FLUORSPAR DEPOSITS OF INDIA*

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Fluorspar (CaF_2) is an essential mineral in that it is indispensable in steel and aluminium industry. The resources of India with respect to this mineral are inadequate to meet the domestic demands. Any essential mineral becomes a strategic mineral when the nation has to depend on its import from outside sources.

The revolutionary uses of fluorine, of which fluorspar is the only source material, in rocket fuel and atomic weapons has enhanced the strategic importance of fluorspar.

An assessment of the fluorspar deposits of the country (the reserves, demand, potentialities and further requirements) is necessary for its proper utilization and conservation in the event of an emergency caused by war, which is now not very infrequent.

The principal deposits of fluorspar which are being worked at present are that of Amba-Dungar in Gujarat and Mando-Ki-Pal in Rajasthan and Chandi-Dongri in Madhya Pradesh. A similar deposit with a marginal production is being worked at Chowkri-Chhapoli in Rajasthan. Other small occurrences from Rajasthan, Madhya Pradesh etc. are reported.

The present situation with regard to production, demand and the necessary import of fluorspar has been discussed. The need for an intensive search and exploration programme for the mineral is suggested with a view to gaining at least self-sufficiency, if not a surplus situation.

INTRODUCTION

The importance of any mineral to a country depends mainly upon two things viz., the uses of the mineral in the industry and its resources in the country. New discoveries on the revolutionery uses add to the importance of the mineral which when in short supply becomes strategic for the nation.

Amongst the non-metallic minerals fluorspar has now emerged as one of the basic raw material in the modern age of science and technology. It is already a very important raw material as flux in the aluminium, iron and steel industry and serves as a major source of hydrofluoric acid to the chemical industry. Fluorspar is the only major source of fluorine which has now found use in rocket fuel as propellent and in nuclear explosions thus becoming one of the much needed basic raw material in the present age of space research and in the development of atomic weapons which paradoxically act as deterrent against a major war. Fluorine is one of the most

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poisonous and dangerous gas and so are its compounds. But carbon tetrafluoride is an amazing compound which is absolutely non-poisonous and does not explode when mixed with air. It is very stable and is able to change from the solid directly to gaseous state with a great absorption of heat. This property of carbon tetrafluoride has been exploited to develop special refrigerators for deep freezing where temperatures as low as minus 100°C can be maintained. Preservation of foodstuffs for any longer period poses no problem now.

Not everything is known about fluorine yet and the future may see still more remarkable uses of fluorine and its complex compounds which possess immense potentiality in future engineering and other fields of technology.

Fluorspar has so far not received its due place in the exploration programme of minerals. It deserves respect and attention as it is bound to play an important role in the national economy.

Major Deposits and Occurrences of Fluorspar

The occurrences of fluorspar in India are widely distributed in the states of Gujarat, Rajasthan and Madhya Pradesh. The main production of fluorspar is however, confined only to two areas: at Amba Dungar in Baroda district of Gujarat and at Mando-Ki-Pal in Dungarpur district of Rajasthan. Marginal production is also available from Chowkri-Chhapoli in Sikar District, Rajasthan. The Chandidongri deposit in Durg district of Madhya Pradesh had not been under production since 1966, although upgrading of the ores already mined was being carried out. The mining has been again started there shortly. A total reserve of about 14 million tonnes of fluorspar has been estimated from these four deposits which is shown below for individual deposits along with the grades available.

Locality	Reserves (in million tonnes)	Grade % CaF_2
1. Amba Dungar (Gujarat)	11.6	30%
2. Mando-Ki-Pal (Rajasthan)	1.6	18%
3. Chowkri-Chhapoli (Rajasthan)	0.254	18%
4. Chandidongri (Madhya Pradesh)	0.535	16%

Amba Dungar—Situated 50 km south of Chhota Udaipur in Baroda district of Gujarat, Amba Dungar is now a world famous locality very much due to the occurrence of carbonatite rocks in the area, rather than its rich fluorspar deposit.

