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WOLLASTONITE

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GOVERNMENT OF INDIA
MINISTRY OF MINES
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Wollastonite is a chemically simple mineral named in honour of English Mineralogist and Chemist Sir W.H.Wollaston. Wollastonite is composed of calcium and silica with a chemical formula $CaSiO_3$. Wollastonite may contain impurities like iron, potassium, manganese, etc. Though normally wollastonite is bright white in colour, the impurities can produce grey, cream, brown or red colour in wollastonite. Wollastonite is formed when limestone/ dolomite is subjected to high temperature and pressure in the presence of silica bearing fluid as in skarn deposits or metamorphic rocks. It occurs as aggregates of bladed or needle-like crystals with hardness of 4.5 to 5 on Mohs' scale. The uses of wollastonite in applications other than as filler include marine wallboard, paint, plastic, in refractory liners in steel mills and as a partial replacement for short-fibre asbestos in certain applications.

RESERVES/RESOURCES

Major deposits of wollastonite have been found in Ajmer, Dungarpur, Pali, Sirohi and Udaipur districts in Rajasthan. Besides, in Ghoda area, Banaskantha district in Gujarat and in Dharmapuri and Tirunelveli districts in Tamil Nadu, occurrences of a few deposits have been reported. As on 1.4.2015, the reserves\resources of wollastonite, as per NMI database, based on UNFC system are placed at 16.47 million tonnes of which reserves under proved and probable categories together constitute 2.24 million tonnes (14%) and remaining resources constitute for the balance14.23 million tonnes (86%). Out of the total resources, about 88% (14.47 million tonnes) including 2.24 million tonnes reserves are located in Rajasthan and the remaining about 12% resources (1.99 million tonnes) in Gujarat. Meagre resources are also located in Tamil Nadu (3,533 tonnes) (Table-1).

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are given in the review on "Exploration & Development" in "General Reviews".

PRODUCTION & STOCKS

Production of wollastonite at 153 thousand tonnes in 2017-18 decreased by 8% as compared to 166 thousand tonnes in the preceding year. There were four reporting mines in 2017-18 which were the same as in the previous year. The entire production was reported from Private Sector mines located in Rajasthan only (Tables-2 to 4).

Mine-head closing stocks of wollastonite at the end of the year 2017-18 were 25,518 tonnes as against 17,782 tonnes in the previous year (Table- 5).

The average daily employment of labour during 2017-18 was 293 as against 306 in the previous year.

Table – 2: Principal Producers of Wollastonite, 2017-18

Name & address of producer	Location of mine	
	State	District
Wolkem Industries Ltd, P.B.21, E-101, Mewar Industrial Area, Madri, Dist. Udaipur- 313 003, Rajasthan.	Rajasthan	Udaipur Pali
Renu Atre C-378, Pradhan Marg, Malviya Nagar, Jaipur- 302 017, Rajasthan.	Rajasthan	Ajmer

Table 1: Reserves/Resources of Wollastonite as on 1.4.2015

(By Grades / States)

(In tonnes)

Grade\State	Reserves				Remaining Resources								Total Resources (A+B)
	Proved	Probable		Total	Feasibility	Pre-feasibility		Measured	Indicated	Inferred	Reconnaissance	Total	
	STD111	STD121	STD122	(A)	STD211	STD221	STD222	STD331	STD332	STD333	STD334	(B)	
All India : Total	**1953384**	**48075**	**240003**	**2241462**	**3750118**	**12000**	**3748191**	**76088**	**3325042**	**3316385**	**-**	**14227824**	**16469286**
By Grades													
Marketable	1953384	-	197253	2150637	837864	-	3724191	76088	-	1083475	-	5721618	7872255
Unclassified	-	48075	42750	90825	2912254	12000	24000	-	3325042	2154300	-	8427596	8518421
Not-known	-	-	-	-	-	-	-	-	-	78610	-	78610	78610
By States													
Gujarat	-	-	-	-	-	-	-	-	-	1990000	-	1990000	1990000
Rajasthan	1953384	48075	240003	2241462	3750118	12000	3748191	76088	3325042	1322852	-	12234291	14475753
Tamil Nadu	-	-	-	-	-	-	-	-	-	3533	-	3533	3533

Figures rounded off.

