MANGANESE

BY

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INTRODUCTION

• Mn metal was discovered by a Swedish Chemist J. Gahn in 1774.
• In 1774, this metal was isolated by Scheeli.
• Commercially exploitable deposits of manganese occur both on the continent and on the floors of present day marine and lacustrine basins.
• India is recognized as the 4th largest producer of Manganese ore in the world (2010) with about 5.6 million tonnes of production in a year.

• It is widely distributed in the earth’s crust in the form of oxides, carbonates and silicates and produced by electolysis or reduction of its oxides (Thermit process).
INTRODUCTION

• The metal is derived from the weathering of crustal rocks or volcanic exhalations and is deposited on the ocean floor, consumed in the subduction zones riding on the oceanic crust and is recycled to form new igneous rocks and associated ore bodies.
Many manganese deposits now resting on the continents have been recognized as having originally formed the ocean floor and thus a connecting bridge between the deposits on the continents and those occurring on ocean floors has been established.
USE

• Manganese is essential to iron and steel production by virtue of its sulfurfixing, deoxidizing and alloying properties.

• Manganese alloy is the largest produced ferro-alloy in the world with a share of about 41% of the global production of ferro-alloys.
• In the chemical industry, generally high-grade material is used for potassium permanganate.
• Manganese sulphide is used in the manufacture of salts and in calico printing.
• Manganese chloride is used in cotton textile as a bronze dye. Manganese salts are used in photography and in leather and matchbox industries.
• Manganese dioxide is used for manufacturing dry cell batteries in which it functions as a depolariser of hydrogen.

• Manganese dioxide has been used since antiquity to neutralize the greenish tinge in glass caused by trace amounts of iron contamination.

• Manganese is also used as a brown pigment that can be used to make paint and is a constituent of natural umber.
• Manganese compounds have been used as pigments and for the coloring of ceramics and glass.

• Manganese also finds use as driers for oils, varnishes and paints. Manganese is an essential trace nutrient in all known forms of life.
MINERALOGY
### Chemical Composition of the Important Manganese Minerals