The area is geologically very interesting and complex too. The cretaceous sandstones and limestones (Bagh beds) and the overlying Deccan basalts (Eocene) are domed up by the basic alkaline intrusives. The domed up basalts have been dropped on a ring fracture and an inner ring of carbonatite cone sheet surrounded by an outer ring of alkaline rocks form the ring complex of an intrusive volcanic centre at Amba Dungar. The alkaline solutions have feldspathised the sandstones in the vicinity of the contacts with the carbonatites. These feldspathised zones contain the major fluorspar mineralization. It occurs in the form of veins, ranging in thickness from one to three metres, and cavity fillings.

Recognition of the existence of the carbonatite in the area (Sukheswala & Udas 1963, 1964, 1967; and Deans *et al.* 1972) has changed the earlier views of Subramaniyam & Parimoo (1963, 1964) about the origin of this deposit by the reaction between the fluorine emanations from the basaltic magma chamber with the Bagh limestones. Now it is considered with some certainty that residual hydrothermal solutions from basic alkaline magma are responsible for the fluorspar mineralisation.

Amba Dungar is the biggest fluorspar deposit of India and is one of the largest in the world. With its known reserves of 11.6 million tonnes it possesses the potentiality to meet fully the domestic demands of the country when developed to its maximum output capacity. At present the beneficiation plant has the capacity of 120 tonnes of fluorite per day.

Mando-Ki-Pal—The Mando-Ki-Pal fluorspar deposit is situated at a distance of 25 km east of Dungarpur and 140 km south of Udaipur in Southern Rajasthan. The deposit is scattered in an area of 130 sq. km. in the southernmost portion of the Sarara inlier of the Banded Gneissic Complex (Precambrian). Granitic gneisses, schists, pegmatites and local microbreccias and silicified mylonites of the Banded Gneissic Complex and phyllites and quartzites of the Aravallis (Precambrian) constitute the rock types of the area. Shear zones, predominantly, in the Banded Gneissic Complex form the structural controls for the fluorspar mineralisation of the deposit which consists of about 40 individual localities. The rocks in the shear zones are strongly brecciated, mylonitised and silicified which imparts them a chert like look in the field. The earlier accounts of the area describe the host rocks as cherts and limestones etc. (Sethi 1966). Recent works by Ranawat (1970), and Pandya and Ranawat (1971) have brought to the light the cataclastic and mylonitic nature of the host rocks of mineralisation. The mineralisation of fluorspar is confined mainly to steeply dipping shear zones which are randomly distributed in different rock types in the area and with no particular trend. Naturally the fluorspar veins too, which are confined to the shear zones only, possess the same attitude as that of the shear zones. The fluorspar mineralisation occurs in the form of cavity fillings, fissure fillings, joint fillings, and breccia fillings in different localities. The localities of mineralisation are distributed between Hatai in north, Mando-Ki-Pal range in south, Garkhumbario in east and Deoli in west.

More important localities where the mineralisation is extensive, depending upon the magnitude of the shear, are: 1) Samotha, 2) Gehuwara, 3) Thorwali and 4) Kaila. These four blocks are the main mining centres of this deposit.

Ranawat (Personal communication 1972) attributes to the deposit a hydrothermal (leptothermal) origin.

Chowkri-Chhapoli—The fluorspar deposit of Chowkri-Chhapoli lies at the border of the Sikar and Jhunjhunu districts of Northern Rajasthan, at a distance of 85 km NNW of Jaipur. A tonalite boss, which is the host rock of mineralisation, intrudes into the garnetiferous biotite schists of the Ajabgarh series of the Delhi System near Salwari (Ranawat & Pandya 1972). The fluorspar mineralisation is found in fissure veins. Another locality 8 km NNW of Salwari is near the village of Chhapoli where fluorspar mineralisation occurs in felspathic quartzites. The Salwari Tonalite and Chhapoli granite are considered to be the source of mineralising solutions.

Chandi Dongri—The fluorspar deposit of Chandi Dongri, the oldest known in the country, is situated at 24 km from Dongargarh and 80 km from Durg in Southern Madhya Pradesh. The mineralisation is confined to sheared cherty quartzites, quartz veins and pegmatite veins. The deposit occurs in two small ridges in the middle part of a 20 km long shear zone marked by low discontinuous ridges between Lanatidongri in the south and Baratalao in the north. The mineralisation is in the form of small veinlets and stringers of fluorspar generally occupying the joints and fractures in the rocks. Dissemination of fluorspar is also noticed in the space between the veinlets.

