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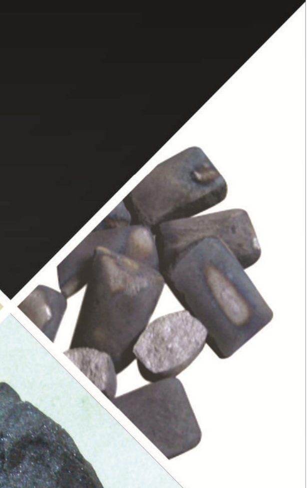




Market Survey on Manganese Ore

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Market Survey

on

MANGANESE ORE

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PREFACE

The present report on Market Survey on Manganese Ore is the 35th publication in the series of Market Survey Reports brought out by the Mineral Economics Division of the Indian Bureau of Mines. Manganese ore in the form of ferromanganese and silicomanganese is an important and indispensable input raw material in steel making. The production capacities of the manganese-based alloys has increased manifold to cater to the increased steel production capacity as well as exports. In view of this, the domestic demand of manganese ore has surpassed the indigenous production. Hence, from the raw material security point of view it was considered necessary to take up a Market Survey on Manganese Ore to analyse its domestic availability/demand (short term as well as long term), import dependence, the global scenario and the future outlook.

In this survey, domestic and export demand has been forecast. The supply position analysing, the resources and production in the country has been dealt with in detail. The demand of manganese ore by the steel industry as well as the manganese-based alloy industry is discussed in the report. An attempt has also been made to analyse the foreign markets for raw material availability to fill in the gap in domestic demand.

The co-operation extended by various Central and State Government Departments, producers, processors and consumers of manganese ore and the agencies concerned with trade who responded to our questionnaires are thankfully acknowledged. We are also thankful to MOIL Ltd, Nagpur and Indian Ferroalloys Producers' Association (IFAPA) for their co-operation in supplying valuable information and holding fruitful discussions.

It is hoped that this Market Survey Report on Manganese Ore will be helpful in the development of strategies for steel industry and manganese-based alloy industry.

Nagpur

October, 2013

C. S. Gundewar
Controller General
Indian Bureau of Mines

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Chapter 1

INTRODUCTION

MANGANESE ore is an important and indispensable input raw material for steel making and steel production and its consumption is among the key indicators of industrial development in any country. Manganese ore in the form of ferro and silicomanganese alloys are the most essential ingredients in the production of steel, both crude and stainless.

In the recent years, the manganese ore has gained importance and seen the trade volume grow world over and in India. The rise in demand may be attributed to increase in steel production capacity in many developing countries. Presently, India is the second largest importer of manganese ore in the world after China. The domestic production of manganese ore in the recent past has not been able to keep pace with the present demand due to various reasons, despite abundant resources. The shortage is met through imports.

India is endowed with adequate resources of manganese ore, but the grade of mineral produced in India is a matter of concern. The average grade of indigenously produced manganese ore has turned out to be lower and lower in the past years. To meet the industries' demand for required standard grades, the country imports high grade manganese ores for sweetening the domestic lean ores.

Production of manganese ore in the country is reported from nine states, distributed among public and private sectors. MOIL Ltd, a public sector company is the major producer of manganese ore, contributing about 46% of the total production of the country in the year 2010-11.

The domestic demand and consumption of manganese ore has increased sharply because of increased production of manganese-based alloys which are consumed indigenously and also exported. However, suitable grade availability poses a challenge to the manganese-based alloy industry. The average grade of the domestically produced manganese ore has fell to 33.43% Mn from 38.70% Mn, leading to increased imports of high grade manganese ore.

Although the production of manganese ore in the country is on decline, the production of value added products namely, ferromanganese and silicomanganese has witnessed substantial increase. The higher demand of manganese ore for this sector is met through imports. The country is now the second largest exporter of silicomanganese in the world.

With this background, Indian Bureau of Mines conducted a Market Survey Study on manganese ore. In this study, an attempt has been made to study the present and future availability of manganese ore and its demand in present and future based on the role in overall development of end-user industry as well as value added exports. The study emphasize specifically on demand for manganese ore from steel industry as well as exports.

The methodology adopted for this study basically consisted of desk survey comprising literature consultation, documentation of information from the reports/records and also collection of information from producers, processors, exporters, consumers of manganese ore and other concerned organizations through questionnaires. Besides, field surveys were undertaken to important producing and consuming centres of manganese ore in the country like Maharashtra, Madhya Pradesh, Chhattisgarh etc. for gathering first-hand information on demand-supply position.

Chapter 2

USES & SPECIFICATIONS

MANGANESE is an important raw material for the steel, ferrous and foundry industries. It is used in the battery, ceramic, chemical and welding industries in addition to its vital use and functions in steel, aluminum and other non-ferrous metals and alloys.

Manganese is named for various black minerals such as pyrolusite and psilomelane. There are many minerals that contain manganese of which perhaps a dozen are important. A list of important manganese bearing minerals with their physical properties is given at **Table: 2.1** and also shown in **Plate: 2.1.**

Table: 2.1- List of Important Manganese Bearing Minerals

Mineral	Formula	Colour	Mn(%)	Hardness	Specific Gravity
Pyrolusite	MnO_2	Steel grey to black	63.2	6-7	5
Ramsdellite	MnO_2	Dark grey to black	63	3	4.7
Polianite	MnO_2	Black to steel grey	-	6-6.5	5
Manganite	Mn_2O_3 H_2O	Black to steel grey	62	4	4.3
Cryptomelane	KMn_8O_{16}	Black to steel grey	45-60	5-6	4.3
Psilomelane	$BaMn_9O_{18}$ $2H_2O$	Black to dark grey	-	5-6	4.4-4.7
Hausmanite	$MnMn_2O_4$	Brown to black	72	4.8	4.7-5.0
Braunite	$3Mn_2O_3Mn$ SiO_3	Brown to black	50-60	6.0-6.5	4.7.-4.9
Bixbyite	$(Mn,Fe)_2O_3$	Black	30-40	6	5
Jacobsite	$MnFe_2O_4$	Black	24	6	4.8
Hollandite	$BaMn_8O_{16}$	Black to steel grey	-	6	4.5-5.0
Coronadite	$PbMn_8O_{16}$	Black to steel grey	-	5.2-5.6	4.5-5.0
Rhodochrosite	$MnCO_3$	Red-rose to brown	48	3.5-4.5	3.3-3.6
Rhodonite	$MnSiO_3$	Pink	42	5.5-6.5	3.4-3.6
Alabandite	MnS	Iron black	-	3.5-4	3.95
Wad	Variable	Dull black to brown black	-	5-6	3-4.28

Source: Manganese, the Other Uses, Stanley A. Weiss.pp-26

In addition to the minerals listed above in **Table: 2.1,** following minerals are also manganese bearing:

Minerals	Chemical Formula
Bementite	$2\ Mn\ SiO_3\ H_2O$
Kutnahorite	$(CaMn)\ (CO_3)_2$
Lithiophorite	$LiMn_3\ Al_2O_3\ 3\ H_2O$
Manganocalcite(Manganoancalcite)	$(CaMn)\ CO_3$
Manganosite	MnO
Nsutite	MnO_2
Partridgeite	Mn_2O_3
Piedmontite	$2Ca\ (Al,\ Fe,\ Mn_3)\ (OH)\ Si_3\ O_{12}$
Rancieite	$(Ca,Mn)\ Mn_4O_9\ 2\ H_2O$
Spessartite	$Mn_3\ Al_2\ Si_3O_{12}$
Tephroite	$Mn_2\ SiO_4$
Todorokite	$(Mn,\ Ba,\ Ca,\ Mg)\ Mn_3O_7\ H_2O$

Source: The Panel on Manganese Supply and Its Industrial Application, USBM.

The principal manganese minerals are braunite formed due to metamorphism and are psilomelane, pyrolusite and wad formed due to secondary epigenetic enrichment.

Factors Controlling the End Use

The Manganese ore differs from other minerals in its utilisation. Many ores are utilised to extract only one product, while the manganese ore is utilised for making products which are utilised in metallurgy as well as in non-metallurgical application. However, the requirements of manganese content, physical characteristics of ore as well as presence of deleterious constituents are primary factors which control its optimum utilisation. The presence of phosphorus in higher quantities makes manganese ore unsuitable for ferromanganese, while high phosphorus and high iron content makes it unsuitable for battery industry. High silica restricts its use in blast furnace or in EAF for the simple reason that presence of silica increases the slag volume, thus increasing the power consumption. Therefore, it is necessary to consider the chemical and physical characteristics of an ore before its ultimate utilisation by end use industry.

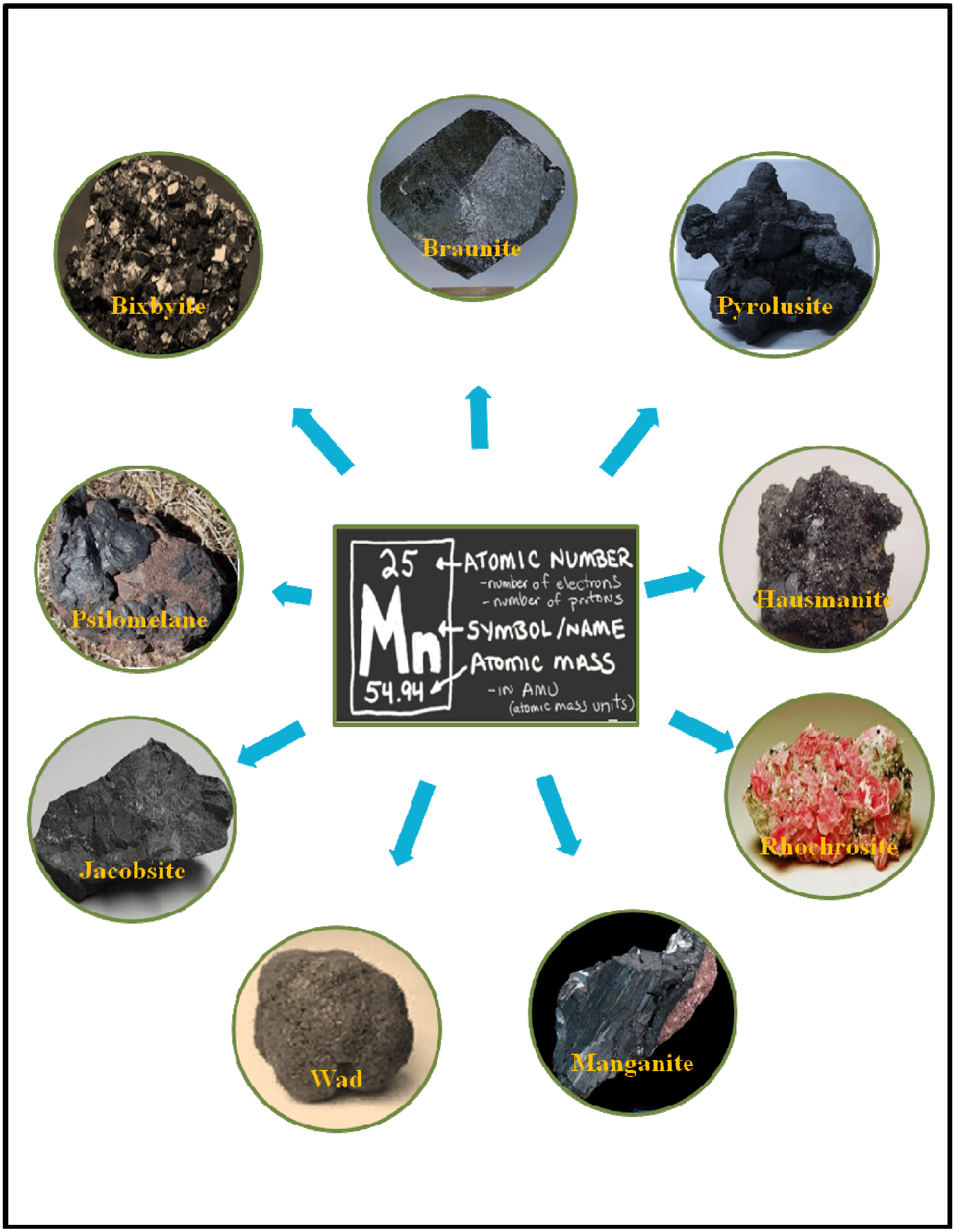
Metallurgical Industry: Desirable characteristics

The best ores (or blends) for manganese alloy production should have manganese to iron ratio of 7.5 to 1, be easily reducible, minimize energy consumption, be low in contaminants, have good physical structure and produce manageable amounts of slag.

The higher purity ores available in the world today have $SiO_2 + Al_2O_3$ contents ranging from 4.5% to 11%, requiring the electric furnace to consume energy and reducing agent in the smelting of these slag producing compounds. To recover the investment in power and reducing agent, many

Plate: 2.1

Important Manganese Bearing Minerals



producers employ a "slag-recycle" operating practice to produce a slag containing +30% Mn for subsequent use in the production of silicomanganese. By this method, 95% or more of the manganese content in the ore may be converted to useable product.

Using this slag-recycle practice, the original ore blend must contain higher manganese to iron ratio of not less than 8.5 to 1 for 80% standard ferromanganese and 6 to 1 for 75% standard ferromanganese. Generally, the high and medium grade ores are used in alloy production. The lower grade ores with less than 35% manganese plus about 20% iron content are used in blast furnace additions to manage the hot metal. However, some high grade metallurgical grade ore is also used in blast furnace additions.

Blending of Ores for Alloy Production

Because of the complex factors involved, the non-integrated manganese alloy producers consider blending of ores a preferred policy and it is almost the universal policy. This means that not a single ore, however good, would be used exclusively as the alloy producer will obtain some commercial benefit by using lower cost off-grade ores as well. Generally, a minimum average of 37% manganese in the blend is tolerated.

On the other hand, many ferromanganese producers having its own manganese ore and a ferroalloy industry (integrated producers) have a tendency to make the use of its own ores, even if they are of different quality.

It is evident that ores which give the best furnace performance will be used preferentially. These are generally the high grade ores, but they will be blended to some degree for technical and economic reasons. In other words, the various manganese ores are complementary rather than substitute for each other. Thus, the amount of certain less than ideal ores that are used is conditioned by the availability of the more suitable grade material with which to blend them. However, regardless of abundance, some ores will be used only in certain manageable proportions unless current practice changes.

Battery Industry

Satisfactory performance of battery is usually the determining factor for use of battery grade manganese ore. And therefore, chemical composition can vary over wide limits. However, the battery grade manganese dioxide from Moanda, Gabon, which dominates the market contains 83.64% MnO_2. Battery grade manganese ore is also reported from Ghana (78% MnO_2), Mexico (76% MnO_2) and Greece (67% and 74-75% MnO_2).

Several factors control the suitability of manganese ore for dry-cell manufacture. Chemically, the ore should have high oxygen availability for the cell hydrogen reaction, a minimum of iron and should be free of copper, nickel, cobalt, arsenic and other metals and should be electronegative to zinc. Physically, the ore should be somewhat hard but porous. Since it is believed that the depolarizing action in the cell is a surface reaction (i.e. starts at the surface but diffuses throughout the particle), the porous ore is able to react throughout its mass besides the outer surface. MnO_2 with higher water content is more suitable as a depolarizer. It is thought that water in any form plays an important role during the discharge of MnO_2; that it helps proton migration and that the reaction can proceed more readily through the built in water.

Chemical Industry

The manganese ore that is used in chemical applications should be high in its oxygen content as it is considered to be suitable for use in the production of manganese compounds and chemicals, in agriculture, in welding, in ceramics and a wide range of other industries. Suitable ores are used to produce chemicals such as hydroquinone, potassium permanganate and other permanganates.

There are a few manganese deposits that produce ore specifically for their oxygen content. The Imini mine in Morocco sells its products on the basis of manganese dioxide, the Transvaal deposits of South Africa are mined exclusively for the manganese ore to provide manganese dioxide for domestic uranium oxide production. But, manganese ore classified as 'metallurgical ore' are also used in non-metallurgical applications.

Specifications

The Bureau of Indian Standards (BIS) has classified the manganese ores as per IS: 11895 (reaffirmed in 2006) depending on Mn, Fe, SiO_2 and MnO_2 contents of the ores. (**Table: 2.2.**)

Table: 2.2- Classification of Manganese Ore (IS: 11895-2006)

Sl No.	Type	Constituents (%)				
		Mn	Fe	SiO_2	MnO_2	Fe+Mn
1.	Manganese ore	35 & above	-	-	-	-
2.	Ferruginous manganese ore	Below 35 and upto 25	Below 23 and upto 13	-	-	48(min)
3.	Siliceous manganese ore	Below 30 and upto 25	-	15 (min)	-	-
4.	Manganiferous iron ore	Below 25 and upto 10	Below 48 and upto 30	-	-	55(min)
5.	Manganese ore (Chemical grade)	-	5(max)	-	Above 78	-

Source: Bureau of Indian Standards, (BIS)

The end use grade classification as recommended by the Expert Group constituted by Indian Bureau of Mines in September 2000 in its reports on Classification of Minerals with Regard to its Possible Optimum Industrial Use is given in table below. A detailed description of grades adopted in the estimation of resources is given in **Chapter-4 "Supply"**.

Table: 2.3 - End Use Grade Classification of Manganese Ore (Expert Group Recommendation)

Sl No.	Grade of Ore	Chemical Composition	Specifications
1.	Battery/Chemical	MnO_2 by mass (dry basis)	72% (Min)
		Cu, Pb, Cr and Ni	Trace
2.	Ferromanganese Grade	Mn	38% (Min)
		Mn: Fe Ratio	2.5:1 (Min)
		P	7:1(Max)
3.	Blast Furnace Grade	Mn	25 to (-)35%
		P	0.2% (Max)
		Al_2O_3	7.5% (Max)
		SiO_2	13% (Max)
4.	Medium Grade	Mn	35 to 37%

Uses

As discussed above, manganese ore is used in both metallurgical and non-metallurgical purposes. A flow chart of application of manganese ore in various industries/products is given in **Figure: 2.1** and **Plate: 2.2** and the standard specifications prescribed by Bureau of Indian Standards (BIS) for use in different industries are given in **Annexure: 2.I**.

(A) Metallurgical

Presently, the most important use (95%) of manganese ore is metallurgical, primarily as ferromanganese and silicomanganese, and alloy related industries. The remaining five per cent is used by the non-alloying industries, which include chemical, paint, fertilizer, and battery industries, and in the production of manganese metal. According to the International Manganese Institute (IMnI), in steelmaking, 70% of manganese ore is used as an alloying element, while the remaining 30% is employed for "its properties as a sulphide former and deoxidant."

Manganese ore is an useful and essential constituent of steel. Since no quality steel can be produced without a small amount of manganese, manganese is aptly called 'Achilles heel' of the steel industry. Manganese metal is used in the production of low cost stainless steel required for dairy and food processing industry. Pure manganese has been found to be useful as an additive, particularly in the manufacture of special high quality steel, where a high degree of purity is necessary. The manganese ore has its multiple functions as it combines with metallurgical constituents and removes the residual sulphur and act as a mild deoxidizer to control the morphology of sulphides and as an alloying agent to increase strength, toughness and hardness of the steel. The manganese content varies depending on the desired properties of finished product. Manganese ore is also used in the production of certain alloys of copper, aluminum, nickel, titanium, magnesium and zinc. It is also used in miniscule quantities for electronic applications along with either bismuth or gold or silver.

Plate:2.2

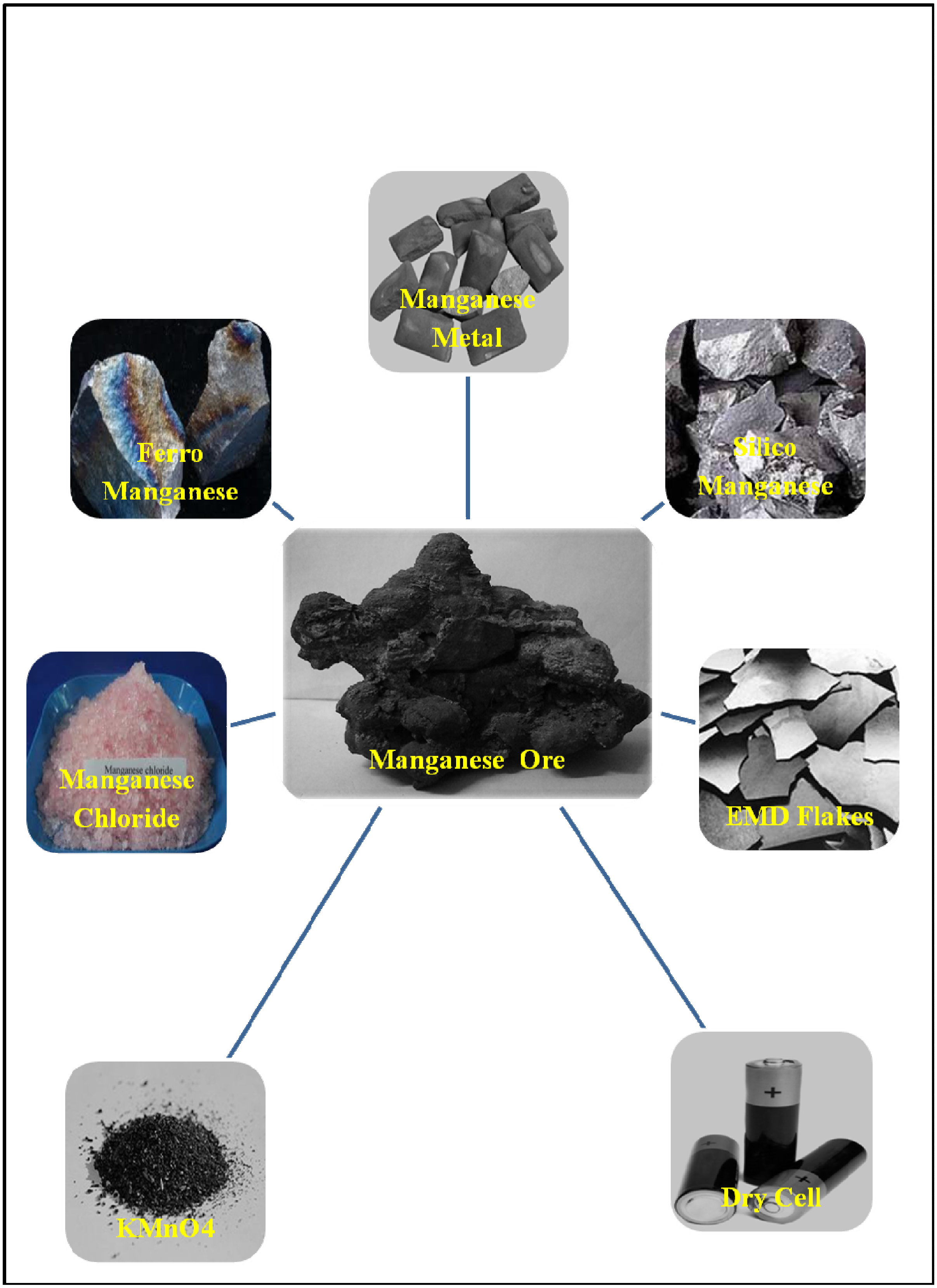
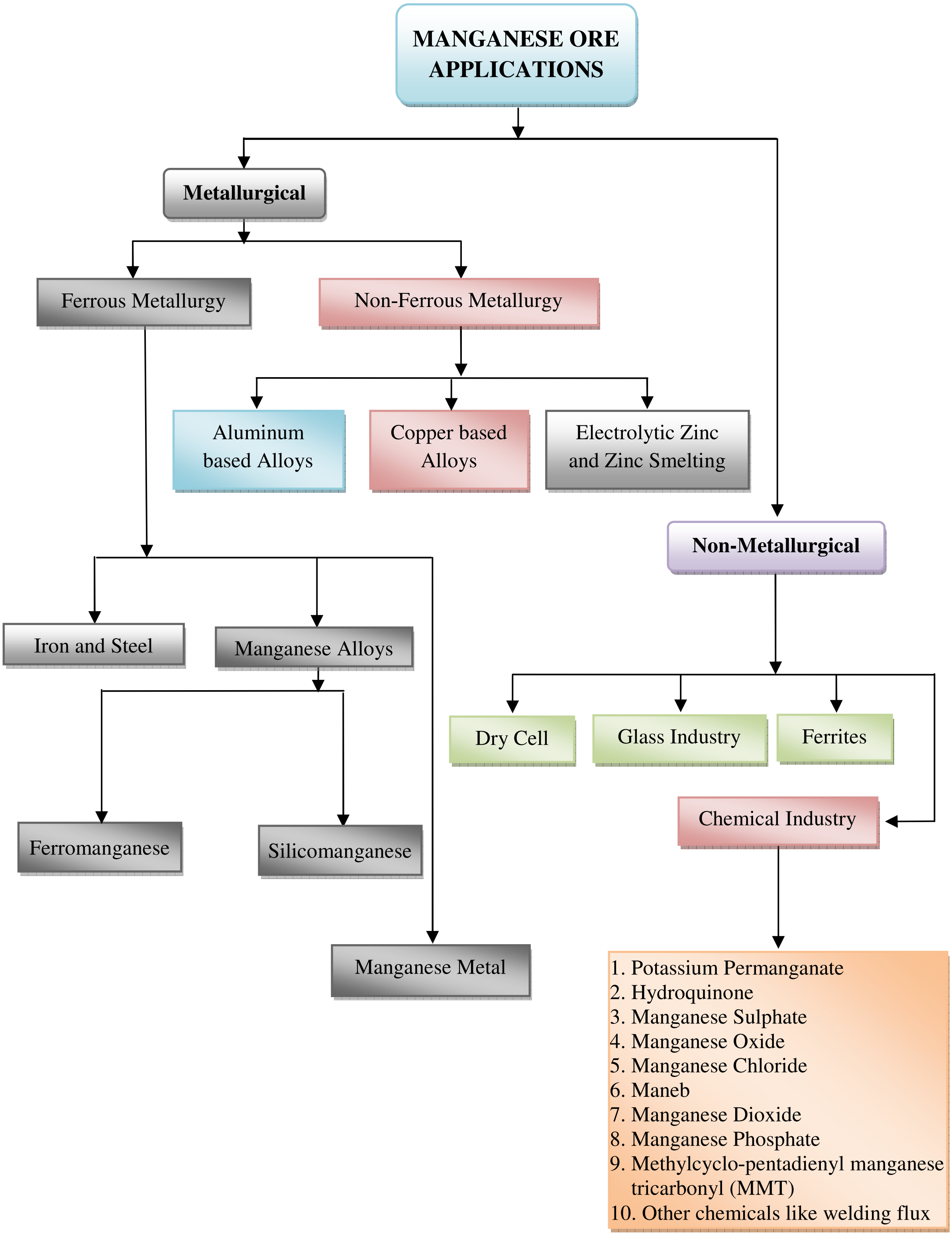

Manganese
Metal
Ferro
Manganese
Silico
Manganese
Manganese Chloride
Manganese chloride
Manganese Ore
EMD Flakes
KMnO4
Dry Cell

Figure: 2.1


MANGANESE ORE APPLICATIONS
Metallurgical
Ferrous Metallurgy
Non-Ferrous Metallurgy
Aluminum based Alloys
Copper based Alloys
Electrolytic Zinc and Zinc Smelting
Non-Metallurgical
Iron and Steel
Manganese Alloys
Dry Cell
Glass Industry
Ferrites
Ferromanganese
Silicomanganese
Chemical Industry
Manganese Metal
1. Potassium Permanganate
2. Hydroquinone
3. Manganese Sulphate
4. Manganese Oxide
5. Manganese Chloride
6. Maneb
7. Manganese Dioxide
8. Manganese Phosphate
9. Methylcyclo-pentadienyl manganese tricarbonyl (MMT)
10. Other chemicals like welding flux

Manganese ore is added to non-ferrous metals to improve properties such as hot and cold strengths, resistance to corrosion and formability.

1) Ferrous Metallurgy

(a) Iron & Steel

Manganese ore is essential for production of all types of steel and cast iron. In addition to its general desulphurising, deoxidizing and conditioning effects, it imparts the qualities of strength, toughness, stiffness, wear resistance and hardness that make steel such a useful engineering material. In cast iron production, manganese ore is principally used to counteract the deleterious effect of sulphur and as an alloying element in order to impart certain qualities to the finished steel. When there is insufficient manganese, the sulphur combines with iron to form a ferrous sulphide, which create the path of weakness and it melts at hot rolling temperature, causing a surface cracking phenomenon known as "hot shortness".

The presence of phosphorous, even in minute quantities also plays a significant role in the initiation of fractures. Thirty per cent of the manganese is used for its properties as a sulphide former and deoxidant. Low grade manganese ore analyzing 25 to 30% Mn content is directly used in the blast furnace for the desired quality of hot metal. It is added to the charge of the furnace to prevent re-oxidation of the pig iron. The specifications of the manganese ore for steel melting shop (SMS) grade are more or less similar to that of the BF grade except for phosphorous content which is specified up to a limit of 0.18% for SMS use. The specifications (IS: 11281-2005) prescribed by BIS for manganese ore for the production of iron & steel is given in **Table: 2.4**.

Table: 2.4 - Specifications of Manganese Ore for Production of Iron & Steel (IS: 11281-2005)

Chemical Requirements

Constituents	Steel Melting Grade Ore (SMS)	Blast Furnace Grade Ore (BF)
Mn	25 % (min)	25% (min)
Al_2O_3	8% (max)	These elements are not of consequence for iron making, hence not specified
SiO_2	8% (max)	
Fe_2O_3	18 to 24%	-
P	0.18 % (max)	0.35 %(max)

Physical Requirements

The physical requirements stipulate that the ore shall be lumpy, hard, dense and no friable material with the size range as given below:

SMS grade ore	BF grade ore
10 to 40 mm	25 to 85 mm

- 10 mm: 10% (max) -10 mm: 10% (max)

+ 40 mm: 10% (max) + 85 mm: 10% (max)

The steel plants generally consume manganese ore with 25 to 30% Mn, 5.0 to 15% SiO_2, 5 to 8% Al_2O_3, 14 to 26% Fe and 0.074 to 0.34% P. As per IS specifications, manganese ore for use in blast furnace should contain a minimum of 25% Mn and a maximum of 0.35% P which fairly conform to the user industry specifications. So far as the constituents like Al_2O_3, SiO_2 and Fe_2O_3 are concerned, they are of no consequence for blast furnace and hence not specified by BIS. The details like physical properties and chemical constituents of manganese ore consumed by different steel plants are given in **Annexure- 2.II**.

b) Manganese Alloys

The important ferroalloys of manganese are, i) Ferromanganese, ii) Silicomanganese and iii) Spiegeleisen.

i) Ferromanganese (FeMn)

Ferromanganese is the most important manganese alloy produced and used in large quantities. Three types of product namely high carbon ferromanganese, medium carbon ferromanganese and low carbon ferromanganese are produced.

High carbon ferromanganese is also called the 'standard grade' ferromanganese, commonly used for adding manganese to steel as a deoxidising agent and alloying agent and for cleansing purposes. Medium carbon ferromanganese is used for making low carbon steels and high manganese steels. Low carbon ferromanganese is used in the manufacture of chrome-nickel steel in which the carbon content must be kept below 0.10%. The low carbon ferromanganese is particularly used for adding manganese to very low carbon steels where high carbon is not suitable. However, demand for high carbon ferromanganese is more.

High carbon ferromanganese (HC Fe-Mn with 65 to 80% Mn and 6 to 8% C) is produced in submerged electric arc furnaces either by fluxed or fluxless process. The medium carbon (MC Fe-Mn with 74-80% Mn and 1 to 3% C) and low carbon (LC Fe-Mn with 80 to 90% Mn and 0.07 to 0.75% C) ferromanganese requirements are met by refining the high carbon ferromanganese by reducing the carbon content. A small amount of ferromanganese called extra low carbon ferromanganese practically free of carbon is produced by alumino-thermic process.

The most important problem in manganese ore for ferromanganese production is the high phosphorous content which poses a serious problem in the metallurgy. Manganese improves the quality of steel and acts as a deoxidizer. The factors considered important for manganese ore for use in the production of ferromanganese are Mn/Fe ratio, Mn content, P content and contents of slag forming constituents like SiO_2 and Al_2O_3. Since 75 to 80% of manganese present in the ore is recovered in the form of ferromanganese, the furnace burden should have a high Fe/Mn ratio and high manganese content. Phosphorous in the ore should be as low as possible; otherwise it would cause "cold hardness" in steel. Similarly, slag forming constituents like SiO_2 and Al_2O_3 should also be within the limits to save the power consumption and to increase the furnace efficiency. Specifications

(IS: 4763-2006) for manganese ore prescribed by BIS for use in the manufacture of ferromanganese are given in **Table: 2.5**.

Table: 2.5 - Specifications of Manganese Ore for the Production of Ferromanganese (IS: 4763-2006)

Grade	Constituents (%)				
Mn%	Fe (max)	SiO_2 (max)	Al_2O_3 (max)	$SiO_2+Al_2O_3$ (max)	Mn/FeRatio (min)
1. 48 and over	7	7.5	2	8	7
2. Below 48 upto 46	8	9	3	10	6
3. Below 46 upto 44	10	10	3.5	10	4.5
4. Below 44 upto 42	11	11	4	12	3.5
5. Below 42 upto 40	13	12	5	13	3
6. Below 40 upto 38	15	13	6	15	2.5

The phosphorus content for each grade as mentioned above shall fall within one of the following groups:

Grade	Percent
Low	Less than 0.8 % P
Medium	0.08 to 0.15% P
High	More than 0.15% P

The various specifications for production of different grades of ferromanganese are published by Bureau of Indian Standards (BIS). The material shall be supplied in the form of properly cleaned lumps reasonably free from any slag and non-metallic residues. The material shall be supplied in the sizes between 50 and 150 mm with the percentage of fines limited to 10 per cent, out of which -3 mm size is limited to 3% only. The analysis of ferromanganese produced by different plants is given in **Annexure: 2.III**.

The ferromanganese industry requires manganese ore with somewhat stringent specifications demanding higher Mn content, Mn/Fe ratio and lower silica, alumina and phosphorous contents. In actual practice, manganese ore with as low as 36% Mn is also used in suitable blend with high grade manganese ore of 44 to 48% Mn. Manganese Ores consumed generally contain 5 to 18.5% SiO_2, 5.67 to 18% Fe and 0.03 to 0.25% P, which are slightly on the higher side than that prescribed by the BIS. The physical properties and chemical specifications of manganese ore consumed by Ferro manganese producing plants is given in **Annexure: 2.IV.** Earlier, the high grade ores containing <48% Mn with 7:1 Mn/Fe ratio were used. Due to depletion of the reserves of high grade ores, now the industry has started using medium grade ores containing as low as 36 to 38% Mn after blending with high grade ores.

ii) Silicomanganese (Si-Mn)

Silicomanganese is used as a more effective deoxidizing agent than high carbon ferromanganese in the production of various types of steels. It is also used as feed stock to produce refined alloys like medium and low carbon ferromanganese. There is an increase in usage of silicomanganese in the steel making. Silicomanganese is preferred in many of the mini steel mills because it contains the right proportion of manganese and silicon and low carbon. As per the BIS specifications (IS: 1470-1990) the silicomanganese contains 14-28% Si, 50-74% Mn and 1to 2.5% C. The presence of silicon has the added advantage of producing cleaner steel and also has the property of reducing the time required from the stage of alloy addition to the pouring of ingot. Besides, it gives better mechanical properties due to change in morphology of deoxidation products in regular round shape, and consequently the non-metallic inclusions are brought down in finished products.

For the manufacture of silicomanganese, the grade of manganese ore should be much of the same as for the manufacture of ferromanganese, but lower percentage of manganese as low as 35% are permissible with higher silica content. There are no BIS specifications for use of manganese ore in the production of silicomanganese. However, specifications prescribed by BIS for the manufacture of silicomanganese are available. The BIS has specified six grades of silico manganese. The requirements for various grades of silicomanganese commonly used in iron & steel industry as per IS: 1470-1990 of BIS are given in **Table: 2.6**.

Table: 2.6 - Chemical Composition of Silicomanganese (IS: 1470-1990)

Sl No.	Grade	Constituents (%)						
		Mn	Si	C (Max)	P (Max)	S (Max)	As (Max)	Ni, Cr, Mo (Max)
i)	Si 18 Mn 72	70 to 74	16 to 20	1.5	0.20	0.03	0.01	-
ii)	Si 23 Mn 68	65 to 70	20 to 25	1.5	0.30	0.05	0.01	-
iii)	Si 18 Mn 68	65 to 70	16 to 20	2.0	0.30	0.02	0.01	-
iv)	Si 19 Mn 63	60 to 65	17 to 20	2.0	0.30	0.03	0.01	0.75
v)	Si 16 Mn 63	60 to 65	14 to 17	2.5	0.30	0.03	0.01	-
vi)	Si 26 Mn 53	50 to 55	24 to 28	1.5	0.30	0.03	0.01	-

iii) Manganese Metal

Manganese metal is also produced from manganese ore. Manganese metal produced from electrolytic process is called Electrolytic Manganese Metal (EMM). It is expensive. Its relatively high price limits the use of the metal mainly to production of some stainless steel, aluminium and copper alloys. The trend in the aluminium industry has been towards a briquette containing about 75% manganese and 25% aluminium made from manganese and aluminium powder. The introduction of the electrolytic manganese of 99.98% purity completely free from impurities like phosphorous, carbon, etc. has opened up scope for the production of new series of stainless steel. It is established that nickel in stainless steel of 18/8 type can be replaced by manganese metal without affecting the rustproof properties. Manganese metal is one of the most important alloying element and a deoxidizer in ferrous and non-ferrous alloys, to obtain improved physical properties. It is also extensively used in welding industry.

Although India possesses the basic technology for production of EMM, developed at NML in the early fifties, there is still no production of EMM in the country. Its use, therefore, has been limited to non-ferrous metallurgical applications for which the entire requirement is met by imports. High grade ores are commercially preferred for the production of manganese metal. There are no BIS specifications for manganese ore for the production of manganese metal. However, the BIS have prescribed the requirement for four grades of electrolytic manganese metal commonly used in the ferrous and non-ferrous metal industry, which are given in **Table: 2.7.**

Table: 2.7 - Chemical Composition of Electrolytic ManganeseMetal (EMM) (IS: 2021-1993)

Grade	Constituents (%)									
	Mn (min)	Si (max)	Fe (max)	C (max)	S (max)	P (max)	Al (max)	Heavy metals	Hydro-gen (max)	Nitro-gen (max)
M Mn 95	95	1.0	2.5	0.2	0.005	0.1	-	-	-	-
MMn 95/C	95	1.0	2.0	0.06	0.05	0.1	0.5	-	-	-
M Mn 99	99.9	0.01	0.001	0.006	0.03	Traces	-	0.005	0.015	-
M Mn 95N	94 to96	0.01	0.001	0.006	0.03	Traces	-	0.005	0.015	4 to 6

2) Non-ferrous Metallurgy

Manganese is used in non-ferrous metallurgical industry to improve some of the properties such as strength, hardness, stiffness and corrosion resistance to aluminium and magnesium.

a) Aluminium Based Alloys

Manganese in aluminium generally improves corrosion resistance. Aluminium alloy containing 1% or more manganese are widely used in beverage cans and in food handling equipment and corrugated roof sheets, bus bodies, colliery cage, paneling, car radiator, etc. They are easy to shape and stiffer than pure aluminium.

b) Copper Based Alloys

The copper based alloys are strengthened by small additions of manganese. 'Manganese Bronzes' are used to deoxidise the alloy and improve its castability, workability and mechanical strength for marine propellers and fittings gears and bearings. Manganese is also used in copper alloys as a deoxidiser. Nickel manganese alloys are used for certain special application, e.g. sparking plug points. 'Manganin' an alloy containing 80 parts copper, 18 parts manganese and 1.5 to 2 parts nickel is widely used in heating coils and electrical furnaces because of its extremely high electrical resistance. In order to reduce cost, manganese can replace part of the nickel in nickel-silver alloys.

Higher level of manganese content is found in some alloys for specific applications. These are produced in small quantities for specific properties such as damping capacity in high thermal expansion coefficient. One such alloy, with 72% Mn, 18% Cu, 10% Ni is used for bimetallic strips in temperature control devices fitted to cars and other vehicles. Another alloy, sold under the commercial name "Manifor" is a non-magnetic high-strength alloy (60% Cu, 20% Mn, 20% Ni), is used to manufacture small parts for the watch making industry.

c) Electrolytic Zinc and Zinc Smelting

Manganese is used in two stages in electrolytic zinc process. Prior to electrolysis, zinc sulphate solution must be purified to remove undesirable elements, especially iron. The ferrous sulphate present in the electrolyte is transformed into ferric sulphate. Oxidation of ferrous to ferric iron is obtained in some methods by use of manganese dioxide. In the electrolytic stage, manganese dioxide limits corrosion of the lead anodes; increases current efficiency and coats the aluminium cathodes to facilitate stripping of the zinc deposit. Manganese or manganiferous ores may be used as a flux in the smelting of base metal ores.

d) Other Metals

Manganese is also an alloying element addition to other metal such as zinc alloys with 0.1 to 0.2% Mn content. Manganese can also be added to gold, silver, bismuth etc., to give strength to alloys which are used for very specific applications, generally related to the electronic industry.

B) Non-Metallurgical

The use of manganese for non-metallurgical purpose is significant though the quantity of ore used for this purpose is comparatively less. The industries which consume manganese ore are i) Dry Cell Battery ii) Chemicals iii) Glass iv) Ferrites v) Ceramics etc. Details of industry-wise uses are discussed below:

i) Dry Cell

The high grade manganese dioxide (Pyrolusite) is used in the manufacturing of dry cell. It acts as an oxidizing agent or a depolarizer of hydrogen which collects as a non-conducting film on electrodes, thus facilitating continuous flow of current within the cell. In other words, it acts as a scavenger to remove products from the electrolytic solution which would otherwise inhibit or stop electrical flow. The role of the manganese dioxide is to oxidize the hydrogen and form water. The rate at which this occurs depends on the reactivity of the dioxide. According to current concept, MnO_2 participates directly in the electro-chemical reactions of the cell. The cell basically consists of a cathodic mix (negative pole), a paste comprising ground MnO_2, finely divided graphite or acetylene black, ammonium chloride and zinc chloride packed into a zinc can (anode positive pole). A carbon rod which is made of mixture of acetylene carbon black runs through the Centre of cathodic mix to make electric contact.

Although pyrolusite variety of manganese ore is used for making of cells, synthetic products like electrolytic manganese dioxide (EMD) or chemically active manganese dioxide (CMD) or a blend of natural and synthetic can be used as depolarizer in the manufacture of dry cell batteries. Both natural manganese ore and synthetic products should have a high content of manganese dioxide and a small amount of iron and should be free from copper, nickel, cobalt, arsenic, chromium, lead, etc. which are electro-negative to zinc. Physically, the ore should be well crystallised in fine crystals and offer a large surface with gamma structure, which is ideally suitable for dry battery manufacture. The BIS specifications of manganese ore for dry battery manufacture are given in **Table: 2.8** below.

Table: 2.8 -Specifications of Manganese Ore for Dry Cell Batteries (IS: 11153-1996)

Sl.No.	Characteristic	Requirements (%)		
		Natural Ore	Chemically activated MnO_2	Electrolytic MnO_2
1.	MnO_2(On dry basis)	72	85	90
2.	Moisture	3	3	3
3.	Pb(max)	0.1	traces	0.1
4.	Fe (max)	7.0	-	0.1
5.	SO_4 (max)	-	1.5	1.5
6.	Matter insoluble in hydrochloric acid on ignition (max)	10	0.5	0.5
7.	Cu (max)	0.2	-	0.002
8.	Ni (max)	0.04	0.003	0.003
9.	pH of 5% water extract	-	4.5	6.5
10.	Crystal structures	-	-	Gamma variety

The BIS (IS: 11153-1996) has prescribed 72% MnO_2 for natural ore, 85% MnO_2 for chemically activated manganese dioxide and 90% MnO_2 for electrolytic manganese dioxide with small amount of iron and should be free from copper, nickel, cobalt, arsenic, chromium, lead, etc. In practice, the battery industry consumes manganese ore with 70 to 90% MnO_2 and low Fe (2.5 to 4%). The indigenous manganese ore lack gamma structure which is essential for dry battery manufacture. The present trend in the country is to use more of electrolytic manganese dioxide (EMD) because it contains higher MnO_2 content and required gamma structure.

ii) Chemicals

In the chemical industry, the manganese dioxide ore or high grade pyrolusite is used to produce the following types of chemicals viz. potassium permanganate, hydroquinone, manganese sulphate, manganese oxide, manganese chloride, maneb, manganese dioxide, manganese phosphate, MMT, etc. The uses of these chemicals are discussed below:

a) Potassium Permanganate

It is used as a powerful oxidizing agent with bactericidal and algicidal properties, which enable it to be used in purifying drinking water and treating waste water. It also used in chemical manufacturing and purifying processes, pollution control, treatment of municipal water, odour control in sugar refineries, volumetric analysis, etc.

b) Hydroquinone

It is mostly used to produce photographic developers, colouring agents and medicines. It is also used as a stabilizer in plastic monomers for the preparation of rubber chemicals, and coating compound for rubber, stone and textiles. Other stabilization application is in paints and varnishes, in prolonging the life of paraffin wax baths and oils to prevent and remove discoloration. It is also well known as a powerful antioxidant for non-edible fats and oils.

c) Manganese Sulphate

It can be produced either directly or as a by-product. A major portion of manganese sulphate is produced as a by-product in the manufacture of hydroquinone. Manganese is essential in the formation of chlorophyll in plants. Crops deficient in manganese show a lack of greenness and exhibit stunted growth. Manganese sulphate is soluble in water and can be applied conveniently by spraying the land with its solution. It is also used as an animal feed stuff.

d) Manganous Oxide

This chemical is used in agriculture, fertilizer, animal and poultry feed, etc.

e) Manganese Chloride

It is mainly used in the form of flux in magnesium metallurgy. It is used in cotton textiles as a bronze dye and also for giving brown to black surface to bricks. It is also used as a catalyst for chlorination of organic matter, purifier of gas for fluorescent light, decolouration of glass, fertilizer component, drier for chrome pigments as well as raw material for the manufacture of pharmaceutical products such as liquid for mouthwash, insecticides, etc.

f) Maneb (manganese-ethylene bisdithiocarbamate)

It is an organo-chemical compound sold in the form of a yellow powder. It is sold under different trade names as an agricultural fungicide and is widely used for controlling crop and cereal diseases, downy mildew in grape vines, scab in fruit trees, banana and peanut diseases among others.

g) Manganese Dioxide

It is used as a catalyst in the production of artificial flavours like vanilla. It is also used as an oxidizing agent in treating uranium ore to produce the oxide-concentrate known as "yellow cake". Other applications include the colouring of bricks and tiles, driers and as a pigment for paints, etc. Manganese sulphate is widely used as an end product in fertilizers and animal feed, and as an intermediate product in the chemical industry.

h) Manganese Phosphate

It is used to produce surface films which when sealed with oil or wax can protect steels for internal or mild outdoor use. Manganese phosphate improves wear resistance, prevents welding of metals under load, increases lubrication efficiency by oil absorption and assures rapid and safe running-in of moving parts.

i) MMT (Methylcyclo-pentadienyl Manganese Tricarbonyl)

It is an organic manganese compound used on a small scale as an octane booster or anti-knock agent in gasoline. MMT can dramatically improve oil combustion, reducing boiler clogging and soot levels. This application is important from an environmental point of view as it allows lead to be replaced, but it has not yet been fully developed.

j) Other Chemicals

Other manganese chemicals and manganese ores are used in the manufacture of welding rod coatings and fluxes, electrode coating formulations, driers for paint & varnishes, dyes, fungicides and pharmaceuticals and also for leaching of uranium ores.

In the case of manganese ore suitable for use in chemical industries as an oxidizing agent, the manganese content is not much important as the percentage of available oxygen. Pyrolusite, psilomelane and other manganese ores are used to manufacture several chemicals like sulphate, nitrate manganate, permanganate by digestion with acids and other chemicals. For chemical industry, the manganese ore should have MnO_2 75% (min.), Fe 1.5 % (max.), Silica 6% (max.) and copper 0.02% (max.). The size of the ore should be 150 mesh.

There is no BIS specification for manganese ore required for chemical industry. Manganese ore with more than 78 to 90% MnO_2, below 5% SiO_2, and less than 5% Fe_2O_3 is generally used in the chemical industry. In practice, the chemical industry in the country accepts manganese ore even up to 5% silica and 5% Fe_2O_3.

iii) Glass

In glass industry, high grade pyrolusite is used as a decolouriser when iron is present in the glass sand. Replacement by alternative such as selenium and zinc cyanate which are much easier to handle has diminished the manganese market. Manganese is largely used for making cheap ornamental glass. MnO_2 is used in some speciality glasses to produce dielectric properties and coefficient of thermal expansion. Manganese ore is used in the glass to decolourise the greenish tint of glass. Addition of manganese ore in the glass batch should be proportionate to the amount of iron present. For this purpose high grade manganese ore containing more than 85% MnO_2 with not more than 10% iron is used. Some special glasses require 90% MnO_2 and 0.5% Fe.

iv) Ferrites

Ferrites are ferromagnetic ceramic materials made of metal oxides using highly refined methods of ceramic technology. There are no economic substitutes for manganese in ferrites. Commercially, manganese zinc ferrite is an important soft ferrite used mainly for making transformers and inductors.

v) Ceramics

Finely ground pyrolusite is used in the ceramic industry to impart a red, brown, purple or black colour to bodies and glazes and granulated MnO_2 is often used to achieve a speckled effect. In general, it is used in enamels because of its oxidizing properties. During smelting, it breaks down to MnO and oxygen and the oxygen then helps to fuse the enamel and oxidise some of the other ingredients.

Chapter 3

INTERNAL DEMAND

MANGANESE ore is consumed in both metallurgical and non-metallurgical industries. The steel industry is the single largest consumer of manganese ore in the form of ferromanganese and silicomanganese. Therefore, the steel industry is the driving factor for the manganese ore industry. The steel production capacity in the country has increased from 47.91 million tonnes in 2000-01 to 88.40 million tonnes in 2011-12. According to a World Steel Association report, the apparent per capita use of crude steel in India has increased from 22.8 kg in 2001 to 62.0 kg in 2011, as against the world average of 234.2 kg in 2011.

Manganese-based alloys are the important additives in the manufacture of steel for desulphurisation and imparting strength to the steel. There are three types of manganese-based alloys namely, high carbon, medium carbon and low carbon alloys, depending upon the content of carbon and manganese. Steel industry is the major consumer of manganese-based alloys. Small quantities are also consumed in alloy steel, foundry and electrode industries.

In India, production of manganese-based alloys was started in the beginning of late 1950s. These alloys are produced through the route of Blast furnace and Electric Submerged Arc Furnace (EAF). Presently, only EAF route is used to produce ferromanganese. The capacity of manganese-based alloy industry has increased from 700,000 tonnes in 2000-01 to 2,750,000 tonnes in 2010-11 and 2011-12; the total annual capacity of the manganese-based alloys in the country has reached to 3.16 million tonnes. The capacity utilisation of the industry is around 61 per cent. The increase in capacity can be attributed to the increase in steel production capacity as well as export markets. The production of manganese-based alloys is a power intensive industry, hence, its growth depends upon the availability of cheap and uninterrupted power supply. The industries have geared up to the challenge and rely on captive power plants.

In this chapter, the present and future domestic demand for manganese ore is discussed.

Present Demand

Manganese ore is consumed in various industries like ferroalloys (ferromanganese and silicomanganese), iron and steel, battery, lead and zinc metallurgy, chemical and other industries.

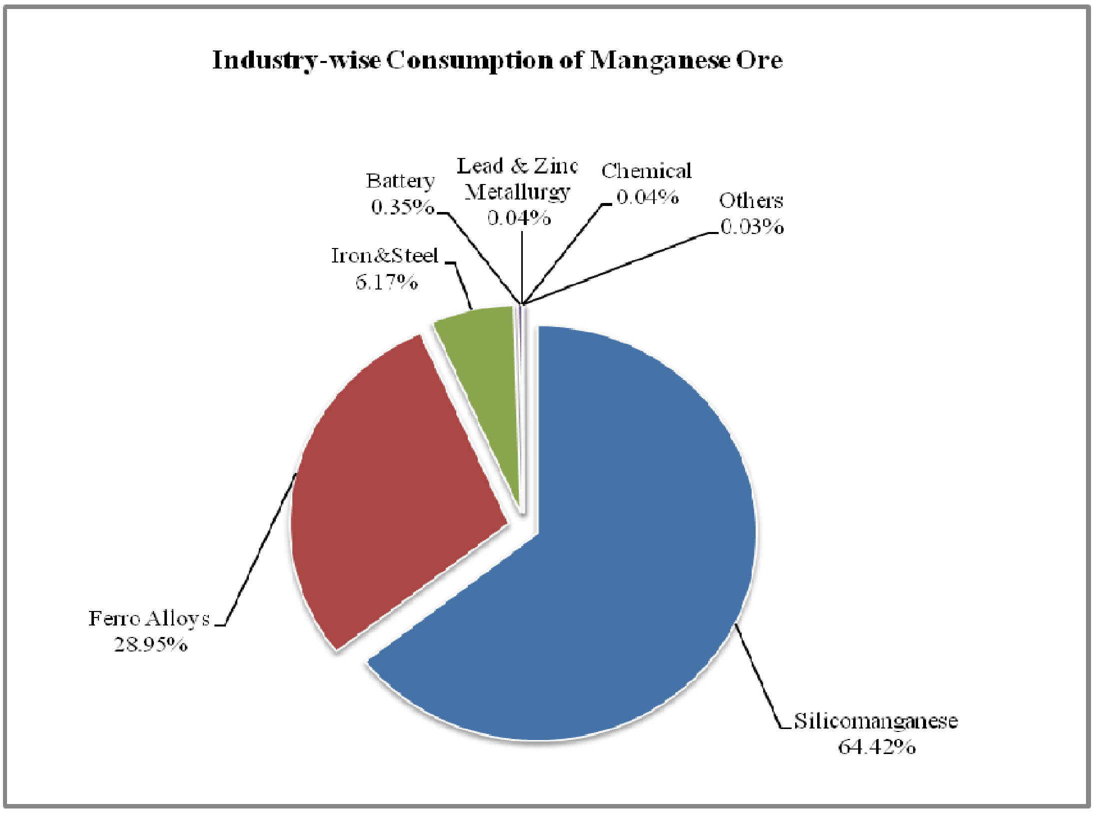
The consumption of manganese ore as reported to Indian Bureau of Mines (IBM) by various industries on non-statutory basis for the period 2005-06 to 2011-12 is given at **Annexure: 3.I.** The reported consumption has increased from 1.81 million tonnes in 2005-06 to 4.13 million tonnes in 2011-12. The industry-wise consumption during 2011-12 is given in **Table: 3.1** and depicted in **Figure: 3.1.**

Table: 3.1 - Industry-wise Reported Consumption of Manganese Ore, 2011-12

Industry	Quantity (In tonnes)	Percentage Share (%)
All Industries	4,130,800	100
Silicomanganese	2,661,100	64.42
Ferroalloys (ferromanganese)	1,196,500	28.95
Iron & Steel	255,000	6.17
Battery	14,600	0.35
Lead & Zinc Metallurgy	1,700	0.04
Chemical	1,600	0.04
Others	300	0.03

Source: Data received from end-users for IMYB on non-statutory basis.
Note: Includes estimates.

Figure: 3.1



In the total consumption, the share of metallurgical industry comprising silicomanganese, ferroalloys, iron & steel and lead & zinc metallurgy comes out to be 99.53% (excluding battery and chemical industry). The consumption data received by the Indian Bureau of Mines is on non-statutory basis and does not represent small-scale consuming industries. (Therefore, an attempt has been made to know the present consumption of manganese ore, especially in steel industry, ferromanganese and silicomanganese and other industries by end use method).

Apparent Domestic Consumption

Apparent consumption of manganese ore by all industries has been calculated on the basis of production, stocks, imports and exports. The trend in apparent consumption of manganese ore during last 12 years from 2000-2001 to 2011-12 is given at **Annexure: 3.II**.

The apparent consumption of manganese ore was estimated at 4.25 million tonnes during 2011-12. **(Table: 3.2)**.

Table: 3.2 - Apparent Consumption of Manganese Ore, 2011-12

(In tonnes)

Opening Stocks	Production	Closing Stocks	Import	Export	Apparent Consumption
858,753	2,349,300	862,800	1,974,951	75,182	4,245,022

End Use Method

A. Metallurgical Industry:

(i) Based on End Use in Iron and Steel Industry

The steel industry is the single largest consumer of manganese ore. It consumes manganese ore directly and also in the form of ferromanganese and silicomanganese. The steel production capacity has increased from 47.91 million tonnes in 2000-01 to 88.40 million tonnes in 2011-12, resulting in the increase in manganese ore consumption in the form of manganese-based alloys.

The crude steel production in 2003-04 was 34.25 million tonnes which increased by 115% and reached to 73.79 million tonnes in 2011-12. The capacity and production of crude steel by major iron and steel plants in the year 2011-12 is given at **Annexure: 3.III**.

In iron and steel industry, manganese ore is used both directly and in the form of ferroalloys namely, ferromanganese and silicomanganese. Direct use of manganese ore is in blast furnace to produce hot metal. On an average 5 kg of manganese ore is required to produce one tonne of hot metal. For crude steel production, both ferromanganese and silicomanganese is used depending upon the route through which crude steel is produced.

On an average 5 kg of ferromanganese and 7 kg of silicomanganese is required to produce one tonne of crude steel. In stainless steel industry, on an average 50 kg of ferromanganese is required to produce one tonne of stainless steel. To produce one tonne of ferromanganese 2.4 tonnes of manganese ore is required and to produce one tonne of silicomanganese 1.8 tonnes of manganese ore is required. Based on these factors, the present demand of manganese ore for production of hot metal, crude steel and stainless steel has been worked out as below:

A. Hot Metal

The production of hot metal during 2011-12 was 40.96 million tonnes. To produce one tonne of hot metal 5 kg of manganese ore is required. Accordingly, the requirement of manganese ore for production of 40.96 million tonnes of hot metal production works out to 0.20 million tonnes.

B. Crude Steel

(i) Ferromanganese vis-à-vis Manganese Ore

The production of crude steel during 2011-12 was 73.79 million tonnes. To produce one tonne of crude steel, 5 kg of ferromanganese is required. Accordingly, the requirement of ferromanganese works out to 0.37 million tonnes. To produce one tonne of ferromanganese, 2.4 tonnes of manganese ore is required. Accordingly, the requirement of manganese ore to produce 0.37 million tonnes of ferromanganese for crude steel production works out to 0.88 million tonnes.

(ii) Silicomanganese vis-à-vis Manganese Ore

To produce one tonne of crude steel, 7 kg of silicomanganese is required. Accordingly the consumption of silicomanganese for crude steel production of 73.79 million tonnes works out to 0.52 million tonnes. To produce one tonne of silicomanganese, 1.8 tonnes of manganese ore is required. Accordingly, the requirement of manganese ore to produce 0.52 million tonnes of silicomanganese works out to 0.936 million tonnes.

C. Stainless Steel

For stainless steel making, only ferromanganese is required. Production of stainless steel during 2011-12 was 2.6 million tonnes. The norm of consumption of ferromanganese for production of one tonne of stainless steel is 50 kg. Accordingly, the consumption of ferromanganese for production of 2.6 million tonnes of stainless steel is worked out to 0.13 million tonnes. To produce one tonne of ferromanganese, 2.4 tonnes of manganese ore is required. Accordingly, the requirement of manganese ore works out to 0.312 million tonnes.

D. Exports

(i) Ferromanganese

During 2011-12, exports of ferromanganese were 0.16 million tonnes, which required 0.384 million tonnes of manganese ore.

(ii) Silicomanganese

During 2011-12, exports of silicomanganese were 0.73 million tonnes, which required 1.314 million tonnes of manganese ore.

E. Dry Cell and Other Industries

(i) Dry Cell Battery

As stated earlier, about 5% of the total manganese ore is consumed in non-metallurgical industry. Amongst the non-metallurgical use, the dry cell industry consumes maximum amount of manganese ore in both forms, namely natural as well as Electrolytic Manganese Di-oxide (EMD).

The production of dry cell has decreased from 2.05 billion units in 2009-10 to 1.962 billion units in 2011-12, registering a negative growth rate of about four per cent.

The consumption of manganese ore in the production of dry cell was estimated by applying a norm of five grams of EMD per dry cell. As per the data with MOIL, about 3.9 tonnes of manganese ore is required for production of one tonne of EMD. The consumption of manganese ore for dry cell manufacturing as estimated on the basis of these norms for 2011-12 is given in **Table: 3.5**.

Table: 3.5 - Estimated Consumption of Manganese Ore in Production of Dry Cell

Particulars	2011-12
Production of Dry Cell Battery	1.962 Billion Units
Consumption of EMD@ 5gms/ Dry Cell	9,815 tonnes
Consumption of Manganese Ore @3.9 tonnes/ tonne of EMD	38,278tonnes

(ii) Other Industries

Other industries which consume manganese ore are alloy steel, chemical and zinc metallurgy. No authentic data about its consumption is available. However, based on the current trends it is estimated that around 12000 tonnes of manganese ore is consumed in these industries.

Total requirement of manganese ore for steel industry and exports in the form of ferromanganese and silicomanganese:

A. Hot Metal -0.200 million tonnes

B. Crude Steel -1.816(0.88 FeMn +0.936 SiMn) million tonnes

C. Stainless Steel -0.310 million tonnes

D. Exports of FeMn & SiMn -1.698 (0.384 FeMn +1.314 SiMn) million tonnes

E. Dry Cell and Other Industries - 0.050 million tonnes

Total (A+B+C+D+E) - 4.074 million tonnes

The consumption thus calculated on the basis of requirement for hot metal & crude steel, production, exports of ferromanganese and silicomanganese, dry cell & other industries by end use method has been arrived at 4.07 million tonnes. The consumption thus calculated is given at **Annexure: 3.IV.**

ii) Based on the Total Production of Ferroalloys

The manganese alloy industry is the major consumer of manganese ore for the production of ferromanganese and silicomanganese. The production of manganese alloys from manganese ore is an energy intensive process and therefore, apart from manganese ore, power plays an important role in the production of manganese alloys.

The production capacity of manganese alloys (ferromanganese and silicomanganese) has increased from 700,000 tonnes in 2000-01 to 3,160,000 tonnes in 2011-12. The production of ferromanganese as reported to IBM was 170,000 tonnes in 2000-01, which increased to

446,733 tonnes in 2011-12, registering an increase of 163 per cent. Similarly, the production of silicomanganese which was 496,814 tonnes in 2000-01 increased to 1,478,403 tonnes in 2011-12, registering an increase of 198 per cent.

To arrive at the total manganese ore consumption in ferromanganese and silicomanganese industries, the norms of consumption as 2.4 tonnes of manganese ore for the production of one tonne of ferromanganese and 1.8 tonnes of manganese ore for one tonne of silicomanganese are adopted. The estimated consumption of manganese ore for the production of ferromanganese and silicomanganese for the period 2000-01 to 2011-12 is given in **Annexure: 3.V.** The estimations for the year 2011-12 are given in **Table: 3.4.**

Table: 3.4 - Estimated Consumption of Manganese Ore in Manganese-based Alloy Industry during 2011-12

(In tonnes)

Sl No.	Particulars	Norms	2011-12
1.	Reported Production of Ferromanganese		446,733
2.	Manganese Ore Consumption	2.4 tonnes of Mn Ore /tonne of ferromanganese	1,072,159
3.	Reported Production of Silicomanganese		1,478,403
4.	Manganese Ore Consumption	1.8 tonnes of Mn Ore /tonne of silicomanganese	2,661,125
5.	Consumption of Manganese Ore i) For Ferromanganese Production ii) For Silicomanganese Production		 1,072,159 2,661,125
		Total	**3,733,284**

Total Estimated Present Demand by End-use Method

The total estimated present demand for manganese ore in various industries for the year after applying end use method is given below:

Estimated Consumption of Manganese Ore by End-use Method

a) Based on Production of Hot metal, Stainless Steel, Crude Steel, Export of FeMn and SiMn, Dry Cell Battery and Other Industries : 4.07 million tonnes

b) Based on Production of Ferroalloys, Hot Metal Dry Cell Battery and Other Industries : 3.98 million tonnes

Present Demand Estimates by Various Methods

As discussed above, the present demand for manganese ore as estimated by various methods is given in **Table: 3.6**.

Table: 3.6-Estimated Present Demand for Manganese Ore in 2011-12 by Various Methods

(In million tonnes)

Sl No.	Methodology Adopted	Total Present Demand	Remarks
1.	Reported Consumption to IBM	4.13	Not Adopted
2.	Apparent Consumption	4.24	Not Adopted
3.	Based on Industry-wise Consumption for Production of Ferromanganese & Silicomanganese, Hot Metal, Dry Cell Battery and Other Industries	3.98	Not Adopted
4.	**Based on consumption in Steel industry (Hot Metal, Stainless Steel, Crude Steel, Export of FeMn and SiMn, Dry Cell Battery and Other Industries)**	**4.07 (Say 4.10)**	**Adopted**

It is seen from the **Table:3.6** that the total consumption of manganese ore in 2011-12 comes out to be 4.24 million tonnes based on apparent consumption (CAGR 12.76%), while the consumption of manganese ore based on reported consumption as compiled by IBM was 4.13 million tonnes. Whereas, the consumption of manganese ore estimated on the basis of ferromanganese and silicomanganese production and consumption in battery and other industries was arrived at 3.98 million tonnes in 2011-12. The present demand for manganese ore based on the consumption of the ferroalloys in steel industry, manganese ore for hot metal, requirement of manganese ore for export of ferromanganese and silicomanganese and other industries (including dry cell battery) is estimated at 4.07 million tonnes (say 4.10 million tonnes).

