

## Quadrant II – Transcript and Related Materials

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### Notes

## Manganese Deposits of India

**Introduction:** - Manganese ores are of vital importance in industrial economy as it is an essential constituent of steel and so far no satisfactory substitute is found yet. Manganese constitute 0.5 to 0.75 % of the steel. India is one of the chief producer of the Manganese ore and it has the deposits surplus than its domestic demands and its ore is one of the chief foreign exchange earner.

**Mineralogy:** - Manganese occurs in nature in the variety of forms such as oxides, hydrated oxides, carbonate and silicate.

The chief manganese ore minerals are

**Oxides:** -

1. Pyrolusite -  $\text{MnO}_2$ , containing 63.2 % of Mn
2. Psilomelane -  $\text{Mn}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$  with  $\text{H}_2\text{O}$ , Ba, Na, K containing 45-60 % of Mn
3. Wad – impure hydrated variety of Pyrolusite and Psilomelane
4. Braunite –  $(2\text{Mn}_2\text{O}_3 \cdot \text{MnSiO}_2)$  containing  $\text{Mn}_2\text{O}_3$  + 10 %  $\text{SiO}_2$  (Mn 65%)
5. Manganite -  $\text{Mn}_2\text{O}_3 \cdot \text{H}_2\text{O}$ , containing 62.4 per cent of Mn

6. Hollandite -  $\text{MnO}_2 + \text{Ba}$  and Fe oxide

7. Sitaparite –  $(\text{MnFe})_2\text{O}_3$  with CaO

**Carbonate: -**

1. Rhodochrosite,  $\text{MnCO}_3$ , containing 47.6 per cent of Mn

**Silicates: -**

1. Rhodonite –  $\text{MnSiO}_3$

2. Spessertite –  $3\text{MnO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{SiO}_2$

**Classification:**

In nature Manganese and Iron generally occur together substituting each other in various proportions.

According to the composition of Manganiferous ores in regard to the proportion of Manganese to Iron.

The following terminologies are used in trade and industry.

- i) Manganese ore – over 40% Mn.
- ii) Ferruginous Manganese ore – 10 – 40% Mn.
- iii) Manganiferous Iron ore – 5 – 10% Mn.
- iv) Iron ore- less than 5% Mn.

For trading purpose Indian Manganese ores are classified in following grades.

**Chemical Grade: -** 1) Peroxide Grade containing 78%  $\text{MnO}_2$ , 4%Fe

**Metallurgical Grades:**

- 1. High grade > 48 % of Mn.
- 2. Medium grade 45-48 % of Mn.
- 3. Low grade < 45 % of Mn.

**Geological Occurrence and Origin.**

Manganese ore may belongs to any one of the following kinds:

- 1. Hydrothermal deposits
- 2. Sedimentary deposits
- 3. Residual Concentrations
- 4. Magmatic deposits
- 5. Metamorphosed deposits

Most of the world's supply of manganese ores, however, are from sedimentary and residual deposits.

- 1) Hydrothermal Deposits formed by magmatic hot water solutions (associated with Koduritic ore in Andhra Pradesh).
- 2) Sedimentary Deposits formed in sea & lakes by chemical and mechanical action.
- 3) Residual Deposits formed by leaching out of gangue minerals from the pre-existing manganese bearing rocks or deposits, leaving behind a residual concentration of Manganese ore. (Lateritized deposits of Bihar and Orissa in India)
- 4) Metamorphosed deposits formed by the intense alteration by heat and pressure of manganiferous sediments. (e.g. Gonditic deposits of M.P.)
- 5) Nodules on sea bed either by chemical precipitate or bacteriogenic as found on the present day sea bed.

Most of the Indian major Mn ore deposits occur as bedded sedimentary (metamorphosed) deposits associated with Gondite series (Archaean) as in M.P., Maharashtra, Gujarat & Orissa. Gondite rocks were formed by intense metamorphism of manganiferous sediments, sands and clays. These were transformed into Quartzites, Phyllites and manganese ores and the mixture into Gondite series.

