

65 Pyrophyllite

Prophyllite ($\text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2 \cdot \text{H}_2\text{O}$) is a hydrous silicate of aluminium. It resembles closely with talc in many physical and optical properties but differs in chemical composition in that talc contains magnesia instead of alumina. Pyrophyllite finds application in high grade ceramics & refractories and also as a filler in pesticide industry. Production of pyrophyllite is mainly reported from Chhatarpur, Tikamgarh and Shivpuri districts of Madhya Pradesh, Mahoba and Lalitpur districts of Uttar Pradesh and Keonjhar district of Odisha

RESOURCES

The total resources of pyrophyllite in India as per UNFC system as on 1.4.2005 are placed at 33.69 million tonnes of which more than 58%; i.e., 19.49 million tonnes are in reserves category. Madhya Pradesh accounts for 46% resources, followed by Odisha (36%) and Uttar Pradesh (13%). The remaining resources are in Andhra Pradesh, Maharashtra and Rajasthan. Gradewise, insecticide grade accounts for 31%, followed by refractory grade 25%, ceramic grade 16% and insecticide and ceramic mixed 9%. The remaining 19% are others, unclassified and not-known grades (Table - 1).

EXPLORATION & DEVELOPMENT

In 2009-10, DGM, Maharashtra, carried out geological survey around Walni Khatgaon village in Sindevahi tehsil of Chandrapur district by mapping and drilling. Resources of 1.29 million tonnes of pyrophyllite was estimated and Sillimanite, Almandine garnet crystals are noticed in the mica schist.

Occurrences of pyrophyllite of variable grade have been observed by the State Directorate of Mines & Minerals, (DMM) West Bengal. The strike extension of the deposit is approximately 800m at Jina Monipur, district Purulia, West Bengal.

PRODUCTION, STOCKS & PRICES

The production of pyrophyllite at 242 thousand tonnes during 2009-10 registered a decrease of about 5% as compared to that in the previous year due to less demand.

There were 33 reporting mines in 2009-10 as against 35 in the preceding year. Besides, the production of pyrophyllite was also reported as an associated mineral by two mines in Maharashtra. Eight principal producers accounted for 94% of total production during the year. The share of public sector in the total production was 5.32% in 2009-10, whereas it was 7% in the previous year.

Six mines each reporting more than 10,000 tonnes accounted for about 79% of total production and 14 mines including one associated mine each reporting production between 1000 to 10,000 tonnes contributed about 19% of total output. Remaining 2% of production was from 15 mines including one associated mine.

Madhya Pradesh continued to be the leading producing state which accounted for 87% of output, followed by Uttar Pradesh 7% and Odisha 5%. The remaining 1% production was reported from Andhra Pradesh, Jharkhand and Maharashtra during the year (Tables - 2 to 5).

Mine-head stocks of pyrophyllite at the end of 2009-10 were 113 thousand tonnes as against 124 thousand tonnes at the beginning of the year (Table - 6).

The average daily employment of labour in pyrophyllite mines during 2009-10 was 1,269 as against 1,473 in the previous year. The prices of pyrophyllite are given in the General Review on Prices.

