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DUNITE & PYROXENITE

(FINAL RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
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17 Dunite & Pyroxenite

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.

RESERVES/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 NMI database, based on UNFC system, total reserves/resources of dunite in the country as on 1.4.2015 have been estimated at about 187.82 million tonnes of which 12.77 million tonnes constitute reserves (about 10.85 million tonnes proved reserves and 1.92 million tonnes probable reserves) and 175.05 million tonnes remaining resources. Dunite resources are located mainly in Tamil Nadu (65%) and Karnataka (17%). The remaining 18% resources are in Jharkhand (9%), Odisha (6%) and Nagaland (3%). 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 estimation is available.

EXPLORATION

During the course of G4 stage of investigation, of Dunite, GSI conducted preliminary exploration in 2015-16, numbers of linear bands of dunite & pyroxenite-bearing basic/ultrabasic/ultramafic rocks in part of Tamil Nadu predominantly noted. The details of exploration of dunite are elicited in Table-2.

Table – 3: Principle Producers of Dunite

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.*

PRODUCTION AND STOCKS

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. List of principle producers of dunite is placed in the Table-3.

Pyroxenite

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

Table – 1 : Reserves/Resources of Dunite as on 1.4.2015
(By Grades/States)

(In '000 tonnes)

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	**10848**	**18**	**1901**	**12768**	**436**	**1925**	**108887**	**25202**	**1087**	**23832**	**13680**	**175049**	**187818**
By Grades													
Grade - I	4969	-	984	5953	264	-	37910	24516	780	11464	2328	77263	83216
Grade-II	5535	-	917	6452	172	1351	70976	686	307	7268	11352	92113	98565
Unclassified	345	18	-	363	-	574	-	-	-	5100	-	5674	6037
By States													
Jharkhand	123	-	262	385	264	-	448	607	780	6121	8637	16857	17242
Karnataka	3074	18	189	3282	-	-	34	23909	-	4606	-	28549	31831
Odisha	308	-	-	308	172	1925	6215	686	307	2531	-	11837	12145
Tamil Nadu	7343	-	1450	8793	-	-	102190	-	-	5773	5044	113007	121800
Nagaland	-	-	-	-	-	-	-	-	-	4800	-	4800	4800

Figures rounded off.

Table – 2 : Details of Exploration Activities for Dunite & Pyroxenite, 2015-16

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 Cauvery Suture Zone (PCSZ), bounded by Moyar-Bhavani Attur Lineament (MOBL) in north & Palghat - Cauvery Lineament (PCL) in South.	1:5000	5	13	757.75	-	A G-4 stage investigation of dunite was taken up with an objective to delineate all the dunite bodies, to bring about their disposition and assess dunite resources.The dunite band under investigation occurs as a linear band between Ichchavari in west (Valasiramani West Block) and Kalingapatti in east (Valasiramani East Block) over a strike length of about 20 km with an average width of 60 m. The potential dunite bands were traced by drilling as segments 'A', 'B' and 'C'. 'A' starts from west of Valasiramani village & extends to south of Okkarakuttai. 'B' at Viralipatti outcrop and 'C' at Kavakarapatti area. Thirteen vertical boreholes (60 m depth) with cumulative length of 757.75 m were drilled in southern band of segments 'A' (8BH) and 'B' (5BH). Serpentinised/ altered dunite occurs between 18-23 m, followed by occurrence of fresh unaltered dunite. Analytical data of BH, VMW-1 and VMW-3 indicate that all the samples show $MgO/SiO_2 \geq 1$, which is suitable for flux in Iron & Steel industry. In BH, VIR-1, 4 bands of dunite with $MgO/SiO_2 \geq 1$ and width varying from 1-7 m are found to occur with intermittent pyroxnite bands. Based on MgO/SiO_2 ratio, it is observed that dunite band of segment 'A' is enriched with high-magnesium minerals compared to segment 'B'. The cut-off grade of dunite is determined based on specification given by IMYB (2011) for dunite & pyroxenite. The samples with more than 41.12% MgO were considered as Gr. I & samples with MgO ranging between 41.12% and 32.44% as Gr II. Resource estimation of dunite in Valasiramani west block will be carried out after receipt of complete analytical data.

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 Feb. 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 58,000 tonnes in the year 2015-16, which increased by about 52% from 38,200 tonnes during the previous year. Iron & Steel Industry was the major consumer of dunite and accounted for about 57% share in 2015-16, followed by Refractory Industry 41%. The remaining 2% was consumed in the Ferro Alloys Industries (Table- 4).

Table – 4: Consumption* of Dunite 2013-14 to 2015-16 (By Industries)

(In tonnes)

Industry	2013-14	2014-15 (R)	2015-16 (P)
All Industries	**48000**	**38200**	**58000**
Iron & Steel	35300	33500	33000
Refractory	12700	4700	23800
Ferro Alloys	-	-	1200

Figures rounded off.

**Includes actual reported consumption and/or estimates made wherever required and Paucity of data, hence consumption may not be complete).*