

GRAPHITE



# Indian Minerals Yearbook 2022

(Part- III : Mineral Reviews)

60<sup>th</sup> Edition

GRAPHITE

(ADVANCE RELEASE)

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December, 2023

# 14 Graphite

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**G**raphite, also known as plumbago or blacklead or mineral carbon, is a stable form of naturally occurring carbon. Structurally, graphite is known to crystallise in hexagonal system and occurs in layered & lamellar form with grey-to-black metallic lustre and a greasy feel. Natural 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 Beneficial '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).

## EXPLORATION & DEVELOPMENT

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

## PRODUCTION & 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 – 1 : Reserves/Resources of Graphite as on 1.4.2020 (P)**  
(By Grades/States)

(In tonnes)

Grade/State	Reserves			Remaining Resources					Total Resources (A+B)			
	Proved STD111	Probable STD121    STD122	Total (A)	Feasibility STD211	Pre-feasibility STD221    STD222	Measured STD331	Indicated STD332	Inferred STD333		Reconnaissance STD334	Total (B)	
<b>All India : Total</b>	<b>4386467</b>	<b>- 4176944</b>	<b>8563411</b>	<b>7964326</b>	<b>3461288</b>	<b>6166401</b>	<b>796464</b>	<b>10679490</b>	<b>31827080</b>	<b>142165128</b>	<b>203060176</b>	<b>211623587</b>
<b>By Grades</b>												
+ 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
Beneficial	-	-	-	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
<b>By States</b>												
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

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**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, Bhubaneswar - 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)**

(Qty in tonnes; Value in ₹'000)

State	2019-20		2020-21		2021-22 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
<b>India</b>	<b>34674</b>	<b>55908</b>	<b>35386</b>	<b>87147</b>	<b>57264</b>	<b>95192</b>
Chhatisgarh	908	409	1701	2041	-	-
Jharkhand	21202	20661	5962	6069	21	23
Odhisa	12564	34838	17697	46633	21029	63519
Tamil Nadu	-	-	10026	32404	36214	31650

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**Table – 4: Production of Graphite, 2020-21 and 2021-22  
(By Sectors/States/Districts)**

(Qty in tonnes; Value in ₹ '000)

State/District	No. of Mines	2020-21					2021-22 (P)					
		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
<b>India</b>	<b>13</b>	<b>822</b>	<b>472</b>	<b>34092</b>	<b>35386</b>	<b>87147</b>	<b>11</b>	<b>1043</b>	<b>1130</b>	<b>55091</b>	<b>57264</b>	<b>95192</b>
Public Sector	1	-	-	10026	10026	32404	1	-	-	36214	36214	31650
Private Sector	12	822	472	24066	25360	54743	10	1043	1130	18877	21050	63543
<b>Chhattisgarh</b>	<b>1</b>						<b>1</b>					
Surguja	1	-	-	1701	1701	2041	1	-	-	-	-	-
<b>Jharkhand</b>	<b>3</b>						<b>1</b>					
Latehar	1	-	-	3259	3259	3178	-	-	-	-	-	-
Palamau	2	-	-	2703	2703	2891	1	-	-	21	21	23
<b>Karnataka</b>	<b>2*</b>						<b>2*</b>					
Mysore	2*	-	-	-	-	-	2*	-	-	-	-	-
<b>Odisha</b>	<b>6</b>	<b>822</b>	<b>472</b>	<b>16403</b>	<b>17697</b>	<b>46633</b>	<b>6</b>	<b>1043</b>	<b>1130</b>	<b>18856</b>	<b>21029</b>	<b>63519</b>
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
<b>Tamil Nadu</b>	<b>1</b>						<b>1</b>					
Sivaganga	1	-	-	10026	10026	32404	1	-	-	36214	36214	31650

\* : Only labour reported during the year.

