Chapter 4

The Manganese Ore Deposits
CHAPTER IV

THE MANGANESE ORE DEPOSITS

Introduction

The chapter deals with the mode of occurrence and controls of localisation of the manganese ore deposits of Sanguem district of Goa.

As mentioned earlier, the territory of Goa is endowed with iron and manganese ore deposits of a rich quality. The iron ore deposits are mostly concentrated in northern Goa with some minor manganese deposits. Towards south the iron ore deposits become less important and the manganese ore deposits assume prominence. If a line is drawn parallel to and little to the south of railway line passing E-W through the heart of the territory, it will almost serve as a boundary line, separating the iron ore deposits of Northern and Central Goa from the manganese ore deposits of Southern Goa. The manganese mining is mostly localised in southern Goa in a few localities such as Rivon, Vilyena, Netravli and Verlem-Salgini. These deposits, therefore, have been divided into four sectors and have been named as under:

(i) Rivon Sector
(ii) Vilyena Sector
(iii) Netravli Sector
(iv) Verlem-Salgini Sector

The mode of occurrence of the deposits and their controls
of localisation are described in the following pages. The observations made in the field are restricted to open cast mines because only in the working mines, the ore deposits are exposed for observations, while nothing is seen on the surface surrounding the mine, as the area has a thick laterite cover. The private companies, presently engaged in the mining of these deposits being small, the working is predominantly done with the help of manual labour. Only in a few cases mining machinery is used. The mining companies are mainly concerned with the exploitation of the deposits which are easily accessible and not much attention is paid to the systematic prospecting and proving of the deposits, excepting for some trial workings. Because of this no subsurface data are available and hence the interpretation regarding the structure of the ore bodies at depth and in three dimensions is mainly based on the observations about their form and behaviour in the mining pits.

The manganese ore deposits in the area are entirely restricted to the phyllites of the Bharwar Supergroup. These have been extensively lateritised. The area being in the tropical climatic zone the weathering is very intense and deep and the rocks being very susceptible to weathering the laterite cover is very thick. The ore is found to occur either in the upper laterite zone or in deeper region which is occupied by lithomarge produced by the weathering of the phyllites.
Rivon Sector

The sector includes about thirty working mining pits which are within a radius of about 5 km around Rivon. The location of the groups of the mining pits are shown in the map (Fig. 4.1) showing the geology of the sector. The rocks which are exposed include metaconglomerate, chlorite-sericite-schists with bands of quartzite and phyllite. At the base of the chlorite-sericite-schists, there is a thin band of metaconglomerate. The metaconglomerate, chlorite-sericite-schist and quartzite are not much lateritised and their exposures are found as ridges and also in the road and stream cuttings where their attitude can be measured. They strike N60° and dip by 35° to 55° towards N150°. On the contrary, the phyllites, which occupy the major part of the sector, show deep and extensive lateritisation. The area, therefore, occupied by them is covered with a thick zone of laterite and no exposures of unaltered phyllite are seen in the area. The existence of the phyllites can only be inferred from their partially weathered relict patches occasionally seen either in the zone of laterite or in the zone of lithomarge exposed in the mining pits.

The manganese ore occurs in the zone of laterite as boulders and concretions or as pockets and lenses in the lateritised phyllite. In some cases below the laterite zone, highly weathered phyllites are seen. These phyllites sometimes have retained their folded character even after their alteration to lithomarge. The crest of the anticlines of
Fig: 4.1
Geological map showing locations of groups of manganese ore mines from Rivon sector Sanguem area, Goa.
such folds show the presence of manganese ore, occupying the highly brecciated portions. In other cases, the country rock is traversed by shear zones and the ore is found in the crushed, fractured and brecciated portions of the shear zone, looking very much similar to a breccia with angular fragments of silica bound together by the manganese oxides which were deposited in the fractures. Similar mode of occurrence for the manganese ores in brecciated fracture zones has been reported by Wilson *et al.* (1970) for the manganese ores of Lecht mine, Tomintoul, Sauffashire. In order to make the picture more clear a few typical vertical sections of the mines from this sector are described with their schematic diagrams.

