800	5127	88865	-	117908	192101
Gujarat	-	-	-	-	-	-	-	-	-	1960	-	1960	1960
Jharkhand	-	-	-	-	-	-	-	-	-	30048	-	30048	30048
Karnataka	-	-	-	-	28000	50520	15500	-	1562	66658	-	162240	162240
Madhya Pradesh	-	-	-	-	197	-	66	-	-	66	-	329	329
Rajasthan	-	-	-	-	41354	19960	4540	-	13000	16555	8716	104125	104125
Tamil Nadu	1516803	-	-	1516803	-	-	-	-	-	343051	-	343051	1859854
West Bengal	-	-	-	-	-	-	-	-	490	5076	-	5566	5566

Figures rounded off

PRODUCTION & STOCKS

Production of Vermiculite was 3061 tonnes in 2021-22 as compared to 1,260 in 2020-21. increased by 143% as compared to that in the previous year. There were 5 reporting mines and one associate mines in 2021-22 as compared to 5 reporting mines in previous year.

Andhra Pradesh was the leading producer of Vermiculite in 2021-22, which accounted for 77% of the total production and remaining 23% was from Tamil Nadu state(Tables-2 to 4).

Mine- head closing stocks of vermiculite at the end of the year 2021-22 were 1,6475 tonnes as against 7,806 tonnes for the previous year. (Table-5).

The average daily employment of labour during the year was 43 in both current and previous year.

Table – 2: Principal Producers of Vermiculite, 2021-22

Name & address of producer	Location of plant/refinery	
	State	District(s)
T. Meenatchi Sundaram, Plot No. 2, Industrial Estate, Gudur P.O., (Mandal), SPSR Nellore - 524 101, Andhra Pradesh.	Andhra Pradesh	Nellore
Tamil Nadu Minerals Ltd, 31, Kamarajar Salaitwad House, Chepauk, Chennai-600 005, Tamil Nadu.	Tamil Nadu	Vellore
Sadhana Minerals 1-116, Masthanvli Complex, Anil Nagar, Bye Pass Road, Gudur, Chillakur, Post-Gudur Dist Nellore-524412 Andhra Pradesh.	Andhra Pradesh	Nellore

Table – 3 : Production of Vermiculite, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**2774**	**3347**	**1260**	**2157**	**3061**	**3768**
Andhra Pradesh	2190	1414	750	469	2370	1481
Karnataka	-	-	-	-	-	-
Tamil Nadu	584	1933	510	1688	691	2287

Table – 4 : Production of Vermiculite, 2020-21 & 2021-22

(By Sectors/States/Districts)

(Quantity in tonnes; Value in ₹ '000)

State	2020-21			2021-22		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**5**	**1260**	**2157**	**5(1)**	**3061**	**3768**
Public sector	1	510	1688	1	691	2287
Private sector	4	750	469	4(1)	2370	4181
Andhra Pradesh	3	750	469	3(1)	2370	4181
Nellore	3	750	469	3(1)	2370	4181
Karnataka (Mysore)	1	-	-	1	-	-
Tamil Nadu	1	510	1688	1	691	2287
Vellore	1	510	1688	1	691	2287

Table – 5 : Mine-head Closing Stocks of Vermiculite 2020-21 & 2021-22

(By States)

(Quantity in tonnes)

State	2020-21	2021-22 (P)
India	**7650**	**16475**
Andhra Pradesh	2462	11267
Karnataka	-	-
Tamil Nadu	5188	5208

MINING AND INDUSTRY

In Andhra Pradesh, vermiculite is available in the district of Nellore, where one working mine have been reported during 2020-21. Vermiculite is mined and refined using a variety of techniques and supplied commercially in a range of particle size grades of vermiculite concentrate. In Tamil Nadu, good quality deposits of vermiculite are mostly found in the North Arcot district, where there are a few working mines. In Karnataka, vermiculite is found in the districts of Hassan, Mandya and Mysuru.

Vermiculite, when heated to a high degree of temperature, exfoliates and expands 8 to 14 times in volume and yields exfoliated vermiculite by loss of water molecules. The chemical composition shows average moisture as 7.89%, loss on ignition 11.05%, SiO_2 30.52%, Fe_2O_3 16.32 % and TiO_2 2.63%. Exfoliation is observed at right angles to the strong basal cleavage. This property is the basis for its commercial use. Change in colour is observed during heating process and this depends upon the compositon of the vermiculite and furnace temperature.

USES

Vermiculite is known for its horticultural applications. It is a common component in potting soils. Unfoliated (unexpanded) vermiculite has only minor uses, such as, for circulation in drilling muds and in the annealing of steel. In order to convert raw vermiculite into a product suitable for industrial use, it must be exfoliated or expanded by heating, a process termed 'exfoliation'. Vermiculite is chemically inert, fireproof, non-conductor of electricity and a good insulator against heat (both radiant and conducted), cold and sound. Unlike cork and other organic lightweight insulating material, it neither rots nor is attacked by vermin and has a fair mechanical strength.

Vermiculite is added to soil for conditioning and lightening either alone or in conjunction with peat or compost. This will accelerate the growth by enabling the plant to absorb the NPK nutrients and promote anchorage for tender young root systems.

It is also used as a carrier in fertilizers, herbicides and insecticides. Cementing mixtures of exfoliated vermiculite and binding agents, such as, gypsum and plaster, have been important products and are applied to structural steel members in commercial buildings.

The mineral is used in various types of building boards and in pollution control applications. Finesized, untreated vermiculite concentrates are included in the preparation of fireproof plaster boards. The exfoliated product forms the basis of some lightweight plasterboard, whilst ground, exfoliated vermiculite is used in various refractory board products.

The principal uses of expanded vermiculite are based on its thermal insulating quality (due to presence of innumerable air cells), low-density, fireproof nature and granular form. Larger vermiculite granules are used as a loose fill for thermal insulation for homes, industrial structures, cold storage, refrigeration and high temperature & low temperature industrial equipment.

Vermiculite is also used for refractory and high temperature insulation as it can withstand hot face temperature of 1,000 °C, i.e., it can act as a thermal insulator.

The high absorbency and chemical inertness of exfoliated vermiculite have made it suitable for a wide range of absorbent packing materials as well as for packaged units for the containment of oil and similar liquids. Like perlite, vermiculite is a mined mineral that is heated to yield a soilless ingredient of potting mixes. Unlike perlite, vermiculite absorbs and retains water and nutrients. This quality is desirable especially in container gardens because of their quicker evaporation rates compared to in-ground plantings. On heating, vermiculite swells up and exfoliates into thin sheets. the swellings may be twenty times or more. The swelled-up vermiculite is very light and thus may be used as an ingredient for the making of light cement or plaster. Vermiculite is also used in the Packing Industry and the making of insulator against heat and sound. Its colour may be yellow, brown or blue. It is very soft and slippery like soap. Pure vermiculite is also used for plaster aggregates as fireproof insulating material in steel/ concrete structures. It is widely used in lightweight insulating material for roof/ floor deck system, insulation fill for homes and commercial building, packaging material, bitumen-coated vermiculite screens, acoustic insulation, etc.

SUBSTITUTES

Expanded perlite is a substitute for exfoliated vermiculite in lightweight concrete and plaster. Other denser but less costly substitutes in these applications are expanded clay, shale, slag and slate. Alternate materials for loose-fill fire-proofing insulation include fibreglass, perlite and slag wool. In agriculture, substitutes include bark and other plant materials, peat, perlite, sawdust and synthetic soil conditioners. Finely-ground pine bark also called "pine fines" is a principal ingredient of most potting mixes. As an alternative to vermiculite, pine fines also has water retentive qualities, especially with smaller particle sizes. Cotton gin waste includes gin leavings, such as, stems, leaves and hulls. Cotton gin compost renders these waste products into a viable alternative to vermiculite, also because of its ability to increase water-holding qualities in mixes. Resembling sphagnum peat moss, coir is the finish product of ground coconut husks. The University of Arkansas Co operative Extension Service reports that coir can retain up to nine times its weight in water.

CONSUMPTION

The apparent consumption of vermiculite more than doubled in 2021-22 at 2,867 tonnes as against 1,103 tonnes in 2020-21.

POLICY

As per foreign trade policy 2015-20, the imports and exports of vermiculite (unexpanded) [ITC (HS) Code 25301010] and vermiculite insulation bricks [ITC (HS) Code 69029030] are allowed 'free'.

WORLD REVIEW

Significant deposits have been reported in Australia, China, Russia, Uganda and some other countries, but reserves and resources informationcome from many sources and in most cases, it is not clear whether the numbers refer to vermiculite alone or vermiculite plus other minerals and host rock and overburden and production data. The details of world reserves of vermiculite are reflected in Table 6 & 7.

To provide a generalised view of the development in various countries, the countrywise description as sourced from the latest available publication of Minerals Yearbook 'USGS' 2018 is furnished below:

Brazil

In 2018, Brazil was estimated to have produced 50,000 tonnes of vermiculite, most of which was mined by Brasil Minérios Ltd., by far the leading vermiculite producer in Brazil . The company's largest mine was the Morro Pelado Mine in Sao Luis de Montes Belos municipality near Goiania in the State of Goias in central Brazil, and its primary processing plant was in Sao Luis. The mine had an estimated production capacity of 50,000 metric tonnes per year (tonnes/year) of vermiculite ore with reserves estimated in 2012 of 1.2 million metric tonnes (Mt) of vermiculite ore. With the expansion of its mining operations continuing, Brasil Minérios produced about 48,700 tonnes of vermiculite concentrate in 2017 (most recent year for which data were available). About 60% of Brazil's vermiculite products were exported, with sales in North America (50% of all exports), Europe (35%), and Asia (15%).

Near Brasilia in Catalao, Goias State, Brasil Minérios owned the mining rights to vermiculite deposits containing estimated vermiculite ore reserves of 3.3 million tonnes. Brasil Minérios' total production capacity was expected to increase to 200,000 tonnes/year when the Catalão Mine reached full capacity during the next several years. Brasil Minérios expected to meet Brazil's domestic demand for vermiculite for 50 years while continuing to be a significant exporter of the mineral. The company also expanded capacity by 15,000 tonnes/year of vermiculite at its exfoliation plants in Sanclerlandia, Goias State, and in Cosmopolis, Sao Paulo State.

Bulgeria

In 2018, Wolff & Müller Minerals Bulgaria OOD, a joint venture between companies from Bulgaria and Germany, mined vermiculite ore from its Belitza opencast mine and had limited production at, and continued development of, the nearby Verona vermiculite deposit in southwestern Bulgaria near the capital of Sofia. The company processed the crude vermiculite ore into a concentrate in superfine- and micron-sized products at its 20,000 tonnes/year vermiculite concentration plant. China

Production levels of vermiculite in China were not available, but based on a 2016 estimate made by the Vermiculite Association that China annually exports 110,000 tonnes of vermiculite, the country's annual production likely was greater than 110,000 tonnes. Production increases in China continued to be constrained by increased enforcement of environmental regulations.

Xinjiang Yuli Xinlong Vermiculite Co Ltd. mined vermiculite ore from its Xinlong Mine in the Bazhou area of Xinjiang Uyghur Autonomous Region. The 120,000tonnes/year vermiculite concentrate Xinlong Mine was the top-producing vermiculite mine in China, from which the company produced 30,000 cubic meters per year of exfoliated vermiculite. The company's leading product was a flake vermiculite concentrate ranging in size from 0.3 to 8.0 millimeters. The company exported most of its products, typically to developed countries and regions such as Europe, Australia, Hong Kong, Japan, the Republic of Korea, Russia, Taiwan, and the United States, but also sold products domestically.

South Africa

In 2018, South Africa continued to be the world's leading producer and exporter of vermiculite, accounting for about 43% of estimated world production In 2018, 180,000 tonnes was produced, most of which was mined by Palabora Mining Co. Ltd. Under the ownership of a consortium consisting of entities from South Africa and China led by the Industrial Development Corp. of South Africa Ltd. and China's Hebei Iron & Steel.

Group, Palabora Mining increased production in 2018 by more than 8% from that in 2017 from its mine in the Limpopo Province.Nearby, the company was preparing for the opencast mining of ore that was equally rich in high-purity vermiculite. The new mine was designed to produce 1.5 million metric tonnes per year of ore and yield 170,000 tonnes/year of vermiculite concentrate, extending the company's total mine life through 2031.Because of grade constraints and lower recovery rates from portions of the vermiculite ore body, the vermiculite product has continued to shift toward fine and superfine grades. Palabora Mining continued to face increased competition in the global vermiculite market, including from Brazil and Uganda, but it regained some of its market share lost in the past few years, in part through competitive pricing. Palabora Mining marketed its vermiculite products through the company's Singapore office to its three international subsidiaries in Australia, Europe, and North America.

Turkey

Organik Madencilik A.S., a 50–50 joint venture of Turkey's Yildirim Group and the Greek mining group S&B [a subsidiary of Imerys SA (Paris, France) has completed plant construction and started producing from the country's first vermiculite mine at the Karakoc vermiculite deposit in Sivas in central Turkey. The deposit, discovered by Turkey's Government Exploration Co. in the 1990s, is thought to hold resources of about 2.8 million tonnes of high-quality vermiculite and 2.5 million tonnes of lower quality vermiculite. The mine had a capacity of 10,000 million/year of vermiculite concentrate, which includes a significant quantity of coarse and medium grades. An unspecified portion of production was further processed by exfoliation. Sales of vermiculite concentrate and of exfoliated vermiculite were planned to go through Imerys' established network.

Uganda

In 2018, Black Mountain Resources Ltd. of Australia completed a company restructuring that included selling i ts interest in the Namekara Vermiculite Mine in the Manafwa district of eastern Uganda in exchange for debt relief. Black Mountain withdrew from the joint venture developing the Namekara Vermiculite Mine citing inconsistent vermiculite sales that resulted in reduced cash flow and the company's inability to service its debt obligations. Namekara Mining Co. Ltd. became the 100% owner of the Namekara Vermiculite Mine and continued mining operations. The large vermiculite deposit had almost 62 million tonnes of inferred resources with a grade of 18.2% vermiculite and containing 11 million tonnes of vermiculite. The mine had an estimated production capacity of 30,000 tonnes/ year of vermiculite concentrate, which includes significant quantities of coarse and medium grades, and enough resources to operate for more than 50 years at previously announced rates of production. Black Mountain had considered a production expansion up to 80,000 tonnes/ year, but Namekara Mining has not announced plans for expansion.

Zimbabwe.

Samrec Vermiculite (Pvt.) Ltd. [a subsidiary of Imerys SA (Paris, France)], the leading vermiculite producer in the country, produced vermiculite concentrate at the Shawa Mine, which is about 300 kilometers southeast of the capital of Harare. The surface mining operation with ore to a depth of 40 meters had a capacity of 40,000 tonnes/year of vermiculite concentrate and an expected mine life of more than 30 years in one of the largest vermiculite deposits in the world. The ore, which included a significant portion of large flake vermiculite, was processed into concentrates, the majority of which was exported to Asia, Europe, the Middle East, and the United States.

The Minerals Marketing Corp. of Zimbabwe, which was responsible for marketing and selling the country's industrial minerals, reported exports of 33,200 tonnes of vermiculite concentrate at a value of $3.79 million in 2018, representing a 42% increase in quantity with a 12% increase in value from about 23,300 tonnes at a value of $3.38 million in 2017. The company cited that the strong U.S. dollar and increased inland costs to sea ports had made the local product prices uncompetitive on the international market.

In 2018, the Government of Zimbabwe launched a Transitional Stabilisation Programme, set to run from October 2018 to December 2020, for economic recovery. The Zimbabwe- based Wickbury Investments (Pvt.) Ltd.'s Dinhidza Vermiculite Mine in Buhera was listed with a nonoperational status and as available for investors. Wickbury Investments, which in 2015 had invested in its production facilities at the mine, marketed its product mainly to Zimbabwe's farming industry as a soil amendment to slow the leaching of fertilizers from soil after excessive rainfall while also promoting the mineral's slow release of fertilizer to the soils. In drier areas, farmers would benefit from the mineral's ability to swell and store water, increase soil aeration, and transport and store nutrients. In both instances, use of vermiculite would improve the long-term fertility of soils.

South Africa was the largest producer of vermiculite(217 thousand tonnes) in the world during 2021, followed by USA (100 thousand tonnes) and Brazil (50 thousand tonnes).

Table – 6: World Reserves of Vermiculite

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total (rounded off)[a]	**26,000**
China	9,500
Australia	127,400
Russia	5,000
South Africa	3,500
Other countries	165

Source: USGS, Mineral Commodity Summaries, 2023

a- Excludes China Production.

** India's total reserves/resources as per UNFC system as on 01.04.2020 were estimated at 2.36 million tonnes.*

Table – 7: World Production of Vermiculite

(By Principal Countries)

(In '000 tonnes)

Country	2019	2020	2021
USA[(a)*]	100	100	100
South Africa	158	118	217
Brazil	50	50	50
Zimbabwe[(a)]	30*	30*	30
Russia	29	29	30
Turkey	1	19	3
China*	15	15	15
Bulgaria*	10	10	10
Uganda	10	14	14
Other countries	3	2	1

***Source**: BGS, World Mineral Production, 2017-21*
***India's production of vermiculite during 2018-19, 2019-20and 2020-21 was 3,636 tonnes, 3,322tonnes and 1,808 tonnes, respectively. * Estimated*
(a):Sold or used by producers
(b): Including beneficiated and directly shipped material
(c) : Years ended 31 March following that stated

(In tonnes)

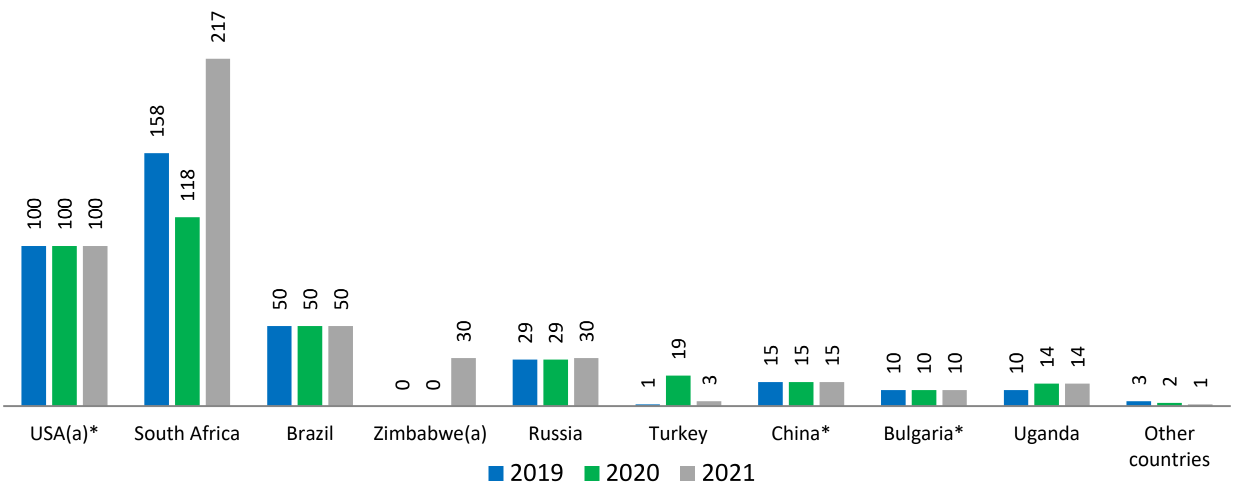


Fig 3: Countrywise Import of Vermiculite

FOREIGN TRADE

Exports

Exports of vermiculite increased by 48% to 1,263 tonnes in 2021-22 as compared to 853 tonnes in 2020-21. Exports were mainly to Japan (48%), UAE and Norway (20% each), Angola (4%), Nepal (3%) and Taiwan (2%) (Table-8).

Imports

The imports of vermiculite also increased drastically by 36% to 1,096 tonnes in 2021-22 from 696 tonnes in 2020-21. Imports were mainly from Kenya (82%), Mozambique (7%), South Africa (5%) and Saudi Arabia (4%). (Table-9).

Table – 8: Exports of Vermiculite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**853**	**11573**	**1263**	**21780**
Japan	300	4216	616	9435
UAE	250	2975	252	4900
Norway	120	1261	242	4467
Angola	-	-	59	1357

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
Taiwan	-	-	28	720
Greece	-	-	24	602
Nepal	5	187	39	217
Tanzania	-	-	3	55
Nigeria	-	-	++	23
Bangladesh	-	-	++	4
Other countries	178	2934	-	-

Figures rounded off

Table – 9: Imports of Vermiculite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**696**	**17234**	**1096**	**25520**
Kenya	440	9627	902	20626
South Africa	120	3638	60	2093
Mozambique	20	613	80	2604
Saudi Arabia	-	-	54	197
Brazil	84	2232	-	-
Japan	5	905	-	-
Turkey	27	211	-	-
Oman	++	8	-	-

Figures rounded off

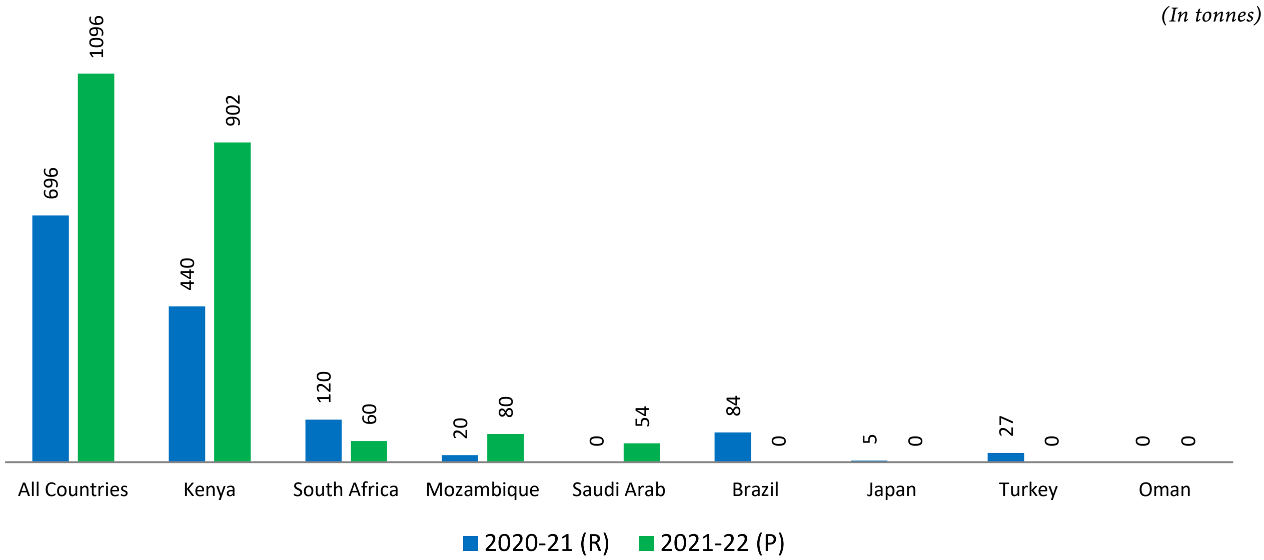


Fig 2: Countrywise Import of Vermiculite

FUTURE OUTLOOK

Exploration and development of vermiculite deposits containing medium, large and premium (coarser) grades (mostly in China and South Africa) are likely to continue because of the higher demand for these larger grades. During the next several years, operations in Brazil and the United States are expected to help maintain regional and global supplies of fine, superfine, and micron grades. Innovative applications continue to emerge including the use of fine-sized to micronsized grades of vermiculite to combat air pollution and absorb water in mines, replacing zeolites in ion-exchange columns, purifying waste water and containing or removing nuclear waste.

28. Wollastonite

25.11
(million tonnes) Total reserves/ resources of wollastonite have been estimated as on 1st April 20202020

1,08,383
(tonnes) Production of wollastonite were reported in 2021-22

11,705
(tonnes) of wollastonite were exported in 2021-22

30,625
(tonnes) of wollastonite were imported in 2021-22

Wollastonite is a chemically simple mineral named in honour of English Mineralogist and Chemist Sir W.H.Wollaston. Wollastonite is composed of calcium and silica with a chemical formula $CaSiO_3$. Wollastonite may contain impurities like iron, potassium, manganese, etc. Though normally wollastonite is bright white in colour, the impurities can produce grey, cream, brown or red colour in wollastonite. Wollastonite is formed when limestone/ dolomite is subjected to high temperature and pressure in the presence of silica-bearing fluid as in skarn deposits or metamorphic rocks. It occurs as aggregates of bladed or needle-like crystals with hardness of 4.5 to 5 on Mohs scale. The uses of wollastonite in applications other than as filler include marine wallboard, paint, plastic, in refractory liners in steel mills and as a partial replacement for short-fibre asbestos in certain applications.