Smaller Occurrences of Fluorspar

Occurrences of fluorspar have been reported from various places some of which when properly tested and investigated, may turn into sizeable deposits.

An occurrence of fluorspar has been reported at Hingoria in Broach district, Gujarat 80 km WSW of Amba Dungar (Udas & Krishnamurthy 1968). The fluorspar occurs as a vein in a calcareous rock which is supposed to be intrusive and has domed up the basalts. The occurrence seems to be very similar to that of Amba Dungar and needs further exploration.

Another similar occurrence of fluorspar has been reported from Koteshwar in Barwaha Tehsil, district Khargaon, Madhya Pradesh which is 200 km. east of Amba Dungar (Sharma & Rode 1966).

Nepheline syenits are found as intrusive into the Vindhyans which have been domed up. The fluorspar mineralisation occurs in felsite dykes which have intruded into the closely folded Vindhyan rocks (Phyllites?). The dykes trend NNW-SSE and contain veins of fluorspar. Fluorspar is found to occur as disseminations also in the felsite.

Other occurrences of minor importance are in Madhya Pradesh at Malhan village in Jabalpur district; at Churakuta, Ghatkachar and Makarmuta in Raipur district. The latter occurrences are being prospected by the Department of Geology and Mining, Government of Madhya Pradesh. The mineralisation is, however, sporadic and is not likely to be economic at present.

In Rajasthan, occurrences of fluorspar are found in Khajuria in Sirohi district; Asind in Bhilwara district; Bairath in Jaipur district and Jhalara in Udaipur district. These are reported to be small occurrences and only marginal production can be expected from them.

Production of Fluorspar

Regular mining of fluorspar did not begin till 1961 when the deposits of Chandi Dongri in M.P. and Khajuria in Rajasthan contributed a total of 332 tonnes of the mineral. Chandi Dongri has, however, given intermittent production from 1939 to 1946 worked by Tatas. From 1961 onwards it has been worked by the Hindustan Steel Ltd; and the ore is being consumed mainly by Bhilai Steel Plant. Mining operations had been discontinued since 1966 and the old stocks of mined fluorspar ores are still being upgraded in a beneficiation plant with a capacity of 1000 tonnes only in one year.

In 1956 the State Department of Geology & Mining of Rajasthan located the fluorspar deposits at Mando-Ki-Pal. The mining operations are being carried by the Rajasthan State Industrial and Mineral Development Corporation Ltd., since, May 1969. It is expected to produce 16000 tonnes of acid grade fluorspar per year and there is a programme of raising the mine production to 330 tonnes of fluorspar with 18 per cent CaF_2 to achieve the target. However the production is far below at present to achieve the said target.

The fluorspar deposit at Amba Dungar was discovered in 1958. The Geological Survey of India proved the reserves of 11.6 million tonnes of fluorspar with 30 per cent CaF_2 in 1964. Since April 1965, the deposit is being worked by the Gujarat Mineral Development Corporation. Till the year 1970 a run-of mine ore production of 47,000 tonnes in year had been achieved. A beneficiation plant has been in operation since September 1970 with an input capacity of 500 tonnes a day. However, at present a production of 120 tonnes a day of acid grade fluorspar is reported.

The total production of fluorspar has shot up from 332 tonnes in 1961 to 2976 tonnes, (excluding the plant production from Chandi Dongri) in 1971. The main reason for this can be attributed to the new discoveries of fluorspar deposits as well to the increased demand of the mineral caused by a phenomenal growth in the aluminium and chemical industries needing this mineral. On the other hand the iron and steel industries have increasingly substituted bauxite for fluorspar thereby reducing its consumption in these industries. Table I shows the production figures of fluorspar in the country for a decade, from 1961 to 1970, alongwith the imported tonnages and its value in Rupees.