**Piplabured Mine**: This is situated about 2 km north-northeast of Rivona. It trends in a N45° direction. It has a length of 50 m, width of 30 m and a depth of 15 m with 3 benches (levels) each 5 m in height. From the surface, the section observed is 2 m of soil, followed downward by a 4 m of hard fractured laterite, which grades into cream to buff coloured lithomarge, 3 m thick. This in turn grades into wad (intimate mixture of manganese oxide and clay) 2 m thick, in which concretions of manganese ore are found. In the wad, two bands of lithomarge, a few centimeters thick, buff and pink in colour, showing folding are present. They are faulted along their anticlinal portions as shown in the schematic diagram (Fig. No. 4.2) wherein the soil, laterite and lithomarge have not been shown. The fault $F_1$ trends
Fig. 42 Schematic diagrams of the mines from Rivon sector, Sanguem area, Goa.
N 135° and dips 70° towards N 225°, the displacement being 20 cm. Fault F2 strikes N-3 and dips 60° towards N 90°. The wad contains some concretionary and breccia type manganese ore. Some fractures have been filled with ore resulting into a box work. Lumpy manganese ores are sometimes traversed by crisscross veins of later formed manganese oxide minerals.

Anvali Bancer Mine: This is 2 kms northeast of Rivona. It trends in E-W direction, has a length of about 250 m, width of 100 m, and a depth of 60 m, with 12 benches, each 5 m in height. From the surface 5 m of hard, compact but fractured laterite grades downward into lithomarge. The lithomarge in turn grades into wad which is seen to grade into a thin zone of powdery ore. Below this, a parent rock rich in manganese is seen. This could be a weathered manganiferous phyllite. The mine is being worked along an anticlinal structure whose axis trends in N10°E direction. Along the axis of the fold, there is a shear zone which shows intense silicification, crushing and brecciation (Plate II, Photo 2). Along this shear zone, manganese has been deposited in cavities and fractures. In the lithomarge, a band of manganese wad can be seen folded as shown in the schematic diagram (Fig. No. A.2). The ore in the lateritic zone is cavernous and in places it is characterized by box work. The ore in the shear zone is mostly of breccia type with angular fragments of chert cemented together by manganese oxides (Plate II, Photo 3). The proportion of chert fragments in the matrix of manganese oxide varies and locally masses of manganese
oxide almost free of chert also occur. The ore also shows stalactitic structure. The vugs and cavities show within them rounded and spheroidal bodies, about one to two centimeters in diameter. These bodies are black, sooty to brownish, snuff coloured and have a smooth velvety surface. Vugs and cavities are also lined with alternating layers of manganese oxides and silica. Lumps of manganese ore are seen to be traversed by veins of later formed manganese minerals. Colloform banding, made up of a series of concentric layers differing in composition, is also seen. Manganese oxides are also found as films along fractures. In the wad, pockets of unreplaceable lithomarge can also be seen (Plate III, Photo 1).