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Formula Description</th>
<th>Source(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Higher Oxides</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrolusite</td>
<td>$\text{MnO}_2$</td>
<td></td>
</tr>
<tr>
<td>Ramsdellite</td>
<td>$\text{MnO}_2$</td>
<td></td>
</tr>
<tr>
<td>Cryptomelane</td>
<td>$K \text{Mn}<em>8\text{O}</em>{16}$ (Richmond &amp; Fleischer, 1942)</td>
<td></td>
</tr>
<tr>
<td>Psilomelane</td>
<td>$(\text{Ba}, \text{H}_2\text{O})_2 \text{Mn}<em>5\text{O}</em>{10}$ (Wadsley, 1952, 1953)</td>
<td></td>
</tr>
<tr>
<td>NsuTite</td>
<td>$\text{Mn}_1-x^4+\text{Mn}_x^2+ 2O_2-2x(\text{OH})_2x$ WHERE $x = 0.06-0.07$ (F-MnO$_2$) (Zwickler et al., 1962)</td>
<td></td>
</tr>
<tr>
<td>Birnessite</td>
<td>$(\text{Na}, \text{Ca}) \text{Mn}<em>7\text{O}</em>{14} \cdot 2.8 \text{H}_2\text{O}$ (Jones and Milne, 1956)</td>
<td></td>
</tr>
<tr>
<td>(δ-MnO$_2$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Todorokite</td>
<td>$(\text{Mn}, \text{Ca}) \text{Mn}_3\text{O}_7 \cdot 2\text{H}_2\text{O}$ (Larson, 1962)</td>
<td></td>
</tr>
<tr>
<td>Manganite</td>
<td>$\beta$-$\text{MnOOH}$</td>
<td></td>
</tr>
<tr>
<td><strong>Hydroxides</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feitknechtite</td>
<td>$\beta$-$\text{MnOOH}$ (Bricker, 1965)</td>
<td></td>
</tr>
<tr>
<td>Pyrochroite</td>
<td>$\text{Mn} (\text{OH})_2$</td>
<td></td>
</tr>
<tr>
<td>Hollandite</td>
<td>$\text{BeR}<em>8\text{O}</em>{16}$; R = Mn$^4+$ MAINLY, ALSO Mn$^2+$, Fe, Co (Richmond &amp; Fleischer, 1943)</td>
<td></td>
</tr>
<tr>
<td>Braunite</td>
<td>$3 \text{Mn}_2\text{O}_3$. MnSiO$_3$ or Mn$^2+$ (Mn$^4+$ Si$^4+$)O$_3$ (Muan, 1959)</td>
<td></td>
</tr>
<tr>
<td><strong>Lower Oxides</strong></td>
<td></td>
<td></td>
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<tr>
<td>Bixbyite</td>
<td>$(\text{Mn}, \text{Fe})_2\text{O}_3$</td>
<td></td>
</tr>
<tr>
<td>Jacobsite</td>
<td>$\text{MnFe}_2\text{O}_4$</td>
<td></td>
</tr>
<tr>
<td>Hausmannite</td>
<td>$\text{Mn}_3\text{O}_4$</td>
<td></td>
</tr>
<tr>
<td><strong>Silicates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neotocite</td>
<td>$(\text{Mn}, \text{Fe}) \text{SiO}_3 \cdot n \text{H}_2\text{O}$</td>
<td></td>
</tr>
<tr>
<td>Bementite</td>
<td>$(\text{Mn}, \text{Mg}, \text{Fe})_6 \text{Si}_4(\text{O}, \text{OH})_6$ (Donnay et al., 1963)</td>
<td></td>
</tr>
<tr>
<td>Rhodonite</td>
<td>$\text{MnO}_2 \cdot \text{SiO}_2$</td>
<td></td>
</tr>
<tr>
<td>Tephroite</td>
<td>$2\text{MnO} \cdot \text{SiO}_2$</td>
<td></td>
</tr>
<tr>
<td><strong>Carbonate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhodochrosite</td>
<td>$\text{MnCO}_3$</td>
<td></td>
</tr>
<tr>
<td><strong>Sulphide</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alabandite</td>
<td>$\text{MnS}$</td>
<td></td>
</tr>
</tbody>
</table>
• Genesis of manganese ore is believed to have occurred due to precipitation from hydrothermal solutions (volcanogene-sedimentary deposit) or by sedimentary processes (non-volcanogene-sedimentary deposit).
• India is one of the largest producers of manganese ore in the world. The distribution of manganese ore resources production of Manganese ores in India is given in Fig.

• Manganese ore deposits of India can be classified into two major genetic types viz; (a) Volcanogene-sedimentary and (b) Non-volcanogene sedimentary.
DISTRIBUTION

• Manganese deposits of India range in age from late Archaean (~3000 Ma.) to middle Proterozoic (~900 Ma.) and are distributed in the states of Jharkhand, Orissa, Andhra Pradesh, Karnataka, Rajasthan, Madhya Pradesh, Maharashtra, Goa and Gujarat.
The manganese deposits of India are found in association with the following groups of Precambrian supracrustal rocks:

- Iron ore group (2950 – 3200 Ma.)
- Dharwar supergroup (2900 – 2600 Ma.)
- Khondalite group (2650 – 1600 Ma.)
- Aravalli supergroup (950 – 1500 Ma.)
- Champner supergroup (950 – 1500 Ma.)
- Sausar group (846 – 986 Ma.)
- Gangpur group (846 – 945 Ma.)
- Penganga beds (846 – 945 Ma.)
TEXTURAL FEATURES

Manganese ores commonly exhibit the following textural features:

• **STALACTITIC**: Elongated forms of manganese minerals deposited from solution by slowly dripping water (Fig.1).

• **BANDED**: Containing alternate bands of silicate mineral and manganese ore (Fig.2).

• **BEDDED ORE**: Consisting of alternate layers of host rock and manganese ore (Fig.3).

• **OOLITIC/PISOLITIC**: Spherical grains of manganese minerals composed of concentric layers of diameter 0.25–2 mm are oolites; rocks composed of concentric layers larger than 2 mm are called pisolites (Fig.4).

• **CAVITY FILLING**: Growth of crystals on the walls of planar fractures in rocks, with the crystal growth generally occurring normal to the walls of the cavities (Fig.5).
Genesis of manganese ore is believed to have occurred due to precipitation from hydrothermal solutions (volcanogene-sedimentary deposit) or by sedimentary processes (non-volcanogene-sedimentary deposit).

