

33 Dunite & Pyroxenite

Dunite is a monomineralic ultrabasic rock consisting of more or less pure olivine. Dunite typically contains 36 to 42% MgO and 36 to 39% SiO₂. Pyroxenite is also an ultrabasic rock consisting of pyroxenes; i.e., predominantly ferromagnesian minerals other than olivine. Olivine is a commercial source of magnesia combined with silica for use in metallurgy, fertilizer, etc. There is a rising trend in use of dunite and pyroxenite in sintering and as a fluxing agent in blast furnace in place of dolomite.

RESOURCES

In India, occurrences of dunite are reported in association with other ultrabasic rocks in chrysotile-bearing areas of Jharkhand and Karnataka; chromite-bearing areas in Orissa, Karnataka and Jharkhand and magnesite-bearing areas in Karnataka and Tamil Nadu. As per the (UNFC) system, total resources of dunite in the country as on 1.4.2005 are estimated at about 168 million tonnes of which 128 million tonnes are

reserves (about 13 million tonnes are proved reserves, 115 million tonnes are probable reserves) and 40 million tonnes are remaining resources. Dunite resources are located mainly in Tamil Nadu (70%) and Karnataka (18%). The remaining 12% resources are in Jharkhand and Orissa. Reserves/resources of dunite are furnished in Table-1.

The occurrences and production of pyroxenite are reported from Jajpur and Singhbhum districts of Orissa and Jharkhand, respectively. However, no resource estimates are available.

EXPLORATION

GSI conducted exploration for Platinum Group of Elements(PGE) in parts of Chhattisgarh, Karnataka, Maharashtra, Meghalaya, Orissa, Tamil Nadu and Uttar Pradesh. During the course of investigations, variants of mafic-ultramafic complexes were reported (Refer review on Platinum & Palladium).

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

Grade/State	Reserves				Remaining resources					Total resources (A+B)	
	Proved STD111	Probable		Total A	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333		Total B
		STD121	STD122		STD221	STD222					
All India : Total	12714	4476	110884	128074	557	1157	23909	384	13848	39855	167929
By Grades											
Grade I	5558	3600	38617	47775	0	0	23909	0	11975	35884	83659
Grade II	7156	876	72267	80299	557	1157	0	384	1873	3971	84270
By States											
Jharkhand	303	3446	3324	7073	0	0	0	0	3410	3410	10483
Karnataka	428	154	955	1537	0	0	23909	0	4038	27947	29484
Orissa	4429	876	2965	8270	557	1157	0	384	627	2725	10995
Tamil Nadu	7554	0	103640	111194	0	0	0	0	5773	5773	116967

Figures rounded off.

DUNITE & PYROXENITE

PRODUCTION, STOCKS AND PRICES

Dunite

Dunite is mainly obtained incidental to mining of magnesite. Its production at 29169 tonnes during the year under review decreased by 2% as compared to that in the previous year due to lack of demand and labour shortage.

There were two mines reporting production of dunite during 2007-08. The production of dunite was reported from one primary mine only which was in public sector and was located in Chickmagalur district of Karnataka. In addition, production of dunite was also obtained as an associated mineral from public sector magnesite mine located in Tamil Nadu. The entire production of dunite was reported from public sector in both the years.

Mine-head stocks of dunite at the end of 2007-08 were 1535 tonnes as against 1908 tonnes in the beginning of the year.

Average daily employment of labour in the sole primary mine of dunite was 13 during 2007-08 as against six in the preceding year.

Prices of dunite are furnished in Table - 6.

Table - 2 : Producers of Dunite, 2007-08

Name and address of producer	Location of mine	
	State	District
Tamil Nadu Magnesite Ltd,* 5/53, Omalur Main Road, Jagir Ammapalayam, Salem – 636 302, Tamil Nadu.	Tamil Nadu	Salem
Steel Authority of India Ltd, Visvesvaraya Iron & Steel Plant, Bhadravati - 577 301, Karnataka.	Karnataka	Chickmagalur

* Produced as an associated mineral with magnesite.

**Table - 3 : Production of Dunite, 2005-06 to 2007-08
(By States)**

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

State	2005-06		2006-07		2007-08 (p)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	36621	7979	29708	4061	29169	10744
Karnataka	10896	970	13236	1059	6438	515
Tamil Nadu	25725	7009	16472	3002	22731	10229

**Table - 4 : Production of Dunite, 2006-07 and 2007-08
(By Sectors/States/Districts)**

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

State/District	2006-07			2007-08 (p)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	1(2)	29708	4061	1*(1)	29169	10744
Public Sector	1(1)	29456	3979	1*(1)	29169	10744
Private Sector	*(1)	252	82	0	0	0
Karnataka	1	13236	1059	1	6438	515
Chickmagalur	1	13236	1059	1	6438	515
Tamil Nadu	*(2)	16472	3002	*(1)	22731	10229
Salem	*(2)	16472	3002	*(1)	22731	10229

* Associated mines producing magnesite.