Mount Udo Mine: This is situated at Colombo, 3 km southeast of Rivona. It has a N100° trend. Length of the mine is 100 m, width is 70 m and the depth is 20 m with 4 benches each of 5 m in height. Below a zone of hard and compact laterite, 3 m thick, in the highly weathered phyllite an anticlinal fold can be seen as shown in the schematic diagram (Fig. No. 4,3). Strike of the northern limb of the fold is N 90° with a dip of 40° towards North. The strike of the southern limb is N 85° with a dip of 50° towards N 175°. The axis of the fold is trending along N 255°. In the beginning of the mining history, the structure produced iron ore, but as the mining proceeded, the depth to which the ore was found from the surface increased and with the increase in depth the ore became ferruginous manganese ore. As the depth of mining still increased the percentage of manganese in the
Fig 4.3 Schematic and block diagrams of the Monte Udo mine from Rivon sector, Sanguem area, Goa.
ore increased. As the depth, to which the ore is found, increases from the surface as mining proceeds, a plunging anticline is predicted as shown in three dimensional diagram (Fig. No. 4.3). The ore is mostly found as concretions along the axial portions. It is usually lumpy and sometimes shows colloform banding, which is disrupted by small fractures. Thus, it can be said that, the mineralisation has taken place along the plunging axis of the fold, resulting into a breccia pipe like ore body. Similar type of structural control has been reported by Rao (1964) in the manganese ore deposits of Vishakhapatnam manganese belts, where the ore deposits are formed by oxidation and enrichment. According to him, good deposits of ore are localised along the noses of the anticlinal drag folds and the pitch of the ore bodies confirm to the plunge of the drag folds.

Gavaram Mine: This is about 4 km to the southeast of Rivona and has a N-S trend. Its length is 30 m, width is 20 m and depth is 15 m with three benches, each 5 m in height. From the surface, 6 m thick laterite is followed downwards by lithomarge which grades into manganese wad. The wad shows thin bands of lithomarge, showing folding and faulting as shown in the schematic diagram (Fig. No. 4.2). Due to the fault, trending N65°, the hanging wall has moved up along the footwall. Hence the wad with manganese concretions of hanging wall has come against the lithomarge band of the foot wall, while the lithomarge band of the hanging wall has been eroded away and transported laterite has been deposited in
its place. The ore is mostly lumpy, found as concretions in the laterite or in the wad and followed in depth below the wad by a zone of powdery ore.

Vilyena Sector

The sector includes about twenty manganese mines which are scattered in an area of about 25 square kms. The location of the groups of the mining pits are shown in the map (Fig. No. 4.4) which also shows the geology of the area. The rocks exposed include phyllites (lateritized) and sericite quartzites striking N 140° and dipping by 32° to 40° towards N50°. The sericite-quartzite exposures are found as ridges and also in the road and stream cuttings where their attitude can be measured. The major part of the sector is occupied by the phyllites, which being more susceptible to weathering than the quartzites, form low lying areas as compared to the high quartzite ridges. Relict patches of highly weathered phyllites are occasionally found in laterite or in lithomarge exposed in the mining pits.

The manganese ore occurs in the laterite, which at places is hard and massive, and at others is soft, pebbly and bouldery. The top portion of laterite is hard and ferruginous and below a depth of about two to four meters, the ferruginous laterite yields ferruginous manganese ore up to a depth of about 6 meters. Below this the ferruginous laterite slowly and gradually becomes clayey laterite or lithomarge. In this clayey laterite, manganese ore occurs in the form of small
Fig. 4.4 Geological map showing locations of groups of manganese ore mines from Vilyena sector, Sanguem area, Goa.
pebbles, concretions and boulders. This is how the ore occurs at Naquini about two kilometers south of Vilyena, while in and around Vilyena proper, the manganese ore is found below a laterite cap of about two to four meters thick. This grades downwards into lithomarge which in turn grades into wad. At places, the laterite directly grades into wad with a thin zone of clayey laterite in between. The wad at depth grades into powdery ore, which sometimes contains concretions of lumpy ore in it. At Chichegal about 3 km north of Vilyena, the ore is found along a shear zone. In this case, the ore is found as fillings in the fractures and small faults and also in open cavities. The lining of the cavities is formed due to encrustations. Colloform banding is also seen to have developed. Breccia type ore, with fragments of chert cemented together by manganese oxides, is of the commonest occurrence. The proportion of the manganese oxides within the chert is variable and locally masses of manganese oxide free of chert are also found.