The merits and demerits of the various methods adopted have been analysed. In case of the apparent consumption method, it is presumed that the quantity which is available after exports and stocks is entirely consumed in the plants. As a matter of fact, substantial quantities remain in transit like railway siding, port yards and transportation through railway and thus, demand estimated by apparent consumption methods appears to be on higher side. In case of the consumption as worked out for IMYB is based partly on actual reports and in some cases based on estimates. Since the coverage of industries both in organised and unorganised sector are not full, therefore not adopted. The other two approaches i.e. end use consumption in different industries like steel and other industries and the other approach i.e. consumption in ferroalloys industry and other industries appear to be realistic and the consumption worked out based on end use in steel and other industry which is 4.10 million tonnes has been adopted. This has been adopted for forecasting the future demand.

FUTURE DEMAND

The demand forecast for manganese ore has been carried out for short and long term. Under the short term, the demand estimates have been made upto 2016-17, whereas the long term demand estimates have been made beyond 2016-17 up to 2029-30.

The different methods adopted in estimating future demand are:

I) Statistical Method

a) Arithmetic Averaging Method

b) Trend Line

c) Moving Average

II) End Use

III) Demand Estimates made by Working Group constituted by Ministry of Steel and Ministry of Mines.

The Working Group constituted by Ministry of Steel and Ministry of Mines have made estimates upto 2016-17 only.

A) Demand Forecast Based on Statistical Method

Various statistical methods are used to forecast the future demand for manganese ore which are as follows:

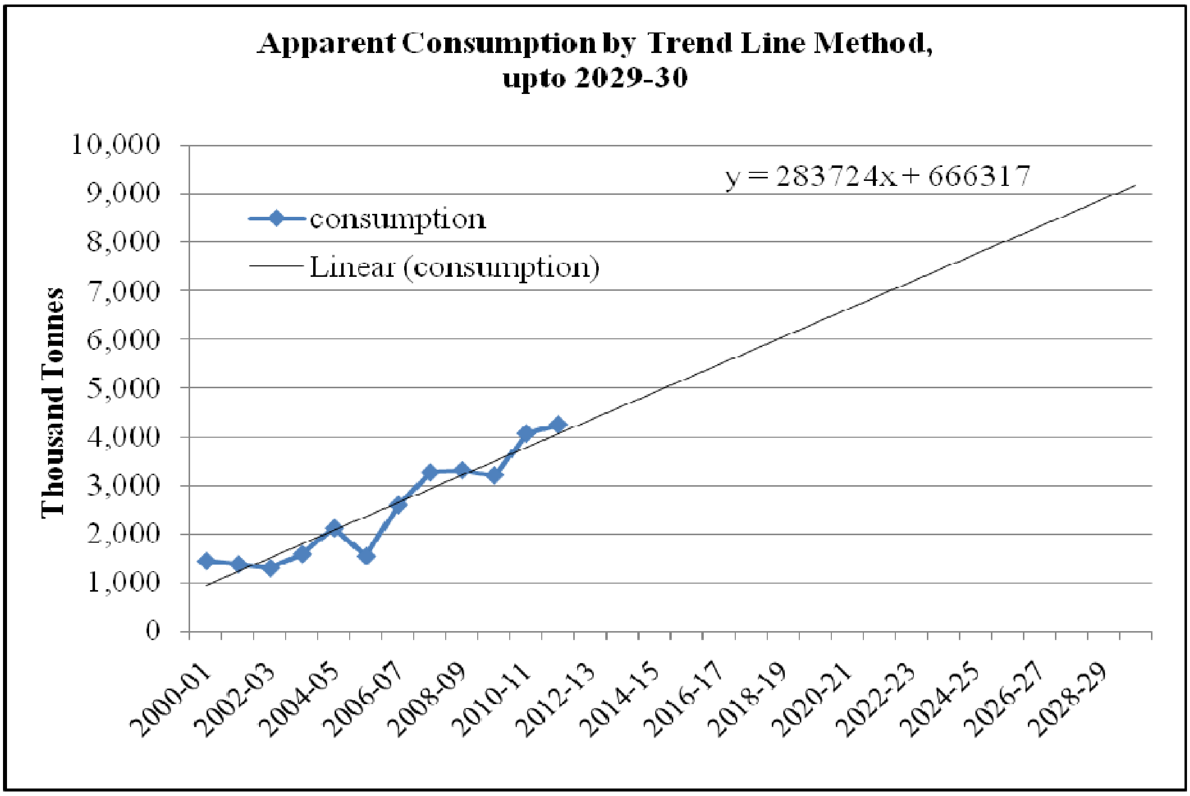
i) Arithmetic Averaging Method

The apparent consumption of manganese ore as given in **Annexure: 3.II** was calculated on the basis of production, stocks, imports and exports. The apparent consumption of manganese ore in 2000-01 was 1.45 million tonnes, which rose to 4.25 million tonnes in 2011-12, registering a CAGR of 12.76 per cent. By applying this method, the future demand for manganese ore works out to 7.39 million tonnes in 2016-17, 22.81 million tonnes in 2025-26 and 36.87 million tonnes by 2029-30. However, it is seen that there is no data consistency and the analysis of the historical data adopted for this purpose revealed that the data on imports is not realistic. Therefore, this method has not been adopted to estimate future demand.

ii) Trend Line Method

The actual data compiled for production, imports and exports was analysed by plotting a linear trend line to arrive at the estimated consumption and difference if any from the actual data.The apparent consumption as arrived by considering production, stocks, imports and exports (**Annexure: 3.II**), a linear trend line was plotted which has given an equation **Y = 283724x+666317 (Figure: 3.2)** and utilising the same, an apparent consumption was estimated in 2011-12 at 4.07 million tonnes. Applying the above equation, the future demand for manganese ore has been estimated at 5.51 million tonnes by 2016-17, 8.10 million tonnes by 2025-26 and 9.25 million tonnes by 2029-30, respectively.

Figure 3.2



iii) Moving Average Method

The apparent consumption data for the last 12 years was considered to arrive at the overall average growth rate for estimating the past trend of consumption and exports (**Annexure: 3.II**). Moving average was calculated by forming overlapping blocks, each for 3 years and then the annual average growth rate of 12.22% was calculated. By applying this growth rate, the future demand for manganese ore works out to 6.83 million tonnes by 2016-17, 19.29 million tonnes by 2025-26 and 30.59 million tonnes by 2029-30, respectively.

B) Demand Forecast Based on End Use

SHORT TERM DEMAND

I (a) Iron & Steel Industry

The present (2011-12) production of crude steel is 73.79 million tonnes and that of stainless steel is 2.60 million tonnes. The National Steel Policy has adopted growth rate of 7% for the domestic steel industry.

The following norms have been adopted to forecast the consumption of manganese ore in the production of hot metal, crude steel, stainless steel and ferro & silicomanganese:

i) 5 kg of ferromanganese in the production of one tonne of crude steel.

ii) 50 kg of ferromanganese in the production of one tonne of stainless steel.

iii) 7 kg of silicomanganese in the production of one tonne of crude steel.

iv) 2.4 tonnes of manganese ore in the production of one tonne of ferromanganese.

v) 1.8 tonnes of manganese ore in the production of one tonne of silicomanganese.

vi) 5 kg of manganese ore in the production of one tonne of hot metal.

It has also been assumed that 95% manganese ore is consumed in the manufacture of ferro & silicomanganese and 5% manganese ore is consumed by other industries.

The production of crude steel, hot metal and stainless steel production during 2011-12 has been taken as base to forecast production of these commodities by 2016-17 by assuming a uniform growth rate of 7% annually, as envisaged in National Steel Policy 2012. Production of crude steel is projected at 103.49 million tonnes in 2016-17, based on the actual production of 73.79 million tonnes in 2011-12. Similarly, by considering 7% uniform growth, the production of stainless steel and hot metal has been projected at 3.65 million tonnes and 57.45 million tonnes, respectively by 2016-17.

i) Ferromanganese

Based on the projected production of crude steel, stainless steel and projected exports of ferromanganese and silicomanganese and applying above norms, demand for ferromanganese has been estimated for the years 2012-13 to 2016-17 and is given at **Annexure: 3.VI.** The demand of ferromanganese for crude steel, stainless steel production and projected exports of ferromanganese and silicomangnese during 2016-17 is estimated at 0.92 million tonnes, equivalent to 2.21 million tonnes of manganese ore.

ii) Silicomanganese

Based on the projected production of crude steel and exports of silicomanganese, the demand estimates for silicomanganese and corresponding demand for manganese ore has been worked out for the period 2012-13 to 2016-17 and is given at **Annexure: 3.VI.**

The demand for silicomanganese to produce103.49 million tonnes of crude steel has been estimated at 0.72 million tonnes by 2016-17, equivalent to 1.30 million tonnes of manganese ore. In addition to domestic demand, it has been estimated that 1.02 million tonnes of silicomanganese, equivalent to 1.84 million tonnes of manganese ore will be exported in 2016-17. Thus, the estimated demand of manganese ore for silicomanganese production, internal consumption and exports comes to 3.14 million tonnes by 2016-17.

iii) Hot Metal

The production of hot metal is projected at 57.45 million tonnes by 2016-17. By applying the norm of consumption of 5 kg per tonne of hot metal, the demand of manganese ore for hot metal industry for the period 2012-13 to 2016-17 is worked out and is given at **Annexure: 3.VI**. The demand by 2016-17 is estimated at 0.29 million tonnes.

Total Demand of Manganese Ore for Metallurgical Industries by 2016-17

The total demand of manganese ore for hot metal, crude steel, stainless steel and exports of ferromanganese and silicomanganese by end-use method is given below:

(In million tonnes)

In Crude Steel Production	
i) As Ferromanganese	1.25
ii)As Silicomanganese	1.30
In Stainless Steel Production	
i) As Ferromanganese	0.43
For Exports	
i) As Ferromanganese	0.53
ii) As Silicomanganese	1.84
In Hot Metal Production	
i) As Manganese Ore	0.29
Total	**5.64**

I (b) Demand Forecast based on Production of Ferromanganese and Silicomanganese

More than 90% of the consumption of manganese ore is reported from ferroalloys industries for the production ferromanganese and silicomanganese. Future demand estimates for manganese ore in the production of ferromanganese and silicomanganese have been attempted considering the demand of ferromanganese and silicomanganese in the domestic steel industry and the export demand, and adopting a norm of 2.4 tonnes of manganese ore per tonne of ferromanganese and 1.8 tonnes of manganese ore per tonne of silicomanganese.

i) Ferromanganese

During 2011-12, the production of ferromanganese was 446, 733 tonnes. Analysis of the data on production of ferromanganese for the period 2000-01 to 2011-12 recorded a growth rate of 9.67 per cent. Besides catering to the domestic steel industry, sizeable quantities of ferromanganese are being exported. Although a growth rate of 7 per cent has been considered for the domestic steel industry, for the ferromanganese industry a growth rate of 10% has been adopted. By adopting a growth rate of 10%, the estimated production by 2016-17 will be 719,468 tonnes. By applying the norm of 2.4 tonnes of manganese ore for the production of one tonne of ferromanganese, the demand of manganese ore to produce 719,468 tonnes of ferromanganese will be 1.73 million tonnes by 2016-17.

ii) Silicomanganese

During 2011-12, the production of silicomanganese was 1.48 million tonnes. Analysis of the data on production of silicomanganese for the period 2000-01 to 2011-12 revealed a varying growth rate. The growth rate on year on year basis varied from (-) 14 to 31 per cent. Considering the growth rate of 7 per cent in steel industry and export demand for silicomanganese, a growth rate of 12% has been adopted to estimate the production of silicomanganese by 2016-17. Accordingly, the future production of silicomanganese will be 2.60 million tonnes by 2016-17. By applying norm of 1.8 tonnes of manganese ore per tonne of silicomanganese, the requirement of manganese ore to produce 2.60 million tonnes of silicomanganese works out to 4.69 million tonnes by 2016-17.

Total Demand of Manganese Ore for Ferromanganese & Silicomanganese Industry

The total demand of manganese ore for ferromanganese and silicomanganese industry by 2016-17 works out to:

Ferromanganese industry	: 1.73million tonnes
Silicomanganese industry	: 4.69 million tonnes
Total	**: 6.42 million tonnes**

II. Other Industries

The other industries which consume manganese ore are battery, chemicals, alloy steel, aluminum, zinc smelting etc. However, battery is the only important industry which consumes 38,277 tonnes of manganese ore in the form of manganese dioxide. The future demand for manganese ore in these industries by 2016-17 is estimated below:

a) Battery Industry

During 2011-12, the production of dry cell as per the DIPP was 1.962 billion nos. The estimated consumption of manganese ore for the production of 1.962 billion nos. of dry cell was 38,277 tonnes. Since the past growth rate in the battery industry has been erratic, an economic growth rate of 6% is considered for the projection of future demand of manganese ore in the production of dry cell. Accordingly, the demand for manganese ore works out to 51,223 tonnes by 2016-17.

b) Industries other than Battery

The present estimated consumption of manganese ore in industries other than battery is 12,000 tonnes during 2011-12. The industries included here are chemicals, alloy steel, aluminum, zinc smelting etc. These industries either consume very little quantity of manganese ore or are located in small-scale sectors. The details of production of various products produced by these industries and the corresponding norm of consumption is not available and therefore an economic growth rate of 6 per cent has been adopted to estimate the future requirement of manganese ore in these industries. Accordingly, the requirement of manganese ore in these industries works out to 16,059 tonnes by 2016-17.

Total demand for manganese ore in iron and steel, exports and other industries by 2016-17 is given at **Annexure: 3.VI**.

Total Demand for Manganese Ore by 2016-17 by End Use Method

1.End Use in Iron and Steel Industry

(a) In Crude Steel Production (including hot metal)	: 3.27 million tonnes
(b) Requirement for the Production of FeMn and SiMn for Export	: 2.37 million tonnes
(c) Other Industries	: 0.07 milliontonnes
Total (a+b+c)	**:5.71 milliontonnes**

2.End Use Consumption in Ferroalloys Industry

(a) Ferromanganese	: 1.73million tonnes
(b) Silicomanganese	: 4.69 million tonnes
(c) Hot Metal	: 0.29million tonnes
(d) Other Industries	: 0.07million tonnes
Total(a+b+c+d)	**:6.78 million tonnes**

LONG TERM DEMAND

(i) Based on Growth Rate

To forecast the long term demand for manganese ore further by 2019-20, the crude steel production of 200 million tonnes and 275 million tonnes by 2025-26 as projected by Ministry of Steel in the report namely, 'A Road Map for Research and Development and Technology for Indian Iron & Steel Industry' and in the Draft Report on National Steel Policy 2012 were utilised to estimate internal demand for manganese ore. In addition, the stainless steel production capacity by 2019-20 and for 2025-26 at 5.6 million tonnes from an article published in Steel World, July 2011"Glaring Indian Stainless Industry' by K.K.Mehrotra, Dir. (Engg.). et al. MECON Ltd" was also taken into account. Applying the parameters adopted to forecast the demand by 2016-17, the total internal demand by 2019-20 and 2025-26 has been estimated at 8.04 million tonnes and 10.95 million tonnes, respectively. The details are given at **Annexure: 3.VII**.

(ii) End Use Method

To work out the long term demand for manganese ore by end-use method, two approaches have been adopted. In the first approach, the requirement has been worked out based on the demand in iron and steel industry (crude steel, stainless steel and hot metal), export demand of ferromanganese & silicomanganese and demand in other industries. In the second approach, the demand has been worked out based on the projected production of ferromanganese & silicomanganese by 2025-26 and 2029-30, which will cater to domestic as well as export market and the projected demand in other industries.

I.(A) Crude Steel Production

By assuming a growth rate of 7 per cent, the production of crude steel is projected at 190 million tonnes by 2025-26 and 249 million tonnes by 2029-30.

(i) Demand for Manganese Ore in the Form of Ferromanganese

By applying the norm of 5 kg of ferromanganese per tonne of crude steel, the demand of ferromanganese in crude steel industry by 2025-26 and 2029-30 is estimated at 0.95 and 1.25 million tonnes, respectively. By applying the norm of 2.4 tonnes of manganese ore to produce one tonne of ferromanganese, the requirement works out to 2.28 million tonnes and 3.00 million tonnes by 2025-26 and 2029-30, respectively.

(ii) Demand of Manganese Ore in the Form of Silicomanganese

By applying the norm of 7 kg of silicomanganese to produce one tonne of crude steel, the demand for silicomanganese in crude steel industry by 2025-26 and 2029-30 is estimated at 1.33 and 1.74 million tonnes, respectively. By applying the norm of 1.8 tonnes of manganese ore to produce one tonne of silicomanganese, the requirement works out to 2.39 million tonnes and 3.13 million tonnes by 2025-26 and 2029-30, respectively.

Total demand of manganese ore for crude steel production in the form of ferromanganese and silicomanganese is given below:

(In million tonnes)

Year	Ferromanganese	Silicomanganese	Total
2025-26	2.28	2.39	4.67
2029-30	3.00	3.13	6.13

I. (B) Stainless Steel Production

By assuming a growth rate of 7 per cent, the production of stainless steel by 2025-26 and 2029-30 is estimated at 7 million tonnes and 9 million tonnes, respectively. To produce one tonne of stainless steel 50 kg of ferromanganese is required. Accordingly, the demand for ferromanganese is estimated 0.34 million tonnes and 0.44 million tonnes by 2025-26 and 2029-30, respectively. By adopting the norm of 2.4 tonnes of manganese ore to produce one tonne of ferromanganese, the demand for manganese ore is worked out to 0.82 million tonnes and 1.06 million tonnes by 2025-26 and 2029-30, respectively.

I. (C) Hot Metal

By applying a growth rate of 7 per cent, the hot metal production is projected at 106 and 108 million tonnes by 2025-26 and 2029-30, respectively. The norm of consumption of manganese ore to produce one tonne of hot metal is 5 kg. Accordingly, the requirement of manganese ore for producing hot metal is estimated at 0.53 million tonnes and 0.69 million tonnes by 2025-26 and 2029-30, respectively.

Total Demand for Manganese Ore in Steel Industry in 2025-26 and 2029-30

(In million tonnes)

Item	2025-26	2029-30
1. Crude Steel (FeMn and SiMn)	4.67	6.13
2. Stainless Steel	0.82	1.06
3. Hot Metal	0.53	0.69
Total	**6.02**	**7.88**

II. Export of Ferroalloys

Ferromanganese

The exports of ferromanganese are projected at 0.40 million tonnes and 0.53 million tonnes by 2025-26 and 2029-30, respectively. By applying the norm of 2.4 tonnes of manganese ore to produce one tonne of ferromanganese, the requirement of manganese ore is estimated at 0.96 million tonnes and 1.27 million tonnes by 2025-26 and 2029-30, respectively.

Silicomanganese

The exports of silicomanganese are projected at 1.88 million tonnes and 2.46 million tonnes by 2025-26 and 2029-30, respectively. To produce one tonne of silicomanganese 1.8 tonnes of manganese ore is required. Accordingly, the requirement of manganese ore is worked out to 3.98 million tonnes and 4.43 million tonnes by 2025-26 and 2029-30, respectively.

Total Demand of Manganese Ore for Export of Ferromanganese and Silicomanganese by 2025-26 and 2029-30

(In million tonnes)

Item	2025-26	2029-30
1. Ferromanganese	0.96	1.27
2. Silicomanganese	3.38	4.43
Total	**4.34**	**5.70**

The demand of manganese ore for the production of crude steel in the form of manganese-based alloys, directed use for internal consumption as well as for exports is estimated to be 13.58 million tonnes by 2029-30. Similarly, the consumption of manganese ore in other industries is estimated at 0.14 million tonnes by 2029-30 which is discussed in foregoing paragraphs. Thus, the total demand for manganese ore is estimated at 13.72 million tonnes by 2029-30. The same is given at **Annexure: 3.VIII.**

Ferroalloys Industry

It is presumed that the domestic ferroalloys industry will gear up to meet the domestic demand in steel industry and also exports. For short term demand upto 2016-17, the production of ferromanganese and silicomanganese was estimated by assuming annual growth rate of 10 per cent and 12 per cent, respectively. These growth rates in the production of ferromanganese and silicomanganese cannot be assumed to continue beyond 2016-17 because the domestic ferroalloys industry is principally export-oriented. The global ferromanganese and silicomanganese industry is very susceptible and dependent on the availability of cheap power, and therefore, a constant growth rate of 10 per cent and 12 per cent in ferromanganese and silicomanganese production does not appears to be realistic. However, it will continue to limit its production depending on the demand in the domestic steel industry and export demand. As indicated above, the estimated requirement of ferromanganese and silicomanganese in steel industry and for exports by 2025-26 and 2029-30 is as follows:

(In million tonnes)

(A) Ferromanganese	2025-26	2029-30
i) Crude Steel	0.95	1.25
ii) Stainless Steel	0.34	0.44
iii) Exports	0.40	0.53
Total	**1.69**	**2.22**
Equivalent Manganese Ore	**4.06**	**5.33**

(In million tonnes)

(B) Silicomanganese	2025-26	2029-30
i) Crude steel	1.33	1.74
ii) Exports	1.88	2.46
Total	**3.21**	**4.20**
Equivalent Manganese Ore	**5.78**	**7.56**

Estimated Demand of Manganese Ore for Ferroalloys Industry by 2025-26 and 2029-30

(In million tonnes)

Item	2025-26	2029-30
1. Ferromanganese	4.06	5.33
2. Silicomanganese	5.78	7.56
Total	**9.84**	**12.89**

II (iii) Other Industries

The future long term demand for manganese ore in other industries by 2025-26 and 2029-30 is estimated below:

(a) Battery Industry

For the projection of future demand for manganese ore in the production of dry cell, an economic growth rate of 6 per cent is considered. Accordingly, the demand for manganese ore is worked out to 86,541 tonnes and 109,256 tonnes by 2025-26 and 2029-30, respectively.

(b)Industries other than Battery Industry

To estimate the future requirement of manganese ore in industries other than battery industry, an economic growth rate of 6 per cent has been adopted. Accordingly, the requirement of manganese ore in these industries worked out to 27,131 tonnes and 34,252 tonnes by 2025-26 and 2029-30, respectively.

Total Demand for Manganese Ore by 2025-26 and 2029-30 by End Use Method

First Approach

(In million tonnes)

Particulars	2025-26	2029-30
1. Iron and Steel(including Hot Metal)	6.02	7.88
2. Exports	4.34	5.70
3. Other Industries	0.12	0.14
Total	**10.48**	**13.72**

Second Approach

(In million tonnes)

Particulars	2025-26	2029-30
1.Ferroalloys Production (including Exports)	9.84	12.89
2. Hot Metal	0.57	0.69
3. Other Industries	0.12	0.14
Total	**10.53**	**13.72**

C. (i) Demand Estimates as per Working Group on Mineral Exploration and Development

Short Term Demand

The Working Group on Mineral Exploration and Development was constituted by Planning Commission to work out the demand for various raw materials required by steel industry, which included manganese ore.

As per the Working Group, 8 per cent growth in respect of production of manganese ore has been considered and a production of 6.70 million tonnes has been envisaged by 2016-17 based on estimated production of about 4.56 million tonnes in 2011-12. It has estimated consumption of 7.31 million tonnes by 2016-17 at 8 per cent growth rate, from an estimated consumption of 4.96 million tonnes in 2011-12. The percentage-wise consumption of manganese ore considered by Working Group is 62% for silicomanganese, 31% for ferroalloys, 5% in iron and steel and 2% in other industries.

Long Term Demand

The Working Group on Mineral Exploration and Development did not make any estimates for the period beyond 2016-17.

ii) Demand Estimated by the Indian Ferro Alloy Producers' Association (IFAPA)

Short Term Demand

To work out the demand of manganese ore in the ferroalloy industry by 2016-17, a subgroup was constituted by the Working Group on Steel Industry for the XII Five Year Plan. This subgroup headed by IFAPA adopted GDP growth rate of 9 per cent and the implied growth in Steel Consumption of 10.3% (based on elasticity of 1.14) and worked out the required Crude Steel Production and Capacity for the XII Plan (year-wise break-up) as given in **Table: 3.7**.

Table: 3.7- Projected Production and Capacity of Steel

(In million tonnes)

	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Production of Finished Steel	68.35	77.60	87.05	96.90	108.05	118.70
Production of Crude Steel	75.94	86.20	96.70	107.70	120.10	131.90
Crude Steel Capacity	84.38	95.80	107.40	119.70	133.40	146.60

Source: IFAPA

Based on the projected steel demand, the requirement of ferroalloys, production, availability and requirement of raw material is given at **Annexure: 3.IX** and **3.X**.

Projection of Requirement of Manganese Ore

Based on the growth rate of 10.30% in the steel consumption, requirement of crude steel production is projected, and accordingly, based on the projected steel production during XII Five Year Plan, ferroalloys consumption is worked out. Based on the ferroalloys requirement, availability of slag and consumption of manganese ore in ferroalloys and other Industries, the manganese ore requirement for the year 2016-17 is worked out to be 7.05 million tonnes and is given at **Annexure: 3.X**.

It will be seen that the manganese ore requirement has been arrived by considering 95% of manganese ore consumption in ferromanganese and silicomanganese industry and 5 per cent of consumption in other industries, to meet both the domestic and export demand.

Long Term Demand

The IFAPA did not make any estimates for the period beyond 2016-17.

iii) Demand Estimates as per the Working Group on Steel Industry

Short Term Demand

The Planning Commission constituted a working Group on Steel Industry for estimation of requirement of various raw materials necessary for steel industry, which included manganese ore also.

The Working Group on Steel industry has studied in detail the demand for manganese ore on the basis of production of crude & stainless steel as well as requirement of manganese-based alloys consumed in the production of steel. The consumption norms which have been adopted by the Sub Group for the production of steel and manganese-based alloys are given below:

i) 5kg of ferromanganese for the production of one tonne of crude steel.

ii) 50 kg of ferromanganese for the production of one tonne of stainless steel.

iii) 12 kg of silicomanganese for the production of one tonne of crude steel.

iv) 2.4 tonnes of manganese ore is required to produce one tonne of ferromanganese.

v) 1.8 tonnes of manganese ore along with 0.6 tonnes of ferromanganese slag for the production of one tonne of silicomanganese.

vi)95% manganese ore is consumed in the manufacture of manganese-based alloys.

Expected consumption of different categories of ferroalloys during the XII Plan has been worked out based on the projected growth rate of 10.3% in steel consumption and the required crude steel production to meet the emergent demand between 2012-13 and 2016-17. Demand for manganese ore, in turn, has been worked out on the basis of:

a) Requirement of manganese-based alloys for projected crude steel production in the XII Plan Period.

b) Availability of slag.

c) Consumption of manganese ore in other industries.

As per the Working Group on Steel Industry, the production of crude steel has been envisaged at 125.90 million tonnes in 2016-17. Based on the total crude steel production and applying above norms, the total consumption of ferromanganese has been calculated at 0.63 million tonnes. Similarly, for the production of stainless steel it has been projected at 0.11 million tonnes. The total internal demand of ferromanganese in 2016-17 for steel industry has been calculated at 0.74 million tonnes equivalent to 1.77 million tonnes of manganese ore.

Similarly, considering the above given norm for consumption of silicomanganese for the production of one tonne of crude steel, the total consumption of silicomanganese has been calculated at 1.51 million tonnes in 2016-17, equivalent to 2.72 million tonnes of manganese ore. In addition to manganese ore, ferromanganese slag is also consumed in the production of silicomanganese as per the norms given above. The ferromanganese slag available for the production of silicomanganese by 2016-17 is estimated at 0.78 million tonnes against the requirement of 1.29 million tonnes. The shortfall will be met through addition of 0.51 million tonnes of manganese ore. Hence, the total internal demand of manganese ore for the production of manganese-based alloys is estimated at 5.00 million tonnes (**Annexure: 3.XI**).

In addition to domestic demand, it has also been estimated that 0.13 million tonnes of ferromanganese equivalent to 0.31 million tonnes of manganese ore and 0.65 million tonnes of silicomanganese equivalent to 1.16 million tonnes of manganese ore will be exported in 2016-17. Hence, the total demand for manganese ore by 2016-17 for the production of manganese-based alloys for internal consumption as well as export is around 6.48 million tonnes. In addition, 5% manganese ore is consumed in other industries, which comes out to be 0.41 million tonnes by 2016-17. As per the demand forecast by Working Group on Steel Industry, the total manganese ore demand has been estimated to be 6.88 million tonnes by the end of XII Five Year Plan. (**Annexure: 3.XI**).

Long Term Demand

The working Group on Steel did not make estimates for year beyond 2016-17.

Analysis of Various Methods of Forecasting

The demand projections, both short term and long term were attempted taking into consideration the end use consumption in various industries, more specifically, the consumption of manganese ore in the production of ferro and silicomanganese, the largest consumer and the ultimate use in iron and steel industry.

To arrive at the future demand for manganese ore by 2016-17, 2025-26 and 2029-30, the present demand for manganese ore during 2011-12 has been taken as a base and various parameters namely, growth rate, consumption norms, apparent consumption as well as consumption by end users were utilised. Also, the future demand for manganese ore in other non- metallurgical industry such as battery, chemical, zinc metallurgy etc. was estimated by applying uniform growth rates. Both statistical and judgemental analysis was used to forecast the demand for manganese ore. Analysis of the demand forecast along with merits and demerits of different methods of forecasting used in the demand projections, and finally, the method adopted in the report is given below:

I) Statistical Methods

a) Arithmetic Averaging Method

In this method, it is assumed that the consumption of mineral increases naturally with the passage of time. It is also assumed that there is Business as Usual in future. As per this method, domestic demand for manganese ore works out to 7.39 million tonnes by 2016-17, 22.81 million tonnes and 36.87 million tonnes by 2025-26 and 2029-30, respectively, which appears to be on higher side as all other influences are not taken care of by the time factor.

b) Trend Line Method

By applying this method, the future demand for manganese ore has been estimated at 5.51 million tonnes by 2016-17, 8.10 million tonnes and 9.25 million tonnes by 2025-26 and 2029-30 respectively, which appears to be on lower side. In this method, consumption data is assumed to be in the form of a time series but its applicability is questionable due to non-recognition of the relationship between the mineral demand and the economic and the technological factors.

c) Moving Average Method

In this method, the moving average is calculated by forming overlapping blocks, each of three years. The success of this method mainly depends upon the past consumption data. By applying this method, the future internal demand for manganese ore by 2016-17 has been arrived at 6.83 million tonnes, 19.29 million tonnes and 30.59 million tonnes by 2025-26 and 2029-30, respectively, which appears to be on higher side. This is also a simple averaging method which does not take care of other influences like market fluctuation, geopolitical factors, etc.

II) End Use Method

a) Based on Iron and Steel Industry

In this method, the present demand during 2011-12 has been taken as a base and 7% uniform growth rate in respect of production for hot metal, crude steel, stainless steel has been considered to arrive at the future demand for manganese ore in the Iron and Steel industry in the country. The internal demand has been estimated by considering consumption norms of manganese ore for the production of ferromanganese and silicomanganese as well as direct use in the production of hot metal and in non-metallurgical industry. Considering these parameters, the total demand for manganese ore in the country have been arrived at 5.71 million tonnes by 2016-17, 10.47 million tonnes and 13.72 million tonnes by 2025-26 and 2029-30, respectively, which is accepted in the present Market Survey Report. This method gives realistic picture because Iron and Steel industry has direct influence in the consumption of manganese ore, and growth in manganese ore industry largely depends on the consumption of steel in the country.

b) Based on Ferromanganese and Silicomanganese Production

In this method, demand for manganese ore was estimated by adopting 10% growth rate in production of ferromanganese and 12% growth rate in the production of silicomanganese. By applying the same, future demand for manganese ore works out to 6.78 million tonnes by 2016-17. These growth rates in the production of ferromanganese and silicomanganese cannot be assumed to continue beyond 2016-17 as the domestic ferroalloys industry is principally export- oriented. The global ferromanganese and silicomanganese industry is very susceptible and dependent on the availability of cheap power. However, it will continue to limit its production depending on the demand in the domestic steel industry and export demand. The future demand of manganese ore works out to 10.53 million tonnes by 2025-26 and 13.72 million tonnes by 2029-30. These estimates are in line with the estimates based on iron and steel industry, which is accepted in this report.

III) Demand Projections Based on Consumption Reported by IFAPA

IFAPA estimated future demand for manganese ore based on growth rate in steel consumption, requirement of crude steel based on the ferroalloys requirement, availability of slag and consumption of manganese ore in ferroalloys and other industries. Accordingly, manganese ore demand is worked out to be at 7.05 million tonnes by 2016-17. The demand for manganese ore is based on projections given by each individual member of IFAPA. The manganese ore requirement has been arrived by considering 95% of manganese ore consumption in ferromanganese and silicomanganese industry and 5% of consumption in other industries to meet both the domestic and export demand. Hence, the projection of future demand made by IFAPA appears to be on lower side. Moreover, IFAPA has not projected scenario after 2016-17, which is not helpful for projecting long term demand.

IV) Demand Projections as per XII Five Year Plan (2012-17)

a) Working Group on Mineral Exploration and Development (Other than Coal and Lignite), Ministry of Mines

In this report, 8 per cent growth in respect of production of manganese ore has been considered. Also, there is no mention of manganese ore consumption in ferromanganese industry. In this report, about 62% of manganese ore consumption is considered for silicomanganese industry, which seems to be on higher side. It has envisaged an estimated consumption of 7.31 million tonnes by 2016-17 at 8% growth rate which appears to be on higher side.

b) Report of theWorking Group on Steel Industry for XII Five Year Plan

The Working Group on steel industry for XII Five Year Plan has considered two scenarios on the basis of total domestic demand for steel and total demand for steel, including export demand. In the report, expected demand for manganese ore during XII Five Year Plan has been worked out based on the projected growth rate of 10.3% in steel consumption and the required crude steel production to meet the emerging demand during XII Five Year Plan. The internal demand for manganese ore has been estimated considering that 95% of manganese ore will be consumed for production of manganese-based alloys and balance will be consumed in other non-metallurgical industries. By applying the above principle, the total internal demand as per the working group on steel industry works out to be 5.41 million tonnes by the end of XII Five Year Plan i.e. by 2016-17.

In addition, India is emerging as a major exporter of manganese-based alloys. The manganese ore required for this export demand has also been worked out by applying the same consumption norms. Accordingly, the export demand of equivalent manganese ore is computed at 1.47 million tonnes by 2016-17. Therefore, the total demand (internal + export) works out to 6.88 million tonnes.

The Working Group has estimated demand for manganese ore by considering consumption norm of silicomanganese of 12 kg per tonne of crude steel, which appear to be on higher side. Also, there is no mention of direct use of manganese ore in production of hot metal. Hence demand projected by Working Group appears to be on higher side.

The demand projection by various methods till the year 2029-30 is given in **Table: 3.8.**

Table: 3.8 - Demand Projections by Different Methods By 2016-17, 2025-26 and 2029-30

(In million tonnes)

Methods of Demand Projection	Demand			Remarks
I) Statistical Methods	**2016-17**	**2025-26**	**2029-30**	
a) Arithmetic Averaging Method	7.39	22.81	36.87	Estimated on higher side
b) Trend Line Method	5.51	8.10	9.25	Estimated on lower side
c) Moving Average Method	6.83	19.29	30.59	Estimated on higher side
II) By End Use Method				
a)Based on Steel Production& Other Industries	**5.71**	**10.47**	**13.72**	**Accepted**
b) Based on Production of Ferromanganese and Silicomanganese & Other Industries	**6.78**	**10.53**	**13.72**	**Accepted**
III) Working Group on Mineral Exploration and Development (other than Coal and Lignite) for XII Five Year Plan	7.31	-	-	Estimated on higher side
IV) IFAPA	7.05	-	-	Estimated on higher side
V) Working Group on Steel Industry constituted by Planning Commission for XII Five Year Plan	6.88	10.95	-	Estimated on higher side

It is seen from the above table, that the estimates made by various methods and agencies are varying with each other. However, the demand forecast made by end use method is adopted in the report as the estimates made by this method appears to be realistic, considering the present scenario of demand of manganese ore in the country. Thus, the total demand of manganese ore by 2029-30 will be 13.72 million tonnes.

Chapter 4

SUPPLY

GLOBALLY, manganese ore is an important and fundamental input raw material in steel making. India is one of the important producers of manganese ore in the world. In the early years of last century, India was the second largest producer of manganese ore after erstwhile USSR. Today, the country ranks fifth position in resources and occupies sixth position as far as production of manganese ore is concerned. Indian manganese ores are generally hard, lumpy and amenable to easy reduction. Though sizeable quantity of manganese ore is produced in the country, some shortage in the supplies of ferromanganese and battery grade has been faced by the domestic industries. The present chapter deals with occurrence, origin, resources and production of manganese ore in India.

Occurrence and Origin

Manganese ore deposits in India are widespread and occur in the Indian Precambrian shield. The deposition of manganese ore in India must have taken place in varying environmental settings and by different geological processes. Almost all the manganese deposits in India are of Precambrian age. The manganese ore deposits in the country occur in the Sausar Group (Madhya Pradesh and Maharashtra), Gangpur Group (Odisha), Aravalli Supergroup (Rajasthan and Madhya Pradesh), Champaner Group (Gujarat), Khondalite Group (Andhra Pradesh and Odisha), Dharwar Supergroup (Karnataka and Goa), and Iron Ore Group (Jharkhand and Odisha). The ore bearing horizons of the Iron Ore Group and the Dharwar Supergroup are either unmetamorphosed or show effects of very low grade metamorphism. The deposits in Aravalli Supergroup show low to moderate metamorphism, whereas in the Sausar and Gangpur Groups, the manganese deposits and other associated rocks show high grade metamorphism (upto amphibolites facies) and manganese ore bodies and other associated rocks belonging to Khondalite Group are metamorphosed upto granulite facies. Various deposits in India can be broadly classified into two groups on the basis of their mode of occurrence and origin.

Syngenetic Sedimentary Bedded Deposits

They are formed by metamorphic reconstitution of manganiferous formations of Precambrian age. The manganese concentration might have taken place during the Precambrian period. These have been followed by orogenesis i.e. folding and metamorphism in different phases. These metamorphosed syngenetic manganiferous formations comprise of oxides and silicates of manganese. They are completely devoid of sulphides and carbonates (except some epigenetic rhodochrosite). The sedimentation must have taken place under strongly oxidising conditions and resulted in precipitation of tetravalent manganese oxides. These deposits are comprised of braunite, hollandite, hausmannite and vredenbergite.

These syngenetic sedimentary bedded types of deposits are found in Madhya Pradesh, Maharashtra, Odisha, Gujarat and Rajasthan.

Secondary Supergene Epigenetic Deposits

This type of deposits is almost entirely secondary, consisting essentially of oxides like psilomelane, pyrolusite etc. which form superficial replacement bodies in Precambrian shales, phyllites, cherts and dolomites. These are also found at the contact of iron formations and phyllites. However, in Karnataka, conformable, tabular or lenticular bodies were found to contain some metamorphic manganese minerals such as braunite. The deposits appear to have been formed from syngenetic, primary sedimentary host rock.

These deposits are generally small but in some areas they are large in size. In general, these ores are of medium or low grade. The lateritoid manganese ores of India also belong to the epigenetic type. They mostly overlie the other manganese deposits. i.e. primary bedded ores and secondary replacement ore bodies. As these ore bodies resemble laterite, they are named as 'lateritoid' manganese ores. They are always high in iron and often graded as ferruginous manganese ore. These deposits are associated with iron ore deposits. They are generally low in phosphorous. Manganese ore deposits of Sandur Schist belt in Karnataka and the deposits in Goa are good examples of secondary supergene deposits.

RESOURCES

The deposits of manganese ore are spread throughout the country. India has huge resources of manganese ore distributed accross 10 states namely, Andhra Pradesh, Goa, Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, and West Bengal.

The total resources estimated as per the National Mineral Inventory (NMI) 2010, were 430 million tonnes which comprised of 142 million tonnes of reserves and 288 million tonnes of remaining resources. Out of the 142 million tonnes of reserves, 97 million tonnes were placed under proved category and 45 million tonnes were placed under probable category.

Grade Classification Adopted

The end use grade classification as adopted by National Mineral Inventory is given in **Table: 4.1**.

Table: 4.1 – End Use Grades of Manganese Ore (NMI-2010)

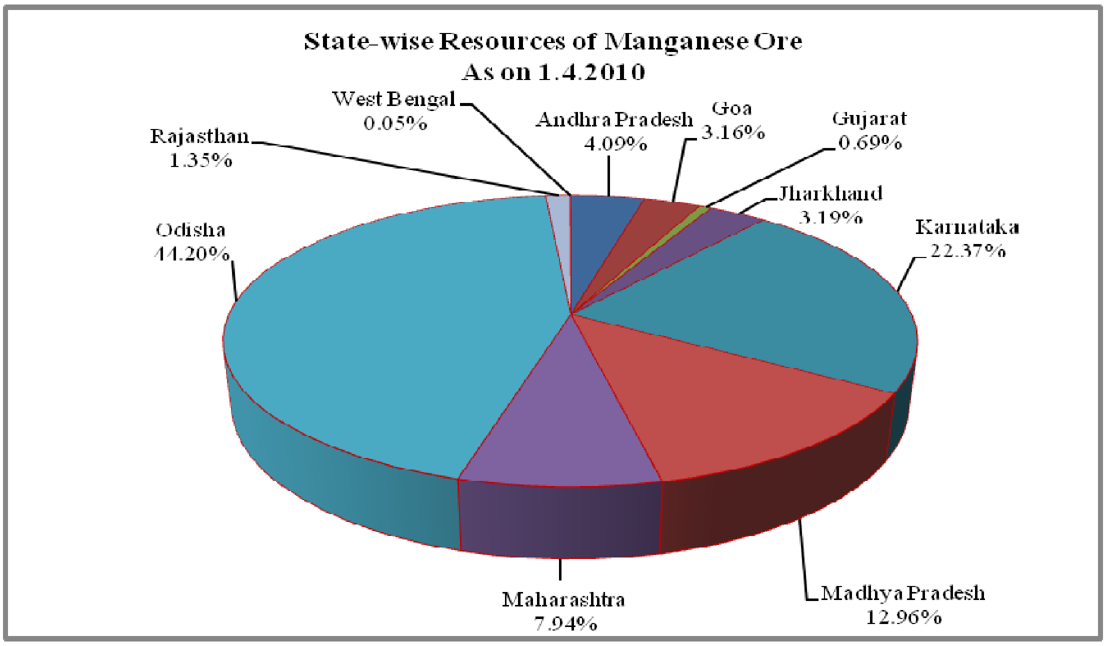
1.	Battery/Chemical Grade,	MnO_2 - 72% (Min.) Cu, Pb, Cr &Ni in traces
2.	Blast Furnace(BF)	Mn - 25 to 35% P - 0.2% (max) Al_2O_3 - 7 .5% (max) SiO_2 - 13% (max)
3.	Ferromanganese	Mn - 38% (min) P - 0.2 % (max) Mn:Fe - 2.5:1 (min), 7:1 (max)
4.	Medium Grade	Mn - 35 to 37%
5.	Mixed Grade	
6.	Ferromanganese of Medium Mixed	
7.	Medium & BF Mixed	
8.	Ferromanganese, medium & BF mixed	
9.	Ferromanganese & BF mixed	
10.	Low	Mn - (+)18% to (-) 25%
11.	Others	Estimation for such grade though usable but cannot be classified into the above grades.
12.	Unclassified	The range of maximum and minimum value of the constituents is such that it does not enable to classify under any grades.
13.	Not known	Such estimation about which information/data is not available/reported to be classified it under any of the grades.

Source: NMI 2010

State-wise and District-wise Resources

The resources of manganese ore are distributed in various districts over 10 states namely, (i) Andhra Pradesh (ii) Goa (iii) Gujarat (iv) Jharkhand (v) Karnataka (vi) Madhya Pradesh (vii) Maharashtra (viii) Odisha, (ix) Rajasthan and (x) West Bengal. The state-wise and district-wise resources of manganese ore are given in **Table: 4.2** and **4.3** and depicted in **Figure: 4.1.**

Figure:4.1



Source: NMI 2010

Table: 4.2 – State-wise, District-wise Reserves/Resources of Manganese Ore as on 1.4.2010

(In '000 tonnes)

State/District	Reserves	Remaining Resources	Total Resources
India	**141979**	**288003**	**429982**
Andhra Pradesh	**4156**	**13443**	**17599**
Adilabad	572	1284	1856
Srikakulam	-	100	100
Vizianagaram	3584	12059	15642
Goa	**674**	**12922**	**13596**
North Goa	-	2092	2092
South Goa	674	10829	11503
Gujarat	**-**	**2954**	**2954**
Panchmahals	-	2180	2180
Vadodara	-	774	774
Jharkhand	**3455**	**10254**	**13710**
Singhbhum (West)	3455	10254	13710

State/District	Reserves	Remaining Resources	Total Resources
Karnataka	**16103**	**80085**	**96188**
Belgaum	87	3347	3434
Bellary	6858	5879	12737
Chikamagalur	-	130	130
Chitradurga	3113	23348	26461
Davangere	-	25	25
Gadag	-	25	25
North Canara	-	29307	29307
Shimoga	134	3551	3685
Tumkur	5911	14472	20383
Madhya Pradesh	**34992**	**20733**	**55725**
Balaghat	21787	17894	39681
Chhindwara	1718	806	2524
Jabalpur	9606	1880	11486
Jhabua	1659	153	1812
Katni	223	-	223
Maharashtra	**12318**	**21835**	**34153**
Bhandara	4507	11134	15641
Nagpur	7811	10700	18511
Odisha	**68499**	**121548**	**190047**
Bolangir	-	1732	1732
Keonjhar	44063	84604	128667
Koraput	-	467	467
Mayurbhanj	-	57	57
Rayagada	51	803	854
Sambalpur	-	120	120
Sundergarh	24385	33765	58150
Rajasthan	**1781**	**4030**	**5811**
Banswara	1781	3520	5301
Udaipur	-	510	510
West Bengal	**-**	**200**	**200**
Midnapur	-	200	200

Source: NMI 2010
The total may not tally due to rounding off.

Table: 4.3 – State-wise/Grade-wise Reserves/Resources of Manganese Ore as on 1.4.2010

(In '000 tonnes)

State/District	Reserves	Remaining Resources	Total Resources
All India (Total)	**141,979**	**288,003**	**429,982**
Battery	112	240	352
BF	49,894	95,961	145,855
Ferromanganese	12,869	22,585	35,455
Ferromanganese & BF	2,425	13,902	16,327
Ferromanganese, Medium & BF Mixed	34,541	31,162	65,703
Low (-) 25% Mn	1,647	7,505	9,152
Medium	8,694	40,034	48,729
Medium & BF Mixed	12,263	32,024	44,287
Mixed	1,763	11,617	13,380
Not Known	2,731	6,702	9,433
Others	7,871	6,053	13,923
Unclassified	7,167	20,216	27,383

contd...

State/District	Reserves	Remaining Resources	Total Resources
Andhra Pradesh (Total)	**4,156**	**13,443**	**17,599**
BF	3,508	6,918	10,426
Ferromanganese	180	978	1,158
Ferromanganese & BF	-	34	34
Low (-) 25% Mn	55	766	821
Medium	99	3,616	3,715
Medium & BF Mixed	8	679	686
Not Known	-	326	326
Others	253	111	364
Unclassified	53	15	68
Goa (Total)	**674**	**12,922**	**13,596**
BF	192	10,315	10,507
Ferromanganese	8	302	310
Ferromanganese Medium & BF Mixed	280	263	543
Low (-) 25% Mn	-	377	377
Medium	-	102	102
Medium & BF Mixed	194	1,422	1,616
Mixed	-	123	123
Not Known	-	12	12
Unclassified	-	5	5
Gujarat (Total)	**-**	**2,954**	**2,954**
Ferromanganese	-	774	774
Mixed	-	2,180	2,180
Jharkhand (Total)	**3,456**	**10,254**	**13,710**
BF	841	6,282	7,123
Ferromanganese	87	159	245
Mixed	885	1347	2232
Unclassified	1,643	2,466	4,109
Karnataka (Total)	**16,103**	**80,085**	**96,188**
Battery	-	90	90
BF	8,588	39,714	48,302
Ferromanganese	3,641	6,462	10,103
Ferromanganese & BF	-	643	643
Ferromanganese, Medium & BF Mixed	-	3,375	3,375
Low (-) 25% Mn	-	96	96
Medium	979	9,628	10,607
Medium & BF Mixed	19	12,540	12,559
Mixed	-	58	58
Not Known	13	1,863	1,876
Others	1,778	1,255	3,033
Unclassified	1,085	4,362	5,447

contd...

State/District	Reserves	Remaining Resources	Total Resources
Madhya Pradesh (Total)	**34,992**	**20,733**	**55,725**
BF	7,785	1,825	9,610
Ferromanganese	3,980	3,823	7,803
Ferromanganese & BF	2,067	1,039	3,106
Ferromanganese, Medium & BF Mixed	11,875	9,653	21,527
Low (-) 25% Mn	16	335	351
Medium	110	629	739
Medium & BF Mixed	6,348	2,801	7399,148
Others	2,625	515	3,140
Unclassified	187	114	301
Maharashtra (Total)	**12,318**	**21,835**	**34,153**
BF	66	2,531	2,597
Ferromanganese	65	1,077	1,142
Ferromanganese, Medium & BF Mixed	10,945	13,743	24,688
Medium	-	22	22
Medium & BF Mixed	800	3,061	3,861
Not Known	95	200	296
Others	272	1,180	1,452
Unclassified	75	20	95
Odisha (Total)	**68,499**	**121,548**	**190,047**
Battery/Chemical	112	150	262
BF	28,914	27,922	56,836
Ferromanganese	4,910	9,009	13,918
Ferromanganese & BF	358	11,868	12,226
Ferromanganese, Medium & BF Mixed	11,442	4,128	15,570
Low (-) 25% Mn	1,576	5,931	7,508
Medium	5,725	23,592	29,317
Medium & BF Mixed	4,895	11,522	16,417
Mixed	878	7,909	8,787
Not Known	2,623	3,801	6,424
Others	2,943	2,992	5,935
Unclassified	4,124	12,724	16,848
Rajasthan(Total)	**1,781**	**4,030**	**5,811**
BF	-	254	254
Ferromanganese	-	1	1
Ferromanganese & BF	-	318	318
Medium	1,780	2,446	4,226
Not Known	-	500	500
Unclassified	-	510	510
West Bengal (Total)	**-**	**200**	**200**
BF	-	200	200

Source: NMI 2010

Note: *1. The total may not tally due to rounding off.*
2. Although 13 grades are classified, only three grades namely 1) Battery/ Chemical grade 2) Ferromanganese grade and 3) Blast furnace are important grade.

State-wise Resources of manganese ore giving the resources and districts where these occur are given in **Table: 4.4.**

Table: 4.4–State-wise Reserves/Resources of Manganese Ore as on 1.4.2010

(In '000 tonnes)

State/District	Reserves	Remaining Resources	Total Resources	Districts
India	**141,979**	**288,003**	**429,982**	
Andhra Pradesh	4,156	13,443	17,599	Adilabad, Srikakulam, Vizianagaram
Goa	674	12,922	13,596	NorthGoa, South Goa
Gujarat	-	2,954	2,954	Panchmahals, Vadodara
Jharkhand	3,456	10,254	13,710	Singhbhum (West)
Karnataka	16,103	80,085	96,188	Belgaum, Bellary, Tumkur, Chitradurga, Gadag Davangere, North Canara, Shimoga, Chikamagalur
Madhya Pradesh	34,992	20,733	55,725	Balaghat, Chhindwara, Katni, Jhabua, Jabalpur
Maharashtra	12,318	21,835	34,153	Bhandara, Nagpur
Odisha	68,499	121,548	190,047	Bolangir, Keonjhar, Koraput, Sundergarh,Rayagada, Sambalpur, Mayurbhanj
Rajasthan	1,781	4,030	5,811	Banswara, Udaipur
West Bengal	-	200	200	Midnapur

Source: NMI 2010

Largest resources of manganese ore to a tune of 190 million tonnes are in the state of Odisha. The share of Odisha in the total resources of the country is 44.20 percent, followed by Karnataka with 96.20 million tonnes of resources (22.37%); Madhya Pradesh 55.72 million tonnes (12.96%); Maharashtra 34.15 million tonnes (7.94%) and Andhra Pradesh 17.60 million tonnes (4.09%). The remaining 8.44% of total resources are contributed together by Jharkhand, Goa, Rajasthan, Gujarat and West Bengal.

I) Odisha

Odisha is the leading state with 190 million tonnes of total resources of manganese ore. Out of these total resources, 68.50 million tonnes are placed under reserve category and the balance 121.50 million tonnes are under remaining resources category. These resources are distributed in seven districts namely, Bolangir, Keonjhar, Koraput, Mayurbhanj, Rayagada, Sambalpur and Sundergarh. More than 98% of resources of manganese ore are located in two districts namely, Keonjhar and Sundergarh. In Keonjhar district, out of 128.66 million tonnes of total resources, 44.06 million tonnes (34%) are reserves and balance 84.60 million tonnes (66%) are remaining resources. In Sundergarh district, out of 58.15 million tonnes of total resources, reserves are 24.38

million tonnes (42%) and the balance 33.77 million tonnes (58%) are categorised as remaining resources. The remaining 3.23 million tonnes of manganese ore resources are situated in other districts namely, Bolangir, Koraput, Mayurbhanj, Rayagada and Sambalpur. Out of the total resources, 56.86 million tonnes are of BF grade, 13.92 million tonnes of FeMn grade, 12.22 million tonnes of FeMn & BF mixed, 15.57 million tonnes of Fe-Mn, medium and BF mixed grade, 29.31 million tonnes of medium grade. The remaining are of battery, low, mixed, not known, other and unclassified grade. The district-wise resources of manganese ore in Odisha are given in **Table: 4.5**.

Table: 4.5 – District-wise Resources of Manganese Ore in Odisha

(In '000 tonnes)

Sl No.	Name of District	Reserves	Remaining Resources	Total Resources	Important Deposits/Mines
1.	Bolangir	-	1,732	1,732	Dungarpalli, Godashankar and Kapilabahal
2.	Keonjhar	44,063	84,604	128,667	Bonai-Keonjhar Belt, Bolani Block, Siljora-Kalimati, Panduli-posi
3.	Koraput	-	467	467	Kutinga - Nishikhal Belt
4.	Mayurbhanj	-	57	57	Budharaja
5.	Rayagada	51	803	854	Lilugumma, Karajolla and Kashipur, Nishikhal
6.	Sambalpur	-	120	120	Kundhal, Bamra
7.	Sundergarh	24,385	33,765	58,150	Gangpur Manganese Belt, Patmunda, BhanjiKusum

Source: NMI 2010

The major deposits/occurrences of manganese ore in the state of Odisha are described below:

1. Bonai-Keonjhar Belt

This belt is one of the most important manganese ore belts in India because of its low phosphorus content in the ore. The belt covers Barbil tehsil of Keonjhar district and Koira tehsil of Sundergarh district. Bonai-Keonjhar iron ore-manganese belt forms a 60 km long & 25 km wide synclinorium referred to as 'Iron-Ore horse shoe' plunging towards north and north east. The banded iron formations which broadly define the outline of the synclinorium, are almost continuously exposed along the margin, while manganese ore bearing shales occur within the core region of the fold. The entire region displays the effect of superposed folding on both near perpendicular axes, the generalised trends being NNE-SSW & WNW-ESE to NW-SE. Bonai-Keonjhar belt forms a part of the oldest metasedimentary formation of the Chhotanagpur plateau and is considered homotaxial with the Dharwars.

Manganese ore has been mainly derived from the secondary enrichment of the original manganiferous shales associated with Precambrian Banded Iron Formations. They also occur as lateritoid cappings extending down to various depths and merging in to underlying parent rocks. Manganese ore is partly syngenetic and structurally controlled and of lateritic origin in parts and occurs in three distinct lithological associations: (i) As thin bands, lenses, stringers & as box works, **(ii)** As irregular pockets, nodules and lenses of variable shapes within laterites, and**(iii)** As thin veins and veinlets cutting across one another within cherts and cherty quartzite.

2. Kutinga-Nishikhal Belt

Kutinga-Nishikhal manganese belt is 32 kms in length running roughly in N-S direction, enclosed within khondalites of the Eastern Ghat Super Group and is divided into two main sectors, namely, Nishikhal sector in the north and Kutinga in the south. Manganese ores occur mainly as bedded deposits parallel to the strike of foliation. The garnetiferous quartzite and calc-granulite occurring in close vicinity of this mineralised belt do not have manganese mineralisation which indicates that the mineralisation is lithologically controlled and enriched by processes of secondary enrichments.

There are three ore bands of which the western most band- I is of high grade, middle band II is of medium grade and eastern band III is of low grade siliceous ore. The manganese ore in this area can be broadly classified in five types, namely, **i) Hard lumpy ore** which is associated with brown ferruginous cherty quartzite **ii) Streaky ore** which occurs as bands interfoliating with quartz-feldspathic rocks **iii) Cavity filled ore** which is mainly dioxide and high grade ores **iv) Brecciated &friable ore** which is associated with quartz-manganese rocks **v) Clayey and waddy ore** which is generally of low grade ores. Chief manganese ores occurring in this belt are pyrolusite, psilomelane and cryptomelane.

3. Gangpur Manganese Belt

The Gangpur manganese belt spreads over a strike length of about 50 km. Manganese ores in the Gangpur Group is associated with Gondites occurring as bedded deposit. The Gangpur belt possibly represent the eastern continuation of the Sausar belt of Madhya Pradesh intervened by a wide tract of Chhattisgarh group of rocks in Chhattisgarh and Odisha.

Manganese minerlisation is of bedded type. Manganese ore associated with Gondite, rock comprising mainly rhodonite and rhodocrosite and is hosted within phyllite & schist and occurs as lenses spread over strike length of more than 50 km running roughly in ENE-WSW direction. The ores have been enriched by processes of supergene enrichment as evidenced by formation of higher oxides like pyrolusite, psilomelane and braunite.

The ore bodies occur as lenses, commonly in en-echelon pattern. Length of the ore zones vary from few metres to 30 m and width from 0.5 m to 3 m as seen from records. There are many pockety occurrences of a lateritic ores within this belt.

Besides these important belts, there are many small deposits/ occurrences of manganese ore in Koraput, Bolangir, Rayagada and Sambalpur districts.

II) Karnataka

Karnataka is the second largest state in respect of resources of manganese ore with 96.18 million tonnes of total resources. Out of these total resources, 16.10 million tonnes are reserves and 80.08 million tonnes are remaining resources. These resources are distributed in nine districts, namely, Belgaum, Bellary, Chikamagalur, Chitradurga, Davanagere, Gadag, North Canara, Shimoga and

Tumkur. District-wise resources of manganese ore with important deposits in Karnataka are given in **Table: 4.6**.

Table: 4.6 – District-wise Resources of Manganese Ore in Karnataka

(In '000 tonnes)

Sl No.	Name of District	Reserves	Remaining Resources	Total Resources	Important Deposits/Mines
1.	Belgaum	87	3,347	3,434	Nagargalli, Jamgaon, Gaveli, Jamgaon
2.	Bellary	6,858	5,879	12,737	Sandur schist belt, Deogiri,Kumaraswamy, Ramdurg
3.	Chikamagalur	-	130	130	Koppa & Shankargudda
4.	Chitradurga	3,113	23,348	26,461	Chitradurga schist belt
5.	Davangere	-	25	25	Sulekere
6.	Gadag	-	25	25	Keluru
7.	North Canara	-	29,307	29,307	North Canara schist belt
8.	Shimoga	134	3,551	3,685	Shimoga schist belt
9.	Tumkur	5,911	14,472	20,383	Kardikolla, Mavinahalli, Harenahalli, Doregudda

Source: NMI 2010

The manganese ore in Karnataka occurs in the stratigraphic level of the Chitradurga Group of Dharwar Super group. They are strati-form, tabular, lenticular, patchy or pockety deposits of varying dimensions. Psilomelane, pyrolusite, cryptomelane and wad are the major minerals of manganese ore found in the state. Banded Iron Formations with manganese ore are interbedded invariably with argillite and at times follow the carbonate band. Brief description of the important manganese deposits of Karnataka is given below:

1. Sandur Schist Belt

The different blocks identified in this belt are Deogiri, Swamihalli, Subbarayanahalli, Sunderbench, Ramgad, Seshagiri and Donikolla. A number of manganese ore deposits of varying dimensions occur all along the western margin of the Sandur schist belt over a length of 40 km with widths ranging from 0.2 to 1.5 km, which occurs between the Lower Yeshwanth Nagar and Upper Donimalai Formations.

The rock types belong to Dharwar Supergroup of Eastern Dharwar Craton. Three manganese ore horizons over a strike length of 15 km with a top lateritoid horizon, a middle reef-like manganese ore zone and clay mixed zone are noticed at the bottom. Basically, there are two types of ores (1) primary manganese ore which is uneconomical and is interbedded with manganiferous greywacke/ argillite and (2) Supergene deposit of economic value.

The ore bodies are tabular lenses and pockets mostly confined to laterite and highly altered and weathered manganiferous phyllite.

2. North Canara Belt

The different blocks/deposits identified in this belt include Palda deposit, Anmod Deposit, Asuli deposit, etc. The ore occurs as conformable unit within phyllite and chert and sometimes with dolomite.

The manganiferous formations in the district are associated with the shelf sedimentary rocks of the Dharwar-Shimoga-Goa schist belt. The manganese ore is found in the rocks belonging to Upper Chitradurga Group of Dharwar Super group. The ores are of two types namely, syngenetic ore and enriched lateritic ore. Most of the workable deposits are of supergene nature. Manganese ores occurs in the shale/argillite. The ore is concentrated during the process of lateritisation and also appears to be structurally controlled. Psilomelane is the most common ore mineral followed by pyrolusite.

3. Chitradurga Schist Belt

In the Chitradurga schist belt manganiferous formations are traceable discontinuously over a strike length of 180 km from Doddaguni in the south to Kandavada in the north. The manganese ores are stratigraphically confined to an argillite and metacherts overlying the conglomerate, orthoquartzite and basic volcanics with Banded Iron Formation at top. The ore is of syngenetic type. The ore minerals are psilomelane, pyrolusite, cryptomelane and wad with iron, clay and quartz as the gangue minerals.

4. Shimoga Schist Belt

In the Shimoga schist belt, there are many deposits in Shikaripura area between Tarlagette and Kageenahalli, Ballur, Hosakoppa, Tuppur block and other areas. Manganese ores are associated with chlorite schist, dolomitic limestone, phyllite interbedded with ferruginous and manganiferous quartzites and meta acid volcanic rocks. The manganese deposits of Shimoga district are mostly ferruginous in nature.

The ores are meta-sedimentary, sedimentary oolitic, cavity filling replacement and float ore types. Most of the manganese ore deposits are of secondary supergene enrichment type. They are stratigraphically confined to the argillite and ferruginous quartzite. The manganese ores found in the deposit are psilomelane, pyrolusite and cryptomelane.

III) Madhya Pradesh

Madhya Pradesh is the third important state in the country as far as manganese ore resources are concerned. It has 55.73 million tonnes of resources of manganese ore. Out of these 35.00 million tonnes (63%) are categorized as reserves and remaining 20.73 million tonnes (37%) are put under remaining resources. The manganese ore resources in the state are distributed amongst 5 districts namely Balaghat, Chhindwara, Jabalpur, Jhabua and Katni. District-wise resources of manganese ore in Madhya Pradesh with important deposits are given in **Table: 4.7**.

Table: 4.7- District-wise Resources of Manganese Ore in Madhya Pradesh

(In '000 tonnes)

Sl No.	Name of District	Reserves	Remaining Resources	Total Resources	Important Deposits/Mines
1.	Balaghat	21,787	17,894	39,681	Ukwa, Balaghat, Sukli, Sitapatore, Katangjhari, Mirgapur
2.	Chhindwara	1,718	806	2,524	GowariWadona, Lodhikheda
3.	Jabalpur	9,606	1,880	11,486	Gosalpur, Gandhigram, Kurro
4.	Jhabua	1,659	153	1,812	KajaliDongri, Amaliyamal
5.	Katni	223	-	223	Jhinna

Source: NMI 2010

The important deposits of manganese ore in Madhya Pradesh are discussed below:

1. Ukwa Deposit

The Ukwa manganese deposit occurs within the Sitasaongi and Mansar formations of the Sausar Group. Manganese ore is interbanded with quartzite. The ore is either massive or banded and consists of braunite, hollandite, bixbyite, pyrolusiteand cryptomelane. Braunite is the dominant constituent. Hematite occurs in close association of braunite and bixbyite.

2. MirgapurDeposit

The Mirgapur manganese ore deposits constitute the NE portion of the arcuate manganese belt of Madhya Pradesh and Maharashtra stretching over a length of 200 km and with a width of 25 km at its central part. The ore occurs as thin bands, pockets and stringers, intercalated with quartz and pegmatite.

IV) Maharashtra

Maharashtra is endowed with 34.15 million tonnes of total resources of manganese ore. Out of these resources, 12.32 million tonnes (36%) are put under reserves category and balance 21.83 million tonnes (64%) are remaining resources. The resources of manganese ore in the state are distributed in only two districts, namely, Nagpur and Bhandara. Nagpur district has 18.51 million tonnes of total resources. District-wise resources of manganese ore in Maharashtra with important deposits are given in **Table: 4.8**.

