

7.4 MAGNESITE

Introduction

Magnesite, a magnesium carbonate (MgCO_3), usually occurs as a secondary deposit as veins and in an alteration product of ultrabasic rocks, serpentinite and other magnesium rich rock types. In India, deposits of commercial significance are located in Uttarakhand, Tamil Nadu, Karnataka & Rajasthan. Other states where resource estimates have been made are Jammu & Kashmir and Himachal Pradesh, with meagre amount in Andhra Pradesh & Kerala.

Magnesite in Uttarakhand and Tamil Nadu occurs as an alteration product of ultra basic rocks. Tamil Nadu Magnesite is characterised by high silica content and Uttarakhand magnesite by calcium, which are deleterious constituents.

The primary use of raw magnesite is in the calcination industry in which about 98% of raw magnesite is consumed. The dead-burnt magnesite (DBM) and fused magnesite are used in refractory industry for manufacturing various refractory products. The low calcined magnesite (caustic magnesia) is used in non-refractory uses and in the manufacture of sorel cement (magnesium oxychloride).

Basis of Grade Classification

The following end-use grade classification of magnesite has been adopted in the NMI as on 1.4.2015.

1. High Grade : Directly useable for making high grade DBM.

MgO	-	45.5% min
SiO ₂	-	2.5% max
CaO	-	1.5% max

2. Medium Grade : Directly useable for making ordinary DBM.

MgO	-	42.5% min
SiO ₂	-	2.5% to 4% max
CaO	-	1.5% max

3. Beneficiable/Low grade :

- a) MgO - 38 to below 42.5%
Magnesite amenable to reduce silica content by simple dressing and sorting.
- b) MgO -35%, CaO-3% (max), Fe₂O₃-3% (max)

This is beneficiated by flotation or other methods.

4. Others : Estimation of such grade through useable/marketable but cannot be classified into above grades.
5. Unclassified : Range of minimum and maximum values of the constituents are too wide to classify under above grades.

Basis of Categorisation of Resources

As per United Nations Framework Classification (UNFC), resources are broadly classified into 'reserves' and 'remaining resources'.

According to the norms of this system, the reserves of magnesite have been placed under proved (111) and probable (121), (122) categories. The remaining resources have been placed under feasibility (211), pre-feasibility (221) & (222), measured (331), indicated (332) inferred (333) and reconnaissance (334) categories.

Salient Features of the Inventory

The total resources of magnesite in the country as on 1.4.2015 are estimated at 394 million tonnes with 82 million tonnes (21%) under reserve category and the balance 312 million tonnes (79%) under remaining resources category. Out of the total resources, about 275 million tonnes (70%) are in freehold and 119 million tonnes (30%) in leasehold areas.

All India scenario of magnesite reserves, remaining resources and total resources as on 1.4.2015 vis-a-vis 1.4.2010 have been given in Tables-1 and 2. The Tables give an idea about changes in terms of increase or decrease of resources as per lease status, grade and state. In Table -3, district-wise reserves/resources have been given.

Of the total resources of magnesite, about 3.2 million tonnes (0.8%) constitutes high grade, 106.5 million tonnes (27%) medium grade, 154.8 million tonnes (39.3%) beneficiable/low grade, 118.2 million tonnes (30%) in mixed grade constituting high, medium & low grades. The balance 11.2 million tonnes (2.8%) are in others, unclassified and not known grades.

The major resources of magnesite have been estimated in Rajasthan, Tamil Nadu and Uttarakhand. Out of these, Uttarakhand is credited with 231 million tonnes (59%) resources, followed by Tamil Nadu 98

Table - 1 : Reserves/Resources of Magnesite as on 1.4.2015 vis-à-vis 1.4.2010
(By Lease Status/Grade)