Netravli Sector

The Netravli sector is almost in the centre of the area and is one of the important manganese mining centres from this area. There are about thirty manganese mines within a radius of five kilometers. The map (Fig. 4.5) shows the location of the groups of the mining pits and the geology of the sector. The rocks exposed in this part of the area include the metabasics, the phyllites and the metagreynackes
Fig 4.5 Geological map showing locations of groups of manganese ore mines from Netravli sector, Sanguem area, Goa.
(upper). The metabasics are the oldest rocks exposed in the area. They strike N 150° and dip by 55° to 58° towards N 60° and they show a thin laterite cover. Overlying the metabasics are the phyllites which show deep lateritisation. Fresh exposures of the phyllites are not found in the area, but highly weathered patches of phyllites can be seen in the laterite in the mine cuttings. Overlying the phyllites are the metagraywackes. They are exposed towards the eastern part of the sector. They strike N 140° and dip 50° towards N 50° at Vargone about a km to the east of Netravli. To the north of Vargone, the strike changes to N 3°, while further north it becomes N 10°. To the south of Vargone, the strike changes from N 140° to N 170°. The manganese mining is entirely restricted to the phyllites (lateritised). The manganese ore in the zone of laterite is in the form of concretions, while along the shear zones breccia type ore can be seen. Below this a zone of wad grading downwards into powdery ore can be seen.

At Vichandrem about 2 km northwest of Netravli, the manganese ore, in the Caneli Dongor mine, occurs below a ferruginous laterite cap of 4 m which gradually becomes clayey laterite, containing small pebbles and gravels of manganese ore. The portion below the wad is not seen as the excavation has just reached wad.

In the Arka Mine 2 km southwest of Netravli, the manganese ore is worked along the core of an inclined isoclinal anticline. The eastern limb of the anticline strikes N 50°
and dips 25° towards N 140°, while the western limb strikes N 190° and dips 30° towards N 100°. The axis of the fold strikes N 170° and is plunging by about 10° towards south.

The mine has a length of about 250 m, width of 60 m and a depth of 50 m with 10 benches, each 5 m in height (Plate III, Photo 2). From the surface a meter of soil is followed downwards by 10 m of ferruginous laterite, which in turn is followed by about 10 m of lithomarge of varying thickness. This is followed by wad and powdery manganese ore. Towards the eastern part of the mine, the laterite yields hard and lumpy ferruginous manganese ore while in the western part of the mine, it yields concretionary manganese ore. Below the lithomarge and wad, the manganese ore is powdery. It is found that along the axis of the anticline, the depth at which the ore is found increases. Hence, it may be inferred that the anticline is plunging towards south by about 10°.

Though no secondary silicification is seen in the mine face, crushing of the phyllites is observed on bench No. 7. A couple of bands of lithomarge, varying in colour from yellow to buff and pinkish, show minor folding. The material above and below such bands is wad. This is seen in the eastern limb of the major fold.

Verlem - Salgini Sector

There are about forty mining pits in this sector in an area of about 10 square kms, out of which about eight are not working. Fig. 4.6 shows the map of the location of the
Fig: 4.6
Geological map showing locations of groups of manganese ore mines from Verlem-Salgini sector, Sanguem area, Goa.
groups of the manganese mining pits and the geology of the sector. The rocks exposed in the area are the phyllites (lateritised) and metagreywackes. Two exposures of phyllites are seen, one around Verlem and the other round Salgini. The phyllites show deep weathering and lateritisation at the surface. All the manganese mining is entirely restricted to the phyllites. Overlying the phyllites are the metagreywackes which strike N 140° and dip by 40° to 44° towards N 50°. The metagreywackes are resistant to weathering and do not show any lateritisation. The rocks are seen to be traversed by two shear zones, one in the NW-SE direction and the other in the NE-SW direction. Along these shear zones, breccia-like manganese ore is seen in which angular fragments of chert are bound together in a matrix of manganese oxides. The area is also traversed by minor faults and the ore is seen to be found along the fault planes in fault breccia. A description of a few vertical sections of mines from this sector will suffice to explain the mode of occurrence of manganese ore in this sector.

