

NON-METALLIC AND REFRACTORY MINERALS GROUP

THE important minerals which fall under this group are (1) Limestone (2) Magnesite (3) Dolomite, (4) Kyanite-Sillimanite (5) Quartz-Silica Sand, (6) Fluorspar and (7) Bentonite.

1. LIMESTONE

Limestone is the most mined and widely used industrial raw material next to coal and iron ore. It is used in the manufacture of cement, as flux in iron and steel industry and ferro-alloys and in fertilizer, chemical and paper industries and also as building material and ornamental stone. It occurs in all the States and distributed in most of the geological formations in India right from the pre-cambrian to recent.

Reserves

The total grade-wise reserves of all the limestone deposits are not fully known. G.S.I. has estimated them as around 17,952 million tonnes of inferred reserves. Some broad estimates of all grades in the different States according to the G.S.I. and other organisations like I.B.M. State Directorates of Geology and Mining etc. are given in Table 1.31. The flux grade includes blast furnace grade and S.M.S. grade varieties.

Specifications, Grades and Uses

There are various specifications to which the

limestone is to be met with to be used for different industries. In some cases the specifications are to be adhered to the chemical analysis (grade) as well as to the physical characteristics of the limestone such as hardness, size etc.

Limestone is most widely used in the manufacture of portland cement and about $\frac{3}{4}$ of the limestone produced in the country is being utilised for the cement industry. Cement grade limestone is to conform to the following specifications :

			%
CaO :—	<42 to 44%	CaO	45.0 (Min)
MgO :—	<3.3	MgO	3.0 (Max. tolerable upto 5.0%).
Al ₂ O ₃ :—	<4.5	Al ₂ O ₃ + SiO ₂	15.0—20.0
Fe ₂ O ₃ :—	<2.5		
SiO ₂ :—	14%	Fe	2.0 (Max.)
Total Carbonate :— 79—81%			

Pure limestone is neither necessary nor desirable. Pyrite and free silica should be absent, and alkalis low.

Next to cement industry, limestone is used as a flux in iron and steel and ferro-manganese industries. Blast furnace grade (B.F.G.) and open-hearth (S.M.S.) grade are the two common types used in iron and steel industry and are to conform to the specifications given in the following page.

<i>B.F. grade</i>	<i>S.M.S. grade</i>
%	%
CaO + MgO 45% (Min)	CaO :— 47% (Min)
CaCO ₃ % 90.0 (Min)	90.0 (Min)
Insolubles 7-12, 12% (Max)	2-4 (4% Max)—5% Max.
(SiO ₂ + Al ₂ O ₃)	
SiO ₂ —10% (Max)	4% (Max)
MgO 4 (Max), 6% (Max)	4 (Max) 3.5% (Max.)
P & S Very low	Very low

**TABLE 1.31—ESTIMATED RESERVES OF LIMESTONE IN DIFFERENT STATES
(IN MILLION TONNES)**

Area	Chemicals	SMS	Flux-Grade (BF)	Others	Cement Grade
(1)	(2)	(3)	(4)	(5)	(6)
Andhra Pradesh	— (1)	—	506.89	—	13,595.74
Assam & Meghalaya	— (2)	—	700.00	60.00	2,898.50
Arunachal Pradesh	— (3)	—	53.0	—	N.A.
Bihar	— (4)	29.97	141.37	24.24	157.75
Gujarat	5.00 (5)	0.08	79.88	34.00	2,000.00
Jammu & Kashmir	— (6)	—	19.18	—	256.09
Diu Island	— (7)	—	N.A.	80.00	113.40
Haryana	— (8)	—	N.A.	—	32.00
Himachal Pradesh	— (9)	—	N.A.	—	386.34
Karnataka	— (10)	223.31	242.30	2.90	15,429.18
Madhya Pradesh	— (11)	132.32	1,427.47	86.95	1,859.96
Maharashtra	— (12)	—	36.93	526.48	2,735.92
Manipur	— (14)	—	N.A.	—	3.0
Orissa	— (15)	1.60	117.40	—	94.40
Pondicherry	— (16)	—	N.A.	—	4.0
Rajasthan	18.06 (17)	50.00	251.33	37.46	5,266.54
Tamil Nadu	— (18)	2.34	6.00	—	295.45
Uttar Pradesh	0.51 (19)	—	336.88	6.78	149.94
Punjab	(20)	—	N.A.	—	1.83
Kerala	(21)	—	N.A.	—	7.14
West Bengal	(22)	—	N.A.	—	—

(Source : I.B.M.) (1971).

The limestone should be of 5 to 10 cm in size dense, massive compact and preferably fine grained and non-gritting on burning and should withstand batch load of the operating furnace.

Limestone is used in fertilizer production in two plants in India namely the Naya Nangal unit of FCI and Rourkela Unit of HSL. The Naya Nangal uses both limestone and dolomite together having combined CaCO₃ + MgCO₃ = 90% Minimum

with CaCO₃ = 54–70% and MgCO₃ = 22–45% ; SiO₂ = 4% (Max.) ; Moisture = 0.5% (Max.) ; organic matter = 0.5% (Max.) ; S = Nil (free or as sulphides). The size range desired of the lumps is from 203 mm (8") with pieces upto 279 mm (11") in the long direction not to exceed 10%.

The Rourkela fertilizer plant uses limestone having insolubles 12% (Max.) and lump size ranging from 3 to 25 mm.

Limestone is used in most of the chemical industries such as calcium carbide manufacture, bleaching powder, soda ash, caustic soda etc. after calcination in the form of lime (CaO), and should be originally of a high grade nature. The following are the specifications of lime for the various chemical industries.

Future Trend

The demand for cement and iron and steel have risen steeply during the last 10 to 15 years and accordingly the requirements of limestone have also increased. The future requirements of limestone for both cement and iron and steel in-

Industry	CaO%	$\text{Fe}_2\text{O}_3\%$ + $\text{Al}_2\text{O}_3\%$	SiO_2	P%	MgO%
1. Calcium carbide	95-97	—	1-3	0.5 (Max)	0.5 (Max)
2. Bleaching powder	95 (Min)	2.0 (Max)	1.5 (Max)	—	2.0 („)
3. Soda ash	$\text{CaCO}_3\%$ = 90-99	$\text{Al}_2\text{O}_3 + \text{SiO}_2 + \text{Fe}_2\text{O}_3$		$\text{MgCO}_3\%$ = %6.0	(„)
		3.0% (Max)			
4. Caustic soda	$\text{CaCO}_3\%$ = 95-98%	$\text{Al}_2\text{O}_3 + \text{SiO}_2 + \text{Fe}_2\text{O}_3$		$\text{MgCO}_3\%$ = %0.5	(„)
		1.5-3.0			
5. Sugar	CaO = 80-85% ; $\text{Fe}_2\text{O}_3 + \text{Al}_2\text{O}_3 = 1.5\%$	Max: $\text{SiO}_2 + \text{insolubles} = 4.0\%$ (Max.)		$\text{MgO} = 1.0\%$	(„)
6. Glass: Colourless glass		$\text{CaCO}_3 = 88.5\%$ Min. $\text{Fe}_2\text{O}_3 = 0.04\%$ Max.)			
		Free carbon = 0.1% (Max.)			
	Bottle glass —	$\text{Fe}_2\text{O}_3 = 0.2\%$ (Max.) other constituents being as above.			
7. Paper: (for sulphite pulp manufacture) :	CaO = 92.5% Min. MgO = 2.5% Max ; $\text{Fe}_2\text{O}_3 + \text{Al}_2\text{O}_3 + \text{SiO}_2 = 3.0\%$ (Max.)				