**Volcanogene-sedimentary deposit:** Formation of manganese deposits of different geological ages from hydrothermal fluid has been suggested. This is supported by occurrence of many deposits at or near active seafloor spreading centers, such as mid-Atlantic, mid-Indian, pacific-Antarctic ridges and sea floor bottom fractures zones. The seawater may act as a metasomatic fluid and substantial leaching of heavy metals by seawater, followed by their precipitation on re-emergence on the ocean floor has been visualized.
Deposition of hydrothermal manganese- and iron - manganese oxides may either take place by direct precipitation from hypogene fluid forming hydrothermal deposits, or through interaction of the hypogene fluid and the basinal waters, leading ultimately to hydrogenous precipitation.
Non-volcanogene-sedimentary deposit:
The process of chemically controlled sedimentation is responsible for the formation of the vast majority of the manganese deposits in recent and ancient geological sequences. The major sources of metals are identified as fluids derived from endogenous system (mainly submarine volcanism and circulation of water at considerable depth) and exogenous processes of weathering of pre-existing rocks.
Where *endogenous systems* provide the source and manganese deposits are ultimately formed by the process of sedimentation in a *hydrodynamic regime*, the term *volcanogenic-sedimentary* is used. Such deposits exhibit characteristic sedimentary features and *conformable interstratification*. 
• For sedimentary deposits formed in a regime devoid of effects of volcanism and through derivation of metals from weathering zones situated either on the continents or on the seafloor, the term non-volcanogene sedimentary is applied.

• Studies in the present-day marine and lacustrine basins have clearly demonstrated that in most cases no single source or mechanics, by itself, could give rise to manganese deposits.
• Frequently, metasedimentary manganese oxide ore bodies and manganese silicate rocks show an intimate and conformable relationship in a syngenetic sequence, although one may also occur in the absence of the other.

• Supergene concentration process at or near the surface in the weathering zones of mainly tropical countries was responsible for the formation of many large manganese deposits. Supergene concentration process involves leaching by surface and sub surface water, leading either to dissolution of elements other than manganese in the country rock or dissolution and re-precipitation of manganese in the near-surface environment within the weathering crust.
• The solubility of manganese **is far greater** than that for iron or aluminum and solubility of manganese is very effectively accelerated by simple organic decay and possible by bacterial reduction.

• Among the various **genetic types of manganese ores**, the largest accumulations of rich varieties occur in supergene settings associated with lateritic crusts.
Fig. 8 DISTRIBUTION OF MANGANESE ORES OF INDIA
1. Manganese deposits associated with Precambrian Iron Ore Group:

*Manganese* deposits confined to the *supracrustal* rocks of iron ore group are encountered in the states of Jharkhand and Orissa. The *manganese oxide* ores are intimately associated with tuffaceous shales and cherts of the Iron ore group and both stratiform and lateritoid type manganese ores are reported. Mineralogically, the *stratiform manganese* ores are composed of pyrolusite, cryptomelane, todorokite and minor manganite and braunite. Lateritic manganese ores consist of pyrolusite, cryptomelane with minor lithiophorite.
Fermor (1909) and Engineer (1956) proposed a lateritic origin for the manganese ores of the region. Spencer (1948) suggested a hydrothermal origin, while Sen (1951) proposed a submarine volcanic origin. Prasad Rao and Murthy (1956) opined that the manganese solutions derived from weathering of syn-sedimentary manganiferous formations at depth gave rise to manganese deposits. Subramanyam and Murthy (1975) and Banerjee (1977) favoured a volcanic source for the manganese deposits. Roy (1981, 1986) preferred a volcanogenic or terrigenous source for the stratiform manganese deposits of the region.
2. Manganese deposits associated with Khondalite Group:

• Stratiform manganese ores of the metasedimentary type hosted in the Precambrian Khondalite group occur extensively in the Srikakulam district of Andhra Pradesh and Koraput and Kalahandi districts of Orissa. The Khondalite group is composed of calc-granulite, garnetsillimanite-graphite granulite, garnetiferous quartzite and quartzite. The manganese
ore bodies are conformably interstratified with the various members of Khondalite group at different stratigraphic levels. The manganese ores and the associated rocks have been subjected to granulite facies metamorphism. Mineralogically, the metasedimentary manganese ore bodies are composed of braunite, hollandite, jacobsite, hausmannite, vredenburgite and the supergene minerals are represented by pyrolusite, cryptomelane and minor nsutite (Roy, 1960).
Fermor (1909) proposed that the manganese ores in the area are formed from the supergene alteration of Kodurites (a hybrid rock consisting of spessartine garnet, K-felspar and apatite). Sriramadas (1963) Rao, (1963, 1964) and Roy (1960, 1966) opined that the manganese ores are of metasedimentary origin, which were later subjected to supergene alteration.
3. Manganese deposits associated with Aravalli Supergroup