PYROPHYLLITE

**Table – 1 : Reserves/Resources of Pyrophyllite as on 1.4.2005
(By Grades/States)**

| Grade/State | Reserves | | | | Remaining resources | | | | Total resources (A+B) | | | | |
|--------------------------------|------------------|----------------|----------------|-----------------|-----------------------|-----------------|----------------|--------------------|-----------------------|---------------------|--------------------|--------------------------|-----------------|
| | Proved STD111 | Probable | | Total (A) | Feasibility STD211 | Pre-feasibility | | Measured STD331 | | Indicated STD332 | Inferred STD333 | Reconnaissance STD334 | Total (B) |
| | | STD121 | STD122 | | | STD221 | STD222 | | | | | | |
| All India : Total | 9584547 | 3653843 | 6251227 | 19489617 | 47400 | 118304 | 3449665 | 867742 | 1638452 | 6870521 | 1213236 | 14205319 | 33694936 |
| By Grades | | | | | | | | | | | | | |
| Refractory | 3179948 | 1118261 | 776106 | 5074315 | - | 50000 | 215527 | - | 1514000 | 1512527 | - | 3292054 | 8366369 |
| Ceramic | 1664817 | 530323 | 828626 | 3023766 | - | - | 7888 | 558850 | 48114 | 1060980 | 793955 | 2466787 | 5490553 |
| Insecticide | 3750675 | 1717941 | 2303055 | 7771671 | - | 16800 | 23100 | 189000 | 3992 | 2484708 | - | 2717600 | 10489271 |
| Insecticide & Ceramic mixed | 205310 | 72297 | 1534702 | 1812309 | - | 48354 | - | 21330 | - | 882475 | 170876 | 1123035 | 2935344 |
| Others | 615762 | - | 589111 | 1204873 | - | - | 3200000 | - | 2025 | 135895 | - | 3337920 | 4542793 |
| Unclassified | 137554 | 215021 | 92272 | 444847 | 47400 | - | - | 94450 | 49848 | 600096 | 248405 | 1040198 | 1485045 |
| Not-known | 30481 | - | 127355 | 157836 | - | 3150 | 3150 | 7112 | 20473 | 193840 | - | 227725 | 3855561 |
| By States | | | | | | | | | | | | | |
| Andhra Pradesh | 11220 | - | 9720 | 20940 | - | - | - | - | - | 15880 | - | 15880 | 36820 |
| Madhya Pradesh | 3539365 | 2447445 | 4309863 | 10296673 | 47400 | 48354 | - | 257000 | 6017 | 4706948 | 248405 | 5314124 | 15610797 |
| Maharashtra | 235741 | 226873 | 41000 | 503614 | - | - | 190000 | - | - | 20000 | - | 210000 | 713614 |
| Odisha | 4529600 | 824800 | 1097800 | 6452200 | - | 66800 | 3223100 | 80 | 1514040 | 1024800 | - | 5828819 | 12281019 |
| Rajasthan | 132260 | 4725 | 100955 | 237940 | - | 3150 | 36565 | 232212 | 68587 | 216993 | - | 557507 | 795447 |
| Uttar Pradesh | 1136361 | 150000 | 691889 | 1978250 | - | - | - | 378450 | 49808 | 885900 | 964831 | 2278989 | 4257239 |

Figures rounded off.

PYROPHYLLITE

**Table – 2 : Principal Producers of Pyrophyllite
2009-10**

| Name and address of producer | Location of mine | |
|---|------------------|------------|
| | State | District |
| Khajurao Minerals, Toria House, 6 KM. Sagar Road ,Dhadari, Chhatarpur- 471 001, Madhya Pradesh. | Madhya Pradesh | Chhatarpur |
| Jindutta Mineral Pvt. Ltd, Toria House, Post Box No. 26, 6 KM. Sagar Road ,Dhadari, Chhatarpur – 471 001, Madhya Pradesh. | Madhya Pradesh | Chhatarpur |
| Ishwar Mining & Industrial Corp.(P) Ltd, Sanjeev Bhaskar 7, Ishwar Nagar, Charan Kamal Mathura Road, New Delhi – 65. | Madhya Pradesh | Shivpuri |
| Banwarilal Newatia Circuit House Road, P.O. Chaibasa-833 201, Singhbhum (W), Jharkhand. | Odisha | Keonjhar |

(Contd.)

Table - 2(Concl.)

| Name and address of producer | Location of mine | |
|---|------------------|------------|
| | State | District |
| Madhya Pradesh State Mining Corp Ltd, Paryavas Bhavan, Area Hills, Jail Road, Bhopal – 462 011, Madhya Pradesh. | Madhya Pradesh | Chhatarpur |
| M/s Eastern Minerals 35, Vivekanand Marg, Cantt. P.O. Jhansi- 284 002, Jhansi, Uttar Pradesh. | Madhya Pradesh | Chhatarpur |
| J. K. Minerals C1 & C2 Industrial Estate, Gwalior Road, Jhansi - 284 003, Uttar Pradesh. | Uttar Pradesh | Lalitpur |
| Devendradhar Badgaya 279, Civil Lines, P.O. Tikamgarh - 472 001. Madhya Pradesh | Madhya Pradesh | Tikamgarh |

