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FLUORITE

(FINAL RELEASE)

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

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12 Fluorite

Fluorite is a very popular mineral, and it naturally occurs in all colours of the spectrum. It is one of the most varied coloured mineral, in the mineral kingdom, and the colours may be very intense and most electric. Pure fluorite is colourless and the colour variations are caused by various impurities. It is a mineral with veritable bouquet of brilliant colours from hallmark colour purple to blue, green, yellow, colourless, brown, pink, black and reddish orange. The rich purple colour is by far the most famous and popular colour. It is an important commercial source of fluorine. Fluorite plays a vital role in the manufacturing Industry and major consuming industries are chemical, cement, iron & steel, electrode etc. It is also used in the production of synthetic cryolite without which aluminium extraction is not possible.

Fluorite is commonly deposited by hydrothermal solution sourced from igneous intrusions. The mineralisation occurs as veins or replacement deposits either by the filling of cavities and fissures or by the replacement of the host rock, typically carbonates.

Mainly two grades of fluorite are involved in consumption and trade, namely, the Acid grade (acid spar) containing more than 97% CaF_2 and the Sub-acid grade analysing 97% or less CaF_2 . The Sub-acid grade includes Metallurgical (60 to 85% CaF_2) and Ceramic (85 to 95% CaF_2) grades and is commonly known as Metallurgical grade (metspar). Fluorite production in the country is meagre when compared with the world production.

In addition to the natural fluorite production, synthetic fluorite is recovered as by-product during uranium processing, petroleum alkylation and stainless pickling. The by-product, fluorosilicic acid, obtained from phosphoric acid plants while processing phosphate rock also supplements fluorite as a source of fluorine.

RESERVES/RESOURCES

As per NMI data base, based on the UNFC system, the total reserves/resources of fluorite in the country as on 1.4.2015 have been estimated at 18.18 million tonnes. Out of these, 0.29 million tonnes are placed under Reserves category (of which 0.22 million tonnes are under Proved category and 0.06 million tonnes under Probable category). The Remaining Resources comprise 17.89 million tonnes.

By States, Gujarat accounts for 66% of the total reserves/resources having 12 million tonnes, followed by Rajasthan with 5.24 million tonnes (29%), Chhattisgarh 0.55 million tonnes (3%) and Maharashtra 0.39 million tonnes (2%). Gradewise, the resources are classified into Marketable grade which accounted for 81% of the total resources followed by low grade (17%) and Unclassified grade (2%) (Table-1).

EXPLORATION & DEVELOPMENT

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

PRODUCTION & STOCKS

The production of fluorite (graded) at 1,079 tonnes in 2018-19 decreased by 18% as compared to that in the previous year.

There was only one reporting mines in 2017-18 and 2018-19. The entire output was reported from a Public Sector mine located in Chandrapur district of Maharashtra owned by Maharashtra State Mining Corporation Ltd. The mine-head closing stocks of fluorite (graded) was 98,597 tonnes in 2018-19 as against 97,359 tonnes in 2017-18 (Tables - 2 to 5).

The average daily labour employed in fluorite mines in 2018-19 was 41 as against 43 in the previous year. The domestic price of fluorite is furnished in the General Review on 'Prices'.

**Table – 1 : Reserves/Resources of Fluorite as on 1.4.2015
(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)	
All India : Total	224824	63860	288684	4976749	745390	571311	1713833	6218421	3522537	145183	17893423	18182107
By Grades												
Marketable	224824	63860	288684	4976749	586080	406111	-	5757010	2497534	145183	14368666	14657350
Low	-	-	-	-	3790	9680	1710348	445660	1000003	-	3169481	3169481
Unclassified	-	-	-	-	155520	155520	3485	15751	25000	-	355276	355276
By States												
Chhattisgarh	-	-	-	65889	153132	9288	185485	5573	126088	-	545455	545455
Gujarat	-	-	-	4279230	-	-	-	5723360	2001920	-	12004510	12004510
Maharashtra	224824	63860	288684	-	-	-	-	-	100000	-	100000	388684
Rajasthan	-	-	-	631630	592258	562023	1528348	489488	1294529	145183	5243458	5243458

Figures rounded off

Table – 2 : Producer of Fluorite, 2018-19

Name and address of producer	Location of mine	
	State	District
Maharashtra State Mining Corporation Ltd, Plot No. 7, Ajni Square, Wardha Road, Nagpur-440 015, Maharashtra.	Maharashtra	Chandrapur