DUNITE & PYROXENITE

Table - 5 : Mine-head Stocks of Dunite, 2007-08(p)
(By States)

State	(In tonnes)	
	At the beginning of the year	At the end of the year
India	1908	1535
Tamil Nadu	1908	1535

The mine-head stocks at the beginning of 2007-08 were 18,064 tonnes as against 28,160 tonnes at the end of the year (Table - 11).

The average daily labour employed in pyroxenite mines in 2007-08 was 131 as against 201 in the previous year.

Table - 6 : Prices of Dunite, 2005-06 to 2007-08
(Domestic Markets)

Grade	Market	(In Rs. per tonne)		
		2005-06	2006-07	2007-08(p)
5 mm to 6 mm	Ex-mine MML (Karnataka)	375	350	350
6 mm to 12 mm	Ex-mine MML (Karnataka)	475	450	450
Random Size	Ex-mine MML (Karnataka)	100	100	100
MgO-28-30%, SiO ₂ -35-40%	Ex-mine Bhadravati (Karnataka)	190	192	202

Table - 7 : Principal Producers of Pyroxenite, 2007-2008

Name and address of producer	Location of mine	
	State	District
* Tata Steel Ltd, Bombay House, 24-Homi Mody Street, Mumbai - 400 001.	Orissa	Jajpur
Pravat kumar Aditya Deo 605/5, Radha Colony, Khasmahal, Tata Nagar Singhbhum East-831 002 Jharkhand.	Jharkhand	Singhbhum East

Pyroxenite

The total production of pyroxenite at 314,554 tonnes in 2007-08 increased by 4% over the previous year. There were five reporting mines in both the years (Tables -7 to 10).

* Associated mine with Chromite.

Table - 8 : Production of Pyroxenite, 2005-06 to 2007-08 (p)
(By States)

State	(Quantity in tonnes; value in Rs.'000)					
	2005-06		2006-07		2007-08 (p)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	340953	111957	301733	82693	314554	95825
Jharkhand	65293	15476	80323	18041	49466	11855
Orissa	275660	96481	221410	64652	265088	83970

DUNITE & PYROXENITE

Table – 9 : Production of Pyroxenite, 2006-07 & 2007-08 (p)
(By Sectors/States/Districts)

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

State/District	2006-07			2007-08		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	5(1)	301733	82693	5(1)	314554	95825
Private sector	5(1)	301733	82693	5(1)	314554	95825
Jharkhand	5	80323	18041	5	49466	11855
Singhbhum (East)	4	77238	17616	4	49131	11809
Singhbhum (West)	1	3085	425	1	335	46
Orissa	(1)	221410	64652	(1)	265088	83970
Jajpur	(1)	221410	64652	(1)	265088	83970

Figures in parentheses indicate number of associated mines.

Table – 10 : Production of Pyroxenite, 2006-07 & 2007-08 (p)
(By Frequency Groups)

(Quantity in tonnes)

Production group	No. of mines		Production		Percentage in total production		Cumulative percentage	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
Total	5(1)	5(1)	301733	314554	100.00	100.00	-	-
Upto 5000	1	2	3085	2031	1.02	0.65	1.02	0.65
5001-10000	1	1	7515	9195	2.49	2.92	3.51	3.57
10001-50000	3	2	69723	38240	23.11	12.16	26.62	15.73
50001 & above	(1)	(1)	221410	265088	73.38	84.27	100.00	100.00

Figures in parentheses indicate number of associated mines.

Table – 11 : Mine-head Stocks of Pyroxenite, 2007-08 (p)
(By States)

(In tonnes)

State	At the beginning of the year	At the end of the year
India	18064	28160
Jharkhand	3510	2319
Orissa	14554	25841

DUNITE & PYROXENITE

USES

Dunite and pyroxenite are preferred as flux to dolomite as a source of MgO in sintering and also in iron and steel industry. Main benefits of olivine over dolomite in slag conditioning are : higher MgO content, no requirement of preheat treatment, reduced energy consumption, lower coke consumption, reduced slag volume and lower CO₂ emissions. Presence of higher amount of silica in dolomite leads to lower sinter basicity (i.e. CaO/SiO₂) at around 2.5 than 3.5 of dolomite and the phases in sinter change to those having better reducibility. The net result is a reduction in the resistance of the cohesive zone to gas flow in the blast furnace leading to drop in fuel rate and higher productivity. In addition, the magnesium silicates do not call for calcination (unlike the carbonates) and thus lowers energy requirement in the blast furnace. At Tata Steel, about 20 kg pyroxenite is added directly for a tonne of hot metal in the blast furnace burden while limiting the MgO content in sinter to 1.5-1.7 percent.