**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		Cumulative percentage	
	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)	2020-21	2021-22 (P)
<b>India</b>	<b>13</b>	<b>11</b>	<b>35386</b>	<b>77264</b>	<b>100</b>	<b>100</b>	-	-
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

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**Table – 6: Mine-head Closing Stocks of Graphite, 2020-21 & 2021-22  
(By States/Grades)**

(In tonnes)

State	2020-21				2021-22 (P)			
	Grade: Fixed Carbon content			Total	Grade: Fixed Carbon content			Total
	80% or more	40% or more but less than 80%	Less than 40%		80% or more	40% or more but less than 80%	Less than 40%	
<b>India</b>	<b>86</b>	<b>105</b>	<b>182373</b>	<b>179191</b>	<b>86</b>	<b>159</b>	<b>176393</b>	<b>176601</b>
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 Senthudayanathapuram of Sivagangai 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	8-1085%	min.	150-500
Clay-bonded crucibles	60-65	+80%	-20 to +100 mesh
Silicon carbide crucibles	35	80-89%	+150
Expanded (or flexible) graphite foils and products based thereon (e.g. sealing gaskets in refineries, fuel pumps, automobiles)	100	90% min. (preferably +99%)	250-1800
Pencils	50-60	+95-98%	50 max.
Brake-linings	1-15	98% min.	75 max.
Foundry	-	40-70%	53-75
Batteries			
a) Dry cells	-	88% min.	75 max.
b) Alkaline	-	98% min.	5-75
Brushes	-	Usually 99%	Usually less than 53
Lubricants	-	98-99%	53-106
Sintered products (e.g. clog wheels)	-	98-99%	5
Paint	Up to 75	50-55% 75% min.	Amorphous powder flake
Braid used for sealing (e.g. in ship)	40-50	95% min.	-
Graphitised grease (used in seamless steel tube manufacturing)	-	+99%	38 max.
Colloidal graphite	100	99.9%	Colloidal

### CONSUMPTION

As per the information received from various graphite consuming units and estimates, the consumption of various grades of graphite during 2019-20 was 19,000 tonnes which showed a decline of about 18 % as compared to 23,200 tonnes in the preceding year. Out of the total consumption in 2019-20, graphite products (crucible, pencil etc.) were 11,700 tonnes (62%), Foundry Industry 5,500 tonnes (29%), Refractory Industry 700 tonnes (4%) and Others (Dry Cell battery, cement, Iron & Steel, Paint, paper etc.) 1,100 tonnes (6%). Industrywise consumption data are provided in (Table - 7).

**Table - 7 : Consumption\* of Graphite 2017-18 to 2019-20 (By Industries)**

Industry	(In tonnes)		
	2017-18	2018-19 (P)	2019-20 (P)
<b>All Industries</b>	<b>71700(23)</b>	<b>23200(16)</b>	<b>19000(12)</b>
Chemicals	13800	13800	-
Foundry	4800	5600	5500
Graphite products (Crucible, Pencil, etc.)	50400	2000	11700
Refractory	1200	700	700
Others (Dry cell battery, cement, iron & steel, paint, paper, etc.)	1500	1100	1100

*Figures rounded off*

*\*Includes actual reported consumption and/or estimates made wherever required and due to paucity of data, consumption may not be complete.*

*( ) Number of plants reported /estimated. The apparent consumption graphite has been estimated as 68.9 thousand tonnes.*

### 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 & Uzbekistan (2% each) and Mexico & Dem. P. R. of Korea ( 1% each) (Table-8).



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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-9).

A generalised view of the development in various countries with countrywise description sourced from latest available publication of minerals yearbook 'USGS 2017' is furnished below:

### Brazil

Brazil was one of the leading country of graphite with estimated production of 90,000 tonnes of marketable natural graphite in 2017. Nacional de Grafite Ltda. was the only producer of natural flake

**Table – 8 : World Reserves of Graphite (Natural)  
(By Principal Countries)**

(In '000 tonnes)	
Country	Reserves
<b>World: Total (rounded off)</b>	<b>320000000</b>
USA	(4)
Austria	(4)
Brazil	74000000
Canada	(4)
China	52000000
Germany	(4)
India*	8000000
Korea,North	2000000
Korea, Republic of	18,00,000
Madagascar	26000000
Mexico	3100000
Mozambique	25000000
Norway	600000
Russia	14000000
Sri Lanka	1500000
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.

## 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

graphite in Tanzania during 2022. High-grade crystalline flake graphite projects were being developed in Brazil with at least two companies conducting or considering graphite exploration and development.

### Canada

Canada was one of the leading country of graphite with a production of 40,000 tonnes of natural flake graphite reported from two active open pit mines in 2017. About 80% production reported from the Lac des Iles flake graphite mine in Quebec, operated by Imerys Graphite & Carbon, and approximately 20% from the Black Crystal flake graphite quarry in British Columbia, owned by Eagle Graphite Corp. During 2017, 24 potential graphite producers were exploring and developing flake graphite projects in Canada.