**Table – 3 : Production of Pyrophyllite, 2007-08 to 2009-10
(By States)**

(Qty in tonnes; value in Rs. '000)

| State | 2007-08 | | 2008-09 | | 2009-10(P) | |
|----------------|---------------|--------------|---------------|--------------|---------------|--------------|
| | Quantity | Value | Quantity | Value | Quantity | Value |
| India | 203707 | 43381 | 255699 | 55831 | 242397 | 54046 |
| Andhra Pradesh | 15 | 2 | 32 | 5 | 34 | 5 |
| Jharkhand | 4011 | 1284 | 4629 | 2315 | 1007 | 504 |
| Madhya Pradesh | 169867 | 36238 | 210622 | 44306 | 211016 | 47218 |
| Maharashtra | 1652 | 367 | 2127 | 625 | 1484 | 460 |
| Odisha | 5997 | 910 | 15655 | 2949 | 11926 | 2154 |
| Uttar Pradesh | 22165 | 4580 | 22634 | 5631 | 16930 | 3705 |

PYROPHYLLITE

**Table – 4 : Production of Pyrophyllite, 2008-09 & 2009-10
(By Sectors/States/Districts)**

(Qty in tonnes; Value in Rs. '000)

| State/District | 2008-09 | | | 2009-10(p) | | |
|-----------------------|--------------|---------------|--------------|--------------|---------------|--------------|
| | No. of Mines | Quantity | Value | No. of Mines | Quantity | Value |
| India | 35(5) | 255699 | 55831 | 33(2) | 242397 | 54046 |
| Public Sector | 1(1) | 18166 | 4693 | 1(1) | 12916 | 3344 |
| Private Sector | 34(4) | 237533 | 51138 | 32(1) | 229481 | 50702 |
| Andhra Pradesh | 1 | 32 | 5 | 1 | 34 | 5 |
| Cuddapah | 1 | 32 | 5 | 1 | 34 | 5 |
| Jharkhand | 1 | 4629 | 2315 | 1 | 1007 | 504 |
| Seraikela Kharaswa | 1 | 4629 | 2315 | 1 | 1007 | 504 |
| Madhya Pradesh | 23 | 210622 | 44306 | 21 | 211016 | 47218 |
| Chhatarpur | 13 | 156239 | 30427 | 12 | 154520 | 32195 |
| Shivpuri | 1 | 19257 | 5777 | 1 | 27789 | 8337 |
| Tikamgarh | 9 | 35126 | 8102 | 8 | 28707 | 6686 |
| Maharashtra | (5) | 2127 | 625 | (2) | 1484 | 460 |
| Bhandara | (5) | 2127 | 625 | (2) | 1484 | 460 |
| Odisha | 2 | 15655 | 2949 | 2 | 11926 | 2154 |
| Keonjhar | 2 | 15655 | 2949 | 2 | 11926 | 2154 |
| Uttar Pradesh | 8 | 22634 | 5631 | 8 | 16930 | 3705 |
| Jhansi | 3 | 669 | 226 | 2 | 1392 | 470 |
| Lalitpur | 3 | 9971 | 2186 | 3 | 10221 | 2247 |
| Mahoba | 2 | 11994 | 3219 | 3 | 5317 | 988 |

Figures in parentheses indicate associated mines of sillimanite & kyanite.