**Table – 3 : Production of Fluorite (Graded), 2016-17 to 2018-19
(By States)**

(Qty in tonnes; Value in `'000)

State	2016-17		2017-18		2018-19 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India/	1175	6733	1314	8646	1079	8483
Maharashtra	1175	6733	1314	8646	1079	8483

**Table – 4 : Production of Fluorite (Graded), 2017-18 & 2018-19
(By Sector/States/Districts)**

(Qty in tonnes; Value in `'000)

State/District	2017-18			2018-19 (P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	1	1314	8646	1	1079	8483
Public Sector	1	1314	8646	1	1079	8483
Maharashtra	1	1314	8646	1	1079	8483
Chandrapur	1	1314	8646	1	1079	8483

**Table – 5 : Mine-head Closing Stocks of Fluorite, 2017-18 & 2018-19
(By States)**

(In tonnes)

State	2017-18	2018-19 (P)
India	97359	98597
Gujarat	83372	84372
Maharashtra	13987	14225

MINING

Maharashtra State Mining Corporation (MSMC) operates Dongargaon fluorite mines in District Chandrapur, Maharashtra. Mining is carried out by semi-mechanised opencast method. The run-of-mine is hand sorted for marketing of fluorite (graded).

BENEFICIATION

Fluorspar is beneficiated by hand sorting followed by gravity concentration methods, such as, heavy media, jigs and tables in order to separate calcite and silicate mineral impurities. Low-grade fluorite produced is used after beneficiation in the industries. GMDC has a beneficiation plant of 500 tpd capacity located at Kadipani to produce Acid grade (96% CaF_2) and Metallurgical grade (90% CaF_2) fluorite by upgrading the low-grade fluorspar ore from 23-25% CaF_2 by flotation method. Besides, it has facility to produce MFC & MET grade powder analysing 75 to 85% CaF_2 & 85 to 92.5% CaF_2 respectively, other products, such as starch briquettes (81% CaF_2 min.) and silicate briquettes (79% CaF_2 min.). As per annual report of GMDC 2016-17, the Government of Gujarat has accorded approval for setting up beneficiation plant of 40,000 MTPA capacity at Kadipani, district Vadodara, in joint venture with Gujarat Fluoro Chemicals Ltd, Noida and Navin Fluorine International, Mumbai. Based on pilot test report, Global tender will be floated for selection of EPC contract. Valuation report for Kadipani assets has been received, on which basis, land will be leased to JV Company and asset transfer will be carried out in favour of JV Company.

CONSUMPTION

The apparent consumption of fluorite was about 2,59,167 tonnes in 2018-19, as against the 2,15,223 tonnes in 2017-18.

SPECIFICATIONS

BIS has prescribed IS: 8587-1993 (First Revision, reaffirmed 2011) for Acid grade fluorite for use in chemical industries, and IS: 4574-1989 (Second Revision, reaffirmed 2008) for fluorite in metallurgical industries.

USES

Acid grade fluorite is used as a feedstock in the manufacture of hydrofluoric acid (HF) and to produce aluminium fluoride (AlF_3). The major use of HF is for the production of a wide range of fluorocarbon chemicals, including hydrofluoro-carbons (HFCs) hydrochlorofluorocarbons (HCFCs), and fluoropolymers. But, owing to environmental concerns, part of chlorofluoro-carbons (CFCs) are replaced by HCFCs. HF is used in the manufacture of uranium tetrafluoride an important ingredient used for producing nuclear fuel and fission explosives. It is also used in stainless pickling, petroleum alkylation, glass etching, oil & gas well treatment and as etcher/cleaner in Electronic Industry.

HF is used in the manufacture of a host of fluorine chemicals used in dielectrics, metallurgy, wood preservatives, herbicides, mouthwashes, decay-preventing dentifrices, plastics and water fluoridation.

AlF_3 manufactured from Acid grade fluorite is used as a flux in electrolytic recovery of aluminium. On an average, worldwide consumption of fluorides is about 21 kg for every tonne of aluminium produced. This ranged from 10 to 12 kg per tonne in a modern pre-baked aluminium smelter and about 40 kg in an old Soderberg smelter without scrubber.

Ceramic grade fluorite containing 85 to 95% CaF_2 is used in Ceramic Industry as a flux and as an opacifier in the production of flat glass, white or opal glass and enamels. The addition of 10-30% Ceramic grade fluorspar to glass makes it opaque, white and opalescent. It is also used in the manufacture of magnesium, some manganese chemicals and welding rod coating.