Table-3: Production of Wollastonite, 2015-16 to 2017-18
(By State)

(Qty in tonnes; Value in ₹'000)

State	2015-16		2016-17		2017-18 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India/Rajasthan	**175348**	**150313**	**166186**	**158823**	**153049**	**126700**

Table-4: Production of Wollastonite, 2016-17 and 2017-18
(By Sector/State/Districts)

(Qty in tonnes; Value in ₹'000)

State/District	2016-17			2017-18 (P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India/Private sector	**4**	**166186**	**158823**	**4**	**153049**	**126700**
Rajasthan	**4**	**166186**	**158823**	**4**	**153049**	**126700**
Ajmer	2	11385	4839	2	12220	5194
Pali	-	-	-	1	-	-
Sirohi	1	15246	31315	-	-	-
Udaipur	1	139555	122669	1	140829	121506

Table-5: Mine-head Closing Stocks of Wollastonite, 2016-17 & 2017-18
(By State)

(Qty in tonnes)

State	2016-17	2017-18 (P)
India/Rajasthan	**17782**	**25518**

MINING, PROCESSING & MARKETING

Wollastonite is mined by opencast method essentially through manual and semi-mechanised method. In some of the mines viz. Belka Pahar mine of M/s Wolkem Industries Ltd in Sirohi district, Rajasthan, manual selection and manual sorting are practised for improving recovery of ore. The run-of-mine is selectively hand-sorted to the size of 30 cm to 50 cm to remove the associated minerals, such as, calcite, diopside, garnet, quartz and iron. Wollastonite, thus separated, is then crushed to various sizes at two crushing plants near Sirohi railway station with a capacity of 80,000 tonnes per year. Principal commercial grades produced are: White Kemolit (S1 to S5) and off-white Kemolit (H1 to H5 and LG 25) which are milled products in the size range of 100 to 500 mesh. Besides, micronised products are also marketed i.e. Wolkron (1008, 1010, 1015, 1020, 1025 and 10825) in the low aspect ratio and Kemolit 1025 and 1020 in the high aspect ratio. In addition, speciality products and surface modified products are also marketed as Kemolit and Fillex, respectively. Wollastonite is processed to make it useful for various applications. The commonly associated minerals like garnet and diopside are removed by high intensity magnetic separators after grinding. Some of the other materials are chemically removed to improve binding in the resin-based products.

Processing improvements integral to new product development focus on the following:

(i) High aspect ratio, fine particle size grades used as reinforcements to compete against milled glass fibres, synthetic fibres and whiskers.

(ii) Fine particle size high aspect ratio grades to compete against other mineral reinforcements, such as, talcs and clays, in the thermoplastic compounds.

Hand-sorted wollastonite has few impurities and is of high aspect ratio.

USES & SPECIFICATIONS

The use of wollastonite depends on the acicularity or the aspect ratio, i.e., ratio between length and width of a crystal, chemical composition, brightness and fibre length. Wollastonite having aspect ratio in the range from 3:1 to 5:1 has little potential for reinforcing applications. Hence, market is primarily confined to ceramic, metallurgical fluxes and simple filler and coating applications. Wollastonite reduces the volume of the expensive plastic or resin medium and contributes to physical and chemical properties of the finished products. It improves tear strength, dielectric properties and retains mechanical properties at elevated temperatures.

Wollastonite is used primarily in automobile brakes, ceramics, metallurgical processing, paper, paint, plastic, cosmetics, adhesives and as a replacement of asbestos in asbestos-cement boards and sheets. Some of the properties that make it so useful are high brightness & whiteness, low moisture & oil absorption, low volatile content and the acicular nature of some wollastonite. A better compatibility between the polymer and the filler is achieved by chemical surface treatment of the mineral filler. Wollastonite results improved flexural modules in polypropylene and improved reinforcement in nylon. It is also used as performance additive in a wide range of construction material (concrete, stucco and adhesives).

Bulk of the demand for wollastonite in the country is in the Ceramic Industry for the manufacture of floor and wall tiles. In ceramics, wollastonite decreases shrinkage and gas evolution during firing. Small quantities are used in asbestos-cement products as a partial replacement for short fibre asbestos, paint, insecticide, marine wallboard and welding rod industries. In metallurgical applications, wollastonite serves as a flux for welding, a source for calcium oxide, as slag conditioners and to protect the source of molten metal during the continuous casting of steel. The addition of wollastonite to metallurgical fluxes provides ready fusibility, good insulating qualities and low viscosity.

A new development with very large potential is the use of wollastonite as a sequestration mineral for carbon dioxide, a major factor in global warming. Unlike other methods, sequestration by wollastonite is permanent and results in a mixture of precipitated calcium carbonate and silica that may have filler applications in paper, plastics & rubber.

SUBSTITUTE

The acicular nature of many wollastonite products allow it to compete with other acicular materials, such as, ceramic fibre, glass fibre, steel fibre and several organic fibres, such as, aramid, polyethylene, polypropylene, and polytetrafluoroethylene in products where improvements in dimensional stability, flexural modulus and heat deflection are sought. Wollastonite also competes with several nonfibrous minerals or rocks, such as, kaolin, mica and talc, which are added to plastics to increase flexural strength and such minerals as baryte, calcium carbonate, gypsum and talc, which impart dimensional stability to plastics. In ceramics, wollastonite competes with carbonates, feldspar, lime and silica as a source of calcium and silica. America Selenite has developed a very high-aspect-ratio synthetic whiskers which can replace the higher-end wollastonite.