**Table – 5 : Production of Pyrophyllite, 2008-09 & 2009-10 (P)
(By Frequency Groups)**

(Qty in tonnes)

| Production Group | No. of Mines | | Production for the group | | Percentage in total production | | Cumulative percentage | |
|-------------------|--------------|--------------|--------------------------|---------------|--------------------------------|------------|-----------------------|---------|
| | 2008-09 | 2009-10 | 2008-09 | 2009-10 | 2008-09 | 2009-10 | 2008-09 | 2009-10 |
| All Groups | 35(5) | 33(2) | 255699 | 242397 | 100 | 100 | – | – |
| Up to 500 | 9(4) | 11(1) | 2263 | 2047 | 1 | 1 | 1 | 1 |
| 501 –1000 | 3 | 3 | 2394 | 2412 | 1 | 1 | 2 | 2 |
| 1001 –2000 | 9(1) | 5(1) | 12710 | 9052 | 5 | 4 | 7 | 6 |
| 2001 –5000 | 5 | 5 | 19311 | 14961 | 8 | 6 | 15 | 12 |
| 5001 –10000 | 2 | 3 | 16080 | 22062 | 6 | 9 | 21 | 21 |
| 10001-15000 | 2 | 2 | 24814 | 23633 | 10 | 10 | 31 | 31 |
| 15001 & above | 5 | 4 | 178127 | 168230 | 69 | 69 | 100 | 100 |

Figures in parentheses indicate associated mines.

PYROPHYLLITE

Table – 6 : Mine-head stocks of Pyrophyllite 2009-10 (P) (By States)

| State | (In tonnes) | |
|----------------|------------------------------|------------------------|
| | At the beginning of the year | At the end of the year |
| India | 124100 | 113229 |
| Andhra Pradesh | 17 | 9 |
| Jharkhand | 908 | 104 |
| Madhya Pradesh | 67625 | 70485 |
| Maharashtra | 963 | 745 |
| Odisha | 4714 | 2337 |
| Rajasthan | 77 | 204 |
| Uttar Pradesh | 49796 | 39345 |

MINING, MARKETING AND TRANSPORT

All pyrophyllite mines in the country are being operated manually, except a few semi-mechanised opencast mines in Madhya Pradesh, which deploy excavators and payloaders. In some mines benches of height varying from 1.5 to 3.5 m and width varying from 4 to 10 m have been developed in overburden. For ensuring qualitative improvement in the mine environment and ecology, some mine owners have planted trees like Acacia, Shishum, Eucalyptus, Jamun and Mango. Pyrophyllite is sorted out by experienced workers on visual assessment and then transported to grinding units to obtain 70 to 300 mesh powder as per the requirement of consumers.

CONSUMPTION

The reported domestic consumption of pyrophyllite was at 29,000 tonnes in 2009-10. Refractory was the main consuming industry accounting for about 93.79% and the ceramic industry consumed the remaining 6% (Table -7).

Table – 7 : Reported Consumption of Pyrophyllite 2007-08 to 2009-10 (By Industries)

| Industry | (In tonnes) | | |
|-----------------------|--------------|--------------|--------------|
| | 2007-08 | 2008-09(R) | 2009-10(P) |
| All Industries | 25300 | 30400 | 29000 |
| Ceramic | 1800 (5) | 1800 (5) | 1800 (5) |
| Refractory | 23500(10) | 28600(11) | 27200(11) |

Figures rounded off. Data collected on non-statutory basis. Figures in parentheses denote the number of units in organised sector reporting* consumption. (*Includes actual reported consumption and/or estimates made wherever required).

USES AND SPECIFICATIONS

Pyrophyllite is harder than talc and unlike talc, pyrophyllite does not flux when fired. It is, therefore, used in high-grade ceramic products, electric insulators and refractories. Pyrophyllite imparts thermal shock resistance to ceramic bodies. It is also used as filler and dusting powder in various industries. In glass industry, pyrophyllite is used instead of felspar as a source of aluminium. Owing to its softness and mode of occurrence in lumps it is used extensively in handicraft industries for making various articles.

Low thermal expansion and shrinkage characteristics of pyrophyllite make it a useful ingredient in ceramic blends and may substitute either pitcher (grog) or silica. Pyrophyllite allows faster firing cycles in the manufacture of whiteware. In production of stoneware and chinaware, more mechanical strength as well as improved whiteness can be achieved at lower firing temperature. Hence, pyrophyllite is consumed in refractory as well as in wall tiles, sanitaryware, electrical porcelain and other ceramic and vitreous china products.