Metallurgical grade fluorite is used primarily as fluxing agent by Steel Industry. It is added to slag to make it more reactive through increased fluidity. Fluorite of different grades is used in the manufacture of aluminium, cement and glass fibres. It is also used in the melt shop by Foundry Industry.

INDUSTRY

Many fluorine-based chemicals like hydrofluoric acid, aluminium fluoride, cryolite, sodium silicofluoride and hydrofluorosilicic acid are produced by Chemical and Fertilizer industries in the country.

In addition to material produced indigenously, substantial quantity of high-grade fluorite was also imported to meet the demand of the fluorine-based Chemical Industries.

The Tanfac Industries Ltd is a Joint Sector Company of TIDCO and Aditya Birla Group at Cuddalore, Tamil Nadu. It is engaged in the manufacture of fluorine chemicals, such as, aluminium fluoride, anhydrous hydrofluoric acid, sodium silicofluoride, ammonium bifluoride, potassium fluoride, and various other fluorine-based chemicals. The Company has an annual installed capacity of 16,500 tonnes each of aluminium fluoride and anhydrous hydrogen fluoride, 67,200 tonnes of sulphuric acid, 14,000 tonnes of hydrofluoric acid and 3,400 tonnes of speciality fluorides. The Company's topline had gone up by 19% in the year 2017-18 due to increased sales volume of HF, aluminium fluoride and sulphuric acid. Revival of IBAP plant by successfully reducing the cost of production through process optimisations and successfully developing and marketing value-added products out of by-products generated from the IBAP process.

Navin Fluorine Industries Ltd, Surat, Gujarat, has an installed capacity of about 22,000 tpy of hydrofluoric acid. The Company produces a number of fluorine chemicals, namely, hydrofluoric acid, cryolite, aluminium fluoride and various other organic and inorganic fluorine-based chemicals.

Apatite and rock phosphate containing 3 to 4% CaF_2 was another useful source for recovery of fluorine. Coimbatore Pioneer Fertilizer Ltd has reported production of sodium silicofluoride in the past. Similarly, hydrofluorosilicic acid was reportedly produced by Rashtriya Chemicals & Fertilizer Ltd, Mumbai, whereas Dharamsi Morarji Chemical Co. Ltd, Ambernath, Maharashtra no longer reported

production of fluorine chemicals. Aluminium fluoride produced by Southern Petrochemical Industries Corporation Ltd, Thoothukudi, Tamil Nadu with an installed capacity of 2,560 tpy.

SUBSTITUTES

Olivine or dolomitic limestone can be used as substitute for fluorite in Iron & Steel industry. The by-product fluorosilicic acid from phosphoric acid production could also be used as a substitute in aluminium fluoride production.

ENVIRONMENT

Fluorine attracts environmental concern. Use of fluorine in drinking water has begun to wane. Fluorine is toxic in high concentration but beneficial in low concentration. Although fluorine has been under attack ever since its use in water in 1949, the only significant health problem with which it has been linked was 'Fluorosis', a disease that involves health defects and bone lesions. This problem is caused by concentration of fluoride that is much higher than the permissible levels in municipal water supplies. As per Indian Standards, the permissible limit of fluoride in the drinking water is 1.5 mg/l. "Defluoridisation by adsorption" is a common economical and efficient method for removal of excess fluoride from drinking water. Electrolytic precipitation based on use of aluminium salts and by electrochemical route, etc. are the other few methods used for defluoridisation.

Fluorine is at the centre of controversy over chlorofluorocarbons (CFCs), which causes depletion of atmospheric ozone layer that protects the earth from ultraviolet radiation, a major cause of skin cancer. The hydrofluorocarbon (HFC) and hydrochlorofluorocarbon (HCFC) compounds, which have been developed as an alternative to CFC, require more hydrofluoric acid than CFC and are expected to boost fluorite consumption. These greenhouse gases are being phased out in stages. It is reported that even if CFC emission is stopped, the present level of these gases may take up to ten years to reach the upper atmosphere where they could persist for a century or more.

According to United Nations Environment Programme (UNEP), an international agreement to curtail illegal trade in CFC and other ozone depleting chemicals came into effect on 10th November 1999. The agreement, which was authorised through an amendment to the Montreal Protocol in 1997, requires nations to create licensing system for international sales of ozone depleting chemicals. Further, as a part of the Montreal Protocol, 129 nations agreed on a three-year funding package to enable developing countries to continue their efforts to phase out CFC and other ozone depleting chemicals, and accordingly, the Fund's Executive Committee approved major agreements with China and India to finance the shutdown of CFC production facilities in the two countries during the next ten years.

