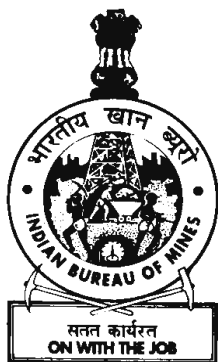


APATITE AND ROCK PHOSPHATE



Indian Minerals Yearbook 2020

(Part- III : MINERAL REVIEWS)

59th Edition

APATITE AND ROCK PHOSPHATE

(ADVANCE RELEASE)

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1 Apatite and Rock Phosphate

Apatite is a group of phosphate minerals and 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 hydroxylapatite, fluorapatite and chlorapatite. Fluorapatite $\text{Ca}_5(\text{PO}_4)_3\text{F}$ is the most common variety of apatite and also a secondary source of fluorine. Collophane ($\text{Ca}_3\text{P}_2\text{O}_8$) 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. About 80% 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 1.4.2015 has been placed at 24.05 million tonnes. Out of

these resources, the Reserves are placed at 0.03 million tonnes, while 24.02 million tonnes are placed under Remaining Resources category. Of the total reserves/resources, West Bengal accounts for the bulk of 57%, followed by Jharkhand (30%) and Meghalaya (5%). The remaining 8% resources are located in Rajasthan, Andhra Pradesh, Gujarat and Tamil Nadu. Gradewise, soil reclamation grade accounts for 53% followed by beneficiable grade (28%), Low Non-beneficiable grade (13%) and remaining Blendable, Unclassified & Not-known grades (6%). The resources of Chemical Fertilizer grade are over one percent (Table-1).

Rock Phosphate

The total reserves/resources of rock phosphate as per NMI data, based on UNFC system as on 1.4.2015 has been placed at 312.68 million tonnes. Out of these, the reserves constitute only 45.80 million tonnes while 266.87 million tonnes are under Remaining Resources category. Of the total reserves/resources, 34% are in Jharkhand, 31% 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 (29%), Blendable (11%), Chemical Fertilizer & Soil Reclamation (8% each) and remaining Unclassified and Not-known grades (about 7%) (Table-2).

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).

The mine-head closing stocks at the end of 2019-20 was 6,521 tonnes same as in 2018-19 (Table-4). The average daily labour employed in apatite mines during 2019-20 was nil as against 01 in the previous year.

APATITE AND ROCK PHOSPHATE

**Table – 1 : Reserves/Resources of Apatite as on 1.4.2015
(By Grades/States)**

State/Grade	Reserves				Remaining Resources						Total Resources (A+B)		
	Proved STD111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333		Reconnaissance STD334	Total (B)
		STD121	STD122			STD221	STD222						
All India : Total	27715	-	1680	29395	1385734	491818	1225345	2281521	11481250	6132768	1017646	24016082	24045477
By Grades													
Chemical Fertilizer	27715	-	1680	29395	-	-	-	30000	-	200163	-	230163	259558
Soil Reclamation	-	-	-	-	1385734	491818	1225345	2233500	6243000	1131430	-	12710827	12710827
Low/Non-beneficiabile	-	-	-	-	-	-	-	3360	2363000	50000	666646	3083006	3083006
Beneficiabile	-	-	-	-	-	-	-	12477	1875250	4561175	351000	6799902	6799902
Blendable	-	-	-	-	-	-	-	2184	-	-	-	2184	2184
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	-	-	-	-	1385734	491818	1225345	120000	8845250	852605	666646	13587398	13587398

