

APATITE AND ROCK PHOSPHATE



# Indian Minerals Yearbook 2022

(Part- III : MINERAL REVIEWS)

61<sup>th</sup> Edition

**APATITE AND ROCK PHOSPHATE**

**(ADVANCE RELEASE)**

**GOVERNMENT OF INDIA  
MINISTRY OF MINES  
INDIAN BUREAU OF MINES**

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# 1 Apatite and Rock Phosphate

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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  $\text{Ca}_5(\text{PO}_4)_3\text{F}$  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. 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%  $\text{CaF}_2$  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).

### 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).

## 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 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.

APATITE AND ROCK PHOSPHATE

**Table – 1 : Reserves/Resources of Apatite as on 1.4.2020  
(By Grades/States)**

State/Grade	Reserves				Remaining Resources							Total Resources (A+B)
	Proved STD111	Probable STD121	Total (A)	Feasibility STD211	Pre-feasibility STD221	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)		
<b>All India : Total</b>	<b>27715</b>	<b>1680</b>	<b>29395</b>	<b>499149</b>	<b>-</b>	<b>2281521</b>	<b>11481250</b>	<b>5801338</b>	<b>1017646</b>	<b>21080904</b>	<b>21110299</b>	
<b>By Grades</b>												
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	
<b>By States</b>												
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

APATITE AND ROCK PHOSPHATE

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

State/Grade	Reserves										Remaining Resources										Total Resources (A+B)
	Proved		Probable		Total		Feasibility		Pre-feasibility		Measured		Indicated		Inferred		Reconnaissance		Total		
	STD111	STD121	STD121	STD122	STD122	STD211	STD211	STD222	STD221	STD222	STD331	STD332	STD333	STD333	STD334	STD334	STD334	STD334	STD334	STD334	
<b>All India : Total</b>	<b>27103158</b>	<b>-</b>	<b>3772935</b>	<b>30876093</b>	<b>13669080</b>	<b>29796846</b>	<b>34526541</b>	<b>2879833</b>	<b>3539750</b>	<b>186657066</b>	<b>9308275</b>	<b>280377392</b>	<b>311255485</b>								
<b>By Grades</b>																					
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								
Beneficial	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								
<b>By States</b>																					
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

APATITE AND ROCK PHOSPHATE

**Table – 3 : Production of Apatite, 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	Quantity	Value	No. of mines	Quantity	Value
<b>India</b>	-	-	-	-	-	-
Public sector	-	-	-	-	-	-
Private sector	-	-	-	-	-	-
<b>Andhra Pradesh</b>	-	-	-	-	-	-
Visakhapatnam	-	-	-	-	-	-
<b>West Bengal</b>	-	-	-	-	-	-
Purulia	-	-	-	-	-	-

**Table – 4 : Mine-head Closing Stocks of Apatite, 2020-21 & 2021-22  
(By States/Grades)**

(In tonnes)

State	2020-21	2021-22 (P)
<b>India</b>	<b>6306</b>	<b>6306</b>
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).

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).

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

**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

APATITE AND ROCK PHOSPHATE

**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
<b>India</b>	<b>1400189</b>	<b>4731313</b>	<b>1455829</b>	<b>4694525</b>	<b>1395079</b>	<b>7616476</b>
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	No. of mines	2020-21					2021-22 (P)							
		Grade: P <sub>2</sub> O <sub>5</sub> content				Total	No. of mines	Grade: P <sub>2</sub> O <sub>5</sub> 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
<b>India</b>	<b>6</b>	<b>194629</b>	<b>552577</b>	<b>-</b>	<b>708623</b>	<b>1455829</b>	<b>4694525</b>	<b>7</b>	<b>250616</b>	<b>429719</b>	<b>-</b>	<b>714744</b>	<b>1395079</b>	<b>7616476</b>
Public														
Sector	5	194629	552577	-	610743	1357949	4602518	6	250616	429719	-	615214	1295549	7522918
Private														
Sector	1	-	-	-	97880	97880	92007	1	-	-	-	99530	99530	93558
<b>Madhya Pradesh</b>	<b>5</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>97880</b>	<b>97880</b>	<b>92007</b>	<b>6</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>113730</b>	<b>113730</b>	<b>111398</b>
Chhatarpur	2	-	-	-	97880	97880	92007	2	-	-	-	99530	99530	93558
Jhabua	2	-	-	-	-	-	-	3	-	-	-	14200	14200	17840
Sagar	1	-	-	-	-	-	-	1	-	-	-	-	-	-
<b>Rajasthan</b>	<b>1</b>	<b>194629</b>	<b>552577</b>	<b>-</b>	<b>610743</b>	<b>1357949</b>	<b>4602518</b>	<b>1</b>	<b>250616</b>	<b>429719</b>	<b>-</b>	<b>601014</b>	<b>1281349</b>	<b>7505078</b>
Udaipur	1	194629	552577	-	610743	1357949	4602518	1	250616	429719	-	601014	1281349	7505078

**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 <sub>2</sub> O <sub>5</sub> content					Grade: P <sub>2</sub> O <sub>5</sub> 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
<b>India</b>	<b>353080</b>	<b>342076</b>	<b>79148</b>	<b>1548092</b>	<b>2322396</b>	<b>322903</b>	<b>355188</b>	<b>79067</b>	<b>1520400</b>	<b>2277558</b>
Madhya Pradesh	-	1377	3756	62727	67860	-	1377	3675	77166	82218
Rajasthan	353080	340699	75392	1485365	2254536	322903	353811	75392	1443234	2195340

## 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

## APATITE AND ROCK PHOSPHATE

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 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  $55^\circ$  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 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.