Table: 4.8 – District-wise Resources of Manganese Ore in Maharashtra

(In '000 tonnes)

Sl No.	Name of District	Reserves	Remaining Resources	Total Resources	Important Deposits/Mines
1.	Bhandara	4,507	11,134	15,641	Chikla Group, Hiwara, Dongri-Buzurg
2.	Nagpur	7,811	10,700	18,511	Dumri, Satak, Beldongri Block, Kodegoan-Gumgaon-Ramdongri Block, Bhandarbodi, Mansar, Bichwa, Kandri

Source: NMI 2010

The details of important deposits are as follows:

1. Dongri-Buzurg Block

Dongri-Buzurg is the largest known supergene oxidized deposit in Madhya Pradesh - Maharashtra Manganese belt. The manganese ore horizon comprises bands of manganese ore, manganiferous quartzite, gondite and rhodonite. The ore horizon is thickest in its central part and tapers down to about 2 m at the ends.

2. Chikla Mines Block

The manganese ore in Chikla mines is associated with gondite, a regionally metamorphosed manganiferous and non-calcareous rock, characterised by spessartite and quartz with or without manganese silicates showing essentially bedded character.

3. Dumri - Satak - Beldongri Block

The manganese ore occurs associated with gondite and manganiferous quartzite and is of synsedimentary-syngenetic type. In Dumri-Satak- Beldongri Block, three ore bodies have been identified. Manganese ore bands are intercalated with gondite and manganiferous quartzite. The ore is generally hard and lumpy. The ore mainly consists of braunite, jacobsite, pyrolusite and psilomelane with coarse grains and aggregates of spessartite.

4. Kodegoan-Gumgaon - Ramdongri Block

The rock types in Kodegaon-Ramdongri blocks include quartz muscovite schist, sillimanite schist and garnet-muscovite-biotite schist. The formations are intensely folded into tight isoclinal folds plunging towards east at shallow angles. The ore horizon occurs as discontinuous bands and lenses.

V) Andhra Pradesh

Andhra Pradesh possesses 17.60 million tonnes of total resources of manganese ore (4.09%). Out of these resources, 4.15 million tonnes (23.6%) are put under reserves category and balance 13.44 million tonnes (76.4%) are remaining resources. The resources are distributed in three districts namely, Adilabad, Srikakulam, Vizianagaram. The Vizianagaram is the most important district contributing 88.9% of the total resources in the state followed by Adilabad (10.6%) and Srikakulam (0.5%). District-wise resources of manganese ore in Andhra Pradesh are given in **Table: 4.9**.

Table: 4.9 – District-wise Resources of Manganese Ore in Andhra Pradesh

(In '000 tonnes)

Sl No.	Name of District	Reserves	Remaining Resources	Total Resources	Important Deposits/Mines
1.	Adilabad	572	1,284	1,856	Goatkur-Guda Block, PitarikuntaBlock
2.	Srikakulam	-	100	100	Mallikarjuna
3.	Vizianagaram	3,584	12,059	15,642	Garbham Block, Garividi Block Avagudem – Aitemvalasa Block

Source: NMI 2010

The mining of manganese ore started from the state of Andhra Pradesh long back in the year 1895. Manganese ore deposits in Andhra Pradesh occur as localised pockets in the Eastern Ghat metamorphic rocks of the Archeans and Proterozoic Penganga sediments. The deposits associated with the Archaean metamorphics are located in Vizianagaram and Srikakulam districts and those with the Penganga sediments are located in Adilabad district. The manganese ores are generally of low grade with high phosphorus content, and hence, need beneficiation or blending with suitable high grade ores.

1. Garbham Block

Manganese ore deposits of Garbham block occur in the flat topography in which some of the oldest mines of the country are located. The manganese ore is stratiform with intense supergene alteration. Cross folding has resulted into pinching and swelling of the ore bodies.

The hinge portions of the cross folds are the favourable places for manganese ore occurrence. The manganese ore was subjected to intense supergene alteration with development of powdery to medium hard ore consisting of pyrolusite, psilomelane/cryptomelane, braunite, jacobsite, hausmannite and manganite.

2. Garividi Block

The Garividi block is about 20 km SE of Garbham block and is situated in a more or less similar geological environment. The manganese ore in this block defines a single continuous stratigraphic unit, bounded by calc-gneisses and khondalite.

The manganese ore in Garividi block is conspicuously disposed within calc-granulite at the contact of khondalite which forms the footwall. The bottoming up of the ore is manifested by either gradual presence of lean ore rich in silicates or abrupt appearance of garnet biotite gneiss. The crestal portions of the crossfolds are the favourable places for thick and enriched ore zones. The ore is moderately soft, hard and lumpy, and consists of pyrolusite, psilomelane, cryptomelane,braunite, jacobsite, manganite and wad. It is dark black to greenish black in colour.

3. Avagudem-Aitemvalasa Block

The Avagudem block comprises two sectors, i) Avagudem and ii) Aitemvalasa. The rock units of the Avagudem sector consist of coarse-grained quartzite, calc-gneiss khondalite and manganese ore in the area occurs as enclaves.

The Aitemvalasa sector consists of coarse-grained quartzite with layers of fine-grained quartzite, calc-gneiss, manganese ore, khondalite and migmatite. Manganese ore in both Avagudem and Aitemvalasa sectors is dominantly associated with calc-gneiss,where the quality of the ore is superior to the ore associated with quartzite, where the ore is mostly of silicate type. Supergene alternation is intense in calc-gneiss association which is probably due to the higher concentration of manganese (deposited as pure manganiferous sediments).

4. Goatkur-Guda Block

The manganese ore bands in Goatkur-Guda block are associated with the chert-jasper band and as such, have stratigraphical/lithological control. The mineable manganese ore is restricted to the depth of oxidation where the primary manganese bands are enriched to pyrolusite and psilomelane type of oxide ores and is made up mostly of pyrolusite, manganite, psilomelane and wad. The ore is mostly powdery and fine with a small proportion of compact, massive pyrolusite and manganite ore.

5. Pitarikunta Block

The manganese ore deposits of the Pitarikunta block also occur in the same geological milieu as that of the Goatkur-Guda Block and are similar to that of Goatkur-Guda block, shows very little or no metamorphism and contains meager effects of supergene alteration.

VI) Jharkhand

Jharkhand has 13.71million tonnes of total resources of manganese ore. Out of these, 3.45 million tonnes (25.2%) are categorized as reserves and remaining 10.25 million tonnes (74.8%) are put under remaining resources. The manganese ore resources in Jharkhand are located in only one district namely, Singhbhum (West).

Lateritoid deposits of manganese ore of small size consisting of psilomelane and pyrolusite occur near Chaibasa in south Singhbhum district. The manganese ore is also reported to occur close to the iron ore deposits of Noamundi and Gua and west of Barajamda, as lenticular and irregular deposits.

VII) Goa

Goa has total resources of 13.60 million tonnes of manganese ore out of which 0.67 million tonnes are reserves and 12.92 million tonnes are remaining resources. The manganese ore resources of Goa are distributed amongst two districts namely, North Goa and South Goa. Out of the two districts, South Goa is the most important district contributing 84.5% of the total resources and North Goa contributes the balance 15.5% of the resources. District-wise resources of manganese ore in Goa are given in **Table: 4.10**.

Table: 4.10 – District-wise Resources of Manganese Ore in Goa

(In '000 tonnes)

Sl No.	Name of District	Reserves	Remaining Resources	Total Resources	Important Deposits/Mines
1.	North Goa	-	2092	2092	Vaguem, Dabo(Surla), Pedichem,Telachem Temba
2.	South Goa	674	10829	11503	Rivona, Kolamba, Murge, Devan

The state of Goa is endowed with fairly good deposits of manganese ore. Most of the manganese deposits of Goa are located in Sanguem and Quepem talukas of South Goa. The deposits are located near Rivona, Kolamba, Murge, Devan and other areas.

The manganese ore deposits of Goa are lateritic occurring at or near the surface over areas occupied by iron-manganese phyllites. They are irregular lensoid bodies and pockets of varying dimensions. The deposits are lateritised at the surface with concretions of black coloured iron and manganese ores followed at depth by banded manganese ores and then by manganiferous clay or wad. The ore minerals are pyrolusite, psilomelane, partly cryptomelane, and manganite.

VIII) Rajasthan

Rajasthan is endowed with 5.80 million tonnes of total resources of manganese ore. Out of these, 1.78 million tonnes are reserves and 4.03 million tonnes are remaining resources. The resources of manganese ore in Rajasthan are distributed in two districts namely, Banswara and Udaipur. Banswara contributes 91.4% of the total resources and balance 8.6% are contributed by Udaipur. District-wise resources of manganese ore in Rajasthan are given in **Table: 4.11.**

Table: 4.11 – District-wise Resources of Manganese Ore in Rajasthan

(In '000 tonnes)

Sl No.	Name of District	Reserves	Remaining Resources	Total Resources	Important Deposits/Mines
1.	Banswara	1780	3520	5300	Khunta, Ghatia, Tambesara, Gararia
2.	Udaipur	-	510	510	Umira and Chotisar

Source: NMI 2010

Manganese ore deposits in Rajasthan are located mainly in Banswara district. The deposits occur in a belt extending for a length of 20 km in NE-SW direction with width varying from place to place in the area between Gararia. The major deposits are located at Khunta, Ghatia and Tambesara. The major problems with the manganese ore in the area is the high iron and silica content in the ore. The manganese deposits in this area are derived from metasomatic replacement of the phyllites and quartzites by manganese bearing meteoric solution. Deposits/occurrences are also present in Udaipur district near Umiraand Chotisar. Ores consist mainly of braunite, pyrolusite and psilomelane.

IX) Gujarat

Gujarat has 2.95 million tonnes of total resources of manganese ore. All the resources are categorised under remaining resources. These resources are distributed among two districts namely, Panchmahals and Vadodara. Panchmahals is the important district and has 2.18 million tonnes of resources (73.9%) and balance 0.77 million tonnes(26.1%) are contributed by Vadodara district. District-wise resources of manganese ore in Gujarat are given in **Table: 4.12**.

Table: 4.12 - District-Wise Resources of Manganese Ore in Gujarat

(In '000 tonnes)

Sl No.	Name of District	Reserves	Remaining Resources	Total Resources	Important Deposits/Mines
1.	Panchmahals	-	2180	2180	Shivrajpurand Bamankua
2.	Vadodara	-	774	774	Pani Deposit

Source: NMI 2010

These deposits occur in villages of Shivrajpurand Bamankua in PanchMahals and Pani in Vadodara districts. These manganese deposits were first reported in 1869 in erstwhile state of Bombay. The exploitation of the deposits commenced in 1905. The deposits occur as supergene sulphide enrichment in phyllites, quartzites, cherts gneisses and schists of Precambrian Champaner series of the Dharwar System. The rocks are highly folded and metamorphosed. The deposit occurs in bedded form or as irregular nests, veins and lenticular bodies. The manganese mineralisation is structurally controlled, and hence, follows folded structure of the country rocks.

X) West Bengal

West Bengal is the least important state in the country as far as manganese ore is concerned. West Bengal possesses only 0.2 millon tonnes of manganese ore resources and are located at Thakurani in Midnapur district. All the resources are categorized under remaining resources.

Sea Bed Manganese Nodules

Apart from the traditional terrestrial resources of manganese ore, one more type of resource of manganese ore is Sea Bed Manganese Nodules. The river waters flowing to the sea and oceans contain a considerable amount of manganese salts in solution. As per Department of Ocean Development's Report, typical analysis of manganese nodules found in the sea bed is - i) Iron - 20.0%, ii) Manganese - 11.5%, iii) Silica - 20.7%, iv) Aluminium - 6.3%, v) Calcium - 3.8 %, vi) Barium - 0.5%, vii) Titanium - 0.5%, viii) Cobalt - 0.3%, ix) Water - 15.3%, x) Oxygen - 20.4%, xi) Others - 0.7%.

The nodules occur in almost all the deep sea basins witnessing low sedimentation rates. Abundant ore grade deposits are located in Equatorial North Pacific (Clario-clippertone Fracture Zone), Cooks Island and Central India Basin. The studies carried out by various agencies reveal that the world nodule deposits might be about 1.7 to 3.0 trillion tonnes. The distribution and abundance of the nodules depend upon the rate of sedimentation, the length of time available for their accretion and availability of the nucleating material. In general, low sedimentation rate leads to higher abundance of nodules (provided the nucleating material is available). The nucleating material could be rock fragments, sediment lumps, shark teeth, pumice etc. Relatively higher concentration of nodules is observed in areas of submarine volcanic activity due to the abundant availability of nucleating material.

Sea bed manganese nodules were first described by Sir John Murray in 1876. They are found in the shape of potato on the floors of many oceans. They have a dull luster and earthy brown to bluish black colour. The smaller nodules are spherical in shape. They become elliptical or discoidal with increase in their size. Each nodule is composed of one or more nuclei surrounded by discontinuous concentric layers of oxide of manganese, iron and other metals. There are clay layers at irregular intervals showing periods of non-growth with metallic oxides. Larger nodules also exhibit concentric and radial fractures.

Though these nodules are termed as sea bed manganese nodules, manganese is not their only constituent. Iron, nickel, cobalt, molybdenum, copper, zinc etc. are also enriched significantly in these nodules. The better name for these nodules could be 'Poly Metallic Nodules'. It is expected that the commercial exploitation of these nodules will not be commenced in the near future, not at least for manganese.

In India, an average abundance of nodules is reported to be 7.5 kg per sq. m in siliceous ooze area and upto 5 kg per sq. m in red clay area. The availability of nodules is estimated at about 300 million tonnes.

INDIAN SCENARIO

Central Indian Ocean Basin (CIOB)

The Central Indian Ocean Basin (CIOB) is located between Central Indian Ridge and the Ninety East Ridge and bounded in South by the South West Indian Ridge. It receives sediments from the Ganges and Brahmaputra runoffs.

Until two decades ago, there was very little information available on Indian Ocean Nodules. Cronan and Moorby made a comprehensive study of the Indian Ocean Nodules and encrustations. Their study revealed that CIOB is the most promising for ore grade nodules. The preparation of exploration of manganese nodules started in 1977 to meet the country's growing demand for metal. This exploration was taken up with the aim to identify the mine site in Indian Ocean. More than 4 million sq km of sea floor was surveyed by India. The prime areas containing nodules were identified. An application for Indian mine site was submitted as per the United Nations Convention on Law of the Sea (UNCLOS). India was recongnised as "Pioneer Investor" in deep sea bed mining by the UNCLOS in 1982 and the Indian mine site was registered in 1987.

Based on over 420,000 line kilometers of single beam echo-sounding data, three regions of different reliefs have been identified, namely, high relief areas, medium relief areas and plain areas. Three types of sediments were also identified, namely, terrigenous sediments, siliceous sediments and pelagic red clay sediments. Topographic features of the ocean bed have a strong influence on the movement and distribution of water masses, transportation of sediments, chemical activity etc. These features have a substantial impact on the metal enrichment in nodules and their distribution and abundance on the sea floor. Ore grade nodules occur only in the central part of the basin, which is occupied mainly by the siliceous sediments. Maximum occurrence of the nodules is reported on the pelagic clays.

Out of over 4 million sq km area surveyed, two areas of 150,000 sq km, each containing nodules of equal commercial values have been identified. One of the areas has been allotted to India in accordance with a resolution of the UNCLOS. India, thus obtained a registration as the first Pioneer investor and a mine site of 150,000 sq km in the CIOB. Average nodule abundance in this area is 4.39 kg/sq m.

The size of the nodules varies from less than 2 cm to more than 10 cm. Spheroidal and ellipsoidal nodules with rough surface are more common among smaller sizes. The shape is change to discoidal and elongated with increase in size, the largest becoming the polynucleate.

Todorokite is the dominant mineral in the nodules of northern CIOB. They are associated with siliceous sediments rich in montmorillonite, chlorite and illite. Ä – MnO_2 is dominant in the nodules from the southern CIOB. They are associated with pelagic clay sediments. Manganese content is the highest in plains (25.6%) and lowest at hill tops (22.4%), whereas the Fe content is highest at hill tops (8.9%) and lowest in plains (6.96%). Smaller nodules are more rich in Mn, Cu, and Ni than the larger nodules. This could be due to burial of smaller nodules where Mn, Cu, and Ni are supplied by digenesis. Basin depth also influences the size. Nodules from shallow depth are of larger size which contain rock fragments as nuclei and are rich in Co and Fe. The nodules from deeper zones are mostly medium to small size with the nuclei being consolidated mud.

The average concentration of the metals in nodules of different sizes is given in the **Table: 4.13**.

Table: 4.13–Average Concentration of the Metal Content (%) In Manganese Nodules from CIOB

Element	Siliceous Ooze			Red Clay		
	Maximum	Minimum	Mean	Maximum	Minimum	Mean
Mn	34.60	18.10	26.50	29.10	13.20	21.70
Fe	13.60	2.40	6.60	18.70	4.80	9.90
Cu	1.86	0.36	1.12	1.30	0.23	0.52
Ni	1.60	0.64	1.14	1.54	0.32	0.66
Co	0.33	0.06	0.11	0.43	0.12	0.18

Source: *Hand book of Marine Mineral Deposits by David S. Cronan.*

PRODUCTION

The data on production of manganese ore for the period 1999-2000 to 2011-12 is given in **Annexure-4.1**. Analysis of this data indicates there is an overall rising trend in the total production of the manganese ore in the country. In the year 1999-2000, the production of the manganese ore of all grades was reported at 1.59 million tonnes which showed an overall increase of 81% in 12 years and reached 3.06 million tonnes in 2010-11. Production was reported from 141 mines in 2010-11. During 2011-12, production declined to 2.35 million tonnes. There were 18 mines in public sector and 126 mines in private sector which accounted for 47% and 53% respectively, of the all India production during 2011-12.

State-wise Production of Manganese Ore

Although the occurrences of manganese ore are widespread in the country, the production is reported from only few states . Amongst these states, Maharashtra, Madhya Pradesh, Odisha and Karnataka together produced 85% of the total all India production of manganese ore of all the grades in 2011-12 (**Annexure: 4.I**). Maharashtra accounted for 28% followed by Madhya Pradesh (27%) and Odisha (24%) of the total production in 2011-12. States like Goa which were important producers of manganese ore earlier have reduced their production because of the falling grades and increase in depth of mining.

However, with the rising demand, state like Gujarat has again re-opened or re-worked their dumps and produced sizeable quantities of manganese ore. The state-wise production of manganese ore of all grades in 1999-2000 v/s 2011-12 is shown in **Figure: 4.2** and **Table: 4.14**.

Table: 4.14 – State-wise Production of Manganese Ore of All Grades 1999-2000 v/s2011-12

(In tonnes)

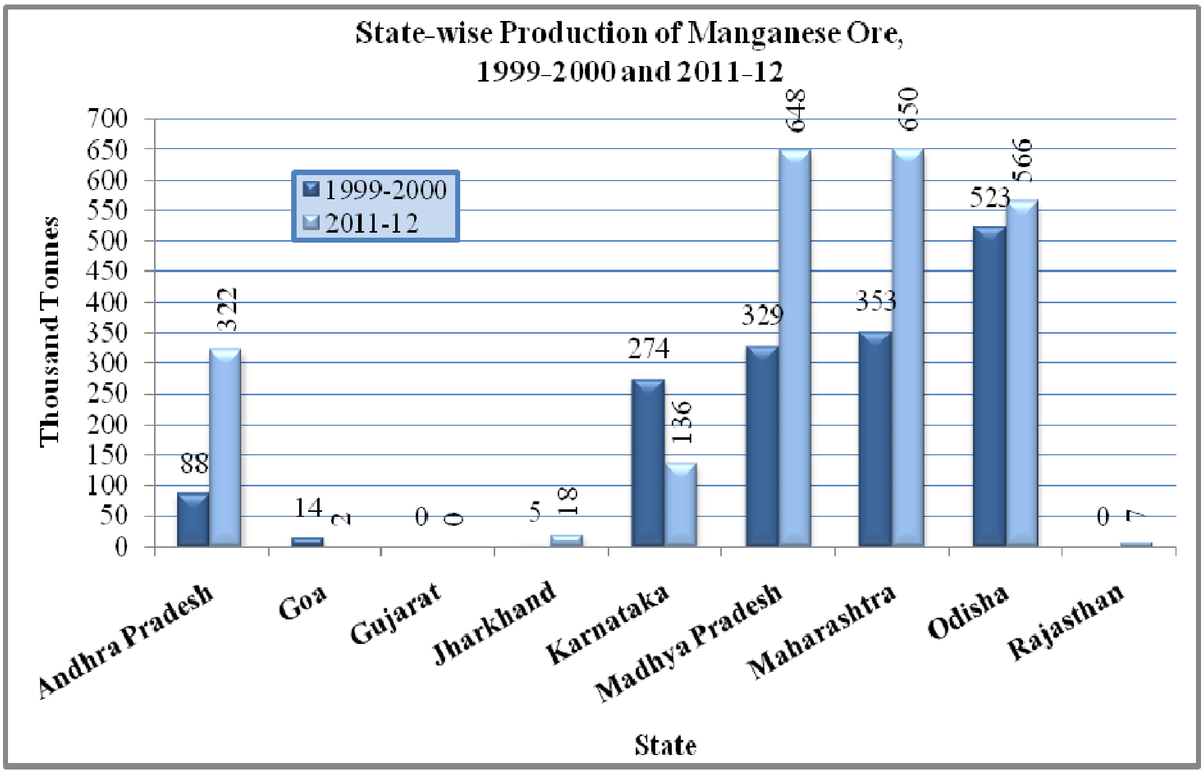
State	Production	
	1999-2000	2011-12
India	**1,585,726**	**2,349,300**
Public Sector	**932,866**	**1,099,243**
Private Sector	**652,860**	**1,250,057**
Andhra Pradesh	87,554	322,087
Goa	14,229	1,550
Gujarat*	-	-
Jharkhand	5,388	18,265
Karnataka	274,052	136,072
Madhya Pradesh	328,698	648,283
Maharashtra	352,584	649,898
Odisha	523,221	565,662
Rajasthan	-	7,483

Source: IBM

** No production was reported in 1999-2000 and 2011-12. However, production of 245.24 thousand tonnes was reported in 2010-11 exclusively of <25% Mn*

The state-wise and district-wise production of manganese ore from 1999-2000 to 2011-12 is given at **Annexure: 4.II.**

Figure: 4.2



Source: IBM

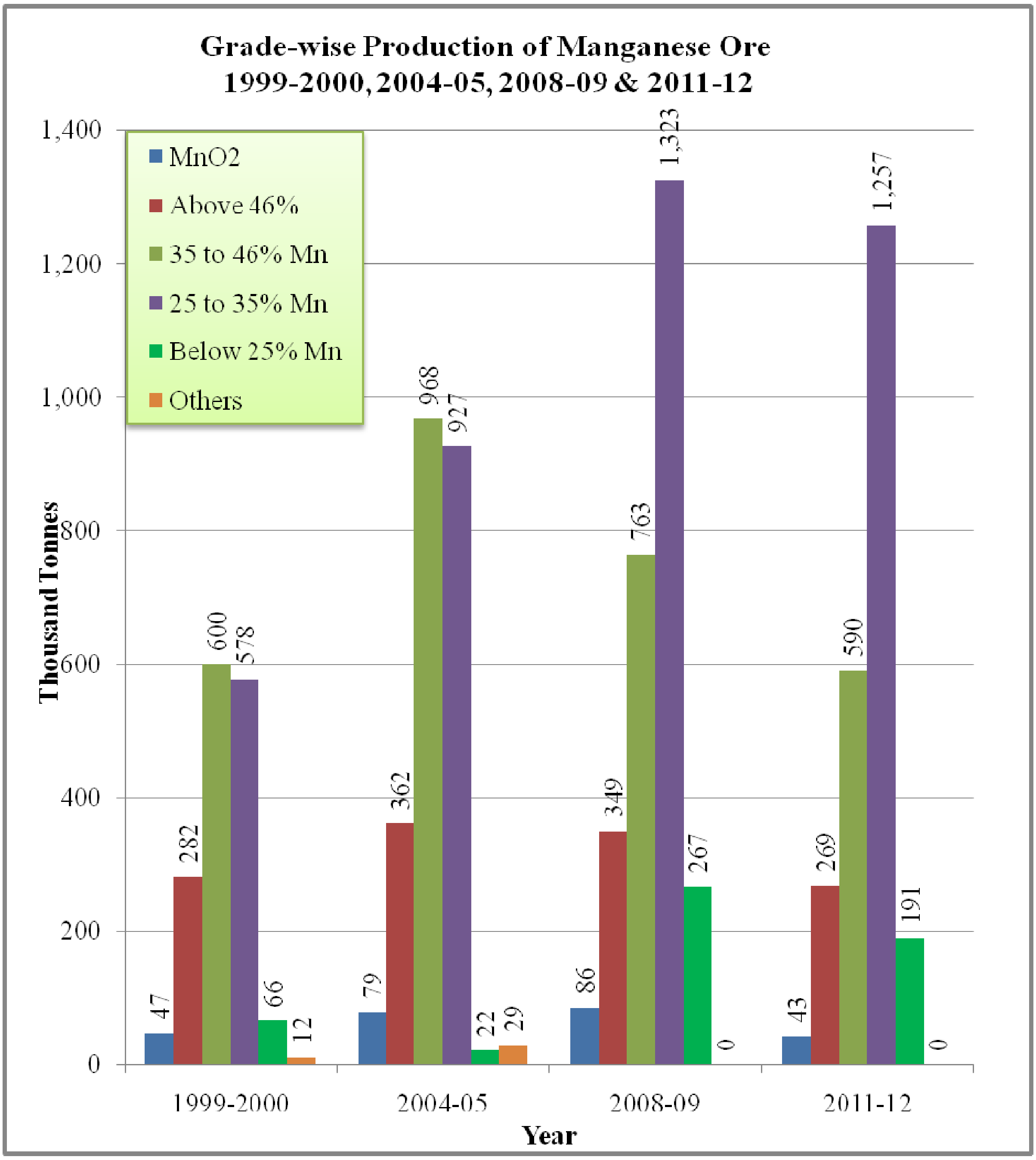
Grade-wise Production of Manganese Ore

The grade of manganese ore is of utmost importance for the end user industry. The production of manganese ore is reported under following grades based on the manganese content of ore.

i) MnO2 ii) Above 46% Mn iii) 35-46% Mn iv) 25-35% Mn and v) Below 25% Mn

The grade-wise production of manganese ore from 1999-2000 to 2011-12 is given at **Annexure: 4.III** and a comparative bar diagram is shown in **Figure: 4.3.**

Figure: 4.3



Source: IBM

It is seen from the **Table: 4.15** that during 1999-2000, the production of 25-35% Mn was 578,068 tonnes, which increased to 1,256,850 tonnes in 2011-12.

The share of various grades in the total all India production of manganese ore during 1999-2000 and 2011-12 is given in **Table-4.15**.

Table: 4.15 – Percentage Share of Grade-wise Production During 1999-2000 v/s 2011-12

(In tonnes)

Grade	Production 1999-2000	% Share	Production 2011-12	% Share
MnO_2	47,402	2.98	42,633	1.81
>46%Mn	281,915	17.78	268,967	11.45
35-46% Mn	599,649	37.83	590,124	25.12
25-35% Mn	578,068	36.45	1,256,850	53.50
<25% Mn (including others)	78,692	4.96	190,726	8.12
Total	**1,585,726**		**2,349,300**	

Source: IBM

The state-wise and grade-wise production of manganese ore during 1999-2000 vis-à-vis 2011-12 is given in **Table 4.16**.

Table: 4.16 - State-wise/Grade-wise Production of Manganese Ore During 1999-2000 v/s2011-12

(In '000 tonnes)

State	MnO_2	>46%	35-46%	25-35%	<25%	Total	MnO_2	>46%	35-46%	25-35%	<25%	Total
Madhya Pradesh	0.59	119.59	152.77	50.22	5.52	328.69	-	179.6	136.92	261.47	70.30	648.28
Odisha	22.89	54.49	182.00	221.51	42.32	523.21	37.18	40.97	189.67	257.67	40.16	565.66
Maharashtra	23.92	105.58	103.44	118.43	1.22	352.59	5.28	48.26	227.81	365.57	2.98	649.89
Karnataka	-	0.65	153.85	107.07	12.49	274.06	-	-	26.57	106.60	2.90	136.10
Andhra Pradesh	-	-	4.59	66.85	16.12	87.56	-	-	87.60	241.37	73.10	322.09
Gujarat*	-	-	-	-	-	-	-	-	-	-	-	-
Rajasthan	-	-	-	-	-	-	-	-	-	7.48	-	7.48
Jharkhand	-	0.12	0.52	3.86	0.89	5.39	0.17	0.15	1.51	15.13	1.31	18.26
Goa	-	1.49	2.48	10.13	0.13	14.23	-	-	-	1.55	-	1.55
Total	**47.40**	**281.92**	**599.65**	**578.07**	**78.69**	**1585.73**	**42.63**	**268.97**	**590.12**	**1256.85**	**190.75**	**2349.31**

Source: IBM

Note: Total may not tally due to rounding off of data.

** No production was reported in 1999-2000 and 2011-12. However, production of 245.24 thousand tonnes was reported in 2010-11 exclusively of <25% Mn*

State-wise & Grade-wise Production of Manganese Ore

State-wise production is discussed below:

1) Madhya Pradesh

Madhya Pradesh is the largest producer of manganese ore amongst the nine manganese ore producing states since many years. Madhya Pradesh contributed 28% of the total manganese ore production in India in 2011-12. The production of MnO_2 is not being reported since 1999-2000. The production of all grades is increasing, except the 35-46% Mn grade which has decreased from 152 thousand tonnes to 83 thousand tonnes in 2010-11 and again increased to 137 thousand tonnes in 2011-12. In the production of the first grade manganese ore (i.e. +46% Mn), Madhya Pradesh occupies the top position. The state contributed 67% in the production of this grade in the country in 2011-12. Grade-wise production of manganese ore in the state during 1999-2000 to 2011-12 is given **Table: 4.17** and depicted in **Figure: 4.4**.

Table: 4.17-Production of Manganese Ore Grade-wise in Madhya Pradesh 1999-2000 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
1999-2000	593	119,592	152,772	50,218	2,891	2,632	328,968
2000-01	-	132,579	133,057	57,330	-	395	323,361
2001-02	-	133,275	113,304	63,143	17,797	2,216	329,735
2002-03	-	141,064	142,301	56,530	3,863	640	344,398
2003-04	-	151,051	132,681	92,237	702	-	376,671
2004-05	-	192,331	123,908	111,512	3,689	13,969	445,409
2005-06	-	196,759	128,567	94,858	4,647	305	425,136
2006-07	-	199,228	142,672	96,892	27,887	8,214	474,893
2007-08	-	201,447	117,498	314,349	40,705	-	673,999
2008-09	-	225,491	100,955	267,204	132,464	-	726,114
2009-10	-	212,431	103,933	158,163	132,621	-	607,148
2010-11	-	198,349	82,979	249,608	185,349	-	716,285
2011-12	-	179,587	136,916	261,475	70,305	-	648,283

Source: IBM

1) Odisha

Though Odisha occupies the first position in the resources of manganese ore amongst the states, it is the third largest manganese ore producing state in the country. In 2011-12, Odisha contributed 24% of the total production of manganese ore in the country.

Odisha is the leading producer of MnO_2 since 2004-05. It produced 37 thousand tonnes of MnO_2 in 2011-12 which was 87% of the total production of MnO_2 in the country. Grade-wise production of manganese ore in the state during 1999-2000 to 2011-12 is given in **Table: 4.18** and depicted in **Figure: 4.5**.

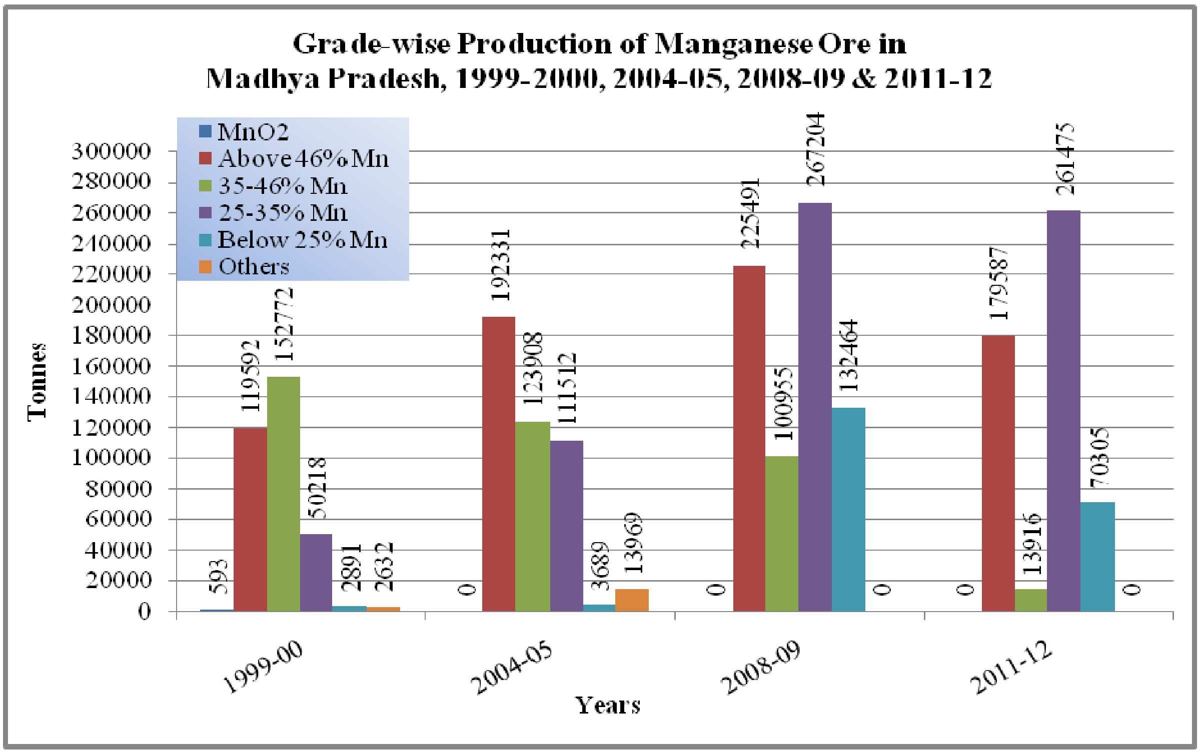
Table: 4.18 -Production of Manganese Ore Grade-wise in Odisha 1999-2000 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
1999-2000	22,889	54,491	182,003	221,514	35,659	6,665	523,221
2000-01	5,888	57,592	212,433	255,323	12,646	2,134	546,016
2001-02	8,030	58,720	221,424	241,129	-	13,378	542,701
2002-03	23,171	73,847	330,304	179,688	12,789	4,627	624,426
2003-04	20,105	57,123	350,501	155,183	13,884	1,591	598,387
2004-05	42,488	75,911	502,468	241,216	600	15,392	878,075
2005-06	60,779	70,634	328,969	151,247	80	100	611,809
2006-07	45,341	71,331	389,497	180,614	-	-	686,783
2007-08	46,678	29,411	279,523	297,839	14,329	-	667,780
2008-09	65,628	43,892	301,479	349,209	79,722	-	839,930
2009-10	52,103	32,413	206,926	253,804	60,067	-	605,313
2010-11	49,563	43,417	250,515	271,528	62,703	-	655,984
2011-12	37,182	40,974	189,667	257,676	40,163	-	565,662

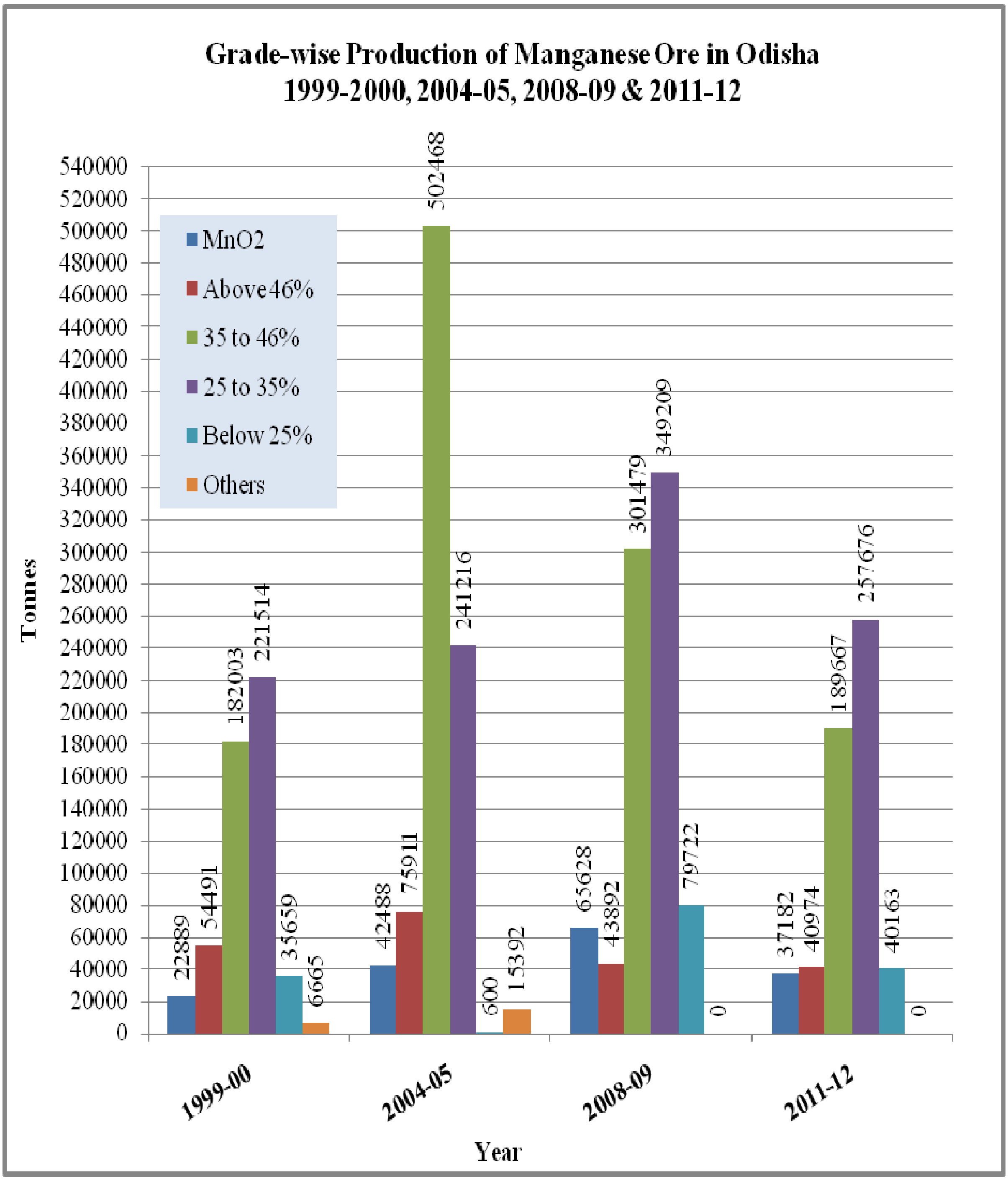
Source: IBM

Figure: 4.4



Source: IBM

Figure:4.5



Source: IBM

3) Maharashtra

Historically, Maharashtra is one of the oldest manganese ore producing states in India. In 2011-12, with 6.5 lakh tonnes of production, it was the leading manganese ore producing state. Grade-wise production of manganese ore in the state during 1999-2000 to 2011-12 is given **Table: 4.19** and depicted in **Figure: 4.6**.

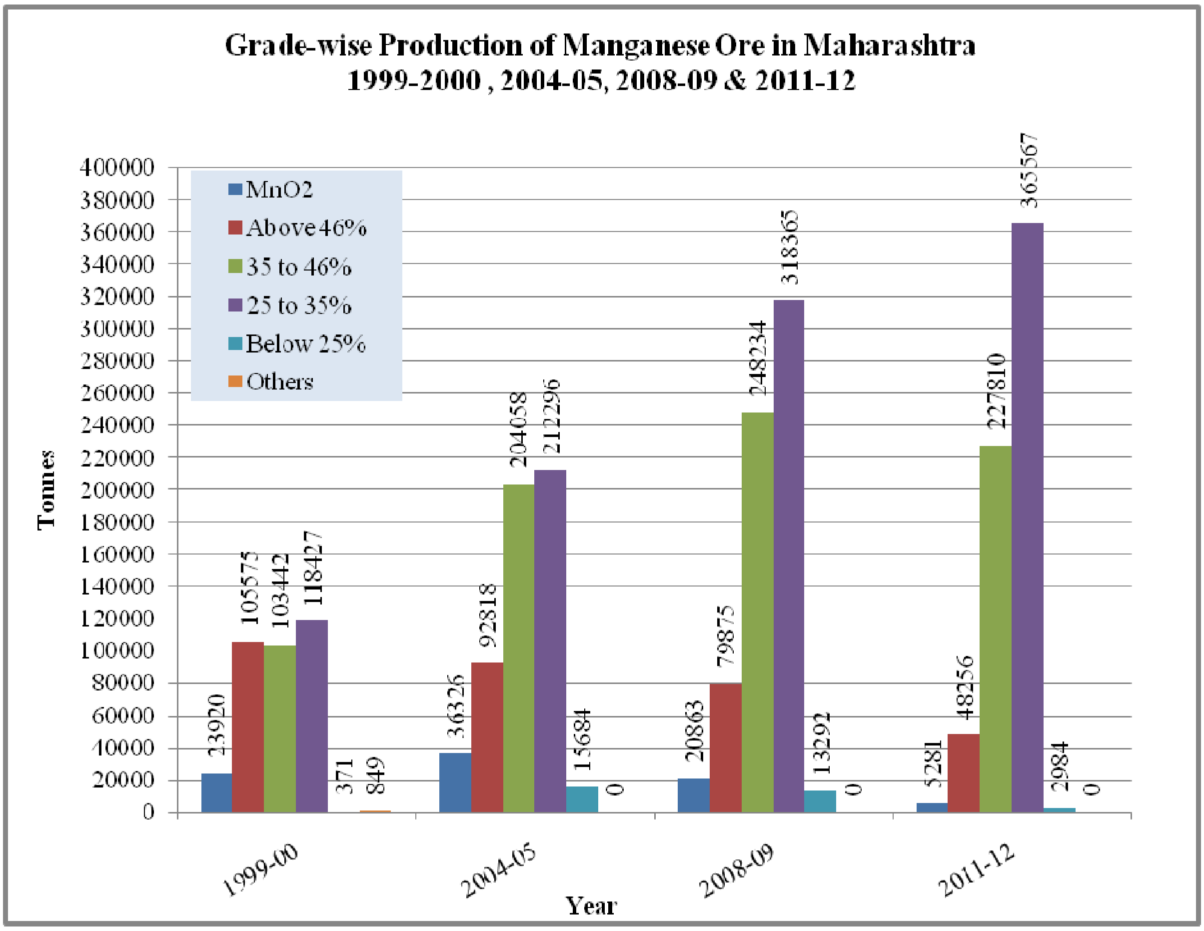
Table: 4.19-Production of Manganese Ore Grade-wise in Maharashtra 1999-2000 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
1999-2000	23,920	105,575	103,442	118,427	371	849	352,584
2000-01	21,254	105,216	115,951	109,046	8,289	2,878	362,634
2001-02	23,676	100,357	170,111	92,291	7,614	1,248	395,297
2002-03	25,106	110,007	170,466	89,426	768	-	395,773
2003-04	36,406	108,721	169,502	133,516	5,307	25	453,477
2004-05	36,326	92,818	204,058	212,296	15,684	-	561,182
2005-06	31,757	72,354	204,655	193,212	9,982	-	511,960
2006-07	31,304	90,898	196,078	281,307	15,342	18,842	633,771
2007-08	33,981	7,525	255,404	467,968	15,386	-	780,264
2008-09	20,863	79,875	248,234	318,365	13,292	-	680,629
2009-10	13,557	82,289	229,935	283,620	4,119	-	613,520
2010-11	4,455	57,026	209,115	397,459	4,773	-	672,828
2011-12	5,281	48,256	227,810	365,567	2,984	-	649,898

Source: IBM

Figure:4.6



Source: IBM

4) Karnataka

Karnataka is the fifth largest manganese ore producing state in the country. Analysis of the production data revealed that during 1999-2000 to 2010-11, the production fluctuated widely from 213,446 tonnes in 2001-02 to 413,287 tonnes in 2010-11. However, during 2011-12 the production was mere 136,072 tonnes. Grade-wise production of manganese ore in the state during 1999-2000 to 2011-12 is given in **Table: 4.20** and depicted in **Figure: 4.7**.

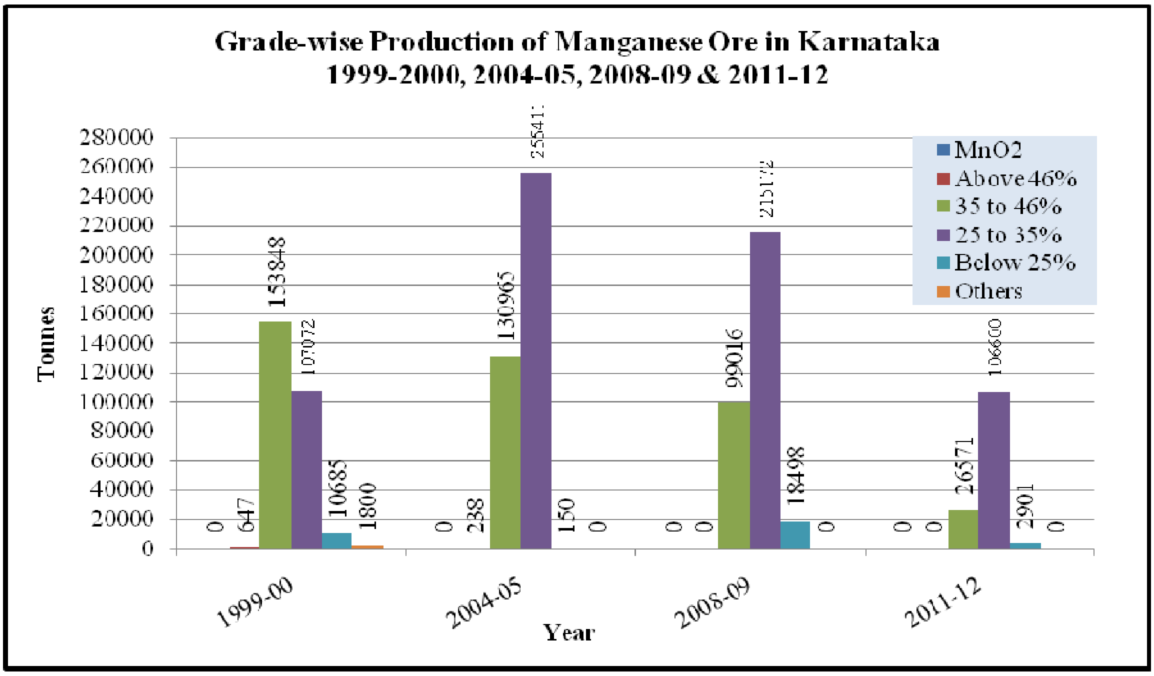
Table: 4.20 -Production of Manganese Ore Grade-wise in Karnataka 1999-2000 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
1999-2000	-	647	153,848	107,072	10,685	1,800	274,052
2000-01	-	351	112,507	102,411	3,613	-	218,882
2001-02	-	369	117,192	95,560	175	150	213,446
2002-03	-	50	108,816	112,886	2,390	820	224,962
2003-04	-	396	102,458	156,370	335	-	259,559
2004-05	-	238	130,965	255,411	150	-	386,764
2005-06	-	12	93,641	173,454	-	-	267,107
2006-07	-	-	84,045	165,807	2,143	-	251,995
2007-08	-	-	116,772	188,289	46,828	-	351,889
2008-09	-	-	99,016	215,172	18,498	-	332,686
2009-10	-	-	68,798	216,379	15,986	-	301,163
2010-11	-	-	64,459	291,327	57,501	-	413,287
2011-12	-	-	26,571	106,600	2,901	-	136,072

Source: IBM

Figure:4.7



Source: IBM

5) Andhra Pradesh

Historically, Andhra Pradesh was the first state reporting commercial production of manganese ore in India in 1892. The contribution of Andhra Pradesh in the production of manganese ore in the country in 2011-12 was around 14 per cent.

The grade-wise production of manganese ore in the state during 1999-2000 to 2011-12 is given in **Table: 4.21** and depicted in **Figure: 4.8**. The data shows that since 2007-08, the production has recorded a rising trend and increased to 322,087 tonnes in 2011-12 from 140,963 tonnes in 2007-08.

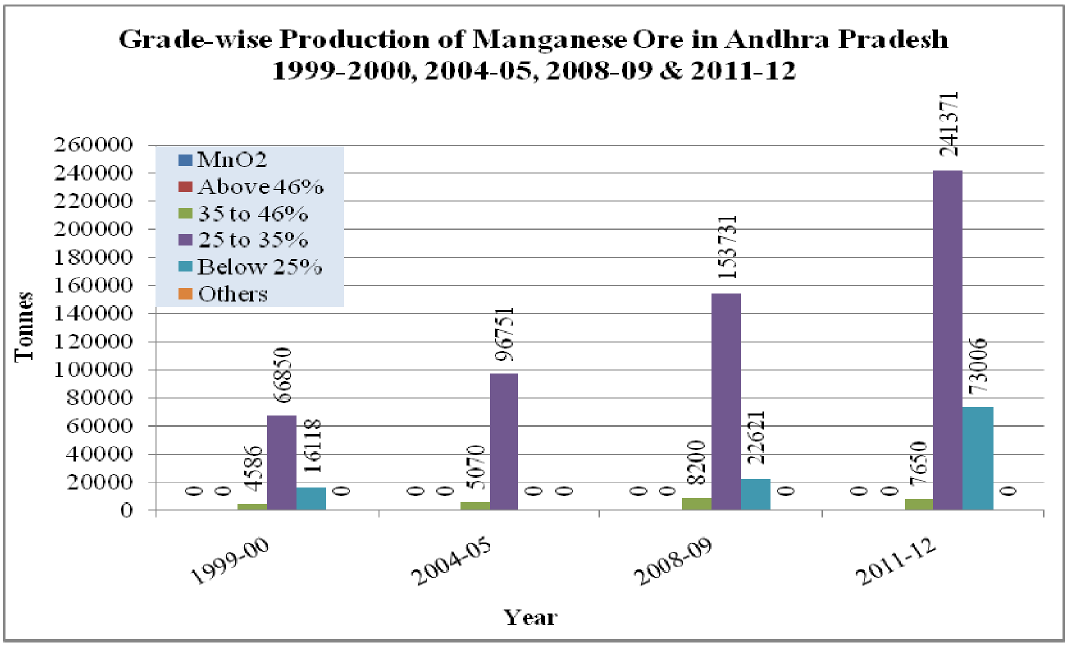
Table: 4.21 -Production of Manganese Ore Grade-wise in Andhra Pradesh 1999-2000 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
1999-2000	-	-	4,586	66,850	16,118	-	87,554
2000-01	-	-	4,964	82,519	43,342	-	130,825
2001-02	-	-	7,106	68,061	19,750	-	94,917
2002-03	-	-	5,932	63,452	3,259	-	72,643
2003-04	-	-	5,217	52,804	-	-	58,021
2004-05	-	-	5,070	96,751	-	-	101,821
2005-06	-	-	2,850	81,597	-	-	84,447
2006-07	-	-	3,650	58,620	2,082	-	64,352
2007-08	-	-	3,020	115,107	22,836	-	140,963
2008-09	-	-	8,200	153,731	22,621	-	184,552
2009-10	-	-	10,470	221,285	28,873	-	260,628
2010-11	-	-	5,600	242,299	42,886	-	290,785
2011-12	-	-	7,650	241,371	73,066	-	322,087

Source: IBM

Figure:4.8



Source: IBM

6) Gujarat

Recently, production of manganese ore was reported in 2009-10. The only grade of manganese ore produced in the state is “below 25% Mn” and the production was 55 thousand tonnes in 2009-10. The production increased by 345% to 2.45 lakh tonnes in 2010-11. No Production was reported during 2011-12. (**Table: 4.22**).

Table: 4.22 -Production of Manganese Ore Grade-wise in Gujarat 2009-10 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
2009-10	-	-	-	-	55,090	-	55,090
2010-11	-	-	-	-	245,240	-	245,240
2011-12	-	-	-	-	-	-	-

Source: IBM

7) Rajasthan

The production of manganese ore was reported from Rajasthan in 2007-08 for the first time. During the production was at 1,454 tonnes. It increased to 16,638 tonnes in 2010-11 but declined to 7,483 tonnes in 2011-12. The only grade of manganese ore produced in Rajasthan is 25 to 35 % Mn. Data on grade-wise production of manganese ore is given in **Table: 4.23**.

Table: 4.23 -Production of Manganese Ore Grade-wise in Rajasthan 2007-08 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
2007-08	-	-	-	1,454	-	-	1,454
2008-09	-	-	-	7,900	-	-	7,900
2009-10	-	-	-	8,443	-	-	8,443
2010-11	-	-	-	16,638	-	-	16,638
2011-12	-	-	-	7,483	-	-	7,483

Source: IBM

8) Jharkhand

Production of manganese ore is being reported from Jharkhand since many years, but the quantity of ore produced is very less. Jharkhand produces very small quantities of all grades of manganese ore except “others”. Production of very small quantity of MnO_2 is also reported from the state from 2009-10 (**Table: 4.24**).

Table: 4.24 - Production of Manganese Ore Grade-wise in Jharkhand, 1999-2000 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
1999-2000	-	118	518	3,860	892	-	5,388
2000-01	-	447	1,677	452	32	-	2,608
2001-02	-	118	812	1,014	-	-	1,944
2002-03	-	328	2,963	1,829	-	-	5,120
2003-04	-	56	611	6,653	68	-	7,388
2004-05	-	110	1,187	4,673	5	-	5,975
2005-06	-	-	179	367	93	-	639
2006-07	-	-	118	405	-	-	523
2007-08	-	-	1,539	10,509	-	-	12,048
2008-09	-	-	5,092	10,952	-	-	16,044
2009-10	96	150	1,284	36,240	2,105	-	39,875
2010-11	196	720	1,889	41,508	585	-	44,898
2011-12	170	150	1,510	15,128	1,307	-	18,265

Source: IBM

9) Goa

Goa is also producing manganese ore since many years and like Jharkhand the quantity is very less. Small production of almost all grades of manganese ore is reported from Goa, except two grades, namely, MnO_2 and Others. The total production of manganese ore of all grades as reported in 1999-2000 was 14,229 tonnes which decreased to 1,550 tonnes in 2011-12 which is negligible as compared to the total production of manganese ore in the country during the same year (**Table: 4.25**).

Table: 4.25 - Production of Manganese Ore Grade-wise in Goa 1999-2000 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
1999-2000	-	1,492	2,480	10,127	130	-	14,229
2000-01	-	1,050	2,982	6,198	902	-	11,132
2001-02	-	890	2,542	5,913	20	-	9,365
2002-03	-	517	3,943	5,982	468	140	11,050
2003-04	-	1,174	3,514	6,562	2,400	-	13,650
2004-05	-	350	414	4,866	1,540	-	7,170
2005-06	-	340	310	3,905	700	-	5,255
2006-07	-	310	160	2,440	550	-	3,460
2007-08	-	-	-	580	-	-	580
2008-09	-	-	250	920	-	-	1,170
2009-10	-	-	770	-	-	-	770
2010-11	-	-	-	240	200	-	440
2011-12	-	-	-	1,550	-	-	1,550

Source: IBM

Chapter 4A

DEMAND & SUPPLY ANALYSIS

THE present internal demand for domestic consumption and exports of manganese ore was arrived at by analysing three important factors. First, the envisaged steel production capacity. Second, production and requirement of ferromanganese and silicomanganese for steel production as well as for exports and the equivalent manganese ore required to produce ferro and silicomanganese. Third, the use of manganese ore directly in hot metal production and other industries for the year 2011-12.

Other statistical methods were also tested to arrive at the present internal demand, namely, arithmetic average, trend line and moving average methods. The forecast made by other agencies, namely, Ministry of Steel, Planning Commission & IFAPA were also analysed. Present internal demand based on end use consumption by steel industry, ferro and silicomanganese production, battery and other industries were found to be realistic, hence adopted. Total present internal demand of manganese ore during 2011-12 have been arrived at 4.10 million tonnes, both for internal consumption as well as exports.

The production of manganese ore in 2011-12 have been reported at 2.35 million tonnes against the demand of 4.10 million tonnes, leaving a gap of 1.76 million tonnes which is met by imports. The future demand forecast have been arrived at (both for short term and long term) by considering the uniform growth rate of 7 per cent in production of crude steel, stainless steel, hot metal and resultant consumption of manganese ore in the production of ferro and silicomanganese and their exports. The growth rate for ferromanganese production has been taken as 10 per cent and that for silicomanganese, the growth rate has been considered as 12 per cent. The growth rate of 6 per cent has been considered for battery industry and other industries.

The present production of manganese ore is less than the demand, or in other words, the country is deficient in manganese ore supply and the requirement of end use industry is met through imports.

To analyse the future demand vis-à-vis production of manganese ore, it is felt necessary to forecast the production of manganese ore at least for the short term. To arrive at the future production of manganese ore, past production data from 2000-01 to 2011-12 was analysed to arrive at an average growth rate of production at 5.09 per cent on year on year basis. This growth rate has been utilized to forecast the production of manganese ore considering the Business As Usual. The total demand vis-à-vis production forecast by adopting a growth of 5.09 per cent thus arrived from 2012-13 to 2016-17 is given in **Table: 4A.1**.

Table: 4A.1- Projection of Manganese Ore Production and Future Demand (2012-13 to 2016-17)

(In million tonnes)

Year	Production Forecast*	Future Demand	Supply Gap
2012-13	2.47	4.34	1.87
2013-14	2.59	4.66	2.07
2014-15	2.73	4.98	2.26
2015-16	2.86	5.34	2.48
2016-17	3.01	5.71	2.70

**By adopting a CAGR of 5.09 % on year on year basis.*

It is seen from the table that there is a gap of 1.87 million tonnes in 2012-13 to 2.70 million tonnes in 2016-17. To meet the requirement of industry, the country has resorted to imports which will continue in future, as far as short term forecast is concerned.

The Working Group on Mineral Exploration and Development (other than Coal and Lignite) for the XII Five Year Plan constituted by Planning Commission has adopted a growth rate of 8 per cent on year on year basis till 2016-17 and as per the Core Group-II Report on Raw Material and Infrastructure issues in Iron and Steel for XII Five Year Plan, constituted by Planning Commission has considered a growth of 7 per cent in manganese ore industry in India. These growth rates seems to be on higher side as the projected production by working group in 2011-12 was 4.56 million tonnes and by Core Group-II, the production of manganese ore have been forecasted at 3.09 million tonnes as against the actual production of 2.34 million tonnes during the same period. In view of this, the growth rates of Working Group as well as Core Group have not been considered.

As far as long term forecast demand is concerned the similar methodology, as adopted for short term forecast, has been adopted. The long term forecast from 2017-18 to 2029-30 is given below in **Table: 4A.2.**

Table: 4A.2- Demand Forecast of Manganese Ore (2017-18 to 2029-30)

(In million tonnes)

Year	Demand Forecast
2017-18	6.12
2018-19	6.53
2019-20	6.97
2020-21	7.50
2021-22	8.03
2022-23	8.55
2023-24	9.13
2024-25	9.79
2025-26	10.47
2026-27	11.22
2027-28	11.99
2028-29	12.85
2029-30	13.72

To meet the demand in long term, it is presumed that after implementing the guidelines laid down by the Working Group and plans of MOIL, there will be increased indigenous availability of manganese ore and dependence on imported ore will be reduced considerably.

Measures/Recommendations for Augmentation of Manganese Ore Supply

A. The Working Group on Steel Industry for the XII Five Year Plan, Ministry of Steel has also suggested measures under Development and Policy Recommendations for Manganese Ore. The major recommendations are as below:

i) Manganese ore production will have to be raised to fully meet the domestic demand by enhancing output from the existing mines and by opening additional virgin deposits. The industry can raise supply of manganese ores by acquiring mines overseas.

ii) Focused attention is needed to ensure higher rate of recovery of manganese and improve the quality of the ores by engaging beneficiation and sintering processes.

iii) Geological Survey of India (GSI) may undertake extensive drilling to identify new ore deposits in higher depths. Deep-sea nodules can be a potential resource for manganese in the future.

iv) Renewal of mining leases and grant of new leases can be expedited by a single window clearance system, especially in respect of obtaining environment and forest clearances.

v) Infrastructure development, such as railways, roads and ports, linking the mining areas to the consumption areas and export markets may be taken on priority basis so that the overall transportation costs are lowered.

vi) Since the manganese ore is not widely traded and there is no benchmark price domestically available, it is recommended that a third party and neutral e-market portal may be developed. The industries, both the ore producers and the ore consumers such as ferroalloys and the steel may together support such a venture.

vii) With technological advancement, the specific consumption rate of manganese in steel making has reduced from 46 kg per tonne to as low as 30 kg per tonne. There is a need for development of techno-commercially viable value added intermediates for exports like beneficiated manganese ore agglomerates such as sinter and pellets.

viii) R & D is required for reclamation of old mined out areas, and to ascertain the impact of manganese mining on the ecology (air and water).

B. The Sub-Group-II Report of the Working Group on Iron and Steel for XII Five Year Plan (2012-17). Ministry of Steel recommendations are as follows:

i) India is deficient in high grade, low phosphorous manganese ore reserves. As large consumers are directly importing, for small consumers necessary support through PSU needs to be extended.

ii) In view of significant increase in demand for manganese ore by XII Plan end, the production capacity needs significant augmentation and, correspondingly, reserves and resources also need to be augmented. Investor-friendly atmosphere for exploration/exploitation of low-grade, low tonnage, scattered deposits and to discover high-grade deposits has to be created.

iii) India should acquire mines of high-grade manganese ore deposits available in SouthAfrica, as a part of raw material security.

C. Future Plans of MOIL

i) MOIL will invest Rs. 1,200 crore in a phased manner to increase production to over 2 million tonnes by 2020 from the present production of 1.1 million tonnes. It has ambitious plans to expand and diversify and is taking up several mining projects. Recently, MOIL has been allotted 597 hectares more area for prospecting and mining of manganese ore.

ii) MOIL is exploring possibilities of joint venture for operation and production of ferromanganese and silicomanganese with Steel Authority of India (SAIL) and Rashtriya Ispat Nigam Ltd. (RINL) for setting up ferroalloy plants at Bhilai (Chhattisgarh) and Vizag (Andhra Pradesh), respectively.

The joint venture companies are working towards expeditious installation of the plants. Similarly, MOIL, in association with National Minerals Development Corporation (NMDC), as part of its global expansion, has invited proposals for production of manganese ore and other minerals through expression of interest. It has initiated plans for acquiring mining properties in other countries like South Africa, Brazil and Australia. This could either be in the form of acquiring a stake in a company with an operating mine or through the outright purchase of a yet-to-be-developed mine.

D. Present Resources Status of Manganese Ore

Present resources of manganese ore of all grades have been placed at 430 million tonnes as on 1.4.2010 as per NMI. The share of reserve is only 33% and the balance 67% falls under remaining resources.

It is presumed that the resources will be brought under reserve category by the exploring agencies, thus making way for new mining ventures. This will further enhance the indigenous availability of manganese ore. Technological development in beneficiation of low grade ore, sintering and agglomeration can further enhance the availability as well as utilisation of low grade ores and fines.

Chapter 5

MINING

HISTORY

THE history of manganese ore mining in India has passed through an interesting phase since late 19th century. The discovery of manganese ore was made by noticing that railway contractors were breaking up the blocks of manganese ore for ballast. The existence of manganese ore in the Vizagapatanam (erstwhile) district of Madras state (erstwhile) was known since 1852. In the year 1891, a syndicate was formed to work the deposits, now known as Kodur Mine. Later in 1895, the syndicate was converted in to the Vizianagaram Mining Company Ltd to work the Garbham deposit. This is the first recorded event of commercial production of manganese ore in India.

The success of the Vizianagaram Mining Company Ltd naturally brought others into the field, and as a result, by 1898, various deposits in the district were discovered. Until 1899, Vizagapatanam (erstwhile) was the only district in India producing manganese ore. In the same year, Vizianagaram Mining Company Ltd also prospected some areas in Nagpur district of the Central Provinces and Berar.

In the year 1900, Central Provinces Prospecting Syndicate was formed to work the already known deposits of Mansar and Koregaon and newly discovered deposits of Gumgaon, Ramdongri, Kandri, Beldongri, Satak and Lohdongri. In the same year, work was started on the Mansar deposit and the first shipment took place in the year 1900. In the year 1901, the same syndicate started work on a very large deposit near Balaghat town in the district of Balaghat and has since then extended its operations to other deposits in the same district. In the year 1903, the syndicate started work on the Chikla and Kurumura deposits in the Bhandara district. The total production of this syndicate from these three districts had so increased that it reached to 1/6th (about 17%) of the total output of the world for the year 1906.

The success of this syndicate led others to prospect the same areas in the Central Provinces for further deposits, with the resultant discovery of the large number of previously unknown deposits.

In the beginning of 1902, M/s Charle's Jambon and Cie of Calcutta (erstwhile) started work on several deposits in Nagpur district. In 1905, this company started to open up various deposits in the Bhandara district, namely, Kosumbah, Sukli, Hotora, and Miragpur.

In the year 1902, in Chhindwara district, manganese ore deposits were discovered by a syndicate named M/s Gow Smith, Dundas Whiffin & Co. Some of these deposits are Kanchi-Dhana, Sitapar and Gowari. Apart from the Central Provinces, there were many areas like Jhabua State in Central India, South of Chaibasa in (erstwhile) Bengal State and presently in Jharkhand, Talevadi in the Belgaum district of (erstwhile) Bombay and presently in Karnataka State which were explored.