- Stratiform Manganese ore deposits confined to the Precambrian Aravalli group occur in the Jhabua district of Madhya pradesh and Udaipur district of Rajasthan.

- In Madhya Pradesh, manganese oxide ores are interstratified with gondite, quartzite and phyllite. Mineralogically, the manganese ores are composed of braunite, bixbyite, hollandite and jacobsite.
In Rajasthan, manganese oxide ores occur as conformable beds within carbonaceous phyllites and are associated with phosphorite and copper mineralization in the Maton formation. Manganese minerals are represented mainly by pyrolusite and cryptomelane.

Nayak (1966) opined that regional metamorphism of the manganiferous pelitic, psammitic and calcareous sediments resulted in the development of oxide- and silicate ores of manganese. The metasedimentary manganese ores were later subjected to supergene alteration giving rise to supergene manganese ores.
4.. *Manganese deposits associated with Champner Group*

- Metasedimentary manganese oxide ores associated with the Champner group are reported from the *Shivrajpur-Bamankua area of Panch Mahal district* in Gujarat. Manganese ores in the area occur as bands interbedded and co-folded with cherty quartzite and phyllite.
The ore-bearing sequences in the area have been **metamorphosed to greenschist facies**, as evidenced by the presence of braunite and recrystallized pyrolusite. Gondite is totally absent. The manganese-**oxides** are made of braunite, hollandite, bixbyite and hausmmanite and supergene alteration resulted in the formation of pyrolusite and cryptomelane. Manganese-**silicates** include garnet, rhodonite, and manganese-bearing pyroxene. **Supergene alteration** of the metasedimentary manganese ores has yielded pyrolusite, cryptomelane and manganite.
To the east of the Shivrajpur-Bamankua area in the Goldongri hill, manganese oxide ores are interbanded with manganese silicate rocks enclosed in calcsilicates. The metasedimentary manganese ores consist of braunite and hollandite with minor bixbyite and hausmannite. Supergene alteration of the metasedimentary ores resulted in the development of pyrolusite and cryptomelane.
• **Sen (1964) and Roy (1967)** proposed a contact metamorphic origin for the manganiferous rocks.

5. **Manganese deposits associated with Sausar Group:**

Manganese ores associated with the Sausar group of rocks occur in Madhya Pradesh and Maharashtra, extending as an arcuate belt for a length of over 200 km with an average width of about 30 km. Metasedimentary oxide manganese ore bodies interbedded with metasediments of the Sausar group (comprising of pelitic, psammitic and carbonate rocks) are encountered in Balaghat and Chindwara districts of Madhya Pradesh state and Nagpur and Bhandara districts of Maharashtra state.
Manganese ore bodies occur at the bottom, middle and top of the argillaceous Mansar formation of the Sausar group and also within the underlying calc-silicate and marble-bearing Lohangi formation of the Sausar group. In the Mansar formation, interbedded Mn-oxide ores and manganese-oxide-silicate rocks (gondites) exhibiting primary sedimentary structures forming Syn-sedimentary sequences occur. The metasedimentary formations have been subjected to greenschist to amphibolite facies metamorphism. Manganese minerals reported are: braunite, hollandite, jacobsite, manganite and bixbyite, spessertine and rhodonite.
6. Manganese deposits associated with Gangpur Group:

• Manganiferous formations associated with Gangpur group are encountered in the Sundargarh district of Orissa. The manganese oxide ore bodies and gondite are interbanded and co-folded with the pelitic schists of Ghoriajor formation which constitutes the upper formation of the Gangpur group.
• The pelitic schists and the manganese ores have been subjected to amphibolite facies metamorphism. The manganese ore bodies are composed of braunite, bixbyite, hollandite, jacobsite, hausmannite, vredenburgite.