RESERVES/RESOURCES

Major deposits of wollastonite have been found in Ajmer, Dungarpur, Pali, Sirohi and Udaipur districts in Rajasthan. Besides, in Ghoda area, Banaskantha district in Gujarat and in Dharmapuri and Tirunelveli districts in Tamil Nadu, occurrences of a few deposits have been reported. As on 1.4.2020, the reserves/resources of wollastonite, as per NMI database, based on UNFC system are placed at 25.11 million tonnes of which Reserves under Proved and Probable categories together constitute 2.68 million tonnes (11%) and Remaining Resources constitute for the balance 22.43 million tonnes (89%). Out of the total resources, about 92% (23.11 million tonnes) including 2.68 million tonnes reserves are located in Rajasthan and the remaining about 8% resources (1.99 million tonnes) in Gujarat. Meagre resources are also located in Tamil Nadu (3,533 tonnes) (Table-1).

Table - 1: Reserves/Resources of Wollastonite as on 1.4.2020 (P)

(By Grades/States)

(In tonnes)

Grade/State	Reserves				Remaining Resources								Total
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconna-issance	Total	Resources
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	(A+B)
All India : Total	**2388641**	**190739**	**101598**	**2680978**	**4563016**	**1245009**	**8559760**	**0**	**3325042**	**4597200**	**137461**	**22427488**	**25108466**
By Grades													
Marketable	1790818	0	0	1790818	0	0	8194950	0	0	966850	0	9161800	10952618
Unclassified	449206	190739	0	639945	3680144	550276	322733	0	3325042	2647244	137461	10662900	11302845
Not-known	148617	0	101598	250215	882872	694733	42077	0	0	983106	0	2602788	2853003
By States													
Gujarat	0	0	0	0	0	0	0	0	0	1990000	0	1990000	1990000
Rajasthan	2388641	190739	101598	2680978	4563016	1245009	8559760	0	3325042	2603667	137461	20433955	23114933
Tamil Nadu	0	0	0	0	0	0	0	0	0	3533	0	3533	3533

Figures rounded off.

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION & STOCKS

Production of wollastonite at 1,08,383 tonnes in 2021- 22 increased by 4% as compared to 1,03,902 tonnes in the preceding year. There were three reporting mines in 2021-22 as compared to four mines in the previous year. The entire production was reported only from Private Sector mines located in the State of Rajasthan (Tables-2 to 4).

Mine-head closing stocks of wollastonite at the end of the year 2021-22 were 1,37,750 tonnes as against 1,18,407 tonnes in the previous year (Table- 5).

The average daily employment of labour in wollastonite mines during 2021-22 was 191 as against 219 in the previous year.

Table – 2: Principal Producers of Wollastonite, 2021-22

Name & address of producer	Location of plant/refinery	
	State	District(s)
Wolkem Industries Ltd, P.B.21, E-101, Mewar Industrial Area, Madri, Distt Udaipur- 313 003, Rajasthan.	Rajasthan	Udaipur
Renu Atre, C-378, Pradhan Marg Jaipur- 302 017, Rajasthan.	Rajasthan	Jaipur
Sadhana Bhargava C-57 Shiv Margdundlod Colony, Jaipur District-Jaipur-302005, Rajasthan	Rajasthan	Ajmer

Table-3: Production of Wollastonite, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India/Rajasthan	**124757**	**139695**	**103902**	**122210**	**108383**	**99265**

(In tonnes)

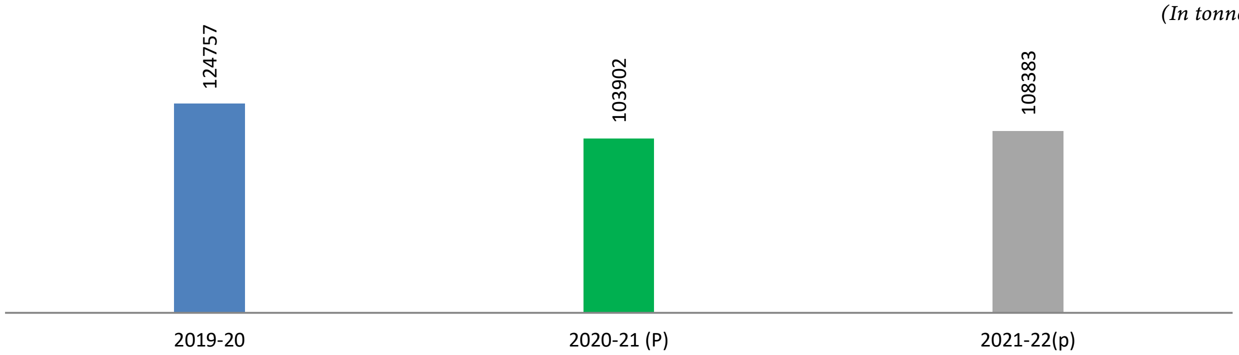


Fig 1: Production of Wollastonite in India

Table-4: Production of Wollastonite, 2020-21 and 2021-22

(By Sectors/States/Districts)

(Quantity in tonnes; Value in ₹ '000)

State/District	2020-21			2021-22(P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India/Private sector	**4**	**103902**	**122210**	**3**	**108383**	**99265**
Rajasthan	**4**	**103902**	**122210**	**3**	**108383**	**99265**
Ajmer	2	312	181	2	598	348
Pali	1	-	-	-	-	-
Udaipur	1	103590	122029	1	107785	98917

Table-5: Mine-head Closing Stocks of Wollastonite, 2020-21 & 2021-22

(By States)

(Qty in tonnes)

State	2020-21	2021-22 (P)
India/Rajasthan	118407	137750

MINING, PROCESSING & MARKETING

Wollastonite is mined by opencast method essentially through manual and semi-mechanised method. In some of the mines viz. Belka Pahar mine of M/s Wolkem Industries Ltd in Sirohi district, Rajasthan, manual selection and manual sorting are practised for improving recovery of ore. The run-of-mine is selectively hand-sorted to the size of 30 cm to 50 cm to remove the associated minerals such as calcite, diopside, garnet, quartz and iron. Wollastonite, thus separated, is then crushed to various sizes at two crushing plants near Sirohi railway station with a capacity of 80,000 tonnes per year. Principal commercial grades produced are: White Kemolit (S1 to S5) and off-white Kemolit (H1 to H5 and LG 25) which are milled products in the size range of 100 to 500 mesh. Besides, micronised products are also marketed, i.e., Wolkron (1008, 1010, 1015, 1020, 1025 and 10825) in the low-aspect-ratio and Kemolit 1025 and 1020 in the high-aspect-ratio. In addition, speciality products and surface modified products are also marketed as Kemolit and Fillex, respectively. Wollastonite is processed to make it useful for various applications. The commonly associated minerals like garnet and diopside are removed by high intensity magnetic separators after grinding. Some of the other materials are chemically removed to improve binding in the resin-based products.

Processing improvements integral to new product development focus on the following:

(i) High-aspect-ratio, fine particle size grades used as reinforcements to compete against milled glass fibres, synthetic fibres and whiskers.

(ii) Fine particle size high aspect ratio grades to compete against other mineral reinforcements, such as, talcs and clays, in the thermoplastic compounds.

Hand-sorted wollastonite has few impurities and is of high-aspect-ratio.

USES & SPECIFICATIONS

The use of wollastonite depends on the acicularity or the aspect ratio, i.e., ratio between length and width of a crystal, chemical composition, brightness and fibre length. Wollastonite having aspect ratio in the range from 3:1 to 5:1 has little potential for reinforcing applications. Hence, market is primarily confined to ceramic, metallurgical fluxes and simple filler and coating applications. Wollastonite reduces the volume of the expensive plastic or resin medium and contributes to physical and chemical properties of the finished products. It improves tear strength, dielectric properties and retains mechanical properties at elevated temperatures.

Wollastonite is used primarily in automobile brakes, ceramics, metallurgical processing, paper, paint, plastic, cosmetics, adhesives and as a replacement of asbestos in asbestos- cement boards and sheets. Some of the properties that make it so useful are high brightness & whiteness, low moisture & oil absorption, low volatile content and the acicular nature of some wollastonite. A better compatibility between the polymer and the filler is achieved by chemical surface treatment of the mineral filler. Wollastonite results improved flexural modules in polypropylene and improved reinforcement in nylon. It is also used as performance additive in a wide ra nge of construction material (concrete, stucco and adhesives).

Bulk of the demand for wollastonite in the country is in the Ceramic Industry for the manufacture of floor and wall tiles. In ceramics, wollastonite decreases shrinkage and gas evolution during firing. Small quantities are used in asbestos-cement products as a partial replacement for short fibre asbestos, paint, insecticide, marine wallboard and welding rod industries. In metallurgical applications, wollastonite serves as a flux for welding, a source for calcium oxide, as slag conditioners and to protect the source of molten metal during the continuous casting of steel. The addition of wollastonite to metallurgical fluxes provides ready fusibility, good insulating qualities and low viscosity.

A new development with very large potential is the use of wollastonite as a sequestration mineral for carbon dioxide, a major factor in global warming. Unlike other methods, sequestration by wollastonite is permanent and results in a mixture of precipitated calcium carbonate and silica that may have filler applications in paper, plastics & rubber.

SUBSTITUTE

The acicular nature of many wollastonite products allow it to compete with other acicular materials, such as, ceramic fibre, glass fibre, steel fibre and several organic fibres such as aramid, polyethylene, polypropylene, and polytetrafluoroethylene in products where improvements in dimensional stability, flexural modulus and heat deflection are sought. Wollastonite also competes with several nonfibrous minerals or rocks such as kaolin, mica and talc, which are added to plastics to increase flexural strength and such minerals as baryte, calcium carbonate, gypsum and talc, which impart dimensional stability to plastics. In ceramics, wollastonite competes with carbonates, feldspar, lime and silica as a source of calcium and silica. Its use in ceramics depends on the formulation of the ceramic body and the fixing method.

CONSUMPTION

The apparent consumption of wollastonite at 1,07,960 tonnes in 2021-22 increased by 9% as compared to 98,943 tonnes in 2020-21.

WORLD REVIEW

World reserves of wollastonite exceed 100 millon tonnes. Many deposits, however, have not been surveyed, precluding accurate estimates of reserves. large deposits of wollastonite have been identified in China, Finland, India, Mexico and the United States. Smaller but significant deposits were in Canada, Chile, Kenya, Namibia, South Africa, Spain, Sudan, Tajikistan, Turkey and Uzbekistan.

In 2018, global sales of refined wollastonite were thought to be in the range of 8,50,000 to 9,00,000 tonnes.

China was the largest producer of wollastonite with a production of 900 thousand tonnes in the year 2021. India with 104 thousand tonnes, Mexico (102 thousand tonnes) and USA (50 thousand tonnes) were the other major producers. In addition to these countries, small quantities of wollastonite were also produced in Spain and Australia.

The Ceramic Industry probably accounts for the major consumption of wollastonite worldwide, followed by polymers (plastic and rubber) and paint. The remaining were used in construction, friction products and metallurgical applications.

The countrywise production of wollastonite by principal countries from 2019 to 2021 is furnished in Table-6.

Table –6 : World Production of Wollastonite

(By Principal Countries)

(In tonnes)

Country	2019	2020	2021
China[e]	**890000**	**890000**	**900000**
India[a]	124657	103902	104000(e)
Mexico	159498	131518	102711
USA[e]	50000	40000	50000
Finland(e)	11000	11000	11000
Spain	7165	17412	17246
Australia[b]	-	2426	4495

Source: BGS, World Mineral Production, 2017-2021 ; e - estimated

(a) : India's production of wollastonite during 2019-20, 2020-21 and 2021-22 was 125 thousand tonnes, 104 thousand tonnes and 108 thousand tonnes respectively.

a) Years ended 31st March following that stated.

b) Years ended 30th June of that stated.

FOREIGN TRADE

Exports

In 2021-22, exports of wollastonite decreased by 15% to 11,705 tonnes from 13,716 tonnes in the previous year. Exports were mainly to Belgium (57%), Hungary & Germany (11% each), Japan (9%) and UK (3%) (Table-7).

Table – 7 : Exports of Wollastonite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**13716**	**311809**	**11705**	**282266**
Belgium	7409	176460	6723	167779
Germany	1458	33734	1240	29991
Hungary	2200	43038	1334	27088
Japan	1406	27029	1078	23675
UK	258	6447	383	10399
Poland	78	2643	156	5403
France	300	8144	168	4890
Mexico	-	-	82	3431
Australia	88	2664	58	1909
Turkey	40	1163	115	1650
Other countries	479	10487	368	6051

Figures rounded off

(In tonnes)

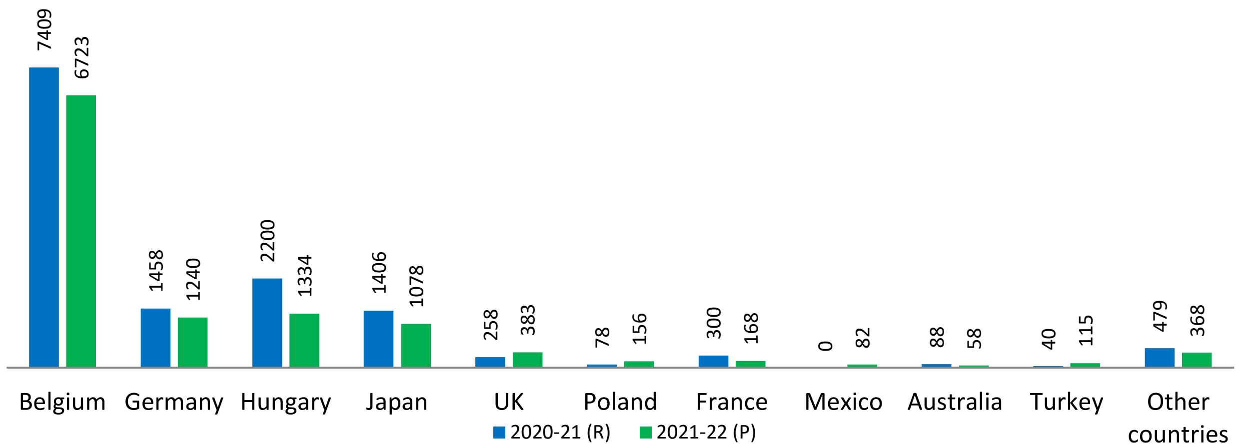


Fig 2: Countrywise Exports of Wollastonite

Imports

Unlike exports, imports of wollastonite increased marginally by 27% to 30,625 tonnes as compared to 24,049 tonnes in the previous year. Imports were almost entirely from China (99%) and the remaining 1% were from Mexico and other countries (Table-8).

Table – 8 : Imports of Wollastonite

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**24049**	**370375**	**30625**	**675667**
China	23739	347010	30294	644660
Mexico	75	5900	133	10604
Belgium	8	1023	50	7589
Canada	40	2877	80	5099
USA	150	8951	41	3160
Netherlands	-	-	19	2175
Japan	9	2938	4	1228
Germany	1	213	2	620
Denmark	2	1054	1	448
Korea	-	-	1	84
Other countries	25	409	-	-

Figures rounded off

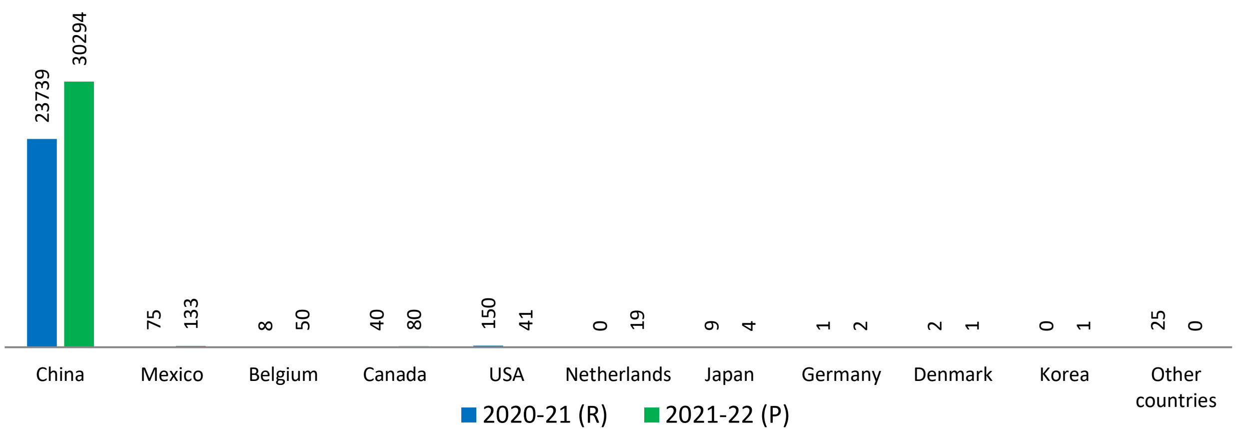


Fig 3: Countrywise Imports of Wollastonite

FUTURE OUTLOOK

Presently, India is world's second largest producer of wollastonite after China. The existing mines in the country are in a position to meet the domestic requirements of the Ceramic Industry as well as export demand. There is an increasing demand for wollastonite in the international markets, especially in ceramic, metallurgy, paint, construction and as asbestos substitute. Present apparent consumption is around 1,07,960 tonnes.

The exports of processed wollastonite with high-aspect-ratio and powdered wollastonite may have to be encouraged for the betterment of export of value-added products. As a result of augmentation of resources of wollastonite in the States of Tamil Nadu and Gujarat, India would end up being in a formidable position to cope with any futuristic demand.

29. Zircon

15,600
(tonnes) Production of zircon were reported in 2019-20

<1
(tonne) of zircon ores and concentrates were exported in 2021-22

94,839
(tonnes) of zircon ores and concentrates were imported in 2021-22

Zirconium is the twentieth most abundant element in the Earth's crust and occurs in a variety of rock types and geological environment but most often, in the form of zircon ($ZrSiO_4$) found usually as a constituent in heavy mineral sand assemblages, which include ilmenite, rutile, leucoxene, monazite and garnet in varying proportions. Zircon sand and baddeleyite (an oxide-ZrO_2) are used via their salts to extract zirconium and hafnium. Normally, all zirconium compounds contain between 1 .4 % and 3 % hafnium. Zircon is very stable at high temperature and has excellent thermal shock resistance, low thermal conductivity and chemical inertness. It finds use chiefly in industries like ceramic, refractory, abrasive, foundry, chemical and speciality alloys. Gem variety of zircon is used in jewellery. Ministry of Mines vide Notification No.S.O.2356 (E) dated 11.07.2016, zircon covered under beach sand minerals was inserted as entry 12 of Part B of the First Schedule to the MMDR Act, 1957.

RESERVES/RESOURCES

Zircon occurs in close association with other heavy minerals, such as, ilmenite, rutile and monazite in beach sands, along the coastal tracts of the country. Its concentration in the deposits is about 0.6–18.7% of the total heavy minerals. Indian zircons analyse 63–66% ZrO_2. AMD has carried out reconnaissance investigation in parts of Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Kerala, Odisha and West Bengal during 2008-14. The resource estimation in these areas have been carried out up to March 2020. The resources of zircon are placed at 36.56 million tonnes as per Department of Atomic Energy (DAE). However, the Statewise break-up as on March 2020 is not available, so far the breakup of 33.71 million tonnes resources up to 2016 is furnished in Table-1.

Table – 1: Resources of Zircon

(In million tonnes)

State	Resources#
Total	**33.71**
Andhra Pradesh	11.94
Bihar/Jharkhand	0.08
Gujarat	0.01
Kerala	7.83
Maharashtra	0.01
Odisha	3.25
Tamil Nadu	10.2
West Bengal	0.39

Source:Department of Atomic Energy, Mumbai

 # :Inclusive of indicated, inferred and speculative categories.

As per letter received from Department of Atomic Energy dated 26.07.2018.

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on Exploration & Development under "General Reviews".

PRODUCTION AND PRICES

Production of zircon increased to 15,600 tonnes in 2019-20 from 11,906 tonnes in the preceding year. The production of zircon is provided in Table-2. Prices of zircon as furnished by IREL and KMML are detailed in Table- 3.

Table – 2: Production of Zircon 2017-18 to 2019-20

(In tonnes)

Year	Production of Zircon*
2017-18	9107
2018-19	11906
2019-20	15600

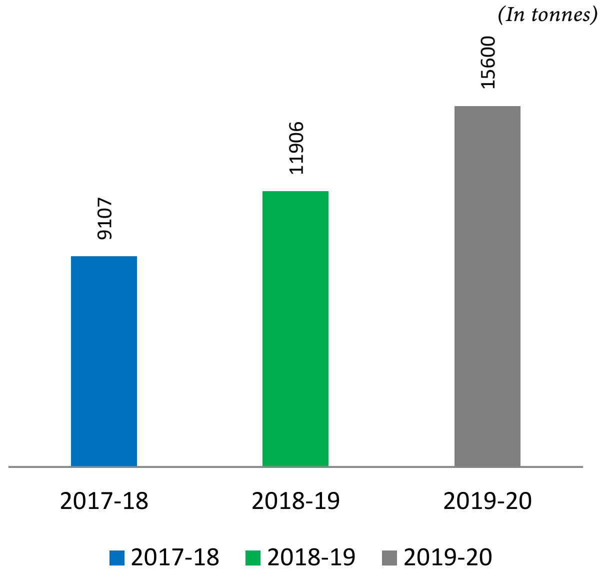


Fig 1: Production of Zircon in India

Table –3: Prices of Zircon, 2017-18 to 2019-20

(₹ per tonne)

Period	Grade	Price	Remarks
IREL			
2017-18	Q	70215	-
	MK	-	-
	OR	61638	-
2018-19	Q	105245	-
	MK	103099	-
	OR	90149	-
2019-20	Q	106790	-
	MK	107032	-
	OR	95297	-
KMML			
2017-18	Zircon Gr.I	85167	Average
	Zircon Gr.II	80167	Average
	Zircon Gr.III	76167	Average
	Zircon Gr.IV	Nil	
2018-19	Zircon Gr.I	109750	Average
	Zircon Gr.II	104750	Average
	Zircon Gr.III	100750	Average
	Zircon Gr.IV	98500	Average
2019-20	Zircon Gr.I	115000	Average
	Zircon Gr.II	110000	Average
	Zircon Gr.III	106000	Average
	Zircon Gr.1V	102000	Average

Source: Department of Atomic Energy, Mumbai.

MINING AND PROCESSING

As per Gazette Notification No. S.O. 2685 dated 27.07.2019, grant of operating rights in any offshore in terms of any reconnaissance permit, exploration licence or production lease of atomic minerals as defined in Part B of the First Schedule of the Mines and Mineral (Development and Regulation) Act, 1957 is prohibited to any person, except the Government or Government Company or a Corporation owned or controlled by the Government. The Indian Rare Earths Ltd (IREL), a Government of India Undertaking and Kerala Minerals and Metals Limited (KMML), a Kerala State Government Undertaking, are engaged actively in mining and processing of beach sands in India. Zircon is recovered by these companies as a co-product of mining/ dredging of heavy mineral sands which include ilmenite, rutile, leucoxene, monazite, sillimanite and garnet. Beach sand deposits containing these minerals are obtained from coastal tracts of Manavalakurichi in Tamil Nadu, Chavara in Kerala and Gopalpur in Odisha. As such, no deposit is being worked exclusively for zircon alone. For details regarding mining and processing, etc., Review on 'Ilmenite and Rutile' may be referred. Plantwise capacity and production of zircon during 2017-18 to 2019-20 are given in Table -4.

Table –4 : Plantwise Capacity and Pewdvction of Zircon Ore, 2017-18 to 2019-20

(By States)

(In tonnes)

Company	Location	Specification	Installed capacity** (tpy)	Production		
				2017-18	2018-19	2019-20
Total			**39000**	**13951**	**-**	
Indian Rare Earths Ltd	Manavalakurichi, Kanniyakumari distt., Tamil Nadu	65% ZrO_2+HfO_2 (min)	10000	*	2190	
	Chavara, Kollam distt., Kerala	65% ZrO_2+HfO_2 (min.)	17500	2649	3072	11490
	Orissa Sand Complex, Ganjam distt., Odisha	64.25% ZrO_2 (min)	5000	6458	6694	
Kerala Minerals & Metals Ltd	Chavara, Kollam distt., Kerala	Zircon Gr.I 64.0% (min.) Zircon Gr.II 62% (min.)	6500	4844	4762	4110

Source: Respective Producers and Department of Atomic Energy, Mumbai.

** During 2017-18 plant was not operating from Jan. 17 because of non-availablity of environment clearance.*

*** Excluding the V.V.Mineral's installed capacity of 18,000 tpy vide their letter and e-mail dated 09.09.2019 regarding non-operation of mining.*

INDUSTRY

IREL has set up a dry grinding mill at Chavara, Kerala to produce Zirflour for its application in the Ceramic Industry. A wet grinding mill was also set up at Chavara to produce micro-zir for its specialised application as opacifier. Besides, IREL established a small chemical plant at Manavalakurichi, Tamil Nadu to produce zircon frit, zirconium chloride, etc., primarily for supply of zircon frit to Department of Atomic Energy's Nuclear Fuel Complex (NFC), Hyderabad. A pilot plant (3.5 tpy capacity) was set up at Orissa Sand Complex (OSCOM) to produce a whole range of zirconia stabilised with CaO, MgO and rare earths.

