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% SiO_2. 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 Odisha, 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 Odisha. Reserves/ resources of dunite are furnished in Table-1.

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

EXPLORATION

During FS, 2009-10 in the course of Platinum Group of Elements(PGE) investigations, GSI conducted preliminary exploration in the pyroxenite bearing basic/ultrabasic/ultramafic rocks in parts of Gondpipri, Chandrapur district, Maharashtra, Padhar area (Betual belts), Betul & Chhindwara districts, Madhya Pradesh and ophiolite belts in Manipur. During investigation in Sathyamangalam Group in Tamil Nadu, four ultramafic (meta pyroxenite) bands extending over 850 m length in Siviyarpalaiyam area were delineated and meta pyroxenite was encountered during scout drilling in Solavanur block.

State Directorate (DMG), Nagaland conducted geological studies of dunite bearing deposits at Chokla-Wui-Kenjong area, Tuensang district.

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

(In '000 tonnes)

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

Figures rounded off.

PRODUCTION, STOCKS AND PRICES

Dunite

Dunite is mainly obtained incidental to mining of magnesite. Its production at 57,182 tonnes during the year under review increased by 12% as compared to that in the previous year due to increase in demand.

The production of dunite was reported from only one primary mine which was in public sector located in Chickmagalur district of Karnataka. In addition, production of dunite was also obtained as an associated mineral from public sector magnesite mines located in Salem district of Tamil Nadu and Mysore district of Karnataka. Thus, the entire production of dunite during the year was reported from public sector as against 97% in the previous year (Tables - 2 to 4).

Mine-head stocks of dunite at the end of 2009-10 were 4,752 tonnes as against 5,623 tonnes at the beginning of the year (Table - 5).

Average daily employment of labour in the sole primary mine of dunite was 7 during 2009-10 as against 3 in the preceding year.

Prices of dunite are furnished in the General Review on Prices.

Table – 2 : Producers of Dunite, 2009-10

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
Mysore Mineral Limited,* 39-Mahatma Gandhi Road, Bangalore, Karnataka.	Karnataka	Mysore
Steel Authority of India Ltd, Visvesvaraya Iron & Steel Plant, Bhadravati - 577 301, Karnataka.	Karnataka	Chickmagalur

* *Producing dunite as an associated mineral with magnesite.*

Table – 3 : Production of Dunite, 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	**57989**	**15127**	**50935**	**23482**	**57182**	**15055**
Karnataka	33408	4297	32550	7486	37346	8830
Tamil Nadu	24581	10830	18385	15996	19836	6225

Table – 4 : Production of Dunite, 2008-09 and 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	**1(3)**	**50935**	**23482**	**1(2)**	**57182**	**15055**
Public sector	1(2)	49505	23017	1(2)	57182	15055
Private sector	(1)	1430	465	-	-	-
Karnataka	**1(1)**	**32550**	**7486**	**1(1)**	**37346**	**8830**
Chickmagalur	1	1706	145	1	1996	170
Mysore	(1)	30844	7341	(1)	35350	8660
Tamil Nadu	**(2)**	**18385**	**15996**	**(1)**	**19836**	**6225**
Salem	(2)	18385	15996	(1)	19836	6225

Figures in parentheses indicate the number of associated mines producing magnesite.

Table – 5 : Mine-head Stocks of Dunite 2009-10(P) (By States)

(In tonnes)

State	At the beginning of the year	At the end of the year
India	**5623**	**4752**
Karnataka	2677	2511
Tamil Nadu	2946	2241

Pyroxenite

The total production of pyroxenite at 279,002 tonnes in 2009-10 decreased by 1% over the previous year. There were three reporting mines during the year 2009-10 as against four in the previous year (Tables - 6 to 9).

The mine-head stocks at the end of 2009-10 was 28,916 tonnes as against 26,751tonnes at beginning of the year (Table - 10).

The average daily labour employed in pyroxenite mines in 2009-10 was 118 as against 121 in the previous year.

Table – 6 : Principal Producers of Pyroxenite 2009-10

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

** Associated mine with chromite.*

Table – 7 : Production of Pyroxenite, 2007-08 to 2009-10 (By States)

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

State	2007-08		2008-09		2009-10 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**289321**	**90746**	**281785**	**139143**	**279002**	**153873**
Jharkhand	47716	11500	50875	13297	49308	12662
Odisha	241605	79246	230910	125846	229694	141211

Table – 8 : Production of Pyroxenite, 2008-09 & 2009-10 (By Sectors/States/Districts)

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

State/District	2008-09			2009-10 (P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**4(1)**	**281785**	**139143**	**3(1)**	**279002**	**153873**
Private sector	4(1)	281785	139143	3(1)	279002	153873
Jharkhand	**4**	**50875**	**13297**	**3**	**49308**	**12662**
Singhbhum (East)	4	50875	13297	3	49308	12662
Odisha	**(1)**	**230910**	**125846**	**(1)**	**229694**	**141211**
Jajpur	(1)	230910	125846	(1)	229694	141211

Figures in parentheses indicate number of associated mines.

Table – 9 : Production of Pyroxenite, 2008-09 & 2009-10
(By Frequency Groups)

(Quantity 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
Total	**4(1)**	**3(1)**	**281785**	**279002**	**100.00**	**100.00**	**100.00**	**100.00**
Up to 5000	1	–	215	–	0.08	–	0.08	–
5001-10000	–	1	–	9312	–	3.34	0.08	3.34
10001-50000	3	2	50660	39996	17.98	14.33	18.06	17.67
50001 and above	(1)	(1)	230910	229694	81.94	82.33	100.00	100.00

Figures in parentheses indicate number of associated mines.

Table – 10 : Mine-head Stocks of Pyroxenite, 2009-10 (P)
(By States)

(In tonnes)

State	At the beginning of the year	At the end of the year
India	**26751**	**28916**
Jharkhand	1538	7504
Odisha	25213	21412

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 CO_2 emissions. Presence of higher amount of silica in dolomite leads to lower sinter basicity (i.e. CaO/SiO_2) 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: SiO_2 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 100ºC 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 1650ºC 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 poduction platforms. Olivine also contributes magnesia and iron as nutrients to the soil.

SPECIFICATIONS

Olivine should contain 45 to 51% MgO, 40 to 43% SiO_2, 7 to 8% Fe_2O_3, 0.2 to 0.8% CaO and 1.8 to 2% Al_2O_3 and TiO_2, MnO, Cr_2O_3, 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_2O_3%
Grade-I	41.12	33.41	12.74	below 1
Grade-II	32.44	29.16	24.09	–

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_2O_3%	CaO%	Cr_2O_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.

CONSUMPTION

Dunite is being consumed almost entirely by the refractory industry. Reported consumption of dunite in the organised sector was 4,200 tonnes in 2009-10, a decrease of 21% from the previous year. Entire consumption was in refractory industry; iron and steel industry did not report consumption (Table - 11).

Table – 11 : Reported Consumption of Dunite
2007-08 to 2009-10
(By Industries)

(In tonnes)

Industry	2007-08	2008-09(R)	2009-10(P)
All Industries	**4600**	**5300**	**4200**
Iron & Steel	–	1100(1)	Nil(1)
Refractory	4600(4)	4200(4)	4200(4)

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).*