In the year 1924, the 'Central Provinces Prospecting Syndicate' was renamed as 'Central Provinces Manganese Ore Company Limited' (CPMO). It continued to run extensive mining operations for manganese ore within the present day state of Madhya Pradesh (erstwhile Central Provinces) prior to Independence of India. The Memoirs of Geological Survey of India volume XXXVII, The Manganese Ore Deposits of India by L. Leigh Fermor was referred for the details of history of manganese ore in India.

In the year 1962, a company was set up in the name of Manganese Ore (India) Ltd by Government of India. Subsequently in 2010, the company was renamed as 'MOIL Limited'. It is presently operating 10 mines (seven underground and three opencast) and produces about 1.10 million tonnes of manganese ore per annum.

Other deposits of manganese ore in India were discovered in the erstwhile states of Bengal, Bombay, Mysore and Sandur. The deposits of manganese ores and manganiferous iron ores situated to the south of Chaibasa in the Singhbhum district in the state of Bengal (erstwhile) have been known since their discovery in 1890. During 1907, deposits have been discovered in other parts of Singhbhum and Gangpur region. In 1904, manganese ore was discovered in Talevadi, Belgaum district of (erstwhile) Bombay State. Other area prospected in the state was Shivarajpur in the Panchmahals district. Manganese ore deposits were discovered in Kumri in the Shimoga district of erstwhile Mysore state. Deposits were also discovered at Shankargudda, Hosahalli, Shridarahalli, Gangur and near Shikaripur in the same district. In 1905, a syndicate namely, 'Mysore Mining Syndicate' was formed to take over the concession and mining operation in the identified deposits in Shimoga district. The Ramandurg deposits in the Sandur state were opened up in 1905 and production was started in the same year. Later, production was started from Kannevihalli deposits in the year 1906.

Mining

During the course of century old manganese mining in India, the techniques of mining has witnessed sea change. From the primitive method of quarrying to the modern techniques with a high degree of mechanization, the industry has come of age .

In the early days of discovery of deposits in various parts of India, ore was found scattered on the highest part of the ore ridge. The ore was mined out along the crest by making small pits and whenever the pit starts yielding manganese ore of economic value, it was gradually developed into a working pit or quarry.

As much of the near surface deposits have been already worked out and ore body is found to extend in depth, underground mining has been adopted. In 1957, when manganese market was passing through a boom period, total number of operating mines (excluding Goa)was about 604. As the demand fell during the period of 1960 to 1970, the number of operating mines came down to 373. Again in 1981, number of operating mines was declined to 263. While in the year 1992-93, number of reporting mines was 186 which further declined to 115 in 2000-01. In the year 2010-11, there were 141 operating mines. With the exception of eight underground mines, which are presently under operation in the states of Madhya Pradesh and Maharashtra, all the remaining mines are worked by open cast method.

Method of Mining

The cardinal rule of mine exploitation is to select a mining method that best matches the unique characteristics (natural, geological, environmental, etc.) of the mineral deposit being mined within limits imposed by safety, technology and economics, to yield lowest cost and return to maximum profit. The following two methods are generally adopted:

1. Open Cast Method
2. Underground Mining Method

In addition to these two methods, low grade dumps accumulated over the years were reworked for producing manganese ore and termed as dump working.

I) Open Cast Method

In open cast mining, overburden is stripped and transported upto disposal area to uncover the mineral deposit. Both stripping and mining are conducted from one or a sequence of benches formed to reach deposit.

Open cast mining is classified into two methods based on their mode of operation, namely manual mining and mechanized mining. A generalized flow chart is also placed at **Figure: 5.1**.

a) Manual Mining

In manually operated mine, the height of the bench is normally kept at 1.5 metre. On bench of hard rocks, holes are drilled manually or by pneumatic drill with restricted depth. The holes are charged with explosives and fired by using ordinary detonators. Waste is loaded into tub and pushed manually over the rail lines to the dump yard. Manganese ore is extracted with the help of crow bars, advantage being taken of the division of planes of the ore body. The huge blocks thus detached are broken by using heavy sledge-hammers to a manageable size and then carried down the hill or taken out of the mine. The ore if necessary, is cleaned manually and sized by using small cobbling-hammers and finally piled into rectangular stacks for final dispatch.

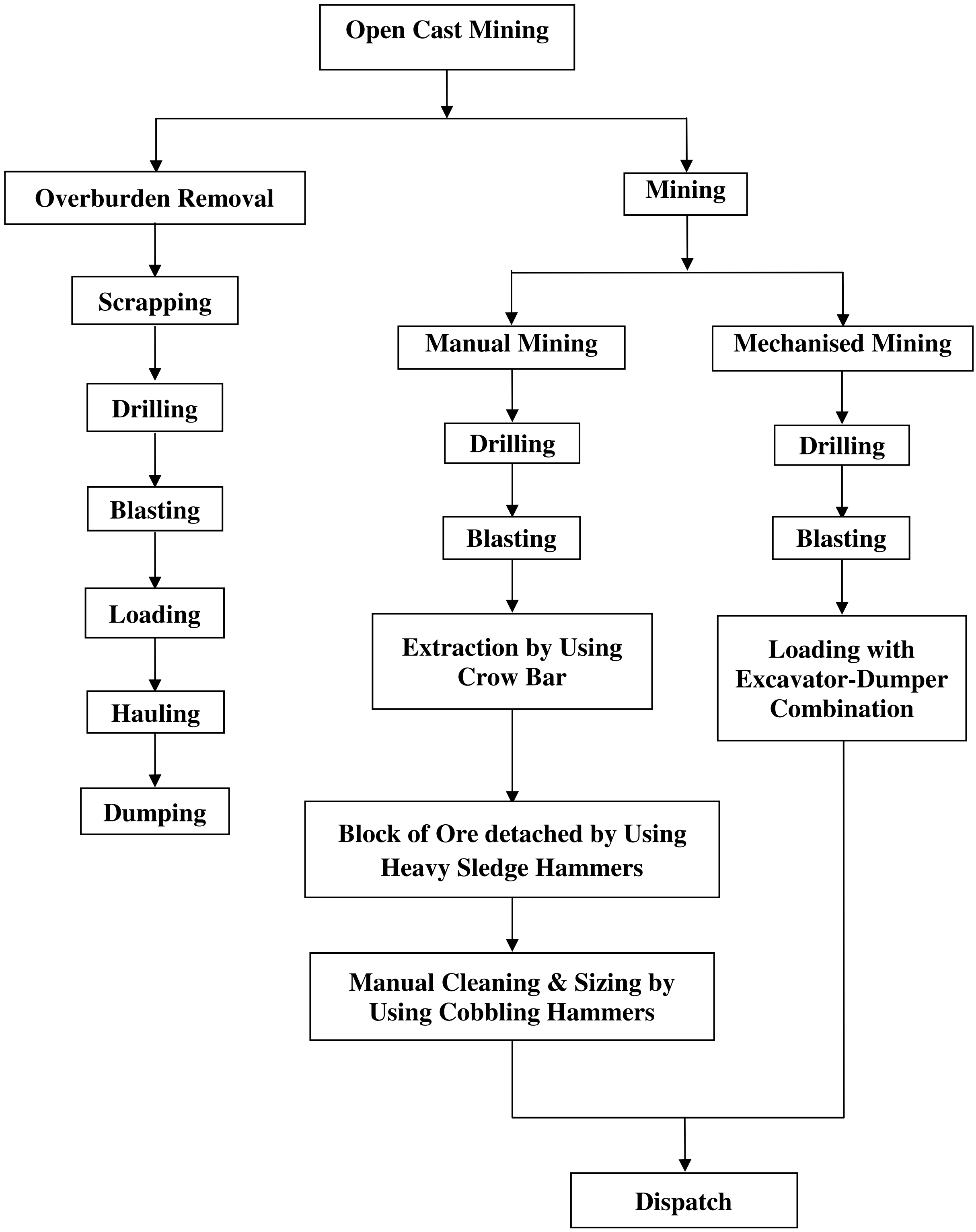
b) Mechanised Mining

In mechanised mining operation, machines are deployed for removal of overburden and ore. Open cast mining centres on the stripping operation. Thus the selection of stripping equipment is the paramount decision to be made. For large scale operations, varying capacity of excavators are being used such as dragline, shovel, etc. In the mechanised mines, the number of benches are more. Each successive bench is being cut to a small radius because of the slope, imposed by safety consideration. Individual benches are to be designed in such a way that it accommodates the material handling equipment. The height of the bench is limited to the reach of excavator and the width must be sufficient to accommodate most of the fly rock from a bench blast and provide enough maneuvering room for excavators and haulage units. In majority of the open cast manganese ore mines in India, Shovel-Dumper combination are used for removal of overburden and extraction of manganese ore. Dongri-Buzurg opencast mine, Garbham opencast mine are the examples of mechanised open cast mining, whereas Sandur opencast mine is an example of semi mechanised mining.

Open cast mining is classified into two methods based on their mode of operation, namely manual mining and mechanized mining. A generalized flow chart is also placed at **Figure: 5.1**.

Figure: 5.1

Flow Chart for Manganese Ore Open Cast Mining



II) Underground Mining

During the early days of manganese ore mining in India, majority of the deposits were worked by open cast method. Depending upon the cost economics, ratio of overburden to ore and continuity of the ore beyond depths which do not permit open cast mining, underground mining has been adopted.

Irrespective of method of mining, the basic development remains the same, which consist of access to the ore body, which is either through adit or incline or shaft or combination of any of these. These entries also act as a main transport arteries of the mine. Horizontal development through ore drives on levels, cross-cuts and vertical development through raises, winzes.

The sequence of underground mining operation is given in flow chart at **Figure: 5.2**. The detailed description of underground mining have been discussed in a case study of Balaghat underground mine.

The most influencing factors in selection of underground mining method are ore and rock strength, strata condition, presence of ground water, rock temperature, gradient etc. There are four types of stoping methods mainly practiced in Central India for extraction of ore from underground mines, which are discussed as follows:

1. Cut & fill stoping
2. Open stoping
3. Square-set stoping
4. Caving method of stoping.

1) Cut and Fill Stoping

The cut and fill method is the most commonly practiced stoping method in the underground mines having widely competent rock mass.

In this method, normally an overhand mining method is followed. Horizontal slices of ores are extracted in the stope and voids are filled with waste rock generated during development work in the mines. If the waste rock is not available or not suitable, tailing or sand from the surface is hydraulically slurried and piped in underground for filling of voids in the stope.

2) Open Stoping

In open stoping method, no filling is used to support walls and only simple form of scattered timbering is used as a temporary support. The openings to the deposit are driven horizontally in regular or random pattern to form pillars for ground support. These pillars are generally formed in waste or in low grade ores.

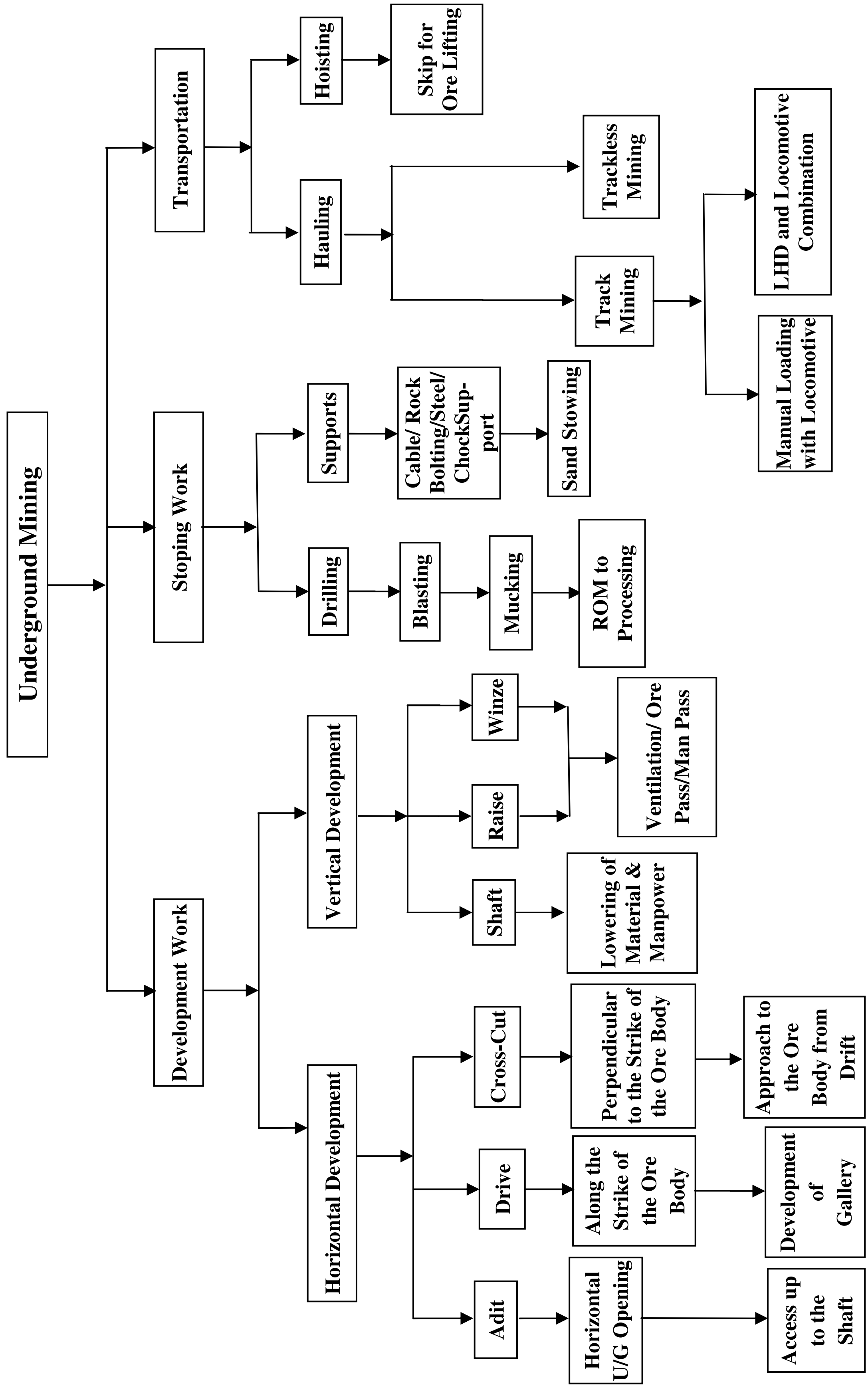
Nowadays, this method is not much practiced as the trend is for mechanisation in open stopes. In the past, with slower working method, it was possible to work by open stoping in weaker wall rocks by leaving pillars of low grade in-situ.

3) Square- Set Stoping

The square-set method of stoping is useful where the ground condition and roof strata are weak. In this method, small blocks of ore are systematically extracted and replaced by a rectangular

Figure: 5.2

Flow Chart of Manganese Ore Underground Mining



framework of timber sets. These timber sets are framed into an integrated support structure and backfilled it floor by floor. For erection of square-set, it is essential to wedge, brace or block each timber in place to preserve the integrity and rigidity of the entire structure. Ore passes and manways are formed in structure along with incline flooring for transportation of ore by gravity within stopes. This method is highly labour intensive, costly and it requires skilled labour for setting the timbers in systematic manner.

4) Caving Method of Stoping

In this method, blocks of ore are undercut to induce caving, permitting broken ore to be drawn off down. Ore body is extracted in descending order by horizontal slices of about three metre thickness. A slices drift is driven from the rise heading along the strike of the ore body, which is also used for passage of ore through appropriate compartments. The ore in the slices are extracted from both sides of drift. After extraction of ore from the stopes, timbering in the preceding stope is removed and the ground is allowed to cave over the entire mineral extracted area of the stope. In this method, dilution of ore with waste rock is very high leading to potential loss of ore. Hence, there is limited chance of selective mining of high and low grade ores from the stope.

Dump Working

In the past, when there was practically no internal market for manganese ore, production was entirely dependent on demand from foreign countries. The overseas buyers were very strict about the physical and chemical specifications of acceptable grade of ores. The prices offered were very low and the transport facilities were poor. As a consequence, the mine operations had no alternative but to resort to selective mining and ore dressing, which in turn, resulted in huge accumulation of dumps containing low grade ores. With the change in technology as well as growing demand for low grade manganese ore, subgrade material which was mixed with waste dumps are now saleable in domestic market.

In the dump mining, work is started by developing benches in 1.2 metre to 1.5 metre height and 1.5 metre to 2.4 metre width. Crow bars and pick axes are generally used to loose and separate out the ores from the waste. While digging, lumpy ore pieces are handpicked, dressed and stacked separately from dispatch. Remaining finer material is screened in the screening plant. The (+) 6mm lumpy ores are further handpicked and balance (-) 6 mm fines are fed to jig for further recovery of manganese ore.

Normally, from the dump mining, recovered ore with grade varying from 15% to 20% are acceptable in domestic market. Generally, it gives a production of both jigged and lumpy ore. The undersize (-) 3 mm material is dumped near the temporary site of the mobile screening plant and the processed manganese ore is dispatched by trucks.

Mining Practices in Important Mines

Some of the mining practices adopted in an individual mines are being discussed below:

I) Dongri-Buzurg Open Cast Mine, District Bhandara, Maharashtra

History

The manganese ore deposit at Dongri-Buzurg was discovered by Geological Survey of India in 1893. In the year 1903, mining was started by Central Provinces Prospecting Syndicate on this deposit. The ore band crops out along the crest on ridge of a range of hills of which it forms the backbone. The strike direction of ore band is South-West to West-South-West at its West end and curls round so as to strike about due East at the East end **(Plate: 5.1)**.

The ore band was first seen on a low hillock at the west end. The band then rises up the main ridge, which has two peaks, the higher Eastern one rising to about 290 feet above Kurumura pond at the East end. It again descends and then crops out on a series of hillocks.

At the Western end of the band and for a long way up to the ridge to the first on western peak, the ore band consists of fine grained spessartite-quartz rock, largely altered to psilomelane, and inter-bedded with pinkish, whitish and dark grey, quartzites. The ore ridge forms the boundary between the village area of 'Dongri-Buzurg' or 'Ponwar Dongri' on the North and the part of Kurumura known as Balapur Hamesha on the South.

In Dongri-Buzurg deposit, a different sort of ore is found. It consists of mix of psilomelane and pyrolusite from which it has variation in gradation from pure psilomelane on the one hand to pure pyrolusite on the other hand.

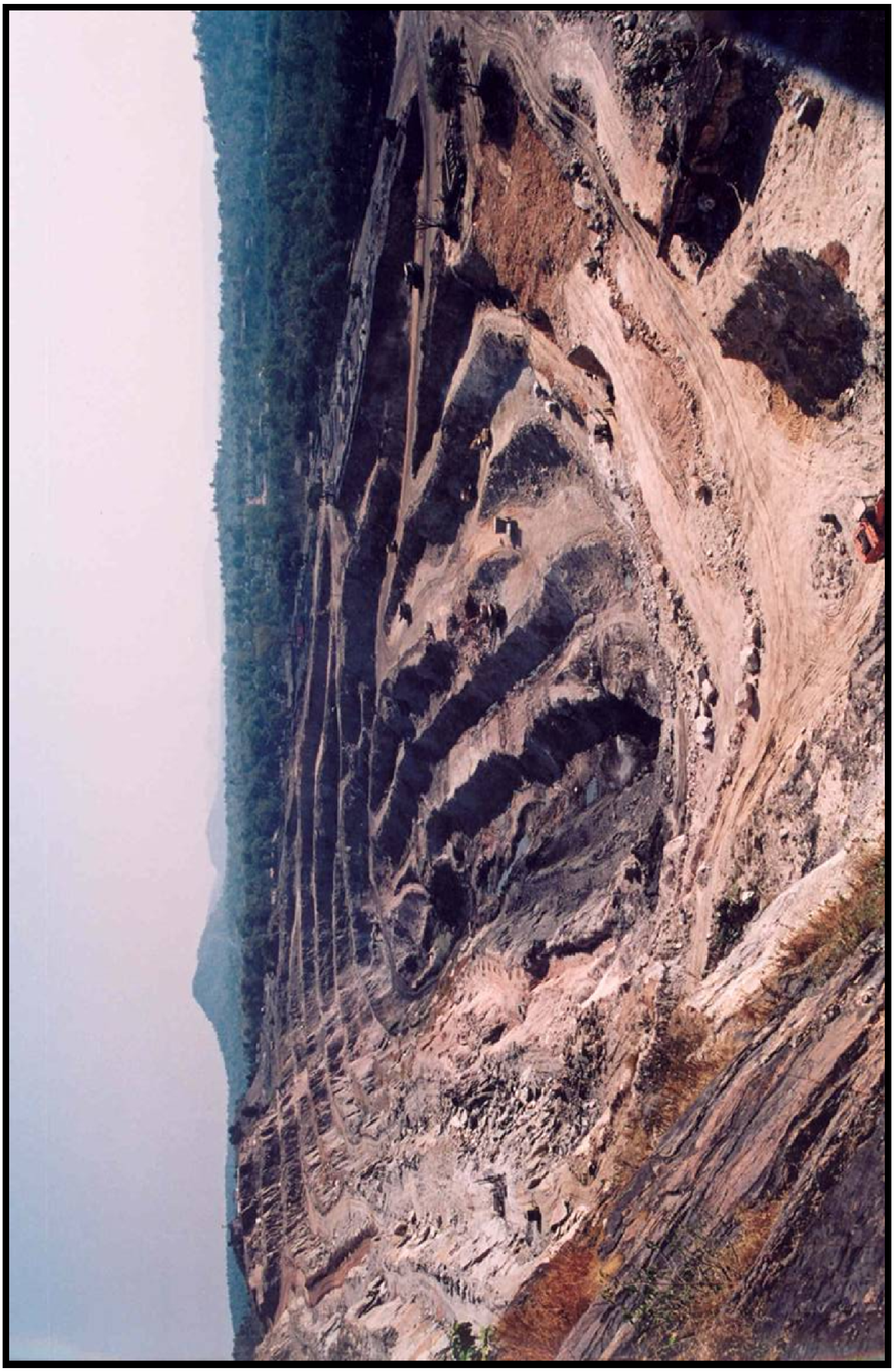
The manganese ore band has been proved to a strike length of 2135 metres in East-West direction with steep Southerly dip at 60^o. The thickness of ore band ranges from 2 to 30 metres, with maximum thickness at central part. Ore horizon comprises of alternating band of manganese ore, manganiferous quartzite and gondite. The principal ore reported from the mine is pyrolusite.

Manganese ore is mined by mechanised opencast method. The ore body is approached by formation of benches along the strike of the deposit. Benches are formed on footwall and hang wall side. Machines are deployed for the removal of overburden and ore. The bench configuration of the mine is height 10 metres and width 12 metres. There are total 15 benches on footwall side and three benches on hang wall side. Mining is done by using shovel-dumper combination along with using auxiliary equipment such as ripper-dozer, wheel loader, grader, etc. There are six numbers of hydraulic shovels having bucket capacity, ranging from 4.5 m^3 to 3.0 m^3 which are deployed for excavation of overburden and ore. Total 24 numbers of dumpers, each having 25 tonnes carrying capacity are deployed for hauling of excavated material.

Deep-hole blasting is being practiced for loosening of overburden. There are five numbers of drilling machines of ICM and ECM make having drilling capacity of 25 metre per hour with 100 mm hole diameter. The excavated overburden is transported to the dump, which is situated at footwall side of the mine and mined ore is transported to the processing plant for further processing.

The annual production capacity of the mine is 3 lakh tonnes. This is the only mine of MOIL which produces manganese dioxide ore. The production of manganese ore comprising of 35% lump, 60% fines in size ranges from (-) 12.5 mm to (+) 6mm and 5% waste. There are about 27 number of

Plate:5.1



Dongri-Buzurg Open Cast Mine, MOIL, Maharashtra

grades maintained at stockpile which is depending upon the manganese content and sizes, available for selling in the domestic market. The major grades at the stockpile for dispatch are Dioxide Ore, DROM, 2nd grade, LGHS, etc.

II) Sandur Open Cast Mine, Dist. Bellary, Karnataka

Sandur Manganese Ore Mine is situated on a plateau in the Deogiri, Subrayanahalli village of Sandur district in Karnataka. In the mining lease area, manganese ore occurs as discrete lenses, pods, pockets and irregular shaped bodies.

The manganese ore deposits are worked by semi-mechanised mining method. Machines are deployed for removal of overburden, whereas extraction of ore is done manually. Working mines are in various shapes and sizes with depth of mine ranging from 20 metres to 152 metres. Development of mine is done by starting the advance of benches from the top bench. Extra width was kept in production benches to facilitate stacking of ore and to provide working space for the production gangs. Roads are developed and modified to provide access to the benches. There are many pits in the lease area which are formed over the period of working. But keeping in view the current requirement, only a few major pits are being worked.

In the year 2010-11, manganese ore production was about 236 thousand tonnes as against 223 thousand tonnes in 2009-10. For further processing of R.O.M, dry crushing and screening plant for sized ore production was installed at the mining site. Preliminary sorting of the manganese ore is done manually at pit head.

III) Garbham Open Cast Mine, District Vizianagaram, Andhra Pradesh

Garbham manganese ore mine is a captive mine of the Visakhapatnam Steel Plant, which is located in Merakamudidam Mandal, Vizianagaram district in Andhra Pradesh. The lease hold area of the mine is 264.54 hectares. The occurrence of ore in the Eastern Ghat is confined in Vizianagaram district. The ore formations in this part of the Eastern Ghat Supergroup of rocks belong to the Precambrian age and manganese deposit mostly occur in pocket type. The ores are mostly friable and fine in nature.

The mining is being carried out by opencast method. The ore body being lensoidal widely varies in width and length. The overburden is removed by deploying HEMM such as excavator-220, front end loaders, dozers and rear dumpers of 10 tonnes carrying capacity.

The low grade and high grade ores are stacked separately and blended suitably for getting the desired composition of manganese ore for use in the steel plant. The current production of the mine is about 1000 tonnes of fines and about 100 tonnes of lumps per month for captive use.

To improve the quality of the ore being mined, company has proposed to introduce drilling and blasting by using 100mm diameter drill for overburden removal and for blasting, cap-sensitive slurry explosive with ammonium nitrate.

IV) Balaghat Underground Mine (MOIL), District Balaghat, Madhya Pradesh

Balaghat Underground Mine is situated at Bharveli village, district Balaghat, Madhya Pradesh. The mine is operated by M/s MOIL Ltd, one of the largest and oldest manganese ore producers in the country. Balaghat mine was started in 1903.

The Balaghat deposit was discovered for the Central Provinces Prospecting Syndicate (CPPS) by an Indian (Zain-Ul-Abadin), who was given a contract and started working in September 1901. During this period, some quantity of ore was extracted. At the end of 1902, the deposit was taken by 'CPPS' for further development work. In the initial working days of the deposit, mining was done by first removing wall rock and then layers of ore from the footwall (East) side by inserting crow bars into the dividing planes, levered over one by one and allowed to fall. Thereafter, they were broken by sledge hammers or when too thick, by lighting wood fire below the fallen mass resulted into unequal expansion of the upper and lower surface of the slab caused it to crack down. There was often a great difficulty in detaching these slabs but it was all done by crow bars, wedges and sledge hammers. The ore was broken up by coolies into a convenient size, passed it for cleaning by using cobbling-hammers.

The strike length of the ore body is 2.80 km having general strike direction NE-SW and dip varies from 25^0 to 85^0 towards NW. The width of the ore body is as thin as one metre at both the ends, whereas it increases to as high as 30 metre in the central portion and thins out on both the sides. Braunite is the principal mineral associated with other minerals such as psilomelane, hollandite etc.

Initially, this deposit was worked by open cast method. The shallow depth deposits gradually depleted and further extension of the ore body in depth was proved. Techno-economic limit of the open cast working was reached and hence, there was an increase in ore to overburden ratio. These factors forced the operator to switch over to underground method. Presently, Balaghat mine is worked by underground cut and fill mining method with pre-mining supports like cable bolts and rock bolts. The cavity is filled with hydraulic sand stowing.

The ore body is approached through shafts namely Hardy's, Edwards and Holmes and main drive from hanging wall side, considering the geo-mechanical properties of the ore-bearing strata and ground condition on both hanging wall and foot wall side, respectively. The first underground level was opened at 2nd and 3rd level through adit. Later, underground working was developed by sinking shaft to approach 4th level and below. 4th level was worked by Hardy's shaft and 5th level was worked by Edward's shaft. The Holmes shaft is sunken upto 12th level and serves the level from 6th to 12th. The old Hardy's shaft which was serving for only 4th level has been widened and deepened upto 10th level and renamed as a production shaft. The deepening of the production shaft is in progress for approaching below the 12th level upto 15th level.

The extraction of ore has been completed upto 8th level. Stoping is being carried out in 9th, 10th, 11th and12th levels simultaneously. At present, Holme's shaft has been sunken upto 12th level and production shaft upto10th level and sinking is in progress for 15th level.

Sequence of stoping operations in Balaghat mine is described below:

1. Stope blocks are developed by driving two cross-cuts from haulage roadway at 30 metre interval and these cross-cuts are interconnected through ore drive.
2. Stripping of ore drive in horizontal slices of 3 metres height, upto full width of the ore body. After completion of 1st slice of 3 metres height, the striping of next slice is subsequently started.

3. A rib pillar of 6 metres width is left in-situ across ore body making 2.4x2.1 metres ore drive across the pillar in footwall contact. The distance of 60 metres is maintained in between two consecutive rib pillars from centre to centre.
4. While stripping, the back of the stope is supported by cable bolt of 16 mm diameter having depth 12 metres in a grid pattern of 2 x 2metres. Additional row of the rock bolts is provided in between the grid pattern of the cable bolts so that the distance between the two consecutive rows of the cable bolts and rock bolts are not more than one metre.
5. After stripping of the ore drive, man-way and ore chute is constructed and raised upto 2.5 metres height. A gap of 1.5 metres is maintained between stope back and manways.
6. After completion of operation, the excavated area is filled upto 2 metres height by sand or rock generated during development heading, leaving a gap of one metre above filled level. First lift of mining is done by raising over man-way and ore pass. The man-way/ore pass will be further extended upto the back of the stope.
7. After completion of stripping operation, construction of chute and man-way and filling of the stripped area by filling material is done.
8. 2 to 5 metres depth holes are drilled with spacing of 0.8 metre and burden of 0.8 metre covering a width of 4.4 m of the ore block. The same is blasted by using explosive and blasted muck is handled manually or by LHD after proper dressing and supporting of roof wall rock.
9. When ore block has been extracted upto 23 metre, one side of the man-way/ore chute will be filled by sand leaving a gap of 1m between stope back and sand bed for the purpose of ventilation. During filling, 2.4 X 2.1 metre passage will be left in footwall for travelling way and 2nd outlet purpose. Another side of man-way and ore pass will be extracted from the next cut.

In Balaghat mine, MOIL has introduced LHD for hauling of blasted ore from stopes to the withdrawal points. After introduction of LHD, the stope productivity is expected to increase from 15000 to 20,000 tonnes per annum.

Mine Support System

In the beginning of the underground operations, chock and prop support method has long been practiced. Later on, the square-set support system has been adopted. The timbers which were used for making square sets were specially brought from Burma. This method allows considerable root convergence and also responsible for opening of joints and sliding of wedges which leads to premature collapses of the stope with the loss of unextracted ore. With the possibility of more difficult ground condition at deeper levels, the square-set support method found to be unsafe as well as low productive. With this scenario, in Balaghat mine, various types of supports are used which are as follows:

i) Sand Stowing

It is the most important support system of Balaghat mine on which the production rests. Water with sand in the ratio of 2.5:1 to 3:1 is mixed in mixing chamber of sand stowing plant and is sent to the void space created by extracting ore on stoping by force. The water drains out and sand settles down and provides support to adjoining strata. In the past, the filling material was dropped in the main fill passes from surface and distributed to different levels. This process consume more time for transporting to the end of stowing location. To avoid these, two sand stowing plants were installed for sand filling, one at channel 2400 and another at channel 5400.

ii) Roof Bolting

This method is most applicable where the immediate roof is weak but where stronger rock occurs on top portions. In this method, a hole is drilled in the roof and at the end; long bolt is anchored by wedging it deep into the stronger rock in the root. Such bolts are placed at suitable distance from each other. Flat iron plates, strips of sufficient strength and thickness are fixed to the other end of the bolts by nuts. The nuts are tightened so that the steel strips press against the roof, and thus, support intervening space between the bolts.

iii) Cable Bolting

It is done for strong support in which layers are stitched. A drill hole of 12 metres depth is done by samba drill machine. After drilling, cement-water mixture in a ratio of 0.45:1 is fed into the hole. In this method, drilling and grouting is done in a grid pattern of 2 x 2 metres. The diameter of the rope is 16 mm having load bearing capacity of 25 tonnes. After excavation of 9 metres depth, another cable bolt is inserted and old cable is cut down.

iv) Waste Filling/Waste Packing

In this method, the waste material is filled in the mined out portion of the mine. Then cement slurry is injected into the weak portion of the ground through notches, which have been drilled to required depth. The grouting pressure is raised systematically from about 20 lbs per square inch to about 60 lbs per square inch in formations.

v) Steel Support with Concrete

These are used when roof pressure is excessive or where the working faces are to be advanced rapidly. It is generally used in cross-cuts nearer to the contact of ore zone.

vi) Rib and Post Pillar

Generally, barren part of the mine is left as a pillar for the mine support. Two types of pillars are used, one is rib pillar and another one is post pillar. If the width of the ore body is more than 12 metres then post pillar has to be left. The distance between two pillars is 20 metres. The width of rib pillar is 6 metres. These natural pillars cannot be disturbed during mining operation.

vii) Chock

These are constructed by placing two length of timber parallel to each other and then by laying two more pieces of timber at right angle to the first set and so on. The hollow enclosure may be filled with rocksor left empty. It is used when immediate support is required.

Chapter 6

PROCESSING

IN almost all the important manganese ore producing countries in the world, the run of mine ores are subjected to some sort of mechanical beneficiation before they are made marketable, either for internal consumption or for export. The manganese ore as mined may not be suitable for utilization in the end user industry and hence, it requires beneficiation to improve its quality by reducing the deleterious constituents. The types of impurities normally present in the manganese ore are metallic, non-metallic, gangue and volatiles. In metallic category, the impurities such as Fe, Pb, Cu, Zn, Ag and As are included. In non-metallic category, the impurities include sulphur and phosphorous. The gangue category includes SiO_2, Al_2O_3, CaO, MgO, BaO and volatiles impurities include H_2O, CO_2 and organic matters.

Depending upon the nature of ore and the techniques employed for removal of impurities present, upgradation of manganese ore may result in the production of a beneficiated product, which is either in the form of coarse concentrates or lumps and fines.

Ordinary ore dressing methods like crushing, screening hand sorting, jigging and heavy media separation of ores produce "coarse concentrate" or lumps at a relatively cheaper cost and are applicable to simple ores, where the common gangue and the manganese minerals are free from gangue at a coarser size.

The more complicated and elaborate beneficiation processes like finer crushing, tabling, magnetic separation, floatation, reduction, roasting etc. are applied to the complex ores where the gangue consists of different types of minerals or is in intimate association with the ore minerals. The beneficiated ore so produced in the form of fines is subjected to agglomeration before any metallurgical use.

Methods of Beneficiation

Depending upon the types of manganese ore, various beneficiation methods are generally employed. Beneficiation methods generally applied is given in **Table 6.1.**

Table-6.1: Beneficiation Processes Adopted Vis-a -Vis Impurities in Ore

Sl No.	Type of Manganese Ore	Beneficiation Methods Applied
1.	Simple ores - generally contain quartz, chert, feldspar, clay amphibole, pyroxene, barytes etc.	Hand picking, heavy media separation, jigging and magnetic separation
2.	Ferruginous ores – generally contains hematite, hydrated iron oxides and magnetite	Magnetic separation
3.	Garnetiferous ores- containing garnet	Electrostatic separation
4.	Complex ores - iron, phosphorous, silica etc.	Hydrometallurgical method
5.	Complex ores and low grade fines	Pyrometallurgical method

A brief description of the beneficiation practices adopted is as follows:

i) Hand Sorting and Picking

This is the most common method used in the manganese mining industry. This method is found to be the most efficient method for dressing of manganese ore on the basis of its specific gravity characteristics, colour and luster. In this method, washed ore is sorted manually according to their size and impurities are removed by picking them from the washed ore. This method is slow and requires more space and manpower as the ore has to be spread out and involves expensive double handling. Presently, a picking conveyor belt is installed in the processing plants on which impurities are removed manually from the moving conveyor belt.

ii) Jigging

In this process, valuable minerals are separated from the gangue when the mixture of the two is allowed to settle in a rising current of water. The heavier minerals, which are usually the valuable minerals settle at the bottom, while the lighter ones rise with the current and are removed from the top. In the early days, hand operated jigs were commonly employed for beneficiating the low grade manganese ores. However, presently, mechanically operated air pulsating jigs are widely used for the removal of impurities.

iii) Tabling

In this method, ores of very fine size can be treated depending upon the nature of association of the gangue and the valuable minerals. In tabling, table consisting of a deck is kept at slightly slopping angle. Deck is fitted with riffles which act as a sinking tank. When the table is given a reciprocating motion at right angle to the flow of the fluid, generally in water, the heavier particles settle down in the riffles because of the force acting upon them and carried along the diagonal line of the table and collected.

iv) Heavy Media separation

In this process, light gangue materials are separated from heavy manganese material in a medium of ferrosilicon in water. The heavy pieces of ore sink in the medium and are separated from the lighter gangue which does not sink. The produced products are directed from drum separator to the vibrating screen, where the material is washed to remove the adhering ferrosilicon.

v) Magnetic Separation

In this method, varying magnetic susceptibility of minerals is being utilized. By varying the magnetic field of separator, minerals of different magnetic susceptibilities can be separated from each other. With low intensity, the highly magnetic minerals first separate and then by increasing the intensity of magnetic current, the minerals lower in the series, having feeble magnetic property can be separated. In case where separation is to be effected in finer sizes, wet magnetic separation is used, provided the minerals are highly magnetic.

vi) Electrostatic Separation

In this process, relative conductivity of various minerals is taken advantage of separating one from another. Basically, the separation takes place between conductors and non-conductors. Metallic minerals which are capable of discharging the charge instantaneously when brought in contact with conducting material are called conductors.

The other minerals, specially the non-metallic minerals, which do not leak the charge when in the field are called non-conductors. In this method, an electric field is applied between the wire electrode and the rotor. When the mixture of conducting and non-conducting material is fed through the field the conducting particles remain unaffected and follow the tangential path, whereas non-conducting particles retain charge and remain pinned down on the rotor in the field. Manganese ores associated with the garnetiferous gangue are generally upgraded by electrostatic separation method.

In case of ore where the conventional ore dressing fail to remove the deleterious constituents, the other methods adopted for the beneficiation of manganese ore are hydrometallurgical and pyrometallurgical method.

Hydrometallurgical Method

In this process, separation of the manganese ore from iron, silica, phosphorous and other impurities present in the ore are accomplished by chemical means. The process generally involves the dissolution of manganese in the ore with gaseous sulphur dioxide, sulphuric acid and ferrous sulphate, ammonium sulphate with nitric acid or concentrated hydrochloric acid.

Pyrometallurgical Method

In this process, the ore minerals are broken down by the action of heat. This is the most common method used for the beneficiation of low grade manganese ore fines. For effective utilization of fines and conservation of mineral resources, it is necessary to make them usable by combining the fine sizes into a suitable size receptible to blast furnace. This is achieved by agglomeration.

A) Agglomeration

Generally, the process of combining smaller particles into large hard mass retaining the identity of the original particles is broadly called agglomeration. Different names have been assigned to agglomeration depending upon the techniques involved in uniting the particles. These are i) Briquetting, ii) Sintering, iii) Pelletising, iv) Nodulising.

i) Briquetting

In this method, fine particles are agglomerated by the application of pressure. Some binder is usually added. The briquettes may be prepared in the form of tablets, balls, rods etc. The most common machine used for briquetting is a double roll machine, where the rolls are of alloy steel and are provided with pockets of desired shape. The briquetting temperature is 100^0 C and pressure applied is 4000 lb per square inch.

ii) Sintering

Sintering technique involves bonding of mineral particles by incipient fusion. This technique is commonly applied for manganese ore fines having size of (-) 6mm. It is well known that manganese ore of size less than (-) 6mm is not used in the blast furnaces. Hanging and slipping of blast furnace generally results when the gas passing through the burden is restricted by excess of fines. This condition is dreaded by all blast furnace operators. Sintering offers solution to this problem of fines which could not be utilized otherwise. The sintering process follows three main steps viz, (i) Preparation of feed, (ii) Fusion of the prepared layer of the raw materials on the sintering machine and (iii) Cooling of the agglomerated mass.

iii) Pelletising

It is an advanced method of sintering where pellets instead of loose mix are fired and heat hardened. It is a method of agglomerating the fine particles by rolling them to form small spheres, the pellets. The wet pellets are subsequently heat treated to impart them required strength. Pelletising involves two basic steps, Balling and Firing. The grounded material is added with a bonding agent such as bentonite, borax, lime, magnesia etc. in adequate proportion and with requisite quantity of water and mixed to acquire plasticity. The mixture is fed to either drums or discs, also known as flying saucers. The balls or green pellets are formed as result of rolling action. These are then coated by rolling in a drum with finely powdered fuel such as coal. These coated balls are next fired and heat hardened on a travelling grate-kiln at a high temperature. Pellets are proved to offer better performance than sinters in the blast furnace. The usual pellet size varies from10 mm to 25 mm.

iv) Nodulising

It involves incipient fusion of particles. This method requires continuous movement between the charge and the equipment and is generally carried out in a rotary kiln at a temperature of 1250^0C to 1370^0C. At this temperature, spherical bodies of different diameters are formed from the particles. Nodulising process is used for practically any fine size but the process nowadays is replaced completely by pelletisation and sintering.

The above descriptions about various processes of beneficiation of ROM ore have been adopted by industries as per their requirements. A large number of small manganese ore mines working in the private as well as public sector either sell ROM or adopt manual means for washing/ jigging for improvement of ore.

MOIL, a public sector company adopts modern means of beneficiation and established modern state-of-the art Integrated Manganese Ore Beneficiation Plant (IMB) at Bharveli mine, district Balaghat, Madhya Pradesh and at Dongri-Buzurg mine Dongri-Buzurg, District Bhandara, Maharashtra. A short description of processes adopted by both the plants is given below:

i) Integrated Manganese Ore Beneficiation Plant(IMB) at Bharveli Mine, District Balaghat, Madhya Pradesh

Bharveli mine situated in Balaghat district of Madhya Pradesh is an underground mine. Owing to large scale mechanisation, there is a dilution of ROM grade by inter-mixing of country rock with the ore. Considering the ever decreasing ROM quality, stringent market requirements and proposed increase in production capacity of the mine, MOIL has set up a modern, cost effective beneficiation plant with a capacity of 5 lakh TPA with state-of-the art technology for up-gradation of low grade manganese ore.

Manganese ore of Bharveli underground mine is hard/ lumpy mainly consists of braunite and other minerals such as psilomelane and holandite. The major physical impurities mixed with ROM are quartzite, schist, country rock, chert, quartz etc. The size of ROM is not uniform; hence primary crushing is necessary before feeding to IMB plant.

ROM is being hoisted by 3.5 tonnes capacity skip through shaft from underground mine and being received at 100 tonnes bunker at crushing and screening plant and fed to vibrating screen having 75 mm aperture. The over size is conveyed to crusher to down size it to (-) 75 mm and then transported through belt conveyer to beneficiation building. The entire (-) 75 mm fraction of ROM is fed to wet vibrating screen with 25 mm aperture. (-) 75 to (+) 25 mm lumpy ore is conveyed to twin hoppers of 800 tonnes each. The (-)75 mm (+) 25mm is reclaimed on three numbers of slow moving picking conveyor belt through vibro-feeder, which is passing through sprinkle to subdue the dust and washing the ore for better visibility to identify the waste rock pieces. Sorted out high grade lumpy ore is transported through conveyor belt to 100 tonnes capacity product bunker for final dispatch.

The (-) 25 mm ore is subjected to wet screening on a vibrating screen of 6mm aperture to obtain (-) 25 to (+) 6mm and (-) 6 mm fraction. Overflow of 6 mm screen is fed to electronically controlled air pulsated coarse jig through 925 tonnes surge hopper. High grade manganese ore concentrate produced from the jig is dewatered and moved through belt conveyor for storing in a storage bin.

Under flow of 6 mm screen is fed to spiral classifier to separate out (-) 65 mesh fines from (-) 6 mm fraction. The under flow of classifier stored in a 30 tonnes surge hopped and fed to electronically controlled air pulsated fines jig for further beneficiation through vibro-feeder. Fines jig concentrates are drained in dewatering screen and stored in a separate storage bin.

Classifier out flow containing (-) 65 mesh fines fraction is drained out and accumulated in four number of slime tank. The settled and dried fines are saleable product of the plant.

Fine heavy materials are trickled down the bed through the jig screen to form jig hutch. The overflow of slime tank is recycled back to the circulating water tank and this water is pumped to top of the building for operation of jigs. The plant is designed with closed water circuit system after settling 80% water is clarified and reused. Rest is lost due to evaporation & absorption but no water is allowed to spell over or discharge outside.

To control the air pollution during screening & crushing operation, two numbers of dust collectors are provided separately at screen and crusher houses. The “State-of-the art” Integrated Manganese Ore Beneficiation Plant is environment friendly. The pollution control system through continuous water sprinkling and provision of dust suppression units has made the plant pollution free.

The Integrated Manganese Ore Beneficiation Plant is a classic example of value addition to the integrated mining operation. The recovery of cleaned ore jumped to 76% compared to less than 50% in old manual system, along with complete recycling and reuse of water. A flow chart of the beneficiation process adopted at the plant is given at **Figure: 6.1** and **Plate: 6.1.**

ii) IMB Plant, Dongri - Buzurg Mine

Dongri-Buzurg mine is a mechanized open cast mine. ROM from the mine is a mixture of soft as well as hard lumpy in nature, mainly consisting of pyrolusite mineral. During mining operation, ROM is mixed with the country rock mainly schist, quartzite, soil, weathered rock, laterite etc. During mining and transportation, huge quantity of fines is generated, which makes it necessary to screen and wash the ore to separate out in various sizes. Certain portion of ores from the weathered zone is subjected to beneficiation activity at IMB plant.

ROM is being received at 100 tonnes bunker at crushing and screening plants. ROM from bunker is fed to vibrating screen having 75 mm aperture. The oversize (+) 75 mm size is conveyed to crusher for further reduction in size to (-) 75mm and then transported through belt conveyor to processing plant. The entire (-) 75mm fraction is fed to single deck vibration screen having 25 mm aperture. (-) 75mm and (+) 25 mm lumpy ore is conveyed to 30 tonnes hopper for final dispatch.

The (-) 25 mm ore is subjected to wet screening on double deck vibrating screen of 10 mm and 1 mm aperture to obtain (-) 25 mm to (+) 10 mm and (-) 10 mm to (+) 1 mm fraction. The underflow (-) 1 mm fraction is stored in a settling tank for recovery of fines.

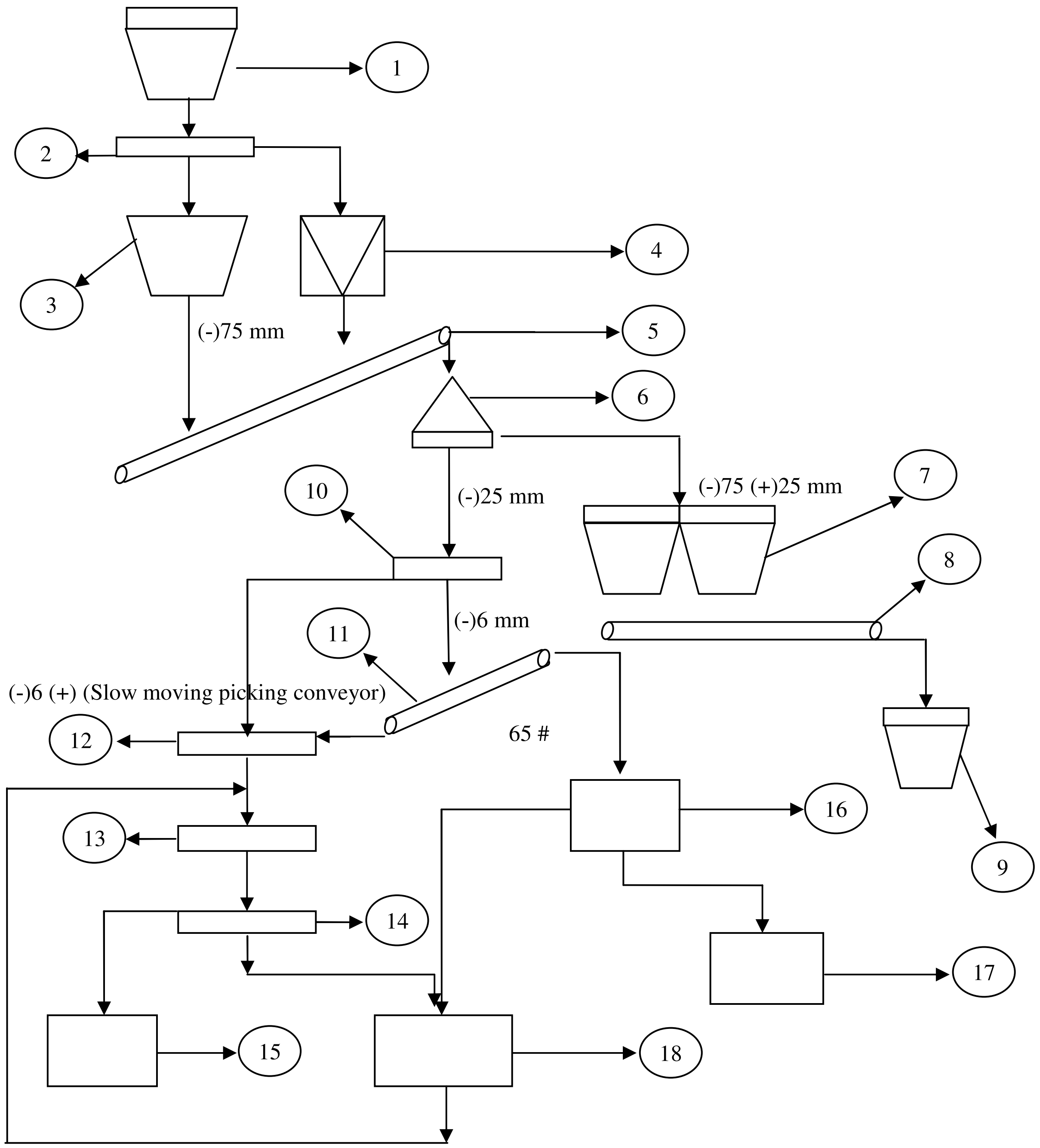
Plate: 6.1

Integrated Manganese Ore Beneficiation Plant MOIL
Balaghat, Madhya Pradesh

(Panoramic View)

Figure: 6.1

Flow Chart of IMB Plant Balaghat Mine



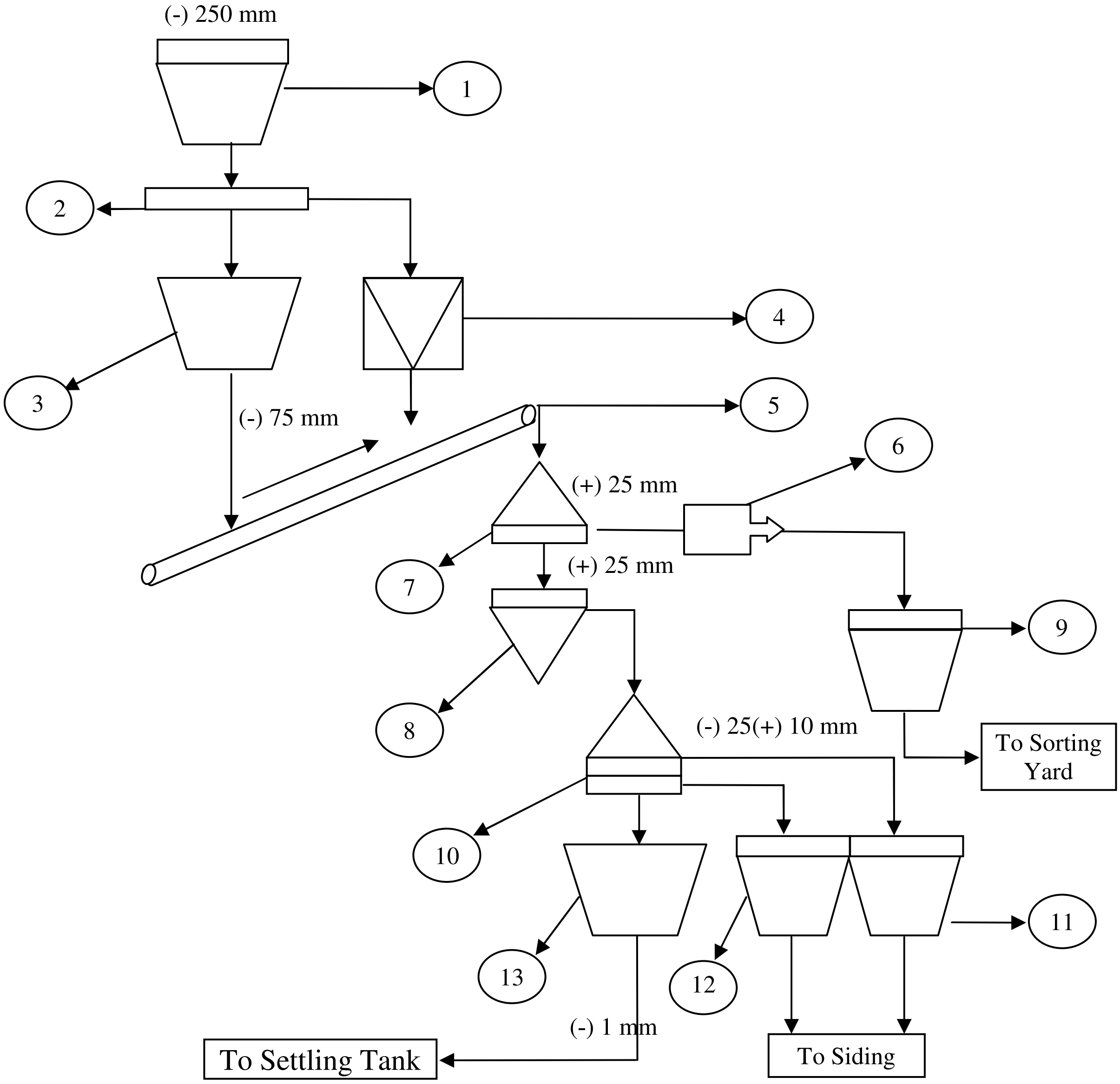
1. 250 Tonnes Bunker	9. Final Product Bunker	17.Stock Yard
2. Vib. Grizzly	10. Vibrating Screen	18.Circulating WaterTank
3. Jaw Crusher	11. Spiral Classifier	
4. Feeder	12.Vibro Feeder	
5. Belt Conveyor	13. Air Pulsating Jig	
6. Wet Vib. Crusher	14. De-Watering Screen	
7. Twin Hopper of 800 Tonnes	15. Storage Bin	
8. Belt Conveyor	16. Slime Tank	

The washed ore (-) 25mm to (+) 10 mm and (-) 10 mm to (+) 1 mm size is transported through conveyor belt to twin hopper having size of 20 tonnes and by using trucks, processed ore is finally sent to sorting yard for hand sorting and stacking.

A flow chart of the beneficiation process adopted at Dongri-Buzurg IMB plant is given at **Figure 6.2.**

Figure: 6.2

Flow Chart of IMB Plant Dongri-Buzurg Mine



1.500 Tonnes Bunker
2. Vib. Grizzly
3.Vib. Feeder Discharge Chute
4. Jaw Crusher
5. Belt Conveyor
6. (+) 25 mm Discharge Chute
7. Vib. Screen
8. S.D. Discharge Chute
9. 30 Tonnes Hopper
10.Vib. Screen D.D.
11. 20 Tonnes Hopper
12. 20 Tonnes Hopper
13. Water Hopper

iii) Electrolytic Manganese Dioxide Plant Dongri-Buzurg

In the Dongri-Buzurg complex, 'MOIL' operates Electrolytic Manganese Dioxide (EMD) Plant. The EMD plant was commissioned in the year 1991 with an installed capacity of 800 tpy. This plant was the second of its kind in the country built using indigenous technology and jointly developed by IIT Madras, NML Jamshedpur and MECON Ranchi, first being the plant of UCIL at Thane which is not in operation presently.

To make EMD, manganese ore is raw material. The manufacturing process involves reduction of raw manganese (MnO_2) to manganese oxide (MnO). Generally, rotary kiln is used for the reduction of the ore using coke, coal, furnace oil or natural gas. Reaction which takes place during reduction process is

$$MnO_2 + Co + H_2 \longrightarrow 2\ MnO + CO_2 + H_2O$$

About 90 to 97% of MnO_2 is reduced to the soluble form MnO during reduction in the region of 800°-900°C temperature. The reduced ore, MnO is preferably wet ground in ball mill to finer particle size for better leaching by acid solution. At Dongri- Buzurg EMD plant, this process is outsourced to major contractor.

At Dongri-Buzurg EMD plant, MnO fines are leached with H_2SO_4 to produce $MnSO_4$ in agitating tank. In this process, temperature at 80°C is maintained with the help of boiler. The main reaction during leaching is as under

$$MnO + H_2SO_4 \quad ^{80deg.C} \quad MnSO_4 + H_2O$$

The produced manganese sulphate slurry is treated in a thicker. The clear solution is filtered so also the thickened sledge. The clear filtered manganese solution is then treated with BaS or H_2S to remove heavy metals like copper, nickel, cobalt and some iron, while the pH is maintained around 5.5 to 6.5 depending on impurities.

The solution after filtration and purification fed to electrolytic cell through a system of ceramic lined pipes in a closed circuit. The cells are made up of mild steel with rubber lining. At Dongri-Buzurg EMD plant, there are total 47 such cells. In an individual cell, a total number of 32 plates of anode charge and 36 plates of cathode charge are placed. The anode plates are generally made up of graphite, lead or titanium, while the cathodes are made from graphite, copper or lead. The anodes are made up of titanium oxide and the cathodes are made up of lead. The temperature of cell is maintained at 80°C to 90°C with 2700 ampere current. The anode and cathode plates are kept alternatively in cells and there is a continuous supply of electric current to the cell.

The overall cell reaction is:

$$MnSO_4 + 2\ H_2O \quad ^{-2e} \quad MnO_2 + H_2SO_4 + H_2$$

It takes about 110 to 120 hours for deposition of EMD on anode plates, generally it is called one heat. One heat produces about 550 kg of EMD. Hydrogen liberated at cathode escapes to atmosphere acting as a gas lift in the cell aiding electrolytic circulation. The cell is kept covered with fiber glass hangers to conserve heat and decrease loss of vapour and acid/$MnSO_4$ along with escaping hydrogen.

Once the EMD deposit reaches a critical thickness, the cell is taken out of line and anodes stripped by using wooden hammers. Washed entrapped acid neutralised with Na2CO3 or NaOH by increasing pH level to about 6 to 7 is produced. EMD is dried with the help of drier at relatively low temperature. EMD flakes are grounded in a ceramic ball mill to 200 mesh size and final product with desired quality is packed in air tight HDPE bags. Depleted cell liquor is regenerated by leaching manganese oxide with sulphuric acid (make up) followed by purification for reuse. It required one tonne of manganese to produce 300 to 400 kg of EMD. The plant is operating at 90-93% efficiency.

EMD plant has its own laboratory facility with latest instruments like Atomic Absorption Spectrometer, Electronic pH Meter and XRF Machine. These instruments are used for real time checking of produced EMD quality and chemicals used in making of EMD. A flow chart of the EMD plant at Dongri-Buzurg mine is given at **Figure: 6.3** and **Plate: 6.2.**

Figure: 6.3

Flow Chart of EMD Plant Dongri-Buzurg Mine

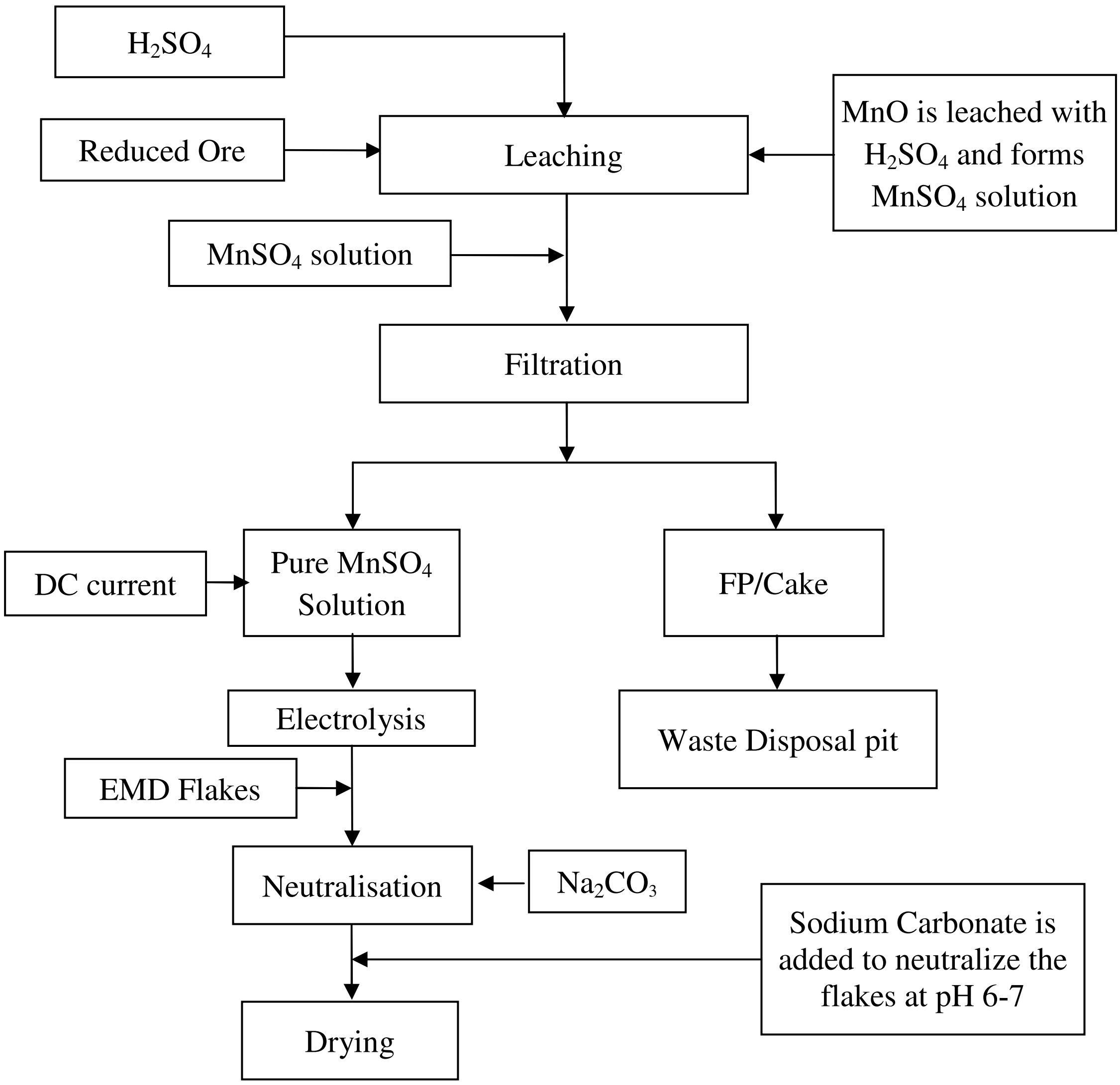


Plate: 6.2

Arrangement of Electrolytic Cells at Electrolytic Manganese Dioxide Plant, MOIL Dongri-Buzurg Maharashtra

5.5 Research & Development

A number of laboratories in the country have carried out beneficiation studies on manganese ore. The Indian Bureau of Mines, the Institute of Minerals and Material Technology and the National Metallurgical Laboratory have conducted large number of ore dressing investigations on manganese ores of different parts of the country as well as on leached sea nodules residue.

The status of beneficiation works carried out by various organisations during past 10 years is discussed below:

A) Indian Bureau of Mines

(i) A sub-grade manganese ore sample from Netra Manganese Mines of M/s Pacific Minerals Pvt. Ltd, Balaghat, Madhya Pradesh was received for an assessment of recovery of marketable grade manganese concentrate from sub-grade ore. The sample as received assayed 26.52% Mn, 6.93% Fe, 33.03% SiO_2 and 5.68% Al_2O_3. Sample is subjected to gravity separation followed by magnetic separation yielded a concentrate assaying 40.12% Mn, 9.01% Fe and 15.00% SiO_2 with 76.3% Mn recovery. The concentrate obtained is of marketable grade.

(ii) A sample of ROM manganese ore from Balaghat mine of MOIL Ltd, Madhya Pradesh was received for pilot scale testing. The purpose of pilot scale testing of the sample is to analyse the effect of scrubbing and to find out any possibility of replacing the existing scrubber and direct wet screening without sacrificing the metallurgical results.

The sample as received assayed 39.50% Mn, 3.80% Fe, 21.68% SiO_2 and 0.09% P. Scrubbing of the as received sample yielded a (+) 6mm product assaying 42.57% Mn, 3.6% Fe, 16.76% SiO_2 and 0.07% P with 76.9% wt. yield. However, screening of as received sample at 6 mm yielded a (+) 6 mm product assaying 41.09% Mn, 3.6% Fe, 18.59% SiO_2 and 0.07% P with 79.2% wt. yield. The result shows that there is a definite effect of scrubbing operation with up-gradation of Mn content of about 1.5% and reduction of silica content by about 2.0%.