Figures rounded off

APATITE AND ROCK PHOSPHATE

**Table – 2 : Reserves/Resources of Rock Phosphate as on 1.4.2015
(By Grades/States)**

State/Grade	Reserves										Remaining Resources										Total Resources (A+B)					
	Proved					Probable					Total					Recomnaissance						Total				
	STD111	STD121	STD122	STD122	STD122	Feasibility	Pre-feasibility	Measured	Indicated	Inferred	Recomnaissance	STD333	STD334	STD332	STD333	STD334	STD332	STD333	STD334	STD332		STD333	STD334	(B)	(A+B)	
All India : Total	43832936	5179	1969370	45807485	10679080	36271671	25008353	29126333	3549750	185771368	2678275	266871130	312678615													
By Grades																										
Chemical Fertilizer	8612446	5179	439204	9056829	-	12936477	1682389	-	15000	2284379	-	16918245	25975074													
Blendable	10446537	-	477000	10923537	6394650	-	5849933	13333	-	12092513	-	24350429	35273966													
Soil Reclamation	-	-	-	-	705867	251437	7672812	732800	10000	16887166	-	26260082	26260082													
Beneficial	24773953	-	1053166	25827119	3578563	23083757	6976076	2166500	2784750	25288989	20750	63899385	89726504													
Low grade	-	-	-	-	-	-	-	-	-	115547549	-	115547549	115547549													
Unclassified	-	-	-	-	-	-	2827143	-	740000	10095773	2657525	16320441	16320441													
Not-known	-	-	-	-	-	-	-	-	-	3575000	-	3575000	3575000													
By States																										
Gujarat	-	-	-	-	-	-	-	-	-	314820	-	314820	314820													
Jharkhand	-	-	-	-	-	-	-	-	-	107370000	-	107370000	107370000													
Madhya Pradesh	5999399	5179	1492370	7496948	6460616	14981336	15702042	-	2730000	10629258	50625	50553877	58050825													
Meghalaya	-	-	-	-	-	-	-	-	-	1311035	-	1311035	1311035													
Rajasthan	37833537	-	477000	38310537	1154961	20857437	4453355	152633	79750	28043783	2627650	57369569	95680106													
Uttar Pradesh	-	-	-	-	-	432898	3118586	-	740000	21481960	-	25773444	25773444													
Uttarakhand	-	-	-	-	3063503	-	1734370	2760000	-	16620513	-	24178386	24178386													

Figures rounded off

APATITE AND ROCK PHOSPHATE

**Table – 3 : Production of Apatite, 2018-19 & 2019-20
(By Sectors/States/Districts/Grades)**

(Quantity in tonnes; Value in `'000)

State/District	2018-19			2019-20 (P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	1 *	-	-	-	-	-
Public sector	1 *	-	-	-	-	-
Private sector	-	-	-	-	-	-
Andhra Pradesh	-	-	-	-	-	-
Visakhapatnam	-	-	-	-	-	-
West Bengal	1 *	-	-	-	-	-
Purulia	1 *	-	-	-	-	-

* Only labour reported.

**Table – 4 : Mine-head Closing Stocks of Apatite, 2018-19 & 2019-20
(By States/Grades)**

(In tonnes)

State	2018-19	2019-20 (P)
India	6521	6521
Andhra Pradesh	215	215
West Bengal	6306	6306

Phosphorite/Rock Phosphate

The total production of phosphorite/rock phosphate is at 1,400 thousand tonnes in 2019-20 nearly same as compared to that in the previous year (Tables - 5 to 7).

There were 6 reporting mines in 2019-20 as compared to 7 reporting mines in 2018-19. Rajasthan continued to be the principal producing State contributing 93% of the total production and the

remaining 7% share was contributed by Madhya Pradesh.

The mine-head closing stocks of phosphorite/rock phosphate in the year 2019-20 were 2,198 thousand tonnes as compared to 2,347 thousand tonnes in 2018-19 (Table-8).

The average daily labour employed in phosphorite/rock phosphate mines in 2019-20 was 982 as against 1,200 in the previous year.

Table – 5 : Principal Producers of Phosphorite/Rock Phosphate, 2019-20

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

APATITE AND ROCK PHOSPHATE

**Table – 6 : Production of Phosphorite/Rock Phosphate, 2017-18 to 2019-20
(By States)**

(Quantity in tonnes; Value in `'000)

State	2017-18		2018-19		2019-20 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	1515645	3668267	1421086	3883571	1400186	4319097
Madhya Pradesh	113947	108783	98600	88543	99960	94422
Rajasthan	1401698	3559484	1322486	3795028	1300226	4224675

**Table – 7 : Production of Phosphorite/Rock Phosphate, 2018-19 & 2019-20
(By Sectors/States/Districts/Grades)**

(Quantity in tonnes; Value in `'000)

