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DUNITE & PYROXENITE

(FINAL RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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Dunite is a monomineralic ultrabasic rock that consists of more or less pure olivine. Dunite typically contains 36 to 42% MgO and 36 to 39% SiO_2. Olivine is a commercial source of magnesia combined with silica that is mainly used in metallurgy, fertilizer, etc. Pyroxenite is also an ultrabasic rock that consists of pyroxenes i.e., predominantly ferromagnesian minerals other than olivine. 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, Jharkhand & Nagaland and magnesite-bearing areas in Karnataka & Tamil Nadu. As per the UNFC system, total resources of dunite in the country as on 1.4.2010 are estimated at about 185 million tonnes of which 17 million tonnes constitute reserves (about 15 million tonnes proved reserves and 2 million tonnes probable reserves) and 168 million tonnes remaining resources. Dunite resources are located mainly in Tamil Nadu (63%) and Karnataka (17%). The remaining 20% resources are in Jharkhand, Odisha and Nagaland. Reserves/resources of dunite are furnished in Table-1.

The occurrences and production of pyroxenite are reported from Jajpur district in Odisha and Singhbhum (East) district in Jharkhand. However, no resource estimates are available.

EXPLORATION

During the course of chromite, gold & Platinum Group of Elements (PGE) investigations, GSI conducted preliminary exploration in 2014-15, numbers of discontinuous bands/lenses of dunite & pyroxenite-bearing basic/ultrabasic/ultramafic rocks in parts of Kerala, Maharashtra, Madhya Pradesh, Odisha, Telangana & Tamil Nadu predominantly noted. The details of exploration of dunite are elicited in Table-2.

PRODUCTION, STOCKS AND PRICES

Dunite

As per GOI notification S.O. 423(E) dated 10th February 2015, Dunite has been declared as 'Minor Mineral' hence the production beyond January, 2015 is not available with IBM.

Dunite is mainly obtained incidental to mining of magnesite. Its production at 75,050 tonnes during the year (up to January 2015) under review increased by 16 % as compared to that in the previous full year.

The production of dunite was reported from only one primary mine which was in public sector located in Chikkamagaluru district of Karnataka. In addition, production of dunite was also reported as an associated mineral from public and private sector magnesite mines located at Salem district in Tamil Nadu and nominal production reported from Karnataka. Thus, 44% production of dunite during the year was reported from public sector and 56% was reported from private sector enterprises. Ninety nine percent of the total production was reported by four principal producers operating as many mines (Tables -3 to 5).

Mine-head closing stocks of dunite for the year 2014-15 were 22,724 tonnes as against 19,110 tonnes in the previous year 2013-14 (Table- 6).

Average daily employment of labour in the sole primary mine of dunite was 9 during 2014-15 as against 6 in the preceding year.

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

Table – 3: Principal Producers of Dunite 2014-15

Name and address of producer	Location of mine	
	State	District
Dalmia Bharat Sugar and Industries Ltd, Dalmiapuram, Tiruchirapalli-621 651, Tamil Nadu.	Tamil Nadu	Salem
Tamil Nadu Magnesite Ltd* 5/53, Omalur Main Road, Jagir Ammapalayam, Salem – 636 302, Tamil Nadu.	Tamil Nadu	Salem
Steel Authority of India Ltd Ispat Bhavan, Lodhi Road, New Delhi-110 003	Karnataka	Chikkamagaluru
A.S.Shankarganesan,* 22-A,Kumar Nagar South, 3rd Street, Gandhi Nagar, Tiruppur-641 603, Tamil Nadu.	Tamil Nadu	Erode

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

Table – 1: Reserves/Resources of Dunite as on 1.4.2010
(By Grades/States)

(In '000 tonnes)