(iii) Pilot scale studies were carried out on a low grade manganese ore samples from Balaghat mine of MOIL Ltd to generate four concentrates on the required size ranges confirming to the stipulated chemical specifications. The process comprised of scrubbing, wet screening, classification, hand picking and jigging. The concentrates generated are given as:

Assay	**Percentage**	
Size	**Mn**	**SiO_2**
(-) 75 to (+) 25 mm	51.36	7.39
(-) 25 to (+) 6 mm	49.80	9.36
(-) 6 to (+) 1.5 mm	50.39	5.48
(-) 1.5 mm	36.65	19.41

The overall manganese recovery was 77.7 per cent.

B) Institute of Minerals and Materials Technology, Bhubaneswar

(i) IMMT has conducted beneficiation studies on low grade ferruginous manganese ore of Joda region to reduce iron content in the ore for improvement in the Mn/Fe ratio. Four different types of samples were subjected to WHIMS at 14000 Gauss and 10000 Gauss to separate iron rich minerals. The result shows that there is an improvement in the Mn/Fe ratio which is increased from 1.5 to 3 with Mn content 35 to 42% by using this technique.

(ii) IMMT has carried out mineralogical and geochemical study on Mn ore samples from Koka and Leliguma in Raigada district. The Mn ore from both locations are of low grade type and dominantly contain higher oxy-hydroxide manganese minerals. The gangue constituents are quartz, feldspar and kaolinite. The Koka Mn ore contains about 17% Mn and 25% Fe, whereas the Leliguma Mn ore contains about 23% Mn and 6% Fe but it is rich in phosphorous content. Preliminary beneficiation through roast reduction followed by magnetic separation techniques showed appreciable upgradation of Koka manganese ore.

C) National Metallurgical Laboratory (NML), Jamshedpur

(i) The NML has carried out beneficiation tests on sea nodules residue to produce standard grade Fe-Si-Mn. For this, leached residue was blended with Mn ore/Fe-Mn slag/ Mn Metal to have required Mn/Fe ratio. During processing of polymetallic sea nodules, a substantial quantity of residue containing 20% Mn, 10% Fe and 8% Si is generated.

Attempts were also made to recover the manganese as Fe-Mn-Si by two-stage smelting of leached sea nodules residue without any blending. Several experiments were conducted on a 20 kg scale to optimise the various parameters viz, quantity of reductant, soaking time etc. to recover standard grade Fe-Si-Mn. Based on the above study, the two-stage smelting process decided to be tried on 350 kg scale in the newly set up Fe-Si-Mn pilot plant.

(ii) NML has developed a process on pilot scale for the extraction of metals from the sea nodules following the "reduction roast - ammonia leaching – electro-winning - leach residue treatment" route. The recoveries of metal on pilot scale processing of sea nodules are Cu - 95%, Ni - 95% and Co - 8%. Manganese recovery in the form of standard grade Fe-Si-Mn from the leached sea nodules residue has been made by smelting route on pilot scale with the Mn recovery of about 75 per cent.

(iii) In the year 2007, NML has conducted a study on leached sea nodules for the recovery of manganese nodules. During the study, attempts were made to produce standard grade Fe-Si-Mn alloy by using direct smelting process without using additive. For this, two-stage smelting of wash residue was carried out. In the first stage smelting, small amount of coke was added for selective reduction and separation of iron rich alloy, allowing most of the manganese to remain in the slag. In the second stage smelting, the manganese rich slag of 1st stage was smelted with sufficient amount of coke to get desired grade of Fe-Si-Mn. The Mn rich slag obtained from the 1st stage smelting was subjected to 2nd stage smelting with sufficient amount of coke and standard grade Fe-Si-Mn was produced.

Chapter 7

FOREIGN MARKETS

MANGANESE being an important ingredient in the production of steel and many important alloys is traded in large quantities in the form of ore and in the form of alloys worldover. The countries with large steel and manganese alloy production capacities imports manganese ore to meet their domestic requirement as well as for exporting manganese-based value added products.

In the early 20th century, India was a major exporter of manganese ore as the domestic demand was very low. In the post-independence era, with the increased steel capacity, the exports started decreasing in order to meet the domestic demand. Presently, India has emerged as a major importer of manganese ore to meet the demand of its manganese alloy industry.

In the present chapter, the global scenario of reserves, production, exports and imports of manganese ore and India's foreign trade are discussed.

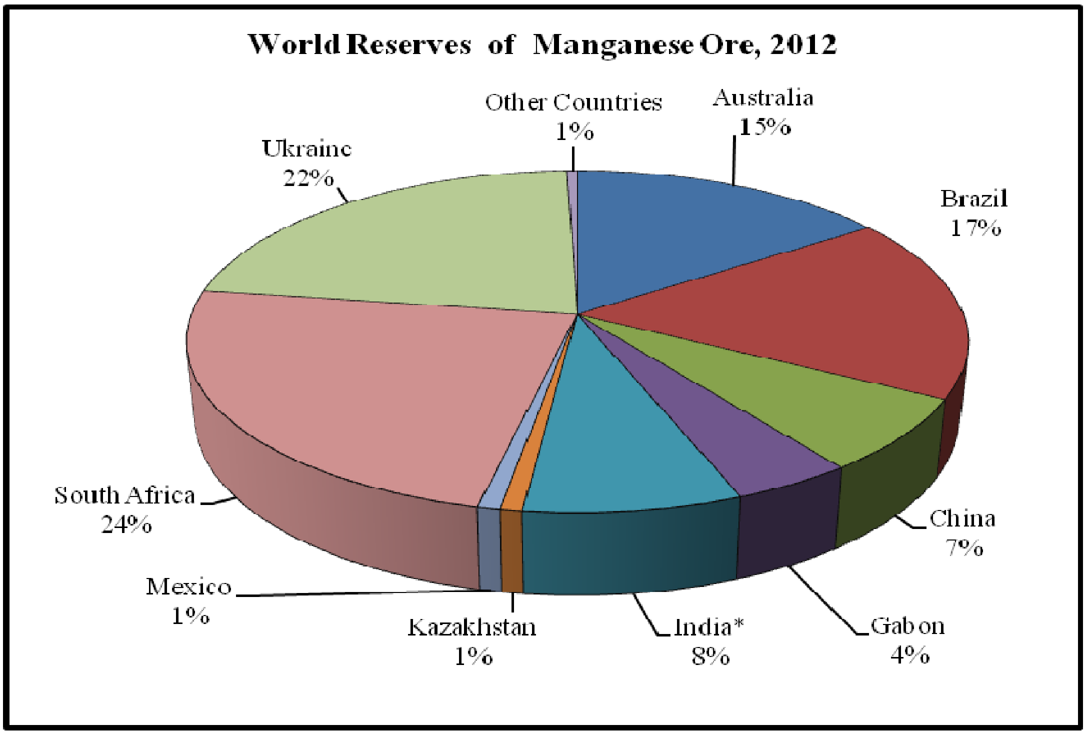
World Reserves

The world reserves of manganese ore in terms of metal content are published by USGS in Mineral Commodity Summaries, an annual publication. As per Mineral Commodity Summaries, 2013, the world reserves of manganese ore in terms of metal content are placed at 630 million tonnes. In the year 2012, maximum reserves of manganese ore in terms of metal content were in South Africa with a share of 24% (150 million tonnes), followed by Ukraine 22% (140 million tonnes), Brazil 17% (110 million tonnes) and Australia 15% (97 million tonnes). The other important countries having significant share in the world reserves are India (8% with 49 million tonnes), China (7% with 44 million tonnes) and Gabon (3% with 27 million tonnes). As per Mineral Commodity Summaries 2013, India's share in the world reserves are 8% (49 million tonnes) out of the total world reserves in terms of metal content. However, as per National Mineral Inventory (NMI) as on 1.4.2010 (prepared by IBM), the total resources of manganese ore in India are placed at 430 million tonnes with 142 million tonnes of reserves. The world reserves of manganese ore are given at **Annexure: 7.I** and depicted in **Figure: 7.1**.

World Production

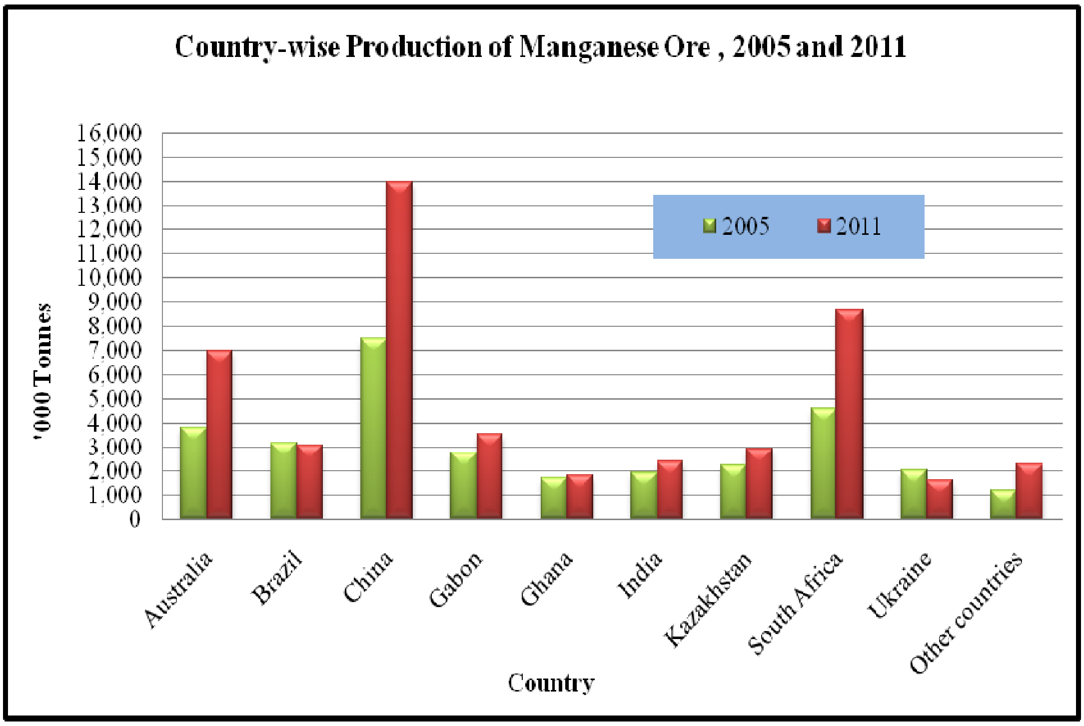
As per the publication, "World Mineral Production" brought out by British Geological Survey, the world production of manganese ore was 30.9 million tonnes in 2005. It increased to 47.3 million tonnes in 2011, showing an overall increase of 153% in last 7 years. However, as per the International Manganese Institute, the world production of manganese ore was 55.4 million tonnes in 2011. The BGS does not publish the production in terms of metal content. As per International Manganese Institute the production in terms of metal content was 17.20 million tonnes during 2011. The world production of manganese ore from 2005 to 2011 is given at **Annexure: 7.II**.

Figure: 7.1



Source: Mineral Commodity Summaries, USGS.
**The total resources of India as estimated by National Mineral Inventory as on 1.4.2010 are placed at 430 million tonnes.*

Figure: 7.2



Source: World Mineral Production of British Geological Survey

In the year 2011, China was the top producer with 14 million tonnes contributing 30% in the world production of manganese ore followed by South Africa 8.65 million tonnes (18%), Australia 6.96 million tonnes (15%), Gabon 3.6 million tonnes (7%), Brazil 2.6 million tonnes (6%) and India 2.39 million tonnes (5%). Remaining 19% was contributed by Ghana, Ukraine, Turkey, Kazakhstan and other countries. The country-wise comparative production of manganese ore in 2005 and 2011 in respect of selected countries is given in **Table: 7.1** and also shown in **Figure: 7.2.** The country-wise production of manganese ore is given at **Annexure: 7.II.**

Table: 7.1- World Production of Manganese Ore During 2005 and 2011 (A Comparison)

Country	2005	2011
Australia	3,829	6,961
Brazil	3,200	3,100
China	7,500	14,000
Gabon	2,753	3,562
Ghana	1,720	1,828
India	1,906	2,387
Kazakhstan	2,208	2,930
South Africa	4,612	8,652
Ukraine	2,000	1,590
Other countries	1,172	2,290
Total	**30,900**	**47,300**

Source: World Mineral Production, British Geological Survey

During 2011, European Union constituted 15 countries reported a production 148.60 thousand tonnes exclusively from Bulgaria. In the rest of the Europe, Turkey reported a production of 72, 000 tonnes.

Amongst CIS countries, Georgia (280,000 tonnes), Kazakhstan (1.1 million tonnes), Russia (120,000 tonnes) and Ukraine (1.34 million tonnes) accounted for a total production of 2.85 million tonnes. In North America, Mexico reported a production of 437,300 tonnes. In South America, Brazil reported a production of 2.82 million tonnes.

In Africa, Egypt (108,000 tonnes), Gabon (4.07 million tonnes), Ghana (1.73 million tonnes), Ivory Coast (43,600 tonnes), Namibia (109,900 tonnes) and South Africa (8.82 million tonnes) accounted for 14.88 million tonnes and in the Middle East, Iran reported a production of 90,000 tonnes.

In the Asian region, China (23 million tonnes), India (2.54 million tonnes), Indonesia (119,100 tonnes), Malaysia (679,600 tonnes), Myanmar (586,000 tonnes), Pakistan (2,200 tonnes), Philippines (4,300 tonnes), Singapore (13,900 tonnes), Thailand (17,200 tonnes) and Vietnam (64,600 tonnes) accounted for 27.03 million tonnes. In the Oceania, Australia (7.05 million tonnes) was the only country which reported production. During 2011, the world production was 55.37 million tonnes. Region-wise contribution is as follows:

Region	Production (In thousand tonnes)
European Union	148.6
Other Europe	72.0
CIS	2848.4
North America	437.3
South America	2815.4
Africa	14878.6
Middle East	90.0
Asia	27029.0
Oceania	7051.2
World Total	**55370.4**

Source: Annual Market Research Report, 2011, IMnI.

Analysis of the production data revealed that Kazakhstan (1.1 million tonnes), Ukraine (1.34 million tonnes), Brazil (2.8 million tonnes), Gabon (4.07 million tonnes), Ghana (1.73 million tonnes), South Africa (8.8 million tonnes), China (23.0 million tonnes), India(2.5 million tonnes) and Australia (7.1 million tonnes) accounted for 51.4 million tonnes i.e. 93% of the world production.

Production of manganese ore is reported from hundreds of mines from different countries. Ten mines in the world have a total capacity of around 22 million tonnes as given in the **Table: 7.2**. Groote Eylandt mine of Groote Eylandt Mining Company Pty. Ltd (GEMCO, a subsidiary of BHP Billiton) in Australia has the largest manganese ore producing capacity of 4.086 million tonnes which is followed by Moanda mine of COMILOG (ERAMET) in Gabon and Mamatwan-Wessels mine of BHP Billiton in South Africa having manganese ore producing capacity of 4.00 million tonnes and 3.4 million tonnes, respectively. The details of these top ten manganese ore mines are given at **Annexure: 7.III.**

Table: 7.2- Leading Manganese Ore Producing Mines by Capacities

Name of the mine	Company	Country	Capacity ('000 tonnes)
Groote Eylandt	GEMCO (BHP Billiton)	Australia	4,086
Moanda	Comilog (Eramet)	Gabon	4,000
Mamatwan-Wessels	BHP Billiton	South Africa	3,400
Nchwaning	Assmang	South Africa	3,000
Azul	CVRD	Brazil	2,500
Urucum	CVRD	Brazil	1,500
Woodie-Woodie	CML	Australia	1,476
Gloria	Assmang	South Africa	700
Molango	Autlan	Mexico	300
Nonoalco	Autlan	Mexico	300

Source: Various Websites.

Top producers: BHP Billiton, CVRD, OM Holdings, Assmang, Comilog (Eramet), ENRC, Consolidated minerals and Autlan are the top producers of manganese ore. The company profiles of these producers are given at **Annexure: 7.XXVII**.

World Apparent Consumption of Manganese Ore

The International Manganese Institute has brought out the Annual Market Research Report for the year 2011. As per this report, the world apparent annual consumption of manganese ore for the year 2011 is estimated at 16.52 million tonnes in terms of metal content. In the year 2011, China was the largest consumer of manganese ore with a consumption of 9269 thousand tonnes (56.10%) followed by Ukraine 871 thousand tonnes (5.27%), South Africa 736 thousand tonnes (4.45%), South Korea 598 thousand tonnes (3.62%) and Norway 459 thousand tonnes (2.78%). The remaining 4590 thousand tonnes (27.78%) was consumed by Japan, Brazil, France, Spain and other countries. The country-wise data on apparent consumption of manganese ore in terms of metal content for the years 2007 to 2011 is given at **Annexure 7.IIIA**.

WORLD TRADE

Exports

Analysis of the trade data for manganese ore published by United Nations revealed that world exports of manganese ore recorded mixed trend during 2005 to 2012. The exports of manganese ore were 15.93 million tonnes in 2005, which decreased considerably to 10.92 million tonnes in 2006, and then exports increased to 18.66 million tonnes in 2012, showing an increase of 9% over the preceding year. The data on country-wise world exports of manganese ore as per United Nations' database is given at **Annexure: 7.IV.**

The important countries engaged in the export of manganese ore are South Africa, Australia, Gabon, Brazil, India, Kazakhstan, and Indonesia. In the year 2012, South Africa was the top exporter of manganese ore with 7.9 million tonnes (42%), Australia 6.8 million tonnes (36%), Brazil 2.1 million tonnes (8%), India 84 thousand tonnes (0.5%), and remaining 13.5% was contributed by other countries such as Indonesia, Ukraine and Zambia and others.

Imports

As per the trade data of manganese ore, published by United Nations, from the year 2005 to 2012, the world imports of manganese ore showed a mixed trend. Since 2005, except in the year 2009, when a number of mineral commodities showed a steep decrease as far as world trade is concerned, manganese ore also followed the trend and decreased by 16.6% to 14.97 million tonnes in 2009 as compared to the preceding year. In 2012, it decreased to 20.37 million tones, registering a decrease of 6% over the preceding year. The country-wise world imports of manganese ore as per United Nations' database is shown at **Annexure: 7.V**

In 2012, China was the traditional top importer of manganese ore with a robust contribution of 61% (12.37 million tonnes) followed by India 12% (2.39 million tonnes), Republic of Korea 6.2% (1.3 million tonnes), Japan 5.7% (1.15 million tonnes) and Ukraine 3.6% (728 thousand tonnes). Remaining 11.5% was shared by France, Russia, Spain and other countries. Since 2007, India, a traditional exporter of manganese ore has become a second major importer of manganese ore.

Region-wise Analysis of Trade

Manganese ore is produced in few countries, but traded in many countries. However, about 20 countries located in different regions of the world are important for one or more aspects like resource availability, production, export or import.

European Union

The European Union consists of 35 countries. Although production is reported from Bulgaria, Hungary and Romania, some of the countries do not report production but import and re-export manganese ore. During 2011, the countries in EU 35 which exported manganese ore and concentrates are as follows:

(In tonnes)

Country	Quantity Exported in 2011
Belgium	9,982
Bulgaria	91,110
France	125,827
Germany	5,035
Netherlands	29,097
Norway	2,600
Spain	623
Turkey	100,172
U.K.	129

The countries in EU 35 are major importers. The importing countries along with the quantity imported are as follows.

(In tonnes)

Country	Quantity Exported in 2011
Australia	334
Belgium	49,393
Bulgaria	133
Czech Republic	28,810
Denmark	1051
Finland	3792
France	647,182
Germany	19,137
Greece	51,374
Hungary	159
Ireland	9,565
Italy	31,269
Macedonia	110,589
Netherlands	33,555
Norway	1,085,383
Poland	4,509
Portugal	56
Romania	66,285
Serbia	14,366

Country	Quantity Exported in 2011
Slovakia	130,519
Spain	508,794
Sweden	438
Switzerland	333
Turkey	1,295
UK	1,656

It could be seen that France, Norway and Spain are important importers of manganese ore.

CIS Countries

The Commonwealth of Independent States (CIS) comprises of countries namely, Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Uzbekistan, Turkmenistan, Ukraine and Georgia. Amongst these countries, Georgia, Kazakhstan, Russia and Ukraine reported production. The important importers are Ukraine (1.24 million tonnes), Russia (231,210 tonnes), while Kazakhstan is an important exporter.

Ukraine

In 2011, imports of manganese ore and concentrates decreased by 7% to 1.2 million tonnes, valued at US $ 497 million. The majority of domestically produced manganese ore and imported manganese ore and concentrates were used to produce ferroalloys and only about 136,700 tonnes of manganese ore and concentrates valued at US $ 18.05 million was exported from Ukraine in 2011. During the same year, Russia imported 231,210 tonnes of manganese ore, from various countries namely South Africa (218,000 tonnes), Gabon (5 tonnes), Brazil (19 tonnes), India (76 tonnes) and 13,110 tonnes from other countries.

Kazakhstan

Kazakhstan is a major exporter in CIS countries and exported 74,376 tonnes of manganese ore to China and 22,238 tonnes to Ukraine in 2011.

North America

In North America, United States and Mexico are important trade point. United States imported 619,218 tonnes of manganese ore mainly from South Africa (80,910 tonnes), Australia (160,792 tonnes) and Gabon (361,394 tonnes).

Mexico, although produced small quantity of manganese ore, imports about 1.22 lakh tonnes mainly from Australia (68,168 tonnes) and Gabon (45,505 tonnes).

South America

In South America, the important countries are Argentina, Chile, Brazil and Venezuela. Brazil is an important exporter. In 2011, it exported 1.69 million tonnes of manganese ore, mainly to China (786,786 tonnes), India (54,515 tonnes), Ukraine (95,671 tonnes), Norway (151,999 tonnes), Japan (58 tonnes), U.S. (9, 500 tonnes) France (454,200 tonnes), Russia (19 tonnes), Mexico (8,244 tonnes), Venezuela (58,384 tonnes), Italy (314 tonnes), Belgium (3,654 tonnes), Netherland (162 tonnes) and Czech Republic (27,603 tonnes).

Venezuela is an important importer and imported 112,018 tonnes in 2011. Brazil was a major supplier.

Africa

In Africa, South Africa, Gabon, Ghana, Morocco, Cote d' Ivoire, Namibia are important front trade points. South Africa is an important exporter and exported 6.6 million tonnes of manganese ore in 2011, mainly to China (3.45 million tonnes), India (0.78 million tonnes), South Korea (0.36 million tonnes), Norway (0.51 million tonnes), Japan (0.62 million tonnes), Spain (0.28 million tonnes) and Russia (0.22 million tonnes).

Gabon is also an important exporter and exported 2.97 million tonnes in 2011, mainly to China (1.45 million tonnes), India (0.18 million tonnes), South Korea (1.47 million tonnes), Norway (0.33 million tonnes), United States (0.36 million tonnes) and Spain (0.13 million tonnes).

Ghana

Ghana is also an exporter and exported 1.67 million tonnes of manganese ore in 2011. The major importers were China (0.85 million tonnes), Ukraine (0.74 million tonnes) and Norway (0.81 million tonnes).

Namibia

Namibia is another important exporter from Africa and exported 109,948 tonnes in 2011. The importers were China (101,107 tonnes) and India (8,781 tonnes). Morocco also exports manganese ore and it exported 54,922 tonnes in 2011. The major importers were China (49,320 tonnes), Spain (1,875 tonnes) and USA (979 tonnes).

Cote d Ivorie exported 43,645 tonnes in 2011. India, with 39,181 tonnes was the major importer. Analysis of the export data reveals that Africa accounts for about 50% of the World exports.

Middle East

Asian Region

In the Asian region, the countries important from trade point are China, India, South Korea, Vietnam, Indonesia and Japan.

China is a major importer and imported 12.98 million tonnes of manganese ore in 2011. South Africa, Australia, Gabon, Brazil, Ghana, Malaysia, Myanmar, India, Indonesia, Namibia and Kazakhstan were major suppliers.

India is both importer and exporter. It imported 1.82 million tonnes in 2011 and exported 129,794 tonnes. The major suppliers to Indian Market were South Africa, Australia, Gabon, Brazil, China and Cote d Ivoire.

South Korea is a major importer and imported 1.39 million tonnes mainly from South Africa, Australia and Gabon.

Vietnam is an exporter and exported 64,326 tonnes in 2011. China was the principal buyer. Indonesia is also an exporter and exported 119,133 tonnes in 2011. China was major buyer. Japan is an important importer and imported 958,394 tonnes in 2011. South Africa (624,387 tonnes), Australia (275,906 tonnes) and Gabon (55,904 tonnes) were the major suppliers.

In the Oceania, Australia is an important exporter. It exported 6.57 million tonnes in 2011. Its principal markets were China, India, South Korea, Ukraine, Japan and USA.

Country-wise Analysis

1. Australia

Australia's manganese ore reserves are placed at 97 million tonnes in 2012 in terms of metal content. Australia possesses 15% of the world's reserves of manganese ore. The production during 2011-12 was 7.36 million tonnes and was reported from two states, namely, Western Australia (2.184 million tonnes) and Northern Territory (5.174 million tonnes). Australia is one of the major exporters of manganese ore and exported 6.19 million tonnes and 6.60 million tonnes during 2010-11 and 2011-12, respectively.

The reserves of manganese ore are located in Western Australia, Queensland, South Australia, New South Wales and Northern Territory. The important deposits are located at Pilbara district and Peak Hill Gold Field areas. These deposits were in the form of thin cappings, blocks or pisolitic fissures & cavity fillings and manganiferous shale beds. The ore was predominantly pyrolusite or cryptomelane with small quantities of braunite in many deposits. Most of the deposits in Western Australia have been mined out or are too small for mining activity. Pilbara Manganese, a wholly owned subsidiary of Consmin, owns and operates the Woodie-Woodie manganese mine in the Pilbara district of Western Australia with a capacity of 1.5 million tonnes per annum. Woodie-Woodie is a renowned mine for consistently producing the highest grade manganese ore in the world and proximity to key Asian market.

The mine has 100 km^2 mining corridor and approximately 5,500 km^2 of Greenfield exploration areas outside this corridor. Multiple open pits are mined by utilizing Consmin's owned and operated mining fleet. The ore undergoes processing of crushing, screening and heavy media separation. PMI owns and operates the Woodie-Woodie fines operation located approximately 400 km^2 of port Head land.

PMI (Process Minerals International) operates its Woodie-Woodie mine in Pilbara region of Western Australia, adjacent to the Consolidated Minerals Limited's Woodie-Woodie operation. PMI is the only privately owned independent producer in Australia. PMI has an annual production of 400,000 tonnes of high grade manganese fines with a mine life exceeding 10 years.

Western Australia

During 2011 and 2012, production of manganese ore in Western Australia was 839,149 tonnes and 700,325 tonnes, respectively. Presently, mines in operation are Woodie-Woodie of Pilbara Manganese Mine and Peak Hills Nicholas Doun mine of Process Minerals International (PMI).

Queensland

Sporadic mining of manganiferous jasperoidal bodies in the Texas beds has occurred since the late 1800s. Most of the major manganese mines (War Effort, Mount Fuller and Mount Devine) are located on Inglewood, although some small deposits (Mount Gammie, The Glen) also occur to the East on Allora.

Northern Territory

The Northern Territory is one of the World's largest manganese producing state in Australia. There are currently two mines in operation namely, Groote Eylandt mine operated by GEMCO and the Bootu Creek mine operated by OM Holding Limited. The resources of manganese ore in Northern Territory are estimated at more than 200 million tonnes. Manganese occurrences in the Northern Territory have been classified into three types: sedimentary, hydrothermal and surficial.

Presently, the Groote Eylandt deposit is the major deposit situated about 50 km from the coast of Arnhem Land in the Northern Territory. This deposit contains almost 80% of the total resources in the country. The deposit is developed as a layer upto 15 m thick in the lower cretaceous mullaman sediments. They are composed of clays, quartz, sands, quartzite, pebble gravels and manganiferous marl. These beds are gently dipping to the west unconformably overlie the middle Proterozoic sandstone beds. Manganese ore is reported mainly on the western side of the island. The formation of these deposits in sea marine environment has produced pisolitic type of high grade ore. Oolitic and pisolitic ore in Mesozoic sedimentary rocks on Groote Eylandt in the Gulf of Carpentaria hosts forms on the world's highest grade manganese deposits of 170 million tonnes at 47.1% Mn. In financial year 2012, the production form Groote Eylandt mine was 4.30 million tonnes which is 5% higher than previous year. GEMCO planned to increase beneficiated product capacity from 4.20 million tonnes to 4.80 million tonnes per annum through the induction of dense media circuit by- pass facility. The project is expected to complete by 2013.

The other operating mine in the Northern Territory is Bootu Creek mine, which occurs in Palaeoproterozoic rocks of the Tennant Region at Bootu Creek, 110 km north of Tennant Creek, which commenced operation in 2006. In 2010, the total mineral resources are estimated at 32.5 million tonnes at 22.6% Mn and ore reserves are estimated at 21.5 million tonnes at 21.0% Mn.

South Australia

In South Australia, many small supergene manganese oxide deposits occur throughout the Adelaide Geosyncline. Several of the more accessible deposits along the western margin of the Flinders Ranges have yielded small tonnages. Production from deposits at Coomooroo, Bendledy, Merna Mora, Artipena, Martins Well, Mattawarangula, Springfield, Etna and Ellen Mines totalled 20000 to 30,000 tonnes.

New South Wales

New South Wales has many small manganese deposits that were extensively worked in the past for secondary oxide ore. Primary silicate ore was mined on a small scale in a few deposits in the New England Orogen and significant resources potentially remain, but have little commercial value other than as a source of rhodonite for use as a semiprecious gem and ornamental stone.

Production

Australia's production of manganese ore has recorded general increasing trend since 2005. The production of manganese ore was about 4 million tonnes in 2005, which reached to 6.96 million tonnes in 2011 (calendar year).

Exports

Australia exported 6.60 million tonnes of manganese ore in the year 2011. China with 66.53% was the major destination for Australian exports. The country-wise exports from Australia in 2011 to major countries are given below:

(In '000 tonnes)

Country	China	India	South Korea	Ukraine	Japan	Other Countries	Total
Export	4,371	575	878	196	276	273	6,569

Source: Annual Market Research Report, 2011 of IMnI.

India's Trade

India is already in trade with Australia as a major importer of manganese ore. India imported 568 thousand tonnes of manganese ore of all grades in 2011-12 (**Annexure: 7.XVI**). Indian stakeholders may also look forward for acquiring leases/mining rights in Australia, either individually or as joint ventures.

2. Brazil

As per Mineral Commodity Summaries 2013, Brazil possesses 110 million tonnes of manganese ore reserves in terms of metal content. Brazilian manganese reserves are concentrated in Minas Gerais state with 87% of the total, and Mato Grosso and Para with 6.5% and 4.3%, respectively. All the deposits of manganese ore in Brazil originated as Precambrian manganiferous oxide or carbonate-silicate sediments associated with iron formation. Most of the high grade manganese ore deposits were developed from lower grade manganiferous sediments by a process of selective replacement by manganese along with leaching of impurities from the host rocks under tropical weathering conditions. These deposits are residual lateritic concentrations. The iron, silica and alumina contents are lowest in the ore bodies that are intensely weathered.

Globally, Brazil is the fifth largest producer of manganese ore in 2011. Brazil currently produces about 7% (3.10 million tonnes) of the 47 million tonnes of global manganese ore output. In terms of production, Vale dominates manganese ore production in Brazil, accounting for some 95% of overall output. Vale's Brazilian manganese output is concentrated in four production complexes distributed throughout the country: the Minas Gerais complex alongside the Bahia, Corumba and Mina do Azul complexes.

The deposits of Minas Gerais were the first to be exploited for export of manganese ore. The Mina do Azul mine in the Para state is the largest producer of manganese ore with a capacity of 2.5 million tpy. Another important deposit is located in Corumba and Ladario in Mato Grosso do Sul State with a capacity of 1.5 million tpy.

Brazil's other player in manganese production is Mineracao Buritirama. "Mineracao Buritirama S.A. was set up in 1982 with the purpose of mining and commercializing the significant manganese ore reserves of the mine located at Serra de Buritirama, municipality of Marabá in the State of Para. The Buritirama ore body was discovered in 1966. The implementation of the project began in 1992 and completed in January 1994. Total reserves are estimated at 18.4 million tonnes of high-grade manganese ore. The mine has a production capacity of one million tonnes per year of first-class manganese ore. Buritirama manganese ore may be ranked as metallurgical, with 45% Mn grade, low phosphorous grade and high Mn/Fe ratio.

Production

The production of manganese ore reported from Brazil in 2005 was 3.2 million tonnes, which decreased to 3.1million tonnes in 2011 (calendar year). CVRD operates three mines.

The details of the mines operated by CVRD in Brazil are as follows:

Mining Site	Company	Location	Description	Mineralisation	Operation
Azul	Vale MinaDo Azul S.A	State of Para	Open pit mining operation and on site beneficiation plant.	High grade ore with 40% Mn(min)	Crushing and classification, steps, producing lumps and fines
Morroda Mina	Vale Manganes MCR	State of Minas Gerais	Open pit mining	Low grade ores, 24% Mn	Crushing and classification steps producing lumps and fines for Barbacena and Ouraprets ferroalloys plants
Urucum		State of Mato Grasso do sul	Underground mining operations and on site beneficiation plants	High grade ore with 40% Mn (min)	Crushing and classification steps producing lumps and fines.

The production from three mines of CVRD during 2010, 2011 and 2012 are as follows:

(In million tonnes)

Mines	2010	2011	2012
Azul	1.6	2.1	1.9
Morroda Mina Mine	0.1	0.1	0.2
Urucum	0.2	0.3	0.3
Total	**1.8**	**2.5**	**2.4**

Export

Brazil is an important exporter of manganese ore. It exported 1.7 million tonnes of manganese ore in 2011. The major countries which imported manganese ore from Brazil are China (46.62%), France (26.89 %) and Norway (9%). The remaining 17.49% was imported by other countries. The important amongst them are India, USA, Mexico, Venezuela, Belgium and Czech Republic.

India's Trade

India imported 70 thousand tonnes of manganese ore of all grades from Brazil in 2011-12 (**Annexure: 7.XVI**). Considering the production capacity and production of manganese ore in Brazil, India can foresee better prospects for imports from Brazil if satisfactory grade is available. The stakeholders in India can also explore possibilities for mining rights or leases individually or as joint ventures.

3. China

China is involved in all activities relating manganese ore such as production, export, import and consumption etc. However, the exports are meager as compared to the production and imports, indicating huge domestic consumption.

As per Mineral Commodity Summaries 2013, China is endowed with 44 million tonnes of reserves of manganese ore in terms of metal content. The geology characteristics of the Chinese manganese ore is characterized that the major ore body consists of marine deposit of manganese carbonate, which takes more than 80% of the total reserve. The second is the layer controlled iron-manganese ore, the other ore like silver-lead-zinc ore and weathered leaching manganese ore and the manganese ore body of volcanic rock characterized as small and complicated ore deposit.

Manganese ore bodies mainly located in the province of Guangxi, Hunan, Guizhou, Sichuan, Yunnan and Liaoning in China distribute extremely uneven. There is less manganese ore reserve in other places like coast areas and northwest areas.

The nature of manganese ore reserve is relatively poor. The average grade is 22%. Mn content in the ore of manganese carbonate is below 20%. High grade ore and good quality ore is extremely deficient. Phosphorous content in the ore is high. Some ore is high phosphorous ore. Another characteristic of the ore is high silica content. Some useful elements like iron, lead, zinc, cobalt, nickel, gold, silver and etc. coexist in some ore body. Most manganese ore bodies needs underground mining. However, most of the ore layer is thin and deep in underground mining and very hard to mine.The complicated structure, the fine grains and high silica of the ore pose great difficulties in mineral separation.

In China,there are hundreds of manganese mines. Most mines are small and medium in size. The average mining recovery is 80%-86%. The average ore dressing recovery is 70%-75%. The general recovery is 60%-64%.

There are not many open pits, such as Daxin Mine, Liancheng Mine, Xiaodai Mine, Jianshui Mine. The mines equip with drillers, loading machines and trucks. The level of most of the equipment is not advanced. Manual operation and part of manual operation are common in local small mines. Few mines use hyrdomining process such as Bayi and Dongxiangqiao mine.

Underground mining is the major mining process. There are Zunyi Mine, Xiangtan Mine,Heqing Mine, Dounan Mine, Huayuan Mine, Songtao Mine etc. Most of the ore bodies are thin declined or gradually declined. The thickness and the angle along the direction vary significantly. The other features are multi-layers, developed gap and unstable wall rock of roof and floor.

Production

China is traditional producer of manganese ore for a long time. The production of manganese ore has seen a spurt beginning the year 2005 with the production reaching 7.5 million tonnes from 4.5 million tonnes in 2004 which gradually increased to 14 million tonnes in 2011.

Imports

China is the top importer of manganese ore in the world for many years now. The total imports in 2011 were 12.98 million tonnes. It imports manganese mainly from Australia (33.66%), South Africa (26.62%), Gabon (11.14%), Brazil (6.06%), Ghana (6.55%) and other countries. The country-wise imports to China in 2011 from major countries are given below:

(In '000 tonnes)

Country	South Africa	Australia	Gabon	Brazil	Ghana	Other Countries	Total
Import	3,457	4,371	1,446	787	851	2,072	12,984

Source: Annual Market Research Report, 2011 of IMnI.

India's Trade

India's export to China was 157 thousand tonnes in 2008-09, which decreased to 71 thousand tonnes in 2011-12. There were imports of manganese ore from China to a tune of 52 thousand tonnes in 2011-12 of all grades.

Considering the above facts, China could be a promising market for Indian manganese ore of low and medium grades. China can also be considered as a good market for Indian manganese alloys, which are basic raw materials for steel making.

4. France

France possesses practically no reserves of manganese ores of economic importance. Obviously, there is no reported production of manganese ore from France. Owing to large capacities of steel in France, the demand of manganese ore is also high in the country. As there is no domestic production of manganese ore, France is completely dependent on imports of all grades of manganese ore to fulfill the demand for its steel and other manganese ore consuming industries. It imports manganese ore mainly from Brazil, South Africa and Gabon. The apparent consumption of manganese ore in France was 215,600 tonnes in 2011.

Imports

The imports of manganese ore into France were 612 thousand tonnes in 2011 and supplied from Brazil (74.18%), Gabon (13.88%) and South Africa (11.44%).

France has good capacity of steel but low production of silicomanganese, hence, the country would be a good prospective market for Indian manganese based alloys, specifically silicomanganese.

5. Gabon

Gabon has 27 million tonnes of manganese reserves in terms of manganese metal content.The reserves of manganese ore are distributed in five plateaus in the country. They are Bangombe, Okouma, Bafoula, Massengo and Yeye. The mineralized area in the Bangaombe plateau is about 19 sq km and that in Okouma plateau is 13 sq km. All deposits in Gabon are resulted due to supergene enrichment of Precambrian Francevillian sediments. The ore is manganese carbonate i.e. rhodochrosite. The ore-bearing carbonaceous black shales overlies an iron formation, particularly in Okouma plateau. The ore zone is comprised of thin basal units of manganese oxides and hydroxides. Bands of ore are also found in ochrous matrix containing small fragments, intercalated with the ore bands are argillaceous, siliceous and ferruginous bands. Other manganese minerals found along with the ore are pyrolusite, manganite, psilomelane and cryptomelane.

The open pit manganese ore mine at Moanda in the south western part of the country with a capacity of four million tpy is the largest manganese ore mine in Gabon. The Moanda mine is operated by COMILOG (ERAMET). This mine exploits one of the world's richest manganese ore deposits. The Moanda ore contains 46% Mn on an average. The mine is operated by opencast method. The ore is covered by a 4 to 5 metre thick layer of overburden. This is extracted by dragline. The ROM is extracted using mechanical excavators and loaded into 110 tonnes capacity dumpers. The ore is processed at the beneficiation plant. The beneficiated ore is subsequently transported to Moanda railway station by conveyor belt. The non-marketable ore fines undergo dense medium beneficiation, which increase Mn content from 43% to 52 per cent. This concentrate is mixed with coke and sintered in the furnace at 1300°C, to obtain the product containing approximately 58% manganese. Production of manganese ore is also reported from Bembele mine in Moyen-Ogooue province with a capacity of 0.5 million tpy.

Production

In the last seven years, the production of manganese ore in Gabon has been steadily increasing. The production reported in the year 2005 was 2.75 million tonnes which increased to 3.2 million tonnes and 3.6 million tonnes in 2010 and 2011, respectively.

Exports

Gabon is an important exporter of manganese ore for the past many years. The export of manganese ore from Gabon was 2.97 million tonnes in 2011, mainly to China (48.64%), India (6.05%), South Korea (4.94%), Japan (1.88%) and Ukraine (1.95%). Gabon being an important exporter of manganese ore with a very little domestic demand, the trend in exports generally follows the trend in production of Gabon's manganese ore:

(In '000 tonnes)

Country	China	India	South Korea	Ukraine	Japan	Other Countries	Total
Export	1,446	180	147	58	56	1,086	2,973

Source: Annual Market Research Report, 2011 of IMnI.

India's Trade

India is importing high grade (ferromanganese grade) manganese ore from Gabon since 2006 and presently is one of the major buyers of high grade manganese ore to meet the domestic demand.

India imported 173 thousand tonnes of manganese ore in 2011-12 from Gabon with a share of 8.82% of total all India imports of manganese ore. Owing to the increasing production in Gabon, India can look forward for more imports of high grade manganese ore. India may also look forward for manganese mining rights/leases in Gabon.

6. Ghana

The most important source of high grade manganese ore in Ghana is located at Nauto in Tarkwa district in Southern Ghana which is known as Nauto deposit. The ores found in the area are pyrolusite, cryptomelane and battery grade MnO_2 with some manganite.

Production

The production of manganese ore during the period 2005-2011 varied between 1 to1.8 million tonnes. The production of manganese ore in Ghana was 1.83 million tonnes in 2011. There is one operational manganese ore mine at Tarkwa Banso in the western region utilising open cast, strip mining method. Ghana Manganese Company through its wholly owned subsidiary owns 90% of Ghana Manganese Company Ltd (GMC). The remaining 10 % is owned by Government of Ghana. It owns and operates the Nsuta manganese mine in the western region of Ghana. GMC holds a mining concession for manganese ore in area of 175 km^2 in and around Nsuta in the western region of Ghana, less than 3% of which has been mined till date.

GMC ore is one of the highest manganese to iron ratio ore in the market (Mn: Fe- 3:1) and is low in phosphorous, alumina and other heavy metal impurities making it well suited for both alloy and manganese metal production. The production in 2010 was 1.5 million tonnes with 28% Mn. The mine is located close to the local port of Takoradi, which is approximately 63 km from mine. At Takoradi, GMC own and operates its own ship loading infrastructure. The total reserves in the Nsuata manganese mine are placed at 38.30 million tonnes with 28.8% Mn, which includes reserves of 24.4 million tonnes with 29.2% Mn.

Shaw River Manganese Ltd, an exploration and development company has manganese exploration projects in Butre area near Accra in Ghana. The Butre Project is strategically located 30 km from bulk port of Takoradi and 200 km west of the capital Accra, Republic of Ghana. The Butre Project contains known manganese occurrences at Jimra Bepo, consisting of multiple in situ manganese oxide seam upto 12 metres thick. The Shaw River intends to confirm an initial exploration target of in situ DSO oxide manganese ore of 1.7 to 1.9 million tonnes at 35 to 45% manganese and an additional 1.5 to 1.7 million tonnes at 15 to 25% manganese of sedimentary ores, which will require beneficiation.

Exports

Ghana is an important exporter of manganese ore in the African continent. The export of manganese ore was 1.67 million tonnes in 2011. The main destination of Ghana's manganese ores are China (50.95%), Ukraine (44.14%) and Norway (4.85%).

India's Trade

India is not in trade of manganese ore with Ghana in recent past, but considering the increasing production of manganese ore in Ghana, India may look forward to import high grade manganese ore from Ghana.

7. Japan

Japan has minor reserves of manganese ore and are of poor grade. Some of the manganese reserves of Japan occur in the form of hydrothermal rhodochrosite veins mainly in tuff, tuff breccias of Miocene age. These deposits are located in the south western part of Hokkaido province. Some deposits are of layered and lenticular type which occurs in Paleozoic and Mesozoic. These deposits occur in Southern part of the Hokkaido province. The Hydrothermal types of deposits are associated with lead & zinc ores. The lead and zinc ores are beneficiated by floatation process to separate them from manganese. The reserves of manganese ore in Japan are poor in quality as well as quantity.

Production

As there are no significant reserves of manganese ore in Japan, the production of manganese ore in the country is also insignificant and the country has to rely upon import to meet its manganese ore demand for its steel production capacities.

Imports

The imports of manganese ore were 958 thousand tonnes in 2011 mainly from South Africa (65.13%), Australia (28.8%), Gabon (5.84%), and other countries.

India's Trade

India's export to Japan was 100 thousand tonnes in 2002-03, which has decreased to 86 tonnes in 2011-12. Keeping in view the capacities of steel in Japan, India can consider Japan as a prospective market for exporting manganese ore and manganese-based alloys, particularly silicomanganese.

8. Kazakhstan

The important manganese ore reserves in Kazakhstan are located in the western and northern part of the country. The Karzhai deposit in the western Kazakhstan is one of the major deposit having more than 60 million tonnes of reserves. The ores are mainly psilomelane, braunite, jacobsite etc. Most of the manganese ore produced in the area is of ferromanganese grade. The northern part of the country has several deposits, the most important amongst them are Karsakpai and Mangishiak. The ore in this area is associated with the lower Oligocene quartz gluconite sandy clay formations. The manganese ore comprises of oxide ores like pyrolusite, manganite, psilomelane, cryptomelane etc. The Karsakpai deposit also has braunite mineralisation in sandstone and conglomerates.

Eurasian Natural Resources Corporation (ENRC) operates four mines at Zhairem, UshaKatyn, Vostochnykamyas and Turareas. Tur and East Kamys mines in Kargandy Province and Zhomart and Zapadny near Zhairem are the major mines reporting production of manganese ores. Production is also reported from Atasu and Temirtan mines in Kargandy Province. ENRC produced 1.01 million tonnes of manganese ore concentrate in 2011 and recorded a production of 954,000 in 2012. Price of this ore was US $ 171 per tonne in 2011 and declined to US $ 155 in 2012.

Kaz chrome Kazmarganets (Mn Ore), the ore reserves in Tur supports production at current rate for about 5 years. The Vastochny Kamys ore reserves are likely to be depleted in 2013.

Zhairemsky GOK

The majority of production has been sourced from the Ushkatyan III open pit manganese ore mine, operating 1.1 million tonnes with additional manganese ore sourced from the Ushkatyan III underground mine (0.3 million tonnes) and Zhomart open pit (0.3 million tonnes). The reserves of manganese ore for the group as on 31.12.2012 were placed at 20.60 million tonnes with 22.1% Mn. The total resources, inclusive of reserves are placed at 174.1 million tonnes with 25.6% Mn. The reserves of various mines are as follows:

(In million tonnes)

Mine	Quantity	Mn%
Tur	2.9	25.8
Vostochnykamyas	0.2	12.7
Kazmarganets	3.1	24.9
Zhairemsky GOK		
Ushkatyan I	-	-
Ushkatyan II	6.7	22.7
Ushkatyan III	7.7	21.8
Zhomart	2.8	19.0
Zhomart Stockpile	0.3	14.4
Total Reserves Zhairemsky GOK	17.5	22.1
Kazarmaganets		
Tur	4.3	25.3
VostochnyKanys	1.3	18.7
Total of Kazarmaganets	5.6	23.7
Zhairemsky GOK		
Ushkatyan I	19.1	11.8
Ushkatyan II	6.8	25.8
Ushkatyan III	55.9	21.8
Zhomart	9.0	21.3
Perstenvsky Open Pit	0.8	21.0
Perstenvsky Underground	115.0	27.7
Perstenvsky Stockpile	0.3	16.00
Total of Zhaioremsky Gok Total	206.9	24.3
Grand Total	**212.5**	**24.2**

Production from ENRC's mine was 2.76 million tonnes with 20.20% Mn content in 2012, as against 2.72 million tonnes with 20.4% Mn in 2011. The saleable concentrate produced was 954,000 tonnes.

Production

Kazakhstan is an important producer of manganese ore. The production was reported at 1.3 million tonnes in 2001. It continued to increase till 2006, when the production was 2.5 million tonnes. Thereafter, the production started declining and recorded at 1.1 million tonnes in 2011. In 2012, it however recorded an increased production of 2.9 million tonnes.

Exports

Kazakhstan exported 96 thousand tonnes of manganese ore in 2011, mainly to China and Ukraine.

India's Trade

India was not in trade of manganese ore with Kazakhstan in recent past. The reason might be the lower grade of Kazakhstan's manganese ore of which India has adequate reserves. Kazakhstan may not be India's target market in near future.

9. South Africa

South Africa is endowed with rich deposits of manganese ore. The total reserves of manganese ore in South Africa have been estimated at 150 million tonnes. The major manganese ore reserves in the country are located in the Northern Cape Province spreading across two districts, namely, Kuruman (Kalahari) and Postmasburg.

The Kuruman (Kalahari) manganese ore deposit extends over a length of 41 km with N-S strike. The width varies from 5-20 km. The southern end of the deposit at Mamatwan might have been terminated by a fault. The deposit occurs as chemical precipitate. The rock types consist of banded iron formations with three manganiferous horizons, all belonging to the Daspoort stage of Precambrian Transvaal system and overlie the Ongeluk lavas. Mineralogy of the Kuruman district is rather complex. There are 17 manganiferous minerals found in the area, the principal minerals being braunite, bixybite, hausmannite, jocobsite and cryptomelane.The Mn content in the manganese ore in this area varies from 34 to 39% Mn and the Mn: Fe ratio varies from 7.9 to 9.5.

The Postmasburg deposit is made of a series of irregular epigenetic or replacement deposits varying in grades from ferruginous manganese ore (20% Mn) to high grade manganese ore (upto 50% Mn). The manganese ore in the western belt is associated with Gamagara formations overlying Campbell Rand dolomite. The ore is developed only where Gamagara formations rest directly on the dolomite. The manganese ore is believed to have formed by leaching of manganese from dolomite near the surface and replacement of Gamagara shale by manganiferous solutions. The major manganese ore minerals found in the western belt are braunite, bixybite, pyrolusite and hausmannite. The eastern belt comprises of Pre-Gamagara residual chert breccias and the underlined Campbell Rand dolomite. The principal manganese ores occurring in the eastern belt are braunite, psilomelane and hausmannite.

The Mamatwan & Wessels manganese ore mines near Hotazel in Kuruman district with a combined capacity of about 4.5 million tpy is the largest manganese ore mine in the country. Nchwaning and Gloria manganese ore mines with a joint capacity of 3.6 million tpy are the second largest manganese ore mine in the country. Nchwaning and Gloria manganese ore mines are located near Black Rock in the Kuruman district, about 105 km North of Postmasburg in North Cape Province. Kalahari mine operated by Renova group is another important manganese ore mine with a capacity of one million tpy. Besides, an open pit mine in the North West Province is producing manganese dioxide with a capacity of 24000 tpy and is operated by METMIN (Metorex Pty. Ltd).

Production

Production of manganese ore in South Africa was 4.6 million tonnes in 2005. It is increasing since then steadily with a decline in 2009 and increased to 8.6 million tonnes in 2011.

Exports

South Africa is traditional exporter of manganese ore. In 2011, it exported 6.6 million tonnes of manganese ore, mainly to China (52.34%), India (11.90%), Japan (9.44%), Norway (7.71%), Rep. of Korea (5.49%) and some other countries. The country-wise exports from South Africa in 2011 to major countries are given below:

(In '000 tonnes)

Country	China	India	South Korea	Ukraine	Norway	Japan	Other Countries	Total
Export	3,457	786	363	91	509	624	775	6,605

Source: Annual Market Research Report, 2011 of IMnI.

India's Trade

India started importing manganese ore (particularly ferromanganese grade) from South Africa in 2007 and since then the exports of manganese ore from South Africa to India is on rise. The imports of manganese ore in 2011-12 was 936 thousand tonnes as compared to 579 thousand tonnes in 2010-11. In view of the large export capacity of South Africa, India can foresee fairly good imports of manganese ore from South Africa. Considering the huge reserves of manganese ore in South Africa, acquiring of mining rights/leases can also be considered by the Indian stakeholders.

10. Ukraine

Ukraine possesses 140 million tonnes of manganese ore in terms of metal content. There are two manganese ore basins, one in Nikopol and the other is in VelykyTokMak, which produces manganese ore. The manganese ore is located in the southern part of the country in a basin known as Southern Ukrainian Basin. Most of the manganese ore is located in the Nikopol district. This basin consists of six deposits. Two out of these six deposits are important which are known as Nikopol East and Nikopol West. These deposits are situated 50 km south-west of Zaporozh'e Donetsk north of the Kakhovka reservoir. These deposits belong to the lower Oligocene manganese bearing sedimentary formations. They are probably the greatest and the most continuous accumulation of manganese in the world. All of them do not come under the definition of ore because of thinness, chemical composition or other uneconomic factors. The ores found in the deposit are mainly oxides, carbonates and mixed oxide/carbonates. The other area is VelykyTokMak which produces most of the manganese ore in Ukraine.

Ordzhonikidze mine operated by Ordzhonikidze GOK of Private Bank Group and Marganets manganese ore mine operated by Marganets GOK also of Private Bank Group are the other two important manganese ore producing mines in Ukraine.

Production

The production of manganese ore is comparatively less as compared to the availability of resources. Ukraine is the second largest country in terms of resources in the entire world. The production of manganese ore in 2011 was about 1.6 million tonnes as compared to 2.0 million tonnes in 2005. The Marganets Mining and Beneficiation Complex GOK produced 748,869 tonnes of manganese concentrates and marketable ore in 2011 and the Ordzhonikidze GOK produced 222,631 tonnes of manganese ore. The majority of the domestically produced and imported manganese ore and concentrate were used to produce ferroalloys.

Imports

Ukraine imported 1.2 million tonnes of manganese ore in 2011. The major suppliers of manganese ore to Ukraine were Ghana (61.29%), Australia (16.28%), Brazil (7.89%), South Africa (7.56%) and Gabon (4.82%).

Exports

Ukraine also exports a small quantity of manganese ore to various countries. However, these exports were irregular in nature. In the year 2011, it exported only 137 thousand tonnes.

India's Trade

In the recent past, India has not traded manganese ore with Ukraine.

11. Indonesia

Manganese ore occurs throughout the Indonesian archipelago, although not always in prospective economic deposits. The main composition of Indonesian Manganese ore occurs as pyrolusite and psilomelane deposits, both of which have an oxide composition and are formed in sedimentary deposits and residue. Grades are extremely high in the order of +50% Mn.

Kefa Manganeseore Operation- Asia Minerals Corporations Ltd (AMC), through its subsidiary PT Asia Mangan Group holds an IVPK production operation licence. Asia Mangan is licensed to purchase local artisanal production and export through Wini port.

Manganese production in all of Indonesia does not reach 10% of total manganese production worldwide. But, the potential of manganese allocation in Indonesia is comparatively large in dispersed locations in entire Indonesia. The supply position can be found in Java Island, Sumatra Island, Rian Island, Kalimantan Island, Sulewasi Island, Nusa Tengara, Maluku and Papua. PT PAM Alam Mineral has mines located in Trenggalok, TulungAgung of East Java.

Bracken International Mining (BIM), an Australian company owns six mine licences covering 8208 hectares in West Timor with combined reserves of more than 300 million tonnes. The Big George mine is 35 km from Kupong's main export loading port. The mines are ready to produce and export to world markets. The mines have been producing ore in a limited capacity since early 2010 with trial exports of manganese shipped to customers in China.

12. Other Countries

Other countries which report production of manganese ore are Namibia, Pakistan, Myanmar, Malaysia, Philippines and Cote de Ivoire. Most of these countries sell their production of manganese ore.

India's Foreign Trade

India was a major exporter of manganese ore till 1970 and exported more than 75% of its total production to various countries in the early 1970's. USA was the major importer of Indian manganese ore. The reason behind the high exports in the past may be attributed to the fact that India did not have any major steel producing capacities during those times and the domestic demand of manganese ore was very less. Over the years, the steel industry in India catapulted on the path of growth, which increased the domestic demand for manganese ore. As a result, the exports of manganese ore decreased. Presently, India exports a very small quantity of manganese ore.

On the flipside, the imports of manganese ore increased due to a spurt in the production of manganese-based alloys, more specifically of silicomanganese. Over the years, the production of ferromanganese increased from a level of 170 thousand tonnes in 2000-01 to 447 thousand tonnes in 2011-12. The silicomanganese production increased from a level of 276 thousand tonnes in 2000-01 to 1478 thousand tonnes in 2011-12. The domestic production of manganese ore is not sufficient and has to rely on imports to meet the demand of ferroalloys industry. India is now a net importer of manganese ore.

The ferromanganese and silicomanganese has become an exportable commodity and is being exported in large quantities. The export of ferromanganese has increased from a level of 5.38 thousand tonnes in 2000-01 to 159.12 thousand tonnes in 2011-12, whereas, the exports of silicomanganese increased from about 61.50 thousand tonnes in 2000-01 to about 732.42 thousand tonnes in 2011-12.

Exports

The data on country-wise exports from India for the period 2001-02 to 2011-12 is given at **Annexure: 7.VI.** The exports of manganese ore are of nine grades as below:
i) First Grade (+ 46%) Mn, **ii)** Second Grade (35-46%) Mn, **iii)** Ore with 30-35% Mn, **iv)** Other ore **v)** Ferruginous Manganese Ore, **vi)** Electrolytic Manganese dioxide, **vii)** Manganese Oxide other than MnO_2, **viii)** Manganese Dioxide and **ix)** Manganese Dioxide & Oxide other than MnO_2. The export data for these grades is given at **Annexures: 7.VII to 7.XV.**

The exports of manganese ore (total) from India showed a general decreasing trend since 2004-05. The exports which were 318 thousand tonnes in 2004-05 decreased to 75 thousand tonnes in 2011-12. The major destinations for the exports of Indian manganese ore for the period under consideration were China, Rep. of Korea, Bhutan and other countries.

In the last decade, Japan was the major importer of India's first grade manganese ore i.e. (+) 46% Mn. Subsequently, China became the major destination for the export of first grade of manganese ore from India. Since 2006-07, Bhutan is the major country to which India is exporting its first grade manganese ore. The exports of second grade manganese ore (35-46% Mn) are also showing decreasing trend from 102 thousand tonnes in 2001-02 to only 2000 tonnes in 2010-11. All the exports were to China. In 2011-12, there are no exports of the second grade manganese ore. The exports of manganese ore of the grade 30 to 35% Mn is also decreasing from 150 thousand tonnes in 2003-04 to 66 thousand tonnes in 2007-08 and 8000 tonnes in 2011-12. Manganese ore of the grade classified under the grade "others" was 29 thousand tonnes in 2002-03. Since then, it has increased to a level of 34 thousand tonnes in 2011-12. China and Bhutan were the major countries to which India exported manganese ore of this grade. There were no exports of ferruginous manganese ore from India since 2005-06.

The exports of manganese dioxide and oxides other than $Mn\text{-}O_2$ (total) did not show any continuous trend and varied between 757 tonnes and 2,639 tonnes during 2002-03 to 2010-11. The exports of manganese dioxide and oxides other than $Mn\text{-}O_2$ (total) were 2,119 tonnes in 2010-11 and 7,215 tonnes in 2011-12.

Imports

The data on country-wise imports by India for the period 2001-02 to 2011-12 is given at **Annexure: 7.XVI**. The imports of manganese ore (total) into India showed a general increasing trend since 2004-05. The imports which were 241 thousand tonnes in 2004-05 decreased drastically to 13 tonnes in 2005-06, and then started increasing from 284 thousand tonnes in 2006-07 and further to 1.96 million tonnes in 2011-12. The major countries from which India imported manganese ore for the period under consideration were South Africa, Australia, Brazil, Gabon and other countries. The imports of manganese ore are also of nine grades as in the case of exports. The import data for various grades is given at **Annexures: 7.XVII to 7.XXVI.**

The imports of (+) 46% Mn grade manganese ore in India showed a mixed trend. The major countries supplying (+)46% Mn grade manganese ore to India were South Africa, Australia and Gabon since 2006-07. In 2011-12, the total imports were 860 thousand tonnes, out of which the share of South Africa was 254 thousand tonnes, Australia 344 thousand tonnes and Gabon 125 thousand tonnes. China, Brazil, Ivory Coast and other countries also contributed in the total imports.

The total imports of manganese ore of the grade 35 to 46% Mn was only 238 tonnes in 2005-06 in the country, which increased to 1.07 million tonnes in 2011-12. The major countries from which India imported manganese ore of this grade in 2011-12 were South Africa 663 thousand tonnes, Australia 224 thousand tonnes, Gabon 47 thousand tonnes and China 33 thousand tonnes. Balance was contributed by Ivory Coast, Turkey and other countries. The imports of manganese ore of the grade 30 to 35% Mn and the 'other' grade were meager. There were no imports of ferruginous manganese ore in the country during the same period.

The imports of manganese dioxide (total) were 5,541 tonnes in 2003-04 which increased gradually to reach 8,963 tonnes in 2010-11. The imports were mainly from China in 2010-11. There were no imports of manganese dioxide (total) in 2011-12.

Trade Destinations for Indian Manganese Ore

India was a major exporter of manganese ore of all grades but in the recent past it is observed that high grade ore resources in the country are depleting. Therefore, the exports of high grade manganese ore i.e. +46% Mn are restricted and the export is permitted only through licence. Ministry of Commerce has imposed ceilings on the quantity to be exported in case of certain grades.

China, Rep. of Korea, Pakistan, Japan, and Russia were the major countries importing manganese ore from India. India is now exporting manganese ore to China and other neighbouring countries like Bhutan and Nepal. India may explore opportunities to export its BF grade manganese ore to other countries also.

As already stated, India's demand of high grade manganese ore(+46% Mn and 35 to 46% Mn) has increased due to higher production capacities of manganese-based alloys. The combined capacity of ferromanganese and silicomanganese has increased from 0.7 million tonnes in 2000-01 to 3.16 million tonnes in 2011-12. India's domestic supply of manganese ore is not adequate to meet the increased demand from ferromanganese and silicomanganse industry and the shortfall has to be fulfilled by imports. South Africa, Australia, Gabon, Brazil and Ghana are the major exporters of manganese ore worldwide. India is already importing high grade manganese ore from these countries, except Ghana. India may look forward to continue the imports from these countries and may add Ghana, Kazakhstan and Ukraine in the list of importers, if satisfactory grade is available from these countries at a competitive price.

Export- Import Policy

The export-import (Exim) policy of manganese ore is decided by the Ministry of Commerce, Government of India.

Export Policy

The export policy for years 2009-14 is given in **Table: 7.5.**

Table:7.5 Export Policies for Manganese Ore

S. No.	Tariff Item HS Code	Unit	Item Description	Export Policy	Nature of restriction
1.	26020000	Kg	Manganese ore excluding the following : Lumpy / blended manganese ore with more than 46 per cent manganese	STE	Exported through a) MMTC Ltd b) MOIL Ltd for manganese ore produced in MOIL mines
2.	26020010	Kg	Lumpy/blended Manganese ore with more than 46% manganese	Restricted	Export permitted through Licence

Import Policy

As per the Import Policy for years 2009-14, the import of manganese ore of all grades is free.

Global Demand Supply Analysis

As per the Annual Market Research Report for the year 2011, brought out by International manganese Institute, the World apparent annual consumption was 16.52 million tonnes in terms of metal content. As against this, the global production of manganese ore was 17.20 million tonnes. This indicates that demand-supply position of manganese ore in 2011 was just comfortable. The major producers of manganese ore are namely, Australia, Brazil, Gabon, Ghana, Kazakhstan, and South Africa.

Global Capacity Additions Planned

Country-wise capacity additions in Manganese ore Production Planned upto 2015 are as follows:

Country	Company	Mine Project	Incremental Capacity Addition (tonnes)
Australia (Northern Territory)	OM Holding Ltd	Bootu Creek Mine	150,000
Australia (East Pilbara)	Mineral Resources Ltd. & Nancok Prospecting Ltd	Nicholas Dome	370,000
Australia (Northern Territory)	GEMCO	Groote Eylandt	600,000
Cote d'-Ivoire(Grand-Lauzou)	CML	Lauzou Mine	300,000(New Mine)
Cote d'-Ivoire(Grand-Lauzou)	-do-	-do-	200,000 (capacity addition)
India (Maharashtra, Madhya Pradesh)	OMML	Patmunda	210,000
-do-	Rungta Mines	Siljora-Kalimati Mn & Iron mine	60,000
India (Odisha, Sundergarh)	MOIL	10 Mines	360,000
-do-	MOIL	Balaghat & DongriBuzurg	500,000
Gabon (Hauf-Ogoru)	COMILOG	Moanda	600,000
Gabon (Moyen-Ogoru)	CICMH	M Bembele Mn Mine	800,000 (New Mine)
Russia(Kemerovo)	SGMK	SGMK Mn Mine	600,000 (New Mine)
Russia(Mezhdure-chenskkemeron)	Filial Zakrytogo ZAO	Usink	400,000 (New Mine)

Country	Company	Mine Project	Incremental Capacity Addition (tonnes)
South Africa (Northern Cape)	UMK	Kalahari Mn Mine	400,000 (Mine Expansion)
-do-	Nesinbintle Mining (Pty) Ltd & others	Tshipi, Kalahari	200,000 (New Mine)
-do-	-do-	-do-	2,200,000 (Mine Expansion)
South Africa (Eastern Cape)	Kalagadi Mn (Pty) Ltd	Kalagadi Coega	320,000
South Africa (Northern Cape)	BHP Billiton	Wessels Mine	500,000
South Africa (North west)	Kudumane Manganese Resources (Pty) Ltd	Kudumane	2,000,000 (New Mine)
Zambia (Luapula)	DharniSampada Pvt. Ltd	TaurianMn Mine	480,000
Zambia (Central &Luapula)	Asia Minerals Ltd (AML)	Various Mines	400,000
Kazakhstan (Alonaty)	Electro Mn & Thyssen Krupp AG	Tekli EMM Plant	30,000(EMM)
Malaysia (Sarawak)	OM Materials	Sarawak Ferroalloy and Sinter Plant	300,000 (Mn Ore Sinters)
Indonesia (EastMusa,Tengarra, West Timor)	Bracken International Mining	Big George West Timor Mine	360,000
-do-	-do-	-do-	2,280,000
Mali (Gao)	Mali Mn SA	Ansongo Mn Mine	100,000 (New)
Mexico(Hidalgo)	Autlan Minera	Tajo Naopa	200,000

Global Concerns

RSA's dominance in resource in lack of infrastructure

South Africa accounts for 79% of the global manganese ore reserves. It has the biggest deposit in the world located at Kalahari with high grade reserves. Although the country holds about 80% of the resources, it lacks in infrastructure. It has only one dedicated manganese export terminal at Port Elizabeth, about 1100 km from the mine. Port Elizabeth is accessible only to three producers. It also has constraints with regards capacity expansion, due to environmental considerations. Further, the mechanised plant is quite old and needs to be replaced. The other port at Saldanha Bay is presently dedicated for iron ore, and allowing handling of manganese ore may lead to contamination of the two ores. Other port is at Durban, 700 km from mine. At Kouga port development of facilities is capital intensive.