• Roy (1981) visualized a terrigenous source for manganese in the Penganga beds that was followed by diagenetic remobilization of manganese and reconstitution, leading to the formation of economic grade manganese deposits.
• Manganese ores confined to the Precambrian Dharwar supergroup of rocks occur in the NNW-SSE trending supracrustal belts and encountered in parts of Karnataka and Goa. In Karnataka, the manganese ores are encountered in North Kanara, Shimoga, Chitradurga and Sandur schist belts.
7. Manganese deposits associated with Penganga beds:

In the Proterozoic Penganga beds that occur in the Godavari rift valley in parts of Andhra Pradesh and Maharastra states, the manganese oxide ores are interstratified with stromatolitic limestone and intermixed with chert, jasper and shales. The manganese ore beds exhibit penecontemporaneous deformation, pinch and swell and slump structures along with diagenetic features. Manganese is essentially composed of todorokite, pyrolusite, ramsdellite, nsutite, birnessite and minor braunite.
8. Manganese deposits associated with Dharwar Supergroup:

Manganese ores confined to the Precambrian Dharwar supergroup of rocks occur in the NNW-SSE trending supracrustal belts and encountered in parts of Karnataka and Goa. In Karnataka, the manganese ores are encountered in North Kanara, Shimoga, Chitradurga and Sandur schist belts. Manganese deposits in the Karnataka craton are restricted to the Chitradurga group of rocks. Prominent deposits are encountered are in the Sandur schist belt of the eastern block of the Karnataka craton and Chitradurga, Shimoga and North Kanara belts of the western block of the Karnataka craton.
The NNW-SSE trending Sandur schist belt is well known for its economic concentrations of iron and manganese and is one of the best examples of the Precambrian greenstone belts of the world containing iron and manganese mineralization. *Manganese and iron ore deposits* are confined respectively to Deogiri and Raman Mala formations. *Iron- and manganese- bearing arenites* consist of quartz, hematite, magnetite, pyrolusite, cryptomelane, lithiophorite and minor braunite.
Manikyamba et al., (1995) reported derivation of iron and manganese of the Deogiri formation from volcanogene hydrothermal solutions. The manganese- and ironbearing formations were deposited in the shallow shelf region within the photic zone and above the wave base. The manganese- and iron- oxides present in arenites, argillites, cherts and carbonates were subjected to supergene enrichment leading to mineable economic concentrations of manganese ore.
• **North Kanara schist belt** consists of > 2.6 Ga. supracrustal consisting of metabasalts overlain by continuous beds of metasedimentary rocks. The metasedimentary succession is represented by conglomerate, orthoquartzite-arenite, stromatolitic limestone/dolomite, phllyite/argillite, manganiferous formation and banded iron formation, succeeded by a thick sequence of greywackes. The metasediments belong to the Chitraduraga group.
The late Archaean manganiferous- and iron-formations occur along N- to NW trending discontinuous ridges. Manganese exhibit massive, finely laminated and banded textures and are composed essentially of pyrolusite, cryptomelane.
• The host rocks exhibit isoclinal folding and **greenschist facies**. Mangenese and iron formations were intensely **lateritized** during the Neogene period. **The manganiferous formation** varies from massive layers and/or lenticular bodies, several metres thick sandwiched between phyllitic layers, to very thin banded layers interbeded with similar layers of either quartzite (metachert) or siliceous phyllite.
• **Krishna Rao et al.**, (1989) invoke a volcanic source for the **late Archaean manganiferous formation of the North Kanara region**. Subsequent lateritic alteration caused extensive remobilization of Mn from the metasedimentary ores.
**Chitradurga Schist Belt** is a linear belt of supracrustal rocks extending for about 350 km. Manganese mineralization is encountered mainly in the Chitradurga and Chikkanayakanahalli areas in the Chitradurga schist belt. **Manganese mineralization** is confined to manganiferous chert and phyllite. The uniformity in the composition of the manganese-rich bands and the **co-folded nature** of the manganese-bands indicate they are metasedimentary in origin.
DISTRIBUTION
INDIAN DISTRIBUTION OF MN-DEPOSIT