CONSUMPTION

The estimated consumption of wollastonite is at 144,300 tonnes in 2017-18. The Ceramic Industry solely consumed the entire quantity of wollastonite (Table-6).

Table-6 : Estimated Consumption* of Wollastonite 2015-16 to 2017-18 (By Industries)

(In tonnes)

Industry	2015-16	2016-17^{e}	2017-18(P)
All Industries	**164200**	**153000**	**144300**
Ceramic	164200	153000	144300^{e}

Figures rounded off.
*(*Includes reported consumption and/or estimates wherever required and due to paucity of data, coverage not be completed).*

WORLD REVIEW

World reserves of wollastonite exceed 100 millon tonnes. Many deposits, however, have not been surveyed, precluding accurate reserves estimates.

The large deposits of wollastonite were in China, Finland, India, Mexico and the United States. Smaller but significant deposits were in Canada, Chile, Kenya, Namibia, South Africa, Spain, Sudan, Tajikistan, Turkey and Uzbekistan.

In 2017, China was the largest producer of wollastonite with a production of 1.10 million tonnes. India with 0.15 million tonnes Mexico with 0.08 million tonnes and USA having 0.05 million tonnes were the other major producers. Small quantities of wollastonite were also produced in other countries as well.

The Ceramic Industry probably accounts for the major consumption of wollastonite worldwide, followed by polymers (plastic and rubber) and paint. The remaining were used in construction, friction products and metallurgical applications.

The countrywise production of wollastonite by principal countries from 2015 to 2017 is furnished in Table-7.

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

(In tonnes)

Country	2015	2016	2017
China[e]	1000000	1100000	1100000
Finland[e]	10000	10000	10000
India*	175348	166186	153049
Mexico	57451	63683	87562
Spain	17700	13553	19135
USA[e]	70000	60000	50000
Australia	2428	1797	1749

Source: *World Mineral Production, 2013-2017.*

* *India's production of wollastonite during 2015-16, 2016-17 and 2017-18 was 175 thousand tonnes, 166 thousand tonnes and 153 thousand tonnes respectively.*

FOREIGN TRADE

Exports

In 2017-18, exports of wollastonite decreased drastically by 25% to 12,478 tonnes from 16,700 tonnes in the previous year. Exports were mainly to Belgium (54%), Japan (23%), Germany (13%), France (3%) and UK (2%) (Table-8).

Imports

Imports of wollastonite increased drastically more than three fold to 11,461 tonnes in 2017-18 as compared to 3,483 tonnes in the previous year. Imports were mainly from China (95%), USA & Spain (2% each), and Mexico (1%)(Table-9).

Table – 8 : Exports of Wollastonite (By Countries)

Country	2016-17		2017-18	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**16700**	**293524**	**12478**	**224919**
Belgium	8823	163212	6688	123287
Japan	4203	65244	2880	43485
Germany	1987	36905	1674	32840
France	336	7473	348	7851
UK	316	6325	231	4376
USA	180	2911	180	3446
Malaysia	6	207	31	1891
Australia	22	577	66	1641
Iran	65	1493	44	1074
Saudi Arabia	105	792	125	848
Other countries	657	8385	211	4180

Table – 9 : Imports of Wollastonite (By Countries)

Country	2016-17		2017-18	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**3483**	**73052**	**11461**	**156397**
China	2169	31454	10872	131847
USA	195	12921	255	13876
Mexico	65	2751	107	4654
Spain	1032	22767	192	4540
Germany	16	2135	6	546
Japan	2	734	2	492
Vietnam	-	-	27	287
Netherlands	-	-	++	67
UK	4	283	-	-
Unspecified countries	-	-	++	88
Other countries	++	7	-	-

FUTURE OUTLOOK

Presently, India is world's second largest producer of wollastonite after China. The existing mines in the country are in a position to meet the domestic requirements of the Ceramic Industry as well as export demand. There is an increasing demand for wollastonite in the international markets, especially in ceramic, metallurgy, paint, construction and as asbestos substitute. Present consumption is around 1.5 lac tonnes. It is expected that the apparent domestic demand will grow at an expected growth rate of 9%.

The exports of processed wollastonite with high aspect ratio and powdered wollastonite may be encouraged for the betterment of export of value added products. As a result of augmenting of the resources of wollastonite in the States of Tamil Nadu and Gujarat, India would be in a formidable position to cope with futuristic demand.