Transnet National Port Authority is the port authority in RSA which is authorised to control and manage all the seven commercial ports in the country out of the total 16 ports in RSA along the 2954 km coastline. These ports are Richards Bay, Durban, East London, Port Elizabeth, Mossel Bay, Cape Town and Saldanha. Transnet is studying plans for a heavy-haul manganese channel either through Saldanha on South Africa's west coast or through the new deep-water harbour at Ngquara on the East coast.

Depleting Manganese Ore Content

A major worry over a period of time for manganese ore and manganese alloys producers has been the manganese content. More and more manganese ore is required for the production of manganese alloys as the content is depleting. The highest grade available in very few countries is approximately 44% Mn content. As per the data with International Manganese Institute, the ratio between wet manganese ore produced and the Mn content has been increasing gradually. The ratio was 2.89 in 2000 which has now gone upto 3.27 in 2009. This reflects deterioration in the quality of ore across the globe which is a matter of great concern.

China's Power Scenario

Manganese alloy production is an energy intensive process and major production of the world manganese alloys comes from China. Thus, availability of power is crucial for Chinese ferroalloys industry. Moreover, it produces 97% of Electrolytic Manganese Metal (EMM) and the whole world is dependent on China for EMM.

China's EMM Dominance - A Potential Threat

EMM is an expensive alloying material used for very specific applications and China has been a dominant player in producing EMM. China produces 97.44% of the World's EMM from low grade deposits. EMM is mainly used in manufacturing stainless steel 200 series.

Chapter 8

PRICES

THE prices of manganese ore, like other commodities, mainly depend upon the demand in the industry and supply position in the market. The prices of the manganese ore depend upon many other factors such as grade (percentage of manganese in ore and other essential constituents and deleterious constituents), size, cost of mining, various taxes and tariffs levied by state as well as central government etc. Considering the above facts, there are different price quotations for same grade at different markets in different states.

Manganese ore is traded between the buyers and sellers and the prices are quoted, negotiated and contracted on FOR or ex-mine basis in the domestic markets and on FOBT, CIF or FOB basis in the overseas markets. The prices of manganese ore vary according to the grade of the ore and the location of the mine or the loading station. The classification of the grades by producers, consumers and traders are not the same. The nomenclature of grade also differs from state to state and even mine to mine. This is due to the fact that the ore market consisted of a number of sub markets because of difference in ore quality requirement for end use-ferroalloys production, blast furnace, iron making and manufacture of manganese chemicals.

The demand for manganese ore is influenced by demand for manganese alloys for steel manufacture or for exports. This has obvious impact on prices of manganese ore, both in domestic as well as international markets.

Domestic Prices

During the endeavour of this Market Survey Study, data on prices was collected from various producers for the period 2009-10 to 2011-12. The same is given at **Annexure: 8.I**. The prices of all grades of manganese ore, in general, recorded an increasing trend. The data on prices for the period 2005-06 to 2010-11 for various markets is given at **Annexure: 8.II**. The state-wise prices of manganese ore quoted at different loading points and mining sectors are discussed below:

ODISHA

Odisha is one of the major manganese ore producing state. There are many loading centres/ markets in the state. The major loading stations in Odisha are Siljora-Kalimati and at the mines owned by M/s OMC and M/s OMDC.

Price data for Siljora-Kalimati market is available for 2005-06 to 2010-11. The manganese ore at this loading station was marketed under four grades namely, i)MnO_2,ii) (+)46% Mn, iii) (+)35% Mn, and iv) (+)25% Mn. During the period from 2005-06 to 2010-11, the highest prices for all the four grades were quoted in 2008-09 at Rs. 25,214 per tonne for (MnO_2), Rs. 22,708 per tonne for (+46%Mn), Rs. 15,459 per tonne for (+35%) and Rs. 12,860 per tonne for (+25%).

OMC Prices

Analysis of the price data revealed that the prices of manganese ore varied greatly. During 2005-06, the ex-mine OMC prices varied between Rs. 515 per tonne to Rs. 6,350 per tonne depending upon the manganese content and international scenario in manganese ore prices.

In 2006-07, the ex-mine OMC prices of manganese ore varied between Rs. 515 per tonne and Rs. 4200 per tonne, depending on the grade. The year 2007-08 witnessed substantial increase in price in line with international prices and varied between Rs. 805 per tonne and Rs. 22,410 per tonne depending on grade. In the year 2008-09, the prices ranged between Rs.8,501 per tonne and Rs. 22,410 per tonne. There has been no sale of manganese ore by OMC since 2009-10.

Price Quotations by OMML Ltd

M/s. Orissa Manganese and Minerals Limited sells ore ex-mine Patmunda, Bhanjikusum and Orahuri. Prices of MnO_2 were quoted at Rs. 19,450 per tonne in 2009-10. It increased to Rs. 26,750 per tonne and maintained the same level during 2011-12. For manganese ore with 46% Mn, the price quoted was Rs. 13,580 per tonne in 2009-10. During 2010-11, prices increased to Rs. 24,148 per tonne and declined to Rs. 14,100 per tonne in 2011-12. For manganese ore with 35-46% Mn, the price quoted during 2009-10 was Rs. 7,250 per tonne, increased to around Rs.11, 000 per tonne in 2010-11 and then declined to Rs. 8,050 per tonne in 2011-12. For grade with 25-35% Mn, the price quoted was Rs. 3,350 per tonne, increased to around Rs. 7,200 per tonne in 2010-11 and then declined to Rs. 5,050 per tonne in 2011-12. For manganese ore with (-) 25% Mn, the rate quoted was Rs. 3,200 per tonne in 2009-10, increased to Rs. 4,600 per tonne in 2010-11, and subsequently declined to Rs. 340 per tonne in 2011-12.

Bhanja Minerals, Keonjhar

M/s. Bhanja Minerals produces lumps (three grades- high grade, medium grade, low grade) and fines (low grade). For high grade lumps the price quoted was Rs. 6,500 per tonne in 2009-10, which increased to Rs. 15,500 per tonne in 2010-11 and declined to Rs. 14,500 per tonne in 2011-12. For medium grade lumps, the price quoted was Rs. 4,387 per tonne in 2009-10, which increased to Rs. 6,794 per tonne in 2010-11 and maintained the same level in 2011-12. For low grade lumps, the price quoted was Rs. 2,517 per tonne in 2009-10, increased to Rs. 4,058 per tonne in 2010-11 and touched Rs. 4,257 per tonne in 2011-12.

OMDC Ltd

The ex-mine price of manganese ore with 30% Mn produced by OMDC was quoted between Rs. 901 and Rs. 1,225 per tonne in 2005-06. It was quoted at Rs. 3,313 per tonne in 2007-08 and during 2010-11 and 2011-12 it was quoted between Rs. 1,125 and Rs. 2,475 per tonne, respectively.

MnO_2 Prices

In 2005-06, the MnO_2 price quotation by OMC varied between Rs. 7,215 and Rs. 11,730 per tonne depending upon MnO_2 content. The year 2007-08 recorded sharp rise in the prices and was quoted between Rs. 5,500 per tonne and Rs. 25,200 per tonne. During 2009-10, the price was quoted at Rs. 25,200 per tonne. There was no rate quoted since 2009-10.

MADHYA PRADESH AND MAHARASHTRA

Madhya Pradesh and Maharashtra are two states in which many important mines and loading stations/markets are located. The major manganese ore producing mines in Madhya Pradesh and Maharashtra are being operated by MOIL. M/s. Pacific Minerals, Balaghat and M/s. A.P.Trivedi & Sons, Balaghat also operate mines in Madhya Pradesh.

MOIL Prices

MOIL, a public sector enterprise is the single largest producer of manganese ore in the country and mainly caters to the indigenous industries. It produces number of grades of manganese ore from its mines and fix prices on the basis of Mn content, deleterious material as well as sizes. MOIL publishes price and availability on quarterly basis.

The chemical analyses and physical properties of various grades which influence price and the corresponding prices as on 1.1.2013, in respect of MOIL are given in **Table: 8.1**.

Table: 8.1- Grades of Manganese Ore Marketed by MOIL
(As on 1.1.2013)

Ore Code	Grade	Mn%	P%	SiO_2%	Fe%	+75 mm	+25 mm	+10 mm	+6 mm	+3 mm	-3 mm	Prices As on 1.1.2013 (Rs./ Tonne)
Ferro Grade												
BG102	1st Gr. LP "L"	49.5	0.1	8	4.8	8	-	88	1.5	1.5	1	14067
BG 1408	46-48% Jigged(R-9)	48	0.08	9.5	5.5	0	0	60	23	12.5	4.5	12956
BG1466	46% Jigged Fines	46.5	0.1	10	6.5	0	0	0	10	50	40	11660
BL2409	2ndGr. Lump (N-06)	44	0.24	16	7	1	55	40	1	2	1	11513
BL3480	3rd Gr. Small (N-0)	38	0.25	22	7	-	-	60	28	5	7	8048
BL4206	3rd Gr. Bed (N-03)	38	0.25	22	7	3	85	7	2	2	1	8942
CH4413	4thGr. Lump (N-06)	37.5	0.25	24	7.5	5	-	90	3	1	1	8825
DB2268	3rd Gr. 42/44 'S'(N-03)	43	0.2	13	7.5	0	0	60	23	10	7	11617
DB2367	2nd Gr. 42/44 'L'(N-04)	43	0.22	13.5	7.5	1	84	7	2	3	3	11645
GM2416	2nd Gr. Lump(N-06)	44	0.21	12	7	5	-	90	2	1	2	11513
GM2477	2nd Gr. Small Ore(N-09)	42	0.25	15	7.5	-	-	-	30	55	15	9890
GM4187	3rd Gr. Jigged(Hand Scre)	38	0.25	17.5	8.5	0	0	50	20	22	8	8055
GM4239	3rd Gr. Bed Lump(N-03)	36	0.25	22	8	0	80	9	2.5	2	1.5	8475
GM4417	4thGr. Lump (N-06)	32	0.25	28	7.8	6	60	32	1	1	0	7532
KD1418	1st Gr. Lump(N-06)	47	0.2	14	6	-	-	95	2	1	2	12308

Ore Code	Grade	Mn%	P %	SiO_2%	Fe%	+75 mm	+25 mm	+10 mm	+6 mm	+3 mm	-3 mm	Prices As on 1.1.2013 (Rs./ Tonne)
KD3419	3rd Gr. Small (N-06)	39	0.21	21	7	0	0	38	40	12	10	8314
KD4273	3rd Gr. Dump Lump	38.5	0.2	25.5	6	-	-	94	2	2	2	9059
MS4228	3rd Gr. Lumpy (N-02)	38	0.26	22	7.5	-	90	4	2	2	2	8942
MS4317	Low Grade Ore Small	33	0.26	26	7.5	0	0	60	20	9	11	6983
SP270	2nd Gr. Bed Lump 42/44%	42	0.27	13	9	-	-	94	1.5	1.25	3.25	10494
SP4454	Low Gr. Bed Lump 38%	38	0.37	22	9	-	60	25	9	6	-	8539
TD2424	2ndGr. Lump (N-06)	43	0.28	15	8	-	-	96	0	1	3	10743
TD4318	Tirodi Low Gr.(N-03)	37	0.25	22	7	-	-	95	3	1	1	8314
TD4427	4th Gr. Small (N-06)	38	0.26	20	8	0	0	40	30	18	12	7689
UK3485	40% Chitawar Ore	40	0.43	17	7	-	-	93	3	2	2	8111
UK1314	1st Gr. Bed Lumpy	46	0.19	14	6	-	-	93	3	2	2	11499
UK3313	3rd Gr. Dump Small(N-03)	40	0.17	20	6	0	0	60	21	13	6	8994
UK4445	37% Samnapur	37	0.2	27	6	0	0	60	21	13	6	8314
Silicomanganese Grade												
SMGR LMP	SMGR LMP	30	0.25 /0.32	29/33	7/9	-	90/ 95	1	1	1	2	5678
SMGR SMP	SMGR SMP	30	0.25/ 0.32	29/33	7/9	0	0	80	10	3	7	5106
SMGR LMH	SMGR LMH	30	0.25/ 0.32	29/33	7/9	-	90/ 95	1	1	1	2	5944
SMGR SMH	SMGR SMH	30	0.25/ 0.32	29/33	7/9	0	0	80	10	3	7	5327
SMGRDB L	SMGr. Dongri Lump	30	0.19	27	8.6	5	85	3	3	2	7	6240
SMGRDB S	SMGr. Dongri Small	30	0.19	27	8.6	0	0	75	12	8	5	5615
SMGRBG S	SM Gr. BG S	30	0.1	38	5.5	0	0	50	28	17	5	5893
Silico manganese Grade-Low Mn (25%)												
BLL461	SM Grade 25%	25	0.25	35	7	0	0	80	10	3	7	3107
BLL492	SM Grade 25%(N-11)	25	0.25	42	7	-	-	97	1	1	1	3280
BGL462	SM Grade 25%	25	0.1	50	5	-	-	95	5	0	0	3117
CHL442	Chikla Low	25	0.275	37	7	0	0	93	3	2	2	3453
DBL456	Grade Small 25% SM Gr Lump	25	0.2	35	9	5	85	3	3	2	2	3672

Ore Code	Grade	Mn%	P%	SiO_2%	Fe%	+75 mm	+25 mm	+10 mm	+6 mm	+3 mm	-3 mm	Prices As on 1.1.2013 (Rs./ Tonne)
DBL457	25% SM Gr Small	25	0.2	35	9	0	5	70	9	8	8	3672
GML464	SM Grade 25%	25	0.28	36	8.5	0	0	50	20	22	8	3107
KDL446	25% SM Gr Kandri (N-06)	25	0.27	35	6	3	90	4	1	1	1	3453
MSL447	25% SM Gr Mansar	25	0.3	42	8	-	-	90	5	2	3	3280
MSL498	SM Gr Small 25% Mn (N-12)	25	0.3	40	8	-	-	70	16	6	8	3107
TDL443	Tirodi Low Grade Lump	24	0.31	35	9	-	75	15	5	2	3	3148
TDL499	SM Grade Small 25%Mn(N12)	25	0.35	45	7.5	-	-	90	5	2	3	3117
UKL448	25% SM Gr Ukwa	25	0.193	45	8	0	0	60	21	13	6	2804
Fines												
BGF452	BG Hutch Product (N-06)	32	0.1	27	6	0	0	0	3	17	80	3001
BLF496	25% Beldongri Fines (N-11)	25	0.241	35	7	0	0	0	20	30	50	2626
CHF473	Chikla Fines (N-09)	26	0.22	35	6	0	0	0	6	27	67	2002
DBF474	DB Fines (N-09)	30	0.2	24	12	0	0	0	0	5	95	2992
DBF475	DB Fines (N-09)	35	0.2	18	13	0	0	0	0	0	100	4699
DBF487	DongriBuzurg Fines(N-10)	28	0.2	26	12	0	0	0	0	5	95	2792
GMF449	35% Gumgaon Fines(N-06)	35	0.25	25	7.8	0	0	0	0	70	30	3365
GMF465	Gumgaon Fines	30	0.28	28	8	0	0	0	0	70	30	2309
KDF393	KD Fines(N-06)	34	0.2	26	5.4	0	0	0	0	20	80	2823
MSF479	Dump Fines (N-09)	30	0.275	33	7.85	0	0	0	20	35	45	3234
SPF486	Sitapatore Fines(N-10)	28	0.23	35	6.5	0	0	1.5	6.5	20	72	2661
TDF488	Tirodi Fines(N-10)	28	0.3	34	7.5	0	0	0	13	20	65	2661
UKF495	28% Ukwa Hutch (N-11)	28	0.35	30	5.5	0	0	0	0	10	90	1861
Chemical Grade												
DB3385	Dongri 38/40% Chem (-10)	39	0.2	18	10	0	0	0	25	30	45	9589
DB3494	Dongri33/35% Chem.	34	0.21	20.5	11	-	-	-	25	30	45	3149

Note: BG-Balaghat, Bl-Beldongri, CH-Chikla, DB-DongriBuzurg, GM-Gumgaon, KD-Kandri, MS – Mansar ,SP-Sitapatore, TD-Tirodi, UK-Ukwa, SMGR LMP-silicomanganese grade Lump Madhya Pradesh, SMGR LMH- silicomanganese grade Lump Maharashtra, SMGR SMP -silicomanganese grade Small Size Madhya Pradesh, SMGR SMH- silicomanganese grade Small Size Maharashtra.

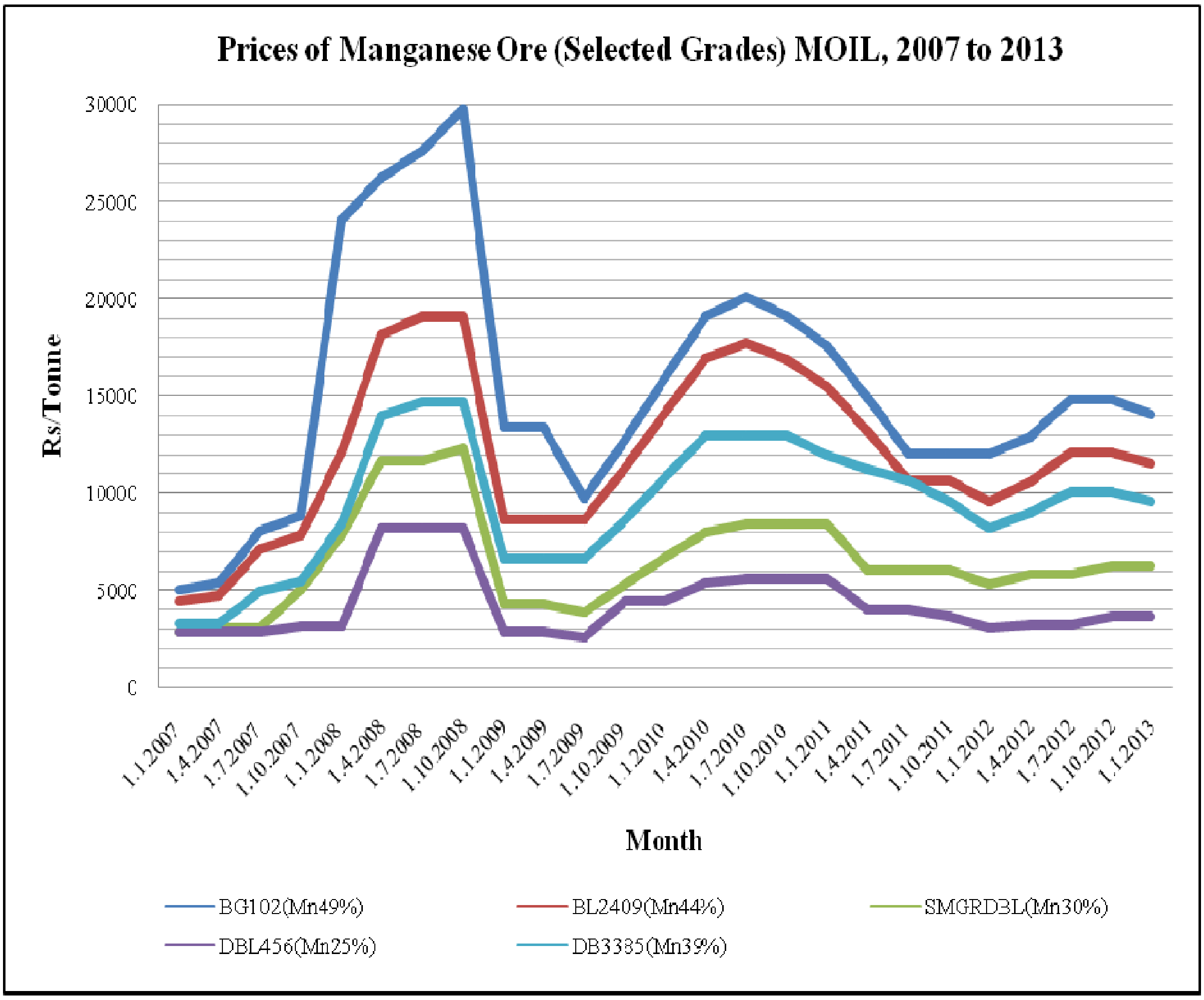
Past Data on Prices Quoted by MOIL

The past data prices quoted by MOIL is given at **Annexure: 8 III-A** (1.1.2011 to 1.1.2013), **Annexure: 8III -B** (1.1.2009 to 1.10.2010), **Annexure: 8 III – C** (1.1.2007 to 1.10.2008).

Analysis of Past Data as on 1.1.2013

As already stated, there are more than 63 grades marketed by MOIL in five major categories. The variation in the prices of five important grades is depicted in **Figure: 8.1.**

Figure: 8.1



As per the prices published on 1.1.2013, MOIL markets 63 grades under five major categories namely, Ferro grade (28 grades), Silicomanganese grade (7 grades), Silicomanganese grade (low Mn 25%) (7 grades), Fines (13 grades) and Chemical grade (2 grades).

It will be seen from the prices data as on 1.1.2013 that the prices of ferro grade manganese ore produced by MOIL varied between Rs. 6,983 per tonne and Rs. 14,067 per tonne depending on the grade and the mine from which it is produced. The highest quotation for BG102 at Rs. 14,067 and the lowest was Rs. 6983 per tonne for MS 4317.

The prices for silicomanganese grade with 30% Mn varied between Rs. 5,106 per tonne and Rs. 6,240 per tonne, depending upon the grade and mine. The highest price of Rs. 6,240 per tonne was quoted for SMGR LMP and the lowest of Rs. 5,106 per tonne was quoted for SMGR SMP. In case of silicomanganese grade ore with 25% Mn, prices varied between Rs. 2,804 per tonne being the lowest for UKL448 and the highest of Rs. 3,672 per tonne for DBL456.

For silicomanganese grade with 20% Mn which are mainly fines, the prices ranged between Rs. 1,861 per tonne for UKF450 and Rs. 4,699 per tonne for DBF 475. Under chemical grade the lowest quotations were Rs. 3,149 per tonne for DB3494 and Rs. 9,589 per tonne for grade DB3385.

Analysis of Past Data of MOIL Prices

Ferro Grade

BG 102(1st grade LP "L") is the highest grade in this group with Mn% 49.5 (**Table: 8.1**) was quoted at Rs. 29,789 per tonne as on 1.10.2008 and minimum at Rs. 4,990 per tonne as on 1.1.2007. Analysis of the price data indicates that the price was quoted at Rs. 4,990 per tonne on 1.1.2007 which increased to Rs. 24,100 per tonne as on 1.1.2008 and further to Rs. 29,789 per tonne as on 1.10.2008. Thereafter, prices started declining and were quoted at the lowest level of Rs. 9,725 per tonne as on 1.7.2009. With effect from 1.10.2009, the prices increased to Rs. 12,750 per tonne and increased to a level of Rs. 20,082 as on 1.7.2010 and again started declining to a low level of Rs. 12,047 per tonne as on 1.10.2011. Since 1.7. 2012, the prices are hovering around Rs.14000 per tonne.

Silicomanganese Grade

SMGRDBL is the highest grade in this group. Analysis of the data indicates that the price was quoted at Rs. 2835 per tonne as on 1.1.2007, which increased to Rs. 5028 per tonne on 1.10.2007 and further to Rs. 12275 per tonne as on 1.10.2008. The prices fell to Rs. 4286 per tonne as on 1.1.2009 and further to Rs. 3866 per tonne as on 1.7.2009. The prices of this grade increased to Rs.5335 per tonne as on 1.10.2009 and touched Rs. 8403 per tonne as on 1.7.2010. The prices started declining in 2011 and were quoted at Rs. 7225 per tonne and decreased to Rs. 5056 per tonne as on 1.1.2012. The period 1.4.2012 to 1.10.2012 witnessed increased in prices and were quoted at Rs. 6257 per tonne as on 1.10.2012. However, the prices came down to Rs. 5944 per tonne as on 1.1.2013.

Silicomanganese Grade Low (Mn 25%)

In this category, there are nine sub grades. As on 1.10.2007, the prices of this grade varied between Rs. 2696 and Rs. 3122 per tonne depending on the mine and grade of ore. The prices in general increased as on 1.1.2008 and were quoted between Rs. 4179 per tonne and Rs. 4839 per tonne. The period 1.4.2008 to 1.12.2008 witnessed increasing trend. As on 1.10.2008, the prices varied between Rs. 7362 and Rs. 9743 per tonne. As on 1.1.2009, the prices of this grade ore from various locations fell compared to 1.10.2008 and were quoted between Rs. 2227 and Rs. 3410 per tonne. The price quotation as on 1.7.2009 was on the lower side and was quoted between Rs. 2476 and Rs. 3069 per tonne. As on 1.1.2010, prices maintained increasing trend during the quarters April and July 2010. The prices were quoted between Rs. 5040 and Rs. 6671 per tonne as on 1.7.2010. The prices quoted as on 1.10.2010 was on the lower side and maintained a slump till 31.3.2012. The prices were quoted between Rs. 2499 and Rs. 3077 per tonne as on 1.1.2012. Since 1.4.2012, prices started recovering and were quoted between Rs. 2907 and Rs. 3231 per tonne. During July and October quarters, the prices increased and were quoted between Rs. 2952 and Rs. 3635 per tonne. The prices were quoted lower at Rs. 2804 and Rs. 3672 per tonne during the quarter 1.1.2013.

Silicomanganese Grade Low (Mn 20%)

There are three grades under this group. However, Grade code TDL-469 was the most important grade till 1.7.2007. Since then the prices of this group has not been quoted.

Fines

Under this group, the important grade is DB Fines (N-09) Grade code (DBF-475) was quoted for the first time on 1.4.2009 and the maximum price was quoted at Rs. 6104 per tonne as on 1.7.2010 and minimum at Rs. 2808 per tonne as on 1.4.2009.

Chemical Grade

The important grade is Dongri 38/40% Chemical (-10) Grade code (DB3385). Maximum price of this grade was quoted at Rs. 14663 per tonne as on 1.10.2008 and minimum at Rs. 3300 per tonne as on 1.1.2007.

Price Quotations by M/s. A.P. Trivedi & Sons and M/s. Pacific Minerals

The price quotations in respect of M/s. A.P. Trivedi & Sons and M/s. Pacific Minerals, Balaghat are available for the period 2009-10 and 2010-11 only (**Annexure: 8.1**). Analysis of the price data of these agencies indicate that compared to 2009-10, the prices in 2010-11 recorded an increase of Rs. 4965 per tonne in case of manganese ore with (+) 46% Mn and of Rs. 2500 per tonne in case of grade with 35-46% Mn. The prices of other grade also recorded an increase.

KARNATAKA

Manganese ore in Karnataka is traded mainly by Sandur Manganese and Iron Ore Ltd (SMIORE), Mysore Minerals Ltd, Mineral Enterprises Ltd, Chitradurga and Milan Minerals Pvt. Ltd Tumkur in four different grades from below 25% Mn to 35- 46% Mn. The price quotations for these companies for the period 2009-10 to 2011-12 are given at **Annexure: 8.1.** The prices of

35-46% Mn grade quoted by SMIORE in 2009-10 was Rs. 6706 per tonne, which increased to Rs.11189 in 2010-11 and fell in 2011-12 and were quoted at Rs. 9467 per tonne. The prices of other grades also registered same trend. Price quotations of Mineral Enterprises Ltd, Chitradurga were for two grades: (i) below 25% Mn and (ii) 25-35% Mn. During the period, 2009-10 to 2011-12, the prices of manganese ore in general recorded increasing trend.

International Prices

Pricing Mechanism

Manganese ore is generally traded between countries on contract (either by C.I.F. or F.O.B.) basis. Contracts involving international transportation often contain abbreviated trade terms that describe matters such as the time and place of delivery, terms of payment and responsibility of paying the costs of freight and insurance. FOB and CIF are the most two popular trade terms defined by International Chamber Of Commerce (I.C.C.) to harmonize the possible dispute arising from the international trade practice.

C. I. F. (Cost, Insurance and Freight) is price quoted by the seller which includes packing, shipping, and insurance charges. CIF indicates a trade in which the seller is required to arrange the carriage of goods by sea to the port of destination and provide the buyer with documents necessary to obtain the goods from the transporting agency. As per the International Chamber Of Commerce (I.C.C.), CIF indicates the price invoiced or quoted by the seller, including insurance and all other charges such as packing, shipping etc. upto the port of destination.

F.O.B. is a trade term which indicates that the seller has to deliver the goods on a ship designated by the buyer. The seller fulfills his obligations when the goods are loaded on the ship. F.O.B. price indicates that the price invoiced or quoted by a seller includes all charges up to loading of the goods on a ship at the port of departure specified by the buyer. The major difference between CIF and FOB is cost of the transportation and insurance during the transit period of the goods. In addition, there is term known as C.I.P. which means, Carriage and Insurance Paid. The CIP price includes insurance and all charges upto a named place in the country of destination (usually the buyer's warehouse).

There is another important term used in the trading of manganese ore which is known as Dry Metric Tonne Unit (D.M.T.U.). The unit is of 10 kg i.e. one tonne divided into 100 parts. For example, if the price of manganese is quoted as "$8 per DMTU", it is equal to $ 800 per tonne of pure manganese metal.

Benchmark Pricing

Platts is a leading global provider of energy, petrochemicals and metals information and a premier source of benchmark price assessments for these commodity markets. With effect from 2012, Platts has started publishing the daily spot market price for manganese ore, reflecting the price at which a cargo could be traded on a CIF North China basis. These assessed values are based on confirmed spot cargo transactions, or the tradable price falling between firm cargo bids/offers, or in the absence of liquidity, where spot market transactions would have been concluded for the benchmark grade. Spot price bids/offers or trades on the basis of FOB or CIF in other locations may be netted back to CIF North China using prevailing spot freight rates for dry bulk carriers on the day of assessment. All prices are quoted in US dollars per dry contained manganese unit ($/DMTU).

The assessment reflects high grade manganese ore lumps normalised to a standard specification of 44% Mn content. All values deemed typical, specifications with Mn content ranging from 41% to 46% are to be normalised to a standard where Fe content is 6.00%, SiO_2- 8.00%, Al_2O_3- 7.00%, P - 0.11%, moisture - 3.00% and sizing at 5 mm to 80 mm, 90% passing. Quality assessments are made at discharge port. The price data is published in Platts weekly and is not available in the public domain.

Prices Published by Metal Bulletin

Metal Bulletin Ltd through its weekly magazine, "Metal Bulletin" publishes the prices of manganese ore on weekly basis under the head-Bulk Alloys.

The Metal Bulletin Manganese Ore Indices, MBMnOI44 and MBMnOI38, are two weekly reference prices for the manganese ore spot market. They are a tonnage-weighted calculation of actual transactions that have been normalised to a base specification of manganese content (44% Mn and 38% Mn respectively) and delivery point or loading point (Tianjin and Port Elizabeth respectively).

The data on prices of manganese ore as published in Metal Bulletin June, 2010 to June 2013 was compiled and is given in **Table: 8.2.**

Table: 8.2- Prices of Manganese Ore as Published in Metal Bulletin

(In US $/dmtu)

Period	Grade		
	48/50%Mn FOB (Max. 0.1%P)	44% Mn (CIF Tianjin)	38%Mn (FOB Port Elizabeth)
June 2010 to August 2010	8.00-9.25	-	-
16th August 2010 to 25th Oct.2010	7.50-8.50	-	-
Nov.2010 to Dec. 2010 and January 2011to May, 2011	6.50-7.50	-	-
June 2011 to January 2012	5.30-5.50	-	-
February 2012 to June 2012	4.50-4.75	-	-
July 2012 to August 2012	5.10-5.30	-	-
13th Aug. 2012 to 22nd Oct.2012	5.00-5.20	-	-
15thOct. 2012	5.00-5.20	4.91	3.77
22nd Oct.2012	5.00-5.20	4.98	3.88
29th Oct.2012	-	5.13	3.93
5th Nov.2012	-	5.10	3.93
12th Nov. 2012	-	5.09	3.97
19th Nov. 2012	-	5.08	3.93

Period	Grade		
	48/50%Mn FOB (Max. 0.1%P)	**44% Mn (CIF Tianjin)**	**38%Mn (FOB Port Elizabeth)**
26th Nov. 2012	-	5.04	3.86
3rd Dec. 2012	-	5.09	3.84
10th Dec.2012	-	5.10	3.84
17th Dec.2012 to 24th Dec.2012	-	5.15	3.94
21st January 2013	-	5.47	4.38
28th January 2013	-	5.49	4.38
4th February 2013	-	5.48	4.45
11th to 18th February 2013	-	5.52	4.49
1st April 2013	-	5.72	4.47
8th April 2013	-	5.72	4.49
15th April 2013	-	5.79	4.46
22nd April 2013	-	5.81	4.42
29th April 2013	-	5.78	4.40
20th May 2013	-	5.75	4.35
17th June 2013	-	5.62	4.03

Source: Metal Bulletin.

The prices have been quoted on FOB and CIF basis from Tianjin, China and Port Elizabeth, South Africa and are Metal Bulletin Copyright on dmtu basis. All Chinese domestic prices include VAT of 17%.

It can be seen from the **Table: 8.2** that from June 2010 to October 2012, there was only one grade 48/50% Mn with 0.1% P (max.) and the prices were quoted on FOB basis. The prices of this grade were highest during the period June 2010 to August 2010. During the period from 15th October 2012 to 22nd October 2012, there were three grades namely, 48/50% Mn, 0.1% P (max.) 44% Mn and 38% Mn for which prices were quoted and from 29th October 2012 onwards, the prices were quoted for only two grades namely, 44% Mn CIF Tianjin, China and 38% Mn FOB Port Elizabeth, South Africa. The details of the prices are given in **Table: 8.2**. The prices of 44% Mn grade CIF Tianjin, China were highest at US $ 5.8 per dmtu as on 22nd April, 2013 and lowest at US $ 4.9 per dmtu as on 15th October 2012. The prices of 38% Mn FOB Port Elizabeth, South Africa were highest at US $ 4.49 per dmtu as on 8th April 2013 and lowest at US $ 3.77 per dmtu as on 15th October, 2012.

Historical Data for International Prices of Manganese Ore

A well documented data based on historical prices of manganese ore of different grades from various origins of the world is not available in the public domain. In view of this, the past data as available in various sources has been documented as below:

In the fiscal year 2005 (April 2005 to March 2006), the International benchmark price for metallurgical grade ore increased by 63% as compared to 2004, when price negotiations between BHP

Billiton Ltd and major Japanese consumers were concluded in February on an FOB basis. For delivery during the annual contract year, the agreed price was US $ 3.99 per mtu for ore from the Groote Eylandt Mine in Australia.

In the fiscal year 2006 (April 2006 to March 2007), the International benchmark price for metallurgical grade ore decreased by 24.5% as against the year 2005, when price negotiations between BHP Billiton Ltd and major Japanese consumers were concluded in December on an FOB basis. For delivery during the annual contract year, the agreed price was US $ 3.00 per mtu for ore from the Groote Eylandt Mine in Australia (Text Report- 2005). The decrease in manganese ore prices can be attributed primarily to an increased supply of manganese ore.

In the fiscal year 2007 (April 2007 to March 2008), the International benchmark Price for metallurgical grade ore decreased by 10% from that in 2006, when price negotiations between BHP Billiton Ltd and major Japanese consumers were concluded in January, 2007 on an FOB basis. For delivery during the annual contract year, the agreed price was US $ 2.71 per mtu for ore from the Groote Eylandt Mine in Australia. The decrease in manganese ore prices can be attributed to primarily to an increased supply of manganese ore.

In the year 2008, there was 314% to 413% increase in the International benchmark Price for metallurgical grade ore containing 48% manganese. The price was set between Japanese consumers and BHP Billiton Ltd in February. The prices were above or below these values depending on ore quality, time of year, and nature of transaction. The year-average spot market price for this grade, based on weekly average of Chinese cost and freight (CNF) transaction prices was US$ 14.70 per mtu. The range in CNF spot market prices per mtu peaked in June and July at US $ 17.50 to US $ 18.5 per mtu up from US $ 11.50 to US $ 12.00 per mtu at the beginning of the year and about double that in late December (US $ 8.00 to US $ 8.50).

In the fiscal year 2008 (April 2008 to March 2009), the BHP Billiton Ltd and major consumers negotiated for the first time, a range in international benchmark prices for metallurgical grade ore. The contract included a clause that the World allows Japanese prices to be reviewed on a quarterly or a semi-annual basis on fluctuation in Chinese manganese ore spot market prices. On FOB basis for delivery during the annual contract year, the agreed price range was US$ 8.50 to US$ 11.20 per mtu for ore from the Groote Eylandt Mine in Australia up 314% to 413% from US $ 2.70 in fiscal year 2007.

The primary influences on manganese ore price at the time were increased global consumption, particularly by China and India and lower production in Brazil, China & South Africa for technical and local economic reasons.

In the year 2009, there was 51% decrease in the annual average international benchmark price for metallurgical grade ore containing 48% Mn as calculated from monthly contract prices set between Japanese consumer and Australian producers (ABARI unpublished Data January to December, 2009). Prices were above or below this value depending on ore quality, time or year and nature of transaction. The year average spot market price for this grade of ore based on weekly averages of Chinese cost and freight (CNF) transaction prices was US$ 5.61 per mtu. The range in CNF spot market prices per mtu peaked in January at US$ 8.00 to US $ 8.50, fell to a low of US $ 4.02 to US $ 4.25 in mid-year, then rose to finish the year at US$ 6.85 to US $ 7.10 per mtu because of improved market condition.

In the year 2010, there was 11% increase in the annual average international benchmark price for metallurgical grade ore containing 46 to 48% Mn as calculated from quarterly contract prices set between Japanese consumers and Australian producers (ABARI-2011). The international benchmark price for the first time reflected cost insurance and freight rather than FOB charges.

The 2010 average spot market price for this grade of ore based on weekly averages of Chinese cost and freight (CNF) transaction prices was reported at US $ 7.23 per mtu. The range in CNF spot market prices per mtu peaked in May at US $ 8.50 to US $ 8.90, and then trended downwards to finish the year at US $ 6.50 to US $ 6.80 per mtu because of increased world mine capacity and high manganese ore inventories at Chinese ports which were reported to be more than 2.50 million tonnes.

In the year 2011, there was 23% decrease in the annual average international benchmark price for metallurgical grade ore containing 46 to 48% Mn as calculated from quarterly contract prices set between Japanese consumers and Australian producers (ABARI-2012). The only spot market prices reported for manganese ore were for deliveries to China.

In 2011, the average spot market price for metallurgical grade ore containing 46% Mn based on weekly averages of Chinese cost and freight (CNF) transaction prices as reported was US$ 4.84 per mtu. This was a 33% decrease from that of 2010. The range in CNF spot market prices per mtu were the highest in January at US$ 6.50 to US $ 6.80 and then trended downward to finish the year at US $ 4.65 to US $ 4.75 per mtu. The CNF prices remained relatively lower in 2011 than those in 2010 because of a dip in Chinese crude steel production and high manganese ore inventories at Chinese ports which were reported to be more than 3.40 million tonnes at the year end.

Market-wise Prices

1. Australia

Australia is marketing its manganese ore under following five grades:

1. Lumpy, Mn 48%, Fe < 5%, SiO_2> 12%, P< 0.1%,
2. Lumpy, Mn 45.5%,
3. Lumpy, Mn 37-38%, Fe < 5%, SiO_2>20%, P< 0.1%,
4. Lumpy, Mn 33-35%, Fe < 22%,
5. Particle, Mn 48%, Fe < 5%, P< 0.1%.

The prices quoted for these grades during the period from May 2011 to September 2012 are given in **Table: 8.3**.

Table: 8.3 - Monthly Prices of Manganese Ore in Australia

(In US $/ dmtu)

Month	Lumpy Mn-48%	Lumpy Mn-45.5%	Lumpy Mn-37-38%	Lumpy Mn-33-35%	Particle Mn-48%	Remark
May to July 2011	5.4-5.5	5.3-5.4	4.9-5.0	-	5.1-5.2	CIF China
September to October 2011	5.4-5.5	5.5-5.6	4.9-5.0	-	-	CIF China
November to December 2011	5.4-5.5	5.5-5.6	-	-	-	CIF China
January to February 2012	-	4.75-4.8	4.9-5.0	-	4.3-4.4	CIF China
March 2012	-	4.75-4.8	-	-	4.3-4.4	CIF China
April 2012	-	4.75-4.8	-	-	4.1-4.2	CIF China
May 2012	5.2-5.3	5.0-5.1	-	-	4.3-4.4	CIF China
June 2012	5.2-5.3	5.1-5.2	-	-	4.45-4.5	CIF China
July 2012	5.5-5.6	5.35-5.40	-	-	4.8-4.9	CIF China
August to September 2012	5.75-5.8	5.35-5.40	-	4.6-4.65	4.8-4.9	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

2. South Africa

Manganese ore from South Africa is marketed under five grades namely:

1. Lumpy, Mn 42-44%, Fe <10%, P< 0.1%,
2. Lumpy, Mn 42%, Fe <12-16%,
3. Lumpy, Mn 37.5%, Fe < 5%, P< 0.1%,
4. Lumpy, Mn 32-33%, Fe <20-22%,
5. Fines, Mn 37.5%, Fe < 5%, P< 0.1%.

The prices quoted for these grades during the period from May 2011 to September 2012 are given in **Table: 8.4.**

Table: 8.4 - Monthly Prices of Manganese Ore in South Africa

(In US $/ dmtu)

Month	Lumpy Mn-42-44%	Lumpy Mn-42%	Lumpy Mn-37.5%	Lumpy Mn-32-33%	Fines Mn-37.5%	Remark
May to July 2011	5.3-5.4	4.85-4.9	4.7-4.8	4.6-4.7	-	CIF China
September 2011	5.5-5.6	4.85-4.9	4.8-4.9	4.9-5.0	-	CIF China
October to December 2011	5.6-5.7	4.85-4.9	4.8-4.9	5.0-5.1	-	CIF China
January to February 2012	4.8-4.9	-	4.0-4.1	4.75-4.85	-	CIF China
March 2012	4.7-4.8	4.2-4.3	4.1-4.2	4.6-4.7	-	CIF China
April 2012	4.6-4.7	4.2-4.3	4.15-4.25	4.5-4.6	-	CIF China
May 2012	4.8-4.9	4.5-4.6	-	4.7-4.8	4.25	CIF China

Month	Lumpy Mn-42-44%	Lumpy Mn-42%	Lumpy Mn-37.5%	Lumpy Mn-32-33%	Fines Mn-37.5%	Remark
June 2012	5.0-5.15	4.65-4.7	4.65-4.85	4.7-4.8	4.25	CIF China
July 2012	5.0-5.15	-	4.85-4.90	4.8-4.9	4.25	CIF China
August 2012	5.0-5.15	-	4.75-4.85	4.7-4.8	4.25	CIF China
September 2012	5.0-5.15	4.4-4.45	4.75-4.85	4.7-4.8	4.25	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

3. Gabon

Manganese ore from Gabon is marketed under three grades namely:

1. Lumpy, Mn48%, Fe< 5%,
2. Lumpy, Mn 44-45%, Fe < 5%,
3. Particle, Mn 43%.

The prices quoted for these grades during the period from May 2011 to September 2012 are given in **Table: 8.5.**

Month	Lumpy Mn-48%	Lumpy Mn-44-45%	Particle Mn-43%	Remark
May to July 2011	5.6-5.7	5.3-5.4	5.0-5.1	CIF China
September to December 2011	5.6-5.7	5.3-5.4	5.0-5.1	CIF China
January to April 2012	4.65-4.75	4.3-4.4	4.0-4.1	CIF China
May 2012	-	4.65	-	CIF China
June 2012	-	4.65	4.1	CIF China
July 2012	-	5.1-5.15	-	CIF China
August to September 2012	-	5.0-5.05	4.5	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

4. Brazil

Manganese ore from Brazil is marketed under three grades namely:

1. Lumpy (CVRD), Mn44-45%, Fe < 5%, P< 0.1%,
2. Lumpy, Mn 38-40%, P< 0.1%,
3. Particle (CVRD), Mn 44-45%, Fe < 5%, P< 0.1%.

CVRD,(Companhia vale do Rio Doce) Brazil is engaged in production of manganese ore. At present, the name is changed as Vale S.A.

The prices quoted for these grades during the period from May 2011 to September 2012 are given in **Table: 8.6.**

Table: 8.6 - Monthly Prices of Manganese Ore in Brazil

(In US $/ dmtu)

Month	Lumpy (CVRD) Mn44-45%	Lumpy Mn38-40%	Particle (CVRD) Mn44-45%	Remark
May to July 2011	5.3-5.4	4.8-4.9	-	CIF China
September to December 2011	5.5-5.6	5.0-5.1	-	CIF China
January 2012	4.1-4.2	-	-	CIF China
February 2012	4.5-4.6	-	-	CIF China
March 2012	4.1-4.2	-	-	CIF China
April 2012	4.1-4.2	4.3-4.4	-	CIF China
May 2012	4.4-4.6	4.2-4.4	4.3	CIF China
June 2012	4.4-4.6	-	4.3	CIF China
July 2012	5.1-5.3	-	4.8-5.0	CIF China
August to September 2012	4.6-4.7	-	4.5-4.6	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

5. Ghana

During the period from April to September 2012, Ghana marketed its manganese ore under only one grade i.e. carbonate manganese ore with Mn 28%, Fe <2%. The prices quoted for these grades during the period mentioned above are given in **Table: 8.7.**

Table: 8.7 - Monthly Prices of Manganese Ore in Ghana

(In US $/ dmtu)

Month	Carbonate Ore	Remark
April 2012	4.7-4.8	CIF China
May 2012	5.2-5.3	CIF China
June to September 2012	5.5-5.6	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

6. Indonesia

Indonesian manganese ore is marketed under three grades namely:

1. Lumpy, Mn>50%, Fe < 5%, P< 0.1%,
2. Lumpy, Mn44-45%, Fe < 5%, P< 0.1%,
3. Lumpy, Mn40%, Fe <5%,P< 0.1%.

The prices quoted for these grades during the period from May 2011 to September 2012 are given in **Table: 8.8.**

Table: 8.8 - Monthly Prices of Manganese Ore in Indonesia

(In US $/ dmtu)

Month	Lumpy Mn>50%	Lumpy Mn-44-45%	Lumpy Mn-40%	Remark
May 2011	6.6-6.7	6.3-6.4	-	CIF China
June 2011	6.2-6.3	5.9-6.0	-	CIF China
July 2011	6.2-6.3	5.5-5.6	-	CIF China
September 2011	6.0-6.1	5.4-5.5	-	CIF China
October 2011	5.9-6.0	5.4-5.5	-	CIF China
November 2011	6.0-6.1	5.4-5.5	-	CIF China
December 2011	5.9-6.0	5.3-5.4	5.0-5.1	CIF China
January 2012	5.5-5.6	4.9-5.0	4.4-4.5	CIF China
February 2012	5.3-5.4	4.5-4.6	4.2-4.3	CIF China
March 2012	5.2-5.3	4.4-4.5	4.1-4.2	CIF China
April to September 2012	5.2-5.3	4.4-4.5	4.0-4.1	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

7. Zambia

Manganese ore from Zambia is marketed under two grades namely:

1. Lumpy, Mn>50%, Fe <3%, P< 0.1%,
2. Lumpy, Mn 42-43%, Fe <4%, P< 0.1%

The prices quoted for these grades during the period from May 2011 to September 2012 are given in **Table: 8.9.**

Table: 8.9 - Monthly Prices of Manganese Ore in Zambia

(In US $/ dmtu)

Month	Lumpy Mn> 50%	Lumpy Mn-42-43%	Remark
May to June 2011	5.8-5.9	-	CIF China
July 2011	6.2-6.4	-	CIF China
September 2011	5.9-6.0	-	CIF China
October to December 2011	5.8-5.9	-	CIF China
January 2012	5.6-5.8	5.3-5.5	CIF China
February 2012	5.6-5.7	-	CIF China
March 2012	5.1-5.2	4.5-4.6	CIF China
April to September 2012	5.1-5.2	4.1-4.2	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

8. Turkey

Manganese ore from Turkey is marketed under three grades namely:

1. Lumpy, Mn 42-44%, Fe < 5%,
2. Lumpy, Mn 40-42%, Fe < 5%,
3. Lumpy, Mn 34-36%, SiO_2 20%.

The prices quoted for these grades during the period from May 2011 to September 2012 are given in **Table: 8.10.**

Table: 8.10 - Monthly Prices of Manganese Ore in Turkey

(In US $/ dmtu)

Month	Lumpy Mn-42-44%	Lumpy Mn-40-42%	Lumpy Mn-34-36%	Remark
May 2011	5.6-5.7	5.4-5.5	-	CIF China
June 2011	5.5-5.6	5.3-5.4	-	CIF China
July 2011	5.3-5.4	5.0-5.1	-	CIF China
September 2011	5.4-5.5	5.2-5.3	-	CIF China
October 2011	5.4-5.5	5.2-5.3	4.5-4.6	CIF China
November 2011	5.4-5.5	5.2-5.3	4.1-4.2	CIF China
December 2011	5.4-5.5	5.2-5.3	4.5-4.6	CIF China
January 2012	4.8-4.9	-	4.0-4.1	CIF China
February 2012	4.8-4.9	4.6-4.7	4.0-4.1	CIF China
March to April 2012	4.6-4.7	4.4-4.5	3.8-3.9	CIF China
May 2012	4.8-4.9	4.6-4.7	4.0-4.1	CIF China
June 2012	5.5-5.6	5.3-5.4	4.4-4.5	CIF China
July to September 2012	5.5-5.6	5.3-5.4	4.7-4.8	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

9. Cote d' Ivoire

The only grade of manganese ore marketed by Cote d' Ivoire is Lumpy Mn 40-42% and Fe 3-6%. The prices quoted for this grade during the period from September 2011 to September 2012 are given in **Table: 8.11.**

Table: 8.11 - Monthly Prices of Manganese Ore in Cote D'Ivoire

(In US $/ dmtu)

Month	Lumpy Mn-40-42%	Remark
September to January 2012	4.8-5.1	CIF China
February 2012	4.5-4.6	CIF China
March to September 2012	4.3-4.4	CIF China

Source: Various Sources.Note: one dmtu is 10 kg of metal content in the ore.

Prices of manganese Ore in China on November 29, 2012

China imports manganese ore of different grades from different countries. The CIF prices of imported manganese ore in China on November 29, 2012 are given in **Table: 8.12**.

Table: 8.12 – CIF Prices of Imported Manganese Ore in China on November 29, 2012

(In US $/ dmtu)

Product	Origin	Specifications	Price
Lump	Australia (BHP)	Mn - 43-44%	-
Lump	Australia (BHP)	Mn - 45.5%	5.2 (Bulk)
Ore (Small Size)	Australia (BHP)	Mn - 48%	4.75(Bulk)
Ore (Small Size)	Australia (BHP)	Mn - 43%	-
Lump	South Africa (BHP)	Mn -37.5%, Fe-5%, P-0.03%	4.7
Lump	Australia (CML)	Mn - 46%	4.95- 5.5 (Bulk)
Lump	Australia (CML)	Mn - 48%, Si-15%	5.75 (Bulk)
Lump	Gabon (Comilog)	Mn - 44-45%	4.85- 5.0 (Bulk)
Lump	Gabon (Comilog)	Mn - 48%	-
Ore (Small Size)	Gabon (Comilog)	Mn - 43%, P-0.10-0.12%	4.35 (Bulk)
Lump	Australia (OM)	Mn - 37%, Si-18%, P-0.05%	4.75(Bulk)
Lump	South Africa (UMK)	Mn -37.5%	4.9 (Bulk)
Lump	Zambia	Mn -48-50%, Fe-2%	5.1-5.2 (Bulk)
Lump	South Africa	Mn -46%, Fe-10-12%	4.8-4.9(Bulk)
Ore (Small Size)	South Africa	Mn - 46%, Fe-10-12%	4.4-4.7 (Bulk)
Lump	South Africa (SIE)	Mn -30-34%, Fe-20-23%	4.7-4.75(Bulk)
Lump	Brazil (Vale)	Mn -44%, Fe-4%, P-0.04%	4.4-4.6(Bulk)
Lump	Indonesia	Mn -44%	4.9-5.1(Bulk)
Lump	Malaysia	Mn -32%	3.8-4.0

Source: http://ironoreteam.com

Prices as on August 5, 2013

In the port of Tianjin, the main stream traded price for Australian manganese ore (Mn 48% lumps) was RMB 41.5-42 per mtu, RMB 34.5- 35 per mtu for South African mixed carbonate manganese ore (Mn 38% lump) and RMB 38 per mtu for South African high iron manganese ore (Mn 35-36%, Fe 18%). In southern ports the main stream quotations for Australian manganese ore (Mn 48% lumps) were RMB 42-43 per mtu. Main stream traded prices were RMB 38- 38.5 per mtu for South African high iron manganese ore (Mn 35-36%, Fe 20%), RMB 34-35 per mtu for South African mixed carbonate manganese ore (Mn38% lump).

Chapter 9

SUMMARY

MANGANESE ore in the form of ferromanganese and silicomanganese is an important and indispensable input raw material in steel making. The production capacities of the manganese-based alloys has increased manifold to cater to the increased steel production capacity as well as exports. Therefore, the indigenous production has surpassed the domestic demand. In view of the importance of manganese ore for ferroalloy industry, it was considered necessary to take up a Market Survey on Manganese Ore to analyse its demand vis-à-vis domestic availability. The supply of manganese ore is crucial for future steel production capacities and manganese-based alloys production.

The production capacities of manganese-based alloys namely; ferromanganese and silicomanganese were 31.6 lakh tonnes in 2011-12 against the capacities available. The production was 19.24 lakh tonnes in 2011-12 (ferromanganese 4.46 lakh tonnes and silicomanganese 14.78 lakh tonnes). The country has also emerged as the major producer as well as exporter of silicomanganese in recent years apart from catering to the increasing domestic demand.

Present consumption of manganese ore is in the metallurgical use, more specifically in the production of manganese-based alloys. The increased domestic steel production resulted increase in domestic demand for manganese-based alloys, and its exports have led to high demand for manganese ore. About 90% of manganese ore is presently consumed for the production of manganese-based alloys i.e. ferromanganese and silicomanganese. The balance is consumed in battery, chemical, foundry and alloy steel industries. The present internal demand in 2011-12 was estimated at 4.10 million tonnes for all industries which is more than the total indigenous production of manganese ore.

India is one of the important countries in the world as far as reserves of manganese ore are concerned. The Country is placed at 5th place in the reserves tally in the world. Resources of manganese ore in the country have been placed at 430 million tonnes as per NMI, 1.4.2010. Out of total resources, 142 million tonnes (about 33%) fall under reserve category. The resources are spread over ten states but the bulk of resources are available in the state of Odisha (44%) followed by Karnataka (22%), Madhya Pradesh (13%), Maharashtra (8%) and Andhra Pradesh (4%).

India produces a number of grades of manganese ore with varying Mn content (from less than 46% Mn to more than 25% Mn). The production of all grades of manganese ore was 2.35 million tonnes in 2011-12 less than 3.05 million tonnes in 2010-11. The production of 25-35% Mn grade was maximum at 1,256 thousand tonnes in 2011-12 contributing 54% to the total production. During the year 2011-12, maximum production was reported from Maharashtra (28%), followed by Madhya Pradesh (27%) and Odisha (24%). Andhra Pradesh, Goa, Karnataka, Jharkhand and Rajasthan together contributed rest (21%) in all India production. Amongst the manganese ore producers, MOIL Ltd, the major public sector producer contributed about 45% of the domestic production in 2011-12.

To fulfill the demand for ferromanganese & silicomanganese, large quantities of manganese ore is being imported. India is a major importer of manganese ore. During the year 2011-12, the country imported about 1.97 million tonnes of manganese ore of all grades. The share of high grade (less than 46% Mn) was 44 per cent. India was an important manganese ore exporting country in the past. However, the exports has dwindled to only about 75 thousand tonnes in 2011-12.

As far as the world scenario of manganese ore is concerned, the world reserves of manganese ore in terms of metal content are placed at 630 million tonnes in 2012. The world production of manganese ore in 2011was reported at 47.30 million tonnes. China with 30% of the world production was the leading producer of manganese ore followed by South Africa, Australia, Gabon, Brazil and India. China was also the major importer with a share of 61% in the world imports followed by India (12%) in 2012. India mainly imports manganese ore of the grade 25-35% Mn. India's total imports of manganese ore of all grades stood at 1.96 million tonnes mainly from South Africa, Brazil and Australia. South Africa was the major exporter of manganese ore with a share of 42% in the total world exports followed by Australia, Brazil, Kazakhstan and other countries in 2012.

The Planning Commission has estimated steel production at 125.9 million tonnes by 2016-17 at the end of XII Five year plan and 200 million tonnes by 2020. Based on estimated steel production as well as demand from other metallurgical uses and non-metallurgical uses the demand for manganese ore by 2016-17 have been estimated at 6.88 million tonnes and 8.04 million tonnes by 2020.

Considering a steel production of 103.49 million tonnes (at 7% uniform growth rate), demand of 5.71 million tonnes of manganese ore have been envisaged by 2016-17 and considering a steel production of 249 million tonnes in 2029-30, the demand for manganese ore to a tune of 13.72 million tonnes have been forecasted.

To meet the future demand, the supply forecast of indigenously produced of manganese ore was made on the basis of CAGR of 5.09% at 3.01 million tonnes by 2016-17 leaving a supply gap of about 2.70 million tonnes in the envisaged future demand of 5.71 million tonnes by 2016-17, for domestic consumption as well as exports. To fulfill the gap, the country has to rely upon imports in near future. India may look forward to import manganese ore from Australia, Brazil, Gabon, Ghana, and South Africa to boost the supply.

ANNEXURES

Annexure: 2.I

BIS Standards for Manganese in Various Applications

Sl No.	Standard No.	Year	Title	Status
1.	IS 11281	2005	Manganese ore for the production of iron and steel making	Active
2.	IS 4763	2006	Manganese ore for production of ferromanganese	Active
3.	IS 11895	2006	Classification of manganese ore, ferruginous manganese ore, silicious manganese ore, Dioxide manganese ore and manganiferous iron	Active
4.	IS 372	1962	Manganese ore - battery grade (tentative)	Inactive
5.	IS 373	1952	Manganese ore metallurgical grade (tentative)	Inactive
6.	IS 11153	1996	Manganese dioxide for dry batteries - Specification	Active
7.	IS 12596	1989	Manganese Ore Sinters for Blending for Ferromanganese Production - Specification	Active
8.	IS 5713	1981	Manganese dioxide for explosive and pyrotechnic compositions	Active
9.	IS 1171	1996	Ferromanganese (1Amendment)	Active
10.	IS 1470	1990	Silicomanganese	Active
11.	IS 2021	1993	Metallic manganese	Active
12.	IS 3012	1985	Chromemanganese	Active
13.	IS 10535	1983	Manganese sulphate, monohydrate	Active
14.	IS 11236	1985	Manganese acetate	Active
15.	IS 11237	1985	Manganese carbonate	Active
16.	IS 15063	2001	Alkaline Manganese Dioxide Cells - Specification	Active
17.	IS 8144	1997	Multipurpose dry batteries (2 Amendments)	Active
18.	IS 9128	1999	Heavy duty dry batteries (1 Amendment)	Active
19.	IS 203	1984	Dry batteries for flashlights (4 Amendments)	Inactive
20.	IS 2576	1975	Specification for Dry Batteries for Transistor Radio Receivers (4 Amendments)	Inactive
21.	IS 267	1976	Inert cells	Inactive
22.	IS 276	2000	Austenitic-Manganese Steel Castings - Specification	Active
23.	IS 503	1963	Alloy austenitic manganese steel castings	Inactive

Source: http://bis.org.in/writeup.htm

Annexure: 2.II

Physical Properties and Chemical Analysis of Manganese Ore Consumed by Iron & Steel Industry

Sl No.	Name of Industry	Product Manufactured	Physical Properties	Chemical Analysis								
				Mn%	MnO_2% (min)	Mn/Fe Ratio	SiO_2% (max)	Al_2O_3% (max)	Fe% (max)	P% (max)	S% (max)	Remarks
1.	Bhilai Steel Plant, Bhilai Nagar, Durg, (Chhattisgarh).	Hot Metal	25-85 mm	30	-	-	30	5	-	0.3	-	-
2.	Bokaro Steel Plant, Bokaro, (Jharkhand).	Hot Metal	-10 mm (15% max) +40mm (10% max)	30	-	-	3.3	7.5	15-28	-	-	-
3.	Durgapur Steel Plant, Durgapur, (West Bengal).	Hot Metal	-	30	-	-	3.3	7.5	15-28	-	-	-
4.	KIOCL Pellet Plant, Mangalore, Dakshin Kannada, (Karnataka).	Hot Metal	-	25-50	44	-	12% (max)		-	-	-	-
5.	Visakhapatnam Steel Plant, Visakhapatnam, (Andhra Pradesh).	Hot Metal	-10 mm (10% max) +40mm (15% max)	30	-	-	-	-	-	-	-	-
6.	IISCO Steel Plant, Burnpur, Burdwan, (West Bengal).	Hot Metal	-10 mm (10% max) +40mm (15% max)	30	-	-	-	-	-	-	-	-
7.	Kirloskar Ferrous Industries Ltd, Koppal, (Karnataka).	Pig Iron	10to 40mm (90% max)	28	-	-	8	-	20	-	-	-
8.	Visa Steel Ltd, Kalinga Nagar, Jajpur, (Odisha)	Hot Metal	-	<35	-	-	-	-	-	-	-	-

Source: Replies received from various ferroalloys producers

Annexure: 2.III

Physical Properties and Chemical Analysis of Manganese Alloys Produced by Ferroalloy Industry

Sl No.	Name of Industry	Product Manufactured	Physical Properties	Chemical Analysis							
				Mn%	MnO_2	Mn/Fe Ratio	Si % (max)	Fe% (max)	P % (max)	S % (max)	C %
1.	Ferro-Alloys Corp. Ltd, Shreeramnagar, Vizianagaram, (A.P.).	HC Ferro-manganese	25-150 mm +/- 10%	70-80	-	-	1-5	-	0.35	0.05	-
	Ferro-Alloys Corp. Ltd, Shreeramnagar, Vizianagaram, (A.P.).	Silicomanganese	10-150 mm +/- 10%	60-70	-	-	16-20	-	0.30	-	2(max)
2.	Hira Power & Steel Ltd, Raipur, (Chhattisgarh) Unit -1	HC Ferro-manganese	-	70-75	-	-	1.5	-	0.4	0.05	6-8
	-do- Unit-2	HC Ferro-manganese	-	60-65	-	-	-	-	-	-	-
		Silicomanganese High Carbon	-	60-65	-	-	14-17	-	0.35	0.05	2.0
3.	Rohit Ferro-Tech Ltd, SKP House, 132A, S.P.Mukharjee Road, Kolkata (West Bengal).	HC Ferro-manganese	10-50 mm	75-80	-	-	1.2	-	0.25	0.03	7.5
4.	Rohit Ferro-Alloys Ltd,SKP House, 132A, S.P.Mukharjee Road, Kolkata (West Bengal).	HC Ferro-manganese	10-50 mm	70-75	-	-	1.5	-	0.30	0.030	8.0
5.	Andhra Ferro Alloys Ltd, Srinivasanagar, Vizianagaram, (A.P.).	Silicomanganese	-	60 (min)	-	-	14	-	0.3	0.035	2.5
6.	GMR Technologies & Industries, Ravivalsa, Srikakulam(A.P.).	Ferro-manganese	-	60	-	-	16	-	0.5	0.05	-
7.	Nav Bharat Ferroalloys Ltd, Khammam, (A.P.).	Silicomanganese	-	60-70	-	-	15-16	-	0.03	0.03	2

Annexure: 2.III contd..