State/ District	No. of mines	2018-19						2019-20 (P)						
		Grade: P ₂ O ₅ content				Total		Grade: P ₂ O 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	7	232971	592571	-	595544	1421086	3883571	6	133421	677187	3550	586028	1400186	4319097
Public														
Sector	5	232971	592571	-	496944	1322486	3795028	5	133421	677187	-	489618	1300226	4224675
Private														
Sector	2	-	-	-	98600	98600	88543	1	-	-	3550	96410	99960	94422
Madhya Pradesh	5	-	-	-	98600	98600	88543	5	-	-	3550	96410	99960	94422
Chhatarpur	2	-	-	-	98600	98600	88543	2	-	-	3550	96410	99960	94422
Jhabua	2	-	-	-	-	-	-	2	-	-	-	-	-	-
Sagar	1	-	-	-	-	-	-	1	-	-	-	-	-	-
Rajasthan	2	232971	592571	-	496944	1322486	3795028	1	133421	677187	-	489618	1300226	4224675
Udaipur	2	232971	592571	-	496944	1322486	3795028	1	133421	677187	-	489618	1300226	4224675

**Table –8: Mine-head Closing Stocks of Phosphorite/Rock Phosphate, 2018-19 & 2019-20
(By States/Grades)**

(In tonnes)

State	2018-19					2019-20 (P)				
	Grade: P ₂ O ₅ content					Grade: P ₂ O 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	649876	158432	78696	1460151	2347155	454067	182590	81919	1479087	2197663
Madhya Pradesh	-	1377	3304	58498	63179	-	1377	6527	54126	62030
Rajasthan	649876	157055	75392	1401653	2283976	454067	181213	75392	1424961	2135633

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

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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 production of phosphorite/rock phosphate in India was reported from five State Public Sector mines. Of these, Chhatarpur, Jhabua districts of Madhya Pradesh have two mine each, and Sagar district have one mine, while Udaipur district of Rajasthan has one mine. The one fully mechanised mine under the Private Sector (Hindustan Zinc Limited) is also located in Udaipur district, Rajasthan. The strike of the mine is in NE-SW direction and reserves as on 1.4.2017 are 3.56 million tonnes.

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 jack hammers 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 55° 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 from 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 Annual Report 2019-20, presently, there are about 32 large size urea, 19 DAP and complex, 110 SSP and 2 ammonium sulphate plants.

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Among the major fertilizer products, the estimated production of urea during the year 2019-20 was 24.92 million tonnes (6.90 million tonnes from Public Sector, 6.96 million tonnes from Cooperative Sector and 10.08 million tonnes from Private Sector), Diammonium Phosphate (DAP) 4.48 million tonnes (1.89 million tonnes from Cooperative Sector and 2.59 million tonnes from Private Sector), complex fertilizers 9.24 million tonnes (1.55 million tonnes from Public Sector, 2.25 million tonnes from Cooperative Sector and 5.43 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 venture in countries which are rich in fertilizer resources with arrangements to buy back and to enter into long-term agreement for supplying fertilizer to India. The Department of Fertilizers has undertaken joint ventures abroad with 5 countries in the previous years. Although during the year 2018-19, no joint venture with any country was signed, a number of major developments that took place with the following countries were reported.

Algeria: An Algerian Government owned mining company and other mining companies like ASMIDAL visited India. During their interaction, the delegation invited Indian companies for undertaking feasibility studies for cooperation in the Fertilizer Sector. Subsequently, a draft MoU covering only the broader aspects has been prepared and shared with the Algerian side for comments. Subsequently, comments from MEA, DIPP and consortium members were sought. The comments received have been incorporated in the draft Framework Agreement and the same has been shared with MEA for further sharing with Algerian side, response from Algerian side is awaited.

Malaysia: The Malaysian Prime Minister presented a proposal for the setting up of a urea and ammonia manufacturing plant in Melaka, Malaysia with production capacity of 2.4 million tonnes of urea and 1.35 million tonnes for ammonia per annum at an estimated investment for US\$ 2.1 billion with assured G2G buy-back arrangement between India and Malaysia. Subsequently, an MoU was signed between India and Malaysia on 01.04.2017. The Commercial Negotiation Committee (CNC) has already had two meetings. From the CNC meeting, it emerges that Malaysia side is insisting on their own proposals in respect of mode of sales, contract quantity and shipment size and applicable price. Further for finalisation of the terms and conditions Indian side proposed for third meeting to be held in Malaysia. Response from Malaysia side is awaited.