**Bhutanbai Mine**: Situated at Verlem it trends N 330°, has a length of 300 m, width of 75 m and depth of 30 m with 6 benches each of 5 m height. The vertical section shows half a meter of soil followed by 5 m of fractured laterite, followed by 4 m of lithomarge. This is followed by manganese wad about 2 m thick with concretions of lumpy manganese ore. This grades downwards into powdery manganese ore. A number of crisscross silica veins can also be seen in the powdery
ore as well as in the wall above it. On the 6th bench from the bottom, three shear zones can be seen. The two that trend N 295^o and N 300^o are about a meter wide each and the third one which trends N 285^o is about three quarters of a meter wide. The first two, which are almost parallel, are about 15 m apart and towards the southern portion of the mine converge towards each other and are joined by cross fractures. The portion in between has been intensely fractured and in this portion secondary mineralisation has taken place. Along the middle shear zone, which trends N 285^o, two parallel faults are seen as shown in the schematic diagram (Fig. No. 4.7). The strike of the faults is N 280^o with a dip of 50^o towards N 10^o (Plate III, Photo 3). This shear zone also shows mineralisation. The shear zones are not expressed on the surface in the laterite outside the mine. On the lower levels of the hill, where this mine is situated, several pits separated from one another by considerable distance are being worked for manganese ore. It is probable that, they are also being worked along the same shear zones which are mineralised. Hence the shear zone can be inferred to be about one kilometer in length. However, it cannot be said with certainty that the mineralisation occurs as a continuous reef along the shear zone, but may be present as disconnected patches.

**Connahs Mine:** Situated at Verlem it has a N-S trend. It has a length of 100 m, a width of 40 m and a depth of 40 m
Fig. 4.7
Block diagrams indicating attitude of ore body in the mines from Verlem-Salgini sector, Sanguem area, Goa.
with 8 benches of 5 m height each. The downward succession from the surface is 3 m of soil followed by 12 m of laterite, 5 m of lithomarge and wad with powdery manganese ore below it. The area is traversed by a shear zone and secondary ore occurs along the shear zone as breccia type ore. Two prominent sets of fractures are seen, one set trending N 210° and the other set in N 320° direction. Along the N 320° set, there is a minor fault which dips by 55° towards N 230°. The fault surface exhibits slickensiding. Due to this fault, the lithomarge of the hanging wall side has come in contact with wad and manganese ore of the foot wall (Plate IV, Photo 1). The bottom of the lithomarge is not seen and hence the exact downthrow of fault cannot be ascertained (Fig. No. 4.8). The fault is seen only in the mine but is not seen on the surface around the mine.

Marubigad Mine: The mine has a N 80° trend. It has a length of 25 m, a width of 20 m and a depth of 30 m with 6 benches of 5 m height each. The thickness of laterite here is about 14 m. The laterite shows open cavities with fillings of manganese oxide minerals. The laterite is followed downwards by lithomarge, 5 m thick and then by wad which contains some bands of lithomarge showing folding (Plate IV, Photo 2). The wad grades into powdery manganese ore. The wad above the powdery ore zone has some concretions of manganese ore. A fault, trending N 90° and dipping by 35° towards N 180° is exposed in the mine. Due to this fault, wad, which is about 3 m thick, has come in contact with powdery manganese
Fig. 48: Schematic diagrams showing vertical sections of mines from Verlem-Salgini sector, Sanguem area, Goa.
ore of the foot wall (Fig. No. 4,6). Both along the hanging wall and foot wall, manganese ore is being worked. Along the fault plane, the secondary ore is of breccia type. Vugs and cavities filled with ore, are also seen. The bottom ore is powdery in nature. Cavernous ore in the laterite at the top is, at places, characterised by box work.