**Table – 9 : World Production of Graphite  
(By Principal Countries)**

(In tonnes)			
Country	2019	2020	2021
<b>World Total</b>	<b>1100000</b>	<b>1100000</b>	<b>1300000</b>
<b>(Rounded off)</b>			
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
<b>Other countries</b>	<b>41699</b>	<b>38941</b>	<b>40159</b>

**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 production of graphite during 2018-19, 2019-20 and 2020-21 was at 39 thousand tonnes, 34 thousand tonnes and 30 thousand tonnes, respectively.

Tanzania (25%), Nepal (15%), Malaysia (11%), and UAE (10.1%).

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%),

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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 - 10 to 14).

### 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

**Table – 10 : Exports of Graphite (Natural)  
(By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>716</b>	<b>42994</b>	<b>764</b>	<b>46963</b>
Tanzania	185	8683	325	15745
Malaysia	81	4470	106	5470
China P Rp	15	962	48	3390
U A E	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 Pr	40	2389	12	1391
Mauritius	3	87	9	1071
Other countries	268	19738	136	10300

*Figures rounded off*

**Table – 11: Exports of Graphite (Artificial)  
(By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>21744</b>	<b>2820004</b>	<b>28218</b>	<b>4090984</b>
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 Pr	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*

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**Table– 12 : Exports of Graphite Bricks & Shapes  
(By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>515</b>	<b>8408</b>	<b>59</b>	<b>4099</b>
Bangladesh Pr	-	-	7	1491
Jordan	14	1220	11	839
Taiwan	2	46	27	562
Sri Lanka Dsr	++	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– 13 : Exports of Graphite Crucibles  
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>20</b>	<b>2256</b>	<b>416</b>	<b>28081</b>
Taiwan	-	-	135	8145
Netherlands	-	-	58	6059
Rwanda	-	-	40	3637
UK	++	81	21	2666
Zimbabwe	-	-	60	1825
Iraq	-	-	20	1690
U S A	8	139	44	1141
Mali	-	-	5	873
Congo	-	-	8	765
Bangladesh	-	-	15	544
Other countries	12	2036	10	736

*Figures rounded off*

**Table – 14 : Exports of Silicon Carbide Crucibles  
(By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>3728</b>	<b>624851</b>	<b>30137</b>	<b>888930</b>
UAE	534	115347	8293	134771
U S A	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*

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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 increased to 269 tonnes in 2021-22 from tonnes in the preceding year. China was the main supplier country. Imports of silicon carbide crucibles increased to 918 tonnes in 2021-22 from

**Table – 15 : Imports of Graphite (Natural)  
(By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>40153</b>	<b>1808218</b>	<b>54047</b>	<b>2651642</b>
Madagascar	9437	544250	20850	1095472
China P Rp	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

386 tonnes in the previous year. Imports were mainly from China (97%), Germany (2%) and Netherlands (Tables - 15 to 19).

**Table – 16 : Imports of Graphite (Artificial)  
(By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>54327</b>	<b>5422418</b>	<b>75657</b>	<b>8125841</b>
China P Rp	25414	1996380	32787	3538380
Germany	4789	1345986	3517	1028785
U K	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

**Table – 17 : Imports of Graphite Bricks & Shapes  
(By Countries)**

Country_Name	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>5430</b>	<b>21390</b>	<b>20053</b>	<b>23733</b>
China	90	11574	39	15453
U S A	3440	7545	14	8259
Belgium	++	8	200000	21
Japan	1900	2263	-	-

Figures rounded off

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**Table – 18 : Imports of Graphite Crucibles (By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>906</b>	<b>50672</b>	<b>296</b>	<b>38483</b>
China P Rp	312	42252	266	34727
Germany	-	-	30	2631
Italy	551	2199	++	1025
Japan	++	++	++	100
Hong kong	2	5820	-	-
Canada	++	209	-	-
Korea Rp	1	189	-	-
U S A	40	3	-	-

Figures rounded off

**Table – 19 : Imports of Silicon Carbide Crucibles (By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>386</b>	<b>70638</b>	<b>918</b>	<b>135424</b>
China	319	55172	892	117199
Germany	26	8518	14	7141
Netherlands	-	-	6	4901
U S A	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.