Limestone of similar grade is used in the manufacture of bleaching powder, caustic soda and soda ash. It is also used for buildings and construction purposes.

Production, Domestic Consumption

Production of limestone as seen for the last few years is on the increase due to domestic demand for the expanding cement and iron and steel industries of the country. Madhya Pradesh tops the list among the various states producing limestone. The production figures for the different states are given in Table 1.32. The domestic consumption of limestone in the various industries is given in Table 1.33. Besides limestone, lime-kankar, lime shells and calcareous sea sand/marl are also used in the various above industries.

Import and Export

There was no import of limestone to India after 1965. The export trend of limestone/lime for the last few years is given in Table 1.34.

Industry are likely to increase further in the coming years with the expansion programmes in both these industries. As the reserves of high grade limestone meant for iron and steel industry are limited, the necessity is there now for conservation and proper utilisation of the resources by proper development and expansion of the existing mines to the full capacity and by beneficiation of low grade limestone.

Attempts are also to be made to develop substitute materials to be used for cement industry in partial replacement of limestone with B.F. slags etc. to minimise the limestone usage and conserve the same.

The future requirements of limestone for internal consumption as estimated by Planning Group on Minerals would be 38.3 million tonnes of cement grade and 10.7 million tonnes of flux grade for 1978-79. It is further estimated that it is likely to touch 25.0 million tonnes of flux grade by 1990-91.

TABLE 1.32—STATEWISE PRODUCTION OF LIMESTONE (IN TONNES)

State	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1. Andhra Pradesh	17,62,697	17,87,277	19,02,960	21,76,833	23,86,018	26,15,530	24,41,533	—	—	—
2. Assam/Meghalaya	30,357	50,598	65,989	85,796	64,702	86,757	74,403			
3. Bihar	21,86,241	20,88,468	22,49,704	22,28,767	21,81,362	19,71,670	20,26,849			
4. Gujarat	19,03,509	19,84,952	21,42,779	22,19,134	20,90,189	22,65,281	26,18,471			
5. Haryana	4,92,829	4,77,357	5,14,191	5,07,696	4,67,842	4,92,779	4,57,537			
6. Himachal Pradesh	34,001	43,040	5,070	48,637	47,904	33,933	24,911			
7. Jammu & Kashmir	10,184	13,718	12,079	3,322	17,083	15,958	12,498			
8. Karnataka	16,82,920	16,56,028	17,45,635	21,07,087	23,40,906	24,30,015	21,61,534			
9. Madhya Pradesh	38,68,403	36,92,173	39,26,434	40,44,430	40,88,146	45,42,543	45,81,916			
10. Maharashtra	98,485	1,19,354	68,660	1,95,449	3,76,667	3,62,578	5,04,213			
11. Orissa	23,15,157	21,26,437	26,02,945	26,55,758	28,58,057	26,95,023	28,59,132			
12. Punjab	—	690	260	1,152	659	—	—			
13. Rajasthan	17,15,793	17,26,487	18,91,716	21,62,891	20,80,563	21,95,674	24,15,158			
14. Tamil Nadu	27,01,092	31,35,380	31,35,553	32,33,714	36,93,353	40,56,978	43,70,933			
15. Uttar Pradesh	10,09,095	6,77,640	6,99,370	8,34,163	10,97,433	12,92,264	9,75,315			
16. West Bengal	19,941	6,675	11,145	7,643	9,846	6,773	9,148			
Total (India)	1,98,30,704	1,95,86,269	2,10,20,121	2,25,12,472	2,38,00,730	2,50,72,756	2,55,43,551	2,38,30,000	2,58,16,161	2,57,58,817

TABLE 1.33—DOMESTIC CONSUMPTION OF LIMESTONE (IN TONNES)

Industry	1967	1968
(1) Cement	1,46,27,506	1,54,07,861
(2) Iron & Steel	27,90,677	33,28,841
(3) Chemical	6,41,675	8,95,655
(4) Others	14,08,692	14,83,327
Total	1,94,68,550	2,11,15,684

(Source : I.B.M.)

TABLE 1.34—EXPORTS OF LIMESTONE/LIME (IN TONNES)

1967	1968	1969	1970	1971	1972	1973	1974
1,129	408	465	298	282	3,016	75,454	60,727

2. MAGNESITE AND DOLOMITE

Magnesite is widely used in the basic refractory industry, cements and flooring after calcination. It is also used as a raw material for magnesium compounds and metallic magnesium and in chemical industry. It has got a potential export market.

Dolomite is now-a-days employed as a flux stone in blast furnaces, particularly in the making of ferro-silicon and ferro-manganese because it carries very little of the silica or the manganese into the slag. Calcined dolomite and dolomitic limestone are widely used in basic open-hearth and bessemer convertors in steel industry. It is also used in refractory, glass, paper and other industries.

Both magnesite and dolomite occur in almost all the states in the country, and got wide distribution.

Reserves, Specifications and Uses

Magnesite occurs in Andhra Pradesh, Bihar, Gujarat, Jammu & Kashmir, Karnataka, Rajasthan, Tamil Nadu and Uttar Pradesh, the most important deposits lying in Bihar (Singhbhum), Tamil-Nadu (Salem), and Uttar Pradesh (Almora) respectively. The important deposits are given in Table 1.35.

The specifications and grades of magnesite differ widely on the usage. It is chiefly used in refractories industry for the manufacture of basic refractory bricks after calcining to be used in the open hearth, electric arc furnaces and hot metal mixers, soaking pits etc. in iron and steel industry, and in copper converters. It is an important source of magnesium metal and also used in manufacture of special cements, chemicals, pharmaceuticals and rubber industry.

I.S.I. Specifications

Light magnesium carbonate for rubber industry — I.S. 1420-1959 states that the material should consist of hydrated basic magnesium carbonate in the form of dry, fine, white powder free from gritty impurities and added substances and conform to the specifications given in Table 1.36.

Refractories

According to I.S. 1749 1961 and I.S. 1750-1961 magnesite used for the manufacture of magnesite bricks and dead-burnt pea-magnesite should conform to the specifications given in Table 1.37. The Indian manufacturers of lightly calcined and dead-burnt magnesite utilize magnesite with 44-46% MgO and 2.6% SiO₂ (max).

Production, Domestic Consumption and Export

Tamil Nadu accounts for more than 90% of magnesite production in the country followed by Karnataka, Rajasthan and U.P. The annual production figures are given in Table 1.38. Domestic consumption of magnesite industry-wise is given in Table 1.39.

Export Policy

Magnesite is outside the purview of the export control order 1968 and is freely allowed to be exported without any export licence. The export figures of magnesite (mostly calcined) are given in Table 1.40.

Import Policy

Magnesite can be imported for refractory purposes for export production only. The import figures are given Table 1.41.