Jordan: MoU has been signed between India and Jordan on 1.3.2018 at New Delhi during the visit of Jordan King to India for proposed mining and beneficiation of Rock Phosphate and for setting up production facility in Jordan for Phosphoric acid/DAP/NPK with a longterm agreement for 100% off take to India. A Joint Steering Committee has been formed. Final agenda alongwith requirement has been forwarded to Jordanian side. Reply from Jordanian side is awaited.

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 universities 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 phosphogypsum which is formed as a by-product during manufacturing of phosphoric acid. It contains about 1% P_2O_5 , 1% F and 10-30 times more radon, none of which is desirable. Environment Protection Agency (EPA) of USA stipulated in 1989 that phosphogypsum 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 phosphogypsum 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 prescribed 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 2019-20 was about 9.10 million tonnes as against the 9.29 million tonnes during preceding year i.e. decreased by 2% in 2019-20.

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 Foreign Trade Policy 2015-2020. 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.

Government of India notified new Urea Policy extended for the period 01.6.2015 to 31.3.2019 for existing gas-based urea manufacturing units.

WORLD REVIEW

The world reserves of phosphate rock are about 71 billion tonnes, located mainly in Morocco & Western Sahara (70%), China (5%), Egypt (4%) & Algeria (3% each). The remaining 18% is located in other countries (Table - 9).

The world production of phosphate rock decreased slightly by 2% to 226 million tonnes in 2019 from 230 million tonnes in 2018. China (41%), Morocco (16%), USA (10%), Russia (6%) and Peru (5%) have been the major producers (Table- 10).

To give a generalised view of the development in various countries, the country wise description is sourced from latest available publication of Minerals Yearbook 'USGS' 2017 is furnished below:

Morocco

OCP Group continued with an expansion programme that was to increase its mine capacity from 39.0 Mt/yr to 52.1 Mt/yr during the next decade. A 12 Mt/yr expansion at Gantour was ongoing in 2017 and was planned to be completed by 2023. OCP planned to open new mines at Meskala deposit in the Essaouisa Region after 2023.

Saudi Arabia

Ma'aden Phosphate Co. (MPC) began production in mid 2017 at the Umm Wu'al Phosphate Mine on the Al-Khabra deposit. The mine was part of the Wa'ad Al Shammal phosphate project joint venture among MPC (60%), Mosaic (25%) and Saudi Arabian Basic Industries Corp. (15%). The project included the phosphate rock mine beneficiation plant and production facilities for phosphoric acid, animal feed, purified phosphoric acid, sodium tripolyphosphate and sulphuric acid. Proposals to expand the existing fertilizer plants at Ras Al Khair are also part of the project. The production capacities planned are 5.3 million tpy of phosphate concentrate, 1.5 million tpy of phosphoric acid and 3.5 million tpy of phosphate fertilizers. The new phase of the project was planned to be operational by 2024.

Table – 9: World Reserves of Phosphate Rock (By Principal Countries)

(In '000 tonnes)

Country	Reserves
World: Total (rounded)	71000000
Algeria	2200000
Australia	1100000 ⁵
Brazil	1600000
China ⁽⁶⁾	3200000
Egypt	2800000
Finland	1000000
India*	46000
Israel	57000
Jordan	800000
Kazakhstan	260000
Mexico	30000
Morocco & Western Sahara	50000000
Peru	210000
Russia	600000
Saudi Arabia	1400000
Senegal	50000
South Africa	1400000
Syria	1800000
Togo	30000
Tunisia	100000
USA	1000000
Uzbekistan	100000
Vietnam	30000
Other countries	840000

Source: USGS, Mineral Commodity Summaries, 2021

⁵For Australia, Joint Ore Reserves Committee compliant reserves were 113 million tonnes.

*India's total reserves/resources of rock phosphate as per National Mineral Inventory as on 1.4.2015 are 312.68 million tonnes.

⁶Production data for large mines only, 96 reported by the National Bureau of statistics of China.

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**Table – 10 : World Production of Phosphate Rock
(By Principal Countries)**

(In '000 tonnes)			
Country	2017	2018	2019
World: Total (rounded off)	255000	230000	226000
China	123132	96326	93324
Morocco	32800	37600	35300
USA	27900	25700	23300
Russia	13200	13600	13800
Peru	8450	10308	11092
Jordan	8688	8022	9223
Saudi Arabia	5800	6090	6200(e)
Brazil ^(d)	6033	5740	5300
Vietnam	4588	4332	4652
Other countries	24618	20538	22672

Source : BGS, World Mineral Production, 2015-19.

d: Including beneficiated and directly shipped material.

e: Years ended 30 June of that stated.