The NFC manufactures and supplies fuel bundles for Pressurised Heavy Water Reactors (PHWRs) and Boiling Water Reactors (BWRs) of NPCIL. Highest ever production of PHWR fuel bundles, Zirconium Oxide, Zirconium sponge and Niobium metal was achieved during the period. The NFC, Hyderabad, has different types of production facilities which include the zirconium oxide plant for processing of zircon to pure zirconium oxide and zirconium sponge plant for conversion of zirconium oxide to pure sponge metal and Zirconium Complex (ZC) at Pazhayakayal, near Thoothukudi, Tamil Nadu. NFC Hyderabad produced 424 tonnes, 585 tonnes and 470 tonnes of zirconium oxide during 2018-19, 2019-20 and 2020-21, respectively. ZC, Pazhayakayal, produced 573 tonnes, 454 tonnes and 408 tonnes of ZrO_2 in 2018-19, 2019-20 and 2020-21, respectively. Besides, the Zircaloy Fabrication Plant produces various zirconium alloy tubings and sheet, rod and wire products. The plant also has facilities for reclamation of zircaloy mill-scrap. Zircon sand is processed through caustic fusion, dissolution, solvent extraction (to remove hafnium), precipitation and calcination to obtain zirconium oxide. The pure oxide is then subjected to high temperature chlorination, reactive metal reduction and vacuum distillation to obtain homogeneous zirconium sponge. The sponge is briquetted with alloying ingredients and melted in vacuum to produce zircaloy ingots. The alloy ingots are extruded to convert into seamless tubes, sheets and bars. The total installed capacity and production of zirconium oxide and zirconium sponge plants at NFC and ZC are furnished in Table-5.

Besides, Bhalla Chemical Works Pvt. Ltd operates three plants—two of which are located in Gurgaon, Haryana to manufacture zirconium derivatives (ZrO_2), based on imported zircon ore (capacity 10,000 tpy) and zirconium silicate opacifiers (capacity 5,000 tpy). The third plant of the Company in Rajasthan manufactures zirconium oxychloride crystals and special zirconias (capacity 10,000 tpy).

Table –5 : Production of Zirconium Oxide and Sponge Plants of DAE at NFC and ZC, 2018-19 to 2020-21

(In tonnes)

Company	Installed capacity** (tpy)	Production		
		2018-19	2019-20	2020-21
Zirconium Oxide Plant, NFC, Hyderabad	600	424	585	470
Zirconium Sponge Plant, NFC, Hyderabad	400	-	-	-
Zirconium Oxide Plant, ZC, Pazhayakayal	500	573	454	408
Zirconium Sponge Plant, ZC, Pazhayakayal	250	-	-	-

Source: Department of Atomic Energy, Mumbai.

USES & CONSUMPTION

Zircon's exceptional qualities of hardness and durability make it a must-use for the manufacture of ceramics and refractory tiles and also for a range of other high-tech applications, such as, armour plating on military aircraft, heat shield in space shuttles, potentially as solid oxide fuel cells in hydrogen- powered vehicles and in many industrial & chemical applications. Owing to its chemical inertness, very low heat conductivity, high specific gravity, low expansion, good resistance to abrasion, high melting point and no shrinkage on being heated up to 1,750^0 C, zircon is found to be an outstanding refractory material. Zircon finds its application in ceramics, zirconia, chemicals, refractory and foundry & castings which accounts for zircon's total world estimated consumption. Zirconia and Zirconium chemicals can be used for a variety of uses. Yttria-stablised zirconia (YSZ) is used in the manufacture of oxygen sensors that control combustion in automobile engines and furnaces. In Foundry Industry, zircon is used as facing for foundry moulds as it increases the resistance to metal penetration and accords a uniform finish to castings. Zircon sand is preferred to silica sand because of its uniform size, higher melting point, low thermal expansion and resistance to molten metal , acidic chemicals , slag, etc. Zircon containing 64% ZrO_2 is used generally for foundry applications. In Ceramic Industry, finely ground high-grade zircon and zirconium dioxide are used as opacifier in melts for vitreous enamelling and as pigment in ceramic glazes. Zirconium oxide is considered as a potential ceramic material for high temperature applications like engine components. Usually, zircon containing 65% ZrO_2 is preferred in ceramics. The toughened zirconia finds its use in ceramic coatings in jet aircraft engines and in other applications where strength and high temperature oxidation resistance are important. Zirconia ceramics are also used in automobile sensors for the microprocessor control of engines. In Chemical Industry, its property of high resistance to corrosion is used where dry chlorine, hydrochloric acid and caustic alkalies are involved. Abrasive and grinding wheels made from zircon sands are used for polishing optical glasses. Zircon powder is used as a medium in waterjet cutting machines.

Zirconium and zirconium powders are used in ammunition, primers, detonation caps, flashlight mixtures, radio tubes and in various heating elements. Hafnium-free zirconium metal is used as cladding material in atomic reactors due to its low absorbing cross section for thermal neutron. Green, blue, indigo, red, orange coloured zircon is used as a natural gemstone and also processed to produce cubic zirconia—a synthetic gemstone resembling diamond. Zircon compounds have a very low toxicity and are not perceived as a potential environmental hazard. They are even said to have some medicinal properties and are now increasingly preferred in the manufacture of food products and pharmaceuticals too. It is also widely used in television and computer screens, resistance to corrosion and erosion makes zircon products ideal for use in the Chemical Industry and in desalination plants. Zircon flour is manufactured by milling zircon sand. It is used in ceramic frits, foundry mould coatings, ceramic shells for investment casting, refractories, friction products, insulating fibres and glass. Zircon opacifier are used in refractories and friction products. Zirconium metal or sponge is used mainly in the Nuclear Industry with a requirement for minimum content of hafnium.

Consumption of zircon/zirflour decreased considerably by 17% to 13,829 tonnes in 2019-20 from 16,600 tonnes in 2018-19. The consumption of zircon during the year 2019-20 was reported only by IREL. Consumption of zircon/zirflour during the year 2017-18 to 2019-20 is furnished in Table- 6.

Table –6: Estimated Consumption * of Zircon 2017-18 to 2019-20

(By Industries)

(In tonnes)

Industry	2017-18	2018-19 (R)	2019-20 (P)
All Industries	**17500**	**16600**	**13829#**
Ceramic	7200	6300	3963
Refractory	9700	9400	1153
Others (Alloy steel, iron& steel, Chemical, foundry, paint and cement)	600	900	8751

Figures rounded off.
** Includes actual reported consumption and/or estimates made wherever required. Due to paucity of data, coverage may not be complete.*
 # Only reported by IREL.
#

RESEARCH & DEVELOPMENT

Various R&D studies have been conducted by R&D Laboratory, OSCOM, Department of Atomic Energy, to improve the metallurgical performance of mining and mineral separation plants. As a result throughput of the plants has increased and the grade and recovery of heavy minerals in concentrate has been enhanced. The two most outstanding contributions of this laboratory in the areas of value addition are development of new process flow sheets for the preparation of synthetic rutile from OSCOM ilmenite and zirconia from zircon.

IREL Technology Development Council (IRELTDC) has been formed with an objective of promoting industrial scale R&D that would be beneficial to the overall programme of DAE in both strategic and non-strategic fields utilizing mineral & value added products of IREL.

POLICY

Zircon was earlier classified as a 'prescribed substance', as per notifications issued under Atomic Energy Act, 1962. From the revised list notified vide S.O. No. 61(E), dated 20.1.2006, zircon has been deleted, subject to the condition that the mineral shall remain a prescribed substance till the policy on exploration of beach sand minerals notified on 6.10.1998, is adopted/revised/modified by Ministry of Mines or till 1.1.2007, whichever occurs earlier and shall cease to be so thereafter. Ministry of Mines, vide Notification No.S.O.2356(E) dated 11.07.2016, zircon covered under beach sand minerals was inserted as entry 12 after entry 11 of Part B of the First Schedule to the MMDR Act, 1957. As per the Foreign Trade Policy, 2015-20, the export and import of zirconium ores and concentrates under ITC (HS) Code 26151000 are freely allowed. The notification reads:

S.O. 1592(E)—In pursuance of Clauses (f) and (g) of Sub-section (1) of Section 2 and Section 3 of the Atomic Energy Act,1962 (No. 33 of 1962) and in supersession of the notifications of the Government of India in the Department of Atomic Energy vide Number S.O. 61(E) dated 20th January 2006, the Central Government hereby notifies the substances, equipment and technology specified in the Schedule appended hereto as 'Prescribed Substances, Prescribed Equipment and Technology'.

Under Category 0A303 and under Heading Nuclear materials, nuclear-related other materials, equipment and technology—" Zirconium with hafnium content of less than 1 part to 500 parts of zirconium by weight (i.e. less than 2,000 ppm) in the form of metal, alloys containing more than 50% zirconium by weight, compounds, manufactures thereof, waste or scrap of any of the foregoing".

G.S.R. 134(E) dated 20.02.2019 — In exercise of the powers conferred under Section 11B of the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957) and Rule 36 of the Atomic Minerals Concession Rules, 2016, the Central Government hereby makes the following amendments further to amend the Atomic Minerals Concession Rules, 2016, namely—

2. (1) These rules may be called the Atomic Minerals Concession (Second Amendment) Rules, 2019.

   (2) They shall come into force on the date of their publication in the Official Gazette.

3. In the Atomic Minerals Concession Rules, 2016, for Schedule A, the following Schedule shall be substituted, namely—

PARTICULARS OF THRESHOLD VALUE FOR ATOMIC MINERALS

[See Rule 2 (1) (m) and Rule 36]

10.	Uranium bearing tailings left over from ores after extraction of copper and gold, ilmenite and other titanium ores.	60 ppm U_3O_8 and/or 250 ppm ThO_2.
11.	Zirconium bearing minerals and ores including zircon.	All cases of zircon-bearing minerals occurring in Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e. the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade. In other cases, zircon containing less than 2,000 ppm of Hafnium.
12.	Beach Sand Minerals, i.e., economic heavy minerals found in the teri or beach sand, which include ilmenite, rutile, leucoxene, garnet, monazite, zircon and sillimanite	All cases of Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e., the threshold is 0.00% monazite inTotal Heavy Minerals), irrespective of monazite grade.

WORLD REVIEW

World reserves of zirconium are placed at 68 million tonnes in terms of ZrO_2. The world's largest reserves are with Australia (71%), South Africa (9%) and Senegal (4%). The world production of zirconium minerals was estimated at 1.12 million tonnes in 2021 which decreased by 7% as against 1.20 million tonnes in the previous year . Australia (40%), South Africa (24%), Mozambique (9%) are the principal producers of zirconium minerals (Tables-7 & 8).

Table – 7: World Reserves of Zirconium

(By Principal Countries)

(In '000 tonnes)

Country	Reserves
Australia	68000
China	500
Indonesia	NA
Mozambique	1800
Senegal	2600
South Africa	5900
USA	500
Other countries	11000

Source: USGS, Mineral Commodity Summaries, 2023

[a]*For Australia, Joint Ore Reserves Committee-compliant reserves were 22.1 million tonnes.*

Table – 8 : World Production of Zirconium Minerals

(By Principal Countries)

(In tonnes)

Country	2019	2020	2021
World: Total (rounded off)	**1372000**	**1205000**	**1125000**
Australia	499335	434339	448022
South Africa*	370000	320000	270000
Mozambique	87181	78138	100158
Senegal	58432	59000	64000
Indonesia (d)*	73000	64000	58000
China*	33500	33500	50000
Kenya	48356	32224	25928
Ukraine	22000	22000	22000
Madagascar	28500	25300	22000
USA	100000	90000	20000
Other countries	73666	68676	45018

Source: BGS, World Mineral Production, 2017-21.

*Note: *) Estimate*

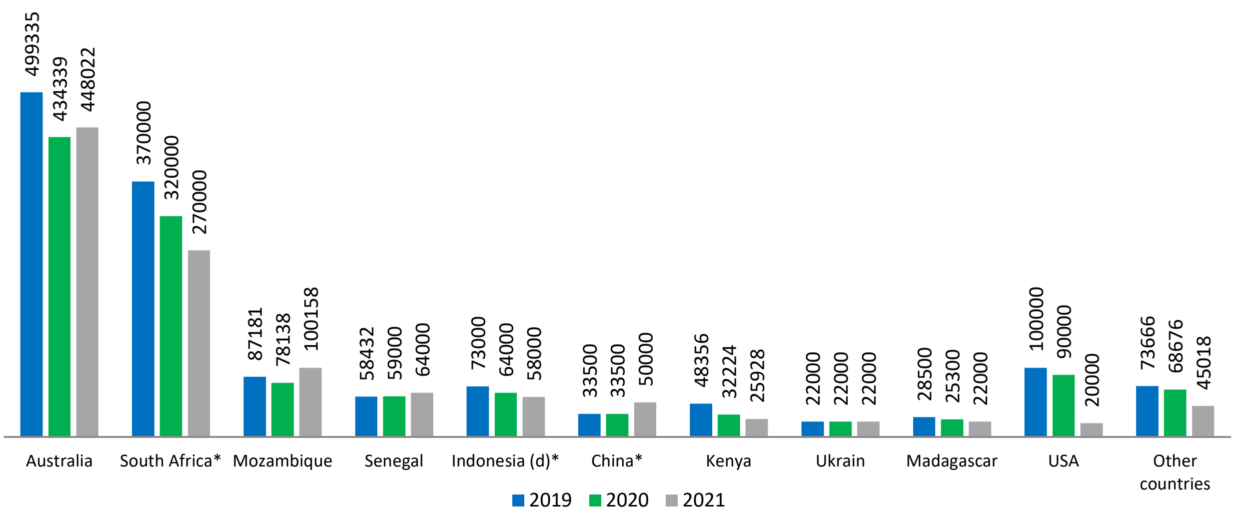


Fig 2: Production of Zircon ore

To provide a generalised view of the development in various countries, country-wise description as sourced from latest available publication of Minerals Yearbook 'USGS' -2018 is furnished below :

Australia

Iluka produced 328,000 tonnes of zircon from its operations in Australia, an increase of 12% from that in 2017. The majority of the Cataby project in Western Australia was constructed in 2018 and was expected to begin production in the first half of 2019. With a projected mine life of 8.5 years, zircon production was anticipated to average about 50,000 metric tonnes per year. Iluka completed the feasibility study for moving mining from the Jacinth deposit to the adjacent Ambrosia deposit and the decision was made to proceed with the move sooner than originally planned. By the end of 2018, work was initiated on the Ambrosia deposit.

Tronox Holdings plc produced 34,000 tonnes of zircon from its Cooljarloo Mine in Western Australia, unchanged from that in 2017.

Sheffield Resources Ltd. obtained offtake agreements to account for almost all zircon and zircon concentrate production during the first 4- year phase of its Thunderbird project. Production of zircon in the first year of production was expected to be about 80,000 tonnes, increasing to 110,000 tonnes in the fourth year of production. Contingent on financing, Sheffield was expecting to commence production at Thunderbird in 2020.

China

As the leading consumer of zirconium mineral concentrates, China imported 1.05 million tonnes in 2018, an increase of 3% from 1.02 million tonnes imported in the previous year.

Kenya

Base Resources Ltd. produced 38,600 tonnes of zircon from its Kwale operation in the reporting year ending June 30, 2018, a decrease of 13% from that in the previous year. During the year, the Kwale Phase 2 mine project was ongoing. This work involved shutting down the mine and wet concentrator plant for the month of March to complete equipment installation and start a second hydraulic unit.

Madagascar

Base Resources acquired an 85% interest in the Toliara project in January and worked throughout the year to develop a labour plan and training programs in consultation with the Government and local communities. A prefeasibility study was expected to be completed in the first quarter of 2019, and the company projected production would begin in late 2021.

Mozambique

Kenmare Resources plc produced 74,700 tonnes of primary and secondary zircon at the Moma Mine in 2018 . Increased production resulted from projects to increase recovery rates and capacity enhancement of the zircon recovery circuits. The company announced plans to expand capacity to increase ilmenite coproduct production by 20% by 2021.

Senegal

In July, Eramet Group acquired full ownership of the Grande Côte mineral sands operation operated by TiZir Ltd. Eramet reported zircon sales of 65,000 tonnes.

South Africa

Tronox produced 119,000 tonnes of zircon from its Namakwa Sands operation and 53,000 tonnes of zircon from its KZNSands operation in South Africa, for a total of 172,000 tonnes, an increase of 3% from that in 2017.

In 2018, Mineral Commodities Ltd. produced 17,000 tonnes of zircon-rutile concentrate, containing 68% zircon and 17% rutile, at its Tormin Mine in Western Cape Province. Although the amount of ore processed was greater than that in 2017, the zircon and rutile ore grades decreased from those in 2017.

Tanzania

Strandline Resources Ltd. continued to wait for mining licenses and seek funding for its Fungoni heavy-mineral-sands project. According to a definitive feasibility study completed in 2017, ore reserves were 12.3 million tonnes containing 3.9% heavy minerals.

FOREIGN TRADE

Exports

Exports of zirconium ores and concentrates were negligible in 2021-22 similar to that of the previous year. Exports were mostly to Austria and meagre quantity to China. Exports of zirconium and scrap increased to 3 tonnes in 2020-21 as compared to negligible quantity recorded in the previous year. Exports of zirconium waste & scraps was also increased to 2 tonnes in the year 2021-22 as compared to that of the year 2020-21 (Tables-9 to 12).

Table –9: Exports of Zirconium Ores & Conc.

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**21**	**++**	**180**
Austria	++	16	-	-
Tanzania Rep	-	-	++	180
Venezuela	++	1	-	-
Latvia	++	++	-	-
China P Rp	++	4	-	-

Figures rounded off

Table – 10: Exports of Zirconium & Scrap

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**24791**	**3**	**25189**
USA	++	13170	++	3434
Iraq	++	3963	1	5424
Nigeria	-	-	++	2972
Australia	++	1994	++	2626
USE	++	984	++	777
Peru	++	45	++	2384
Taiwan	++	707	++	2134
Vietnam	-	-	++	1823
Japan	-	-	++	1622
Canada	++	78	++	674
Other countries	++	3852	2	1319

Figures rounded off

Table – 11: Exports of Zirconium Waste & Scrap

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**14644**	**2**	**13258**
USA	++	9601	++	1031
Sweden	++	2330	++	47
Australia	++	1994	++	2626
Nigeria	-	-	++	2972
Taiwan	-	-	++	2020
Japan	-	-	++	1622
Ghana	-	-	++	300
UK	-	-	++	134
Peru	++	45	++	2384
Bangladesh Pr	-	-	2	93
Other countries	++	674	++	29

Figures rounded off

Table – 12: Exports of Zirconium Unwrought Powder

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**10147**	**1**	**11931**
Iraq	++	3963	1	5424
USA	++	3569	++	2403
Vietnam Soc Rep	-	-	++	1823
UAE	++	757	++	770
Taiwan	++	707	++	114
France	-	-	++	420
Canada	++	78	++	674
Denmark	-	-	++	114
Greece	-	-	++	63
Singapore	-	-	++	53
Other countries	++	1073	++	44

Figures rounded off

Imports

Imports of zirconium ores and concentrates increased by 38% to 94,839 tonnes in 2021-22 from 68,675 tonnes in the previous year. Main suppliers were Australia (51%), South Africa (18%), Malaysia (17%) and Thailand (4%). Imports of zirconium and scrap drastically increased to 45 tonnes in 2021-22 from 3 tonnes in 2020-21. Imports were mainly from China (71%),France (13%) and Malaysia (4%) Similarly imports of zirconium waste & scrap also increased substantially to 42 tonnes in 2021-22 as compared to 3 tonnes in the preceding year. Imports were only from China (76%), France (7%) and Malaysia (5%) (Tables-13 to 17).

Table– 13: Imports of Zirconium Ores & Conc.

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**68675**	**6993378**	**94839**	**11260337**
Australia	24963	2547148	48157	5605301
Indonesia	13076	1351599	3293	544617
South Africa	10530	1035297	16885	1797571
Malaysia	7253	757539	16177	2029298
USA	6179	632461	2853	331378
Senegal	2235	226470	979	132217
Vietnam	1338	132319	1172	174328
Sri Lanka	1282	124796	1130	136381
Ukraine	830	87831	364	38347
Thailand	234	20691	3477	424799
Other countries	755	77227	352	46100

Figures rounded off

(In tonnes)

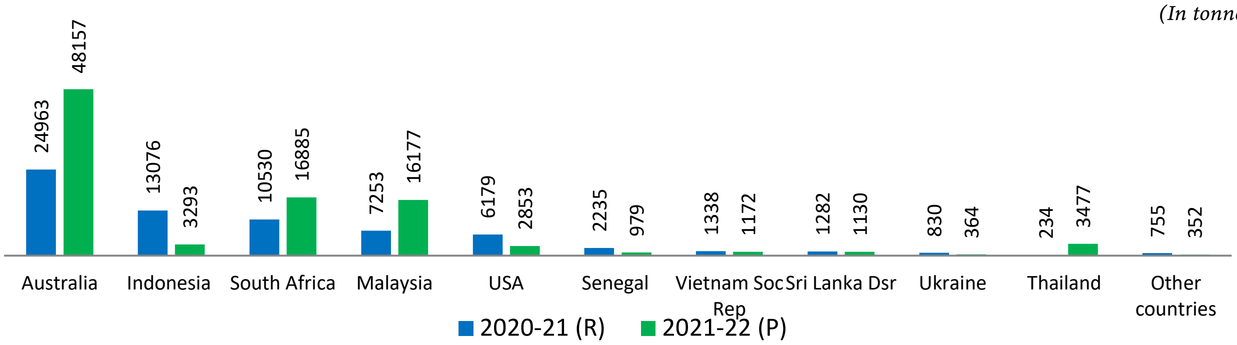


Fig 3: Countrywise Imports of Zircon Ores & Conc.

Table – 14: Imports of Zirconium & Scrap

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**3**	**23298**	**45**	**170561**
China P Rp	1	8723	32	21363
USA	1	5964	1	7780
Italy	++	3914	++	6054
Germany	1	1978	1	16898
Malaysia	++	1439	2	5836
Japan	++	710	1	4177
UK	-	-	1	6600
Hong Kong	++	67	++	883
France	++	24	6	31782
Canada	-	-	1	68030
Other countries	++	479	++	1158

Figures rounded off

Table – 15: Imports of Zirconium Unwrought Powders

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**++**	**115**	**3**	**28924**
USA	++	100	-	-
Ukraine	++	15	-	-
France	-	-	3	26306
Germany	-	-	++	1957
UK	-	-	++	15
Korea, Rp of	-	-	++	563
Hong Kong	-	-	++	83

Figures rounded off

Table – 16: Imports of Zirconium Waste & Scrap

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**3**	**23183**	**42**	**141637**
China	1	8723	32	21363
USA	1	5864	1	7780
Italy	++	3914	++	6054
Germany	1	1978	1	14941
Malaysia	++	1439	2	5836
Japan	++	710	1	4177
UK	-	-	1	6585
Hong Kon	++	67	++	800
France	++	24	3	5476
Canada	-	-	1	68030
Other countries	++	464	++	595

Figures rounded off

Table – 17: Imports of Ferro- Zirconium

(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	**374**	**51237**	**522**	**96181**
China	346	46248	512	92825
Hong Kong	15	3395	-	-
UAE	8	1371	2	334
UK	5	223	-	-
Netherlands	-	-	8	3022

Figures rounded off

FUTURE OUTLOOK

The development of digital printing of ceramic tile pattern has the potential to increase demand since higher zircon content of the base tile is required to impart aesthitically appealing product and to optimise the cost of the digital printing process.

As per the Zircon Market updates of 2023 by Zircomet Limited, the global demand for zircon sand was estimated at 1.2 million tonnes for both 2021 and 2022. This is a 20% increase over that of 2019 and 2020. The demand has been driven by India, China and Europe.

Current demand remains firm in China, particularly in the Ceramics Industry which is attribudable the diphing of covid restrictions and reviving of Construction Industry. It is expected that tae supply will remain quite tight during 2023 and further mine development is needed to meet future demand. As zircon sand is the starting raw material for the majority of zirconium chemicals and zirconium oxides, prices of these materials are expected to remain firm with upward pressure during 2023.

Zircon and Zirflor are the key ingredients in ceramics, foundry and refraction and are likely to see growth path on account of Government of India's thrust for 'Housing for all'.