Olivine helps to condition the slag as well as to control the basicity through reduction of alkali recirculation. Its higher reaction temperature reduces low temperature breakdown and swelling of burden, thus maintaining permeability and reducing coke consumption. The olivine may be added directly to the blast furnace charge as lump (10 to 40 mm), a sinter feed (3 to 6 mm), or mixed with low silica iron ore fines and pressed into pellets. When lump is added directly to the furnace, olivine can replace partly limestone and dolomite flux in the reduction of iron ore. In comparison with dolomite, olivine has a higher MgO content (requires less material for a given MgO level), MgO: SiO₂ ratio, (allows MgO levels to be raised without changing the basicity of the slag) and lower LOI; i.e., 0.3-0.7% (conserves the energy required to drive off unwanted carbon dioxide). As a sinter feed, olivine reduces the sintering temperature by 100°C max., thus producing harder sinter and less fines. Olivine is

added directly to the iron ore as a flux during the formation of the pellets so that the fluxed pellets swell less, reduce more quickly, and have a narrower melting range. However, on the other side, high silica content in olivine restricts its use to low silica iron ores because a high total silica content creates excessive slag formation.

Dunite is well suited as a refractory having low and uniform coefficient of thermal expansion, good resistance to thermal shock, spalling and slag attack, a high green strength and resistance to metal attack. Dunite may be calcined in rotary kilns at 1650°C for refractory and foundry applications. Other uses of olivine are as loose-grainshot blasting abrasive, filtration media, in mineral wool production, filler in speciality paints, asphalt, mastics, and weighing agent in concrete oil production platforms. Olivine also contributes magnesia and iron as nutrients to the soil.

SPECIFICATIONS

Olivine should contain 45 to 51% MgO, 40 to 43% SiO₂, 7 to 8% Fe₂O₃, 0.2 to 0.8% CaO and 1.8 to 2% Al₂O₃ and TiO₂, MnO, Cr₂O₃, NiO and CaO for various uses. For blast furnace use, olivine should contain 47 to 48% MgO with 10 to 40 mm lump size. For foundry use, the size should be AFS 20, 30, 60, 90, 120 and for flour, filler and fertilizer grades, size recommended is up to 0.8 mm, up to 0.02 mm and less than 0.1 mm, respectively.

As per the end use grade classification, the reserves of 'fresh' and 'weathered' dunite had been classified as Gr. I and Gr. II, respectively. However, it was recommended to also assign chemical specification to these grade based on the experience of Tata Steel Ltd and GSI as given below:

Grade	MgO%	SiO ₂ %	LOI%	Cr ₂ O ₃ %
Grade-I	41.12	33.41	12.74	below 1
Grade-II	32.44	29.16	24.09	-

DUNITE & PYROXENITE

For steel and alloy manufacturing, pyroxenite lumps as well as fines/dust are being consumed. Tata Steel is a major supplier of pyroxenite to the ferro-alloy manufacturers. The specifications of pyroxenite as per Indian Ferro Alloys Producers Association (IFAPA) are as follows:

Grade	MgO%	SiO ₂ %	Al ₂ O ₃ %	CaO%	Cr ₂ O ₃ %
Grade-1	34 min	36-39max	1-2	1-3 min	1 min
Grade-2	34.38	35	1-2	1 max	3.5 - 6

BIS has adopted IS : 7297-1974(reaffirmed 2003) as specification for olivine sand for use in steel foundries.

WORLD REVIEW

Large deposits of olivine-bearing dunites are located in Norway, Sweden, CIS countries, Austria, Japan, New Zealand, Zimbabwe, South Africa, USA, New Caledonia, Italy, Greece, Spain, India, Brazil and Canada.

Production capacity of olivine in the world was estimated at 8.4 million tonnes excluding CIS countries. Large-scale production of olivine was limited to Norway accounting for over 30% world production, followed by Japan (24%), Spain (12%), Greenland (7%) and Brazil, China, Taiwan (4% each). Data on CIS countries was not available.