TABLE I

Production of fluorspar in India

Year	Production tonnes	Import in tonnes	Value in Rs.
1961	332	5891	N.A.
1962	657	9373	19,00000
1963	708	8690	16,87000
1964	389	2144	5,58000
1965	651	5004	11,55000
1966	2266	5908	20,90000
1967	1926	7069	32,64000
1968	1315	4280	30,83000
1969	2952	13045	71,68000
1970	7562	9058	63,53000

Note : From 1966 onwards the production figures include the quantity of fluorspar upgraded in Chandi Dongri from the already existing stock-pile.

N.A.—Not available.

In 1971 India imported 16,869 of fluorspar worth Rs. 12,47,000, showing a considerable increase in demand of this mineral.

Internal Demand of Fluorspar

The present output of fluorspar is far below the domestic need and as such there is a wide gap between the production and the consumption of fluorspar in the country, Table II below shows the consumption of fluorspar in different industries in India during 1965 to 1969 :

Table II

Consumption of Fluorspar in India

Industry	1965	1966	1967	1968	1969
Iron & Steel	5100	4564	3765	2385	3049
Foundry	55	196	219	474	561
Aluminium	246	344	303	261	386
Chemicals	91	91	1526	5742	7524
Glass & Ceramic	68	84	89	123	123
Cement	217	182	122	160	250
Antimony	33	33	21	21	21
Electrode	9	77	91	80	80
Total	5819	5571	6136	9246	11994

From the Table II it becomes apparent that the most spectacular rise in consumption of fluorspar has been due to chemicals followed by foundry and electrodes in lesser amounts. The iron and steel industry shows rather a decline in consumption of fluorspar obviously because of the substitution of fluorspar by bauxite. The chemical industry shows potentialities of increased demand with its further growth in the country.

Future Requirements

Only 25 per cent of the total requirement were met with the domestic production of fluorspar in 1970. The domestic production and the imported quantity of fluorspar together meet only 50 per cent of the total requirements of country in terms of fluorspar.

The another 50 per cent were imported as manufactured products in the form of cryolite, aluminium fluoride and other chemicals.

To meet the internal demand it is necessary to increase the domestic production by 8 times within a period of three years (Sinha & Sammanwar 1971). Table III below shows the industry-wise projected demand of fluorspar by 1973-74 and 1978-79, The total approximate requirement of fluorspar by 1983-84 is also shown (Roy Chowdhury 1973).

TABLE III

Industry-wise projected demand of fluorspar by 1973–74 *and* 1978–79 *(from Sinha & Sammanwar* 1971)

Industry	1973-74	1978-79	1983-94
Iron & Steel	5850	7500	
Foundry	617	678	
Aluminium	27450	42700	
Chemicals other than Na_3AlF_6 and AlF_3	4687	5155	
Cement	275	302	
Glass	135	140	
Antimony Smelting	25	25	
Electrode	88	96	
Electrodes abrasives Glass Fluorspar equivalent of cryolite	68	74	
Total	39195	56670	75,000 Approx.

EXPLORATION FOR NEW DEPOSITS OF FLUORSPAR IN THE COUNTRY

To meet the demand for fluorspar in the next two five year plans it is expedient not only to explore intensively the present known deposits and occurrences of this mineral but also to extend the work of prospecting to other unexplored areas. Roy Chowdhury (1973) recommends a search for fluorspar along the fringes of high level granite cupolas particularly in Rajasthan and Madhya Pradesh.

However, it is interesting to note that except the major deposit of Amba Dungar and the minor occurrence of Hingoria in Broach district of Gujarat all the other reported occurrences of fluorspar in India are restricted to the Precambrian terrain of rocks. The occurrences in Precambrian rocks of Rajasthan and Madhya Pradesh so far, have not indicated any substantial tonnages. Also, no significant occurrence has been reported from the vast tract in South India. It seems that areas connected with post-trappean volcanic activity are the likely places where geological environment conducive to the mineralisation of fluorspar exists. Although presence of limestone in the area associated with volcanic activity is not absolutely necessary for the formation of fluorspar, it may work out to be the guiding factor for further prospecting in India based on the example of Amba Dungar in Gujarat.

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