Sl No.	Name of Industry	Product Manufactured	Physical Properties	Chemical Analysis							
				Mn%	MnO_2	Mn/Fe Ratio	Si % (max)	Fe% (max)	P % (max)	S % (max)	C %
8.	INDSIL Energy & Electrochemical Ltd, Raipur, (Chhattisgarh).	Silicomanganese	-	55	-	-	23-27	-	0.15	0.02	0.1 to 0.3
9.	Chhattisgarh Electricity Co. Ltd, Raipur, (Chhattisgarh).	HC Ferro-manganese	-	70-75	-	-	1.5-2.0	-	0.35-0.40	0.05	-
		HC Silico-manganese	-	60-65	-	-	1.5-2.0	-	0.30-0.35	0.05	2.0-2.5
		MC Ferro-manganese	-	70-75	-	-	2	-	0.25	0.05	1.5
10.	S.R. Chemicals and Ferroalloys Ltd, Belgaum, (Karnataka).	LC Ferro-manganese	-	70	-	-	-	-	0.12	-	0.1
11.	INDSIL Hydropower & Manganese Ltd, Palakkad, (Kerala)	Silicomanganese	-	55 (min)	-	-	23-27	-	0.15	0.02	0.1-0.5
12.	MOIL Ltd, Balaghat,(M. P.).	HC Ferro-manganese	40-100	78	-	-	1	-	0.33	0.02	7.50
13.	Jalan Ispat Casting Ltd, Meghnagar, Jhabua, (M.P.)	Silicomanganese	-	60-65	-	-	15-20	-	0.35	-	2
14.	Maharashtra Electrosmelt Ltd, Chandrapur, (Maharashtra).	HC Ferro-manganese	-	70-74 and74-78	-	-	1.5	-	0.43	-	6.8
		MC Ferro-manganese	-	70-74 and74-78	-	-	2 (max)	-	0.4	2	1-3
		LC Ferro-manganese	-	70-74 and74-78	-	-	2	-	0.4	-	1.5
		Silicomanganese	-	60-65 and 65 (min)	-	-	15-20	-	0.35	-	2 (max)
15.	Nagpur Power & Industries Ltd, Nagpur,(Maharashtra).	HC Ferro-manganese	-	70-75	-	-	-	-	0.4	-	-
		Silicomanganese	-	60-65	-	-	-	-	0.35	-	-
16.	Jindal Steel & Power Ltd, Kharsdia, Raigarh, (M.P.).	Silicomanganese	-	60	-	-	15	-	0.3	-	-

Annexure: 2.III contd..

Annexure: 2.III concld.

Sl No.	Name of Industry	Product Manufactured	Physical Properties	Chemical Analysis							
				Mn%	MnO_2	Mn/Fe Ratio	Si% (max)	Fe% (max)	P% (max)	S% (max)	C%
17.	Dandeli Steel & Ferro Alloys Ltd, Dandeli, Uttara Kannada, (Karnataka).	Ferro-manganese	37 mm	70-75	-	-	2.4	-	0.15	0.05	0.1
18.	Cosmic Ferro-tech ltd, Bishnupur, Bankura, (West Bengal).	HC Ferro-manganese	-	66-77	-	-	1.4	-	0.3	-	6.5-7
19.	Sri Gayatri Minerals Pvt. Ltd, Bishnupur, Bankura, (West Bengal).	Silicomanganese	-	60-65	-	-	15 (min)	-	0.3	0.03	2
20.	Karthik Alloys Ltd,Cuncolim, (Goa).	Silico-manganese	-	60-65	-	-	22-25	-	0.15-0.2	0.05	0.2-0.5
21.	Srinivasa Ferro-AlloysLtd, Durgapur, Burdwan, (West Bengal).	HC Ferro-manganese	-	70-74	-	-	1.5	-	0.25, 0.30, 0.35 (max)	0.03	6-8
22.	Natural Sugar & Allied Industries Ltd, Ranjani, Osmanabad, (Maharashtra).	HC Ferro-manganese	-	70-75	-	-	2-2.5	-	0.3	-	6-8
		Silico-manganese	-	60-65	-	-	13-15	-	0.3	-	2-2.5
23.	Tata Steel Ltd, Joda, Keonjhar, (Odisha).	HC Ferro-manganese	-	+70	-	-	0.3-0.2	-	0.2-0.4	-	6-8

Source: Replies received from various ferroalloys producers.

Annexure: 2.IV

Physical Properties and Chemical Analysis of Manganese Ore Consumed by Ferro Manganese Industry

Sl No.	Name of Industry	Product Manufactured	Physical Properties	Chemical Analysis								
				Mn%	MnO_2	Mn/Fe Ratio	SiO_2%	Al_2O_3%	Fe_2O_3%	S %	P %	Remarks
1.	Nav Bharat Ferroalloys Ltd, Khammam, (A.P.).	Silicomanganese	-	28-50	-	-	8-30	-	5-8	-	0.1 - 0.3	-
2.	Monnet Ispat & Energy Ltd, Raipur, (Chhattisgarh).	-	0-100% Lumps & Fines	28-46	-	-	6 -34	-	5-16	0.2	0.1	-
3.	Hira Power & Steel Ltd, Raipur, (Chhattisgarh).	Ferromanganese Silicomanganese	-	32-35	-	-	-	-	-	-	-	-
4.	MOIL Ltd, Balaghat,(M. P.).	HC FeMn	-	44-48	-	-	12-14	-	4.5-5.5	-	0.1	-
5.	Maharashtra Electrosmelt Ltd, Chandrapur, (Maharashtra).	FeMn & SiMn	+5 to 100 mm	38-46	-	-	10-16	-	6-17	-	0.5-0.25	-
6.	Tata Steel Ltd, Joda, Keonjhar, (Odisha).	FeMn & SiMn	10-75 mm	>40 for FeMn >36 for SiMn	-	-	-	-	-	-	-	-
7.	Rohit Ferro-Tech Ltd, Bishnupur plant, Dwarika,(West Bengal).	FeMn & SiMn	-	30-48	-	-	2-33	-	5-24	-	0.03-0.32	-
8.	Rohit Ferro-Tech Ltd, Haldia, (West Bengal).	FeMn & SiMn	-	30-48	-	-	2-33	-	5-24	-	0.03-0.32	-
9.	Vandana Global Ltd, Raipur, (Chhattisgarh).	SiMn	-	30-43	-	-	-	-	-	-	-	-
10.	Sarda Energy & Minerals Ltd, Raipur, (Chhattisgarh).	FeMn & SiMn	-	37-48	-	-	-	-	-	-	-	-
11.	Concast Steel & Power Ltd, Jharsuguda, (Odisha)	SiMn	-	24-49	4.00-26.00	0.11-0.24	3-26	-	3-20	-	0.02-0.3	-

Annexure: 2.IV contd..

Annexure: 2.IV (concld.)

Sl No.	Name of Industry	Product Manufactured	Physical Properties	Chemical Analysis								
				Mn%	MnO_2	Mn/Fe Ratio	SiO_2%	Al_2O_3%	Fe_2O_3%	S %	P %	Remarks
12.	S.R. Chemicals and Ferroalloys Ltd, Belgaum, (Karnataka).	FeMn	-	>40	>60	-	10	-	1.5	-	-	
13.	Hira Concast Ltd, Burdwan, (West Bengal)	-	-	28-46	-	-	18-33	-	7-9	0.25-0.30	-	-
14.	Ramnik Power & Alloys (P) Ltd, Sarand, Balaghat, (M.P.)	SiMn	-	30 (Min.)		-	-	-	6 (min)	-	-	-
15.	Nagpur Power & Industries Ltd, Nagpur,(Maharashtra).		5-25 mm	42-46		-	3.6	6-7	7-8	0.10-0.12	-	
16.	MSP Sponge Iron Ltd, Raigarh, (Chhattisgarh).	SiMn	-	30-32	-	-	-	-	17-18	-	-	-
17.	SMTC Power & Industries Pvt. Ltd, Kamptee, Nagpur, Maharashtra.	FeMn & SiMn	-	22-48	-	-	-	-	-	-	-	-
18.	Micron Minerals Pvt. Ltd, Butibori, Nagpur, (Maharashtra).	FeMn & SiMn	-	22-48	-	-	-	-	-	-	-	-

Source: Replies received from various ferroalloys producers.

Annexure: 3.I

Consumption of Manganese Ore in Different Industries, 2005-06 to 2011-12

(In tonnes)

Industry	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Industries	1,806,000	2,313,800	2,541,800	2,625,900	2,915,800	3,595,800	4,130,800
Ferroalloys	-	656,600	763,200	912,000	843,000	1,190,500	1,196,500
Ferromanganese	573,200	-	-	-	-	-	-
Silicomanganese	1,073,500	1,409,300	1,545,500	1,545,500	1,919,700	2,235,900	2,661,100
Iron and Steel	123,400	213,800	153,400	148,000	134,600	151,200	255,000
Battery	31,500	29,700	29,700	16,900	14,900	14,600	14,600
Chemicals	2,500	2,500	2,500	1,600	1,600	1,600	1,600
Lead & Zinc Metallurgy	1,700	1,700	1,700	1,700	1,700	1,700	1,700
Alloy Steel	100	100	100	100	100	100	100
Others	100	100	100	300	400	200	200

Source: IBM.

Annexure: 3.II

Apparent Consumption of Manganese Ore, 2000-2001 to 2011-12

(In tonnes)

Year	Opening Stock	Production	Closing Stock	Imports	Exports	Apparent consumption	CAGR
2000-01	702,431	1,595,458	583,389	2,888	265,010	1,452,378	
2001-02	622,402	1,587,305	582,280	7,722	248,103	1,387,046	-4.50
2002-03	604,205	1,678,372	642,477	7,621	335,672	1,312,049	-5.41
2003-04	659,948	1,776,153	605,654	6,258	239,632	1,597,073	21.72
2004-05	561,537	2,386,396	745,982	240,914	317,787	2,125,078	33.06
2005-06	829,397	1,906,353	957,371	13,281	237,344	1,554,316	-26.86
2006-07	837,420	2,115,507	478,631	284,202	157,312	2,601,186	67.35
2007-08	452,916	2,696,980	361,347	686,053	208,372	3,266,230	25.57
2008-09	374,599	2,789,025	498,818	852,198	205,424	3,311,580	1.39
2009-10	827,064	2,491,950	618,486	797,933	289,468	3,208,993	-3.10
2010-11	625,265	3,056,385	798,006	1,299,643	117,963	4,065,324	26.69
2011-12	858,753	2,349,300	862,800	1,974,951	75,182	4,245,022	4.42
						CAGR	**12.76**

Source: IBM

Annexure: 3.III

Capacity and Production of Crude Steel, 2011-12
(By Principal Producers)

(In 000'tonnes)

Sl No.	Units	Annual installed Capacity of Crude Steel (2011-12)	Production of Crude Steel (2011-12)
Public Sector			
1.	Bokaro Steel Plant (Jharkhand)	4360	4,901
2.	Bhilai Steel Plant (Chhattisgarh)	3,925	3,647
3.	Rourkela Steel Plant (Odisha)	1,900	2,170
4.	Durgapur Steel Plant (West Bengal)	1802	1,914
5.	IISCO Steel Plant (West Bengal)	500	330
6.	Visvesvaraya Iron steel plant (Karnataka)	118	91
7.	Salem Steel Plant (Tamil Nadu)	320	96
8.	Visakhapatnam Steel Plant (Andhra Pradesh)	3,000	3,128
9.	IDCOL, Kalinga Iron Works Ltd (Odisha)	NA	NA
Private Sector			
10.	Tata Steel Ltd (Jharkhand)	6,800	7,128
11.	JSW Steel Ltd (Karnataka)	6,800	7,363
12.	Ispat Industries Ltd (Maharashtra)	3,000	2,466
13.	Essar Steel Ltd (Gujarat)	4,600	4,309
14.	Jindal Steel & Power Ltd (Chhattisgarh)	3,000	2,757
15.	Lloyds Steel Ltd (Maharashtra)	850	620
16.	Jindal Stainless Steel Ltd	NA	703
	Total	**40,975**	**41,623**

Figures rounded off.

Source: Annual Report of Ministry of Steel.

Annexure: 3.IIIA

Production of Crude Steel
(2003-04 to 2012-13)

(In million tonnes)

Sl No.	Year	Production of Crude Steel (2012-13)
1.	2003-04	34.25
2.	2004-05	38.49
3.	2005-06	41.66
4.	2006-07	50.82
5.	2007-08	56.07
6.	2008-09	57.16
7.	2009-10	60.62
8.	2010-11	68.62
9.	2011-12	73.42
10.	2012-13	78.31

Figures rounded off.
Source: Joint Plant Committee.

Annexure: 3.IV

Estimated Consumption of Manganese Ore in Steel and Other Industries

(In million tonnes)

Sl No.	Particulars	Consumption Norms	2011-12
1.	Crude Steel Production		73.79
2.	Stainless Steel Production		2.60*
3.	Hot Metal Production		40.96
Ferromanganese Consumption			
4.	Consumption of FeMn in Crude Steel Production	5 kg/ tonne of crude steel	0.37
5.	Consumption of FeMn in Stainless Steel Production	50 kg/tonne of stainless steel	0.13
6.	Total FeMn Consumption (4+5)		0.50
7.	Export of FeMn		0.16
	Total		**0.66**
Silicomanganese Consumption			
8.	Consumption of SiMn in Crude Steel Production	7 kg/ tonne of*** crude steel	0.52
9.	Export of SiMn		0.73
	Total		**1.25**
Consumption of Manganese Ore			
10.	Consumption of Manganese Ore in Production of Hot Metal	5 kg/tonne of*** hot metal	0.20
11.	Consumption of Manganese Ore in Production of FeMn	2.4 tonnes/tonne of FeMn	1.58**
12.	Consumption of Manganese Ore SiMn	1.8 tonnes/tonne of SiMn	2.24**
13.	**Total Consumption of Manganese Ore in Steel Production (10+11+12)**		**4.02**
14.	Consumption of Manganese Ore in Other Non-metallurgical Industry		0.05
	Grand Total Consumption (13+14)		**4.07**

** Production for the year 2010-11 has been assumed to be at same level in 2011-12.*

*** Includes consumption of manganese ore for the production of exported alloys.*

**** Norms calculated by IBM.*

Annexure: 3.V

Estimated Consumption of Manganese Ore in Ferromanganese and Silicomanganese Production, 2000-01 to 2011-12

(In tonnes)

Year	Production of Ferro-Manganese	Estimated Consumption of Manganese Ore@ 2.4 T/ T of FeMn	Production of Silico-Manganese	Estimated Consumption of Manganese Ore @ 1.8T/ T of SiMn	Total Estimated Consumption of Manganese Ore	CAGR
2000-01	170,000	408,000	276,008	496,814	904,814	21.44
2001-02	206,624	495,898	235,730	424,314	920,212	1.70
2002-03	236,678	568,027	304,212	547,582	1,115,609	21.23
2003-04	248,388	596,131	380,316	684569	1,280,700	14.80
2004-05	270,234	648,562	498,047	896,485	1,545,047	20.64
2005-06	273,057	655,337	564,633	1,016,339	1,671,676	8.20
2006-07	296,726	712,142	738,314	1,328,965	2,041,107	22.10
2007-08	391,210	938,904	911,402	1,640,524	2,579,428	26.37
2008-09	386,447	927,473	935,889	1,684,600	2,612,073	1.27
2009-10	356,123	854,695	1,116,047	2,008,885	2,863,580	9.63
2010-11	404,000	969,600	1,299,000	2,338,200	3,307,800	15.51
2011-12	446,733	1,072,159	1,478,403	2,661,125	3,733,284	12.86

Annexure: 3.VI

Demand Projections of Manganese Ore Based on Steel Production, Exports and Other Industries

(2012-13 to 2016-17)

(In million tonnes)

Sl No.	Particulars	Consumption Norm	2012-13	2013-14	2014-15	2015-16	2016-17
1.	Crude Steel Production		78.96	84.48	90.40	96.72	103.49
2.	Stainless Steel Production		2.78	2.98	3.19	3.41	3.65
3.	Hot Metal Production		43.83	46.90	50.18	53.69	57.45
	Ferromanganese						
4.	a) In Crude Steel	5Kg/T CS	0.39	0.42	0.45	0.48	0.52
5.	b) In Stainless Steel	50 Kg/T SS	0.14	0.15	0.16	0.17	0.18
6.	Total Demand		0.53	0.57	0.61	0.65	0.70
7.	Equivalent Manganese Ore		1.27	1.37	1.46	1.56	1.68
8.	Projected Exports of FeMn	2.4T/T of FeMn	0.17	0.18	0.20	0.21	0.22
9.	Equivalent Manganese Ore		0.41	0.43	0.48	0.50	0.53
10.	Total Demand Of Manganese Ore (8+10)	2.4T/T of FeMn	1.68	1.80	1.94	2.06	2.21
	Silicomanganese						
11.	In Crude Steel	7 Kg/T CS	0.55	0.59	0.63	0.68	0.72
12.	Equivalent Manganese Ore	1.8 T/T of SiMn	0.99	1.06	1.13	1.22	1.30
13.	Projected Exports of SiMn		0.78	0.84	0.89	0.96	1.02
14.	Equivalent Manganese Ore		1.40	1.51	1.60	1.73	1.84
15.	Total Demand Of Manganese Ore in Silicomanganese Industry (14+16)	1.8 T/T of SiMn	2.39	2.57	2.73	2.95	3.14
16.	Direct Consumption of Manganese Ore in the Making of Hot Metal	5 Kg/T Hot Metal	0.22	0.23	0.25	0.27	0.29
17.	Total Demand of Manganese Ore steel and Mn alloy Industry (10+15+17)		4.29	4.60	4.92	5.28	5.64
18.	Manganese Ore Demand in Other Industries (5%)		0.05	0.06	0.06	0.06	0.07
	Total Demand (17+18)		**4.34**	**4.66**	**4.98**	**5.34**	**5.71**

CS: Crude Steel, SS: Stainless Steel.

Annexure: 3.VII

Demand Projection of Manganese Alloys & Manganese Ore During 2016-17, 2019-20 and 2025-26

(In '000 tonnes)

Particulars	Consumption Norm	2016-17	2019-20	2025-26
Crude Steel Production		125,900	200,000	275,000
Stainless Steel Production		2,180	5,600*	5,600
Ferromanganese				
a) In Crude Steel	5Kg/T CS	630	1,000	1,375
b) In Stainless Steel	50 Kg/T SS	109	280	280
Total Demand		739	1,280	1,655
Equivalent Manganese Ore	2.4T/T of FeMn	**1,772**	**3,072**	**3,972**
Projected Exports		**130**	**-**	**-**
Equivalent Manganese Ore		**312**	**-**	**-**
Total Demand Of Manganese Ore		**2,084**	**3,0720**	**3,972**
Silicomanganese				
a) In Crude Steel	12Kg/T CS	1,511	2,400	3,300
Equivalent Manganese Ore	1.8 T/T of SiMn	**2,719**	**4,320**	**5,940**
FeMn Slag for the production of SiMn	0.6T/T of SiMn	**1,294**	**1,400**	**1,980**
FeMn Slag Available	**0.9T/T of FeMn**	**782**	1152	**1,480**
Mn Ore Added to Compensate Slag Shortfall		**512**	**248**	**490**
Projected Exports		**645**	**-**	**-**
Equivalent Manganese Ore		**1,161**	**-**	**-**
Total Demand Of Manganese Ore for the production of SiMn		4,392	4,568	6,430
Manganese Ore Demand for Ferro & Silicomanganese		6,476	7,640	10,402
Manganese Ore Demand for Other Industries		341	402	547
Total Internal Demand		6,817	8,042	10,949

Source: Working Group, Ministry of Steel, National Steel policy, 2012 (Draft Report).

** 5.6 million tonnes of Stainless steel production by 2019-2020.(Steel World, July 2011 PP55).*

Presuming 200 million tonnes of crude steel production and 5.6 million tonnes of stainless steel production by 2020, 300 million tonnes of steel production capacity with 275 million tonnes of crude steel production by 2025-26 as per National Steel Policy, 2012 (Draft Report).

Annexure: 3.VIII

Demand Projection of Manganese Ore Based on Steel Production, Exports and Other Industries, (2017-18 to 2029-30)

(In million tonnes)

Sl No.	Particulars	Consumption Norm	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
1.	Crude Steel Production		111	118	127	136	145	155	166	178	190	204	218	233	249
2.	Stainless Steel Production		4	4	4	5	5	5	6	6	7	7	8	8	9
3.	Hot Metal Production		61	66	70	75	81	86	92	99	106	113	121	129	138
Ferromanganese															
4.	a) In Crude Steel	5Kg/T CS	0.55	0.59	0.63	0.68	0.73	0.78	0.83	0.89	0.95	1.02	1.09	1.17	1.25
5.	b) In Stainless Steel	50 Kg/T SS	0.20	0.21	0.22	0.24	0.26	0.27	0.29	0.31	0.34	0.36	0.38	0.41	0.44
6.	Total Demand		0.75	0.80	0.85	0.92	0.99	1.05	1.12	1.20	1.29	1.38	1.47	1.58	1.69
7.	Equivalent Manganese Ore	2.4T/T of FeMn	1.80	1.92	2.04	2.21	2.38	2.52	2.69	2.88	3.10	3.31	3.53	3.79	4.06
8.	Projected Exports of FeMn		0.24	0.25	0.27	0.29	0.31	0.33	0.35	0.38	0.40	0.43	0.46	0.50	0.53
9.	Equivalent Manganese Ore	2.4T/T of FeMn	0.58	0.60	0.65	0.70	0.74	0.79	0.84	0.91	0.96	1.03	1.10	1.20	1.27
10.	**Total Demand Of Manganese Ore (7+9)**		**2.38**	**2.52**	**2.69**	**2.91**	**3.12**	**3.31**	**3.53**	**3.79**	**4.06**	**4.34**	**4.63**	**4.99**	**5.33**
Silicomanganese															
11.	In Crude Steel	7 Kg/T CS	0.78	0.83	0.89	0.95	1.02	1.09	1.16	1.24	1.33	1.43	1.53	1.63	1.74
12.	Equivalent Manganese Ore	1.8 T/T of SiMn	1.40	1.49	1.60	1.71	1.84	1.96	2.09	2.25	2.39	2.57	2.75	2.93	3.13
13.	Projected Exports of SiMn		1.09	1.17	1.25	1.34	1.43	1.53	1.64	1.75	1.88	2.01	2.15	2.30	2.46
14.	Equivalent Manganese Ore	1.8 T/T of SiMn	1.96	2.11	2.25	2.41	2.57	2.75	2.95	3.15	3.38	3.62	3.87	4.14	4.43
15.	**Total Demand Of Manganese Ore in Silicomanganese Industry(12+14)**		**3.36**	**3.60**	**3.85**	**4.12**	**4.41**	**4.71**	**5.04**	**5.40**	**5.77**	**6.19**	**6.62**	**7.07**	**7.56**
16.	Direct Consumption of Manganese Ore in the making of Hot Metal	5Kg/T Hot Metal	0.31	0.33	0.35	0.38	0.40	0.43	0.46	0.49	0.53	0.57	0.60	0.65	0.69
17.	**Total Demand of Manganese Ore steel and Mn alloy Industry(10+15+16)**		**6.05**	**6.45**	**6.89**	**7.41**	**7.94**	**8.45**	**9.03**	**9.68**	**10.36**	**11.10**	**11.86**	**12.71**	**13.58**
18.	Manganese Ore Demand in Other Industries		0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.14
19.	**Total Demand(17+18)**		**6.12**	**6.53**	**6.97**	**7.50**	**8.03**	**8.55**	**9.13**	**9.79**	**10.47**	**11.22**	**11.99**	**12.85**	**13.72**

Annexure: 3. IX

Demand of Steel and Ferro Alloys for XII Five Year Plan

(Growth Rate at 9 % of GDP and Implied Growth of 10.3 % in Steel Consumption)

Sl No.	Particulars	Unit	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1.	Demand of Mild/ Carbon/Crude Steel	million tonnes	75.94	86.2	96.7	107.70	120.1	131.9
2.	Demand of Mild/ Carbon/Finished Steel	"	68.35	77.6	87.05	96.9	108.05	118.7
3.	Demand of Stainless Steel and Alloy Steel	"	2.10	2.31	2.54	2.8	3.08	3.39
4.	**Ferromanganese** – Domestic	'000 tonnes	456	515	577	640	698	769
5.	Exports	”	80	88	97	107	118	130
6.	**Total**	”	**536**	**603**	**674**	**747**	**816**	**899**
7.	**Silicomanganese** – Domestic	”	911	1034	1160	1292	1441	1583
8.	Exports	”	350	385	424	488	561	645
9.	**Total**	”	**1,261**	**1,419**	**1,584**	**1,780**	**2,002**	**2,228**
10.	**Total Manganese Alloys**	”	**1,797**	**2,022**	**2,258**	**2,527**	**2,818**	**3,127**

Source: IFAPA.

Annexure: 3.X

Demand of Manganese Ore to Meet the Requirement for Manganese Based Alloys and Other Industries for the XII Five Year Plan

(In thousand tonnes)

Sl No.	Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1.	Demand of Ferro Manganese (FeMn)	536	603	674	757	816	899
2.	Demand of Manganese Ore for FeMn	1,286	1,447	1,618	1,793	1,958	2,158
3.	Demand of Silico Manganese (SiMn)	1,261	1,419	1,584	1,780	2,002	2,228
4.	Demand of Manganese Ore for SiMn	2,270	2,554	2,851	3,204	3,604	4,010
5.	**Total (2+4)**	**3,556**	**4,001**	**4,469**	**4,997**	**5,562**	**6,168**
6.	Requirement of FeMn Slag	757	851	950	1,068	1,201	1,337
7.	Availability of FeMn Slag	482	543	607	673	735	809
8.	Manganese Ore required for compensation of FeMn Slag	275	308	343	395	466	528
9.	**Total Requirement of Manganese Ore for Manganese Alloys (5+8) (95%)**	**3,831**	**4,309**	**4,812**	**5,392**	**6,028**	**6,696**
10.	Requirement of Manganese Ore for other Industries (5%)	201	227	253	284	317	352
11.	**Grand Total Requirement Of Manganese Ore (9+10)**	**4,032**	**4,536**	**5,065**	**5,676**	**6,345**	**7,048**

Source: IFAPA

Annexure: 3.XI

Demand Projection of Manganese Alloys & Manganese Ore during the 12th Five Year Plan

(In '000 tonnes)

Particulars	Consumption Norm	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Crude Steel production		**73,700**	**85,900**	**94,500**	**104,000**	**114,500**	**125,900**
Stainless Steel Production		**1,520**	**1,680**	**1,860**	**2,040**	**1,960**	**2,180**
Ferromanganese							
a) in Crude Steel	5Kg/T CS	369	430	473	520	573	630
b) in Stainless Steel	50 Kg/T SS	76	84	93	102	98	109
Total Internal Demand		445	514	566	622	671	739
Equivalent Manganese Ore	**2.4T/T of FeMn**	**1,067**	**1,232**	**1,357**	**1,493**	**1,609**	**1,772**
Projected Exports		80	88	97	107	118	130
Equivalent Manganese Ore		**192**	**211**	**233**	**257**	**283**	**312**
Total Demand of Manganese ore for Production of FeMn		**1,259**	**1,444**	**1,590**	**1,750**	**1,892**	**2,084**
Silicomanganese							
a) In Crude Steel	12Kg/T CS	884	1,031	1,134	1,248	1,374	1,511
Equivalent Manganese Ore		**1,592**	**1,855**	**2,041**	**2,246**	**2,473**	**2,719**
FeMn Slag for production of SiMn	0.6T/T of SiMn	757	850	935	1,042	1,161	1,294
FeMn Slag Available	0.9T/T of FeMn	482	542	597	672	734	782
Mn ore Added to Compensate Slag Shortfall		275	308	338	370	427	512
Projected Exports		350	385	424	488	561	645
Equivalent Manganese Ore	**1.8 T/T of SiMn**	**630**	**693**	**763**	**878**	**1,010**	**1,161**
Total Demand of manganese ore for production of SiMn		**2,497**	**2,856**	**3,142**	**3,495**	**3,910**	**4,392**
Manganese Ore for Production of Mn alloys		**3,756**	**4,300**	**4,732**	**5,244**	**5,802**	**6,477**
Manganese Ore for other non-metallurgical industries (5%)		**235**	**269**	**296**	**328**	**363**	**405**
Total Demand		**3,991**	**4,569**	**5,028**	**5,572**	**6,165**	**6,882**

Source: Based on Working Group Report, XII Five Year Plan.

Annexure: 4.I

Production of Manganese Ore State-wise, 1999-2000 to 2011-12

(In tonnes)

State	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
India	**1,585,726**	**1,595,458**	**1,587,305**	**1,678,372**	**1,776,153**	**2,386,396**	**1,906,353**	**2,115,507**	**2,696,980**	**2,789,025**	**2,491,950**	**3,056,385**	**2,349,300**
Public Sector	932,866	949,449	879,373	931,432	948,250	1,087,143	989,952	1,059,475	1,410,664	1,156,220	1,180,963	1,461,948	1,099,243
Private Sector	652,860	646,009	707,932	746,940	827,903	1,299,253	916,401	1,056,032	1,286,316	1,632,805	1,310,987	1,594,437	1,250,057
Andhra Pradesh	87,554	130,825	94,917	72,643	58,084	101,821	84,447	64,352	140,963	184,552	260,628	290,785	322,087
Goa	14,229	11,132	9,365	11,050	13,650	7,170	5,255	3,460	580	1,170	770	440	1,550
Gujarat	-	-	-	-	-	-	-	-	-	-	55,090	245,240	-
Jharkhand	5,388	2,608	1,944	5,120	7,388	5,975	639	523	12,048	16,044	39,875	44,898	18,265
Karnataka	274,052	218,882	213,346	224,962	259,559	386,764	267,107	251,995	351,889	332,686	301,163	413,287	136,072
Madhya Pradesh	328,698	323,361	329,735	344,398	376,671	445,409	425,136	474,893	673,999	726,114	607,148	716,285	648,283
Maharashtra	352,584	362,634	395,297	395,773	453,477	561,182	511,960	633,501	848,267	680,629	613,520	672,828	649,898
Odisha	523,221	546,016	542,701	624,426	607,387	878,075	611,809	686,783	667,780	839,930	605,313	655,984	565,662
Rajasthan	-	-	-	-	-	-	-	-	1,454	7,900	8,443	16,638	7,483

Annexure: 4.II

Production of Manganese Ore State-wise and District-wise, 1999-2000 to 2011-12

(In tonnes)

State/District	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
India	**1,585,726**	**1,595,458**	**1,587,305**	**1,678,372**	**1,776,153**	**2,386,426**	**1,906,353**	**2,115,507**	**2,696,980**	**2,789,025**	**2,491,950**	**3,056,385**	**2,349,300**
Andhra Pradesh	**87,554**	**130,825**	**94,917**	**72,643**	**58,084**	**101,821**	**84,447**	**64,352**	**140,963**	**184,552**	**260,628**	**290,785**	**322,087**
Adilabad	3,493	2,231	3,086	2,972	5,681	11731	14,367	18,884	36,115	20,821	16,223	21,971	19,373
Vizianagaram	84,061	128,594	91,831	69,671	52,403	90,090	70,080	45,468	104,848	163,731	244,405	268,814	302,714
Goa	**14,229**	**11,132**	**9,365**	**11,050**	**13,650**	**7,170**	**5,255**	**3,460**	**580**	**1,170**	**770**	**440**	**1,550**
South Goa	14,229	11,132	9,365	11,050	13,650	6,830	5,255	3,460	580	1,170	770	440	1,550
North Goa	-	-	-	-	-	340	-	-	-	-	-	-	-
Gujarat	-	-	-	-	-	-	-	-	-	-	**55,090**	**245,240**	-
Panchmahal	-	-	-	-	-	-	-	-	-	-	55,090	245,240	-
Jharkhand	**5,388**	**2,608**	**1,944**	**5,120**	**7,388**	**5,975**	**639**	**523**	**12,048**	**16,044**	**39,875**	**44,898**	**18,265**
Singhbhum (w)	5,388	2,608	1,944	5,120	7,388	5,975	639	523	12,048	16,044	39,875	44,898	18,265
Karnataka	**274,052**	**218,882**	**213,346**	**224,962**	**259,559**	**386,764**	**267,107**	**251,995**	**351,889**	**332,686**	**301,163**	**413,287**	**136,072**
Bellary	253,926	197,212	196,756	213,193	240.781	353,206	242,950	224,261	259,693	263,597	238782	307,097	96,591
Chitradurga	4,588	4,720	1,703	3,810	1,340	4,461	650	400	260	1,301	4270	3,111	2,310
Davangere	14,376	16,935	10,939	5,554	6,787	22,663	15,042	18,132	84,886	61,316	51,390	91,372	37,171
Uttara Kannada	782	-	-	-	-	-	-	-	-	-	-	-	-
Shimoga	-	-	-	-	695	778	630	192	-	364	221	174	-
Tumkur	380	15	3,948	2,405	9,956	5,656	7,835	9,010	7,050	6,108	6,500	11,533	-
Madhya Pradesh	**328,698**	**323,361**	**329,735**	**344,398**	**376,671**	**445,409**	**425,136**	**474,893**	**673,999**	**726,114**	**607,148**	**716,285**	**648,283**
Balaghat	315,146	321,058	328,160	340,439	376,671	443,097	403,040	440735	556,909	537,411	526,592	538,119	552,165
Chhindwara	13,552	2,303	1,575	3,959	-	2,312	22,096	34,158	54,055	47,812	1,558	37,813	39,062
Jabalpur	-	-	-	-	-	-	-	-	-	-	-	538	413
Jhabua	-	-	-	-	-	-	-	-	63,035	140,891	78,998	139,815	56,647

Annexure 4. II contd..

Annexure 4. II concld.

State/District	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Maharashtra	**352,584**	**362,634**	**395,297**	**395,773**	**453,477**	**561,182**	**511,960**	**633,501**	**848,267**	**680,629**	**613,520**	**672,828**	**649,898**
Bhandara	242,400	242,001	261,407	273,640	313,409	384,058	339,230	437,797	646,358	456,882	412,530	450,843	441,813
Nagpur	110,184	120,633	133,890	122,133	140,068	177,124	172,730	195,704	201,909	223,747	200,990	221,985	208,085
Odisha	**523,221**	**546,016**	**542,701**	**624,426**	**607,387**	**878,075**	**611,809**	**686,783**	**667,780**	**839,930**	**605,313**	**655,984**	**565,662**
Keonjhar	373,585	415,391	396,426	469,387	498,825	711,168	470,906	503,202	461,801	468,972	325,453	387,859	457,639
Sundergarh	149,636	130,625	146,275	155,039	108,562	166,907	140,903	183,581	205,979	370,958	279,860	268,125	108,023
Rajasthan	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,454**	**7,900**	**8,443**	**16,638**	**7,483**
Banswara	-	-	-	-	-	-	-	-	1,454	7,900	8,433	16,638	7,483

Source: IBM

Annexure: 4.III

Production of Manganese Ore Grade-wise, 1999-2000 to 2011-12

(In tonnes)

Year	MnO_2	Above 46%	35 to 46%	25 to 35%	Below 25%	Others	Total
1999-2000	47,402	281,915	599,649	578,068	66,746	11,946	1,585,726
2000-01	27,142	297,235	583,571	613,279	68,824	5,407	1,595,458
2001-02	31,706	293,629	632,491	567,131	45,356	16,992	1,587,305
2002-03	48,277	325,813	764,725	509,793	23,537	6,227	1,678,372
2003-04	56,511	318,521	773,484	603,325	22,696	1,616	1,776,153
2004-05	78,814	361,758	968,070	926,725	21,668	29,361	2,386,396
2005-06	92,536	340,099	759,171	698,640	15,502	405	1,906,353
2006-07	76,375	361,767	816,220	786,085	48,004	27,056	2,115,507
2007-08	80,659	306,386	773,756	1,396,095	140,084	-	2,696,980
2008-09	86,491	349,258	763,226	1,323,453	266,597	-	2,789,025
2009-10	65,756	327,283	621,346	1,178,704	298,861	-	2,491,950
2010-11	48,068	283,916	614,557	1,510,607	599,237	-	3,056,385
2011-12	42,633	268,967	590,124	1,256,850	190,726	-	2,349,300

Source: IBM

Annexure: 7.I

World Reserves of Manganese Ore, 2012

(In '000 tonnes of Metal Content)

Country	Reserves
Australia	97,000
Brazil	110,000
China	44,000
Gabon	27,000
India*	49,000
Kazakhstan	5,000
Mexico	5,000
South Africa	150,000
Ukraine	140,000
Other Countries	++
Total	630,000

Source: Mineral Commodity Summaries, USGS
** The total resources of India as estimated by National Mineral Inventory as on 1.4.2010 are placed at 430 million tonnes.*

Annexure:7.II

Country-wise Production of Manganese Ore, 2005 to 2011

(In 000'tonnes)

Country	2005	2006	2007	2008	2009	2010	2011
Australia	3,829	4,567	5,289	4,819	4,444	6,474	6,961
Brazil	3,200	3,128	1,866	2,400	2,300	2,600	3,100
China	7,500	8,000	10,000[e]	11,000[e]	12,000	13,000	14,000
Gabon	2,753	2,979	3,334	3,250	1,992	3,200	3,562
Ghana	1,720	1,578	1,173	1,090	1,013	1,194	1,828
India	1,906	2,116	2,697	2,829	2,492	2,881	2,387
Kazakhstan	2,208	2,531	2,482	2,485	2,457	1,094	2,930
South Africa	4,612	5,213	5,995	6,808	4,576	7,156	8,652
Ukraine	2,000	1,606	1,720	1,447	932	1,589	1,590
Other countries	1,172	1,082	1,394	2,072	1,794	2,712	2,290
Total	**30,900**	**32,800**	**35,950**	**38,200**	**34,000**	**41,900**	**47,300**

Source: World Mineral Production, British Geological Survey.

Note: As per the International Manganese Institute, the World production is 55.4 million tonnes.

Annexure-7.III

Details of Top Ten Manganese Ore Mines in the World

1. Groote Eylandt Manganese Ore Mine, Australia

The mine is located in the island of Groote Eylandt situated in the Gulf of Carpentaria, 50 km off the coast of Arnhem Land in the northern territory of Australia. Manganese ore was first reported from the island in1907, but the economic importance was recognised in 1966. The mine is owned by Groote Eylandt Mining Company Pty. Ltd (GEMCO). GEMCO is a joint venture between BHP Billiton (60%) and Anglo American (40%).

The manganese ore deposit is developed as a layer of thickness up to 25m in the lower cretaceous Mullaman sediments. These sediments comprise of clay, quartz sand, quartzite and manganiferous marl. These beds gently dip towards west and unconformably overlie the middle proterozoic Groote Eylandt beds of sandstones. The ore occurs as pisolites, concretions and in disseminated forms. Chemically, the ores are oxides and carbonates. The total resources of manganese ore are estimated at 109 million tonnes in June 2010, with an average production of 4.2 million tpy. The life of mine is estimated to be 25 years. The grade of ore produced in the mine is excellent with an average Mn content of 46 per cent.

The mining operations in Groote Eylandt were commissioned in March 1966 and are carried by opencast method. The mining operations comprise of stripping and removal of overburden with open pit scrappers. The exposed ore bed is then blasted and loaded by the front end loaders and transported to pit mouth to form elongated heaps along the length of each mining cut. The broken ore is then loaded into rear dump trucks with the help of front end loaders.

The mined out ore is then processed in the beneficiation plant which consists of two drum scrubbers, two classifiers and eight cyclone separators which separate the fines and intermediate products. The fines are further cleaned by jigging. The (+) 12mm ore is then cleaned in nine heavy media separators containing primary and secondary drum separators. The primary separator yields high grade lumps and secondary separator gives siliceous lumps. The processed manganese ore is shifted to stockpiles.

The first phase of the GEMCO expansion (GEEP-1) was commissioned successfully in June 2009. The second phase of expansion (GEEP-2) is expected to increase the capacity of GEMCO mine from 4.2 million tonnes per year of processed ore to 4.8 million tonnes per year. Besides mining facilities, the GEEP-2 will also enhance the infrastructure facilities such as roads, port capacity etc. The GEEP-2 is expected to be commissioned in 2013.

2. Mamatwan - Wessels Manganese Ore Mines, South Africa

The Mamatwan Manganese Ore Mine is situated at the southern end of Kuruman (Kalahari) district in South Africa. It is located about 105 km north of Postmasburg district in Northern Cape Province. The mine is owned by Hotazel Manganese Mine Pty. Ltd. (HMM). The share holding pattern of HMM is BHP Billiton 44.4%, Anglo American 29.6%, Ntsimbintle 9%, NCAB 7%, IZICO

5% and HMM Education Trust 5%. The mining operation in Mamatwan was started in 1964. The operation at Wessels was commissioned in 1973.

The Mamatwan Manganese Ore Mine is located at the southern end of the Kuruman manganese-bearing basin. The southern end of the Mamatwan mine may have been terminated by a fault. The deposit occurs as chemical precipitate. The host rock is fine grained calcareous formations. These formations consist of banded iron formations with three manganiferous horizons at the base and calcareous dolomite up in the succession. The rocks belong to the Daspoort stage of Precambrian Transvaal System and immediately overlie the Ongeluk Lavas. The ore that has been won from the mine shows that the calcareous ore has been upgraded by multistage surfacial processes. The ore body has an average thickness of 19 m.

The Mamatwan mine is operated by open-cast method, whereas Wessels mine is operated by underground method. The combined annual production capacity of both the mines is 3.4 million tonnes. The mined ore is processed at Mamatwan Beneficiation Plant. The process comprises of primary, secondary and tertiary crushing with associated screening plants with dense medium separators and a sinter plant having capacity of 1 mtpa.

There are plans to enhance production capacity of Wessels mine from existing 1 mtpa to 1.5 mtpa. The projects are expected to be completed by 2013.

3. Moanda Manganese Ore Mine, Gabon

The Moanda mine in Gabon is located in the South West part of Gabon and is situated to the west north west of Franceville. The mine is owned by Compagnie Miniese de L'ogooue S.A (Comilog). In Comilog, Eramet International S.A. is share holder of 57.25%, Government owned the share of 25.4% and others holding share of 7.35%. The occurrence of manganese was first reported in 1895 with further discoveries in 1934 & 1944-45. After systematic development since 1951, the actual production commenced in 1962. The production slowly built up to 2 million tpy in 1974. The present capacity of the mine is about 4 million tpy.

Manganese ore is found in 5 plateaus around Moanda. They are Bangombe, Okouma, Bafoula, Massengo and Yeye, the most important being Okouma and Bangombe. The manganese ore in the mine is a result of Supergene Sulphide enrichment of the Precambrian Francevillian sediments. The mining operations are carried out by open cast method using 600 to 900 m long trenches with width of 20 m. These trenches are backfilled with waste after extraction of ore. The stripping ratio is reported to be 1:1. The ore thus mined has 44% Mn. It is then subjected to beneficiation process, which consist of crushing screening and drum washing. The beneficiation yields two high grade products namely, 1) (+) 6mm to (-) 20 mm size and 2) (+) 20 mm to (–) 125mm size. The fines less than 6 mm size are not utilized and stored separately. Specially selected ores from the washing and screening plants are crushed to 1 mm size and concentrated on a series of vibrating tables to yield a final product containing 83-85% MnO_2 which is a battery grade concentrate.

There are plans to enhance the production from present level of 3 million tpy to 4 million tpy. The plans are expected to be completed by the end of 2012.

4. Azul Manganese Ore Mine, Brazil

The deposit was discovered in 1971 by Companhia Meridonial de Mineracao during the exploration of Carajas iron ore deposits. The deposit is located in the district of Serra dos Carajas, state of Para in the north central part of Brazil. The mine was then brought under the control of Amazonia Mineracao (AMZA), an affiliate of Companhia Val de Rio Doce (CVRD).

Geologically, the Azul deposit lies between the north and south limb of a synclinorium composed of Precambrian metasediments of Grao Para Group. The manganese deposit lies above manganiferous Pelitic shales of Rio Fresco Formations that unconformably overlie the Grao Para Group.

The geological structure constituted an asymmetric anticline with east-west axis dipped westward. Two primary manganese ore have been recognized and are essentially composed of rhodocrosite (30 to 50%), silica (15 to 30%), phyllosilcates (15 to 25%), feldspar (upto 10%) and organic matter.

The ore known as manganese dioxide occurs in layers with an average thickness of 11 metres with manganese content of 43%. The main manganese mineral is nsutite.

The mining operation is carried out by open-cast method. The ore is friable and allows mechanical disassemble without the use of explosives. The manganese ore is extracted by crawler tractors, while loading is done by front-end loaders. The production capacity of the mine is 2.5 million tonnes annually. The mined ore is transported from mine to mill concentrator for processing of the ore. The processing of ore basically consists of crushing, sorting and washing to remove the fine fraction (0.15 mm) from the ore. The processed ore is transported up to various stockpiles by using dumper trucks.

5. Molango Manganese Ore Mine, Mexico

This mine is located in the state of Hidalgo. It is 160 km north of Mexico City and 170 km south of Tampico. The area lies in the southern part of Sierra Madre Oriental and is characterized by rugged topography, very steep slopes and sharp mountain peaks. The manganese ore in the mine is associated with manganiferrous limestone of Upper Jurassic Taman formations. The manganiferrous unit has a strike length of 50 km. The width of the formations pinches out towards northwest of the Molango area. On the southern side, it is covered by other sediments and volcanic flows. Though the manganiferrous unit is a continuous lithological unit, it is not continuous with respect to manganese content.

There are two types of deposits in Molango area. The most important is of syngenetic origin and is formed by chemical precipitation as carbonates during the deposition of upper Jurassic sediments. The less important deposit is of epigenetic origin and is comprised of oxides of manganese. The epigenetic ores are small and scattered but are locally quite rich in manganese. The carbonates are rhodochrosite, kutnahorite and manganoan calcite, whereas oxides are poorly crystalline Nsutite, pyrolusite and ramsdellite. The Molango area is part of large anticlonorium.

Manganiferous carbonates in the Molango area are mined by both open cast and underground methods. The Manganiferous unit is mined by open cast method to a depth of about 175 m and then by modified retreating sub-level caving method beneath the open pit. About half of the production comes from underground operations. The high grade epigenetic oxide ore is mined by open pit method by digging small pits not exceeding 30 m in depth.

All the carbonate ore produced from open pit and 30% of the ore produced from the underground operations is subjected to beneficiation directly. The remaining part of the ore is subjected to heavy media separation that recovers about 60% of the material which is then subjected to beneficiation plant. These beneficiated concentrates are then fed to a nodulising plant which consists of crushing and blending facilities and a rotary kiln. The concentrates are then dried, calcined and nodulised to yield a final MnO_2 product containing about 40% MnO_2.

6. Nonoalco Manganese Ore Mine, Mexico

Nonoalco Manganese Ore Mine is located at 178 km north of Mexico City in the state of Hidalgo in Mexico. Nonoalco mine is owned by Compania Minera Autian, S.A. de C.V. (Autian), a state owned enterprise incorporated in 1953. It was privatised in 1993 and the owner was Groupo Ferro Minero. Manganese ore-bearing limestone occurs in a sequence of upper Jurassic Marine Sediments that have been folded into a broad anticlinorium. The manganese ore-bearing limestone beds, the Chipoco formations, directly above a persistent siltstone, the Santiago formations have formed a sound footwall for mine development. Open pit has been developed in the westward dipping outcrops of the manganese-bearing limestone, where oxidation has converted the manganese carbonate to manganese oxides and by leaching away the finely disseminated calcium carbonate. The oxidised ores have about 20% porosity and due to special peroxide qualities, ore is marketed as battery grade manganese concentrates.

The Nonoalco crude ore contains principally nsutite, psilomelane, cryptopmelane and hausmannite. Analysis of the manganese ore is Mn 39% and Fe 9.5%. All Nonoalco manganese ores are beneficiated in a washing and jigging plant located near the open pits on a sloping hillside. Water for processing is obtained from a small stream. There are two processing circuits located side by side. The capacity of the circuits is about 1000 tonnes per day. Average recovery is 85% with principal losses in the primary classifier overflows. The jig tailings assay around 37% Mn and they are being stockpiled for possible future treatment. Froth floatation of the primary fines and regrind coarse tailings offers possibilities of higher manganese recoveries. Four classes of ores are identified with Mn contents varying from 25 to 39% and Fe content varying from 9.5 to 14.5%. The ore is upgraded by beneficiation to 47.5 to 50% Mn and 7 to 8% Fe.

7. Urucum Manganese Ore Mine, Brazil

The Urucum Manganese Ore Mine is located in Morro do Urucum, south of the city of Corumba, Mato Grasso do Sul state in Brazil. The mine is operated by Cia Vale do Rio Doce (CVRD). The mining in the area was first reported in 1912. In 1975, the state of Mato Grasso with Compania Vale do Rio Doce (CVRD) formed a new company, Urucum Mineraco to explore and mine the area.

The rocks in the area comprise of Santa Cruz Formations. These formations consist of four manganese horizons. The first one is 80 m thick ferruginous sandstone and the second horizon is a sequence of haematite and jaspilite. The third horizon is 40 m above the second horizon and the fourth horizon is 40 m above the third horizon.

There are two beds of manganese at Morro do Urucum. Mining is being carried out in the lower bed which ranges in thickness between 3 to 4 metres. The Upper bed is separated from the lower bed by an iron formation of about 35 metre thickness. The upper bed has an average thickness of about 1.2 metres. The lower bed yields manganese ore averaging 46% Mn, 13% Fe, 3% SiO_2, 1.7% Al_2O_3 and nearly 4% K_2O. The estimated reserves of Urucum mine from all the four horizons are about 608 million tonnes. Urucum mine is operated by underground Room and Pillar method. The broken ore is flushed down to simple loading chutes for rail haulage to the mouth of the mine. The ore is crushed to 6 inch size over a grizzly and transported by trucks for dispatch. There is no beneficiation carried out except crushing and screening at the mine site.

8. Nchwaning Manganese Ore Mine, South Africa

Nchwaning Manganese Ore Mine is located in the Kuruman (Kalahari) district,105 km north of Postmasburg in the North Cape Province of South Africa. Nchwaning Manganese Ore Mine was established in 1972. The mine is operated by the Associated Manganese Mines of South Africa Ltd (AMMOSAL).

The manganese ore deposits in North Cape Province were discovered in 1922. AMMOSAL started mining in 1959 in the Kuruman district. The manganese ore deposit of Kuruman district occurs as chemical precipitates. The host rocks are laminated, fine grained calcareous rocks containing about 27% manganese. It was originally deposited as a mixture of manganese hydroxide along with calcium, magnesium and manganese carbonates. The formations consist of banded iron formation with three manganiferous horizons near the base of the zone and calcareous dolomites higher up in the succession. The formations are in the Daspoort stage of the Precambrian Transvaal System and it immediately overlies the Ongeluk Lavas.

In 2011, the reserves of manganese ore in the Nchwaning Mines were 106 million tonnes which decreased from 107 million tonnes in the preceding year. The depletion was mainly due to the continuous yearly production.

The Nchwaning Mine is operated by underground board and pillar method. Bolted development entries access rooms that are 7 to 8 metres wide and 3.2 to 3.5 m high, while pillars are 7m x 7m. The mine is serviced by two shafts, a vertical personnel shaft up to a depth of 400 m and an inclined shaft equipped with conveyors. Hoisting capacity of this shaft is approximately 200,000 tonnes per month. At Nchwaning mine no. 3; seven underground silos are used to store different grades of manganese ore.

At this mine, manganese ore is crushed, washed and screened to various sizes, stacked according to size and grades in stacks ranging in capacity from 280 to 320 tonnes each.

The production reported from Nchwaning mine in 2011 was 2.35 million tonnes. Assmang completed a feasibility study for expanding the capacity of Nchwaning mine in 2009. The company invested in constructing a new processing plant at Nchwaning to expand the mine's processing capacity from 3 million tonnes to 6 million tonnes per annum. The new plant was commissioned in 2010 and is capable of processing 900 tonnes of manganese ore per hour.

Manganese ore produced in the mine is transported to Hotazel, from where the ore is transported to Port Elizabeth by private railway. Project is underway to enhance the production capacity from the current capacity of 3.6 million tonnes to 4 million tonnes per annum by 2013.

9. Gloria Manganese Ore Mine, South Africa

Gloria Manganese Ore Mine is situated in the Kuruman (Kalahari) district, 105 km north of Postmasburg, in the North Cape Province of South Africa. Gloria mine is operated by Associated Manganese Mines of South Africa Ltd (AMMOSAL).

The manganese ore deposits in North Cape Province were discovered in 1922. The manganese ore deposit of Kuruman district occurs as chemical precipitates. The host rocks are laminated fine grained calcareous rocks containing about 27% manganese. It was originally deposited as a mixture of manganese hydroxide along with calcium, magnesium and manganese carbonates. The formations consist of banded iron formation with three manganiferous horizons near the base of the zone and calcareous dolomites higher up in the succession. The formations are in the Daspoort stage of the Precambrian Transvaal System and it immediately overlies the Ongeluk Lavas.

The Gloria mine is operated underground by using board and pillar method. Bolted development entries access rooms that are 7 to 8 metres wide and 3.2 to 3.5 m high. The mine uses latest technology for drilling and hauling. A number of different makes of equipments are used to transport ore to the storage silos. Roofs are barred down using a modified three-wheeled loader called scaler. Production of manganese ore was 700 thousand tonnes in 2010-11, which increased by 5% as compared to 670 thousand tonnes in 2009-10. Manganese ore produced at Gloria mine is transported to Hotazel by private railway, from where it is transported to Port Elizabeth. Owing to the limited capacity of this port, additional export capacity has been secured through Durban and Richards port.

Measured and indicated manganese ore resources are estimated at 92.23 million tonnes at an average grade of 37.8% Mn as a result of remodeling incorporating the data of 42 new additional surface boreholes. The inferred resources decreased to 84 million tonnes.

10. Woodie-Woodie Manganese Ore Mine, Australia

The Woodie -Woodie Manganese Ore Mine is located 400 km South East of Port Hedland in the Pilbara region in West Australia. The mine is operated by Pilbara Manganese Pty. Ltd owned by Consolidated Minerals Ltd, South Africa.

Manganese ore deposit in the Pilbara region is the largest of a series of deposits from the Pilbara manganese Province, which lies towards the eastern margin of the Hamersley and Bangemall basins of the eastern Pilbara craton. Manganese ore deposits occur as cavity filling within the Carawine dolomite and as sheets and lenses in the Pinjian chert breccias overlying the dolomite. Mineralisation is believed to have developed by supergene process within the dolomite and chert breccias during the paleoproterozoic between the withdrawal of the Hamersley Sea and deposition of the 1600 to 1000 Ma Bangemall Group. The enrichment within the dolomite occurs below the unconformity with the manganese group, manganiferous shales of the Bangemall group. Outcrop of manganese ore was first discovered at Woodie -Woodie in 1950 and was mined at small scale until 1990.

Mining is done by opencast method. The manganese ore produced at Woodie - Woodie is high in demand due to its high manganese, low phosphorous content and excellent iron- manganese ratio, making it well suited for blending with the domestic lower grade ore of China and Ukraine.

Exploratory drilling was continued at Woodie - Woodie and Mount Sydney prospects. The aim of this exploratory drilling programme is to advance prospects with the potential to host large scale mining operations that can supplement production from the Woodie – Woodie area

Reserves and resources of manganese ore as on June 2011 were estimated at 16.7 million tonnes having an average grade of 38% Mn content and total resources were estimated at 29.9 million tonnes with 40% Mn content. In the year 2011, the mineral inventory increased by 495 in resources and 26% in reserves as compared to that in the previous year. This increase continues to warrant the company's long term commitment of expansion. In 2011, the production of manganese ore was 1.486 million tonnes which increased by 19% as compared to 1.24 million tonnes in 2010.

Annexure: 7.IIIA

Country-wise Apparent Consumption of Manganese Ore, 2007 to 2011

(In 000' tonnes of metal content)

Country	2007	2008	2009	2010	2011
Brazil	654.90	210.50	309.00	149.00	285.70
China	5784.80	6564.60	6818.80	7511.60	9268.80
France	178.10	242.70	22.00	249.20	215.60
Japan	455.90	469.00	387.10	473.30	401.90
Norway	456.30	523.90	227.30	471.30	459.30
South Africa	798.90	645.20	251.10	549.10	735.90
South Korea	295.10	363.40	309.30	398.90	598.00
Spain	159.50	274.10	14.90	179.60	206.90
Ukraine	1259.30	1410.90	511.00	994.60	870.90
Other countries	3573.50	2870.00	2286.80	2726.80	3480.00
Total	**12616.30**	**13574.30**	**11137.30**	**13703.70**	**16523.00**

Source: Annual Market Research Report 2011, International Manganese Institute (IMnI).

Annexure: 7.IV

Country-wise Exports of Manganese Ore, 2005 to 2012

(In'000 tonnes)

Country	2005	2006	2007	2008	2009	2010	2011	2012
South Africa	2,666	3,161	4,023	5,826	4,144	7,296	6,760	7,901
Australia	2,912	4,202	4,841	4,002	4,655	5,588	6,494	6,762
Gabon	6,816	1,083	3,247	3,067	2,171	NA	NA	NA
Brazil	1,826	1,135	1,288	2,034	1,608	2,326	2,091	1,558
Kazakhstan	446	546	514	684	601	NA	NA	695
Indonesia	17	27	169	172	220	228	164	19
India	292	245	126	220	238	NA	50	84
France	139	304	329	321	139	102	126	119
Bulgaria	53	26	19	17	30	163	91	76
Ukraine	370	24	40	61	11	121	137	22
China	2	2	4	2	27	78	109	125
Turkey	-		13	81	59	52	100	118
Ivory Coast	-		-	47	104	88	61	NA
Mexico	15	13	61	18	38	55	12	11
Morocco	-		32	147	73	91	NA	91
Zambia	-		-	52	40	118	72	NA
Other Countries	378	151	273	404	618	905	797	1,083
Total	**15,932**	**10,919**	**14,979**	**17,155**	**14,776**	**17,211**	**17,064**	**18,664**

Source: United Nations' Data Base.

Annexure: 7.V

Country-wise Imports of Manganese Ore, 2005 to 2012

(In'000 tonnes)

Country	2005	2006	2007	2008	2009	2010	2011	2012
China	4,578	6,208	6,632	7,568	9,618	11,578	12,972	12,366
Korea, Rep. of	351	534	660	808	683	904	1,389	1,267
Ukraine	1,832	1,663	1,502	2,003	886	1,298	1,204	728
Japan	1,326	1,168	1,091	1,106	900	1,102	958	1,154
Norway	1,172	849	1,083	1,233	526	1,122	1,085	NA
France	616	611	678	877	194	721	647	562
India	108	162	558	1,072	631	NA	1,817	2,387
Russia	435	539	725	739	580	551	231	NA
Spain	416	454	399	640	55	407	NA	413
USA	656	572	298	NA	154	255	266	506
Mexico	237	97	188	169	73	169	122	168
Georgia	-	-	139	184	59	228	NA	259
Saudi Arabia	128	151	121	178	71	115	NA	NA
Slovakia	274	285	253	221	81	146	131	145
Romania	357	3	++	16	++	88	66	++
Other countries	641	668	1,010	1,104	458	656	766	415
Total	**13,127**	**13,964**	**15,337**	**17,918**	**14,969**	**19,340**	**21,654**	**20,370**

Source: United Nations' Data Base.

Annexure: 7.VI

India's Exports of Manganese Ore (Total), 2001-02 to 2011-12

(By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**248,103**	**335,672**	**239,632**	**317,787**	**237,344**	**157,312**	**208,372**	**205,424**	**289,468**	**98,979**	**75,183**
Pakistan	28,700	35,650	37,000	-	-	34,000	-	6	-	-	-
Bangladesh	-	-	2868	-	200	-	1552	-	-	1,078	-
Japan	61,500	103,167	5,000	16,500	53,500	85,420	22,500	22,500	31,500	-	86
Columbia	-	-		210	-	-	-	-	-	-	-
Singapore	-	-	-	-	-	-	-	-	-	-	-
Spain	-	-	-	-	478	-	-	-	-	-	-
USA	-	-	-	-	-	-	-	2	++	-	-
Nepal	-	-	-	40	2	-	1	27	++	-	982
China	88,000	66,600	157,709	300,421	151,164	35,221	158,267	156,995	251,065	78,310	71,054
Bhutan	-	-	-	-	-	2,562	25,986	22,800	6,903	19,165	2,968
Korea, Rep. of	67,852	72,500	36,570	-	32,000	-	-	2,094	-	-	-
Bahrain	-	-	-	-	-	-	18	-	-	-	-
Ireland	-	-	-	-	-	-	20	-	-	-	-
UAE	-	-	-	-	-	108	-	-	-	-	-
Saudi Arabia	-	-	-	616	-	-	-	-	-	++	-
Kenya	-	-	-	-	-	-	28	-	-	-	20
Chinese Taipei	-	-	-	-	-	-	-	-	++	-	-
Nigeria	-	-	-	-	-	-	-	1000	-	-	-
Israel										-	-
Italy	-	-	-	-	-	-	-	-	-	25	50
Malaysia	-	-	-	-	-	-	-	-	-	-	21
Chile	-	-	-	-	-	-	-	-	-	-	2
Other countries	2,051	57,755	485	-	-	1	-	-	-	1,659	-

Source: IBM

Annexure: 7.VII

India's Exports of First Grade Manganese Ore (46% Mn or more), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**22,022**	**85,050**	**47,667**	**98,429**	**60,997**	**984**	**20,538**	**4,212**	**3,371**	**16,222**	**33,051**
Bangladesh	-	-	918	-	-	-	1,552	-	-	-	-
USA	-	-	-	-	-	-	-	-	-	-	-
China	-	24,000	10,010	92,700	60,995	-	-	-	-	-	30,500
Nepal	-	-	-	-	2	-	-	27	-	-	982
Bhutan	-	-	-	-	-	984	18,986	4,185	3,371	16,147	1,517
Japan	20,000	-	-	-	-	-	-	-	-	-	-
Korea, Rep. of	-	-	36,570	-	-	-	-	-	-	-	-
Italy	-	-	-	-	-	-	-	-	-	25	50
Chile	-	-	-	-	-	-	-	-	-	-	2
Other countries	2,022	61,050	169	5729	-	-	-	-	-	50	-

Source: IBM

Annexure: 7.VIII

India's Exports of Second Grade Manganese Ore (35-46% Mn), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	*2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**102,000**	**44,604**	**5000**	**-**	**2,369**	**1,579**	**67,950**	**1,344**	**-**	**2,250**	**-**
Bhutan	-	-	-	-	-	1,578	7,000	-	-	-	-
Singapore	-	-	-	-	-	-	-	-	-	-	-
Japan	-	504	5000	-	-	-	-	-	-	-	-
Korea, Rep. of	-	-	-	-	-	-	-	-	-	-	-
China	77,000	-	-	-	1,969	-	60,950	-	-	2,250	-
Spain		-	-	-	400	-		-	-	-	-
Saudi Arabia	-	-	-	-	-	1	-	-	-	-	-
Other countries	25,000	44,100	-	-	-	-	-	1,344	-	-	-

Source: IBM
**Second grade = 35-46% Mn from 2003-04.*

Annexure:7.IX

India's Exports of Manganese Ore (Others), 2001-02 to 2011-12
(By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**16,529**	**28,500**	**36,966**	**67,378**	**43,278**	**34,108**	**53,106**	**131,746**	**161,660**	**67,899**	**34,013**
China	-	-	34,700	66,741	11,000	-	53,057	111,379	133,368	64,350	33,554
Pakistan	-	-	-	-	-	34,000	-	-	-	-	-
Bangladesh	-		1950		200	-	-	-	-	-	-
USA	-	-	-	-	-	-	-	2	++	-	-
Bahrain	-	-	-	-	-	-	-	-		-	-
Japan	16,500	-	-	-	-	-	-	-	25,200	-	86
Nepal	-	-	-	-	-	-	1	++	++	-	++
Korea, Rep. of	-	-	-	-	32,000	-	-	750	-	-	-
Spain	-	-	-	-	78	-	-	-	-	-	-
Ireland	-	-	-	-	-	-	20	-	-	-	-
UAE	-	-	-	-	-	108	-	-	-	-	-
Kenya	-	-	-	-	-	-	28	-	-	-	-
Bhutan	-	-	-	-	-	-	-	18,615	3,092	3,018	352
Chinese Taipei/ Taiwan	-	-	-	-	-	-	-	-	++	-	-
Nigeria	-	-	-	-	-	-		1000	-	-	-
Israel	-	-	-	-	-	-	-	-	-	-	-
Saudi Arabia	-	-	-	-	-	-	-	-	-	-	-
Malaysia	-	-	-	-	-	-	-	-	-	-	21
Other countries	29	28,500	316	637	-	-	-	-	-	531	-

Source: IBM

Annexure:7.X

India's Exports of Ferruginous Manganese Ore, 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**107,552**	**177518**	**-**	**5000**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
China	11,000	9,000	-	5000	-	-	-	-	-	-	-
Japan	-	36,113	-	-	-	-	-	-	-	-	-
Korea, Rep. of	67,852	66,000	-	-	-	-	-	-	-	-	-
Pakistan	28,700	35,650	-	-	-	-	-	-	-	-	-
Qatar	-	4,355	-	-	-	-	-	-	-	-	-
Spain	-	26,400	-	-	-	-	-	-	-	-	-

Source: IBM

Annexure:7.XI

India's Exports of Manganese Ore (30-35%), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**189,998**	**146,980**	**130,700**	**120,641**	**66,778**	**68,122**	**104,737**	**14,858**	**8,099**
China	-	-	112,999	135,980	77,200	35,221	44,260	45,616	97,997	13,780	7,000
Bahrain	-	-	2,999	-	-	-	18	-	-	-	-
Pakistan	-	-	37,000	-	-	-	-	6	-	-	-
Japan	-	-	-	11,000	53,500	85,420	22,500	22,500	6,300	-	-
Bhutan	-	-	37,000	-	-	-	-	-	440	-	1099
Bangladesh	-	-	-	-	-	-	-	-	-	1,078	-

Source: IBM

Annexure:7.XII

India's Exports of Electrolytic Manganese Di Oxide (EMD), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**247**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Chinese Taipei/ Taiwan	-	-	-	-	-	-	-	-	-	-	-
Nepal	112	-	-	-	-	-	-	-	-	-	-
Egypt	-	-	-	-	-	-	-	-	-	-	-
Australia	-	-	-	-	-	-	-	-	-	-	-
Tanzania	20	-	-	-	-	-	-	-	-	-	-
Bangladesh	20	-	-	-	-	-	-	-	-	-	-
U.K.	-	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	-	-	-	-	-	-
Italy	-	-	-	-	-	-	-	-	-	-	-
Finland	-	-	-	-	-	-	-	-	-	-	-
Kenya	-	-	-	-	-	-	-	-	-	-	-
Sri Lanka	28	-	-	-	-	-	-	-	-	-	-
Thailand		-	-	-	-	-	-	-	-	-	-
Other countries	67	-	-	-	-	-	-	-	-	-	-

Source: IBM

Data not available beyond 2001-02.