TABLE 1.35—MAGNESITE DEPOSITS DISTRIBUTION (IN MILLION TONNES)

State	District	Deposit	Reserve extent	Grade
(1) Bihar	Singhbhum	Bhitardari	6.1 (Tale/Refractory (magnesite) (upto 15 metres depth)	
(2) Tamil Nadu	Salem	Suramangalam	43.35 (upto 30 mts. depth) (recoverable reserve)	All grade with 11.0 million ton refractory grade
Reserve of Magnesite in U.P. (GSI)				
(3) Uttar Pradesh	Almora & Pithorgar	Agar Girechina	3.44 m. ton (IBM)	(MgO%) 38-43%
		Dewaldhar	8 m. tons (IBM)	41-42%
		Pungar Valley	12.19 m. tons (DGM)	40-42%
		Lahore Valley	2.54 m. ton (DGM)	41-43%
		Dewalthal	16.81 m. tons	
		That area	Goul—3.34 m. tons	
	Tentative estimate by G.S.I.	Kanada Masauli	Kholi-Amthal 11.35 m. tons	
		(a) Masauli	6.7 m. tons	39-45%
		(b) Dhapali	35.20 m. tons	
		(c) Kanda	11.88 m. tons	39-45%
	Chamoli	Pipal Koti	1 m. ton	
(4) Rajasthan	Ajmer	Sarupa-Ghnaja	1.5 (D.G.M.)	

Source: I.B.M., G.S.I. State Directorates of Geology & Mining.

TABLE 1.36—I.S. 1420-1959 SPECIFICATION FOR LIGHT MAGNESIUM CARBONATE FOR RUBBER INDUSTRY

Chemical constituent	% Assay
SiO ₂	Not prescribed
CaO	1.0 (Max.)
MgO	40-43.5 (Min.)
Fe and Al as oxides	0.1
Chlorides (Cl)	0.2
Sulphates (SO)	0.2 (Max.)
Mn	0.004
Loss on Ignition (LOI)	58.0 (Max.)

Future Trend and Expansion

With the growing iron and steel industry which is the main consumer of refractory grade magnesite, the present reserves position cannot be taken as very satisfactory. As such intensive exploration work for finding out newer deposits of suitable grade is to be geared up besides utilising the low grade deposits after suitable beneficiation treatments to reduce the silica content in the magnesite. Recent indication shows that there exists a huge potentiality of magnesite in Almora and Pithoragarh districts of U.P. However, the beneficiation possibility of high SiO₂ magnesite of Salem will have to be studied.

TABLE 1.37—I.S. 1749 AND 1750-1961 SPECIFICATIONS FOR REFRACTORIES FOR STEEL INDUSTRIES AND DEADBURNT PEA MAGNESITE

Specific Requirements	IS : 1749-1961 Magnesite refractories for steel plants	IS : 1750-1961 Dead-burnt per magnesite
Tolerance on size	1.5% or 1 mm whichever greater	Not prescribed
Chemical analysis		
SiO ₂ %	5.5 max.	5.5 max.
CaO%	2.5 max.	2.5 max.
MgO%	85 min.	85 min.
Refractories under load	1550°C min.	Not prescribed
Apparent porosity % by volume	24 max.	-do-
True specific gravity	3.53 max.	3.53 max.

3. DOLOMITE

Even though inferior to magnesite for utilisation in refractory industry, dolomite has now a days gained importance in view of its cheapness, as well as its utilisation as fluxing agent in iron and steel industry. It occurs in almost all the states

TABLE 1.38—STATEWISE PRODUCTION OF MAGNESITE (IN TONNES)

State	1967	1968	1969	1970	1971	1972	1973	1974	1975
(1) Karnataka	5,444	5,527	7,655	7,422	9,635	9,432	6,582		
(2) Rajasthan	9	3	25	108	231	—	—		
(3) Tamil Nadu	240,995	247,543	287,828	346,761	285,738	241,399	178,732		
(4) Uttar Pradesh	—	—	—	—	—	100	—		
Total (India)	246,448	253,073	295,508	354,291	295,604	250,931	185,314	265,532	313,415

Source: I.B.M.

TABLE 1.39—CONSUMPTION OF MAGNESITE (IN TONNES)

Industry	1967	1968
(1) Calcination	2,23,277	2,40,714
(2) Refractory including iron and steel	1,27,803	1,20,116
(3) Chemical	1,746	1,759
(4) Fertilizer	1,483	1,500
(5) Glass	321	389
(6) Cement	320	320
(7) Foundry	168	108
(8) Abestos products	275	315
(9) Others (abrasives etc.)	163	211

(Source: I.B.M.)

except, Assam, Jammu & Kashmir, Kerala, Tamil Nadu, Punjab and the Union Territories. Orissa and Madhya Pradesh are the chief producing states of dolomite.

Reserves, Specifications and Uses

The reserves of Jalpaiguri district of West Bengal have been estimated as around 243 million

tonnes (G.S.I. report) with all grade. Reserves of some important deposits have been indicated in Table 1.42. Details of many other deposits are not known.

The specifications vary with the uses to which dolomite is put to. High purity dolomite is used in iron and steel, refractory and glass industries. Calcined dolomite and dolomitic limestone are used as linings in different furnaces of iron and steel, copper and lead smelting. Dolomite is also used as a flux for iron ores in blast furnace as well as in open-hearth furnace (low-magnesia limestone), and steel melting shops. The other uses are in paper industry, in lime mortars, and in less quantities in rubber, varnish & paints, tanneries and for soil conditioning and fillers with fertilizers and in the manufacture of magnesium metal. The specifications of different grades of dolomite are given in Table 1.43.

Production, Domestic Consumption, Export and Import

The production of dolomite for the last few

TABLE 1.40—EXPORT OF MAGNESITE (IN TONNES)

1966	1967	1968	1969	1970	1971	1972	1973	1974
34,228	19,922	22,309	25,922	34,155	23,642	16,080	14,397	15,929

Source: I.B.M.

TABLE 1.41—IMPORT OF MAGNESITE (IN TONNES)

1966	1967	1968	1969	1970	1971	1972	1973
273	101	24	131	44	39	51	81

Source: I.B.M.

**TABLE 1.42—RESERVES OF DOLOMITE
(IN MILLION TONNES)**

State	Measured	Indicated	Inferred	Total
Andhra Pradesh	—	89.40	—	89.40
Arunachal Pradesh	—	—	—	20.00
Bihar	—	—	10.05	10.05
Madhya Pradesh	109.39	279.30	254.41	678.21
Maharashtra	—	—	345.00	345.00
Mysore	—	—	211.90	211.90
Orissa	19.69	—	262.55	288.37
Rajasthan	—	101.00	—	101.00
Uttar Pradesh	—	—	17.93	17.93
West Bengal	—	16.00	—	16.00
Total	120608	485.70	1121.84	1777.86
<i>Grade wise</i>				
SMS & Refractory	55.80	21.56	33.01	110.37
BF	61.18	121.29	194.79	377.26

years is given in Table 1.44. Domestic consumption of dolomite for the various industries is given in Table 1.45. Exports of dolomite in the years 1972 and 1973 are 3,769 tonnes and 8,733 tonnes respectively. Earlier to 1972 there is no export of the mineral. No imports of dolomite have taken place so far.

Future Outlook

With the phased increase and envisaged expansions in the coming five year plans of iron and steel industry which is the main domestic consumer field of dolomite, the demand for more output of the mineral is arising year by year and

warrants the exploratory programmes to be abreast to meet the recurring and increasing demands of the industries.

4, FLUORSPAR

The mineral Fluorspar or Fluorite (CaF_2) is the most important commercial source of elemental fluorine and is chiefly used as a fluxing agent in the manufacture of steel and other alloys, aluminium, in the smelting of gold, silver, copper, lead etc. and in the manufacture of hydrofluoric acid, synthetic cryolite, glasses, enamels refrigerants, insecticides etc. Lately it has been used in the extraction of U_{235} from other isotopes of uranium. The present indigenous production of the mineral is far too inadequate of our requirements and is to be imported to some extent. The potential deposits of Ambadungar in Gujarat State and the new finds of Rajasthan and Madhya Pradesh are expected to improve the country's requirements of the mineral.

