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.

**RESOURCES**

Major deposits of wollastonite have been found in 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 (P), 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 balance 14.23 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. Meager resources are also located in Tamil Nadu (3,533 tonnes) (Table-1).

**EXPLORATION & DEVELOPMENT**

The exploration and development details are given in the review on “EXPLORATION & DEVELOPMENT” in “General Reviews”.

**PRODUCTION & STOCKS**

Production of wollastonite at 166 thousand tonnes in 2016-17 decreased by 5% as compared to that in the preceding year. There were four reporting mines in 2016-17 as compared to five mines in the previous year. The entire production was reported from Private Sector mines located in Rajasthan (Tables-2 to 4).

Mine-head closing stocks of wollastonite for the year 2016-17 were 17,580 tonnes as against 13,896 tonnes in the previous year (Table-5).

The average daily employment of labour during 2016-17 was 292 as against 309 in the previous year.

<table>
<thead>
<tr>
<th>Table – 2: Principal Producers of Wollastonite, 2016-17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name &amp; address of producer</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Renu Atre C-378, pradhan Marg, Malviya Nagar, Sanganer, Jaipur- 302 017, Rajasthan.</td>
</tr>
</tbody>
</table>
Table 1: Reserves/Resources of Wollastonite as on 1.4.2015
(By Grades / States)

(In tonnes)

<table>
<thead>
<tr>
<th>Grade/State</th>
<th>Reserves</th>
<th>Remaining Resources</th>
<th>Total Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proved</td>
<td>Feasibility</td>
<td>Total</td>
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<td></td>
<td>STD111</td>
<td>STD111</td>
<td>(A)</td>
</tr>
<tr>
<td></td>
<td>STD121</td>
<td>STD122</td>
<td>(B)</td>
</tr>
<tr>
<td></td>
<td>STD121</td>
<td>STD122</td>
<td>(A+B)</td>
</tr>
<tr>
<td>All India: Total</td>
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<td>48075</td>
<td>240003</td>
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<td></td>
<td>2241462</td>
<td>3750118</td>
<td>12000</td>
</tr>
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<td>3748191</td>
<td>76088</td>
<td></td>
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<tr>
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<td>3316385</td>
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<tr>
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<td></td>
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<td></td>
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<tr>
<td>By Grades</td>
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<td>By States</td>
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<td></td>
<td>1990000</td>
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<td></td>
<td>14475753</td>
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<tr>
<td>Tamil Nadu</td>
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<td>3533</td>
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</table>

Figures rounded off.
WOLLASTONITE

Table-3: Production of Wollastonite, 2014-15 to 2016-17
(By State)

<table>
<thead>
<tr>
<th>State</th>
<th>2014-15 Quantity</th>
<th>2014-15 Value</th>
<th>2015-16 (R) Quantity</th>
<th>2015-16 (R) Value</th>
<th>2016-17 (P) Quantity</th>
<th>2016-17 (P) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajasthan</td>
<td>186524</td>
<td>162113</td>
<td>175348</td>
<td>150313</td>
<td>166186</td>
<td>158935</td>
</tr>
</tbody>
</table>

Table-4: Production of Wollastonite, 2015-16 & 2016-17
(By Sector/State/Districts)

<table>
<thead>
<tr>
<th>State/District</th>
<th>2015-16 No. of mines</th>
<th>2015-16 Quantity</th>
<th>2015-16 Value</th>
<th>2016-17 (P) No. of mines</th>
<th>2016-17 (P) Quantity</th>
<th>2016-17 (P) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajasthan</td>
<td>5</td>
<td>175348</td>
<td>150313</td>
<td>6</td>
<td>166186</td>
<td>158935</td>
</tr>
<tr>
<td>Ajmer</td>
<td>2</td>
<td>15495</td>
<td>6585</td>
<td>4</td>
<td>11385</td>
<td>4839</td>
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<tr>
<td>Pali</td>
<td>1</td>
<td>589</td>
<td>324</td>
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<td>-</td>
</tr>
<tr>
<td>Sirohi</td>
<td>1</td>
<td>14105</td>
<td>25389</td>
<td>1</td>
<td>15246</td>
<td>31225</td>
</tr>
<tr>
<td>Udaipur</td>
<td>1</td>
<td>145159</td>
<td>118015</td>
<td>1</td>
<td>139555</td>
<td>122871</td>
</tr>
</tbody>
</table>