30. Minor Minerals

INTRODUCTION

The Government of India, in exercise of the powers conferred by Clause (e) of Section 3 of Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957), and by issue of Notification, vide Notification S.O.No. 423(E) dated 10th February, 2015; declared the below listed minerals to be Minor Minerals in addition to the earlier declared Minor Minerals, i.e., marble, granite, fuller's earth and bentonite. Most of these minerals were hitherto covered in Indian Minerals Yearbook as individual Reviews:

1. Agate
2. Ball clay
3. Barytes
4. Calcareous sand
5. Calcite
6. Chalk
7. China Clay
8. Clay (others)
9. Corundum
10. Diaspore
11. Dolomite
12. Dunite or pyroxenite
13. Felsite
14. Felspar
15. Fire clay
16. Fuschite Quartzite
17. Gypsum
18. Jasper
19. Kaolin
20. Laterite
21. Limekankar
22. Mica
23. Ochre
24. Pyrophyllite
25. Quartz
26. Quartzite
27. Sand (others)
28. Shale
29. Silica sand
30. Slate
31. Steatite or talc or soapstone

Since minor minerals come under the purview of respective State Governments, certain inadequation in the flow of details with regard to their exploration and development, production, consumption, export/ import details etc. have been experienced at IBM. Lack of promptness in receipt of information from various States has impeded the pace of updating of data regarding these minerals and this has caused limitations in the coverage of these minerals.

Efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual states or by visiting their websites. All possible information/data that could be gathered has been presented in the Review.

In the compilation of IMYB under the Review entitled 'Minor Minerals', the following sub-chapters on minor minerals have been alphabetically sequenced starting from Barytes to the final chapter on Steatite or Talc or Soapstone. Thus this compilation covers almost all Minor Minerals covered in the MM(DR) Act, 1957 as amended up to 2nd September, 2019.

1. Barytes
2. Bentonite
3. Calcite
4. Corundum (Minor) and Sapphire (Major)
5. Diaspore
6. Dolomite
7. Dunite and Pyroxenite
8. Felspar
9. Fireclay
10. Fuller's Earth
11. Granite
12. Gypsum (Minor) and Selenite (Major)
13. Kaolin, Ball Clay, Clay (Others) and Shale
14. Laterite
15. Marble
16. Mica
17. Ochre
18. Other Calcareous Materials
19. Pyrophyllite
20. Quartz and other silica minerals [Moulding sand and Flint stone (Major)]
21. Slate, Sandstone and Other Dimension Stones
22. Talc, Soapstone and Steatite

30-1. Barytes

The Mangampet deposit in Kadapa district of Andhra Pradesh is the single largest barytes deposit in the world.

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'barytes' has been declared as 'Minor Mineral',

The properties like non-corrosive, non-abrasive, insolubility in water, inertness and high specific gravity enable barytes application as a weighting agent in drilling operations

Baryte or barite is a moderately soft crystalline mineral form of barium sulphate ($BaSO_4$). Approximately, 80% barytes produced worldwide is used for oil and gas drilling as a weighting agent in the drill mud, primarily to prevent the explosive release of gas and oil during drilling. Its unique physical and chemical properties are heaviness, high specific gravity, chemical & physical inertness, very low solubility and magnetic neutrality. Barium compounds are utilised as filler, extender and aggregate. Baryte after converting to barium carbonate, is used in the manufacture of ceramic and glass. The Mangampet deposit in Kadapa district of Andhra Pradesh is the single largest barytes deposit in the world.

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'barytes' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or by visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of barytes during 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Barytes

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	2735439	1212038	-
Rajasthan	3000	3287	6800
Telangana	150	-	-
Karnataka	345	1596	-

Source: As received from State DGMs and their websites.

USES AND SPECIFICATIONS

Oil and Gas Drilling

The properties like non-corrosive, non-abrasive, insolubility in water, inertness and high specific gravity enable barytes application as a weighting agent in drilling operations to remove the cutting from the bits, transport cutting to the surface to reduce the friction in the drilling string, control pressure, prevent blow-out and at the same time to provide lubrication. The most desirable characteristic of barytes is its high specific gravity which makes it the only mineral used in substantial tonnages to increase the density of water-based drilling. Barytes powder containing minimum 90% barium sulphate with 4.15 specific gravity is recommended for drilling. For offshore drilling, the specific gravity should be 4.2. At least 97% ground barytes should pass through 75-micron IS sieve and 95% through 53-micron IS sieve. BIS has prescribed IS:2881:1984 (Second Revision, Reaffirmed 2020) as specification of barytes for use in Chemical Industry and Oil-well Drilling Industry.

Chemical

Major barium chemicals obtained from barytes are carbonate, chloride, oxide, hydroxide, nitrate, peroxide and sulphate. Barium carbonate is used in Glass Industry as a flux to add brilliance & clarity in electro-ceramics and for removing inconvenient impurities in phosphoric acid. Barium hydroxide is used in the preparation of barium salts of organic acids which are utilised as additives for lubricating oils and as stabilisers for PVC. Barium sulphate is used as pigment, extender and filler in Rubber and Paper Industries.

Lithopone, a mixture of $BaSO_4$ and ZnS, is used in Paint and Lacquer Industries as white pigment, extenders and fillers. Barium nitrate is used in green signal flares, tracer bullets, primers and detonators. Barium oxide is known for its use in electric furnace. Barium titanate finds its use in miniature electronic and communication equipment. Barytes is also used in explosive manufacture.

For Chemical Industry, purity is the prime criterion, with ferric oxide and strontium sulphate limited to a maximum 1% and fluorine to traces. The mesh size is also important in manufacturing chemicals. Barytes used in explosive manufacture may be bleached or unbleached. It should be in dry powder form free from extraneous matter.

Paint

Barytes is used as filler and extender in Paint Industry. White pigment is manufactured from barytes. Barytes should be free from mud, clay or siliceous minerals. Presence of iron oxide is undesirable. The material should be in the form of dry powder.

Glass

In glass manufacturing, barytes is added to the glass melt for making the glass more workable and enhancing its brilliance. Iron is the most undesirable impurity in barytes.

Rubber

Barytes is used as a filler and extender in rubber products. It is added to rubber compounds to impart resiliency and durability. Barytes containing minimum 99.5% $BaSO_4$ is usually preferred. Since such pure form of barytes is not found in nature, barytes is normally bleached before use. The form of barytes called 'blanc fixe' is known best for its acid resistance properties. The sieve residue through 75-micron and 150-micron should be 4% and 0.01% max., respectively. BIS has prescribed IS:1683-1994 (Second Revision, Reaffirmed 2018) as specification of barytes for use in Rubber Industry.

Other Uses

Barytes is used in the manufacture of asbestos products required for autobrake lining and other frictional materials. It is used as a filler in Paper Industry, oil cloth, X-Ray proof plaster and rope finishes. Finely ground barytes and clay are used as suspension in Barvois system of coal washing. Barytes is also used in concrete aggregate as an absorber of gamma and X-Ray radiation required for reactor shielding. In medicine, it is used in radio diagnosis to highlight the abnormalities in internal body parts. Barytes also finds its use in explosives and pyrotechnics composition for which BIS has laid down specifications vide IS 7588-1992 (First Revision, Reaffirmed 2021).

SUBSTITUTES AND TECHNICAL POSSIBILITIES

Drilling mud substitutes include celestite, witherite calcium carbonate, synthetic haematite and ilmenite but the low cost and technical advantages of barytes deter substitution. Iron ore fines and ilmenite are substitutes used for deep drilling. Apart from calcium carbonate, none of the mineral substitutes has had a major impact on the Barytes Drilling Mud Industry. Reclamation and recycling of drilling muds have been increasingly hampering the requirement for new supplies. Further, new oil exploration techniques and drilling methods have reduced the need for new boreholes and wells, which have led to curtailment in the requirement for drilling muds. As a filler, barytes can be substituted by diatomite, felspar, kaolin, mica, talc and silica flour.

FUTURE OUTLOOK

Maximum quantity of the world's barytes is used in the Petroleum Industry. The worldwide demand for barytes would continue till petroleum products are preferred as chief source of energy given their importance in the transportation and industrial end- use sectors. The future growth in petroleum usage suggests that petroleum exploration will continue to grow and along with it barytes consumption, especially as more drilling has to be done to establish hydrocarbon discoveries which increasingly have become marginal and would get less productive with time. on the domestic front, however, the much needed exploration to locate new deposits of barytes especially in Rajasthan, Himachal Pradesh, etc. would continue.

30-2. Bentonite

Bentonite is among the exportable mineral commodities in India. Since Indian resources of bentonite are of high grades, India has excellent opportunity to cater to diverse industries worldwide.

As defined in Clause (e) of the Section-3 of MM(DR) Act 1957, 'bentonite' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM.

Bentonite has remarkable colloidal and waterproofing properties. Bentonite gels are used as a carrier for a number of cosmetic preparations, toothpastes, creams, etc. Bentonite is also used in Chemical, Rubber, Insecticide & Pesticide Industries and in civil

Bentonite is essentially a highly plastic clay containing not less than 85% clay mineral, montmorillonite. It derives its name from the place where its presence and usages were first discovered, Fort Benton, America. Bentonite's commercial importance is due to its inherent bleaching properties similar to that of fuller's earth, hence, it is also known as bleaching clay. There are two types of bentonites, namely, swelling-type or sodium bentonite and non-swelling-type or calcium bentonite. Sodium bentonite is usually referred to as bentonite, whereas calcium bentonite is called fuller's earth. The commercial importance of bentonite depends more on its physico-chemical properties rather than its chemical composition. Excellent plasticity & lubricity, high dry-bonding strength, high shear & compressive strength, low permeability and low compressibility make bentonite commercially viable. Bentonite is valued in applications, such as, foundry sand binding, drilling mud, iron ore pelletisation and as a waterproofing & sealing agent in civil engineering works. Processing is a prerequisite for bentonite marketing. Bhavnagar and Kachchh districts of Gujarat and Barmer district of Rajasthan are the major producing areas of bentonite. The sodium bentonite mined in Rajasthan tends to be of lower quality and is used as foundry sand. Both activated and granular bentonite are produced in the country. Bentonite is exported both as unprocessed (crude) and processed (including activated) forms.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As defined in Clause (e) of the Section-3 of MM(DR) Act 1957, 'bentonite' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or by visiting their websites. All possible information/data that could be gathered has been presented in this Review.

Statewise production of bentonite during 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Bentonite

(In tonnes)

State	2019-20	2020-21	2021-22
Gujarat	-	-	-
Rajasthan	305000	446075. 2	286670

Source: As received from State DGMs and their websites.
Note : " - " NA

USES & SPECIFICATIONS

Bentonite has high swelling properties along with good viscosity and liquid limit. These properties are highly valued in most of the industrial applications. Sodium bentonite is well-suited as a binder in the preparation of pellets and in foundry and as oil-well drilling mud. Bentonite also acts as a suspending agent in oil-well drilling fluids and is abundantly used in horizontal drilling for shale production. Bentonite exhibits good green strength along with high hot and dry strength which helps in preventing moulds from breaking or cracking during the pouring or cooling process in the Foundry Industry. Owing to high green strength resulting from its property to absorb and then release moisture, bentonite is used in iron ore pelletisation. Sodium-based bentonite of 75 micron size finds suitability in iron ore pelletisation for bonding by user industries. Bentonite clay is also used in pyrotechnics to make end plugs and rocket engine nozzles. Bentonite has remarkable colloidal and waterproofing properties. Bentonite gels are used as a carrier for a number of cosmetic preparations, toothpastes, creams, etc. Bentonite is also used in Chemical, Rubber, Insecticide & Pesticide Industries and in civil construction works. Bentonite in the form of fine powder free from dirt and other foreign matter and of least swelling property is used in Ceramic Industry. Bentonite which is the active mineral in clays with medicinal properties is also prescribed as a bulk laxative and it is also used as a base for many dermatological formulations. Bentonite is also used to prepare sulphur bentonite fertilizer (90:10) which is useful to impart better productivity.

The specifications of bentonite for Chemical & Rubber and Oil-well drilling Industries have been published vide BIS Specification IS:6186-1986 (First Revision Reaffirmed 2020). The specifications for Ceramic Industry have been published vide IS:12621-1988 (Reaffirmed 2022). BIS has revised the specifications of bentonite for use in foundries, the new specifications are prescribed vide IS : 12446 - 2007 (First Revision, Reaffirmed 2022).

FUTURE OUTLOOK

The biggest market for bentonite in both North America and European countries are foundry, cat litter, iron ore pelletising and drilling. Civil engineering and environmental applications, such as, land fills require bentonite for use as a sealant and lubricant. The global market of bentonite and fuller's earth is likely to witness a healthy growth owing to strong demand expected in Foundry and Iron Ore Pelletisation Industry. This is mainly due to strong growth in the automotive production (>100 M vehicles) as well as increase in iron & steel production. Increase in civil construction activity in Asian countries and traditional edible oil refining in Asia will also boost bentonite consumption in near future.

Bentonite is among the exportable mineral commodities in India. Since Indian resources of bentonite are of high grades, India has excellent opportunity to cater to diverse industries worldwide. Bentonite is exported both in unprocessed (crude) and processed (including activated) forms. Though, export of crude bentonite accounts for a higher quantity, the exports of processed bentonite fetch higher value than the crude bentonite. There is a pressing need to develop different processing techniques that suit our available resources, in order to make our products match the international standards. There is scope to establish bentonite processing, granulation and paint grade processed bentonite units in the country to meet the indigenous demand as well as demand in the international market. More and more Indian companies are entering into joint ventures with multinationals in order to meet the challenge of the strong global competition.

30-3. Calcite

Calcite is one of the most abundanly available minerals in the world. It occurs in various shapes, colours and forms. Chemically, it is Calcium Carbonate and has varied uses in different fields.

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'calcite' has been declared as 'Minor Mineral',

Calcite is one of the important ingredients required in Glass and Ceramic Industries for imparting glaze and it is also used as a flux. In pulverised form, it is used as a filler in rubber goods, textile and as an extender in paints and as a carrier in insecticides.

Calcite is a rock forming mineral with chemical formula $CaCO_3$ that contains 56% CaO and 44% CO_2. It is extremely common and found throughout the world in igneous, sedimentary and metamorphic rocks. It is one of the important industrial minerals also known as 'Calc Spar'. Pure crystallised transparent variety of calcite known as 'Iceland Spar' is used for optical purposes.

Calcite is one of the most abundanly available minerals in the world. It occurs in various shapes, colours and forms. Chemically, it is Calcium Carbonate and has varied uses in different fields. Calcite being easily available has been in use in various aspects of importance in the human life since ancient times. Though, its demand is continously on the rise its availability world over will not affect its price.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reveiws

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'calcite' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or by visiting their websites. But data of only a few States could be collected. All possible information/ data that could be gathered has been presented in this Review.

Statewise production of calcite during 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Calcite

(In tonnes)

State	2019-20	2020-21	2021-22
Rajasthan	23000	19693	21440.8
Andhra Pradesh	6500	1003	-

Source: As received from State DGMs and their websites.

USES AND SPECIFICATIONS

The use of calcite is dictated by its level of purity. The highest purity of $CaCO_3$, which is as high as (+) 98%, has minimum inclusions and highest brightness. Its applications are in varying sizes from coarse to as fine as 10 to 2 microns. Various grades of calcite products marketed by Wolkem India Ltd contain $CaCO_3$ at 95–98.5%, MgO at 0.2–0.4%, SiO_2 0.3% and Fe_2O_3 0.03–0.15%.

Calcite is one of the important ingredients required in Glass and Ceramic Industries for imparting glaze and it is also used as a flux. In pulverised form, it is used as a filler in rubber goods, textile and as an extender in paints and as a carrier in insecticides. Other uses are in the manufacture of mortar, cement, bleaching powder, abrasive, for agricultural soiltreatment, pharmaceuticals, etc. It is also used in the preparation of fat lime, soaps, detergents, plastics, polymers, etc. The $CaCO_3$ content in calcite used in Glass Industry is 95% (min.) and in Ceramic Industry is 95%. Calcium oxide is a mild flux and makes the glass stick to the articles shaped by its hardening nature. Generally, 54% (min.) CaO is used. In Ceramic Industry, generally, super-white calcite of 30 mesh is used while in Glass Industry, powder size ranging from 20 to 80 mesh is used.

Calcite as GCC finds extensive use as a filler in Plastics, Paper, Rubber and Paint industry. According to Global Industry Analysis, strong consumption in paper and plastic production may drive the calcite market upwards. In Paper Industry, calcite is used as filler to produce high quality, water proof anti-smudge papers and in plastics it is used as an additive to improve surface opacity, gloss and impact strength.

The transparent crystal of calcite (Iceland Spar) free from flaw is most valued in the Optical Industry for the manufacture of Nicol prism.

BIS has prescribed IS:15751-2007 (reaffirmed in March-2017) as specification for use of calcite in Ceramic Industry.

30-4 Corundum and Sapphire

Corundum is a natural oxide of alumina with 52.9% alumina and 47.1% oxygen. It is very hard (9 on Mohs scale) next only to diamond.	As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'Corundum' has been declared as 'Minor Mineral',	Corundum's bright and glassy lustre, splintery property as it is devoid of cleavage plane and inclusions makes it preferred substance by industry for the manufacture of superior grade abrasives.

Corundum is a natural oxide of alumina with 52.9% alumina and 47.1% oxygen. It is very hard (9 on Mohs scale) next only to diamond. Corundum is found in rocks containing a high percentage of alkalies, deficient in silica and excess of alumina. It is generally found in association with rocks like syenite, nepheline syenite and anorthosite. Described to be formed as a result of metamorphism of high aluminous clay, corundum is often found associated with andalusite, kyanite and sillimanite. Corundum also occurs as masses adjacent to ultramafic intrusives, associated with lamprophyre dykes and as large crystals in pegmatites. The most common occurrence of corundum is as a detrital mineral in streams and beach sands because of its hardness and resistance to weathering. Pure corundum is colourless and clear if transparent, or pale white if opaque. The vivid colours of corundum gem varieties, such as, ruby and sapphire arise primarily from elemental substitution in the Al site by transition metal elements. The most common cations found as substitute are Fe^{+2}, Fe^{+3}, Ti^{+4}, Cr^{+3} and V^{+3}. Pink and red colour corundum are called ruby while blue coloured corundum is called sapphire and all other colours are called fancy sapphires. Usually rubies will have more or less 1 wt% of Cr_2O_3 while blue sapphires primarily have Fe^{+2} and Ti^{+4} substituting into the crystal structure of Al. Some corundum gemstones show "asterism" or a star effect due to inclusion of rutile needles within the crystal of corundum.

RESERVES/RESOURCES

The reserves/resources of corundum in India are found in association with kyanite and sillimanite in Assam, Meghalaya and Maharashtra. It occurs in syenites and ultrabasic rocks in Telangana. A few outcrops of pegmatites containing corundum occur in Bastar district, Chhattisgarh and Morena district, Madhya Pradesh. Translucent to opaque ruby, sometimes with asterism is known to be abundant in Mysuru district in Karnataka.

Precious and semi-precious varieties of corundum have been reported from Tamil Nadu in Kangeyam belt stretching over Karur and Kulithalai tehsils in Tiruchirapalli district and Vedachandur tehsil in Dindigul district.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

Corundum

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'Corundum' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, 'Sapphire' has been retained as Major Mineral. Statewise production of corundum and sapphire is not available.

Ruby

There was no production of ruby reported since the year 2015-16.

CONSUMPTION & USES

Corundum is valued mostly for its abrasive and refractory properties. Its melting point is 2,010 °C and hence it is used in a sintered form for the manufacture of special refractory crucibles, rods and other materials.

Corundum's bright and glassy lustre, splintery property as it is devoid of cleavage plane and inclusions makes it preferred substance by industry for the manufacture of superior grade abrasives. After processing, it is used in grinding and polishing wheels, grinding belts, emery papers and cloth & grinding pastes. High-grade corundum with low iron finds use as ramming mass in the electric arc furnace. It is also used in mortars, wire drawing dies, thread guides and gauge blocks. Gem varieties are sometimes used for pivot supporters in delicate scientific instruments, as jewel in watches. Sapphire has emerged as a versatile material useful to a range of industries in many varied applications including LEDs, optical and Radio Frequency Integrated Circuits (RFICs).

FUTURE OUTLOOK

Corundum has been produced synthetically since 1837 and gem quality of synthetic corundum entered the market place in the early 1990s. Very large sizes of crystals can be made by Czochralski's Drawing Method. Another method is Verneuil process — but synthetic gem variety can be recognised by trained gemologist. The market for synthetic corundum is mainly driven by industrial abrasion applications. The natural occurring corundum has tremendous value in the gemstone market and is the most desirable precious stone after diamond. Owing to its uncommon colours, corundum's demand in the Jewellery Segment is increasingly on the rise. Apart from rubies and sapphire, rare gemstones, such as, padparadscha sapphire, witnessed expanding market demands.

In India, the gemstone market has been expanding. The gemstone market in India (which includes ruby & sapphire) is expected to ramp-up in the coming years.

30-5 Diaspore

Diaspore is a dimorphous form of boehmite, with chemical formula AlO(OH) (beta monohydrate of aluminium). It is an important constituent of bauxite. It is used chiefly for making high-alumina refractory bricks. It is also used as a filler in Plastic Industry and in jewellery as a gemstone.

Diaspore occurs as thin veins, stringers and geode like bodies in association with pyrophyllite in Uttar Pradesh and Madhya Pradesh. The host rock mainly comprises granite, quartz and pyrophyllite of Bundelkhand Supergroup, and as a common constituent of bauxite in Jammu & Kashmir.

PRODUCTION

As per Govt. of India Notification S.O. 423(E), dated 10th February 2015, 'Diaspore' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, no production data was reported from any of the States.

USES & SPECIFICATIONS

Diaspore mainly finds application in the manufacture of high alumina refractories either on its own or by bonding with flint or plastic clay as per content of alumina needed in the finished product. The domestic refractory manufacturers use indigenous diaspore, that analyses Al_2O_3

of 56 to 62%, Fe_2O_3 of 1 to 4% , TiO_2 of 0.8 to 1.5%, with Pyrometric Cone Equivalent (PCE) of 36 (min.) and of size between 75 and 150 mm.

In addition to its industrial applications, diaspore is also used for making decorative items, such as, small figurines, lampshades, flower-vase, etc.

1t is commonly used in refractories, cosmetic & soaps, ceramics, paper, rubber, potteries, insecticides, toys and statues.

FUTURE OUTLOOK

Diaspore (aluminium oxide hydroxide) is one of the three mineral constituents of bauxite ore of a luminium. Principally, it is used in the manufacture of high alumina refractories. India has large reserves of diaspore for its indigenous supply and has adequate resources to meet its future requirements. Gem variety of diaspore called zultanite is not found in Indian reserves.

30-6 Dolomite

Over 95% of the total production of dolomite finds outlet mainly in Iron & Steel and allied industries.	As per Govt of India Notification S.O. 423(E), dated 10th February 2015, dolomite has been declared as 'Minor Mineral'.	Dolomite after calcination is used for refractory purposes (as a substitute of magnesite refractories) in linings of furnaces like basic open-hearth steel furnaces and basic Bessemer converters.

Dolomite ($CaCO_3.MgCO_3$) theoretically contains $CaCO_3$ (54.35%) and $MgCO_3$ (45.65%) or CaO (30.4%), MgO (21.9%) and CO_2 (47.7%). However, in nature, dolomite is not available in this exact proportion. Hence, in commercial parlance, the rock containing 40–45% $MgCO_3$ is usually called dolomite. Dolomite rock that contains either calcite or a mixture of calcite & magnesite in addition to dolomite is called "Dolomitic Limestone". It is grouped under flux & construction minerals and is important for Iron & Steel and Ferroalloys industries. Dolomite occurrences are widespread in almost all parts of the country.

Removal of overburden is imperative in a mining activity, which leads to cutting of t rees and deforestation. The statute provides directives for reclamation of the mined out areas and plantation of trees to regain the aesthetics of the degraded land. A study in this regard was undertaken to get an idea of afforestation efforts and success rate.

Mineral dolomite is found in almost all States and it is mostly mined by opencast method of mining.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, dolomite has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or by visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of dolomite during 2019-20 to 2021-22 is furnished in Table-1.

Table- 1 : Statewise Production of Dolomite

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	2039342	2128467	-
Odisha	1247345.8	1621046.4	1554158.5
Telangana	518052	-	-
Maharashtra	465667	-	-
Rajasthan	177000	117875	192864.77
Karnataka	913373	923669	-

Source: *As received from State DGMs and their websites*
Note : " - " NA

USES & SPECIFICATIONS

Dolomite after calcination is used for refractory purposes (as a substitute of magnesite refractories) in linings of furnaces like basic open-hearth steel furnaces and basic Bessemer converters.

High purity dead-burnt dolomite bricks are required for lining LD furnaces, while mini-steel plants generally require dolomite for fettling and refractory purposes. Like limestone, dolomite is used as a flux in iron & steel, ferroalloys and glass works. Few steel plants have dispensed with the use of dolomite in blast furnaces and its use in the preparation of self-fluxing sinters is found adequate for blast-furnace charge.

It is useful in the recovery of magnesia and also in the manufacture of magnesium metal; it finds important application in the manufacture of basic magnesium carbonate (termed 'technical carbonate', 'block magnesia' or 'magnesia alba') used in pipe and boiler coverings as heat insulation, in pharmaceutical, rubber, chemical Industries, paper, leather, glass, potteries and high-magnesium limes. In agriculture, it is used as a soil conditioner to neutralise acidity. Regular application of dolomite improves crop yields owing to its neutralisation potential. It finds use as a filler in fertilizers, paints & varnishes and for suppression of dust in coal mines. It is also used as a building stone and in the making of flooring tiles as chips & powder

Generally, insolubles like SiO_2, Fe_2O_3 and Al_2O_3 are considered deleterious constituents of dolomite for any industrial use. It is essential that these insolubles should be as low as possible. High purity dolomite with less than one per cent insolubles is preferred for making refractory bricks which are used in the lining of LD furnaces.