Reserves, Specification and Uses

The most important deposits of fluorspar lie in Gujarat State (Ambadungar-Baroda dist.), Madhya Pradesh State (Chandi Dungri-Durg district), and Rajasthan (Mandokopal-Dungarpur dist); Chowkri-Chhapoli and Salwari in Sikar district) besides some minor occurrences in the states of Bihar, J & K, Karnataka, Himachal Pradesh and Punjab. Known reserves are given in Table 1.46. Specifications of the fluorspar vary with the use to which it is put in the various industries. Standards for the various industries are given in Table 1.47 & 1.48.

TABLE 1.43—SPECIFICATION OF DIFFERENT GRADES OF DOLOMITE

Constituents	Refractory grade (furnace lining)	Flux grade	Glass grade	Lime grade
$\text{MgCO}_3\%$	35.0% Min.	—	High grade	28-46
$\text{MgO}\%$	16.6% Min.	20.0 Min.	Dolomite with iron oxide less than 0.2%	
$\text{SiO}_2\%$	1.0% Max.	2.0 Max.		
CaCO_3	Remainder			54.72
$\text{CaO}\%$	20-30	29.0 Min.		
$\text{Al}_2\text{O}_3\%$	2.0 Max.	1.0 Max.		Others 3.0
$\text{Fe}_2\text{O}_3\%$	—	1.0 Max.		

TABLE 1.44—DOLOMITE PRODUCTION (STATE-WISE) (IN TONNES)

State	1967	1968	1969	1970	1971	1972	1973	1974	1975
(1) Andhra Pradesh	656	644	49	121	122	34	—	—	—
(2) Bihar	5,375	1,862	5,789	4,989	2,960	1,826	—	—	—
(3) Gujarat	1,04,621	1,09,434	75,017	61,507	1,20,399	1,20,072	—	—	—
(4) Haryana	791	1,337	1,856	614	247	293	—	—	—
(5) Himachal Pradesh	—	—	—	30	1,625	1,875	—	—	—
(6) Karnataka	7,675	6,097	3,721	2,915	4,045	1,891	—	—	—
(7) Madhya Pradesh	4,61,117	4,62,218	4,77,398	4,14,080	4,16,587	5,12,871	—	—	—
(8) Maharashtra	10,050	22,091	13,642	5,424	5,179	5,343	—	—	—
(9) Orissa	4,58,293	5,70,663	6,11,493	5,77,692	7,02,805	6,26,302	—	—	—
(10) Rajasthan	26,421	20,897	20,713	10,300	14,957	20,065	—	—	—
(11) Uttar Pradesh	74,872	48,422	35,746	32,144	23,991	13,691	—	—	—
(12) West Bengal	17,451	28,687	29,405	39,655	27,389	44,228	—	—	—
Total (India)	11,67,322	12,73,352	12,74,829	11,49,471	13,20,306	13,48,491	13,89,848	11,95,134	14,53,420

TABLE 1.45—DOMESTIC CONSUMPTION OF DOLOMITE (IN TONNES)

Industry	1967	1968
(1) Iron & Steel & Refractory	9,39,344	10,14,929
(2) Fertilizer	47,974	94,754
(3) Ferro-manganese	20,767	32,746
(4) Glass	23,040	22,529
(5) Others	11,103	11,628
TOTAL	10,42,228	11,76,586

Source : I.B.M.

TABLE 1.47—STANDARDS FOR FLUORSPAR FOR METALLURGICAL PURPOSES I.S.I. SPECIFICATIONS

Constituents %	Grade 1 Flux for Aluminium Smelting	Flux for steel making	
		Grade 2	Grade 3
CaF ₂ Min.	97	85	80
SiO ₂ Max.	1	6	8
Effective CaF ₂ Min.	—	70	60
CaCO ₃ Max.	1	—	—
Fe ₂ O ₃ Max.	1	—	—
Sulphur Max.	—	0.3	0.3
Lead Max.	—	0.5	0.5

TABLE 1.46—FLUORSPAR OCCURRENCES AND RESERVES (IN MILLION TONNES)

Deposit	Reserves	Grade CaF ₂ %
Gujarat		
Ambadungar (Baroda Dt.)	11.60	All grades out of 11.60 M. ton 2.5 M. ton contain 25% CaF ₂ .
Hingoria (Broach Dt.)	0.0009	—
Madhya Pradesh		
Chandi Dungri	0.61	0.5-16%
Rajasthan		
Ghowkri-Chhapli	0.7	15%
Kahila	0.25	20%
Mando-Ki-Pal	0.7	17%

Fluorspar is mainly used as flux in the aluminium and steel industries besides foundries and smelters, while large quantities of acid grade fluorspar are required for the production of synthetic cryolite and fluoro-chemicals. It is also used in small amounts in ceramic, glass, enamel, refrigerating, insecticides, preservatives, dyestuffs and other industries.

Production, Domestic Consumption and Import

Indigenous production of fluorspar is on the

increase year by year even though it would not be sufficient to meet domestic consumption which is to be balanced by imports. In fact 80% of our internal needs amounting to about 10,000 tonnes is imported during the year 1972. Production, consumption and import details of fluorspar are given in Table 1.49.

Future Outlook

Until 1965 fluorspar was mainly consumed by the metallurgical industry in India; but pattern of consumption has since changed, and is expected

to be about 29,000 tonnes in 1973-74, which may rise upto 75,000 tonnes in 1983-84 as an inevitable consequence of the future expansion programmes is the core sector like steel, aluminium and other metallurgical industries and chemical glass and ceramic industries in the country. As such development of the known resources on a priority basis and utilization of low grade ores by adopting beneficiation methods is to be resorted for minimising the imports. Further, more reserves are to be established by intensive exploration programmes in potential areas to improve the present reserves position.

TABLE 1.48—FLUORSPAR SPECIFICATIONS FROM U.S. NATIONAL STOCK PILE p. 69 A & B

Fluorspar Grade	CaF ₂ %	CaCO ₃ %	SiO ₂ %	Fe ₂ O ₃ %	Pb %	Zn %	S %	Remarks
	Min.	Max.	Max.	Max.	Max.	Max.	Max.	
Metallurgical								
1. Grade A	70	—	—	—	0.5	—	0.3	—1" and not more than 15% o —16 mesh
2. Grade B	60	—	—	—	0.5	—	0.3	
Chemical								
1. Acid grade	97.0*	1.25	1.5	—	—	—	0.03	—100 mesh
2. Cryolite grade	97.0+	—	1.1	0.25	0.2	0.20	0.03	
3. Ceramic grade	95-98@	1.0	2.3	0.12	—	—	—	—100 mesh

Note : * = Effective CaF₂ is calculated by deducting 2½% from the contained CaF₂ for each 1% SiO₂.

+ = CaF₂ may be 95% Min. provided the available CaF₂ is calculated by deducting 4% from total for each 1% SiO₂.

@ = CaF₂ may be 95% minimum provided CaCO₃ is 1% minimum and CaCO₃ shall not be less than 1.5% for each 1% that the CaF₂ is below 97%.