Lease status/Grade	Reserves			Remaining resources			Total resources		
	1.4.2015	1.4.2010	Net change	1.4.2015	1.4.2010	Net change	1.4.2015	1.4.2010	Net change
	(In '000 tonnes)								
All India : Total	82277	41950	(+) 40327	311711	293222	(+) 18489	393988	335172	(+) 58816
High	-	2618	(-) 2618	3249	631	(+) 2618	3249	3249	No Change
Medium	79174	30040	(+) 49134	27318	16508	(+) 10810	106492	46548	(+) 59944
Beneficial/Low	2949	3491	(-) 542	151850	149986	(+) 1864	154799	153477	(+) 1322
High & Medium mixed	-	-	No Change	2339	2580	(-) 241	2339	2580	(-) 241
Medium & Low mixed	-	1496	(-) 1496	115910	116117	(-) 207	115910	117613	(-) 1703
Others	146	4110	(-) 3964	7480	3885	(+) 3595	7626	7995	(-) 369
Unclassified	-	-	No Change	83	83	No Change	83	83	No Change
Not Known	8	194	(-) 186	3482	3433	(+) 49	3491	3627	(-) 137
Freehold	-	-	No Change	274646	274646	No Change	274646	274646	No Change
High	-	-	No Change	2	2	No Change	2	2	No Change
Medium	-	-	No Change	4362	4362	No Change	4362	4362	No Change
Beneficial/Low	-	-	No Change	148543	148543	No Change	148543	148543	No Change
High & Medium mixed	-	-	No Change	2313	2313	No Change	2313	2313	No Change
Medium & Low mixed	-	-	No Change	115910	115910	No Change	115910	115910	No Change
Others	-	-	No Change	-	-	-	-	-	No Change
Unclassified	-	-	No Change	83	83	No Change	83	83	No Change
Not Known	-	-	No Change	3433	3433	No Change	3433	3433	No Change
Leasehold (Private)	4975	16328	(-) 11353	23249	7291	(+) 15958	28224	23619	(+) 4605
High	-	8	(-) 8	36	28	(+) 8	36	36	No Change
Medium	2050	7436	(-) 5386	12965	1509	(+) 11456	15015	8945	(+) 6070
Beneficial/Low	2772	3088	(-) 316	2720	1443	(+) 1277	5492	4531	(+) 961
High & Medium mixed	-	-	No Change	26	267	(-) 241	25	267	(-) 242
Medium & Low mixed	-	1496	(-) 1496	-	207	(-) 207	-	1703	(-) 1703
Others	146	4106	(-) 3960	7452	3836	(+) 3616	7598	7942	(-) 344
Not Known	8	194	(-) 186	49	-	(+) 49	58	194	(-) 136
Leasehold (Public)	77301	25623	(+) 51678	13816	11284	(+) 2532	91118	36907	(+) 54211
High	-	2610	(-) 2610	3210	600	(+) 2610	3210	3210	No Change
Medium	77124	22605	(+) 54519	9991	10636	(-) 645	87116	33241	(+) 53875
Beneficial/Low	177	403	(-) 226	587	-	(+) 587	763	403	(+) 360
Others	-	4	(-) 4	28	48	(-) 20	28	52	(-) 24

figures rounded off.

million tonnes (25%), Rajasthan 54 million tonnes(14 %) and rest (2 %) is accounted for by other states viz. Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka and Kerala.

A net increase of about 59 million tonnes resources of magnesite have been recorded in the inventory as on 1.4.2015 in comparison to 1.4.2010. This has resulted due to increase of 59 million tonnes resources in leasehold areas. Further, 5 new leasehold deposits with 1.6 million tonnes resources were also included as on 1.4.2015.

In Tamil Nadu, a sharp increase of 57.7 million tonnes of resources have been recorded. This was mainly due to the re-assessment of resources of 'Red Hill' mine in Salem District, after take-over of this leasehold mine by M/s.SAIL Refractory Co.Ltd. from M/s.Burn Standard Co. Ltd. Further, 4 new deposits (with 1.2 million tonnes resources) in Karur, Salem & Tiruppur districts also contributed in increase of

resources. In Karnataka, there is an increase of 1.9 million tonnes of resources due to re-assessment resources in 4 leasehold deposits in Mysore district. In Uttarakhand, inclusion of 1 new leasehold private deposit in Pithoragarh district was recorded. Depletion of about 0.8 million tonnes resources in Jammu & Kashmir and Uttarakhand was reported.

About 33% (132 million tonnes) of the total resources of magnesite estimated in the country are under inferred (333) and reconnaissance (334) categories. These estimates are based on a very limited preliminary exploration. If these areas are examined for further detailed exploration, the confidence level of the magnesite resources may improve.

A total 132 deposits of magnesite have been covered in the NMI as on 1.4.2015; out of which 89 deposits are in freehold and 43 deposits in leasehold areas (leasehold public-12 and leasehold private-31) including 5 new deposits.