Similarly, high-grade dolomite containing low iron (less than 0.15%) is required in Glass Industry. BIS has prescribed the specifications of dolomite used in Glass Industry vide IS: 997-1973; (First Revision; Reaffirmed 2022). Specifications for flux grade dolomite for use in Iron & Steel Industry have been revised and are prescribed in IS: 10346 - 2004 (second revision, Reaffirmed 2023), while specifications of dolomite for Refractory Industry are prescribed in IS: 14296 - 1995 (Reaffirmed 2022). IS:15366-2003 (Reaffirmed 2019) lays down the specifications of dolomite for Paint Industry.

FUTURE OUTLOOK

Over 95% of the total production of dolomite finds outlet mainly in Iron & Steel and allied industries. The importance of high purity dead-burnt dolomite bricks for lining LD furnaces has gained ground due to LD process of steel making. At the same time, a few of the steel plants have dispensed with the use of dolomite pin blast furnace. Mini-steel plants generally require dolomite for fettling and refractory purpose only.

The resources of the Refractory grade dolomite in the country are meagre and this type of material is in short supply though the demand for it is very high especially for producing tar-bonded dolomite bricks.Therefore, intensive search is needed in non-Himalayan regions for locating deposits of massive non-crystalline dolomite, containing less than 2.5% R_2O_3 for use in tar-dolomite bricks required for lining of LD steel furnaces.

30-7 Dunite & Pyroxenite

87,395
(tonnes) of dunite production reported in 2020-21.

As per Govt of India Notification S.O. 423(E), Dated 10th February 2015, 'Dunite & Pyroxenite, have been declared ' Minor Mineral'.

Dunite and pyroxenite are preferred as flux to dolomite as a source of MgO in sintering and also in Iron & Steel Industry.

Dunite is a monomineralic ultrabasic rock that consists of more or less pure olivine. Dunite typically contains 36 to 42% MgO and 36 to 39% SiO_2. Olivine is a commercial source of magnesia combined with silica that is mainly used in metallurgy, fertilizer, etc. Pyroxenite is also an ultrabasic rock that consists of pyroxenes, i.e., predominantly ferromagnesian minerals other than olivine. There is a rising trend in use of dunite and pyroxenite in sintering and as a fluxing agent in blast furnace in place of dolomite.

In India, occurrences of dunite are reported in association with other ultrabasic rocks in chrysotile-bearing areas of Jharkhand and Karnataka; chromite-bearing areas in Odisha, Karnataka, Jharkhand & Nagaland; and magnesite-bearing areas in Karnataka & Tamil Nadu.

The occurrences and production of pyroxenite are reported from Jajpur district in Odisha and Singhbhum (East) district in Jharkhand. However, no production data is available

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'Dunite & Pyroxenite' have been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. Production data for 'dunite & pyroxenite' is presently not available. However, 87,395 tonnes of dunite production was reported during the year 2020-21 as compared to 49,634 tonnes produced last year i.e. 2019-20 predominantly by Karnataka state.

USES & SPECIFICATIONS

Dunite and pyroxenite are preferred as flux to dolomite as a source of MgO in sintering and also in Iron & Steel Industry. Main benefits of olivine over dolomite in slag conditioning are higher MgO content, no requirement of preheat treatment, low LOI, reduced energy consumption, lower coke consumption, reduced slag volume and lower CO_2 emissions. Presence of higher amount of silica in dolomite leads to lower sinter basicity (i.e. CaO/SiO_2) at around 2.5 than 3.5 of dolomite and the phases in sinter change to those having better reducibility. The net result is a reduction in the resistance of the cohesive zone to gas flow in the blast furnace leading to drop in fuel rate and higher productivity. In addition, the magnesium silicates do not call for calcination (unlike the carbonates) and thus lowers energy requirement in the blast furnace.

Olivine helps to condition the slag as well as to control the basicity through reduction of alkali recirculation. Its higher reaction temperature reduces low temperature breakdown and swelling of burden, thus, maintaining permeability and reducing coke consumption. Olivine could be added directly to the blast furnace charge as lump (10 to 40 mm), sinter feed (3 to 6 mm), or mixed with low silica iron ore fines and pressed into pellets.When lump is added directly to the furnace, olivine can replace limestone partly and dolomite flux in the reduction of iron ore. In comparison with dolomite, olivine has higher MgO content (requires less material for a given MgO level), amenable MgO: SiO_2 ratio (allows MgO levels to be raised without changing the basicity of the slag) and lower LOI, i.e., 0.3–0.7% (conserves the energy required to drive off unwanted carbon dioxide). As a sinter feed, olivine reduces the sintering temperature as much as 100 °C, thus, producing harder sinter which in turn generates less fines. Olivine is added directly to the iron ore as flux during the production of pellets so that the fluxed pellets swell less, reduce more quickly and have narrower melting range. However, on the other side, high silica content in olivine restricts its use in low silica iron ores because high silica content creates excessive slag formation in the furnace.

Dunite is well-suited as a refractory material due to its low and uniform coefficient of thermal expansion. Besides, dunite exhibits properties, such as, good resistance to thermal shock; spalling and slag attack; high green strength; and resistance to metal attack. Dunite, calcined in rotary kilns at 1,650 °C increases its refractory and foundry applications. Other uses of olivine are as loose-grainshot blasting abrasive, filtration media, in mineral wool production, filler in speciality paints, asphalt, mastics and weighing agent in concrete oil production platforms. Olivine also contributes magnesia and iron as nutrients to the soil.

Olivine should contain 45 to 51% MgO, 40 to 43% SiO_2, 7 to 8% Fe_2O_3, 0.2 to 0.8% CaO and 1.8 to 2% Al_2O_3 and TiO_2 , MnO, Cr_2O_3 , NiO & CaO for various uses. For blast furnace use, olivine should contain 47 to 48% MgO with 10 to 40 mm lump size. For foundry use, the size should be AFS 20, 30, 60, 90, 120 and for Flour, Filler and Fertilizer grades, size recommended is up to 0.8 mm, up to 0.02 mm and less than 0.1 mm, respectively.

As per the end-use grade classification, the reserves of 'fresh' and 'weathered' dunite have been classified as Gr. I and Gr. II, respectively. However, recommendations to assign chemical specification to these grade based on the experience of Tata Steel Ltd and GSI have been incorporated.

FUTURE OUTLOOK

The importance of dunite as a fluxing agent is increasing in the low silica iron ores. It is also used as a refractory material. India has adequate resources of dunite and pyroxenite to meet all its future industrial applications. With increasing need to augment steel production, requirement of fluxes as well as refractories are bound to increase and India is self-

30-8 Felspar

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'felspar' has been declared as 'Minor Mineral'

Feaditionally,potassium FelsparObtained from labradorite are used as semi-precions stores, In Ceramic Industry, Felspar is used as a fluxngagent and the commonty used ceramic flux carrtains potash Felspar and Sodium Felspar

Marjor producers of felspar are Turkey, Italy and China. Substantial production also Comes from India, Thailand and Iran.

Felspars are one of the most abundant rock-forming minerals in the earth's crust, comprising a complex series of aluminosilicates with varying amounts of potassium, sodium, calcium and, though rarely, barium. Common amongst these are the potash felspars called orthoclase and microcline ($K_2O.Al_2O_3.6SiO_2$), sodium felspar called albite ($Na_2O.Al_2O_3.6SiO_2$) and calcium felspar called anorthite ($CaO.Al_2O_3.2SiO_2$). The sodium and calcium felspars form a continuous series of solid solutions and are together termed plagioclase felspars. Though felspars occur in a variety of colours, pink, brown and grey felspars are known to be common.

Several varieties of felspar minerals are used as gemstones. Three of them, moonstone, sunstone and labradorite are known for their unique optical phenomena. The phenomenal properties of moonstone, sunstone and labradorite are that they almost always cut as dome-shaped cabochons. The uniqueness in their properties is observed when light strikes the microscopic structures within a polished stone at just the right angle. To make that happen, skilled craftmen who understand the optical phenomena of these gems cut the stone in such a way that the planes where the optical phenomena are produced occur parallel to the bottom of the cut gemstone.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'felspar' has been declared 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of felspar during 2019-20 to 2021-22 is furnished in Table-1

Table-1 : Statewise Production of Felspar

(In tonnes)

State	2019-20	2020-21	2021-22
Rajasthan	5171000	3818825	5427702
Telangana	780653	-	-
Andhra Pradesh	211719	-	-
Gujarat	-	-	-
Karnataka	9915	-	-

Source: As received from State DGMs and their websites

USES & SPECIFICATIONS

Traditionally, potassium felspar obtained from labradorite are used as semi-precious stones.

In Ceramic Industry, felspar is used as a fluxing agent and the commonly used ceramic flux contains potash felspar and sodium felspar. After clay, felspar is the biggest ingredient in the raw material batch for ceramic bodies. Typical felspar contents are <25% in earthenware, 25–35% in sanitaryware, 15–30% in whiteware and 10–55% in floor & wall tiles.

In the Abrasive Industry, plagioclase felspar is used in the manufacture of acid-proof refractories. In Welding Electrode Industry, felspar is used as a flux which acts as an arc stabiliser and helps in protecting the molten metal from aerial oxidation.

Physical properties like good dispersability, chemical inertness, stable pH, low free silica content and brightness of 89–95 % improve the filler properties of finely ground felspar material.

Ceramic Industry in India is about a century old and has formed a sizeable industrial base. The products generally comprise ceramic tiles, sanitaryware and crockery items. The Industry has wide variance in type, size, quality and standard. Manufacturing units are spread all-over India. The state-of-the-art ceramic goods are manufactured in the country. The domestic technology is at par with international standard. During the last two decades, there has been a phenomenal growth in the field of high-end technical ceramics to meet specific demands of industries like high alumina ceramic, cutting tools and other structural ceramics.

WORLD SCENARIO

World resources of felspar are large. The major producers of felspar are Turkey, Italy and China. Substantial production also comes from India, Thailand and Iran.

30-9 Fireclay

India possesses Substantial reserves of fireclay. The best deposits occur in association with the coal seams in the Lower Gondwana colfields of Andhra Pradesh, Jharkhand, West Bengal Madhya Pradesh and Neyvelilignitefields in Tamil Nadu

As per Govt. of India Notification S.O. 423(E), dated 10th February 2015, 'fireclay' has been declared as 'Minor Mineral'

Fireclays are used in the manufacture of cement, bricks, blocks, retorts, crucibles, mortars, masses, pottery,floor tiles, etc. Low-grade material is used for manufacturing heavy Sanitaryware, such as, bibes and bath tubs. Firebricks manufactured are used where heat generation is used suwhere involved, such and ovens. furnaces, Kas, in furnaces, Kidfirebricksareused in metallurgical indeextensively

The name fireclay is given to a group of refractory clays which can withstand temperatures above Pyrometric Cone Equivalent (PCE) value of 19. Refractoriness and plasticity are the two main properties needed in fireclay for its suitability in the manufacture of refractory bricks. A good fireclay should have a high fusion point (>1,580 °C) and good plasticity. Fireclay containing high alumina and low iron oxide, lime, magnesia and alkalies is preferred by refractory manufacturers. The aluminous (kaolinitic) variety of fireclay is more refractory because of its hardness and density and absence of iron, giving it a white-burning colour. The absence of alkalies gives it a very high fusion temperature.

India possesses substantial reserves of fireclay. The best deposits occur in association with the coal seams in the Lower Gondwana Coalfields of Andhra Pradesh, Jharkhand, West Bengal, Madhya Pradesh and Neyveli lignite fields in Tamil Nadu. Notable occurrences of fireclay, not associated with coal measures, are reported in Gujarat, Jabalpur region of Madhya Pradesh and Belpahar–Sundargarh areas of Odisha. The reserves of fireclay are substantial but reserves of high-grade (non-plastic) fireclay containing more than 37% alumina are limited.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any are covered in the Review on Exploration & Development under "General Reviews".

PRODUCTION

As per Govt. of India Notification S.O. 423(E), dated 10th February 2015, 'fireclay' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few states could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of fireclay during 2019-20 to 2021-22 is furnished in Table-1.

Table-1 : Statewise Production of Fireclay

(In tonnes)

State	2019-20	2020-21	2021-22
Gujarat	-	-	-
Andhra Pradesh	55254	27090	-
Rajasthan	-	-	1660

Source: As received from State DGMs and their websites.

USES AND SPECIFICATIONS

Fireclays are used in the manufacture of cement, bricks, blocks, retorts, crucibles, mortars, masses, pottery, floor tiles, etc. Low-grade material is used for manufacturing heavy sanitaryware, such as, pipes and bath tubs. Firebricks manufactured are used where heat generation is involved, such as, in furnaces, kilns and ovens. Firebricks are extensively used in metallurgical industries.

Fireclays are usually graded into: i) Low duty ii) Intermediate duty iii) High duty and iv) Super duty, depending upon their capacity to withstand temperature before melting. The Low duty fireclay can withstand temperatures between 1,515 and 1,615 °C (PCE 19–28); Intermediate duty fireclay up to 1,650 °C (PCE 30), High duty fireclay up to 1,700 °C (PCE 32); and Super duty beyond 1,775 °C (PCE 35).

Crude fireclay and other clays including kaolin (china clay) are also used in a few cement manufacturing plants to increase the alumina content in the raw meal and its plasticity. Cement Industry has been the major consumer of crude fireclay followed by Refractory, Ceramic and Iron & Steel industries and other industries, such as, pesticide, alloy steel, graphite products, foundry, sugar, etc.

FUTURE OUTLOOK

Fireclay is one of the most important minerals used in the Refractory Industry. India has huge reserves of fireclay and there does not seem to be any problem in respect of supplies to the Refractory Industry in the near future. However, a serious dearth is being felt in the availability of high-grade fireclay analysing 37% & above Al_2O_3 with Fe_2O_3 and fluxing impurities less than 2% for supply to the refractories. To fulfil the increasing demand of the Refractory Industry, it is imperative that deposits of high-grade fireclay be explored and delineated.

The export prospect of fireclay is relatively less as it is consideredas low-value high bulk mineral. However, fireclay bricks as a commodity could have high export potential and therefore must be encouraged.

30-10 Fuller's Earth

222,871
(tonnes) of fuller's earth produced in Rajasthan in 2021-22.

fuller's earthis used to decolourise, deadorise, dehydrctc and neutral;se various Minerals, Vegetale/animal oils,etc. It is also used in the rnanufachat of No carban Required (NCR) papcus.

USA is the major producer of Fuller's carth. Other major produces are Spain, Mexice and Senegal.

Fuller's earth, like bentonite, is also known as 'bleaching clay' because of its inherent bleaching properties. Fuller's earth is non-plastic clay that can be used to decolourise, filter and purify animal, mineral & vegetable oils and greases. It has great commercial importance like bentonite. Bentonite is a swelling-type clay but fuller's earth is a non-swelling-type clay. This property difference is because of their chemical composition.Bentonite contains sodium, whereas fuller's earth contains calcium. Calciumbentonite, more commonly called fuller's earth, can be converted into sodium bentonite by cation exchange process or acid activation.

PRODUCTION

As defined in Clause (e) of the Section-3 of MM(DR) Act 1957, 'fuller's earth' has been declared 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/ data that could be gathered has been presented in this Review.

Statewise production of fuller's earth during 2019-20 to 2021-22 is furnished in Table-1.

Table-1 : Statewise Production of Fuller's Earth

(In tonnes)

State	2019-20	2020-21	2021-22
Telangana	597205	-	-
Rajasthan	22000	28297	222871
Karnataka	3299	32958	-

Source: As received from State DGMs and their websites.

Note : " - " NA

USES & SPECIFICATIONS

Fuller ' s earth is used to decolo urise, deodorise, dehydrate and neutralise various minerals, vegetable/ animal oils, etc. It is also used in the manufacture of No Carbon Required (NCR) papers. Of late, the growth in consumption in these sectors has been affected because of the advent of more sophisticated techniques in refining and due to availability of effective substitutes like activated bauxite and magnesium silicate. Fuller's earth is generally used in Fertilizer Industry as a carrier. In animal feed, fuller's earth is used as binders for pelletised feeds, carriers of supplement free flowing additives for feed in flour and lubricants to reduce dye friction. Consumption, however, is expected to rise in other unconventional uses as absorbent, for cleaning oil spillage on factory floors; as carrier for insecticides, fungicides; and as a mineral filler & extender.

WORLD SCENARIO

World resources of clays including fuller's earth are quite large, hence country-specific data is not available. USA is the major producer. Other major producers are Spain, Mexico and Senegal.

30-11 Granite

46,320
(million cubic metres) of total Reserve/Resources of gramite have beem established in the country.

Granite, in commercial parlance, is all those crystalline rocks that have pleasing coloures ond strangh to bear the processes of quarrying and cutting & polishing.

Granites are majorly used for decorative purposes and have high export potential.

Granite technically refers to a light-coloured granulose plutonic rock composed of felspars, plagioclase, quartz (35% approx.) and minor amounts of mafic minerals (45% approx.), such as, biotite, hornblende, pyroxene, iron oxides, etc. But, in commercial parlance, the term granite has become synonymous with all those crystalline rocks which have pleasing colours, strength to bear the processes of quarrying and cutting & polishing and which are used commonly for decorative purposes. Being more resistant to wear and tear as well as weathering, granite is most sought-after stone for building as well as has uses as decorative stone. The fascination for granite is due to its amenability for taking mirror-like polish, high compressive strength, longevity and aesthetics. India possesses enormous deposits of all types of dimension stones and is considered as one of the prominent producers of dimension stones in the world. The Dimension Stone Industry employs a workforce of over one million at its various sectors in the country. This Industry plays a vital role in the economy of the States like Tamil Nadu, Andhra Pradesh, Telangana, Karnataka and Rajasthan. Granite Industry is valued at $40 billion and has a potential to generate semi-skilled employment, especially in rural areas.

Within the country, granite used for decorative purposes is considered costly when compared with other materials, hence, its utilisation and trade in the domestic front has been relatively low when compared to its export potential.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on Exploration & Development under "General Reviews".

PRODUCTION

The granite being building stone comes under 'Minor Mineral' as defined in Clause (e) of Section 3 of MM(DR) Act,1957, hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Major production of granite in raw as well as processed form is generally from Andhra Pradesh, Telangana, Rajasthan, Karnataka, Tamil Nadu and Gujarat. Statewise production of granite during 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Black/Coloured Granite

(In cu.m)

State	2019-20	2020-21	2021-22
Rajasthan#	**5665000**	**6561139**	**8805139**
Telangana	1143633	-	-
Andhra Pradesh	1498695	748851	-
Gujarat#	-	-	-
Karnataka@	42130	202964	-
Kerala#*	-	-	-
*Goa***	-	-	-

USES & SPECIFICATIONS

Uses

Granite is the most sought-after among all building stones. In ancient times, granite pillars and beams were a preferred material to support the huge structures of temples and palaces and for making protective walls around them. With the invention of modern tools of greater hardness and polishing ability, the use of granite has rather increased on account of its aesthetic value. The modern motorised tools of tungsten carbide and brazed diamond have enabled the user to cut & polish granite as per the specifications of the Building Sector. Presently, cut and polished granite slabs of 20 mm thickness are preferred for flooring, while tiles of 10 or 12 mm thickness are used for cladding. In addition, gravestones and monuments of various shapes and sizes are also in vogue. The flexibility of the cutting tools has engendered creation of many artifacts of granite for decorative purposes.

Granite also finds its application in making garden furniture, such as, benches, fountains and many other articles which are used for landscaping and/or decorative purposes. The cut-to-size small blocks are used as cobblestone, kerbstone, road sidings and for many other innovative purposes.

Crude granites are utilised for structural purpose after little dressing & sizing, whereas processed granites are used mostly in the construction of buildings and monuments and for interiors and exterior facing. Granites, because of its superior wear resistance and non-denting quality are used as parts in various meteorological and engineering instruments, such as, surface plates, straight edges, parallels, cubes, V' blocks and work-mounting tables of co-ordinate measuring machines.

The surface plates are used as flat datum surface whenever precise measurements of dimensions and geometrical relationships are to be carried out. For this purpose, harder varieties of granite are preferred as they can bear the high-degree of grinding, polishing and calibration required for achieving flat surfaces. For its use as surface plates, granites should have properties, such as, close grain size, homogeneity, high density & hardness, uniform colour, low moisture absorption and should be free from flaws.

Specifications

The properties of granite which are normally valued for exploitation are compressive strength, tensile strength, density, p-wave velocity, etc. For marketability, other requirements like colour, texture, granularity, size, water absorption, porosity, hardness, moisture content, etc. are also essential. Raw blocks should be free from normal defects like fractures, joints, shears, hairline cracks, segregation, veins, etc.

POLICY

Granite is a 'Minor Mineral' under the MM(DR) Act, 1957. The grant of various mineral concessions for granite is, therefore, administered under the Minor Mineral Concession Rules of the respective State Governments. However, the Granite Conservation and Development Rules, 1999 aims at uniform rules for conservation, systematic development and scientific exploitation of granite resources.

WORLD SCENARIO

The top five granite producing countries in descending order were China, Brazil, India, Saudi Arabia and Italy.

Currently, the USA is the world's biggest consumer of granite and its demand is largely fulfilled by imports from Brazil, China and India.

The European Union (EU) is one of the biggest markets for the worldwide Natural Stone Industry. India has also been one of the key players in the global export of natural stones, with substantial share in global exports.

FUTURE OUTLOOK

India possesses one of the best granite deposits in the world having excellent varieties comprising over 200 shades. India accounts for over 20% of the world resources in granite. The total granite resources in India as on 1.4.2015 is estimated at 46,320 million cubic meters.

The current environment for Granite Industry remains challenging. There are multiple headwinds like competition from engineered stone, closure of granite quaries and change in demand trends. Dimension stone market is said to grow at a fervent pace as the demand for granite, marble, sandstone and other dimension stones and stone products is on the rise as the residential consumption and private spending on home are increasing. In addition to this, residential remodelling activity is expected to rise as home owners continue to opt for larger kitchens and multiple bathrooms, expanding the space devoted to countertops. A similar rate of growth in exports can also be achieved with the help of suitable policy framework, infrastructure and other facilities which the Industry expects to consolidate for augmentation of prospects. A well-planned, concerted and dedicated efforts are essentially needed for promotion of Indian stones to galvanise their export prospects.

There is a need to integrate environmental concern and social & economic development of regions into mineral development programmes for achieving sustainable development. Granite mining adversely impacts the environment due to removal of top soil and overburden, which results in degradation of land. The recovery of saleable granite blocks is very low and the waste is mostly in the form of granite rocks having defects of colour, cracks, grain size etc. and these wastes could be used in manufacturing M-sands. The basic objective of sustainable development in mining is to meet the needs of the present without compromising the ability of future generations to meet their own needs.

30-12 Gypsum and Selenite

Gypsum occurs in nature as Mineral Gypsum. Gypsum Sourced form seawater is called Marine Gypsum while that obtained on by-product from chemical/fertilizer plant is called Chemical Gypsum.

Gypsum has been declared as Minor Mineral as per Govt of India Notification S.O.423(E)dated 10.02.2015

Gypsum is widely used in Cement, Fertitizer and Plaster of Paris Industries.

Gypsum ($CaSO_4.2H_2O$) is a hydrated calcium sulphate used widely in various industries because of its special property of losing three-fourth of the combined water of crystallisation when moderately heated (calcined) to about 130 ^{0C}. Besides, calcined gypsum when cooled, finely ground and made plastic with water can be spread out, cast or moulded to any desired surface or form. On drying, it sets into a hard rock-like form. Selenite is a colourless, transparent, naturally occurring crystalline variety of gypsum and is used extensively in Ceramic Industry and for manufacturing Surgicalgrade plaster of Paris, whereas alabaster is a fine- grained, massive variety, white or shaded in colour. Silky and fibrous variety of gypsum is called satin spar. Anhydrite ($CaSO_4$) is a calcium sulphate mineral found associated with gypsum commonly as a massive or fibrous mineral.

Gypsum that occurs in nature is called mineral gypsum. In addition to mineral gypsum, seawater and some chemical and fertilizer plants are sources of by-product marine gypsum and by-product chemical gypsum, respectively. The latter is obtained as by-product phospho-gypsum or fluoro-gypsum or boro-gypsum, depending upon the source. Phosphoric acid plants are important sources of by-product phospho-gypsum.

Marine gypsum is recovered from salt pans during production of common salt in coastal region, particularly, in Gujarat and Tamil Nadu. The recovery of by-product gypsum and marine gypsum together is substantial and is comparable with the production of mineral gypsum.