TABLE 1.49—PRODUCTION, CONSUMPTION AND IMPORT OF FLUORSPAR (IN TONNES)

	1967	1968	1969	1970	1971	1972	1973	1974	1975
Production grade	1,603	1,206	1,880	4,666	3,527	3,301	2,841	3,749	3,065
Production crude	—	—	—	—	—	40,085	35,783		
Domestic consumption									
Iron & Steel		3,765	2,385						
Chemical		1,652	1,785						
Aluminium		303	261						
Foundry		219	474						
Cement		123	160						
Glass		99	132						
Others		117	107						
Total		5,305	6,277						
Import :	11,503	1,158	13,042	9,058	16,869	9,956	677	16,857	

5. KYANITE—SILLIMANITE

Kyanite, sillimanite and andalusite are having identical chemical composition $\text{Al}_2\text{O}_3\text{SiO}_2$ but differ in crystal systems. They are all converted to mullite on calcination, which is widely used as high temperature refractory material as furnace linings in cement ceramics, glass and metallurgical industries besides being used in electrical insulator industry, automobile spark plugs porcelain etc. Raw Kyanite is used in the manufacture of certain ceramic materials. The world famous Lapsa Buru Kyanite deposits of Singhbhum district, Bihar are one of the most important high grade deposits from where the mineral is exported to different countries of the world.

Reserves, Specifications and Uses

Kyanite occurs in Andhra Pradesh, Bihar, Maharashtra, Karnataka, Orissa, Rajasthan and West Bengal. Of these the deposits of Bihar in Singhbhum district are of considerable importance in extent and grade. Workable deposits of kyanite and kyanite-quartz rock are present in Singhbhum district where active production is seen as early as 1924.

The total measured indicated and inferred reserves have been assessed at 2.99 million tonnes. The potentialities of the 67.4 million tonnes of Kyanite-quartz rock of Singhbhum district containing 30% Kyanite are yet to be confirmed. The kyanite-sillimanite deposits of Dahegaon-Pimpalgaon area of Bhandara district in Maharashtra State are of considerable importance and estimated to be 1.87 million tonnes. The details of Kyanite known reserves are given in Table 1.50.

Kyanite is chiefly used as a refractory lining material after calcination which transforms into mullite, in furnaces for glass, melting, non-ferrous metals, ceramics and cement kilns, electrical insulators etc. The specifications of kyanite used by the different refractory units in the country are given in Table 1.51.

The current U.S. National Stockpile Purchase Specifications (P-270) (29.2, 1960), for Indian Kyanite or concentrates are given below :

(a) *Chemical requirements* : Assay % (ignited at 1000°C for one hr.).

(b) *Phycal requirements*

(1) Lump material :— Natural kyanite or electrically fused synthetic mullite not more than 10% by weight shall pass a 12.5 mm (half-inch screen and not more than 1% by weight shall pass the U.S. Standard sieve No. 60 (A.S.T.M. Designation E-11).

(2) Fine material :— Each lot of ore or concentrate in natural condition as loaded into railroad cars in the U.S.A. shall contain not more than 5% by weight which shall be retained on a 12.5 mm ($\frac{1}{2}$ ") screen and not more than 60% by weight shall pass the U.S. Standard sieve No. 16 (A.S.T.M. Designation E-11).

(3) Calcined material :— The calcined material after crushing and screening shall contain not more than 60% by weight which shall pass the U.S. Standard sieve No. 100 (A.S.T.M. Designation E-11). The grains of the calcined refractory material shall be strong and suitable for the manufacture of refractory bricks and special shaped products. These products shall pass the tests required under the procedures laid down for sampling, inspection and testing.

(c) *P.C.E. tests* (Pyrometric cone equivalent).

Each lot shall have its pyrometric cone equivalent determined by the latest revision of A.S.T.M. Designation C-24-56, Pyrometric Cone Equivalent (P.C.E.) of Refractory Material, or by alternate methods approved by the buyer. The PCE shall be as follows for the four types.

Type	—	A	B	C	D
P.C.E. Cone No.		37	37	37	38

Production, Domestic Consumption and Export

The production of Kyanite is given in Table 1.52. The domestic consumption of kyanite is relatively small as compared to the production and the bulk of the production is being exported as export of this mineral was decontrolled since 1960. The domestic consumption and export figures of kyanite are given in Table 1.53.

TABLE 1.50 (a)—INVENTORY OF RESERVES OF KYANITE AS ON 1.1.1973

State	District	Area	RESERVE (In million tonnes)				Source
			Meas.	Indict.	Inf.	Total	
Bihar	Singhbhum	Lapsaburu & Kasidih	0.102	0.159	—	0.261 In Bihar out of 0.261 m. tonnes, 0.1098 m.t. as of commercial high grade (above 60% Al_2O_3 and rest is unclassified.	IBM
Karnataka	Chitradurga, Hassan & Mysore.	Holalkere, Holenarsipur, Kollegal talnus.	—	—	0.4600 0.2999 0.0300	0.7899 In Karnataka out of 0.7899 m. tonnes 0.30 m.t. is of commercial low grade (Al_2O_3 -58-60%) and rest in unclassified.	DGM & Lessee
Maharashtra	Bhandara	Dahegaon & Pimpalgaon	—	—	1.87	1.87 In Maharashtra out of 1.87 m. tonnes 0.103 m.t. contain Al_2O_3 above 60% 0.177 m. tonnes contain Al_2O_3 50 to 60% and rest is below 50% Al_2O_3 .	DGM & M.M.C. Ltd.
Orissa	Dhenkanal	Joradanali	—	0.02 (upto 7.5 m. depth)	0.05 (upto 15 m. depth)	0.07 (Grade unclassified)	Lessee

Future outlook

The total reserves of kyanite (indicated and inferred) are put at 2.99 million tonnes. However, one of this reserve only about 2 lakh tonnes is of high grade lumpy ore. So the reserve position is far from happy. In order to meet the

increased demand of kyanite for domestic consumption and for exports which is placed at 0.15 million tonnes by 1980-81 it is necessary that the present reserves position must be improved by extensive exploration programme of new deposits and by evaluation and utilisation of the huge low grade kyanite-quartz deposits 67.4 million of

TABLE 1.50 (b)—RESERVES OF LOW GRADE KYANITE ORE AS ON 1.1.1975

State	District	Area	Reserve (in million tonnes)				Source
			Meas.	Indict.	Inf.	Total	
Andhra Pradesh	Khammam	Garibpeta	—	—	—	48.00 (Kyanite content 10-12% by volume)	G.S.I.
	Nellore	Malakonda	—	—	—	32.00 (Average recovery of kyanite from the schist is about 24%)	D.G.M
Bihar	Singhbhum	Jothipahar Shirbai Jambami Kanyaluka	—	—	—	67.44 (Kyanite content 30%)	G.S.I.
Karnataka	Coorg	Saiddapura area	—	—	—	4.15 (Out of 4.15 m. tonnes of kyanite bearing rocks 3.70 m. tonnes contain 5 to 15% Kyanite, 0.345 m. tonnes with 10% Kyanite and the rest contain 30-5% Kyanite concentration.	G.S.I.

TABLE 1.51—SPECIFICATIONS OF KYANITE USED BY INDIAN REFRACTORY INDUSTRY ..