Grade/ State	Reserves			Remaining Resources								Total Resources (A+B)
	Proved STD111	Probable STD122	Total (A)	Feasibility STD211	Pre-feasibility STD221	Pre-feasibility STD222	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
All India: Total	**14894**	**2243**	**17137**	**130**	**4717**	**107597**	**24516**	**1164**	**21471**	**8637**	**168231**	**185368**
By Grades												
Grade-I	6005	1326	7331	130	-	37569	24516	780	11007	2157	76158	83489
Grade-II	5551	917	6468	-	4717	70028	-	384	5664	6480	87273	93741
Unclassified	3337	-	3337	-	-	-	-	-	4800	-	4800	8137
By States												
Jharkhand	373	570	943	130	-	140	607	780	6121	8637	16415	17358
Karnataka	3718	223	3940	-	-	-	23909	-	4149	-	28058	31998
Odisha	3337	-	3337	-	4717	5267	-	384	627	-	10995	14333
Tamil Nadu	7466	1450	8916	-	-	102190	-	-	5773	-	107963	116879
Nagaland	-	-	-	-	-	-	-	-	4800	-	4800	4800

Figures rounded off.

Table – 2 : Details of Exploration Activities for Dunite & Pyroxenite, 2014-15

Agency/ State/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
GSI							
Tamil Nadu							
Namakkal	Part of Palghat Moyar-Bhavani-Attur Lineament (MOBL) in north& Palghat - Cauvery Lineament (PCL) in South.	-	-	8	614.85	22	G-4 stage investigation for reappraisal of dunite was carried out. The dunite band (ultramafic rocks), under investigation (G4) occurs as a linear band between Ichchavari in the west and Kalingappatti in the east (say Valasiramani W/E block) over a strike length of about 20 km & average width of 60 m. In Valasiramani East block area altered/weathered dunite with magnesite vein extended as a linear body with ENE-WSW trend fromVEB to Urakkarai for a strike length of 6 km and inferred outcrop varies from 90-125 m. The depth of weathering/ depth of intersection of fresh dunite, depth persistence of dunite & sampling of fresh dunite and to assess their potentiality for industrial application, drilling was carried out in BHs VLS - 1 to 8. The analytical data of 22 nos. of core samples belonging to BH. No. VSL-1 shows, the presence of SiO_2 (33.5-41.5%; Avg 37.38%), MgO (36.62-44.26%; Avg. 40.47%), Al_2O_3 (0.30-1.26%; Avg. 0.51%), CaO (0.64-2.76%; Avg. 1.13%), Fe_2O_3(5.90-8.27%; Avg. 7.07%) and LOI (6.58-14.90%; Avg. 11.91%). Similarly, the analytical data of 16 Nos. of core sample belonging to BH. No. VLS-3 shows SiO_2 (28.70-41.50%; Avg 35.30%), MgO (28.00-47.20%; Avg 38.97%), Al_2O_3 (0.30-6.00%; Avg 1.39%), CaO (0.64-12.80%; Avg 2.43%), Fe_2O_3 (5.90-11.00%; Avg 7.58%) and LOI (6.58-19.30%; Avg 12.66%). The MgO/SiO_2 of rock types $\geq$1 indicating higher Mg content with exception to pyroxenite bands occuring within the dunite/periodotite which is marginally less than 1 (i.e. higher silica and lower MgO).

Table – 4 : Production of Dunite, 2012-13 to 2014-15
(By States)

(Qty in tonnes; Value in ₹'000)

State	2012-13		2013-14		2014-15 *(P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**88274**	**92841**	**64917**	**97848**	**75050**	**108474**
Karnataka	8750	1173	978	173	1123	164
Tamil Nadu	79524	91668	63939	97675	73927	108310

**Data up to January 2015*

Table – 5 : Production of Dunite, 2013-14 and 2014-15
(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹'000)

State/District	2013-14			2014-15* (P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**1(5)**	**64917**	**97848**	**1(6)**	**75050**	**108474**
Public Sector	1(2)	53188	89818	1(2)	32763	75273
Private Sector	(3)	11729	8030	(4)	42287	33201
Karnataka	**1(1)**	**978**	**173**	**1(1)**	**1123**	**164**
Chikkamagaluru	1	600	80	1	1000	134
Mysuru	(1)	378	93	(1)	123	30
Tamil Nadu	**(4)**	**63939**	**97675**	**(5)**	**73927**	**108310**
Erode	(2)	2374	1014	(2)	1177	425
Karur	-	-	-	(1)	10	5
Salem	(2)	61565	96661	(2)	72740	107880