The BIS has prescribed the following specifications for pyrophyllite for ceramic industry (IS:11477-1985; Reaffirmed 2001).

| Characteristic | Requirement (%) | |
|--------------------------------------|-----------------|-----------|
| | Grade-I | Grade-II |
| Loss on ignition | 6% max. | 6% max. |
| SiO ₂ | 65% max. | 60% max. |
| Al ₂ O ₃ | 28% max. | 25% max. |
| Fe ₂ O ₃ * | 1% max. | 1.5% max. |
| TiO ₂ * | 1% max. | 1% max. |
| CaO | 0.5% max. | 1.5% max. |
| K ₂ O & Na ₂ O | 0.5% max. | 1.5% max. |

* Sum of percentage of iron oxide and titanium oxide for Grade-I and Grade-II shall not exceed 1.5% and 2%, respectively.

Note: Grade-I: Suitable for whiteware and insulator industry. Grade-II: Suitable for other ceramic industry.

PYROPHYLLITE

The consumers in refractory industry generally prefer pyrophyllite, containing 26 to 28% Al₂O₃ to 4% alkali and having 23 to 25 PCE (orton cone). For insecticide industry, the specifications of talc/steatite can also be applicable to pyrophyllite as given below:

| | |
|--------------------------------|-------------|
| Loss on ignition | : 7% max. |
| Matter soluble in HCl | : 3% max. |
| Fe ₂ O ₃ | : 1.5% max. |

WORLD REVIEW

The world reserves of pyrophyllite are quite large and sufficient to meet the world demand. The world reserves of talc and pyrophyllite are given in Table - 8. Reserves of pyrophyllite are not available separately.

The world production of pyrophyllite in 2009 decreased to 1.47 million tonnes from 1.72 million tonnes in the previous year. The Republic of Korea was the leading producer accounting for 42%, followed by Japan 23%, India 17%, South Africa 8% and Thailand 7% . (Table - 9).

Table – 8 : World Reserves of Talc and Pyrophyllite (By Principal Countries)

| (In '000 tonnes) | |
|--------------------------------|--------------|
| Country | Reserves |
| World : Total (rounded) | Large |
| Brazil | 180000 |
| China | Large |
| Finland | Large |
| India* | 4000 |
| Japan | 100000 |
| Korea, Republic of | 14000 |
| USA ** | 140000 |
| Other countries | Large |

Source: Mineral Commodity Summaries, 2010.

* India's resources of pyrophyllite as per UNFC System as on 1.4.2005 are estimated at 33.69 million tonnes.

** Excludes pyrophyllite.

The prices of pyrophyllite are normally influenced by alumina content, levels of iron and other impurities, colour, abrasiveness, absorbency, etc.

Table - 9 : World Production of Pyrophyllite

| (In '000 tonnes) | | | |
|------------------------|--------------------|--------------------|--------------------|
| Country | 2007 | 2008 | 2009 |
| World : Total | 1960 | 1718 | 1472 |
| Argentina | 10 | 9 | 10 ^(e) |
| India* | 204 | 235 | 243 |
| Japan | 345 ^(e) | 350 ^(e) | 340 ^(e) |
| Korea, Rep. of | 798 | 893 | 617 |
| Peru | 23 | 18 | 13 |
| Morocco | 26 | 26 | 33 |
| South Africa | 124 | 81 | 115 |
| Thailand | 415 | 107 | 100 ^(e) |
| Vietnam ^(e) | 16 | – | – |

Source: World Mineral Production, 2005-2009.

* India's production of pyrophyllite in 2007-08, 2008-09 and 2009-10, was 204 thousand tonnes, 256 thousand tonnes and 242 thousand tonnes, respectively.

FUTURE OUTLOOK

The use of pyrophyllite in ceramic industry seems to be static whereas the refractory applications are facing the problems as most other refractory minerals due to change in technology and reduction of refractory consumption per tonne of metal. Pyrophyllite will continue to face competition from bentonite and attapulgite in carrier applications. However, use in filler applications appears to be stable.