Some large deposits are found associated with Kodurite series (Archaean) in Orissa and Andhra Pradesh. These rocks consist of Feldspar: spessertite  $Mn_3Al_2(SiO_4)_3$  – andradite  $Ca_3Fe_2(SiO_4)_3$  – garnet, Rhodonite  $MnSiO_3$ , Quartz and apatite. These are believed to be Hybrid rocks produced by assimilation of Mn ore and Mn silicate rocks by an acid igneous magma.

Next important to bedded deposits are lateritoid Deposits. These are delivered from the underlying Archaean manganiferous rocks or ore deposits and are associated with iron ores. These manganese deposits contain appreciable quantity of iron ore in it. Such deposits occur in Bihar, Karnataka, Orissa and Rajasthan.

Less important are the deposits of secondary manganese oxides occurring as Veins, Nodules Lenticles or irregular replacement masses in Phyllites, Schists, Limestones and Quartzites. Such deposits occur in Bihar, Karnataka, Orissa and Rajasthan. These may have been formed by segregation

of Mn from adjacent rocks or the source of Mn may be deep seated and connected with igneous activity as in veins of Rhodochrosite  $\text{MnCO}_3$ .

## **Uses:**

Manganese is one of the important ferroalloy metals. About 95 % manganese produced in the world is used in steel making in which the chief purpose is to remove oxygen and sulphur in order to produce a sound and clean metal.

Manganese steels are used where hardness and toughness are desired such as in armour plates, car-wheels, cutting and grinding machinery, etc.

The manganese ores of high purity is used for dry batteries, the glass industry, paints, pigments, dyes and fertilizers. It is also used for the manufacture of bromine, chlorine, oxygen, permanganates and manganese compounds.

### **I) Most important use of manganese is in metallurgy.**

- 1) **Steel Industry:** for the purpose to remove oxygen from the molten steel, or as a reducing agent. To combine with sulphur and to improve the workability of steel to restore to steel the necessary carbon, to increase strength, toughness and wearing qualities of special steels.
- 2) **Non-ferrous Industry:** Manganese metal is used as a deoxidiser and to improve physical properties like strength and ductility to various alloys.

### **II) Non metallurgical uses of manganese ores are**

- 1) In dry –cell batteries  $\text{MnO}_2$  is used as a depolarizer.
- 2) Used in the manufacture of driers for paints and varnishes.
- 3) In ceramics it is used as a colouring agent.
- 4) In glass industry, when used in large quantity it imparts various colours but when used in small quantity it acts as a bleaching (decolourising) agent.
- 5) In chemical industry Mn is for the production of permanganate and many other chemicals.

## **Geographic Distribution in India:**

- 1) Orissa (44%)
- 2) Karnataka (22%)

- 3) Madhya Pradesh (13%)
- 4) Maharashtra (8%)
- 5) Andhra (4%)
- 6) Jharkhand and Goa (3%)
- 7) Rajasthan, Gujarat and West Bengal (3%)

### **Modes of occurrence and Origin**

#### **Indian Occurrences**

Extensive and rich manganese deposits occur in Madhya Pradesh, Tamil Nadu, Bihar, Orissa, Maharashtra and Karnataka states of India.

India's production of manganese comes 45 per cent from Madhya Pradesh, 25 per cent from Orissa, 12 per cent from Maharashtra and rest of India's production come from Andhra, Bihar, Rajasthan, Tamil Nadu and Mysore.

Manganese ores of India occur as three different types:

1. **The Regionally Metamorphosed deposits:** Deposits in Pre-Cambrian metamorphosed sedimentary rocks, e.g., Gondites and were probably originally laid down as sediments now consisting of primary Braunitite and manganese silicate or of supergene oxidation product of these primary materials. Most of the Madhya Pradesh manganese ores belong to this type.
2. **Residual deposits:** As lateritic or superficial deposits derived by the concentration of manganese during weathering of manganiferous sediments. Most of the Bihar and Orissa ores belong to this type.
3. **As Irregular pocket deposits** e.g., those associated with the kodurites, occurring within the khondalite series of rocks, e.g., Andhra Pradesh Manganese ores.