The United Nations Environment Programme (UNEP) has prepared a Montreal Protocol Handbook that provides additional detail and explanation of the provisions. CIESIN's Thematic Guide on Ozone Depletion and Global Environmental Change presents an in-depth look at causes, human and environmental effects, and policy responses to stratospheric ozone depletion.

The use of the low global warming Potential (GWP) hydrofluoroolefins refrigerant HFO-1234 yf is suggested as a preferred replacement of HFC- 134a by both the U.S. Environmental Protection Agency and the EU Daimler in Europe has opted for CO₂ based air conditioning refrigerant in its 2017 Mercedes E and S class cars.

WORLD REVIEW

The world total reserves of fluorite were 310 million tonnes. World reserves are concentrated mainly in Mexico (22%), China (14%) followed by South Africa (13%) and Mongolia (7%) (Table- 6).

World production of fluorite in 2018 increased by 9% to 5.90 million tonnes as compared to 5.40 million tonnes in the previous year (Table-7).

China (59%), Mexico (20%), South Africa (4%) and Kazakhstan (2%) were the principal producing countries of fluorite in 2018.

To provide generalised view of the development in various countries, the countrywise description as

sourced from the latest available publication of Minerals Yearbook 'USGS 2016' is furnished below :

Bulgaria

In January 2015, Solvay S.A. announced its intention to cease operation at its fluorspar mine in Chiprovtsi. The Company cited reduced demand for fluorspar and depletion of quality ore.

Canada

In April 2015, Canada Fluorspar Inc.(CFI) began development at its site near St.Lawrence on Newfoundland's Burin Peninsula. CFI's resources include the AGS, Blue Beach North, Director and Tarefare veins, which total 8.8 Mt of resources with an average grade of 39% fluorspar. The Company expects to begin operations in late 2017, with the 200,000 tpy capacity mill processing material from the open pit mining operations at the AGS vein.

Kenya

Citing weak demand and low prices, Kenya Fluorspar Company Ltd suspended operations at its facilities in Western Kenya on April 30, 2016. The Company sustained financial losses for the past 3 years and had previously suspended operations for approximately 2 months in 2015.

Table – 6 : World Reserves of Fluorite (By Principal Countries)

Country	(In '000 tonnes) Reserves
World: Total (rounded)	310,000
Argentina	NA
Brazil	1,400
Myanmar	NA
Canada	NA
China	42,000
Germany	NA
Iran	3,400
Mexico	68,000
Mongolia	22,000
Morocco	320
South Africa	41,000
Spain	10,000
Thailand	3,600
UK	4,000
USA	4,000
Vietnam	5000
Other countries	110,000

Source: USGS, Mineral Commodity Summaries, 2020

**Table – 7 : World Production of Fluorite
(By Principal Countries)**

Country	(In tonnes)		
	2016	2017	2018
World Total	5700000	5400000	5900000
Afghanistan	40000 ^e	60000	60000
China ^e	3730000	3500000	3500000
Germany	52552	45375	55000
Kazakhstan ^(e)	100000	100000	100000
Mexico	655555	741678	1182058
Mongolia	167700	108900	101200
Morocco	73920	75500	70000
South Africa ^(e)	165000	257000	260000
Spain	162989	154931	176188
Vietnam	217900	234905	238702
Other countries	331269	161439	167123

Source: BGS, World Mineral Production, 2014-18.

FOREIGN TRADE

Exports

Exports of fluorite increased to 534 tonnes in 2018-19 from 470 tonnes in the previous year. Exports were mainly to Indonesia (20%), Syria & Bangladesh (11%

each), UAE (10%), Brazil & Philippines (9% each). Exports of aluminium fluoride also increased substantially by 12% to 442 tonnes in 2018-19 as compared to 205 tonnes in the previous year. Exports were mainly to Cameroon (67%), Japan (18%) and Denmark((11%). Exports of hydrofluoric acid decreased by 31% in 2018-19 to 2,198 tonnes against 3,170 tonnes in the previous year (Tables- 8 to 10).

Imports

Imports of fluorite increased marginally to 2.6 lakh tonnes in 2018-19 as compared to 2.2 lakh tonnes in the previous year. Imports were mainly from China & South Africa (35% each), Thailand (18%), Vietnam and Morocco (3% each). Imports of aluminium fluoride, however, increased by 25% to 62,374 tonnes in 2018-19 from 49,759 tonnes in the previous year. Imports were mainly from Mexico (33%), China (27%), UAE (20%), Indonesia (10%), Jordan (5%) and Qatar (4%). Similarly, imports of hydrofluoric acid increased drastically by 57% to 391 tonnes in 2018-19 from 249 tonnes in the previous year. Imports were mainly from China (81%) and Germany (18%) (Tables- 11 to 13).