Firm	Physical and chemical analysis Assay %						
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	MgO	LOI	PCE Segar Cone No.
(1) A.C.C. Ltd., Katni fire bricks & pottery works	28.98	66.10	1.30	1.10	1.70	1.18	36
(2) Kumardhubi Fire-clay & silica works Ltd.	—	60.0 (min.)	—	—	—	—	—
(3) Amar Nath Bhaskar Sons (Refractory manufacturers)	—	60.0 (min.)	—	—	—	—	—
(4) TISCO Ltd.	—	High grade 62.0 (Min) Low grade 45.0 (Min)	—	—	—	—	—
(5) Burn & Co. Ltd.	—	60.62	—	—	—	—	—
(6) Belpahar Refractories	—	60 Min.	—	—	—	—	—

(Source : I.B.M.)

TABLE 1.52—STATEWISE PRODUCTION OF KYANITE IN TONNES

State	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
(1) Bihar	63,558	49,409	64,108	73,431	1,02,464	57,380	57,327	39,847		
(2) Haryana	3	—	—	—	—	—	—	—		
(3) Karnataka	190	509	253	218	159	652	998	406		
(4) Orissa	8	419	—	—	123	—	—	—		
(5) Maharashtra	—	—	—	10,481	16,380	5,450	9,557	12,479		
(6) Rajasthan	61	37	—	42	—	—	—	—		
(7) West Bengal	—	—	—	—	—	—	15	—		
Total	63,820	50,374	64,361	84,172	1,19,126	63,482	67,897	52,732	45,337	50,301

TABLE 1.53—CONSUMPTION AND EXPORTS OF KYANITE (IN TONNES)

	1966	1967	1968	1969	1970	1971	1972	1973
Domestic consumption :								
Refractory		9,856	11,721					
Ceramic		2,248	6,738					
Total		12,104	18,459					
Export	35,726	40,653	50,465	45,641	69,331	42,821	28,983	25,091

Singhbhum district by adopting suitable beneficiation methods. The world renowned high grade Lapsa Buru deposit is likely to be depleted in the next decade. The export policy needs modification in allowing the export of calcined product instead of raw kyanite.

6. SILLIMANITE (Al₂O₃, SiO₂)

Like kyanite and andalusite it is also an alumino-silicate with different crystal form and is of similar ceramic and other refractory uses. It can be used directly without calcination as well

as after calcination. On calcination sillimanite becomes the high temperature refractory material mullite which is chiefly used in glass, ceramics and cement industries as furnace linings and in abrasive industries and asbestos products. The calcined raw sillimanite also can be used since sillimanite has a very low expansion in volume on heating. It is, however, not suitable for use in ferrous metallurgy as iron oxide attacks and corrodes the alumina bricks. A part of sillimanite production is consumed by indigenous refractory manufactures while a considerable amount is being exported to foreign countries.

Reserves, Specifications and Uses

Sillimanite deposits of workable importance are present in Khasi Hills, Assam, Bastar and Sidhi districts, Madhya Pradesh and in beach sands of Kerala coast, Manavalam Kuruchi, in Quilon district, Kerala. Deposits of minor importance are reported from Andhra Pradesh (East and West Godavari, Krishna, Srikakulam and Visakhapatnam districts), Bihar (Gaya and Hazaribagh dist.), Maharashtra (Bhandara and Nagpur districts), Karnataka (Mysore district), Orissa (Sambalpur and Sundargarh districts) and Tamil Nadu (Coimbatore and Kanyakumari districts).

All India reserves of sillimanite as estimated by G.S.I. are given in Table 1.54. These exclude the beach sand resources of Kerala (13 m. ton) containing 5-6% Sillimanite.

Sillimanite is used as a refractory material for use in glass, cement, ceramics, chemical, electrical, enamelling, metal smelting and refining, coal carbonisation industries etc. It is also used for electrical insulators manufacture and automobile spark plug bodies.

The normal chemical analysis of sillimanite bricks made from natural sillimanite is :

$Al_2O_3\%$	=	55-65
$SiO_2\%$	=	25-35
$Fe_2O_3\%$	=	0.5-1.5
$TiO_2\%$	=	0.5-1.0
$MgO\%$	=	0.5-0.8
$CaO\%$	=	0.5-1.0
$K_2O + Na_2O\%$	=	0.5-1.0

The commercial value of sillimanite group of minerals and their products (including kyanite and andalusite) is assessed by conducting performance tests for determination of refractoriness (P.C.E. value), particle size, porosity, bulk density, crushing strength and dimensional changes, spalling etc. besides the chemical analysis.

The ISI has formulated specifications for (i) sillimanite refractories for glass melting tank furnaces vide IS : 2044-1962 and (ii) natural sillimanite blocks for glass melting tank furnaces vide IS : 2045-1962.

Production, Domestic Consumption, Export and Import

The production and exports and imports of sillimanite are given in Table 1.55. There are many units manufacturing refractories in the country using sillimanite. The important concerns are M/s. Kumardhubi Fireclay & Silica Works Ltd., and Belpahar Refractories. The domestic consumption of sillimanite in 1968 was 3,573 tonnes.

Future Outlook

The future demand of sillimanite by 1978-79 is put at 0.016 million tonnes. Current production is around 3,000-4,000 tonnes as seen in table 55. The total estimated reserves excluding the beach sand deposits (of both the west and east coasts which are yet to be computed) stand at 0.125 million tonnes. The high grade reserves of Assam are limited and as such this material should be exclusively used for indigenous requirements. Further as the present known reserves are not very large in relation to the anticipated requirements to meet the domestic consumers as well as for exports, all efforts should be put forward to undertake detailed exploration programmes of proving new deposits so as to augment and conserve the existing high grade reserves. Beach sand sillimanite, after proper bonding into blocks and bricks is also to be put into use to conserve the natural block sillimanite reserves.

7. QUARTZ AND SILICA SAND

Quartz, quartzite, sand stone, Silica sand, opal, agate, flint, chalcedony etc. are the many forms

TABLE 1.54—SILLIMANITE RESERVES IN INDIA (IN MILLION TONNES)

State	District	Area	Reserves	Remarks
(1) Assam	Khasi & Jaintia Hills	Sonapahar	0.025	Within a depth of 6 metres.
(2) Madhya Pradesh	Sidhi	Pipra	0.10	Within a depth of 10 metres.

TABLE 1.55—PRODUCTION EXPORTS AND IMPORTS OF SILLIMANITE (IN TONNES)

State	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Production										
(1) Assam (Meghalaya)	9,929	5,752	4,567	3,222	3,005	3,404	2,936	1,462		
(2) Kerala from (Beach sand)	—	3	47	622	452	449	662	1,006		
(3) Madhya Pradesh	464	45	43	102	92	121	67	62		
(4) Tamil Nadu	—	—	—	—	940	352	381	420		
Total	10,393	5,800	4,657	3,946	4,489	4,326	4,046	2,950	2,950	8,116
Export	6,332	2,046	2,514	2,101	1,739	1,628	714	1,003		
Import	5	Negligible	Negligible							