Figures in parentheses indicate mines associated with magnesite.
**Data up to January 2015*

Table – 6 :Mine-head Closing Stocks of Dunite
2013-14 & 2014-15
(By States)

(In tonnes)

State	2013-14	2014-15* (P)
India	**19110**	**22724**
Karnataka	4408	4724
Tamil Nadu	14702	18000

**Data up to January 2015*

Pyroxenite

As per GOI notification S.O. 423(E) dated 10th February 2015, Pyroxenite has been declared as 'Minor Mineral' hence the production beyond January, 2015 is not available with IBM.

There was no production of Pyroxenite during 2014-15 as mines were not operating for want of environmental clearances. There was no reporting mine during the year (Tables -7 & 8).

The mine-head stocks in 2014-15 (up to January 2015) were 7,551 tonnes as against 10,094 tonnes in 2013-14 (Table -9).

There was no labour employed in Pyroxenite mines in 2014-15 as against 29 on average daily basis in the previous year.

Table – 7: Production of Pyroxenite, 2012-13 to 2014-15
(By States)

(Quantity in tonnes; Value in ₹'000)

State	2012-13		2013-14		2014-15 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India/Jharkhand	**58562**	**17980**	**2985**	**806**	**-**	**-**

Table – 8: Production of Pyroxenite, 2013-14 & 2014-15 (By Sectors/States/Districts)

(Quantity in tonnes; Value in ₹'000)

State/District	2013-14			2014-15* (P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India/Private Sector	**2**	**2985**	**806**	**-**	**-**	**-**
Jharkhand/ Singhbhum (East)	2	2985	806	-	-	-

Table – 9: Mine-head Closing Stocks of Pyroxenite, 2013-14 & 2014-15 (By States)

(In tonnes)

State	2013-14	2014-15* (P)
India	**10094**	**7551**
Jharkhand	6547	4910
Odisha	3547	2641

**Data up to January 2015*

USES

Dunite and pyroxenite are preferred as flux to dolomite as a source of MgO in sintering and also in Iron & Steel Industry. Main benefits of olivine over dolomite in slag conditioning are higher MgO content, no requirement of preheat treatment low LOI, 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.

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), 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 limestone partly and dolomite flux in the reduction of iron ore. In comparison with dolomite, olivine has 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 as much as 100°C; thus, producing harder sinter which in turn generates less fines. Olivine is added directly to the iron ore as flux during the production of pellets so that the fluxed pellets swell less, reduce more quickly and have narrower melting range. However, on the other side, high silica content in olivine restricts its use in low silica iron ores because high silica content creates excessive slag formation in the furnace.

Dunite is well-suited as a refractory material due to its low and uniform coefficient of thermal expansion. Besides, dunite exhibits properties such as, good resistance to thermal shock; spalling and slag attack; high green strength; and resistance to metal attack. Dunite, calcined in rotary kilns at 1,650°C increases its 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% 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 have been classified as Gr. I and Gr. II, respectively. However, recommendations to assign chemical specification to these grade based on the experience of Tata Steel Ltd and GSI have been incorporated which is provided 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. 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.	36-39 max.	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 2014) as specification for olivine sand and flour for use in steel foundries.

CONSUMPTION

The Iron & Steel and Refractory Industries are the main consumers of dunite. Consumption of dunite in the organised sector was at 42,800 tonnes in the year 2014-15, which increased by about 11% as compared to that in the previous year. Iron & Steel Industry was the major consumer of dunite and accounted for about 71% share in 2014-15. The remaining 29% was consumed in the Refractory Industry (Table- 10).

Table – 10: Consumption* of Dunite 2012-13 to 2014-15 (By Industries)

(In tonnes)

Industry	2012-13	2013-14 (R)	2014-15 (P)
All Industries	**38800**	**48000**	**42800**
Iron & Steel	26100(4)	35300(4)	30600(4)
Refractory	12700(6)	12700(6)	12200(6)

Figures rounded off.
Figures in parentheses denote the number of units in organised sector.
*(*Paucity of data, hence consumption may not be complete).*