**Table – 8 : Exports of Fluorite
(By Countries)**

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value ('000)	Qty (t)	Value ('000)
All Countries	470	15316	534	23413
Indonesia	144	1623	106	5490
Syria	40	2585	60	4052
Brazil	15	810	49	3366
Bangladesh	190	4637	57	2381
Egypt	89	3229	26	1169
UAE	++	8	54	1102
Jordan	-	-	24	1076
Nigeria	-	-	18	950
Philippines	-	-	50	928
Bhutan	21	420	41	920
Other countries	73	2003	49	1977

Figures rounded off

**Table – 9 : Exports of Aluminium Fluoride
(By Countries)**

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	206	20352	442	36259
Cameroon	-	-	294	24844
Japan	200	19242	80	8281
Denmark	-	-	48	1636
Egypt	-	-	20	1402
Spain	-	-	++	94
Bahrain	-	-	++	1
USA	-	-	++	1
Nigeria	5	1013	-	-
Belgium	++	60	-	-
Nepal	++	37	-	-
Other countries	++	++	-	-

Figures rounded off

**Table – 10 : Exports of Hydrofluoric Acid
(By Countries)**

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	3170	231832	2198	211815
Thailand	811	59206	793	82227
Korea, Rep. of	1060	57997	325	31869
Saudi Arabia	409	49070	248	30415
Australia	107	6941	270	15323
Brazil	81	6099	77	9593
USA	52	3391	91	7173
Turkey	180	10681	117	7111
Bangladesh	73	5307	71	6461
UK	2	3595	2	4240
New Zealand	36	1695	54	2946
Other countries	359	27850	151	14456

Figures rounded off

**Table – 11 : Imports of Fluorite
(By Countries)**

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	221818	3958977	265444	7281830
China	89427	1774347	92686	2900052
South Africa	58832	913482	94035	2229129
Thailand	35198	616219	47423	1365369
Morocco	7644	138669	8593	247948
Vietnam	19602	319504	8723	225225
UAE	21	168	3410	75873
Hong Kong	-	-	2457	59138
Spain	2075	42496	1993	42078
Norway	1617	41845	1392	38087
Pakistan	2190	30306	2303	34487
Other countries	5212	81941	2429	64444

*Figures rounded off***Table – 12 : Imports of Hydrofluoric Acid
(By Countries)**

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	249	30825	391	42197
China	145	15448	315	32229
Germany	38	4896	71	7362
France	++	19	++	1010
UK	4	4250	1	910
UAE	-	-	4	339
Belgium	++	182	++	189
Sweden	++	194	++	88
USA	1	370	++	61
Spain	20	1825	++	9
Taiwan	40	3553	-	-
Other countries	1	88	-	-

Figures rounded off

**Table – 13 : Imports of Aluminium Fluoride
(By Countries)**

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
All Countries	49759	2907543	62374	5607483
China	72	6177	16946	1985301
Mexico	500	33035	20300	1483470
UAE	29541	2058832	12168	1349619
Indonesia	6300	348329	6220	470133
Jordan	-	-	2835	184892
Italy	2970	230396	1107	97012
Qatar	1725	18755	2711	33934
Netherlands	1269	56683	67	2402
South Africa	-	-	20	714
Hong Kong	-	-	++	6
Other countries	7382	155336	-	-

Figures rounded off

FUTURE OUTLOOK

The major driving factors for fluorite market are the growing Chemical Industry and increasing use of fluorite in Cement, Iron & Steel, Glass Industries. The Chemical Industry and Glass Industry account for the major share of the fluorite demand globally. As per TANFAC Annual Report 2017-18, global fluoro-chemical market is expected to reach USD 2.2 billion by 2024, growing at a CAGR of 5.3% from 2016 to 2025.

As per USGS report, improvements in steel making technology have also reduced the unit

consumption of fluorite per unit tonnes of steel produced. In less developed countries, the quantity of fluorite used as a flux in steel making continues to be much higher, but further efficiency improvements are expected to moderate growth.

As on 01.04.2015, the resources of fluorite in India are 18.18 million tonnes which is considered to be limited. Hence, to meet the requirements, the domestic Chemical Industry will have to depend, both qualitatively and quantitatively, on imported fluorite in the coming years, both for direct use and for blending with the domestic Acid grade fluorite.