#### **Manganese ores of Madhya Pradesh**

The manganese ore deposits of Madhya Pradesh occur in an arcuate belt of the country about 130 miles long and ranging in width up to 16 miles and occurring almost at the centre of India, half way between Calcutta and Bombay, in the main Calcutta-Bombay railway line.

General Geology and Stratigraphy: the host rocks to the manganese deposits of Madhya Pradesh are the Sauser series Pre – Cambrian rocks which are a group of intensely deformed and metamorphosed sediments. These rocks have been profusely intruded by granites, gneisses and pegmatites and are overlain by the Lameta formation and the Deccan Traps at some places.

Out of the Sauser series of rocks the Mansar formation is the richest manganese bearing formation. These are some manganese deposits also in the lower Lohangi formation and also in the upper Chorbauli formation.

**Structure:** The regional structural bend of the Sauser series of rocks is East-west and the manganese belt generally follows this trend. The structure is very complex, the rocks having been affected by several major periods of folding and faulting as follows:

- (a) Folding on the East-west axes, ultimately developing in isoclinal folds.
- (b) Refolding of the folds of (a) about axes strongly transverse to parallel axes.
- (c) Large scale recumbent folding; developing at some places Nappe-structures.

The granite gneisses are generally syntectonic while the unfoliated discordant granite plutons, pegmatites and quartz veins are Post-tectonic. The structural deformation of the Sauser series of rocks was accompanied by regional metamorphism ranging in grade from high to low.

#### 1. **Lode deposits**

A. Hypogene or primary deposits:

1. Braunite deposits with or without subordinate manganese silica.
2. Gondite deposits: Quartzites with Spessartite and rhodonite and with some other manganese bearing silicates, some Rhodochrosite and subordinate Braunite.

B. Supergene or secondary deposits:

1. Oxidised Braunite deposits
2. Oxidised Gondite deposits.

#### **11. Detrital or Boulder ore deposits:**

These consist mainly of transported boulders and pebbles of manganese oxides usually derived from the lode deposits.

The lode deposits supply over 90 per cent of the manganese ores, out of which the major production comes from the hypogene types and some production about 25 per cent from the supergene type.

**Relation to host rocks:** The manganese lodes are tabular conformable lenses which occupy three general stratigraphic positions all in close association with Mansar series. The uppermost stratigraphic horizon, in which the manganese deposits occur, is the chorbaoli formation while there are some good deposits in lower Lohangi formation.

### **Andhra Pradesh and Orissa**

The manganese ores of Andhra Pradesh and Orissa occur associated with lime – stones, schists, gneisses and granites. The Koduritic ore composed of pyrolusite, psilomelane, spessarite, braunite, manganese-pyroxenes, quartz and feldspar. This type of manganese ores were formed as a result of reaction between an invading granitic magma and the invaded crystalline rocks of Archaean age such as limestones, schists and gneisses. This Koduritic ore deposits are found in Srikakulam district of Andhra Pradesh and Ganjam and Koraput districts of Orissa.

The lateritoid deposits occur in Keonjhar and Bonai districts of Orissa in the form of lateritoid replacement masses on the rocks of Dharwar age. The ores are psilomelane, pyrolusite and wad.

### **Karnataka**

The lateritoid deposits are secondary surface replacements, widely distributed in Karnataka. The deposits occur within the country rocks of Dharwarian age. The ores generally form irregular bodies confined to the zone of weathering. The manganese minerals of the deposits are psilomelane, pyrolusite and wad with some limestone.

### **Bombay and Goa**

The lateritoid deposits are found in Bombay district of Maharashtra. The ores occur as irregular bodies with schists and phyllites of Dharwar age. The ore – minerals psilomelane, pyrolusite and wad.

The manganese ores of Goa occur as pockets in manganiferous shales. The manganese ores are found in Bardez, Sanguem and few other districts of Goa with high grade iron ores.

### **Bihar**

The lateritoid deposits are found in Barajamda of Singhbhum district in Jharkhand. The manganese ores of the area occur as pockets in manganiferous, ferruginous shales. The manganese ores of the area are psilomelane and pyrolusite with iron ores.