Table-5: Mine-head Closing Stocks of Wollastonite, 2015-16 & 2016-17
(By State)

<table>
<thead>
<tr>
<th>State/Region</th>
<th>2015-16 Quantity</th>
<th>2015-16 Value</th>
<th>2016-17 (P) Quantity</th>
<th>2016-17 (P) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rajasthan</td>
<td>13896</td>
<td>17580</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MINING, PROCESSING & MARKETING

Wollastonite is mined by opencast method essentially through manual and semi-mechanised method. In some of the mines viz. Bel ka Pahar mine of M/s Wolkm 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.

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 153,000 tonnes in 2016-17. The Ceramic Industry solely consumed the entire quantity of wollastonite (Table-6).

Table-6: Estimated Consumption* of Wollastonite 2014-15 to 2016-17 (By Industries) (In tonnes)

<table>
<thead>
<tr>
<th>Industry</th>
<th>2014-15</th>
<th>2015-16 (R)</th>
<th>2016-17 (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Industries</td>
<td>196700</td>
<td>164200</td>
<td>153000</td>
</tr>
<tr>
<td>Ceramic</td>
<td>196700</td>
<td>177900*</td>
<td>153000*</td>
</tr>
</tbody>
</table>

*Figures rounded off. (*Includes reported consumption and/or estimates wherever required and due to paucity of data, coverage not be completed).
# : Consumption taken from the despatches of 2016-17.

WORLD REVIEW

World resources have not been estimated for wollastonite. 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 2015, the world production of wollastonite was 1.34 million tonnes which decreased by 7% as against previous year. China (75%), India (13%) & USA (5%) were the major producers. Small quantities of wollastonite were produced in many 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. China (75%), India (13%) & USA (5%) were the major producers. Small quantities of wollastonite were produced in many 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 2013 to 2015 is furnished in Table-7.

<table>
<thead>
<tr>
<th>Country</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Total</td>
<td>1098252</td>
<td>1439401</td>
<td>1338427</td>
</tr>
<tr>
<td>China</td>
<td>750000</td>
<td>1100000</td>
<td>1000000</td>
</tr>
<tr>
<td>Finland</td>
<td>11500</td>
<td>10000</td>
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<tr>
<td>India</td>
<td>192712</td>
<td>186524</td>
<td>175348</td>
</tr>
<tr>
<td>Mexico</td>
<td>57302</td>
<td>54579</td>
<td>57451</td>
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<tr>
<td>Spain</td>
<td>16738</td>
<td>15298</td>
<td>17700</td>
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<tr>
<td>USA</td>
<td>70000</td>
<td>70000</td>
<td>70000</td>
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<tr>
<td>Other countries</td>
<td>-</td>
<td>3000</td>
<td>7928</td>
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</table>

* India’s production of wollastonite during 2013-14, 2014-15 and 2015-16 was 193 thousand tonnes, 187 thousand tonnes and 175 thousand tonnes respectively.

FOREIGN TRADE

Exports

The exports of wollastonite during 2016-17 were 16,699 tonnes. Exports were mainly to Belgium (53%), Japan (25%), Germany (12%) and Turkey (3%) (Table-8).

In 2015-16, exports of wollastonite decreased by 7% to 16,616 tonnes from 17,864 tonnes in the previous year. Exports were mainly to Belgium (54%), Japan (27%), Germany (7%) and Saudi Arabia (3%) (Table-9).