MANGANESE ORE DEPOSITS OF INDIA

SCALE 100 0 100 200 MILES

DELHI
JAIPUR
BANSWARA
INDORE
MAHARASHTRA
NAGPUR
KORAPUT
CUTTACK
KOLKATA
VIZIANAGRAM
VISAKHAPATNAM
BAY OF BENGAL

Mumbai
goa
Tamil Nadu
Karnataka
Chennai

AFTER: S-ROY (1970)
• Figure 1. Map showing manganese ore deposits in India. 1. Madhya Pradesh-Maharashtra ore belt. 2. Gangpur-
• Bamra deposits. 3. Panch Mahals district Deposits. 4. Jhabua district Deposits, Madhya Pradesh. 5. Vizianagram
<table>
<thead>
<tr>
<th>State</th>
<th>District</th>
<th>Chief Geological Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh</td>
<td>Adilabad</td>
<td>The Mn-ores occur as thin lenses with chert and jasper within limestone. Deposits are of minor nature with low phosphorus content.</td>
</tr>
<tr>
<td></td>
<td>Srikakulam</td>
<td>Associated with kodurite-rock (Garnet granulite and garnetiferous quartzite) forming a part of Khondalite formation, and are formed mainly due to supergene enrichment. Four distinct belts have been demarcated with a total reserves of 1.6 million tonnes. The ore is of low grade with high phosphorus.</td>
</tr>
<tr>
<td>Bihar</td>
<td>Visakhapatnam</td>
<td>Associated with kodurite of Khondalite formation.</td>
</tr>
<tr>
<td></td>
<td>Singhbhum</td>
<td>Associated with rocks of Iron-ore and Kolhan formation as lenticles parallel to bedding or as lateritic material at the surface.</td>
</tr>
<tr>
<td>Goa</td>
<td>To the south of Nissan Val. 363m, and Central and Northern part of Goa</td>
<td>The deposits are of lateritoid type found at or near the surface. The iron-content is inversely proportional to Mn in the ore.</td>
</tr>
<tr>
<td>Gujarat</td>
<td>Panch Mahal Vadodara</td>
<td>The ores are partly lateritoid and partly primary, associated with less metamorphosed Dharwars.</td>
</tr>
<tr>
<td>Karnataka</td>
<td>Bellary (Sandur basin) Chitradurga, Uttarkannad, Dharwad, Shimoga, Tumkur</td>
<td>The deposits are of varying dimensions, associated with limestones, schistose grits, and ochery-schists of the Shimoga-Chitradurga schist belt of Dharwar group. The ores are of lateritoid type and the individual deposits are lenticular and impersistent.</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>Balaghat</td>
<td>They represent gondite type of deposits, associated with metamorphosed Dharwar rocks</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>Bhandara, Nagpur</td>
<td>The ore bodies are banded braunite-quartzite and grade on to quartz spessartite - rhodonite bearing gondite. Weathering has given rise to residual enrichment deposits.</td>
</tr>
</tbody>
</table>

(Contd.)
<table>
<thead>
<tr>
<th>State</th>
<th>District</th>
<th>Chief Geological Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orissa</td>
<td>Ratnagiri</td>
<td>They represent secondary enrichment deposits associated with lateritised Dharwarian metasediments, composed of quartzite, banded hematite-quartzite and phyllite. The ores are generally more ferruginous.</td>
</tr>
<tr>
<td>Orissa</td>
<td>Sundargarh &amp; Keonjhar (Bonai-Keonjhar area)</td>
<td>The ore bodies occur as lenses or in irregular shape in shales, brecciated cherts, and laterites capping them, belonging to Iron-ore group of rocks. The ore deposits are for the most part epigenetic enriched under syngeneric conditions. About 90% of Orissa production comes from this area.</td>
</tr>
<tr>
<td>Orissa</td>
<td>Koraput, Kalahandi &amp; Bolangir (Koraput-Kalahandi-Patua area)</td>
<td>The ore bodies are associated with khondalite suite of the Eastern Ghats group.</td>
</tr>
<tr>
<td>Orissa</td>
<td>Sundargarh (Gangpur area)</td>
<td>The deposits are associated with gonditic rocks.</td>
</tr>
<tr>
<td>Orissa</td>
<td>Sambalpur</td>
<td>The deposits are associated with laterites on the metasediments.</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>Banswara</td>
<td>The deposits are associated with laterite on the metasediments.</td>
</tr>
</tbody>
</table>
Most Important Manganese Ores of India

Psilomelane

Pyrolusite
THANK YOU