FOREIGN TRADE

Exports

In 2019-20, exports of rock phosphate decreased drastically by 84% to 257 tonnes from 1,652 tonnes achieved in the previous year. Exports of phosphatic fertilizers at 173 tonnes in 2019-20 decreased drastically by 98% from 6,947 tonnes recorded in the preceding year. The exports of phosphoric acid increased drastically by manifold to 2,633 tonnes from 360 tonnes. Export of elemental phosphorus increased marginally by 7% to 650 tonnes from 610 tonnes in the preceding year. Rock phosphate was exported mainly to Rep.of Korea (49%), Bangladesh (39%), USA (6%) and Thailand (4%). Elemental phosphorus was also mainly exported to Italy (25%) & USA (22%). In 2019-20, exports of phosphatic fertilizers were mainly to Kenya (42%) and Iran (33%) while phosphoric acid was mainly exported to Brazil (15%) (Tables- 11 to 16).

Imports

Imports of rock phosphate increased slightly by 2% to 7.65 million tonnes in 2019-20 from 7.52 million tonnes in the previous year. Imports were mainly from Jordan (43%), Morocco (26%) and Egypt (16%). Imports of elemental phosphorus decreased slightly to 33,751 tonnes in 2019-20 from 40,080 tonnes in the previous year. The imports of elemental phosphorus were solely from Vietnam (59%) and Russia (37%). During 2019-20, 16 tonnes of phosphatic fertilizers were imported solely from China (100%). Imports of phosphoric acid decreased by 10% to 2.50 million tonnes in 2019-20 from 2.77 million tonnes in the previous year. Imports were mainly from Morocco (37%), Jordan (24%) and Senegal (22%) (Tables- 17 to 22).

**Table – 11: Exports of Rock Phosphate
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All countries	1652	46795	257	2013
Korea, Rep.of	-	-	126	1212
USA	-	-	15	241
Nepal	8	112	5	179
Thailand	-	-	10	179
Oman	-	-	1	100
Bangladesh	200	119	100	99
Czech Republic	1	4	++	2
Uganda	-	-	++	++
Iran	480	35079	-	-
Italy	871	8150	-	-
Other countries	93	3331	-	-

Figures rounded off

**Table – 12 : Exports of Rock Phosphate (Ground)
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	573	36534	243	1658
Korea, Rep. of	-	-	126	1212
USA	-	-	15	241
Oman	-	-	1	100
Bangladesh	++	11	100	99
Nepal	-	-	1	6
Iran	480	35079	-	-
Italy	92	1440	-	-
Czech Republic	1	4	-	-
Germany	++	++	-	-

Figures rounded off

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**Table – 13: Exports of Rock Phosphate (Unground)
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty	Value	Qty	Value
	(t)	(` '000)	(t)	(` '000)
All Countries	1080	10260	14	355
Thailand	-	-	10	179
Nepal	8	112	4	174
Czech Republic	-	-	++	2
Italy	779	6710	-	-
Bhutan	40	2365	-	-
UAE	46	950	-	-
Bangladesh	200	107	-	-
Tunisia	6	15	--	--
Malaysia	++	1	--	--

Figures rounded off

**Table – 14: Exports of Phosphorus (Elemental)
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty	Value	Qty	Value
	(t)	(` '000)	(t)	(` '000)
All Countries	610	224682	650	256684
USA	90	33314	146	54315
Italy	255	85858	160	53715
Brazil	40	17087	54	24686
UAE	4	2047	39	19382
Indonesia	38	16167	28	12245
Canada	28	10575	28	10807
Philippines	29	11909	20	8603
Egypt	-	-	21	8058
Russia	-	-	23	7511
Peru	-	-	18	7067
Other countries	127	47724	114	50296

Figures rounded off

**Table – 15: Exports of Phosphatic Fertilizers
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty	Value	Qty	Value
	(t)	(` '000)	(t)	(` '000)
All Countries	6947	94622	173	13729
Iran	51	11151	57	11473
Kenya	390	7231	72	846
Nepal	5373	57211	35	715
New Zealand	2	130	6	394
Oman	-	-	++	151
Italy	-	-	3	89
Sri Lanka	-	-	++	46
Indonesia	-	-	++	12
Malaysia	1	243	++	2
Australia	++	64	++	1
Other countries	1130	18592	-	-