**Table – 2 : Total Resources of Magnesite as on 1.4.2015 vis-à-vis 1.4.2010
(By States)**

State			(In '000 tonnes)
	Total Resources		Net Change
	As on 1.4.2015	As on 1.4.2010	
All India : Total	393988	335172	(+) 58816
Andhra Pradesh	80	80	No Change
Himachal Pradesh	298	298	No Change
Jammu & Kashmir	4145	4245	(-) 100
Karnataka	5981	4046	(+) 1935
Kerala	40	40	No Change
Rajasthan	53804	53804	No Change
Tamil Nadu	98226	40511	(+) 57715
Uttarakhand	231413	232148	(-) 735

Figures rounded off

Table - 3 : District wise Reserves/Resources of Magnesite as on 1.4.2015

(In '000 tonnes)

State/District	Reserves	Remaining Resources	Total Resources
All India : Total	82276	311711	393988
Andhra Pradesh	-	80	80
Cuddapah	-	80	80
Himachal Pradesh	-	298	298
Chamba	-	298	298
Jammu & Kashmir	-	4145	4145
Leh	-	45	45
Reasi	-	3950	3950
Udhampur	-	149	149
Karnataka	1389	4592	5981
Coorg	-	75	75
Mandya	-	820	820
Mysore	1389	3697	5086
Kerala	-	40	40
Pallakad	-	40	40
Rajasthan	-	53804	53804
Ajmer	-	6372	6372
Dungarpur	-	45000	45000
Pali	-	2427	2427
Udaipur	-	5	5
Tamil Nadu	73577	24649	98226
Coimbatore	-	387	387
Dharmapuri	-	8	8
Karur	27	12	40
Namakkal	-	368	368
Nilgiris	-	161	161
Salem	73005	22893	95897
Tiruchirapalli	-	27	27
Tirunelveli	-	7	7
Tiruppur	545	356	901
Vellore	-	430	430
Uttarakhand	7310	224103	231413
Almora	-	2500	2500
Bageshwar	5999	71156	77155
Chamoli	132	8120	8253
Pithoragarh	1179	142327	143506

figures rounded off.

7.5 SILLIMANITE

Introduction

Sillimanite is an aluminium silicate mineral similar in chemical composition to kyanite i.e. $\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$. Theoretically it contains 62.93% Al_2O_3 and 37.07% SiO_2 . The mode of occurrence, physical and optical properties are however different for these minerals. The decomposition of sillimanite occurs at a range of 1550°C to 1650°C. It is this property to withstand high temperature makes it suitable as a refractory in the form of high alumina refractory bricks. Its application in ceramics is, however, limited. Massive sillimanite is at present being mined in Bhandara district, Maharashtra. Granular variety is recovered as by-product of mining of beach sands from Kerala, Tamil Nadu and Odisha.

Basis of Grade Classification

In the inventory as on 1.4.2015 resources of sillimanite has been classified into the following grades:

- | | |
|-------------------------------|--|
| I. Massive | |
| 1. High Grade | Al_2O_3 (+)58%
Fe_2O_3 1% (max) |
| 2. Medium Grade | Al_2O_3 50% to 58%
Fe_2O_3 1.5% (max) |
| 3. Low Grade | Al_2O_3 40% to 50% |
| 4. High & Medium Grade | |
| 5. Medium & low Grade | |
| 6. High, Medium & low Grade | |
| II. Granular | Sillimanite in beach sand has been classified as granular type
Al_2O_3 58% (min)
Fe_2O_3 0.75% (max) |
| III. Sillimanite Bearing Rock | The rock containing sillimanite with (-) 40% Al_2O_3 |
| IV. Quartz Sillimanite Rock | |
| V. Others | Estimation of such grade though usable/ marketable but cannot be classified into the above grade. |

- | | |
|------------------|---|
| VI. Unclassified | The minimum and maximum ranges of chemical constituents are too wide to be classified into any of the above grades. |
| VII. Not known | The information on chemical constituents is not available or potential/ actual use is not reported. |

Basis of Categorisation of Resources

As per United Nations Framework Classification (UNFC), resources are broadly classified into 'reserves' and 'remaining resources'.

According to the norms of this system, 'reserves' of sillimanite have been placed under proved (111) and probable (121) & (122) categories. The 'remaining resources' have been placed under feasibility (211), pre-feasibility (221) & (222), measured (331), indicated (332), inferred (333) and reconnaissance (334) categories.

Salient Features of the Inventory

The total resources of sillimanite in the country as on 1.4.2015 are estimated at 70,204 thousand tonnes. Of these 6,502 thousand tonnes (9%) fall under 'reserve' category and 63,702 thousand tonnes (91%) are under 'remaining resource' category.

All India scenario of sillimanite reserves, remaining resources and total resources as on 1.4.2015 vis-a-vis 1.4.2010 have been given in Tables - 1 and 2. The tables give an idea about the significant changes in terms of increase and decrease of resources as per lease status, grade and states. In Table-3 district-wise reserves/ resources as on 1.04.2015 have been given.