<table>
<thead>
<tr>
<th>Country</th>
<th>2016-17 Qty (t)</th>
<th>Value (INR 000)</th>
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</thead>
<tbody>
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<td>Belgium</td>
<td>8823</td>
<td>163212</td>
</tr>
<tr>
<td>Japan</td>
<td>4203</td>
<td>65244</td>
</tr>
<tr>
<td>Germany</td>
<td>1987</td>
<td>36905</td>
</tr>
<tr>
<td>Turkey</td>
<td>1987</td>
<td>36905</td>
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<td>USA</td>
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<td>2911</td>
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<td>Saudi Arabia</td>
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<td>Other countries</td>
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</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>2014-15 Qty (t)</th>
<th>Value (INR 000)</th>
<th>2015-16 Qty (t)</th>
<th>Value (INR 000)</th>
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<tr>
<td>Belgium</td>
<td>7989</td>
<td>133579</td>
<td>8899</td>
<td>160416</td>
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<td>Japan</td>
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<td>64254</td>
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<td>Germany</td>
<td>1787</td>
<td>36565</td>
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<td>24186</td>
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<td>Netherlands</td>
<td>520</td>
<td>6806</td>
<td>521</td>
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<td>France</td>
<td>315</td>
<td>6415</td>
<td>294</td>
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<td>Saudi Arabia</td>
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<td>28</td>
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<td>1638</td>
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<td>1407</td>
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<tr>
<td>Singapore</td>
<td>23</td>
<td>1064</td>
<td>35</td>
<td>1098</td>
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<tr>
<td>Other countries</td>
<td>1750</td>
<td>31846</td>
<td>287</td>
<td>5677</td>
</tr>
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</table>
**WOLLASTONITE**

**Imports**

Imports of wollastonite were 3,483 tonnes during 2016-17. Imports were mainly from China (62%), Spain (30%), USA(6%) and Mexico (2%) (Table-10). Imports of wollastonite increased by 45% to 2,818 tonnes in 2015-16 as compared to 1,948 tonnes in the previous year. Imports were mainly from China (90%), USA(7%), Mexico (2%) and Germany (1%) (Table-11).

**Table – 10 : Imports of Wollastonite (By Countries)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Qty (t)</th>
<th>Value (₹'000)</th>
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</thead>
<tbody>
<tr>
<td>All Countries</td>
<td>3483</td>
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</tr>
<tr>
<td>China</td>
<td>2169</td>
<td>31454</td>
</tr>
<tr>
<td>Spain</td>
<td>1032</td>
<td>22767</td>
</tr>
<tr>
<td>USA</td>
<td>195</td>
<td>12921</td>
</tr>
<tr>
<td>Mexico</td>
<td>65</td>
<td>2751</td>
</tr>
<tr>
<td>Germany</td>
<td>16</td>
<td>2135</td>
</tr>
<tr>
<td>Other countries</td>
<td>6</td>
<td>1024</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Country</th>
<th>2014-15 Qty (t)</th>
<th>2015-16 Qty (t)</th>
<th>2014-15 Value (₹'000)</th>
<th>2015-16 Value (₹'000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Countries</td>
<td>1948</td>
<td>2818</td>
<td>32549</td>
<td>53216</td>
</tr>
<tr>
<td>China</td>
<td>1641</td>
<td>2525</td>
<td>19672</td>
<td>35972</td>
</tr>
<tr>
<td>USA</td>
<td>58</td>
<td>189</td>
<td>3740</td>
<td>11870</td>
</tr>
<tr>
<td>Germany</td>
<td>11</td>
<td>37</td>
<td>1523</td>
<td>2661</td>
</tr>
<tr>
<td>Mexico</td>
<td>50</td>
<td>43</td>
<td>2046</td>
<td>1684</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-</td>
<td>15</td>
<td>-</td>
<td>478</td>
</tr>
<tr>
<td>Belgium</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>163</td>
</tr>
<tr>
<td>Finland</td>
<td>8</td>
<td>2</td>
<td>964</td>
<td>144</td>
</tr>
<tr>
<td>Spain</td>
<td>168</td>
<td>6</td>
<td>4191</td>
<td>137</td>
</tr>
<tr>
<td>Japan</td>
<td>-</td>
<td>++</td>
<td>-</td>
<td>89</td>
</tr>
<tr>
<td>Denmark</td>
<td>++</td>
<td>6</td>
<td>++</td>
<td>13</td>
</tr>
<tr>
<td>Other countries</td>
<td>12</td>
<td>++</td>
<td>407</td>
<td>5</td>
</tr>
</tbody>
</table>

**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 be about 220,000 tonnes by 2017-18 at an expected growth rate of 9% .

The Sub-Group Report for 12th Plan Period has recommended that 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.