FGD Gypsum is a unique synthetic product derived from flue gas desulphurisation (FGD) systems at electric power plants. Sulphur dioxide emission control systems used by coal-fired power plants remove sulphur from combustion gases using 'scrubbers'. In addition to FGD gypsum, synthetic gypsum includes materials, such as, phospho-gypsum, titano-gypsum, fluoro-gypsum and citro-gypsum.

Various grades of gypsum (as per $CaSO_4.2H_2O$ content) are produced and consumed by industries like cement, fertilizer plants, plaster of Paris, etc. Gypsum also acts as a neutralising agent and helps in improving soil permeability. In gypsum, calcium or magnesium carbonate, chlorides, other sulphate minerals, clay minerals or silica are considered as deleterious constituents. As a result, mostly mine production of gypsum possesses purity ranging between 70 and 95%.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

GYPSUM

As per Govt of India Notification S.O. 423(E), dated 10 th February 2015 , 'gypsum' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/ data that could be gathered has been presented in this Review. Statewise production of gypsum during 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Gypsum

(In tonnes)

State	2019-20	2020-21	2021-22
Rajasthan	3006000	6788194	3547220
Gujarat	50	-	-

Source: As received from State DGMs and their website.

SELENITE

M/s RSMML, a Public Sector company, is a leading producer of natural gypsum and selenite variety, producing from Thar desert areas of Rajasthan. Gypsum with (+)70% $CaSO_4.2H_2O$ purity produced by RSMML fulfils the demands of the cement industries and powder gypsum is used by farmers as a direct fertilizer for re-conditioning of alkaline soils for reducing alkanity and improving crop production.

The production of selenite was Nil tonnes in the year 2021-22 as against 2,200 tonnes during the previous year. The entire production of selenite was reported by Rajasthan State Mines & Minerals Ltd (RSMML), a Public Sector Undertaking, that operates two mines, one each in Barmer and Bikaner district of Rajasthan.

The mine-head closing stocks of selenite were Nil tonnes at the end of the year 2021-22 as against 23 tonnes at the end of the year 2020-21.

As selenite is not listed under minor minerals, its production details are covered in this Review (Tables-2 to 3).

Table – 2 : Principal Producer of Selenite, 2021-22

Name & Address of Producers	Location of Mines	
	State	District
Rajasthan State Mines & Minerals Ltd. C 89-90, Janpath, Lal Kothi Scheme, Jaipur-302 015, Rajasthan.	Rajasthan	Barmer Bikaner

Table – 3 : Production of Selenite, 2019-20 to 2021-22 (By State)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**1167**	**2353**	**2200**	**41269**	**-**	**-**
Rajasthan	1167	2353	2200	41269	-	-

USES AND SPECIFICATIONS

Cement, fertilizer (ammonium sulphate) and plaster of Paris are the three important industries in which gypsum is utilised. Gypsum of less purity in crushed form is utilised in portland cement manufacturing for controlling the setting time of portland cement (i.e., as a retarder to prevent quick set). It is added to the clinker just befo re final grinding to finished cement. Proportion of gypsum in Cement Industry is 4-5% of the cement produced. Both mineral and by-product gypsum are used in cement manufacture. Calcined gypsum finds use in manufacturing Plaster of Paris. It is also used in manufacturing partition blocks, sheets & tiles, insulation boards for stucco and lattice works. Gypsum board is primarily used as a finish for walls and ceilings. It is also used as a binder in fast dry tennis court clay. Low-grade gypsum is calcined and used as gypsum plaster after preparation of mortar. It is used for internal plastering and masonry work. Requirement of low-grade gypsum for use in Building Industry as per IS:12654-1989 (Reaffirmed 2020) is: $CaSO_4.2H_2O$ not less than 60%. In pottery, calcined gypsum is used for preparation of moulds in the production of sanitarywares. The used and discarded moulds are in turn again used as source of gypsum in cement and other industries. Low-grade gypsum is used in conditioning of alkaline soil and as manure in agriculture mainly for correcting black alkali soils BIS has also prescribed IS: 6046-1982 (First Revision; Reaffirmed 2019) for gypsum for agricultural use.

Selenite, a crystalline variety is used to a limited extent for gypsum plate for petrological microscopes, known as Sensitive Tint. It is also used in the Ceramic Industry for making moulds to manufacture surgical grade plaster of paris and also for producing white cement. Plaster of Paris Industry requires high purity gypsum. Different grades of plaster of Paris are manufactured depending upon the period for setting. For surgical plaster, a minimum 96% $CaSO_4.2H_2O$ grade gypsum is required.

High-purity gypsum can be utilised for manufacturing of ammonium sulphate fertilizer. Ground pure white gypsum is also used as a filler in paper, paints and textile goods. Ground low-grade gypsum is used in mined usting, manufacture of black board chalks and as a filler in insecticides. Besides, gypsum is also used in other industries like pharmaceutical, textile and asbestos products.

Alabaster, a dense, massive, granular and translucent variety, is employed as ornamental stone in statuary and interior decoration.

BIS specification for by-product gypsum (IS:10170-1982, reaffirmed 2023) lays down a minimum 70 % content of $CaSO_4.2H_2O$ and maximum limit of 0.75% Na, 1.0% F and 15% free moisture on dry basis. The material should pass through 2 mm sieve, but 50% of material should also pass through 0.25 mm (60 mesh) sieve. The specifications of by-product gypsum for use in plaster, blocks and boards are as per IS:12679- 1989 (reaffirmed 2010). Besides, BIS has prescribed IS:1290-2023 for mineral gypsum.

Substantial quantity of mineral gypsum as well as phospho-gypsum was used in Agricultural Sector for conditioning of alkaline soil and in Cement Industry. The remaining nominal consumption was in plaster of Paris, asbestos products, ceramic, fertilizer, refractories, textile, pharmaceutical and paint industries. The entire quantity of marine gypsum and gypsum moulds was also consumed in cement and ceramic industries respectively.

WORLD SCENARIO

The world reserves of gypsum are large. China was the largest producer of gypsum followed by Iran, Thailand, USA, Iraq, Turkey, Spain, Mexico, Oman, Japan, Russia, Germany and Australia.

TRADE POLICY

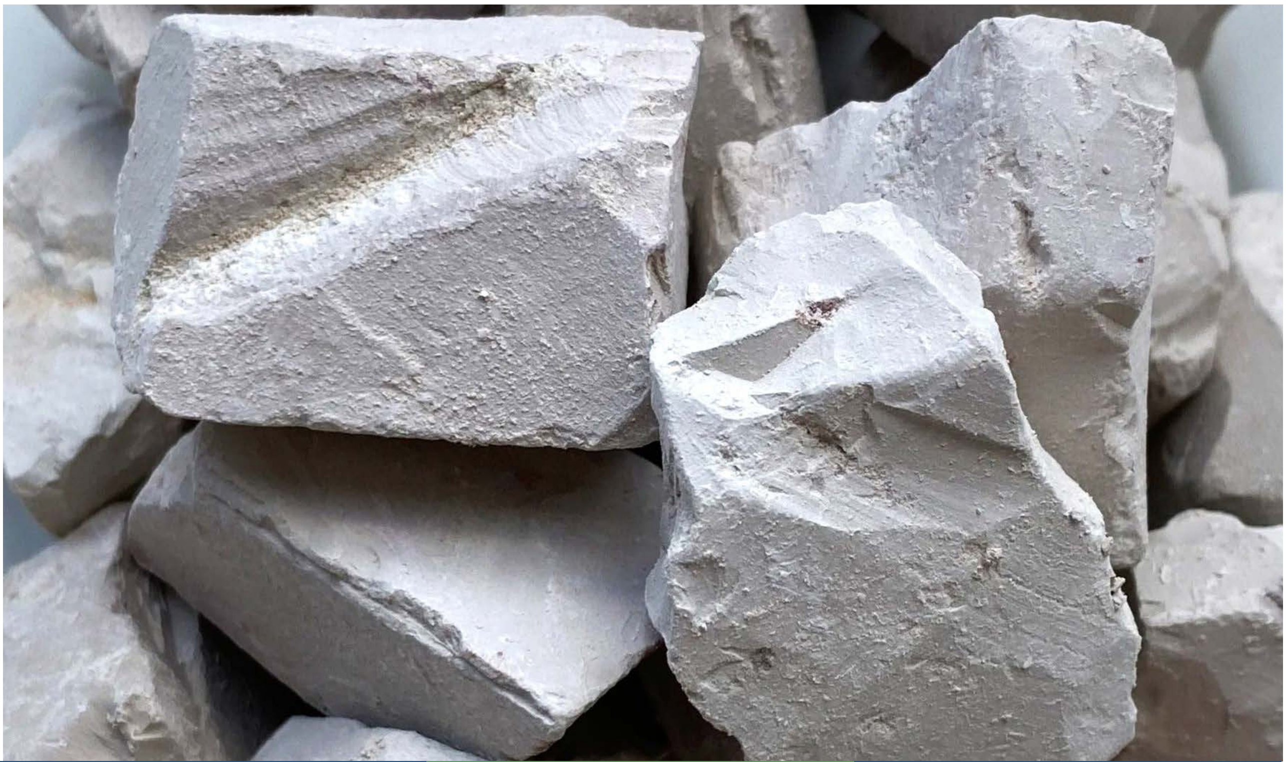
As per 'Export-Import Policy, 2015-2020, gypsum, anhydrite, plasters (consisting of calcined gypsum or calcium sulphate) whether or not coloured, with or without small quantities of accelerators or retarders are free under heading 2,520 of import policy.

FUTURE OUTLOOK

India's domestic resources of gypsum are large enough to meet increased demand. With renewed focus on improving the economy and upscaling industrial developments, India lays greater emphasis on creation of infrastructure. As per the Working Group report, augmentation of infrastructural activities will endanger further growth of the Cement Industry which concomitantly will raise the consumption of gypsum and the reby its demand, with consequence, leading to increased dependence on imports and synthetic gypsum to meet cement demand. Further, as per the report, steps would be necessary to find out suitable mining technology to exploit deep-seated gypsum resources in Bhadvasi deposit, Nagaur district Rajasthan. State-of-the-art technology needs to be adopted for the exploitation of deep-seated gypsum.

Other segments that would attract attention would be production of gypsum wallboard which is currently negligible in India. It could find better prospects because of its light weight and other special characteristics. It being an excellent partition material could facilitate its utility in high rise building constructions. In view of the environmental problem arising from huge accumulation of phospho-gypsum at different fertilizer plants, possibilities of finding other possible means for its utilisation has become a necessity. Low-grade gypsum being cheaper could find better prospects in its application more as a soil conditioner for reclamation of alkaline soils

30-13 Kaolin, Ball Clay, Clay (Others) and Shale



China Clay (Kaolin) has been declared as Minor Mineral as per Govt of India Notification S.O.423(E) dated 10.02.2015

3,978
(thousand tonnes) of China Clay production were reported by Rajasthan State in 2021-22

5,240
(thousand tonnes) of Ball Clay production were reported by Rajasthan State in 2021-22

1. Kaolin (China Clay)

The name kaolin is derived from the village of Gaoling in Jiangxi province, China, where the white clay was mined. Kaolin also known as china clay, is a white commercial clay consisting predominantly of the mineral kaolinite, a hydrated aluminosilicate formed by chemical weathering of aluminium silicate minerals like felspars through a complex sequence of events. It is relatively pure clay predominantly consisting of kaolinite ($Al_2Si_2O_5(OH)_4$), associated with other clay minerals like dickite, halloysite, nacrite and anauxite. Kaolinite and halloysite are the most commonly found members of the kaolin group whilst nacrite and dickite are considered rare but with the progress made in infrared spectroscopy techniques, nacrite and dickite are now found in association with kaolinite in many deposits. As the levels of nacrite and dickite increase with the higher temperatures and pressures at depth, these two minerals are used as a guide by the Oil Industry as an indicator of depth of sediments burial.

Kaolin is commercially valued for its whiteness and fine particle size which distinguish it from other clays, such as, ball clay and fireclay. Other physical characteristics that influence commercial utility include brightness, glossiness, abrasiveness and viscosity. It often contains small amounts of impurities in the form of rock fragments, hydrous oxides and colloidal materials. Kaolin is produced and consumed by the country in crude & processed forms. The major use of crude china clay is in Cement Industry and that of processed china clay in Ceramic Industry. The in situ clay deposits in India are often soft and can be easily extracted without blasting.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'china clay' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few states could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of china clay from 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of China Clay/ White Clay

(In tonnes)

State	2019-20	2020-21	2021-22
Gujarat	-	-	-
Rajasthan	1345000	3604724	3978474
Andhra Pradesh	82485	70080	-
Telangana	44410	-	-
Odisha	5404	-	-
Karnataka	27863	2975	-
Maharashtra*	734096	-	-
Himachal Pradesh*	32843	-	-

Source: As received from State DGMs and their websites.

Note : " - " NA

**Ordinary clay*

USES AND SPECIFICATIONS

China clay (kaolin) is used in a number of industries in both crude and processed forms. The major use for crude china clay in India is in the Cement Industry, whereas Ceramic Industry accounts for consumption of a major share of processed form of china clay. Besides ceramics, processed china clay finds use in other industries in the country, such as, sealants, paper coatings, as extender in fibre glass, paint and as a filler for paper, rubber, plastic, cosmetics, pharmaceuticals and textiles. Crude china clay also finds use in Insecticide and Refractory Industries. Other uses of china clay are in ink, ultramarine, synthetic zeolite, catalyst, water filter candles, soaps & detergents and explosives & pyrotechnic industries. Some of the areas where use of china clay is gaining importance are in the manufacture of plastic film, video and audio tapes where clays are used as anti-blocking agents, and in the field of biotechnology, where ceramics are widely in use for its light weight & high strength properties. EICL has been producing Metakaolin which increases the durability of concrete by lime fixation and arresting of deterioration of concrete by weathering. Himacem has high chemical resistance which makes the product suitable for construction of high span bridges, underwater structures and chemical plants.

The Bureau of Indian Standards (BIS) has prescribed specifications for china clay to be used in different industries. They are IS:505-1995 (Third Revision, Reaffirmed 2011) for paper coating and filler for paper, rubber, textile industries, IS:1463-1983 (Third Revision, Reaffirmed 2000) for cosmetics and IS:7589- 1974 (Reaffirmed 2011) for Explosive & Pyrotechnic Industry. BIS has revised the specifications for china clay for Ceramic Industry to IS:2840-2002 (Second Revision, Reaffirmed 2008) and for Paint Industry to IS:68-2006. The whiteness, particle size, plasticity, contents of alumina, iron and titanium are some important factors which control the specifications of china clay for different end-uses. China clay for ceramic and refractory applications is analysed for grit, brightness, green and dry strength, fixed colour, iron and alumina contents. For filler and extender applications, it must meet very rigid specifications, such as, particle size, colour, brightness and viscosity. The replacement of kaolin as a filler with Precipitated Calcium Carbonate (PCC) and Ground Calcium Carbonate (GCC) results in lowering consumption of kaolin in Paper Industry. Now they are using GCC due to a switch over by paper makers from an acid-based processing route to an alkali-based route for production.

The main consumption of raw china clay is in the china clay process/refining plants industry. The china clay processed by these plants in turn is consumed by various industries except cement, refractory and pesticide industries. The major consumer industries of raw china clay, are pesticide, paint, refractory, paper, cosmetic, rubber, abrasive, asbestos products, chemical, dry cell batteries, textile, electrical, electrode and glass.

TRADE POLICY

As per Import Policy under schedule of ITC (HS) 2022 and export policy under schedule of ITC (HS) 2022 there are no restriction no exports and imports china clay (kaolin).

WORLD SCENARIO

World production of kaolin is increasing steadily. Two-third of the world production comes from USA, China, Turkey, Ukraine, Brazil, Iran and Germany.

FUTURE OUTLOOK

India has abundant resources of kaolin which can easily meet both the internal and the external demands. The processing of kaolin in the country is done mostly by conventional methods like levigation and washing. New capacities for High-tech processing have to be established and existing capacities in the country have to be augmented to meet the demand of processed kaolin in the future.

In the Indian kaolin market, good growth is expected both for hydrous and calcined clay particularly in paint, cables, plastics, rubber and ceramics.

2. Ball Clay

Ball clay commonly consists of 20–80% kaolinite, 10–25% mica & 6–65% quartz. Ball clay and china clay differ only in the degree of plasticity. China clay is less plastic than ball clay. Ball clay is a highly plastic variety of kaolin having high binding power, tensile strength and shrinkage. It is utilised generally after mixing with non-plastic clay to impart the desired plasticity in pottery, porcelain and refractory materials. It also helps in the preparation of glaze, enamels and for imparting a dense vitrified body.

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'ball clay' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected . All possible information/data that could be gathered has been presented in this Review.

Statewise production of ball clay during 2019-20 to 2021-22 is furnished in Table-2.

Table-2: Statewise Production of Ball Clay

(In tonnes)

State	2019-20	2020-21	2021-22
Rajasthan	3014000	4094522	5239855
Andhra Pradesh	186145	139116	-
Gujarat	-	-	-

Source: As received from State DGMs and their websites.

SPECIFICATIONS

The specifications for plastic clay and washed plastic clay for use in Ceramic Industry are prescribed vide IS:4589-2022 (Fourth Revision). About 95% consumption was accounted for by the Ceramic Industry. The remaining consumption (5%) was reported by the Refractory and Abrasive Industries

3. Clay (Others)

As per Govt. of India Notification S.O. 423(E), dated 10th February 2015, 'Clay (Others)' has been de- clared as 'Minor Mineral', hence the production data is not available with IBM. Clay (Others) may contain all types of clays used as brick clay, ordinary clay/earth mitti, chhui mitti, reh mitti, etc. Almost all States pro- duce one or other type of clay. However, no authentic production data is available.

4. Shale

Shale is a fine-grained, plastic sedimentary rock comprised of mud that is a mixture of flakes of clay minerals and tiny fragments of minerals like quartz and calcite. The ratio of clay to other minerals is variable.

Shale which occurs with limestones as parting is rich in alumina content. Hitherto, shale was considered as implacable substance that reduced the quality of limestone due to presence of clay minerals. Now, with advancements and better knowledge, it is utilised as a source of alumina in cement making.

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'shale' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. Considering white shale as a type of shale, the Statewise production of white shale during 2019-20 to 2021-22 is furnished in Table-3.

Table-3: Statewise Production of White Shale/Shale

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	-	-	-
Telangana	18323	-	-
Himachal Pradesh	1276429	1325100	1013152
Karnataka	-	35205	-
Maharashtra*	44234	-	-

Source: As received from State DGMs and their websites.
** : Other than that for building material.*

30-14 Laterite

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'laterite' has been declared as 'Minor Mineral',

Indian Standards code IS 3620-1979 (Reaffirmation 2022) provides specifications and standards for laterite masonry construction in India.

Laterite (from the Latin word later, meaning "brick" or "tile") is a surface formation that is enriched in iron and aluminium. Found mainly in hot, wet tropical areas, it develops by intensive and long-lasting weathering of the underlying parent rock. The mineralogical & chemical composition of laterite depends on their parent rock. Due to the presence of iron oxides, lateritic soils are red in colour ranging from light bright to brown shades. The term 'laterite' was originally used for highly ferruginous deposits, first observed in Malabar Region of coastal Kerala and Dakshina Kannada & other parts of Karnataka. It is a highly weathered material, rich in secondary oxides of iron, aluminium or both. It is either hard or capable of hardening on exposure to moisture and drying.

Laterite and bauxite show a tendency to occur together. Aluminous laterites and ferruginous bauxites are quite common. The most common impurity in both is silica. Laterite gradually passes into bauxite with decrease in iron oxide and increase in aluminium oxide. The laterite deposits may be described on the basis of the dominant extractable minerals in it: (i) aluminous laterite (bauxite), (ii) ferruginous laterite (iron ore), (iii) manganiferous laterite (manganese ore), (iv) nickeliferous laterite (nickel ore) and (v) chromiferous laterite (chrome ore). Laterite with Fe_2O_3:Al_2O_3 ratio more than one, and SiO_2:Fe_2O_3 ratio less than 1.33 is termed as ferruginous laterite, while that having Fe_2O_3 :Al_2O ratio less than one and SiO_2:Al_2O_3 ratio less than 1.33 is termed as aluminous laterite.

Laterite can be considered as polymetallic ore as it is not only the essential repository for aluminium, ratio less than one and SiO_2:Al_2O_3 ratio less than 1.33 is termed as aluminous laterite.

Laterite can be considered as polymetallic ore as it is not only the essential repository for aluminium, but also a source of iron, manganese, cobalt, nickel and chromium. Furthermore, it is the home for several trace elements like gallium and vanadium which can be extracted as by products.

RESERVES/RESOURCES

Laterite occurrences are widespread in the country. Almost all Indian bauxite deposits are associated with laterite, except those in Jammu & Kashmir. Laterite generally occurs as capping on the hills and plateaus of Madhya Pradesh and in some States of the Deccan peninsula at altitudes ranging from coastal to 2,000 m with thickness up to 60 m.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'laterite' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few states could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of laterite from 2019-20 to 2021-22 is furnished in Table-1.

Table-1 : Statewise Production of Laterite

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	707730	71866	-
Telangana	3471995	-	-
Maharashtra	2252671	-	-
Rajasthan	-	-	-
Goa	-	-	-
Kerala*	-	-	-
Karnataka	327842	295060	-

Source: As received from State DGMs and their websites

Note : " - " NA

** : Figure relates to laterite (building) only.*

USES & SPECIFICATIONS

Indian Standards code IS 3620 -1979 (Reaffirmation 2022) provides specifications and standards for laterite masonry construction in India. Unique material properties and regional variations have rendered laterite stone as subject of controversy. The engineering characteristics of laterite from Malabar region of western India have been reflected in research studies conducted and were established in several other published studies.

The compact and ferruginous variety of laterite is used widely as a building stone and road metal. It cannot withstand heavy pressure hence, laterite is used in construction of light structures, partition walls, boundary walls, etc. Laterite as a building stone possesses one advantage that it is soft when quarried and can be easily cut and dressed into blocks and bricks which on exposure to air become hard.

The industrial use of laterite is in the Cement Industry. It is used as an additive for lowering the clinkerisation temperature and supplementing aluminous and iron contents required in the manufacture of cement. It is also reported that laterite is capable of removal of phosphorus from solutions and percolating columns of laterite remove cadmium, chromium and lead to very low concentrations.

FUTURE OUTLOOK

In India, though the resources of laterite are vast and are available in abundance, the work in respect of systematic exploration and estimation of resources have been restricted. There seems to be no major change in the end-use pattern of laterite.

Laterite is widely used as a building stone and road metal. Laterite is a weak stone, but can be used for masonry construction. The property of laterite can be enhanced by suitable water proofing treatments. Long-term study is required to find an optimum size for its varied masonry applications.

The consumption of laterite in cement has risen due to increased demand of cement in the country. The plausibility of diverse application of laterite in future could be in the realm as a viable source for metallic minerals like iron, aluminium, chromite and of trace elements like gallium and vanadium.

30-15 Marble

Marble being building stone, comes under 'Minor Mineral', as defined in Clause (e) of Section 3 of MM(DR) Act, 1957;

Marble is used widely in buildings, monuments and sculptures. Its utility value lies in its beauty, strength and resistance to fire and erosion. Marble has its application in interior and exterior wall cladding, interior and exterior paving, fireplace facing and hearth, lavatory tops, residential and commercial counter tops, table tops, statues and novelty items.

Marble is a 'Minor Mineral' as defined under Clause (e) of Section 3 of Mines and Minerals (Development & Regulation) Act, 1957. The term "marble" is derived from the Latin word Murmur which in turn is said to have been coined from the Greek word Marmorous, meaning shining stone. It is known for its pleasant colours, smooth and uniform texture, moderate hardness, amenability to be quarried into big blocks, smooth & shiny polished surface and silky feel. Marble occupies a unique position among other dimension stones because of its aesthetic value.

In terms of geological definition, it is a metamorphosed limestone produced by re-crystallisation under conditions of thermal and regional metamorphism. In commercial parlance, all calcareous rocks capable of taking polish are classed as marbles. Furthermore, serpentine rocks containing little calcium or magnesium carbonates, if attractive and capable of taking good polish are also classed as marbles. The calcareous stones like onyx, travertine and some limestone have also been classed as marbles. Marble's internal demand has always remained high and most of the production added with recent increase in imports is consumed within the country.

Marble is the most preferred stone in India among all dimension stones. Most of the units in the Marble Industry are in the small-scale sector.

PRODUCTION

Marble being building stone, comes under 'Minor Mineral', as defined in Clause (e) of Section 3 of MM(DR) Act, 1957; hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of marble from 2019-20 to 2021-22 is furnished in Table-1.

Table-1 : Statewise Production of Marble

(In tonnes)

State	2019-20	2020-21	2021-22
Rajasthan	10621000	16159347	10638060
Gujarat	-	-	-
Andhra Pradesh	347	277	-

Source: As received from State DGMs and their websites Note : " - " NA

CLASSIFICATION

A variety of marbles are produced and marketed under various trade names on the basis of colour, shade and pattern. These are i) Plain White Marble ii) Panther Marble iii) White-veined Marble iv) Plain Black Marble v) Black Zebra Marble vi) Green Marble vii) Pink Adanga Marble viii) Pink Marble ix) Grey Marble and x) Brown Marble.