Figures rounded off

**Table – 16: Exports of Phosphoric Acid
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty	Value	Qty	Value
	(t)	(` '000)	(t)	(` '000)
All Countries	360	30931	2633	196836
Brazil	5	712	401	45351
South Africa	-	-	374	21231
Guatemala	++	112	269	15809
UAE	38	1993	160	10732
Nicaragua	-	-	158	9408
USA	5	425	144	8470
Vietnam	73	3924	125	7636
Myanmar	7	234	135	7622
Singapore	2	59	23	7498
Kenya	++	94	136	7365
Other countries	230	23376	708	55713

Figures rounded off

**Table – 17 : Imports of Rock Phosphate
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty	Value	Qty	Value
	(t)	(` '000)	(t)	(` '000)
All Countries	7519156	56379205	7654868	54205952
Jordan	2644129	21942603	3277010	23539768
Morocco	2075879	18342421	1989978	17840735
Egypt	1270762	5863565	1260634	5499357
Togo	834190	6249080	618143	4468832
UAE	230190	1255213	260057	1374333
Algeria	238447	1277780	214817	1221745
Cyprus	47450	274531	31800	171249
Netherlands	460	19032	1416	55953
Hong Kong	745	25537	880	30047
China	155	5146	118	3650
Other countries	176749	1124296	15	282

Figures rounded off

**Table – 18: Imports of Rock Phosphate (Ground)
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty	Value	Qty	Value
	(t)	(` '000)	(t)	(` '000)
All Countries	3815094	29617465	3354266	25970788
Morocco	2075879	18342421	1989978	17840735
Togo	589740	4386790	385228	2758132
Egypt	505265	2520009	416107	2081195
UAE	230190	1255213	260057	1374333
Jordan	265000	2192201	189955	1198614
Algeria	46869	233088	78750	457128
Cyprus	47450	274531	31800	171249
Netherlands	460	19032	1416	55953
Hong Kong	745	25537	880	30047
China	139	4914	94	3367
Other countries	53357	363730	1	35

Figures rounded off

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**Table – 19 : Imports of Rock Phosphate (Unground)
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	3704063	26761739	4300602	28235164
Jordan	2379129	19750402	3087055	22341154
Egypt	765497	3343557	844527	3418163
Togo	244450	1862290	232915	1710700
Algeria	191578	1044692	136067	764617
China	17	233	24	284
USA	-	-	13	144
France	-	-	++	99
Senegal	++	17	1	4
Peru	122404	755364	-	-
Iran	988	5167	-	-
Other countries	++	17	-	-

Figures rounded off

**Table – 20 : Imports of Phosphorus (Elemental)
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	40080	7954161	33751	6552642
Vietnam	26189	5302952	19770	3828940
Russia	9570	1828333	12432	2422015
Kazakhstan	801	154510	1435	275569
Japan	++	480	96	20326
China	-	-	18	5589
USA	436	78041	++	144
UK	++	33	++	29
Germany	++	14	++	27
Belgium	-	-	++	2
Taiwan	-	-	++	++
Other countries	3085	589798	-	-

Figures rounded off

**Table – 21: Imports of Phosphoric Acid
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	2773556	147391854	2501092	119766817
Morocco	934954	49482626	918384	43969976
Jordan	551058	29786774	605783	28552168
Senegal	734678	38635314	549630	26568795
Tunisia	143129	7456639	148353	7024339
USA	207264	10791915	142785	6831998
Vietnam	73725	4321013	75490	3804598
South Africa	85444	4489732	27891	1244510
Egypt	-	-	12004	519501
Taiwan	10600	550863	9709	494298
China	7997	594592	5025	394693
Other countries	24707	1282386	6937	361940

Figures rounded off

**Table – 22: Imports of Phosphatic Fertilizers
(By Countries)**

Country	2018-19 (R)		2019-20 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	2559	99988	16	2324
China	2345	78031	16	2306
Austria	-	-	++	18
Spain	153	16586	-	-
Malaysia	15	4819	-	-
Thailand	46	552	-	-

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. Only about 10-15% requirement of raw material for phosphate fertilizer production is met through indigenous sources. The remaining 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 above two minerals to reduce 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 requirements. The government has been

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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.