## APATITE AND ROCK PHOSPHATE

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 phosphogypsum 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 30<sup>th</sup> 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 type 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 1<sup>st</sup> July, 2021, 6<sup>th</sup> July, 2021 and 5<sup>th</sup> 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 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 2021-22 was about 11 million tonnes as against the 9 million tonnes during preceding year, i.e., increased by about 20 % in 2021-22.

## 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 1<sup>st</sup> 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).

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

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

(In '000 tonnes)

Country	Reserves
<b>World: Total (rounded)</b>	<b>72000000</b>
Algeria	2200000
Australia <sup>5</sup>	1100000
Brazil	1600000
China <sup>6</sup>	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 Summaries, 2023*

<sup>5</sup>For Australia, Joint Ore Reserves Committee compliant or equivalent reserves were 124 million tonnes.

<sup>6</sup>Production data for large mines only, as reported by the National Bureau of Statistics of China.

\*India's total reserves/ resources of rock phosphate 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
<b>World: Total (rounded off)</b>	<b>226000</b>	<b>222000</b>	<b>222000</b>
China	93324	88000 <sup>e</sup>	86000 <sup>e</sup>
Morocco	35300	40700	38122
USA	23300	23500	22000 <sup>e</sup>
Russia	13800	13800	13800 <sup>e</sup>
Peru	11091	8594	10776
Jordan	9223	8938	10015
Saudi Arabia	5716	8000	8400
Brazil <sup>(d)</sup>	4700	5500	5500 <sup>e</sup>
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*

## APATITE AND ROCK PHOSPHATE

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 34.54 % to 540 tonnes from 825 tonnes in the previous year. Exports of phosphatic fertilizers at 428 tonnes in 2021-22 increased by 11.16% from 385 tonnes in the preceding year. The exports of phosphoric acid increased by manifold to 9187 tonnes in 2021-22 from 460 tonnes in the previous year. Export of elemental phosphorus increased by 7.54% 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).

### **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, meager 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).

APATITE AND ROCK PHOSPHATE

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All countries</b>	<b>825</b>	<b>5602</b>	<b>540</b>	<b>11316</b>
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)
<b>All Countries</b>	<b>436</b>	<b>4291</b>	<b>328</b>	<b>2409</b>
USA	102	1923	29	830
Nepal	60	328	++	659
Oman	--	--	42	555
Bangladesh	--	--	240	238
Malaysia	274	2040	17	127

*Figures rounded off*

APATITE AND ROCK PHOSPHATE

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All countries</b>	<b>389</b>	<b>1311</b>	<b>212</b>	<b>8907</b>
U S A	-	-	12	7484
Nepal	29	302	192	1330
Uganda	4	14	8	88
Sri Lanka	-	-		++
Bulgaria	-	-	++	1
Bhutan	72	473	--	--
U K	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)
<b>All Countries</b>	<b>583</b>	<b>246040</b>	<b>627</b>	<b>362922</b>
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*

APATITE AND ROCK PHOSPHATE

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>385</b>	<b>15631</b>	<b>428</b>	<b>16776</b>
Indonesia	-	-	18	10005
Nepal	130	4231	387	4225
Jordan	-	-	20	1304
Australia	-	-	2	737
Denmark	-	-	++	371
Kenya	7	1722	1	128
Argentinaa	-	-	++	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)
<b>All Countries</b>	<b>460</b>	<b>50475</b>	<b>9187</b>	<b>1228169</b>
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*

APATITE AND ROCK PHOSPHATE

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>7781423</b>	<b>53709109</b>	<b>9659818</b>	<b>104667349</b>
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 Rp	--	--	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)
<b>All Countries</b>	<b>3673367</b>	<b>27621345</b>	<b>4667997</b>	<b>52941744</b>
Moroco	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 Rp	--	--	26766	316576
Other countries	248	9328	2	507

*Figures rounded off*



APATITE AND ROCK PHOSPHATE

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>4108056</b>	<b>26087764</b>	<b>4991821</b>	<b>51725605</b>
Jordan	2810631	19938806	3539366	37427357
Egypt	1235242	5617958	890674	7252826
Togo	56667	501464	201290	3152423
Nauru Rp	--	--	111913	1417771
Peru	--	--	60499	671058
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)
<b>All Countries</b>	<b>42551</b>	<b>8199312</b>	<b>52577</b>	<b>17336452</b>
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*

APATITE AND ROCK PHOSPHATE

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>2514246</b>	<b>124688967</b>	<b>6442448</b>	<b>186191658</b>
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
U A E	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)
<b>All Countries</b>	<b>++</b>	<b>51</b>	<b>++</b>	<b>245</b>
Ukraine	++	11	++	245
Korea	++	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 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 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.