In addition, many new varieties of marble have been brought into the folds of classification especially after opening of new mining areas. The important new types classified by BIS are given below:

1. Yellow marble from Jaisalmer.
2. Pista marble (amphibolite variety) from Andhi- Jhiri belt, Jaipur, Alwar and Dausa districts, Rajasthan.
3. Brown green and golden ultramafics from Dunkar, Churu district, Rajasthan.
4. Chocolate-brown and English teak wood marble from Jodhpur district, Rajasthan.
5. Parrot green marble from Jhilo, Sikar district, Rajasthan.
6. Chocolate-brown or wood-finish marble from Mandaldeh, Chittorgarh district, Rajasthan.
7. Purple marble from Tripura Sundari, Banswara district, Rajasthan.
8. Blue marble from Desuri, Pali district, Rajasthan.

POLICY

The Central Government has notified Marble Development and Conservation Rules, 2002 (notified on 15.5.2002) for conservation, systematic development and scientific mining of marble with a purpose to provide a uniform framework that would be applicable throughout the country. The maximum period for which a lease may be granted shall not exceed thirty years and minimum period shall not be less than twenty years. Further, no lease is to be granted unless there is mining plan duly approved by the State Government or any person authorised in this behalf by that Government.

As per the Export-Import Policy, 2015-20, and the Foreign Trade Policy thereunder, the imports of crude or roughly-trimmed, marble & travertine blocks, slabs and ecaussine & calcareous monumental or building stone are restricted while imports of alabaster are freely allowed under heading No. 2515. On the other hand, the imports of items that fall under ITC(HS) Code 68022110 to 68022190 are freely allowed. The Ministry of Commerce and Industry, Deptt. of Commerce, vide Notification No.27(RE-2015)/2015-20, dated 19.9.2015 has made amendment in the Schedule I (Imports) of the ITC(HS) Classification of Export and Import items. The amended entry is as below: "Import permitted freely provided if value is US$200 and above per square metre". Import of marble, classified under Chapter 25 and 68 from Bhutan shall be subjected to a combined annual quota of 10 lakh sq. ft (5,882 tonnes). The quota came into effect from the date of this Notification and shall operate on financial year basis. Monitoring and allocation of the quota shall be made by the Government of Bhutan. The combined annual quota for import of marble from Bhutan will be 5,882 tonnes as per Directorate General of Foreign Trade.

USES AND SPECIFICATIONS

Marble is used widely in buildings, monuments and sculptures. Its utility value lies in its beauty, strength and resistance to fire and erosion. Marble has its application in interior and exterior wall cladding, interior and exterior paving, fireplace facing and hearth, lavatory tops, residential and commercial counter tops, table tops, statues and novelty items. The other non-conventional uses of marble are in toothpaste, paint, whiting, agricultural lime, etc.

Different marble varieties are used basically as both interior and exterior vertical wall cladding and flooring. Their use as structural elements (masonry), statues, epitaphs, graves, etc. is quantitatively less with funeral art accounting for the largest percentage. In interior applications, such as, for floors, marble is used in the form of 20 mm thick cut-to-size slabs. The slabs are also used for interior and outer facings, stairs, table tops, kitchen platforms, etc. The tiles in sizes ranging from 10 x 10 cm to 60 x 60 cm are used for floors, dadoes and for skirting in thickness ranging from 10 to 20 mm. The selected marble blocks free from cracks and other inclusions are used for making artifacts, such as, carved figures, handrails and balustrade for staircases, jalis, fire places, flower vases and many other pieces of art.

The existing Indian standards for marbles (blocks, slabs and tiles) are covered under IS:1130- 1969 (reaffirmed in 2022).

WORLD SCENARIO

Resources of natural stones are substantial in the world and almost every country produces dimension stones. Major exporting countries of marble in the world are Turkey, Italy, Greece, Spain and Iran.

The world famous Carrara deposits in Italy have been worked over 2,000 years, and according to the statements of experts who have examined the mountains of marble in this locality, the quality of high-grade material yet to be excavated is so great that Carrara promises to meet the present rate of demand for its marbles for centuries to come.

30-16 Mica

Mica is widely distributed and occurs in igneous, metamorphic and sedimentary regimes. Mica group represents 34 phyllosilicate minerals that exhibits a layered or platy structure. Commercially important mica minerals are muscovite (potash or white mica) and phlogopite (magnesium or amber mica). Granitic pegmatites are the source of muscovite sheet, while phlogopite is found in areas of metamorphosed sedimentary rocks into which pegmatite-rich granite rocks have been intruded. It possesses highly perfect basal cleavage due to which it can easily and accurately split into very thin sheets or films of any specified thickness. It has a unique combination of elasticity, toughness, flexibility and transparency. It possesses resistance to heat and sudden change in temperature and high dielectric strength. It is chemically inert, stable and does not absorb water.

For over hundred years, India has enjoyed the monopoly in the production and export of sheet mica in the world. Of late, there has been a steady downfall in the production of mica. This declining trend could be attributed to fall in the demand of natural mica in the world market due to technological improvements that facilitate use of reconstituted mica and emergence of mica substitutes.

However, there are sufficient resources in the country to meet the domestic requirement and export demand.

Most important mica-bearing pegmatites occur in Andhra Pradesh, Bihar, Jharkhand, Maharashtra, Odisha, Rajasthan and Telangana. Occurrences of mica pegmatites are also reported from Gujarat, Haryana, Karnataka, Kerala, Tamil Nadu and West Bengal.

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'mica' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of mica from 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Mica

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	16822	16717	-
Rajasthan	16000	17719	42600

Source: As received from State DGMs and their websites.

USES & SPECIFICATIONS

Natural sheet mica is used in Electrical and Electronic Industries in the form of blocks, splittings and films or built-up mica called "micanite". Sheet mica is used in manufacturing fabricated and micanite products, such as, capacitors and commutator segments. Micanite or built-up mica is partly overlapped, irregular-shaped and arranged as splittings cemented together with either an organic or inorganic binder. Other uses of sheet mica include gauge glasses of high pressure steam boilers, diaphragms of oxygen-breathing equipment, marker dials of navigation compasses, quarterwave plates for optical instruments, window covers for radiation pyrometers & thermal regulators, stove window, chimneys for gas & petromax lamps, diaphragms in microwave transmitters and insulation wrappers for high tension radar coils. Besides, high quality natural mica sheets are used in helium-neon lasers where mica sheet works as retardation plate. Of late, mica washers are extensively used in Computer Industry.

Mica paper or reconstituted mica is a paper-like material made by depositing fine flakes of scrap mica as a continuous mat which is then dried. Mica paper is usually impregnated with organic binder. Primary end-uses of mica paper are the same as for micanite or built-up mica.

Micanite is used in electrical insulation mainly because natural mica sheet of sufficient thickness is not always available. This is used in copper commutator segments of DC universal motors and generators, moulding plates from which V-rings are cut and stripped for use in commutators. These moulding plates also find use in the form of tubes and rings as an insulator in transformers, armatures and motor starters. As flexible plates, micanite is also used in electric motors and generator-armatures, field coil insulators & magnet and commutator core insulation. Similarly, as heater plates, micanite is used where high insulation strength at high temperature is required.

In the Construction Sector, mica scrap/ground mica is used in jointing cement for gypsum boards, asphaltic roofings & damp-proof seal, and insulation boards. Ground mica acts as reinforcing filler in plaster for textured coatings. Mica is used in insulation bricks, slabs and tiles because of its excellent thermal and insulating properties. Dry- ground 50 mesh mica is used in the flux coating for arc welding electrodes, with flux containing 3 to 5% mica powder. In paints, mica in the form of powder is used as filler and as an extender because it provides a smoother consistency, improved workability and imparts increased resistance to water penetration and weathering. It also facilitates suspension due to its relatively low specific gravity and platy morphology. Mica is used mainly in four types of paints, such as, bituminous emulsions, exterior paints, fire-retardant paints and pearlescent pigments. Mica is added to drilling fluids to get off the lost circulation zones. The platy structure of mica facilitates the overlapping of particles to form a tight layer or wall, thereby preventing further fluid loss.

Ground mica is used in the Rubber Industry as a dusting agent and as an inert filler in the production of rubber. Mica fillers increase the hardness, tensile strength and tear resistance of rubber articles. In Plastic Industry, mica is used as a filler and reinforcer in thermoplastics to improve the electrical properties, flexural strength & modulus, stiffness, heat deflection temperatures and resistance. Dry-ground mica powder is used in small quantities in cosmetic applications. The property of high resistance of mica to the effect of the sun rays, moisture, gases, water and other chemicals, enables the use of dry-ground mica powder in small quantity to improve the decorative coating and lustre of wallpaper, printing and ceiling papers, etc. Wet- ground mica powder is used in paints, cosmetics, rubber, etc. as a filler. Small quantities of scrap mica/ ground mica are also used in industries like foundries as coating to foundry cores and moulds, as a dry lubricant to prevent hot bearings from seizing up.

SPECIFICATIONS

The Bureau of Indian Standards (BIS) has prepared standards for (a) processed mica, (b) fabricated mica and (c) mica-based products. BIS has brought out the following specifications for mica for various purposes:

IS:1175 – 1981(First Revision, Reaffirmed 2016): Deals with methods of grading and classification of muscovite mica blocks, thins and films according to visual size, visual qualities and presence of structural imperfections.

IS:1885 (Part-53)-1980 (Reaffirmed 2017): Deals with electrotechnical vocabulary, Part-53, Mica.

IS:2001-1968: Deals with specifications of fixed silvered mica capacitors.

IS:2464-1963 (Reaffirmed 2018): Deals with specifications of built-up mica for electrical purposes.

IS:9043-1979 (Reaffirmed 2021): Deals with grading (by size) of phlogopite mica blocks, thins, films and splittings.

IS:9044-1979 (Reaffirmed 2016): Deals with methods of measuring thickness of mica blocks, thins, films and splittings.

IS:9045-1979 (Reaffirmed 2016): Deals with thermal classification of phlogopite mica splittings.

IS :9299 (Part 3/Sec.1)- 1979 (Reaffirmed 2016): Deals with rigid mica material for commutator separators.

IS:9299 (Part3/Sec.2)-1982 (Reaffirmed 2022): Deals with moulding micante materials for electrical purposes.

IS:9299 (Part 3/Sec. 3)-1982 (Reaffirmed 2008): Deals with flexible mica flake tape for insulation of electrical machines.

IS:9299 (Part 3/Sec. 4)- 1982 (Reaffirmed 2021): Deals with rigid mica materials for heating equipment.

IS:13357-1992 (Reaffirmed 2018): Methods of grading and visual classification of muscovite mica splittings.

SUBSTITUTES

Mica and its products can be substituted to some extent by using alumina, ceramics, bentonite, glass, mylar polystyrene, fused quartz, silicon, talc, bakelite, teflon, nylon synthetic mica, acrylate polymers, cellulose acetate, fibre glass, etc.

Some l ightweight aggregates, such as, diatomite, vermiculite and perlite may be substituted for ground mica when used as filler. Ground synthetic fluorophlogopite, fluorine-rich mica, may replace natural ground mica for uses that require thermal and electrical properties of mica.

Sheet mica is used in electrical components, electronics and atomic force microscopy. Many products can be substituted for mica in electrical and electronic uses. Substitutes include Acrylic, Benelex, Cellulose acetate, Delrin, Duranel N, Fibreglass, Fishpaper, Kel F, Kydex, Kapton Lexan, Lucite, Mylar, Nylon, Nylatron, Nomex, Noryl, Phenolics, Plexiglass, Polycarbonate, Polyester, Styrene, Teflon, Vinyl-PVC and Vulcanised Fibre.

TRADE POLICY

As per Import Policy under schedule of ITC (HS) 2022 and export policy under schdule of ITC (HS) 2022, Mica, inculding splittings, mica waste are allowed free without restrictions. The effective Export-Import Policy, exports and imports of varieties of mica blocks, splittings, powder, waste and scrap under Heading 2525 are allowed without restrictions.

WORLD SCENARIO

Resources of scrap and flake mica are available in clay deposits, granite, pegmetite and schist and are considered more than adequate to meet anticipated world demand in the foreseeable future. World resources of sheet mica have not been formally evaluated because of the sporadic occurrences of this material. Large deposits of mica-bearing rock are known to exist in countries, such as, Brazil, India and Madagascar. Limited resources of sheet mica are available in the United States.

30-17 Ochre

Deposits of red ochre are found chiefly in Bharatpur, Bhilwara, Bikaner, Chittorgarh & Udaipur districts in Rajasthan.

As per Govt of India Notification S.O. 423(E), dated 10th February 2015 , ' ochre' has been declared as 'Minor Mineral',

Ochre is a natural mineral pigment known to mankind from ages. In ancient times it had been used in colouring earthen-ware, household utensils and for decorative purposes. Though its use dates back to prehistoric times, ochre's use only became widespread in the late 19th century, when Jean-Etienne Astier of Roussilon introduced the industrial process for making ochre pigment.

It occurs in various shades and colours generally ranging from yellow to deep orange or brown. The pigmentary strength of ochre is mainly due to the presence of oxides of iron. The presence of hydrated iron oxide imparts yellow colour and anhydrous iron oxide red colour. A mixture of ferrous and ferric oxide imparts mainly brown besides other shades.

Depending upon the colour, the ochres are called red ochre, yellow ochre, green earth, sienna, umber and various other names. In addition to red ochre, the red oxide of iron, commonly called 'red oxide' is an important natural pigment which results from alteration of haematite and ferruginous laterite.

Red ochre is mostly used in Cement Industry. The Cement Grade mix raw material requires a minimum quantum of iron and alumina. The red ochre mixed with limestone makes a perfect mix of constituents in the raw material fed to the cement manufacturing units.

Ochres are non- toxic and are used in manufacturing of paints that not only dries quickly but also covers surfaces thoroughly. Occurrences of ochre have been reported from several States in the Country.

Deposits of red ochre are found chiefly in Bharatpur, Bhilwara, Bikaner, Chittorgarh & Udaipur districts in Rajasthan; Gwalior, Katni and Rewa districts in Madhya Pradesh; Anantapur, Kadapa, Visakhapatnam districts in Andhra Pradesh; Bhavnagar, Kachchh & Patan districts in Gujarat; Ballari & Bidar districts in Karnataka and Chandrapur district in Maharashtra.

Deposits of yellow ochre are found in Guntur & Kurnool districts in Andhra Pradesh; Jabalpur, Mandla, Satna & Shahdol districts in Madhya Pradesh; and Nagpur district in Maharashtra.

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'ochre' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of ochre (Andhra Pradesh–yellow ochre, Gujarat–red ochre) during 2019-20 to 2021-22 is furnished in Table-1

Table-1: State-wise Production of Ochre

(In tonnes)

State	2019-20	2020-21	2021-22
Rajasthan	2886000	2807157	42601
Andhra Pradesh	54000	46276	-
Gujarat	-	-	-

Source: *As received from State DGMs and their websites.*

Note : " - " NA

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

FUTURE OUTLOOK

Ochre is being used as natural pigment since ancient times and it is still being used for this purpose. India has huge resources of both yellow and red ochre. It is mostly produced in Andhra Pradesh, Rajasthan, Gujarat, Madhya Pradesh and Maharashtra. It is extensively used in Paint and Colour Industry and Indian resources are large enough to last for many years in future.

30-19. Pyrophyllite

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'pyrophyllite' has been declared as 'Minor Mineral',

Pyrophyllite is harder than talc. Unlike talc, pyrophyllite does not flux when subjected to fire and maintains its strength after heating. It is, therefore, used in high-grade ceramic products, electric insulators and refractories.

Pyrophyllite ($Al_2O_3.4SiO_2.H_2O$) is a hydrous silicate of aluminium. It resembles closely to talc in many physical and optical properties but differs in chemical composition. Pyrophyllite finds application in high-grade ceramics & refractories and also as a filler in Pesticide Industry. Production of pyrophyllite is mainly reported from Chhatarpur, Tikamgarh & Shivpuri districts of Madhya Pradesh; Mahoba, Hamirpur, Jhansi & Lalitpur districts of Uttar Pradesh; Bhandara district of Maharashtra; Bhilwara & Udaipur districts of Rajasthan; Anantapur & Kadapa districts of Andhra Pradesh; and Kendujhar district of Odisha.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'pyrophyllite' has been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected.

All possible information/data that could be gathered has been presented in this Review.

Statewise production of pyrophyllite during 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Pyrophyllite

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	10610	14762	-
Rajasthan	14300	19050	113546
Odisha	5199	2987	5539

Source: As received from State DGMs and their websites.

Note : " - " NA.

USES AND SPECIFICATIONS

Pyrophyllite is harder than talc. Unlike talc, pyrophyllite does not flux when subjected to fire and maintains its strength after heating. It is, therefore, used in high-grade ceramic products, electric insulators and refractories. Pyrophyllite imparts thermal shock resistance to ceramic bodies. It is also used as filler and dusting powder in various industries. In Glass Industry, pyrophyllite is used as a source of aluminium instead of felspar. Owing to its softness and mode of occurrence in lumps, it is used extensively in handicraft industries for making various articles.

Low thermal expansion and shrinkage characteristics of pyrophyllite makes it a useful ingredient in ceramic blends and may substitute either pitcher (grog) or silica. Pyrophyllite allows faster firing cycles in the manufacture of whiteware.

In production of stoneware and chinaware, more mechanical strength as well as improved whiteness can be achieved at lower firing temperature. Pyrophyllite is quite stable up to 800° C and hence, it is consumed in refractory as well as in wall tiles, sanitaryware, electrical porcelain and other ceramic and vitreous china products. Pyrophyllite is non-abrasive, inert with a neutral pH, as well as a good absorbent providing good flowability which allows it to be used as a diluent, extender, vehicle and carrier for liquids, such as, fungicide, insecticide, herbicide and fertilizer.

The BIS has prescribed the specifications for pyrophyllite for Ceramic Industry (IS:11477-2011 first revision) reaffirmed on March 2012.

The consumers in Refractory Industry generally prefer pyrophyllite containing 26 to 28% Al_2O_3, 3 to 4% alkali and having. 23 to 25 Pyrometric Cone Equivalent (PCE). For Insecticide Industry, the specifications of talc/steatite can also be applicable to pyrophyllite as given below:

Loss on Ignition: 7% max.

Matter soluble in HCl: 3% max.

Fe_2O_3: 1.5% max.

FUTURE OUTLOOK

Globally, market demand for pyrophyllite is expected to increase over the next few years on account of steady growth witnessed in the Ceramic Industry and its other refractory applications. Increasing number of applications of pyrophyllite in various end-use industries including paints, electrical, porcelain, insecticides, machinery, rubbers and plastics are likely to aid market growth over the next few years. Pyrophyllite will continue to face competition from bentonite and attapulgite in carrier applications. However, use in filler applications appears to be stable.

30-20 Quartz & Other Silica Minerals

The term 'quartz' is often referred to as a synonym for silica. Silica is one of the ubiquitous materials in the earth's crust. Quartz, quartz crystals, quartzite, silica sand, sand (others) and moulding sand are all coined together in one generic name 'silica minerals'. This is because all these commodities are essentially crystalline silicon dioxide (SiO_2) with variations mostly related to their crystalline structure and presence of minor or trace impurities. Silica occurs in several forms giving rise to different varieties.

Crystalline Varieties

The important varieties of crystalline quartz are vein quartz (massive crystalline quartz); milky quartz (white, translucent to opaque); ferruginous quartz (containing brown limonite and red haematite and almost opaque); aventurine quartz (containing glistening flakes of mica or haematite); cat's eye (opalescent greenish quartz with fibrous structure); rock crystal (clear, colourless, well-crystallised transparent quartz); amethyst (clear-purple or violet- blue), transparent quartz; rose quartz; smoky quartz; etc. Occurrences of massive crystalline quartz in veins or pegmatites have been recorded in almost all the States.

Clastic or Granular Varieties

These varieties include sand consisting largely of unconsolidated quartzose grains (0.06 mm to 2 mm diameter), gravel consisting largely of unconsolidated coarse quartzose grains or pebbles (2 mm to 8 mm in diameter), sandstone and quartzite. Quartzite is a granulose metamorphic rock consisting essentially of quartz and sandstone cemented by silica which has grown in optical continuity around each grain. Occurrences are reported from Andhra Pradesh, Bihar, Delhi, Haryana, Karnataka, Kerala, Madhya Pradesh, Rajasthan,Tamil Nadu, Uttar Pradesh, etc. The silica sand from Naini area in Allahabad district, Uttar Pradesh is of a very high quality.

Cryptocrystalline Varieties

This group includes chalcedony, agate, jasper, onyx, flint and chert. These varieties appear non- crystalline (amorphous) in hand specimens, but under microscope show double refraction which reveals their concealed crystalline nature.

These varieties are reported from Gujarat, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Maharashtra, Madhya Pradesh, Karnataka and Punjab. The most important occurrences of agate are in Ratnapur, Rajpipla area and further west between Rivers Tapi and Narmada in Bharuch district, Gujarat, where it is found as pebbles in varying sizes associated with clay washed down by the river flow. Other occurrences of economic importance are reported from Amravati, Aurangabad, Buldhana, Chandrapur, Nashik and Pune districts in Maharashtra; beds of Rivers Krishna and Godavari in Andhra Pradesh; Dumka district in Jharkhand; Dhar, Mandsaur, Sihore and Shahdol districts in Madhya Pradesh; and Kachchh district in Gujarat.

As per Govt of India Gazette Notification S.O. 423 (E), dated 10th February 2015, 31 minerals have been declared as minor minerals. Out of these 31 minor minerals, agate, fuschite quartzite, jasper, quartz, quartzite, sand (others) and silica sand come under the different variety of silica minerals. Minor minerals come under the purview of respective State Governments and they frame the rules for minor minerals.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

Quartz/Silica Sand/Quartzite/Sand (Others)/ Agate

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'quartz/silica sand/quartzite/ sand (others)/ agate/ jasper' have been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of quartz, silica sand, quartzite during 2019-20 to 2021-22 is furnished in Tables-1 to 3.

Table-1: Statewise Production of Quartz

(In tonnes)

State	2019-20	2020-21	2021-22
Rajasthan	5744000	3037988	2799048
Andhra Pradesh	878270	547390	-
Telangana	813816	-	-
Gujarat	-	-	-
Maharashtra	245050	-	-
Karnataka	127064	71020	-
Odisha	148	2589	1458

Source: As received from State DGMs and their websites.

Note : " - " NA

Table-2: Statewise Production of Silica Sand

(In tonnes)

State	2019-20	2020-21	2021-22
Gujarat	-	-	-
Andhra Pradesh	2871070	1402110	-
Rajasthan	1329000	1306802	1948690
Maharashtra	879007	-	-
Himachal Pradesh	1500	-	7613
Kerala	-	-	-

Source: As received from State DGMs and their websites.

Note : " - " NA

Table-3: Statewise Production of Quartzite

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	525726	851897	-
Gujarat	-	-	-
Rajasthan	17000	120079	-
Odisha	72352	86668	173813

Source: As received from State DGMs and their websites.

Note : " - " NA

Moulding Sand

The production of moulding sand was Nil tonnes in 2021-22 as against 11,737 tonnes in the previous year.

There were four reporting mines in the year 2020- 21 against three reporting mines in 2019-20. The production of moulding sand was reported only from Chhattisgarh State during the year (Table -4 to 7).

Table - 4: Principal Producers of Moulding Sand, 2020-21

Name & address of producers	Location of mine	
	State	District
Mahendra Kumar Seksaria, 271, Ramdev Mandir, Ward-35, Ganjpara, Durg-491 001, Chhattisgarh.	Chhattisgarh	Durg
Smt. Sujata Dakaliya, House No: 19/132, Sahadeo Nagar, Rajnandgaon-491 441, Chhattisgarh.	Chhattisgarh	Rajnandgaon
Bimal Kumar Seksaria, 271, Ramdev Mandir, Ward-35, Ganj Para, Durg- 490 001, Chhattisgarh.	Chhattisgarh	Rajnandgaon

Table –5: Production of Moulding Sand, 2019-20 to 2021-22

(By States)

(Quantity in tonnes; Value in ₹ '000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**12805**	**3683**	**11737**	**3419**	**-**	**-**
Chhattisgarh	12805	3683	11737	3419	-	-

Table – 7 : Production of Moulding Sand, 2019-20 & 2020-21

(By Sector/State/Districts)

(Qty in tonnes; Value in ₹ '000)

State/District	2019-20			2020-21		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**4**	**11737**	**-**	**-**	**-**	**-**
Private sector	-	-	-	-	-	-

Flint Stone

The production of flint stone was not reported since last three years i.e. 2019-20 to 2021-22.