Annexure:7.XIII

India's Exports of Manganese Oxide Other than MnO_2, 2001-02 to 2011-12
(By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**1,751**	**1,792**	**1,315**	**521**	**969**	**989**	**855**	**2,119**	**7,215**
Belgium	-	-	-	175	-	-	-	-	-	-	
Nepal	-	-	-	162	-	-	-	-	-	-	
Chinese Taipei/ Taiwan	-	-	19	-	-	-	-	25	-	55	
Tanzania	-	-	-	134	-	39	13	47	22	-	
Egypt	-	-	60	-	-	-	-	-	-	-	
Israel	-	-	-		350	-	-	-	-	-	
Italy	-	-	-	25	524	49	224	155	250	378	625
Philippines	-	-	28	-	-	-	-			-	
Sri Lanka	-	-	85	41	-	26	51	-	-	-	1,173
Spain	-	-	311	307	-		-	-		263	
Oman	-	-	540	-	100	-	-	-		-	
Switzerland	-	-	15	-	-	-	-	-		-	
Singapore	-	-	15		-	-	-	-		-	
USA	-	-	580	-	-	-	-	-		-	
Thailand	-	-	20	-	-	-	-	-		235	495
Saudi Arabia	-	-	39	227	86	-	-	140	100	40	340
Malaysia	-	-	-	100	100	99	249	151	226	255	
Kenya	-	-	-	66	-	-	2	27	2	-	
Iran	-	-	-	21	-	-	-	-		-	
UAE	-	-	-	44	51	-	-	-	-	-	
Syria	-	-	-	74	-	-	-	-	-	-	
Indonesia	-	-	-	-	-	38	-	37	-	231	433
Malawi	-	-	-	-	30	-	-	-	-	-	
Poland	-	-	-	-	-	97	50	-		-	
Sweden	-	-	-	-	-	96	-	-	-	-	

Annexure: 7.XIII Contd...

Annexure:7. XIII Concld.

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Yemen	-	-	-	-	-	-	81	35	2	-	
Korea, Rep. of	-	-	-	-	-	-	40	243	6	-	
Korea, Dem. Rep.	-	-	-	-	-	-	-	20	-	-	
Russia	-	-	-	-	-	-	-	-	-	220	765
U K	-	-	-	-	-	-	-	-	-	50	299
Vietnam	-	-	-	-	-	-	-	-	-	58	272
Germany	-	-	-	-	-	-	-	-	-	-	1,023
Australia	-	-	-	-	-	-	-	-	-	25	221
Other countries	-	-	39	416	74	77	259	109	247	404	1,569

Source: IBM

Annexure:7.XIV

India's Exports of Manganese Di Oxide, 2001-02 to 2011-12
(By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**888**	**627**	**775**	**620**	**434**	**182**	**690**	**766**	**1,757**
Thailand	-	-	-	5	82	-	59	-	26	-	51
Bangladesh	-	-	233	40	-	15	-	-	21	147	268
Brazil	-	-	38	-	-	-	-	-	-	-	-
China	-	-	-	-	20	-	-	-	-	-	-
Peru	-	-	25	-	-	-	-	-	-	-	-
Egypt	-	-	25	-	-	-	-	-	-	-	-
Germany	-	-	21	-	-	-	-	-	-	-	-
Mauritius	-	-	34	-	-	-	-	-	-	-	-
Nepal	-	-	145	-	-	-	-	-	70	-	-
Netherlands	-	-	18	-	-	-	-	-	-	-	-
Kuwait	-	-	40	-	-	-	-	-	-	52	117
Saudi Arabia	-	-	37	-	224	150	-	-	-	120	235
Malaysia	-	-	-	-	8	34	-	-	-	-	-
UAE	-	-	45	-	-	-	-	28	54	19	-
Singapore	-	-	26	-	-	-	-	-	-	-	-
USA	-	-	18	-	-	-	-	7	1	90	-
Djibouti	-	-	8	-	-	-		-	-	-	-
Sri Lanka	-	-	150	41	96	2	84	1	45	45	-
Jordan	-	-	-	14	30	-	-	-	-	-	-
Tanzania	-	-	-	114	50	127	-	-	-	-	-
Syria	-	-	-	74	-	-	-	-	-	-	-
Korea, Rep. of	-	-	-	84	22	43	103	46	90	200	146
Philippines	-	-	-	73	-	-	-	-	-	71	-
Kenya	-	-	-	10	11	132	39	74	88	48	152
Iran	-	-	-	-	50	-	60	-	-	-	-
Indonesia	-	-	-	-	-	10	38	25	24	-	-
Cyprus	-	-	-	-	-	-	20	-	-	-	-

Annexure: 7.XIV Contd.

Annexure: 7.XIV Concld.

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Russia	-	-	-	-	-	-	20	-	24	-	-
Poland	-	-	-	-	-	-	-	-	-	-	75
Japan	-	-	-	-	-	-	-	-	-	20	-
USA	-	-	-	-	-	-	-	-	-	43	95
Italy	-	-	-	-	-	-	-	-	-	-	75
Spain	-	-	-	-	-	-	-	-	-	-	73
Other countries	-	-	25	172	182	107	31	1	247	156	470

Source: IBM

Annexure: 7.XV

India's Exports of Manganese Di Oxide and Oxide Other than MnO_2 (Total), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**717**	**2,639**	**1,165**	**2,090**	**1,141**	**1,397**	**1,191**	**1,087**	**2,169**	**-**
Korea, Rep. of	-	-	-	-	-	43	143	289	96	200	-
Bangladesh	-	10	233	-	-	-	-	-	-	-	-
Brazil	-	-	44	-	-	-	-	-	-	-	-
Egypt	-	-	85	-	-	-	-	-	-	-	-
Philippines	-	26	28	-	-	-	-	-	-	-	-
Nepal	-	60	176	-	-	-	-	22	74	-	-
Spain	-	-	311	-	-	-	-	-	-	263	-
Sri Lanka	-	139	235	-	96	28	135	-	-	-	-
Oman	-	-	540	-	100	-	-	-	-	-	-
UAE	-	-	45	40	-	-	-	59	54	-	-
USA	-	-	598	-	-	-	-	-	-	-	-
Germany	-	46	21	48	-	-	-	-	-	-	-
Singapore	-	-	41	-	-	-	-	-	-	-	-
Chinese Taipei/ Taiwan	-	-	19	-	-	-	-	-	-	55	-
Mauritius	-	-	34	-	-	-	-	-	-	-	-
Saudi Arabia	-	210	76	227	310	150	5	140	100	119	-
Thailand	-	-	20	-	-	-	-	-		110	-
Italy	-	-	-	25	524	73	224	155	250	253	-
Israel	-	-	-	-	350	-	-	-	-	-	-
Malaysia	-	-	-	100	108	133	249	151	-	178	-
Australia	-	-	-	25	-	-	-	-	-	-	-
Kenya	-	-	-	-	13	132	41	101	90	-	-
Indonesia	-	-	-	-	-	48	32	62	24	152	-
Tanzania	-	-	-	-	54	166	-	47	32	-	-
Poland	-	-	-	-	-	97	-	-	-	50	-
Sweden	-		-	-	-	96	-	-	-	-	-
Korea Dem. Rep	-	-	-	-	-	-	-	20	-	-	-
Yemen	-	-	-	-	-	-	81	-	-	-	-
Russia	-		-	-	-	-	-	-	-	124	-
Other countries	-	226	133	700	535	175	487	145	367	665	-

Source: IBM

Annexure:7.XVI

India's Imports of Manganese Ore (Total), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**7,722**	**7,621**	**6,258**	**241,004**	**13,281**	**284,202**	**686,053**	**852,198**	**728,286**	**1,299,643**	**1,961,396**
Australia	-	-	-	104,799	5	194,767	309,570	348,003	220,175	363,984	568,498
Indonesia	-	-	-	55	-	4,135	20,582	18,692	1,933	-	-
Columbia	-	-	1,365	2,667	2,502	-	-	-	-	-	-
Gabon	2,747	2,020	2,536	3,399	3,175	76,891	185,619	45,547	9,1735	156,036	172,879
China	-	50	75	160	-	-	-	-	-	25,905	52,253
Brazil	1,556	1,517	651	42,167	-	-	-	-	-	54,656	70,404
Ghana	-	-	-	17,476	-	-	-	-	-		-
Singapore	1,093	1,048	100	574	2,075	3,438	10,644	8,745	7,805	7,403	12,308
Pakistan	-	-	-	332	435	2,711	-	-	-	-	-
Belgium	570	410	220	-	-	-	-	-	-	-	-
Sri Lanka	-	-	-	-	210	-	-	-	-	-	-
France	323	105	210	-	-	-	-	-	-	8,279	-
Slovenia	50	-	-	-	-	-	-	-	-	-	-
USA	-	-	-	-	-	-	-	-	-	-	-
South Africa	1,236	1,259	1,099	69,095	2,800	800	67,408	359,794	359,959	578,953	935,987
Poland	3	-	-	100	-	-	-	-	-	-	-
Morocco	-	-	-	-	-	-	-	-	-	-	-
Saudi Arabia	-	-	-	-	-	-	21,800	-	-	-	-
Ivory cost	-	-	-	-	-	-	30,723	28,705	36,757	42,077	43,306
Turkey	-	-	-	-	-	-	3,789	11,951	-	13,576	16,565
Zambia	-	-	-	-	-	-	207	6,161	1,557	10,220	22,264
Thailand	-	-	-	-	-	-	3,741	-	-	-	-
Burkina Faso	-	-	-	-	-	-	-	-	-	8,041	15,011
Unspecified	-	-	-	90	1,875	-	-	-	6,508	-	-
Other countries	144	1,212	2	90	204	1,460	31,970	24,600	1,857	38,792	51,921

Source: IBM

Annexure:7.XVII

India's Imports of First Grade Manganese Ore (46% or more), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**4,686**	**7,475**	**5,617**	**223,413**	**12,293**	**280,023**	**497,385**	**398,033**	**283,146**	**531,465**	**860,032**
Australia	-	-	-	-	5	194,767	262,758	197,853	85,281	167,106	344,830
Brazil	1,044	1,517	651	-	-	-	-	-	-	5,448	47,559
Columbia	-	-	1,365	2,667	2,502	843	-	917	126	-	-
Singapore	1066	1,048	100	574	2,075	2,798	10,584	8,605	7,805	7,353	6,722
China	.-	50	75	-	-	-	10,500	-	-	21,183	17,965
Gabon	450	1920	2,436	3,399	2,575	76,591	138,833	16,958	33,415	94,524	124,717
Indonesia	-	-	-	-	-	2,429	6,407	5,384	652	7,386	-
Belgium	570	410	60	-	-	-	-		-	-	-
Poland	3	-	-	-	-	-	-	-	-	-	-
USA	-	-	-	-	-	-	-	-	-	-	-
Slovenia	50			-	-	-	-	-	-	-	-
UAE	-		-	-	-	-	-	-	-	-	-
South Africa	1,036	1,257	720	69,095	2,650	800	43,236	151,016	146,589	185,923	254,734
France	323	105	210	-	-	-	-	-	-	8,279	-
Morocco	-	-	-	-	1,875	-			-	-	-
Pakistan	-	-	-	-	197	1,199	-	-	-	-	-
Sri Lanka	-	-	-	-	210	-	-		-	-	-
Turkey	-	-	-	-	-	-	-	3,494	-	-	6,304
Zambia	-	-	-	-	-		207	4756	1557	6830	13,284
Thailand	-	-	-	-	-	-	-	-	-	-	-
Saudi Arabia	-	-	-	-	-	-	21,800	-	-	-	-
Ivory Coast	-	-	-	-	-	-	-	3587	6847	15,809	25,738
Tanzania	-	-	-	-	-	-	-	1988	121	-	-
Other countries	144	1168	-	147,678	204	596	3,060	3475	753	19903	13,967

Source: IBM

Annexure: 7.XVIII

India's Imports of Second Grade Manganese Ore (35-46% Mn), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**-**	**-**	**238**	**2,431**	**181,184**	**430,090**	**512,474**	**752,600**	**1,070,827**
Egypt	-	-	-	-	-	-	13,600			-	-
Belgium	-	-	-	-	-	-				-	-
Indonesia	-	-	-	-	-	1,331	10,701	10,924	736	-	-
USA	-	-	-	-		-	-	-	-	-	-
Pakistan	-	-	-	-	238	1,079	3,044	-	-	-	-
Morocco	-	-	-	-	-	-	-	-	-	-	-
Turkey	-	-	-	-	-	21	3,109	5,085	-	10,512	6,474
South Africa	-	-	-	-	-	-	22,000	202,030	213,370	384,126	663,593
Australia	-	-	-	-	-	-	46,812	150,150	134,894	196,878	223,668
Gabon	-	-	-	-	-	-	46,786	28,589	58,320	61,512	47,212
Ivory Coast	-	-	-	-	-	-	30,300	22,658	28,549	26,268	17,568
Thailand	-	-	-	-	-	-	3,691	5,389	-	-	-
Malaysia	-	-	-	-	-	-	1,001	-	-	-	-
Brazil	-	-	-	-	-	-	-	-	69,647	48,757	22,657
Unspecified	-	-	-	-	-	-	-	-	6508	-	-
Burkina Faso	-	-	-	-	-	-	-	-	-	5,435	13,012
China	-	-	-	-	-	-	-	-	-	4,722	33,095
Zambia	-	-	-	-	-	-	-	-	-	2,675	8,980
Tanzania	-	-	-	-	-	-	-	-	-	2,007	-
USA	-	-	-	-	-	-	-	-	-	-	-
Other countries	-	-	-	-	-	-	140	5,265	448	11,175	28,742

Source: IBM

Annexure: 7.XIX

India's Imports of Manganese Ore (Others), 2001-02 to 2011-12
(By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**1,336**	**146**	**641**	**-**	**750**	**1748**	**5,778**	**11,694**	**1,990**	**12,485**	**20,284**
Indonesia	-	-	-	-	-	375	1,868	1,786	545	2,149	1,101
Poland	-	-	-	-	-	-	-	10	-	-	-
Gabon	597	100	100	-	600	300	-	-	-	-	950
Philippines	-	-	-	-	-	-	25	-	-	-	52
Brazil	-	-	-	-	-	-	-	291	74	-	-
Nigeria	-	-	-	-	-	-	-	-	-	-	-
Belgium	-	-	160	-		-	-	-	-	-	-
Pakistan	-	-	-	-	-	433	500	1,265	-	-	-
Singapore	-	-	-	-	-	640	60	140	-	50	-
South Africa	200	2	379	-	150	-	2,172	6,721	-	6,503	13,251
Germany	-	-	-	-	-	-		-	-	-	-
Turkey	-	-	-	-	-	-	680	-	-	3,064	++
Zambia	-	-	-	-	-	-	-	874	-	715	-
Ivory Coast	-	-	-	-	-	-	423	607	1361	-	-
USA	-	-	-	-	-	-	-	-	10	-	-
Oman	-	-	-	-	-	-	-	-	-	-	3,449
China	-	-	-	-	-	-	-	-	-	-	1,193
Tanzania	-	-	-	-	-	-	-	-	-	-	100
Brazil	-	-	-	-	-	-	-	-	-	-	188
Other countries	539	44	2	-	-	-	50	-	-	-	++

Source: IBM

Annexure: 7.XX

India's Imports of Electrolytic Manganese Di Oxide (EMD), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**924**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
UAE	-	-	-	-	-	-	-	-	-	-	-
Japan	144	-	-	-	-	-	-	-	-	-	-
China	683	-	-	-	-	-	-	-	-	-	-
Switzerland	66	-	-	-	-	-	-	-	-	-	-
USA	-	-	-	-	-	-	-	-	-	-	-
Singapore	10	-	-	-	-	-	-	-	-	-	-
Belgium	18	-	-	-	-	-	-	-	-	-	-
Other countries	3	-	-	-	-	-	-	-	-	-	-

Source: IBM, Data for the years 2002-03 to 2011-12 is not available.

Annexure: 7.XXI

India's Imports of Manganese Ore (30-35%), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**-**	**17, 501**	**-**	**-**	**1,002**	**11,062**	**299**	**3,097**	**10,253**
Pakistan	-	-	-	-	-	-	-	150	-	-	-
Malaysia	-	-	-	-	-	-	-	3,709	-	-	-
Ghana	-	-	-	17,476	-	-	-	-	-	-	-
Indonesia	-	-	-	25	-	-	1,002	598	-	-	-
Kenya	-	-	-	-	-	-	-	-	299	-	-
Ivory Coast	-	-	-	-	-	-	-	1,853	-	-	-
Philippines	-	-	-	-	-	-	-	637	-	-	86
South Africa	-	-	-	-	-	-	-	27	-	2,401	4,409
Thailand	-	-	-	-	-	-	-	675	-	-	-
Turkey	-	-	-	-	-	-	-	3,372	-	-	3,787
Zambia	-	-	-	-	-	-	-	41	-	-	-
Brazil	-	-	-	-	-	-	-	-	-	-	-
Oman	-	-	-	-	-	-	-	-	-	-	1,971
Other countries	-	-	-	-	-	-	-	++	-	696	-

Source: IBM

Annexure: 7.XXII

India's Imports of Manganese (Electrolytic), 2001-02 to 2011-12
(By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**538**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
China	432	-	-	-	-	-	-	-	-	-	-
Switzerland	-	-	-	-	-	-	-	-	-	-	-
South Africa	-	-	-	-	-	-	-	-	-	-	-
USA	-	-	-	-	-	-	-	-	-	-	-
Chinese Taipei/ Taiwan	-	-	-	-	-	-	-	-	-	-	-
Korea, Rep. of	-	-	-	-	-	-	-	-	-	-	-
Other countries	106	-	-	-	-	-	-	-	-	-	-

Source: IBM

Annexure: 7.XXIII

India's Imports of Manganese Oxide (Total) Country-wise 2001-02 to 2011-12
(By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**5,541**	**6,271**	**6,775**	**8,978**	**7,039**	**6,429**	**7,293**	**7254**	**-**
Australia	-	-	-	1,370	2,046	589	127	195	-		-
Belgium	-	-	126	1,113	1,004	1,175	1,110	879	594	745	-
China	-	-	4,310	3,086	3,423	6,567	5,630	4,869	5892	7,252	-
Hong Kong	-	-	158	81	-	-	-	-	-	23	-
Ireland	-	-	514	360	-	-	-	-	-		-
Germany	-	-	139	9	13	8	12	12	31	19	-
Japan	-	-	57	40	13	12	-	2	23	55	-
Norway	-	-	-	-	-	160	-	31	100	25	-
Israel	-	-	-	-	-	-	22	71	31	344	-
South Africa	-	-	195	33	80	49	++	-	160	338	-
Singapore	-	-	-	100	105	-	-	-	-	40	-
Greece	-	-	-	-	69	70	-	-	-		-
UK	-	-	-	41	-	18	23		-		-
USA	-	-	-	10	-	-	21	53	62	45	-
France	-	-	-	4	-	-	-	-	-		-
Tanzania	-	-	-	-	-	-	-	273	165		-
Unspecified	-	-	-	22	-	120	20	-	-		-
Other countries	-	-	42	2	22	210	74	44	235	97	-

Source: IBM

Annexure: 7.XXIV

India's Imports of Manganese Di Oxide, 2001-02 to 2011-12
(By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**3,472**	**4,299**	**5,636**	**7,408**	**5,809**	**5,380**	**5,937**	**7,254**	**6,338**
Australia	-	-	-	1,370	2,046	589	127	195	-	-	-
Belgium	-	-	6	11	44	15	10	15	14	28	55
China	-	-	2,664	2,335	3,343	6,483	5,590	4,726	5,661	7,057	5,864
Korea, Rep. of	-	-	-	-	-	-	60	-	-	16	-
Ireland	-	-	424	-	-	-		-	-	-	-
Germany	-	-	137	-	9	1	3	9	12	10	10
Hong Kong	-	-	158	-	-	-	-	-	-	23	50
Japan	-	-	57	-	-	-	-	2	16	49	5
Greece	-	-	-	-	69	-	-	-	-	-	-
Singapore	-	-	-	-	105	85	-	25	26	-	-
South Africa	-	-	-	-	-	29	-	71	20	-	142
U.K.	-	-	-	-	1	7	17	—	-	-	-
USA	-	-	-	-	19	1	1	31	23	24	74
Tanzania	-	-	-	-	-	-	-	273	165	-	-
Kuwait	-	-	-	-	-	-	-	-	-	-	40
France	-	-	-	-	-	-	-	-	-	-	24
Myanmar	-	-	-	-	-	-	-	-	-	-	25
Unspecified	-	-	-	-	-	120	-	20	-	-	-
Other countries	-	-	26	583	++	78	1	13	-	63	49

Source: IBM

Annexure: 7.XXV

India's Imports of Manganese Di Oxide Other than MnO_2, 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**2,069**	**1,945**	**1,139**	**1,570**	**1,230**	**1,069**	**1,213**	**1,709**	**941**
Belgium	-	-	120	1,102	960	1,160	1,100	864	580	717	375
China	-	-	1,646	751	80	84	40	143	231	195	21
Singapore	-	-	-	-	-	-	-	-	-	-	-
Japan	-	-	-	-	13	12	12	++	7	6	5
France	-	-	-	-	++	1	1	-	-	-	-
Ireland	-	-	90	-	-	++	-	-	-	-	-
Germany	-	-	-	6	4	7	9	3	19	9	21
Greece	-	-	-	-	-	69	-	-	-	-	-
Norway	-	-	-	-	-	160	-	-	100	25	-
Israel	-	-	-	-	-	-	22	20	31	344	57
South Africa	-	-	195	-	-	-	-	-	140	338	227
UK	-	-	-	33	80	20	6	-	-	-	-
USA	-	-	-	-	++	11	20	22	39	1	152
Mozambique	-	-	-	-	2	-	-	-	40	-	-
Vietnam	-	-	-	-	-	-	-	-	20	-	-
Unspecified	-	-	-	-	-	-	20	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	20	-
Switzerland	-	-	-	-	-	-	-	-	-	50	-
Italy	-	-	-	-	-	-	-	-	-	-	40
Russia	-	-	-	-	-	-	-	-	-	-	19
Thailand	-	-	-	-	-	-	-	-	-	-	20
Other countries	-	-	18	53	++	46	++	17	6	99	4

Source: IBM

Annexure: 7.XXVI

India's Imports of Manganese Ore (Ferruginous 10% or more), 2001-02 to 2011-12 (By Country)

(In tonnes)

Country	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
All Countries	**-**	**-**	**-**	**-**	**-**	**-**	**704**	**-**	**19,700**	**-**	**-**
Indonesia	-	-	-	-	-	-	604	-	-	-	-
Pakistan	-	-	-	-	-	-	100	-	-	-	-
China	-	-	-	-	-	-	-	-	19,700	-	-

Source: IBM
Data from 2001-02 to 2006-07 & 2010-11to 2011-12 is not available.

Annexure: 7. XXVII

World's Top Ten Producers of Manganese Ore

1. BHP Billiton

BHP Billiton is one of the world's leading producers of manganese ore having operations in Australia and South Africa. The Australian operations include Tasmanian Electro Metallurgical Company Pty Ltd (TEMCO) and Groote Eylandt Mining Company (GEMCO), each of which is 60 per cent owned. In South Africa, it owns 60% of Samancore Manganese Pty Ltd and operates Mamatwan Open cut and Wessels underground manganese mines. BHP Billiton produces a combination of ores and alloys from sites in South Africa and Australia. It is the world's largest producer of manganese ore and one of the top global producers of manganese alloys. Approximately, 80% of its production is sold directly to external customers and remainder is used as feedstock in its alloy smelter. It owns and manages all manganese ore mining operations and alloy plants through joint ventures with Anglo American. Its JV interests are held through Samancore Manganese, which operates its global manganese assets. Samancore Manganese Pty Ltd owns 74% of Hotazel Manganese Mines Pty Ltd (HMM). In Australia, it owns 60% of Groote Eylandt Mining Company Pty Ltd (GEMCO). The saleable production during 2010-2012 was as follows:

Mines	Year (Production '000 tonnes)			
	2010	2011	2012	Capacity
Hotazel Manganese Mine, South Africa	2,718	3,007	3,625	4.2 mtpa
GEMCO, Australia	3,406	4,086	4,306	4.2 mtpa
Total	**6,124**	**7,093**	**7,931**	

Resources

The total resources in GEMCO's property (Eastern Exploratory Areas) in Northern territory are placed at 162 million tonnes with 45.9% Mn and 48% yield, whereas the reserves are placed at 103 million tonnes with 45% Mn and 55% yield.

In Wessel mine, the total resources are placed at 138 million tonnes with Mn content ranging from 41.7 to 49% and yield of 10.4 to 16.6%. The reserves are placed at 69.7 million tonnes with Mn% varying from 42 to 47.8% and yield varying from 11.2 to 17.9%.

In Mamatwan mine, the total resources are placed at 120.3 million tonnes with Mn content varying from 30.6 to 37.5%. The reserves are placed at 75.1 million tonnes with Mn content varying from 36.2 to 36.7% and yield varying from 4.4 to 4.7%.

Besides, BHP Billiton has planned to develop the Benioni and Bordeaux areas in Gabon known as Franksville Project. The total resources in these areas are placed at 43.8 million tonnes with Mn content varying from 24.3 to 36.4% and yield varying from 71 to 73%.

2. ASSMANG

ASSMANG is jointly owned by African Rainbow Mineral Ltd (50%) and Assore Ltd (50%). Currently, it has three operating divisions based on its three commodities namely, chromite, manganese ore and iron ore. ASSMANG's Manganese division consists of three manganese mines in the Northern Cape, Nchwaning and Gloria in South Africa and Fe Mn works at Cato Bridge in Kwa-Zulu-Natal. The locations of the mines are in the Kalahari Manganese Field Region. The ore extracted from Nchwaning and Gloria is of high grade.

3. CONSMIN

Consolidated Minerals Ltd (CONSMIN) is a leading manganese ore producer with mining operations in Australia and Ghana. The principal activities of the company and its subsidiaries are exploration, mining, processing and sale of manganese products. Its operations are primarily conducted through major operating/trading subsidiaries, Consolidated Minerals Pty. Ltd (Australia), Ghana Manganese Co. Ltd (Ghana), Manganese Trading Ltd (Jersey) and Pilbara Trading Ltd (Jersey). Pilbara manganese, a wholly owned subsidiary of CONSMIN owns and operates the Woodie – Woodie manganese mine in the Pilbara district of Western Australia with a capacity of 1.5 mtpa. Woodie –Woodie is renowned for consistently producing highest grade manganese ore in the world. The mine has 100 km^2 mining corridor and 5500 km^2 of Green Field Exploration areas outside the corridor.

Multiple open pits are mined utilising CONSMIN owned and operated mining fleet. The ore undergoes processing of crushing, screening and heavy media separation. The ore is trucked in hundred tonnes road trains via sealed road, 425 km to port Hedland. The total resources as on 30.6.2012 are placed at 36.5 million tonnes with 37% Mn content. Out of these, the reserves are 18 million tonnes with 36% Mn.

CONSMIN through its wholly-owned subsidiaries owns 90% of Ghana Manganese Company Limited. The remaining 10% is owned by the government of Ghana.

The GMC mine also known as Nsuta mine comprises approximately 175 km^2 of land in and around Nsuta in western region of Ghana, of which the current mining area is less than 3% of the total area. The company's operations at GMC are located approximately 63 km by rail or 93 km by public tarred road from the port facilities of Takoradi. Thirty years mining lease was granted to GMC in 2001 and CONSMIN operates under this lease. The manganese ore exported from this lease is a high grade manganese carbonate (as opposed to manganese oxide) with excellent manganese to iron ratio, which makes it well suited to alloy and EMM production. The ore produced is low in phosphorous and other deleterious elements. The total production during 2012 was 1.47 million tonnes. The total resources as on June 2012 were placed at 41.8 million tonnes with 28% Mn, out of which the reserves were placed at 21.8 million tonnes with 29% Mn.

The production of manganese ore by CONSMIN during 2012 was 2.97 million tonnes as against 3.17 million tonnes in 2011.

4. OMH Group

OMH is the holding company in the group. OM (Manganese) Ltd ("OMM") is the operating entity within the OMH Group. OMH owns the Bootu Creek Mine located in the Northern Territory, Australia. Bootu Creek Mine is located 110 km north of Tennant Creek. The exploration and subsequent development of the Bootu Creek Mine commenced in September 2001 and mining operations commenced in November 2005. The main mineral lease is located in Bootu Creek area on Pastoral leases, where the mining and processing operations are based. Two regional exploration project areas are located at Renner springs and Helen springs.

The Bootu Creek mine area contains a number of manganese deposits located along the western and eastern limbs of the Bootu syncline. The individual mineralised horizons are generally strata bound in character and persist over a strike length of 3 km.

The Renner spring area lies 70 km northeast of the Bootu Creek mine and covers an extensive dolomite-siltstone sequence holding a number of shallow dipping and flat lying manganese occurrences. Helen Spring is located 30 km north of the Bootu Creek mine.

Mining at the Bootu Creek mine is carried out using a conventional open cut method of mining, blasting and excavation using hydraulic excavators and dump trucks. Processing of the ore is carried out at the plant located near the mine. During 2011, the production of manganese ore was 0.90 million tonnes with 36.70% Mn as against 0.83 million tonnes with 36.74% Mn in 2010. The total mineral resources as on 31.12.2011 were 32.3 million tonnes at an average manganese grade of 22.3% and out of these the reserves were placed at 17.4 million tonnes with 20.9% Mn.

5. Tshipi E Ntle Manganese Mining (Pty) Ltd (TSHIPI)

OMH has an effective 13% interest in Tshipi through its 26% strategic partnership with Ntsimbintle Mining (Proprietary) Limited, having a majority stake of 50.1 % in the ownership of Tshipi.

Tshipi owns two mining deposits in the world class Kalahari Manganese Field located in Northern Cape of South Africa. The Kalahari Manganese Field which stretches 35 km long and is approximately 15 km wide hosts 80% of the World's economically mineable high grade manganese ore resources. Tshpi's premier project is TshpiBorwa, a new open pit manganese mine and was scheduled for production in second half of 2012. The TshpiBorwa open pit mine has been designed to produce 2.4 mtpa of manganese ore grading 37% Mn and has 163 million tonnes of resources.

6. ERAMET (Comilog)

The ERAMET Group is a French mining and metallurgical Group with leading global position in manganese and nickel. It is the second largest producer of high grade manganese ore at its mine in Moanda (Gabon), being operated through its subsidiary Comilog S.A. Comilog S.A. (Comilog) is a company operating under Gabonese law and 63.71% stake owned by ERAMET.

The Moanda mine exploits world's richest manganese ore deposits containing around 46% Mn. The mine is open cast. The ore is covered by 4 to 5 metre thick layer of overburden. This is extracted by draglines. The total resources as on 1.1.2012, which include Bangombe, Okouma, Bafoula and Massengo deposits in leased area are placed at 8,458 million tonnes of rock ore with 44.4% Mn and 3,174 million tonnes of fines with 40.6% Mn. Out of these, recoverable reserves are placed at 4,860 million tonnes of total rock ore and 1,972 million tonnes of fines. The reserves are placed at 1,552 million tonnes of rock ore and 539 million tonnes of fines.

The ERAMET is world's second largest producer of alloys and the leading global producer of refined alloys which are higher-value-added products. The group possesses seven manganese alloy plants and the only alloy producer having plant located in the three major consuming areas - Europe, the United States and Asia, enabling it both to better serve its customers and to protect itself from market and currency fluctuations.

7. CVRD (Vale)

Vale was established by the Brazilian Government in 1942 under the name Companhio Vale do Rio Doce' or CVRD. Vale is the second largest diversified metals and mining company in the world, one of the 30 largest public traded companies in the world and the largest private sector company in Latin America. Vale operates four manganese ore mine in Brazil. Vale is also one of the largest producers of manganese ore. Vale conducts manganese mining operations through subsidiaries in Brazil and produces several types of manganese ferroalloys through subsidiaries in Brazil, France and Norway. Vale operates on-site beneficiation plants at Azul mine and at the Urucum mine. The Azul and Urucum mines have high grade ore (at least 40% Mn grade), while the Morro da Mina mine has low grade ores. The manganese ore production during 2008 to 2010 was as follows:

Mine	Type	Production (in million tonnes)		
		2008	2009	2010
Azul	Open Pit	2.0	1.4	1.6
Morro Da Mina	Open Pit	0.1	0.1	0.1
Urucum	Underground	0.2	0.2	0.2
Total		**2.3**	**1.7**	**1.9**

Reserves: As on 31.12.2010, the total reserves in the three mines were placed at 70.4 million tonnes with 37.6 % Mn.

8. Minera Autlan

CompaniaMineraAutlan S.A.B. Of CV is a Mexican Public Company listed on the Mexican Stock Exchange. MineraAutlan produces and markets world class manganese ore and ferroalloys. MineraAutlan is an integrated mining Company that explores, extracts, produces and sells manganese minerals and produces and markets ferroalloys. Its products are meant for dry batteries, ceramics, micronutrients and fertilizer markets. It operates three manganese mining units namely, Molango, Naopa and Nonoalco.

Molango Unit- Molango unit reported production of 444,700 tonnes of nodules based on Tajo Naopa Mine. Naopa Mine holds 6.1 million tonnes of ore.

Nonoalco, Molango and Naopa located in the Mexican state of Hidalgo. The Company also has three ferroalloy plants with an annual installed capacity of approximately 221,000 tonnes.

The Molango mine is located in northern Hidalgo State and contains the most important deposits of metallurgical grade manganese ore in North America and Central America and is one of the largest deposits in the World. Molango owns the sole nodulisation rotary kiln for manganese ore in the world which is used to improve the chemical and physical properties of manganese carbonates, single or blended with natural high grade manganese ores.

Naopa- The Naopa mining unit is located in the middle of Molango manganese district and has proved manganese carbonate reserves to be exploited in an open pit.

Nonoalco-Nonoalco is located in south of Molango district.

9. Privat Group

In Ukraine, the Privat group directly or indirectly controls nearly all the ferroalloys industries from the mining of manganese ore (Margametsk and Ordzhonikidze GOK) to the production of ferroalloys. With its partners, "Privat" brought the largest manganese mine in the Soviet Union "Chiaturmarganet". In addition, through the Ukrainian Company Palmay FIG African, it controls Ghana manganese (about one million tonnes manganese ore), Nsuta mine. Privat acquired Consolidated Minerals. Thus, the total production capacity for the extraction of manganese ore now reaches five million tonnes, representing 14% of global production and 95% of merchandise manganese.

10. Eurasian Natural Resources Corporation (ENRC)

ENRC is one of the leading diversified natural resources group with integrated mining, processing, energy, logistical and marketing operations. It operates in Kazakhstan, China, Russia Brazil and Africa (the Democratic Republic of Congo, Zambia, Mozambique and South Africa).

ENRC produced 954,000 tonnes of saleable manganese ore concentrate. The reserves are placed at 20.6 million tonnes with 22.1 % Mn and 7 million tonnes of Fe Mn ore reserves with 4.0% Mn. The total resources are placed at 212.5 million tonnes of ore with 24.2% Mn and 14.9 million tonnes of Fe Mn ore with 1.6% tonnes.

Zhairem GOK located in Zhairem, Karaganda region, Kazakhstan is a major supplier of manganese ore and manganese concentrates to customers throughout Russia, Ukraine and Central Asia. It is one of the largest manganese ore mining companies in Kazakhstan. Zhairem's mineral resource base includes Ushkatym-III, iron-manganese deposits and Zhormat iron-manganese deposits.

Annexure: 8.I

Producers Prices of Manganese Ore, 2009-10 to 2011-12

(₹ per tonne)

Sl No.	Name of Producer	Grade %	Prices		
			2009-10	2010-11	2011-12
1.	Aditya Minerals Pvt. Ltd, Adilabad, Andhra Pradesh.	Below 25	2800	3000	3300
2.	Sandur Manganese & Iron Ores Ltd, Bellary, Karnataka.	36-46	6706	11189	9467
		Below 35	2787	4658	3856
3.	Mineral Enterprises Ltd, Chitradurga, Karnataka.	25-35	3617	4570	4970
		Below 25	778	770	800
4.	Milan Minerals Pvt. Ltd, Tumkur, Karnataka.	25-35	5168	2648	-
5.	Sunflag Iron & Steel Co. Ltd, Nawegaon Mine, Bhandara Maharashtra.	Above 35	NR	463	NR
		Above 25	196	-	-
6.	A.P. Trivedi & Sons, Balaghat, Madhya Pradesh.	Above 46	8485	13450	-
		35-46	5167	7739	-
		25-35	1559	2179	-
		Below 25	843	1774	-
7.	Pacific Minerals Ltd, Balaghat, Madhya Pradesh.	35-45	10500	13000	9100
		25-35	7200	8600	7629
		Below 25	2150	2000	2584
8.	Bhanja Minerals, Keonjhar, Odisha.	HG Lumps	6500	15500	14500
		MG Lumps	4387	6794	6800
		LG Lumps	2517	4058	4247
		LG Fines	Nil	3300	Nil

Annexure: 8.I Contd..

Source: Collected from producers through correspondence.

Annexure: 8.I Concld.

(In ₹ per tonne)

Sl. No.	Name of Producer	Grade %	Prices		
			2009-10	2010-11	2011-12
9.	Orissa Manganese & Minerals Ltd, Patmunda, Sundergarh, Odisha.	MnO_2	19450	27101	26900
		Above 46	13580	24148	14100
		35-46	7250	10999	8050
		25-35	3350	7068	5050
		Below 25	3200	4577	3400
10.	Orissa Manganese & Minerals Ltd, Bhanjikusum, Sundergarh, Odisha.	35-46	7250	12435	13000
		25-35	3350	7995	8500
11.	Orissa Manganese & Minerals Ltd, Orahuri, Sundergarh, Odisha.	MnO_2	19450	26750	26900
		Above 46	13580	14100	14100
		35-46	7250	11305	8050
		25-35	3350	7190	5050
		Below 25	3200	4609	3400

Source: Collected from producers through correspondence.

Annexure: 8.II

Prices of Manganese Ore, 2005-06 to 2010-11

(In ₹ per tonne)

Grade	Market	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
MnO_2	Ex-mine Siljora-Kalimati (Odisha)	9045	8838	15598	25214	-	-
+46% Mn	Ex-mine Siljora-Kalimati (Odisha)	6133	5615	13949	22708	11213	11213
+35% Mn	Ex-mine Siljora-Kalimati (Odisha)	3590	2460	11231	15459	6195	6195
+25% Mn	Ex-mine Siljora-Kalimati (Odisha)	1621	1656	5838	12860	3578	3578
30% Mn	Ex-mine OMDC Ltd Odisha	901-1225	1019	3313	-	1125-2475	1125-2475
Upto 28% Mn	Ex-mine OMC Ltd Odisha	-	-	805-10001	10001	-	-
28-30% Mn	Ex-mine OMC Ltd Odisha	1070-515	615-515	805-11501	11501	-	-
Upto-30% Mn	Ex-mine OMC Ltd Odisha			2514-8501	8501	-	-
30-34% Mn	Ex-mine OMC Ltd Odisha	699-1598	699-1050	2200-13751	13751	-	-
35-37% Mn	Ex-mine OMC Ltd Odisha	1129-3100	1129-2000	2900-16830	16830	-	-
38-40% Mn	Ex-mine OMC Ltd Odisha	1694-4000	1694-2300	3600-19300	19300	-	-
40-42% Mn	Ex-mine OMC Ltd Odisha	2540-4800	2540-3200	3900-20520	20520	-	-
42-44% Mn	Ex-mine OMC Ltd Odisha	3300-5050	3303-3600	4800-22410	22410	-	-
46-48% Mn	Ex-mine OMC Ltd Odisha	4200-6350	4200	5500-25200	25200	-	-
74-76% MnO_2	Ex-mine OMC Ltd Odisha	7215-10800	7215	9448-25200	25200	-	-
78-80% MnO_2	Ex-mine OMC Ltd Odisha	7845-11730	7845	10273-25200	25200	-	-
82-84% MnO_2	Ex-mine OMC Ltd Odisha	NA	10032	13137-25200	25200	-	-
26-35% Mn fines	Ex-mine OMC Ltd Odisha	-	-	245-1100	4011	-	-

Source: IBM *Note: There were no sales of manganese ore from OMC mines during 2009-10 and 2010-11*

Annexure: 8.III-A

Prices of Manganese Ore Marketed by MOIL (From 1.1.2011 to 1.1.2013)

(In ₹ per tonne)

Ore Code	Prices as on								
	1.1.2011	1.4.2011	1.7.2011	1.10.2011	1.1.2012	1.4.2012	1.7.2012	1.10.2012	1.1.2013
Ferro Grade									
BG102	17552	14919	12047	12047	-	12876	14807	14807	14067
BG 1408	16166	13741	11096	11096	-	11859	13638	13638	12956
BG1466	15494	13170	9986	9986	9487	10673	12274	12274	11660
BL2409	15507	13181	10644	10644	9580	10538	12119	12119	11513
BL3480	10841	9215	7441	-	6697	7367	8472	8472	8048
BL4206	12046	10239	8268	8268	7441	8185	9413	9413	8942
CH1266	-	-	11216	11266	10094	-	-	-	-
DB2268	-	-	10266	10266	9239	-	-	-	11617
DB2367	-	-	10767	10767	9690	-	-	-	11645
GM2416	15507	13181	10644	10644	9580	-	12119	12119	11513
GM2477	13321	11323	9144	-	8230	9053	10411	10411	9890
GM4187	10850	9223	7448	7448	6703	7373	8479	8479	8055
GM4239	11414	9702	7835	-	7052	7757	8921	8921	8475
GM4417	10144	8602	6963	6963	6267	6894	7928	7928	7532
KD1418	16580	14093	11380	11380	-	-	-	-	12308
KD3419	11200	9520	7687	7687	6918	7610	8752	8752	8314
KD4273	12203	10373	8376	8376	7538	8292	9536	9536	9059
MS4228	12046	10239	8268	8268	7441	8185	9413	9413	8942
SP270	-	-	-	-	-	9605	11046	11046	10494
SP4454	-	-	-	-	-	7816	8988	8988	8539
TD2424	14471	12300	9932	9932	8939	9833	11308	11308	10743
TD4318	11200	9520	7687	7687	6918	7610	8752	8752	8314
TD4427	10357	8803	7109	7109	6398	7038	8094	8094	7689
UK3485	10926	9287	7499	7499	6749	7424	8538	8538	8111
UK1314	15489	13166	10631	10631	-	10525	-	-	11499
UK3313	12115	10298	8315	8315	7484	8232	9467	9467	8994

Annexure: 8.III-A contd..

(In ₹ per tonne)

Ore Code	Prices as on								
	1.1.2011	1.4.2011	1.7.2011	1.10.2011	1.1.2012	1.4.2012	1.7.2012	1.10.2012	1.1.2013
Ferro Grade									
UK4445	11200	9520	7687	7687	6918	7610	8752	3974	8314
UK3455	-	9777	-	-	-	-	-	-	-
MS2472	15008	-	10301	10301	9271	-	-	11728	-
SP3476	-	-	7480	7480	-	-	-	8516	-
MS1422	14595	-	-	-	-	9918	-	-	-
MS2472	-	-	-	-	-	10198	-	11728	-
SP3476	-	-	-	-	-	7405	-	-	-
TD1482	17134	14564	11760	10584	9363	11642	-	-	-
CH2412	-	-	10403	-	7245	-	-	-	-
CH4207	-	-	8050	8050	6963	-	-	-	-
CH 4263	11272	-	7737	7737	7343	-	-	-	-
CH 4413	-	-	8159	8159	2800	-	-	-	8825
CH 2412	-	-	-	10403	-	-	-	-	-
TD 2423	15140	12869	10392	-	-	-	-	-	-
UK1368	13935	11845	9565	-	-	-	-	-	-
GM 1240	16743	14232	-	-	-	-	-	-	-
MS4317	-	-	-	-	-	-	-	-	6983
Silicomanganese Grade									
SMGR LMP	6903	6213	5489	5489	4830	5313	5977	5977	5678
SMGR SMP	6208	5587	4936	4936	4344	4778	5375	5375	5106
SMGRLMH	7225	6503	5746	5746	5056	5562	6257	6257	5944
SMGRSMH	6475	5828	5149	5149	4531	4984	5607	5607	5327
SMGRDB L	-	-	6031	6031	5307	5838	-	-	6240
SMGRDB S	-	-	5426	5426	4775	5253	-	-	5615
SMGR CHL	-	-	5459	5459	4804	5284	5945	-	-
SMGRBG S	7164	6448	5697	5697	5013	5514	6203	4174	5893

Annexure: 8.III-A contd..

(In ₹ per tonne)

Ore Code	Prices as on								
	1.1.2011	1.4.2011	1.7.2011	1.10.2011	1.1.2012	1.4.2012	1.7.2012	1.10.2012	1.1.2013
Silicomanganese Grade-Low Mn (25%)									
BLL461	4855	4370	3861	3258	2769	2907	3270	3270	3107
BLL492	-	-	-	-	2923	3069	3453	3453	3280
BGL462	4916	4424	3908	3267	2777	2916	3281	3281	3117
CHL442	5396	4856	4290	3620	3077	3231	3635	3635	3453
DBL456	-	-	4022	3620	3077	3231	-	-	3672
DBL457	-	-	3617	3258	2769	2907	-	-	3672
GML464	4855	4370	3861	3258	2769	2907	3270	3270	3107
KDL446	-	-	-	-	3077	3231	3635	3635	3453
MSL447	5396	4856	4290	3439	2933	3069	3453	3453	3280
GML463	6020	5418	-	-	-	-	-	3635	-
BLL 460	5396	4856	4290	3620	3077	3231	3635	-	-
GML463	-	-	4787	-	3077	-	-	-	-
MSL498	-	-	-	-	-	-	-	3270	3107
TDL443	4916	4424	3908	3301	2806	2946	3314	3314	3148
SPL463	-	-	4117	3439	-	-	-	-	-
UKL448	4656	4190	3702	2940	2499	2624	2952	2952	2804
TDL499	-	-	-	-	-	-	-	-	3117
Silicomanganese Grade-Low Mn (20%)									
TDL 469	3933	3540	3127	-	-	-	-	-	-
Fines									
BGF452	3518	3518	3342	3342	2674	2808	3159	3159	3001
BLF496	-	-	-	-	2340	2457	2764	2764	2626
CHF473	2347	2347	2230	2230	1784	1873	2107	2107	2002
DBF474	3507	-	-	-	-	2799	3149	3149	2992
DBF475	5509	-	-	-	4187	4396	4946	4946	4699
DBF487	3274	3274	3110	3110	2488	2612	2939	2939	2792

Annexure: 8.III-A contd..

Annexure: 8.III-A concld..

(In ₹ per tonne)

Ore Code	Prices as on								
	1.1.2011	1.4.2011	1.7.2011	1.10.2011	1.1.2012	1.4.2012	1.7.2012	1.10.2012	1.1.2013
Fines									
GMF449	3944	3944	3747	3747	2998	3148	3542	3542	3365
GMF465	2707	2707	2572	2572	2058	2161	2431	2431	2309
KDF393	3311	3311	3145	3145	2516	2642	2972	2972	2823
MSF479	3792	3792	3602	3602	2882	3026	3404	3404	3234
SPF486	3120	3120	2964	2964	2371	2490	2801	2801	2661
TDF488	3120	3120	2964	2964	2371	2490	2801	2801	2661
BLF 467	3684	3684	3500	3500	-	-	-	-	-
UKF495	-	-	-	-	1658	1741	1959	1959	1861
UK F450	2498	2498	2373	2373	-	-	-	-	-
BLF 373	4299	-	-	-	-	-	-	-	-
Chemical Grade									
DB3385	11938	11222	10661	9595	8156	8972	10094	10094	9589
DB3494	-	-	-	-	5231	5754	6473	6473	3149
DB2320	14627	13749	13062	11756	9993	-	-	-	-

Annexure: 8.III-B

Prices of Manganese Ore Marketed by MOIL (From 1.1.2009 to 1.10.2010)

(In ₹ per tonne)

Ore Code	Prices as on							
	1.1.2009	1.4.2009	1.7.2009	1.10.2009	1.1.2010	1.4.2010	1.7.2010	1.10.2010
Ferro Grade								
BG102	13405	13405	9725	12750	15938	19126	20082	19078
BG 1408	12348	12348	8958	11744	14680	17616	18497	17572
BG1466	11834	11834	8585	11255	14069	16883	17727	16841
BL2409	8593	8593	8593	11265	14081	16897	17742	16855
BL3480	-	-	6007	7875	9844	11813	12404	11784
BL4206	6674	6674	6674	8750	10938	13126	13782	13093
CH4263	6246	6246	-	-	10236	12283	12897	12252
CH4413	6586	6586	6586	8634	10793	12952	13600	-
DB2268	8288	8288	8288	10865	13581	16297	17112	-
DB2367	8692	8692	8692	11395	14244	17093	17948	-
GM1240	-	-	9277	-	15204	18245	-	18199
GM2416	8593	8593	8593	11265	14081	16897	17742	16885
GM2477	-	-	7382	-	12096	14515	-	14479
GM4187	6012	6012	6012	7882	9853	11824	12415	11794
GM4239	6324	-	6324	-	10364	12437	13059	12406
GM4417	5621	5621	5621	7369	-	11053	11606	11026
KD1418	9188	9188	9188	12045	15056	18067	18970	18022
KD3419	6207	7736	6207	8137	10171	12205	12815	12174
KD4273	6762	6762	6762	8865	11081	13297	13962	13264
MS4228	6674	6674	6674	8750	10938	13126	13782	13093
MS1422	-	-	8087	10602	13253	15904	16699	15864
MS4317	5212	-	5212	6833	-	10249	10761	-
SP270	7833	-	-	-	-	-	-	-
TD2424	8019	8019	8019	10513	13141	15769	16557	15729
TD4318	6207	6207	6207	8137	10171	12205	12815	12174

Annexure: 8.III-B contd..

(In ₹ per tonne)

Ore Code	Prices as on							
	1.1.2009	1.4.2009	1.7.2009	1.10.2009	1.1.2010	1.4.2010	1.7.2010	1.10.2010
Ferro Grade								
TD4427	5739	5739	5739	7524	9405	11286	11850	11258
UK3485	-	-	-	-	-	-	12501	11876
UK1314	8583	8583	-	11252	14065	16878	17722	16836
UK1368	7722	7722	7722	10123	12654	-	15944	15147
UK3313	1612	6713	6713	8801	11001	13201	13861	13168
UK4445	1333	6207	6207	8137	10171	12205	12815	12174
KD2272	7736	-	-	-	-	-	-	-
MS2472	8316	-	8316	10902	13628	16354	-	16313
TD1482	-	-	-	-	-	18670	-	18624
UK3455	6373	6373	6373	8355	10444	12533	-	12502
BL2410	7385	7385	7385	9682	12103	14524	15250	-
BL3243	8204	8204	-	10756	13445	16134	16941	-
CH4207	6499	-	-	6499	10650	12780	13419	-
SP3476	-	-	6039	-	9896	11875	12469	-
TD2423	8389	8389	8389	10998	13748	16498	17323	-
KD2272	-	-	-	-	-	15211	-	-
CH2412	8399	-	-	-	-	-	-	-
TD3261	7833	-	-	-	-	-	-	-
Silicomanganese Grade								
SMGR LMP	3910	3910	3519	4856	6070	7284	7648	7266
SMGR SMP	3516	3516	3164	4367	5459	6551	6879	6535
SMGR LMH	4092	4092	3683	5082	6353	7624	8005	7605
SMGR SMH	3668	3668	3301	4555	5694	6833	7175	6816
SMGRDB L	4296	4296	3866	5335	6669	8003	8403	-
SMGRDB S	3865	3865	3479	4801	6001	7201	7561	-
SMGRBG S	-	4058	3652	5090	6300	7560	7938	7541

Annexure: 8.III-B contd..

(In ₹ per tonne)

Ore Code	Prices as on							
	1.1.2009	1.4.2009	1.7.2009	1.10.2009	1.1.2010	1.4.2010	1.7.2010	1.10.2010
Silicomanganese Grade-Low Mn (20%)								
BLL460	3056	3056	2750	-	4745	5694	5979	5680
BLL461	2751	2751	2476	-	-	5124	-	5111
BGL462	2784	2784	-	-	-	5188	-	5175
CHL442	3056	3056	2750	-	4745	5694	5979	5680
DBL456	2864	2864	2578	-	4448	5338	5605	-
DBL457	2577	2577	-	-	4000	4800	5040	-
GML464	2751	2751	2476	-	4270	5124	5380	5111
KDL446	3410	3410	3069	-	5294	6353	6671	-
MSL447	-	-	-	-	-	-	5979	5680
TDL443	2784	2784	2506	-	4323	5188	5447	5175
UKL448	2637	2637	-	-	4094	4913	5159	4901
UKL471	2227	-	-	-	-	-	-	-
GML463	3410	3410	3069	-	5294	6353	6671	6337
SPL463	2932	2932	2639	-	4553	5464	5737	5450
Silicomanganese Grade-Low Mn (20%)								
DBF458	1907	-	-	-	-	-	-	-
TDL469	2227	2227	2024	-	3458	4150	4358	4140
MSL470	2323	2323	-	-	-	-	-	-
Fines								
BGF452	1793	1793	1793	2474	3093	3714	3898	3703
CHF473	-	1196	1196	1650	2063	2476	2600	2470
DBF474	-	1788	1788	2467	3084	3701	3886	3692
DBF475	-	2808	2808	3875	4844	5813	6104	5799
DBF487	-	-	-	-	-	-	-	3446
GMF449	2010	2010	2010	2774	3468	4162	4370	4152
GMF465	1380	-	1380	1904	2380	2856	2999	2849

Annexure: 8.III-B contd..

Annexure: 8.III-B concld..

(In ₹ per tonne)

Ore Code	Prices as on							
	1.1.2009	1.4.2009	1.7.2009	1.10.2009	1.1.2010	1.4.2010	1.7.2010	1.10.2010
KDF393	1688	1688	1688	2329	2911	3493	3668	3485
MSF479	-	-	1933	2668	3335	4002	4202	3992
BLF467	1878	1878	1878	2592	3240	3888	4082	3878
TDF453	1818	1818	1818	2509	3136	3763	3951	3753
UKF450	1273	1273	1273	1757	2196	2635	2767	2629
BLF373	2191	-	2191	3024	-	4536	4763	-
CHF364	1334	-	-	-	-	2761	-	-
MSF406	2191	2191	-	-	-	4536	-	-
UKF362	2095	2095	2095	2891	-	4337	-	-
SPF486	-	-	-	-	-	-	-	3284
Chemical Grade								
DB3385	6598	6598	6598	8650	10813	12976	12976	12976
DB2320	8084	8084	8084	10599	13249	15899	15899	15899

Annexure: 8.III-C

Prices of Manganese Ore Marketed by MOIL (From 1.1.2007 to 1.10.2008)

(In ₹ per tonne)

Ore Code	Prices as on							
	1.1.2009	1.4.2009	1.7.2009	1.10.2009	1.1.2010	1.4.2010	1.7.2010	1.10.2010
Ferro Grade								
BG102	4990	5364	8046	8851	24100	26269	27582	29789
BG 1408	4595	4940	7409	8150	22200	24198	25408	27441
BG2181	4435	4768	7151	7866	-	-	-	-
BG1466	-	-	-	-	21275	23190	24350	26298
BL2409	4410	4741	7111	7822	12124	18186	19095	19095
BG1211	4685	-	-	-	-	-	-	-
BL4206	3425	3682	5523	6075	9416	14124	14830	14830
CH4413	3380	3634	5450	5995	9292	13938	14635	14635
DB2268	-	4572	6858	7544	11693	17540	-	18417
DB2367	-	4795	-	7912	12264	18396	-	19316
GM2416	4410	4741	7111	7822	12124	18186	19095	19095
GM4187	3085	3316	4975	5473	8483	12725	13361	13361
BG3376	3810	-	-	-	-	-	-	-
GM4417	2885	3101	4652	5117	7931	11897	12492	12492
GM330	3655	-	5894	-	6483	10049	-	15828
KD1418	4715	5069	7603	8363	12963	19445	20417	20417
KD3419	3185	3424	5136	5650	8758	13137	13794	13794
KD4273	3470	3730	5595	6155	9540	14310	15026	15026
MS4228	3421	3682	5523	6075	9416	14124	14830	14830
MS4317	2675	2876	4313	4744	7353	11030	11582	11582
SP270	4020	4322	-	7130	11052	16578	-	-
TD4428	2945	3166	-	5224	-	-	-	-
TD2424	4115	4424	6635	7299	11313	16970	17819	17819
TD2425	3705	3983	5974	6571	10185	-	-	-
TD4318	3185	3424	5136	5650	8758	13137	13794	13794

Annexure: 8.III-C contd..

(In ₹ per tonne)

Ore Code	Prices as on							
	1.1.2009	1.4.2009	1.7.2009	1.10.2009	1.1.2010	1.4.2010	1.7.2010	1.10.2010
Ferro Grade								
TD2423	4305	4628	6942	7636	11836	17754	-	18642
TD4427	2945	3166	4749	5224	8097	12146	12753	12753
TD3261	4020	4322	-	7130	-	-	-	-
UK1314	4405	4735	7103	7813	12110	18165	19073	19073
UK3313	3445	3703	5555	6111	9472	14208	14918	14918
UK4445	3185	3424	5136	5650	8758	13137	-	13794
UK2236	4210	-	-	-	-	-	-	-
UK4444	3185	-	-	-	-	-	-	-
UK1398	4595	-	-	-	-	-	-	-
BL2410	3790	4074	6111	6722	10419	15629	16410	16410
BL3243	4210	4526	6189	7468	11575	17363	18231	18231
CH2412	4310	4633	6950	7645	11850	17775	18664	18664
CH4207	3335	3585	5378	5916	9170	13755	14443	14443
CH4263	3205	3445	5168	5685	8812	13218	13879	13879
KD2272	3970	4268	6402	7042	10915	16373	17192	17192
MS2472	-	-	-	-	-	-	18479	18479
UK3455	-	3516	5274	5801	8992	13488	14162	14162
UK1368	-	4260	6390	7029	10895	16343	17160	17160
UK4315	3270	3515	5273	5800	8990	-	-	-
DB4402	-	4237	-	6992	-	-	-	-
TD3426	3445	3703	-	6111	-	-	-	-
MS1422	4150	4461	6692	7361	11410	17115	-	-
SP1321	4500	4838	-	7982	-	-	-	-

Annexure: 8.III-C contd..

(In ₹ per tonne)

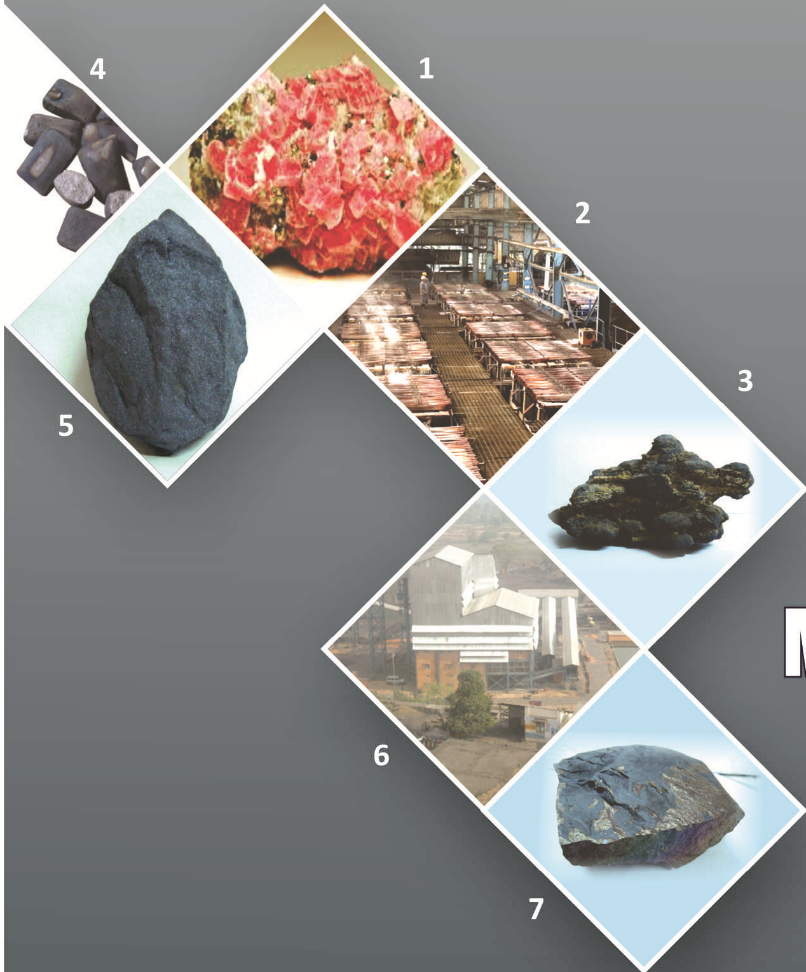
Ore Code	Prices as on							
	1.1.2009	1.4.2009	1.7.2009	1.10.2009	1.1.2010	1.4.2010	1.7.2010	1.10.2010
Silicomanganese Grade								
SMGR LMP	2580	2774	4160	4576	7093	10640	11172	11172
SMGR SMP	2320	-	3741	4115	6378	9567	10045	10045
SMGR LMH	2700	2903	4354	4789	7423	11135	11692	11692
SMGR SMH	2420	2620	3902	4292	6653	9980	10479	10479
SMGRDB L	2835	3048	-	5028	7793	11690	-	12275
SMGRDB S	2550	2741	4112	4523	7011	10517	-	11043
KDL446	1690	1817	2725	2998	-	9279	9743	9743
MSL447	1760	1892	2838	3122	4839	8316	8732	8732
TDL443	1620	1742	2612	2873	4453	7574	7953	7953
UKL448	1520	1634	2451	2696	4179	7176	7535	7535
Silicomanganese Grade-Low Mn (25%)								
BLL461	-	-	-	2966	4597	7485	7859	7859
BGL462	-	-	2722	2994	4641	7574	7953	7953
CHL442	1520	1634	2451	2696	4179	8316	8732	8732
DBL456	-	-	2838	3122	-	-	8183	8183
DBL457	-	-	2696	2966	-	-	-	7362
GML464	-	-	-	2966	4597	-	7859	7859
BLL460	-	-	-	3122	4839	8316	8732	8732
GML463	-	-	-	3122	4839	-	9743	9743
SPL 463	-	-	2721	2993	4639	-	8378	8378

Annexure: 8.III-C contd..

Annexure: 8.III-C concld..

(In ₹ per tonne)

Ore Code	Prices as on							
	1.1.2009	1.4.2009	1.7.2009	1.10.2009	1.1.2010	1.4.2010	1.7.2010	1.10.2010
Silicomanganese Grade-Low Mn (20%)								
MSL470	-	-	-	-	-	-	-	6637
TDL469	-	-	-	-	-	-	-	6362
UKL471	-	-	-	-	-	-	-	6362
Fines								
BGF451	2165	2327	3491	3840	5952	-	-	-
BGF452	1035	1113	1669	1836	2846	4269	5123	5123
BLF373	1263	1360	2040	2244	3478	5217	6260	6260
CHF364	770	828	1242	1366	2117	3176	3811	3811
DBF357	1760	1892	2838	3122	4839	7259	-	-
DBF382	1100	1183	-	-	-	-	-	-
GMF449	1160	1247	1871	2058	3190	4785	5742	5742
GMF80	1290	-	-	-	-	-	-	-
KDF393	975	1048	1572	1729	2680	4020	4824	4824
MSF406	1265	1360	2040	2244	3478	5217	6260	6260
TDF453	1050	1129	1696	1862	2886	4329	5195	5195
UKF362	1210	1301	1951	2146	3326	4989	5987	5987
UKF369	1245	1338	-	2209	-	-	-	-
UKF450	735	790	1185	1304	2021	3032	3638	3638
GMF465	-	-	-	1413	2190	-	3942	3942
BLF467	-	-	-	-	-	-	5366	5366
DBF458	-	-	1775	1953	3027	4541	5449	5449
Chemical Grade								
DB3385	3300	3300	4950	5445	8440	13965	14663	14663
DB167	7000	7000	8718	9590	-	-	-	-
DB2320	4460	4460	6690	7359	11406	17109	17964	17964



Market Survey on Manganese Ore

Key to the cover page photographs

1. Manganese Dioxide Ore, Dongri Buzurg Mine, MOIL
2. EMD Plant, Dongri Buzurg, MOIL
3. Rhodochrosite
4. Ferro Manganese, Balaghat, MOIL
5. IMB Plant, Balaghat, MOIL
6. Manganese Ore lumpy, Balaghat, MOIL
7. Manganese Pellets

भारतीय खान ब्यूरो
INDIAN BUREAU OF MINES
सतत कार्यरत
ON WITH THE JOB

GOVERNMENT OF INDIA
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INDIAN BUREAU OF MINES
NAGPUR