Out of the total resources, about 59,849 thousand tonnes (85%) have been placed in freehold, 10,331 thousand tonnes (15%) in leasehold public areas and a negligible quantity of 24 thousand tonnes in leasehold private sector.

Resources in the inventory have been placed into three groups of grades namely Massive Sillimanite, Granular Sillimanite and Sillimanite bearing rocks. These are based on their natural occurrences. The largest share in the total resources is held by granular variety 51,486 thousand tonnes (73.34%), followed by sillimanite bearing rocks 11,450 thousand tonnes

Table - 1 : Reserves/Resources of Sillimanite as on 1.4.2015 vis-à-vis 1.4.2010
(By Lease Status/Grade)

Lease status/Grade	Reserves			Remaining resources			Total resources		
	1.4.2015	1.4.2010	Net change	1.4.2015	1.4.2010	Net change	1.4.2015	1.4.2010	Net change
All India : Total	6502115	4085052	(+)2417063	63702027	62902385	(+)799642	70204142	66987437	(+)3216705
Massive High Grade	-	-	No change	11903	11903	No change	11903	11903	No change
Massive Medium Grade	-	-	No change	33705	33705	No change	33705	33705	No change
Massive Low Grade	59021	7195	(+)51826	3124605	3110633	(+)13972	3183626	3117828	(+)65798
Massive High & Medium	-	-	No change	19800	19800	No change	19800	19800	No change
Massive Medium & Low	144255	196007	(-)51752	-	1120	(-)1120	144255	197127	(-)52872
Massive High,	-	-	No change	38	38	No change	38	38	No change
Medium & low	-	-	(+)2403549	45200726	44425006	(+)775720	51486125	48306856	(+)3179269
Granular High	6285399	3881850	No change	3748000	3748000	No change	3748000	3748000	No change
Quartz Sillimanite Rock	-	-	No change	11450000	11450000	No change	11450000	11450000	No change
Sillimanite Bearing Rock	-	-	No change	11070	-	(+)11070	11070	-	(+)11070
Others	-	-	(+)13440	-	-	No Change	13440	-	(+)13440
Unclassified	13440	-	No change	102180	102180	No Change	102180	102180	No Change
Not Known	-	-	No change	59848894	59611586	(+)237308	59848894	59611586	(+)237308
Freehold	-	-	No change	20569	20569	No change	20569	20569	No change
Massive Medium Grade	-	-	No change	3108786	3108786	No change	3108786	3108786	No change
Massive Low Grade	-	-	No change	19800	19800	No change	19800	19800	No change
Massive High & Medium	-	-	No change	38	38	No change	38	38	No change
Massive High, Medium & low	-	-	No change	41399521	41162213	(+)237308	41399521	41162213	(+)237308
Granular High	-	-	No change	3748000	3748000	No change	3748000	3748000	No change
Quartz Sillimanite Rock	-	-	No change	11450000	11450000	No change	11450000	11450000	No change
Sillimanite Bearing Rock	-	-	No change	102180	102180	No Change	102180	102180	No change
Not Known	-	-	No change	21723	189362	(-)167639	23805	877362	(-)853557
Leasehold (Private)	2082	688000	(-)685918	8543	8543	No change	8543	8543	No change
Massive High Grade	-	-	No change	819	819	No Change	819	819	No change
Massive Low Grade	-	-	(-)685918	1291	180000	(-)178709	3373	868000	(-)864627
Granular High	2082	688000	-	11070	-	(+)11070	11070	-	(+)11070
Others	-	-	-	3831410	3101437	(+)729973	10331443	6498489	(+)3832954
Leasehold (Public)	6500033	3397052	(+)3102981	3360	3360	No change	3360	3360	No change
Massive High Grade	-	-	No change	13136	13136	No change	13136	13136	No change
Massive Medium Grade	-	-	No change	15000	1028	(+)13972	74021	8223	(+)65798
Massive Low Grade	59021	7195	(+)51826	-	1120	(-)1120	144255	197127	(-)52872
Massive Medium & Low	144255	196007	(-)51752	3799914	3082793	(+)717121	10083231	6276643	(+)3806588
Granular High	6283317	3193850	(+)3089467	-	-	-	13440	-	(+)13440
Unclassified	13440	-	(+)13440	-	-	-	-	-	-

figures rounded off.

(16.31 %), Quartz Sillimanite Rock 3,748 thousand tonnes (5.34%) and massive low grade 3,184 thousand tonnes (4.53%).