TABLE 1.56—RESERVES OF QUARTZ/QUARTZITE, SILICA SAND

State	District	Locality	Reserves	Remarks
(1) Assam & Meghalaya	Garo Hills	Hahim	30,500 tons	Assam State Dept. of Geology & Mining
	United Khasi & Jaintia Hills	Latryngew	2 million tons	-do-
(2) Gujarat	Panch Mahals	Lunawada	0.46 million tons	Gujarat State Department
(3) Karnataka	Bangalore	Neralomaratadoddi	0.01 million tons	Karnataka State Department
	Hassan	S. E. of Arsikere	45,000 tons	Karnataka State Department
(4) Kerala	Alleppy	Varanad, Maruthoorvattam, Pallipuram, Panavelly etc.	60 million tons	Kerala States Directorate
(5) Madhya Pradesh & Uttar Pradesh	Rewa	Rewa-Banda area Dubanhara	111 million tons	GSI 1.14 million tonnes by State Dept.
	Durg	Danitola, Daihan & Gujra	21.34 million tons	2.03 million tons near Danitola suitable for glass manufacture
	Morena	Dhaura, Jakhoda, Sherpur, etc.	9.45 million tons	State Department
	Gwalior	Tighra	1.32 million tons	State Department
(6) Maharastra	Ratnagiri	—	47.75 million tons	Silica Sand
(7) Orissa	Kalahandi	Khadagpur	1.52 million tons	Foundry Sand State Department
(8) Punjab	Gurdaspur	Batala	9 million tons	Upto a depth of 2 metres
(9) Rajasthan	Burdi	—	1.18 million tons	G.S.I.
(10) Tripura	—	Takarjola	16,500 tons	G.S.I.

of natural occurrence of silica with varying degrees of purity or concentration. Pegmatite quartzite, quartzose rocks, felspar rocks (granites) sandstones and silica sand (river sands) are the important and economic sources of the mineral quartz. They occur in almost all the States. Quartz and glass sand are used for glass, ceramic, abrasive and refractory industries, Silica sand is used for moulding purposes in foundries.

Reserves, Specifications and Uses

The reserves of quartz, quartzite and glass sand are quite extensive and wide spread and have not been fully estimated. Some details of the estimates given by G.S.I. and some State Departments of Geology and Mining are given in Table 1.56.

The specifications which are to be adhered depend on the use. Thus different types of specifications are to be observed for use in glass, refractories, foundry industries etc. Quartz/quartzite/silica sand is mainly used for the manufacture of silica refractories, glass, ceramics, abrasives and ferrosilicon. River sand is employed for stowing in collieries and moulding sand for foundries. Quartzite and sand-stone are used for building construction. Quartz and flint pebbles are used as grinding media in ball mills. High grade quartzite lumps are used in blast furnace to reduce the viscosity of blast furnace slags during iron smelting. Perfectly transparent and flawless quartz crystals are used in wireless industry and optical glassess, prisms and lenses. Fine ground silica is used in cement and rubber industries.

TABLE 1.57—ISI SPECIFICATION IS : 488-1953 FOR GLASS SAND

Ingredients	Grade I	Grade II	Grade III
SiO ₂ % Min.	97.5	95.0	92.50
Fe ₂ O ₃ % Max.	0.06	0.12	0.50
TiO ₂ % Max.	0.10	0.10	0.50
Grain size : Remaining on IS test sieve 1mm (aperture 1,000 microns)	Nil	Nil	Nil
Remaining on IS test sieve 60 (aperture 592 microns) % by weight Max.	1.0	1.0	1.0
Passing through IS test sieve 12 (aperture 124 microns) % by weight	5.0	5.0	5.0
Moisture % Max.	5.0	5.0	5.0

Specification for Glass Sand

The ISI has formulated a specification for glass sand IS:488-1953 given in Table 1.57. The specification for glass sand for use in different coloured glasses issued by the society of glass technology, U.K. is given in Table 1.58.

Silica Refractories

Specifications for silica bricks manufacture in the country used by different manufacturing concerns such as Kumardhubi Fire clay and Silica Refractories Ltd., A.C.C. Katni Works, Orissa Cements etc. Quartz, Quartzite, Silica sand etc. containing 97-98.6% SiO₂, 1.3% Al₂O₃ Max; 0.4-0.6% Fe₂O₃ with traces of CaO, MgO and TiO₂. The refractory plant of MISL specifies quartz with 99% SiO₂, 0.5% Al₂O₃ and 0.5% Fe₂O₃ Max. TISCO uses quartzite with 98.66% SiO₂ and 0.67-0.7% Al₂O₃ in steel plant. Bhilai Steel Plant uses quartzite with 92% SiO₂ for viscosity control of slag in the blast furnace operations.

Foundry Sand

The silica sand used for foundry moulding purposes must have high refractoriness to withstand high temperatures of pouring ranging from 1000°C to 1600°C. Rajmahal Sands are widely used for steel castings.

Ferro-silicon

For the manufacture of ferro-silicon MISL used quartz/quartzite with 98.6% SiO₂ and size of 51.75 mm, while Indian Metals and Ferroalloys Ltd., consumed quartz/quartzite with 97% SiO₂ and low alumina and size 15 mm to 80 mm.

TABLE 1.58—SPECIFICATION FOR COLOURED GLASS SAND

Glass variety	Chemical analysis of sands Assay %		
	SiO ₂ % Min.	Fe ₂ O ₃ % Max.	TiO ₂ % Max.
(1) Fine optical glass	99.0	0.008	0.08
(2) High grade domestic and decorative glass	99.0	0.02	0.05
(3) General colourless glass- wares including containers	98.5	0.04	0.10
(4) Indian glass wares	98.0	0.06 to 0.22	Al ₂ O ₃ = 1.22% max.

Production, Domestic Consumption and Export

Production of quartz/quartzite and silica sand are given in Table 1.59. Consumption of quartz/quartzite/silica sand/Moulding sand in various industries are given in Table 1.60. The exports and imports of quartz sand including ground quartz are given in Table 1.61. In recent years the imports have been minimised.

Future Outlook

India is self-sufficient of glass sands requirements. Glass, Ceramic, Refractory, Ferro-silicon and Abrasive manufacturing industries are the important consumers of quartz/silica sand while foundries use moulding sand. The manufacture is being stepped up to meet the increasing demand of optical glass, a strategic material for defence, requirements. Quartz crystals required for use in electronic instrumentation are met by imports. Ferro-silicon of different grades is being manufactured within the country by more than one unit.

8. BENTONITE ($\text{NaCaMg})\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 5 \text{SiO}_2 \cdot n\text{H}_2\text{O}$)

Bentonite constitutes mainly of montmorillonite group of clay minerals and occurs in nature as two types, namely, the swelling type (15-20 times) and the non-swelling type. The swelling type (Sodium base) is used as binder in pelletisation

of iron ore fines, limestone, fluorspar, zinc concentrates etc., as a drilling mud in oil well drilling and as a binder in foundry moulding sands. The non-swelling type (calcium base) is mainly used in decolourising, filtering and catalysis in the petroleum industry and as a binder in foundry moulding sands. The commercial utilisation of bentonite depends more on its physico-chemical properties such as base-exchange capacity, thixotropy, setting time, swelling index, pH etc. than on its chemical composition. Bentonite is supposed to have been formed due to the alteration of volcanic ash or tuff.

Reserves, Specifications and Uses

Bentonite chiefly occurs in the states of Gujarat, Jammu and Kashmir, Rajasthan and

TABLE 1.60—CONSUMPTION OF QUARTZ/SILICA SAND/MOULDING SAND (IN TONNES)

Industry	1967	1968
1. Glass	1,54,953	1,61,324
2. Iron & Steel	1,26,191	1,59,753
3. Foundry	1,63,469	1,55,717
4. Refractory	53,270	63,822
5. Ferro-silicon	41,184	38,782
6. Ceramic	16,282	16,436
7. Others	5,558	6,296
Total	5,60,907	6,02,130

(Source: I.B.M.)