MINING

Mining for silica minerals is carried out by manual opencast method. Quartz produced in the form of lump along with other associated minerals is invariably hammered to pieces and manually sorted before it is despatched to the consuming industries. It is sometimes crushed and marketed. Glass sand is generally screened and washed to remove all the deleterious constituents for its use in Glass Industry.

APMDC owns two crushing plants located at Mahabubnagar district in Andhra Pradesh with crushing capacity of 45 tonnes and 1,000 tonnes a month, respectively. Besides, Maharashtra Minerals Corp. Ltd operates a 50 ,000 tonnes per year beneficiation plant at Phondaghat in

Sindhudurg district. The plant uses advanced technology in washing both by water and chemicals and further grading it in required fractions.

HEALTH HAZARDS

Respirable silica is still a cause of major concern to miners and consumers since many minerals, especially industrial sand and gravel contain crystalline silica. There is a potential threat to workers of getting subjected to "silicosis" in quartz, silica sand and gravel mines. Occupational safety measures & regulations to monitor the levels of crystalline silica in these mines are mandatory. In the USA, the Occupational Safety and Health Administration (OSHA) listed "crystalline silica" as one of their top five priorities for formulation of necessary rules. The OSHA, on the basis of significant information put out by International Agency for Research on Evaluation of Cancer has declared that any material containing more than 0.1% crystalline silica should indicate its carcinogenic hazard.

USES & SPECIFICATIONS

Quartz, quartzite and silica sand are used in various industries like glass, refractory, foundry, ceramic, cosmetic, electrical, abrasives, paints, etc. The primary use of silica is in the manufacture of virtually all types of glasswares, ceramics and ceramic glazes. Other major uses are in metallurgy, (where silica is used as a refractory, foundry mould, fluxes and as a source of silicon for the production of silicon metal and ferro-silicon and other ferro- alloys), silicon carbide manufacture, chemical & construction sectors and as a natural abrasive. Known for its piezoelectric properties, high quality quartz crystal is used in electronic devices, multiple telephone lines, depth-sounding devices, range finders, chronometers, etc.

Sand is also used as a fireproofing material, for sandstowing in mines, soundproofing material and as a filler. Silica sand is also used to maintain or increase the permeability of oil and gas-bearing formations; its application as a filler in acid proof cements, putty, paints, epoxy & polyester resins is inevitable. Besides, it is widely used in horticulture as a filtration medium, and for ornamental purposes as well. Silica flour is used as a filler in plastic and rubber products.

Flint and chert are used in abrasives and tube- mill lining. Besides, chert is used in crushed form as aggregate for concrete and road surfacing. Rounded pebbles of chalcedony are used as balls in ball mill for finer crushing and grinding felspar, calcite & barytes. The different cryptocrystalline varieties of transparent and translucent chalcedony are valued as semi-precious stones and are carved out into a variety of ornaments and used for making different ornamental wares or articles of decoration. Agate pieces after cutting and polishing are sold as semi-precious stones. Big pieces are used in making mortars and pestles for laboratory use. Agate cut into requisite shapes is also used as fulcra of scientific balances and in making edges, planes and bearings of precision instruments.

In India, quartz, quartzite and silica sand are used mainly in glass, foundry, ferroalloys and refractory industries and also as building materials. According to its suitability for different purposes, it may be named as building sand, paving sand, moulding or foundry sand, refractory sand or furnace sand, filter sand, glass sand and grinding & polishing sand.

SUBSTITUTION

In order to reduce the potential threat of "silicosis", a variety of materials are used as substitutes for silica. Basic and neutral refractories (including magnesite, mag-chrome, dolomite and high alumina bricks) have replaced silica in a large number of applications. Chromite, olivine and zircon are alternatives to foundry sands. Garnet and to a lesser extent, olivine, are used in sand blasting to avoid the risk of silicosis. Wollastonite is more favoured than free silicon for use in the Ceramic Industry, again due to the risk of silicosis. In Electronic Industry, replacement of natural quartz crystal by cultured quartz crystal is increasing steadily. It has been estimated that about 10 billion quartz crystals and oscillators per year are manufactured and installed worldwide in all types of electronic devices.

FUTURE OUTLOOK

According to its suitability for different purposes, quartz & silica minerals are named as building sand, paving sand, moulding or foundry sand, refractory sand or furnace sand, glass sand, etc. The future market demand of quartz and silica minerals will depend on its application. However, the main use of silica minerals is in the manufacture of different types of glasses, natural silica sand being the preferred material in the Glass Industry. In India, quartz, quartzite and silica sand are used mainly in glass, foundry, ferroalloys, refractory industries and also as building materials. Silica sand is used in the Oil Industry for the hydraulic fracturing process as it helps in the extraction of gases. The market demand of silica minerals may get very high due to increased use in horizontal well drilling by oil companies.

The demand for quartz, silica sand, moulding sand and quartzite is increasing over the years to cater to the requirement of ferrosilicon, silico- manganese, silico-chrome, silica refractories, glass and for moulding & casting purposes. The requirements of these products are linked up directly with Iron & Steel Industry including alloy steel production. Further, setting up foundries and enhancing their capacities are also linked with Metallurgical Industry. There are very good prospects of increasing the production and also the export of quartz and silica minerals to the neighbouring countries.

30-21Slate, Sandstone & Other Dimension Stones

Slate, sandstone, limestone and quartzite are the principal rock types used as dimension stones other than granite and marble. India is endowed with abundant resources of these types of dimension stones which are increasingly used by domestic consumers. These stones are also important export commodities. India is one of the largest producers of dimension stones in the world.

1. SLATE

Slate is a fine-grained, very low-to-low metamorphic rock possessing well-developed fissility (splitting attitude) tendencies that are parallel to the planes of slaty cleavage. It is formed by the metamorphism of pre-existing clay rocks, such as, claystone, shale or siltstone. The most remarkable feature of this rock is that it has cleavage planes that are well-marked which enable it to be split manually or mechanically into relatively thin slabs. Slate is a low-cost decorative stone used for exterior and interior decoration of buildings. It is significantly used in roofing. It is also used as school slate and also as building dimension stone. The aesthetic value of slate matches that of other dimension stones, granite and marble. Slate has emerged as a low cost alternative to granite and marble which are comparatively expensive. The exports of slate have increased over the period and this has brought a sense of reckoning to Slate Mining Industry of the country. Micaceous and chlorite slates are generally preferred among many slate stone varieties.

OCCURRENCES

The Aravalli Mountain ranges in Rajasthan and Haryana; rock assemblages under Kadapa System in Andhra Pradesh and Tamil Nadu; and Himalayan region in Northern India are the regions where slate deposits along with other metamorphosed products are abundantly known to be present. The availability of slates has also been reported from Madhya Pradesh, Haryana, Himachal Pradesh, Jharkhand, Andhra Pradesh, Rajasthan, Uttarakhand, Bihar and Gujarat.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'slate' has been declared as 'Minor Mineral' hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of slate during 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Slate

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	12980	8810	-
Himachal Pradesh	3451	3478	2769
Rajasthan	1250	998	2405

Source: As received from State DGMs and their websites.

Note : " - " NA

USES AND SPECIFICATIONS

There are two main uses of slate as a natural stone in building work: a) for roofing in the form of roofing tiles and b) for flooring in the form of tiles and for cladding purposes.

For roofing tiles, the slate stone should be exfoliated easily and should be free from minerals like iron sulphides or carbonates which after a period of time could cause corrosion and staining. For cladding or flooring purposes, the slate stone should withstand the impact of the cutting processes involved for producing required sizes, polishing or smoothening process by machines and should not peel off during the process of fixing or laying. Bureau of Indian Standard has laid down Standard IS: 6250-1981 (First revision; reaffirmed 2022), namely, specification for roofing slate tiles with respect to requirement of dimensions, physical properties and workmanship of slate tiles used for sloped roof covering.

2. SANDSTONE

Sandstone is a sedimentary rock largely made up of sand grains in size ranging from 2 mm to 120 mm of varying compositions. The sand may consist of grains of quartz, felspar and other detrital minerals with interstitial cementing material. The composition of sand particles and the cementing material by and large defines the colour of sandstone while the mode of formation decides the thickness of bed which gives rise to various types of sandstones.

The colour of sandstone may range from dark red to brown, earthy to buff, white, yellow and a number of other shades. The pattern of the sandstone depends upon the thickness of bed. Sandstone produced in the country is being marketed as Vindhyan Red, Rainbow, Teak, Modak, Bundi, Bansi Pink, Mandana, Dholpur Cream, etc. The sandstone may occur as massive, thick, non-splittable bands or thin beds or layers that can be split by applying slight pressure. Only the State of Rajasthan reported production of sandstone about 158.14 lakh tonnes & 274.50 lakh tonnes during 2018-19 & 2019-20 respectively.

RESERVES/RESOURCES

Occurrences of sandstone in India are spread across Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Madhya Pradesh, Meghalaya, Mizoram, Karnataka, Odisha, Punjab, Rajasthan, Uttar Pradesh, Tamil Nadu and West Bengal.

The reserve/resource estimation has not been considered important because of its abundance and easy availability. Hence, there is no comprehensive inventory of sandstone. However, the Centre for Development of Stones (CDOS), a 'Government of Rajasthan Undertaking' has reported estimated reserves of sandstone at over 1,000 million tonnes in the country. Huge deposits of sandstone in Rajasthan are associated with Vindhyan and Trans- Aravalli Formations, exposed over an area of nearly 35,000 sq. km covering districts of Dholpur, Bharatpur, Karauli, Sawai Madhopur, Tonk, Bundi, Jhalawar, Kota, Bhilwara and Chittorgarh. It is also found scattered in the districts of western desert plain in the districts of Jodhpur, Churu, Bikaner and Nagaur. Splittable sandstone deposits are confined to an area of 16,000 sq. km, out of which 10,000 sq. km lies in eastern and south-eastern Rajasthan and 6,000 sq. km in western Rajasthan.

In Gujarat, fine to medium-grained sandstone of varying colours ranging from white, light-purplish, reddish-brown, cream to yellow are found in the district of Kachchh. A brownish-yellow sandstone occurs near Chabari and Mainapara in Bhachau tehsil. The sandstone at Rampur, Katada-Roha and Rajoda Dungar near Mangwana in Nakhtrana tehsil is cream coloured and is fairly hard. Extensive deposits are found around Songir, Naswadi, Ghautoli, Namaria and Lachharas in District Vadodara.

The Vindhyan and Satpura Mountains in Madhya Pradesh have vast resources of sandstone. The red, cream and white sandstone are being quarried extensively in Panna and Shivpuri districts and in many areas near Jabalpur.

In Uttar Pradesh, sandstones suitable for making slabs and tiles are located in Agra, Mirzapur, Lalitpur, Allahabad and Sonbhadra districts. The sandstone of Lalitpur district is yellow, light green and maroon and takes good polish. The sandstone in Lalitpur occurs in Madanpur and Rampura (near Deogarh) areas and is traded under the commercial name Royal Gold, Beach Sand and U.P. Green. The sandstone of Agra occurring in Tatpur area is red and mottled and is used for interior as well as exterior flooring and cladding. In Mirzapur and Sonbhadra areas, good quality buff to pale and creamish sandstone is available.

The felspathic sandstone occurring with the coal seams as overburden is also used as building stone. The Kamthi Sandstone occurring in and around Tehsil Saoner, District Nagpur in Maharashtra is being quarried and is used as building stone.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

Sandstone being building stone comes under 'Minor Mineral' as defined in Clause (e) of the Section 3 of MM(DR) Act 1957, hence the producers report the production data directly to the respective States and not to IBM. Production data for sandstone is not available except for that of Rajasthan, Jammu & Kashmir and Karnataka. Karnataka produced about 569 tonnes during the year 2020-21 as compared to 272 tonnes in the previous year; Rajasthan produced 22.4 million tonnes during 2020- 21 as compared to 10.26 million tonnes in the previous year; while J & K produced 3,109 cubic meter of sand stone during current year 2020-21.

3.DIMENSION LIMESTONE

The limestone which is used as dimension stone differs from the limestone used for cement making or for any other industrial purpose in two ways — firstly, chemical composition and secondly, the mode of occurrence. In both the types, the major constituent is calcium carbonate, but, very high silica content gives limestone sufficient hardness to be utilised as a dimension or building stone. The industrial limestone occurs as massive formation with less intercalations while in case of dimension limestone, thin-bedded deposits are preferred. Limestone which is compact and amorphous in texture is known as flaggy or splittable limestone and is quarried in the form of thin slabs ranging in thickness from 12 mm to 50 mm in ready-to-use form. Statewise production of limestone slabs used as dimension stone during 2019-20 to 2021-22 is furnished in Table-3

Table-2: Statewise Production of Limestone Slabs

(In tonnes)

State	2019-20	2020-21	2021-22
Andhra Pradesh	21445258	19482975	-
Telangana	2926619	-	-
Rajasthan	9586000	5153067	3851957

Source: As received from State DGMs and their websites.

Note : " - " NA

Limestone has been used since ancient times for construction of houses, flooring and for various other building purposes. In recent times, the use of limestone has increased manifold mainly for interior flooring, as cobble stones and for decorative purposes in combination with other stones because of its availability in a range of colours and shades. Depending upon the place of origin of limestone and its colour, various types of nomenclatures have been used in the trade for limestone, such as, Kadapa Stone, Shahabad Stone, Kota Stone with different shades and colours (Kota Blue, Kota Brown, etc.), Kachchh Stone, Miliolitic Limestone, etc.

OCCURRENCES

Occurrences of dimension limestone have been reported from several regions across various States, such as, Shahabad Stone of Vijapura at Kalaburagi and Belagavi districts in Karnataka; and 'Kadapa Stone' of Kurnool at Anantapur and Guntur districts and 'Tandur Stone' of Kadapa district in Andhra Pradesh, etc. Other coloured well- known limestones are from Bethamcherla, Tadipatri & Macherla areas in Andhra Pradesh and Nereducherla & Muddimanikyam in Telangana. Occurrence of 'Milliolitic Limestone' from Saurashtra region, 'Yellow Limestone' in Kachchh district of Gujarat, 'Kota Limestone' in Kota district and 'Yellow Limestone' in Jaisalmer district, Rajasthan have also been reported from across the country.

Rajasthan is richly endowed with the occurrence of greenish-grey 'Kota' limestone. The Kota stone has gained tremendous popularity and is widely used for flooring and cladding purposes. The important deposits of limestone are in Kota, Jhalawar, Chittorgarh and Jaisalmer districts, Rajasthan. Kota, Jhalawar and Chittorgarh are the major districts that produc e dimensio n l imestone in the State. Extensive limestone deposits are found in the Upper Stage of the Lower Vindhyans and these limestone varieties have good potential to be used as cement-grade limestone as well as flooring stone. Certain portions of the limestone having splittable form are used extensively as flooring stones. Occurrences of limestone in the north- south belt from Dalla-ka-Khera to Nimbahera which extend into Madhya Pradesh covering a distance of about 70 km have been established. It is fine-grained, thinly bedded and has a total thickness of about 150 m. At a few places, the major portion of the limestone deposit is suitable fo r cement making b ut ther eare pockets, containing splittable forms that can be used for building and flooring purposes directly.

Occurrences of yellow limestone deposits in Jaisalmer is of Jurassic Age and is found in Bada Bag, Mool Sagar and Kanod villages of Jaisalmer. It contains 42 to 51% calcium oxide and has a thickness of about 3 m. It is quarried in the form of blocks and can be sawed into slabs and tiles. It is also termed as yellow marble as it takes reasonably good polish.

Flaggy limestone deposits of Jhalawar and Ramganjmandi, Kota area belong to Lower Vindhyan Group and are available in plenty at Sarola Kotri Chitawa and Khokhriya-Khurd areas. Extensive de posits are available near Ramganjma ndi, Aroliya and Parolia areas. Ramganjmandi and Jhalawar Road are the main railway stations f rom wher e the splittab le limestone produced is dispatched to various parts of the country. In the last few years, export market of this limestone which is popularly known as 'Kota Stone' has been vastly significant.

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

USES & SPECIFICATIONS

Application of Kota Stone ranges from interior flooring, wall cladding to exterior use in paving and facades for building of all kinds and types.

The Kota Stone has a natural split non-slip surface. Massive, dense and fine-grained varieties are generally durable as these are not porous. These are tough and have a crushing strength of 17.8 kg/mm2 and a high compressive strength of over 2,189 kg/cm2. Abrasion value of Kota Stone is 18.12 to 18.32 and it has a high resistance to delamination and failure under freezing and thawing conditions.

Bureau of Indian Standards has prescribed Specification for Limestone (Slab & Tiles) as IS : 1128 - 1974 (First Revision, reaffirmed 2008).

4.OTHER DIMENSION STONES

In addition to the dimension stones already described, other dimension stones are also quarried and used for the construction of houses and other building purposes.

In Odisha, Karnataka, Goa and in parts of coastal States, laterite is quarried in huge quantities. It is utilised as bricks in the construction of houses and pavements. Huge deposits of basalt in Maharashtra, Karnataka and Gujarat are used as building stones since ancient times. Quartzite bands occurring along with phyllite schists are also utilised for building purposes.

In addition, stone aggregates, such as, broken and sized pieces of limestone, dolomite, quartzite and sandstone are mixed either with cement for building and road-making purposes or with asphalt for mending road. To utilise the huge waste generated during mining and processing, a new variety of man-made stone 'Terrazo" has been developed, which is composed of stone chips set in cement, epoxy or polyacrylate and then polished. The Terrazo is an economical alternative to solid marble slabs or tiles.

5.FELSITE

Felsite is a f ine evenly-grained acid or intermediate igneous rock, usually occurring as dykes and veins in country rocks and in the parent plutonic mass. BIS has prescribed the specification IS:10874- 1983 (reaffirmed 2010) for felsite grinding media and liner stones. Felsite has architectural, industrial and antiquity uses. As per GOI Notification S.O.423(E), dated 10.2.2015, felsite has been declared as 'Minor Mineral', hence the production beyond January, 2015 is not available with IBM.

TRADE POLICY

As per the Export-Import Policy announced for the period 2015-20; and the Foreign Trade Policy thereunder, the imports of slate blocks or slabs whether or not roughly trimmed or merely cut are restricted under Heading no. 2514. As per Import policy under schedule of ITC (HS) 2022 and export policy under schedule of ITC (HS) 2022, the imports of slate, whether or not roughly trimmed or merely and, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape are restrictd.

Import of crude or roughly trimmed/cut blocks or slabs of sandstone and other monumental or building stones, viz, pakur stone, stone boulders, and others, are restricted under Heading no. 2516. However, sets of curbstones and flagstones of natural stone (except slate) under Heading no. 6801 and worked monumental building stone (excluding slate), tiles, cubes and similar articles of natural stone including slate, under Heading No. 6802 can be imported freely. Worked slate and articles of slate or of agglomerated slate under Sub-heading 6803 can also be imported freely.

Exports of stone aggregates which are restricted under Chapter 25 of ITC (HS), 2022, Schedule 2-Export policy, are permitted to be exported to Maldives subject to ceiling limits. The annual ceilings are monitored by CAPEXIL and is subject to exporters obtaining appropriate clearances.

FUTURE OUTLOOK

Slate is mostly used as a roofing material, but other uses like cladding and flooring tiles are also gaining momentum. Slate occurs widely in the country and detailed study has to be conducted to quantify the resources. The demand for dimension stones including sandstone & others and stone products is anticipated to grow at around 15%. A similar growth is also expected in exports.

The demand for artifacts, especially carved work is on the rise all over the world. India with its rich tradition of craftmanship and trained artisans can embark upon the world market.

Improved quarrying, finishing & hauling technology, availability of greater variety of stones and the rising cost of alternative construction materials are among the factors that suggest that the demand for dimension stones in future would see steady and consistant growth

30-22 Talc, Soapstone and Steatite

Talc is a hydrous magnesium silicate. In trade parlance, talc often includes: (i) the mineral talc in the form of flakes and fibres; (ii) steatite, the massive compact cryptocrystalline variety of high-grade talc; and (iii) soapstone, the massive talcose rock containing variable talc (usually 50%), which is soft and soapy in nature. Commercial talc may contain other minerals like quartz, calcite, dolomite, magnesite, serpentine, chlorite, tremolite and anthophyllite as impurities. The properties of talc that enable its use in a wide variety of applications are its extreme softness & smoothness, good lustre & sheen, high slip & lubricating property, low moisture content, ability to absorb oil & grease, chemical inertness, high fusion point, low electrical & heat conductivity, high dielectric strength, good retention for filler purposes, whiteness, good hiding power as pigment and high specific heat. In addition, it has the advantage of being relatively abundant. It can be easily mined and prepared for market. Rajasthan is the hub of activities related to talc mining, processing and trade. Talc, Soapstone and Steatite has been declared as 'Minor Mineral', vide Government of India Notification S.O. 423 (E) dated 10th February, 2015.

RESERVES/RESOURCES

As per NMI data, based on the UNFC system, the total reserves/resources of talc/soapstone/steatite as on 1.4.2015 has been estimated at 316 million tonnes of which Reserves and Remaining Resources are 106 million tonnes and 209 million tonnes, respectively. Substantial quantities of reserves/resources are established in Rajasthan (57%) and Uttarakhand (25%). The remaining 18% resources are in Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Odisha, Sikkim, Tamil Nadu and Telangana. By grades, Paper & Textile grade accounts for about 22% share in total resources followed by Insecticides (21%) and Cosmetics (9%). Resources of Ceramic and Paint grades are negligible. Others, Unclassified and Not-known grades account for about (48%) resources (Table-1).

EXPLORATION & DEVELOPMENT

The exploration & development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

PRODUCTION

As per Govt of India Notification S.O. 423(E), dated 10th February 2015, 'talc, soapstone and steatite' have been declared as 'Minor Mineral', hence the producers report the production data directly to the respective States and not to IBM. However, efforts were made to collect this information through correspondence with the State Directorates of Mining and Geology of individual States or visiting their websites. But data of only a few States could be collected. All possible information/data that could be gathered has been presented in this Review.

Statewise production of talc, soapstone and steatite during 2019-20 to 2021-22 is furnished in Table-1.

Table-1: Statewise Production of Talc, Soapstone & Steatite

(In tonnes)

State	2019-20	2020-21	2021-22
Rajasthan	1484000	1590395	1350430
Andhra Pradesh	110921	102260	-
Karnataka	432	721	-
Gujarat	-	-	-

Source: As received from State DGMs and their websites.

Note : " - " NA.

USES & SPECIFICATIONS

Talc in pulverised form is mostly used as a filler in paper, textile, rubber, insecticides and fertilizer industries. Pure talc after calcining, called 'Lava', is used in the manufacture of low-loss ceramic materials essential for radio, radar, television, etc. In roofing products, such as, tar, paper, asphalt shingles and roll roofing, talc acts as a fire retardant and increases weather resistance. Body and face powders (talcum powder) are prepared from the finest quality talc after adding deodorant and perfumes. Massive steatite when cut into panels is used for switchboards and acid Proof tabletops in laboratory, laundry and kitchen sinks, in tubs and tanks as well as for lining alkali tanks in Paper Industry. Due to its high melting point (1,630 ^{0}C), soapstone can be used in refractories and fire places. It is also quite useful in sculpturing.

Indian talc, especially mined in Rajasthan and Andhra Pradesh is comparable with the best quality available in other countries. In the world market, talc, free from grit, having high whiteness and high degree of soapiness feeling is very much sought after in cosmetic, filler and weighing applications. Talc having more than 92% brightness, less than 1% $Fe2O_3$and less than 1.5% $CaCO_3$ is preferred for exports.

Soapstone powder is also used as parting agent in Foundry Industry. Parting agents are used for easy release of moulds and cores from pattern equipment and core boxes. BIS specification IS 8250-1988 (First Revision Reaffirmed, February 2014) prescribes use of off-white or cream-coloured material having a very smooth and slippery feel, passing completely through 75 microns IS-sieve. The material shall be predominantly magnesium silicate and chemical composition as agreed to between buyer and purchaser compatible with naturally occurring soapstone. In Paint Industry, foliated, fibrous weather resistance. Body and face powders (talcum powder) are prepared from the finest quality talc after adding deodorant and perfumes. Massive steatite when cut into panels is used for switchboards and acid Proof tabletops in laboratory, laundry and kitchen sinks, in tubs and tanks as well as for lining alkali tanks in Paper Industry. Due to its high melting point (1,630 0C), soapstone can be used in refractories and fire places. It is also quite useful in sculpturing.

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POLICY

As per Import Policy under Schedule I of ITC (HS) 2022 and Exports Policy under Schedule II of ITC (HS) 2022, Natrual Steatite whether or not roughly trimmed or merely cut by sawing or otherwise, into blocks or slabs of a rectangular (inculding square) shape is allowed; while for talc exports aer allowed freely without restrictions.

FUTURE OUTLOOK

India is one of the principal sources of 'Lava' grade talc suited for specialised purposes like low ceramic materials and of swan-shaped talc. Indian talc is considered to be the second best in the world next to Italian talc. India has large resource base and well-developed production facilities that utilises modern pulverising techniques. Concerted efforts through R & D advancements are necessary to make Indian talc suitable for world market.

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