The state of Odisha has been endowed with the largest share of total resources of sillimanite in the country at 17,657 thousand tonnes (25.15%) followed by Tamil Nadu 17,461 thousand tonnes (24.87%), Uttar Pradesh 11,450 thousand tonnes (16.30%), Andhra Pradesh 8,791 thousand tonnes (12.52%), and Kerala 7,145 thousand tonnes (10.17%). The balance 11% resources are accounted together by other states namely Assam, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Rajasthan and West Bengal.

In the inventory as on 1.4.2015, total resources increased by 3,217 thousand tonnes as compared to earlier inventory as on 1.4.2010. Total 2 new deposits (24.51 thousand tonnes) included in inventory as on 1.04.2015.

Maharashtra recorded an increase of 13 thousand tonnes due re-estimation of lease hold (Pvt.) deposits and Odisha states also show an increase of 4554 thousand tonnes of resources owing to revised estimation.

Andhra Pradesh recorded a decline of 854 thousand tonnes of sillimanite resources due to re-estimation of leasehold private deposit in Srikakulam district. Tamil Nadu reported a decline of 491 thousand tonnes resources due to re-estimation in Kanyakumari district. In Kerala, Chavara deposit of IREL was split into six different blocks and each one was treated as separate new deposit. A downward revision of resources in Chavara lease of KMML was also recorded. This resulted in decline of resources as on 1-04-2015 in Kerala by 5 thousand tonnes as compared to earlier inventory as on 1-04-2010.

A sizeable quantity of the total resources of sillimanite 19,918 thousand tonnes (28%) has been estimated under inferred and reconnaissance categories, based on a limited and preliminary exploration. Out of this, about 13,734 thousand tonnes resources are granular variety estimated in beach sand.

A total of 45 deposits have been covered in the inventory as on 1.4.2015. Out of this, 29 deposits are in freehold and 16 deposits are in leasehold areas (04 leasehold private and 12 leasehold public).

**Table – 2 : Total Resources of Sillimanite as on 1.4.2015 vis-à-vis 1.4.2010
(By States)**

(In tonne)

State	Total Resources		Net Change
	As on 1.4.2015	As on 1.4.2010	
All India : Total	70204142	66987437	(+)3216705
Andhra Pradesh	8790943	9644500	(-)853557
Assam	4604700	4604700	No change
Jharkhand	83000	83000	No change
Karnataka	982725	982725	No change
Kerala	7144941	7150049	(-)5108
Madhya Pradesh	101600	101600	No change
Maharashtra	218856	205930	(+)12926
Meghalaya	55807	55807	No change
Odisha	17657186	13102841	(+)4554345
Rajasthan	819	819	No change
Tamil Nadu	17460565	17952466	(-)491901
Uttar Pradesh	11450000	11450000	No change
West Bengal	1653000	1653000	No change

figures rounded off.

Table - 3 : District wise Reserves/Resources of Sillimanite as on 1.4.2015

(In tonne)

State/District	Reserves	Remaining Resources	Total Resources
All India : Total	6502115	63702027	70204142
Andhra Pradesh	2082	8788861	8790943
Godavari (West)	-	8776500	8776500
Srikakulam	2082	1291	3373
Visakhapatnam	-	11070	11070
Assam	-	4604700	4604700
Karbi Anglong	-	2054700	2054700
Nowgong	-	2550000	2550000
Jharkhand	-	83000	83000
Hazaribagh	-	83000	83000
Karnataka	-	982725	982725
Hassan	-	12000	12000
Mysore	-	965925	965925
South Kanara	-	4800	4800
Kerala	-	7144941	7144941
Alapuzha (Alleppy)	-	32814	32814
Kollam	-	3742927	3742927
Thiruvananthapuram	-	3369200	3369200
Madhya Pradesh	-	101600	101600
Sidhi	-	101600	101600
Maharashtra	203276	15580	218856
Bhandara	203276	15000	218276
Chandrapur	-	580	580
Meghalaya	-	55807	55807
Khasi Hills West	-	55807	55807
Odisha	6156573	11500613	17657186
Deogarh	-	1275000	1275000
Ganjam	6156573	10225613	16382186
Rajasthan	-	819	819
Udaipur	-	819	819
Tamil Nadu	140184	17320381	17460565
Kanyakumari	140184	261481	401665
Karur	-	4000	4000
Tirunelveli	-	17054900	17054900
Uttar Pradesh	-	11450000	11450000
Sonbhadra	-	11450000	11450000
West Bengal	-	1653000	1653000
Midnapur	-	1653000	1653000

figures rounded off.