TABLE 1.59—STATEWISE PRODUCTION OF QUARTZ/QUARTZITE, SILICA SAND (IN TONNES)

State	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Quartz & Silica :										
Andhra Pradesh	65,435	32,240	40,013	54,274	57,553	59,526	55,011	66,426		
Bihar	43,593	38,372	54,338	65,668	60,185	64,394	78,597	81,731		
Gujarat	29,723	39,680	37,493	49,292	54,175	82,740	79,695	67,994		
Goa	—	—	—	18,850	—	—	—	—		
Haryana	50	85	—	—	—	93	545	1,039		
Himachal Pradesh	292	168	—	—	—	—	—	—		
Karnataka	40,139	40,917	40,187	48,028	40,515	51,346	48,174	25,489		
Kerala	6,109	5,094	6,531	6,687	9,999	12,593	17,632	12,805		
Madhya Pradesh	33,055	26,959	38,272	49,030	48,706	53,990				
Maharashtra	17,499	15,128	18,727	22,014	27,126	27,570	39,939	30,501		
Orissa	474	8,150	54,974	80,028	70,670	77,929	81,973	68,796		
Rajasthan	51,593	57,559	55,650	63,742	62,624	80,178	103,996	76,947		
Tamil Nadu	1,428	7,305	638	1,143	309	2,649	4,400	7,810		
Uttar Pradesh	—	—	1,354	15,053	125,516	149,029	170,949	195,941		
West Bengal	64	296	114	527	—	—	—	166		
TOTAL	280,454	271,953	348,341	474,236	557,368	662,037	720,533	664,839	323,013	279,420

Bihar where some commercial exploitation of the deposits is found. Some details of the reserves of bentonite available of the various deposits are given in Table 1.62.

In Bihar, bentonite occurs at Tinpahar and Bakudih deposits in the Rajmahal hills of Santhal Parganas district. The Bakudih deposit is estimated to have a minimum of 100,000 tonnes. Bihar bentonite shows poor physical properties (poor swelling characteristics) mainly due to the presence of gypsum and exchangeable Ca^{2+} , Mg^{2+} . The Gujarat deposits are mostly of non-swelling type. Bentonites from Jammu and Kashmir are low in iron and alumina and high in calcium, which can be converted to sodium base by suitable treatment. Rajasthan deposits are the most extensive and superior to other deposits of the different States.

Specifications and Uses

The specifications of bentonite vary with the use to which it is put to and its use is determined by the original physical and chemical properties, which may be modified if possible in cases wherever it is felt necessary. The industry-wise specifications are given in Table 1.63.

Bentonite is mainly used in foundries for bonding of moulding sands. It is also used as a base for medicinal, cosmetic and pharmaceutical preparations (chemical industry), for oil drilling mud and oil-refining. A small quantity is consumed in paints, ceramics and cosmetics. Sodium bentonite is widely used as binder in pelletisation of iron ore fines, limestone, fluorspar fines etc.

India's Production, consumption, export and import of bentonite are given in Table 1.64. Complete production and indigenous consumption

TABLE 1.64—BENTONITE PRODUCTION, CONSUMPTION, EXPORT & IMPORT (IN TONNES)

Year	Production	Consumption	Export	Import
1967	42,155	19,108	407	6
1968	45,096	20,148	973	11
1969	N.A.	N.A.	1,720	10
1970	N.A.	N.A.	1,461	6
1971	N.A.	N.A.	3,189	9
1972	N.A.	N.A.	3,640	8
1973	N.A.	N.A.	5,752	5

(Source : I.B.M.)

TABLE 1.61—EXPORTS AND IMPORTS OF SAND INCLUDING QUARTZ (IN TONNES)

	1966	1967	1968	1969	1970	1971	1972	1973	1974
Export	2,652	2,388	3,052	2,796	5,496	4,051	1,884	3,158	5,892
Import	230	499	485	65	272	14	2	4	32

(Source : I.B.M.)

TABLE 1.62—RESERVES OF BENTONITE (IN MILLION TONNES)

State	District & Locality	Reserves	Type
(1) Gujarat	Kutch District		DGM
	(1) Mandvi and Mundra taluk	1.479	Non-swelling, bleaching or feebly bleaching type.
	(2) Metra, Wamstimota, Kamla, Majal, Punadi & Wandhshardi in Nakhtrana and Mandvi taluk	0.77	Sodium base with feeble bleaching properties and expansion ratio of 2 to 4.5
	(3) Rotada	0.018	Plastic clay
	(4) Bhavnagar Dist.	40.79	By DGM
(2) Jammu & Kashmir	Kathua Dist.-Uttarbaini-Parmandal area	0.025	Expansion ratio 2.5 to 4.0
(3) Rajasthan	Barmer Dist. Sheo, Bawarlia Nadi, Amba Bari Dhani and Parsat Nadi	54.67	

(Source : G.S.I., I.B.M.)

TABLE 1.63—SPECIFICATIONS OF BENTONITE USED IN DIFFERENT INDIAN INDUSTRIES

Industry	Name of the concern	Specifications
1. Foundry	(1) Cooper Engineering Ltd., Satara Road, Maharashtra	SiO ₂ = 60% Max. Al ₂ O ₃ = 25-27% FeO = 5% LOI = 15%
	(2) Dalmia Iron & Steel Ltd., Calcutta-1	SiO ₂ = 45-50% Fe ₂ O ₃ = } Al ₂ O ₃ = } = 33-36% TiO ₂ = } CaO = 2.5% MgO = Traces LOI = 15.5%
	(3) Bharatiya Electric Steel Ltd., Calcutta-1	1. Green permeability = 180-200% 2. Moisture = 0.2-3% 3. Strength = 7 to 8 lbs. p.s.i. 4. Min. 98% passed through 200 mesh
	(4) Indian Smelting & Refining Co. Ltd., Bombay.	Sodium base bentonite powder, Good swelling 90% Min pH = 7
2. Paint	Shalimar Paints Ltd., Calcutta-16	1. Colour to standard setting properly. 2. Swelling should be equal to standard.
3. Vanaspathi	Indian Vegetable Products Ltd., Bombay-1	1. Screen test = 80%-200% 2. Moisture = 10% 3. Viscosity = 7% Slurry
4. Oil refining	Oil & Natural Gas Commission, Dehra Dun, Uttar Pradesh	1. Moisture content = 12% Max. when dried to constant weight at 105°-110°C 2. Wet sieve analysis—200 Mesh, 2% Max. 3. Viscosity measure by Stormer Viscometer at 600 r.p.m. should not be less than 15 c.p. 4. Filtration loss should not be more than 20 c.c. in 30 minutes at 100 ps.i. Testing should be carried out according to the procedure of the American Petroleum Institute.
5. Drilling mud	Oil India Ltd., Duliajan, Assam	1. No size specification in any form 2. Sieve analysis + 200 Mesh, 2.0% Max. 3. Moisture content = 10% Max. measured by drying to constant wet, at 105°-110°C. 4. Base exchange capacity not less than 80 million ton equivalents per 100 gm. (on oven dry basis). 5. Viscosity—7.0% suspension of bentonite in distilled water stayed for a day should have a viscosity not less than 25 Cen-Viscometer at 20% C.

(Source : I.B.M.)

tion data is not available even though the major users of bentonite in the country are foundries. The demand for bentonite is likely to increase

further due to the top-priority of oil exploration activity in the country besides the innumerable foundries spread over through out the country.