Bodikithenbo Mine: It has a N 300° trend; has a length of 200 m, width of 300 m and a depth of 15 m with 3 benches of 5 m height each. Two meters of soil is followed by 4 m of laterite, followed by 2 m of lithomarge and then by 2 m of wad which grades into powdery manganese ore. A shear zone, 20 m in width, is exposed in the mine. It trends in N 245° direction. A small fault, which trends in N 245° and dips 40° towards N 335° is also seen. Due to this fault, the hanging wall, made of. lithomarge has come in contact with the manganese ore of the footwall. The bottom of the lithomarge is not seen. Secondary manganese ore of breccia type, with angular fragments of chert cemented by manganese oxides, is found along the shear zone. Vugs and cavities are seen filled with crystalline manganese oxides.

Verlem Mine: It has an E-W trend and has a length of 200 m, a width of about 120 m and depth is 70 m with 14 benches each 5 m in height. A soil cover of 2 m is followed by a 50 m thick laterite which gradually grades into a lithomarge about 6 m thick. This grades downwards into wad 2 m thick and then into powdery manganese ore. Some lumpy ore as concretions is found just at the contact of wad and
powdery ore, as shown in the schematic diagram (Fig. No. 4.8). Two faults can be seen in the mine. Both faults are along two shear zones which cross each other. Fault $F_1$, trending N 240° and dipping by 50° towards N 330°, is older than $F_2$, trending N 100° and dipping by 55° towards N 10°. On the hanging wall side of both the faults, lithomarge is present. The bottom of lithomarge is not seen. The fault has developed slickensides and a coating of manganese oxides is seen on them. The ore along shear zones is of breccia type. It is also of interest to note that as working proceeds the depth from the surface at which the ore is found also increases and thus it may be inferred that the ore body is controlled by the two faults on either sides forming a sort of a breccia pipe.

Ghataimaddi Mine: Situated at Salgini has a N 15° trend. Length of the mine is 70 m, width is 20 m and the depth is 55 m with 11 benches 5 m in height each. The manganese ore is worked along a shear zone which traverses altered phyllites (Fig. 4.7). The shear zone trends in a N 120° direction. About 2 m of soil is followed downwards by 5 m of laterite which is hard and fractured. This is followed by lithomarge with lenses and bands of wad containing concretions of lumpy manganese ore. Due to shearing, crushing, pulverisation and faulting of the folded phyllites has taken place (Plate IV, Photo 3). The quartztic portions of the phyllites have been turned into friable silica while the pelitic portions have been turned into clay. The mineralisation
along the shear zone is of secondary type, forming breccia type ores, with cherty fragments cemented by manganese oxides. Mammillary, reniform and botryoidal structures can also be seen in the vugs and cavities in which manganese oxide minerals have crystallised. The cavities with rounded, reniform or spheroidal bodies of manganese oxides, ranging in size from 1 to 2 cm in diameter and brownish or black sooty in colour, have a velvety surface. The cavities also show banding due to alternation of layers of manganese oxide and silica. Such bands may range in thickness from 0.2 cm to 0.5 cm.

Controls of Localisation

It would be clear from the preceding description that the manganese ore deposits are not haphazardly or irregularly scattered throughout the area, but are confined only to certain environments. These environments thus have acted as controls of localisation of these deposits.

In considering the localisation controls it is to be remembered that the deposits occur in the following three different situations:

(i) In the laterite zone as pockets and lenses or concentrations.

(ii) In fracture or shear zones or along the brecciated crests of the folds.

(iii) As concretions in the wad or the zone of powdery ore below the wad.
The localisation controls of these three types will, therefore, have to be considered separately.

One feature that is common to all the three types of deposits is that they all occur in the phyllites. This means that the localisation control has been primarily the lithological control. It is obvious that these rocks have acted as either the host or the parent rocks for these deposits. A similar situation is also reported to exist in the manganese ore deposits of the Sandur Hills in Karnataka (Pascoe 1965). However, it must be mentioned that the deposits do not occur everywhere in the lateritised phyllites but are localised only in certain places. This indicates that though, in general, the phyllites have acted as a controlling factor, there are certain other factors which have also played a major role in the localisation of the deposit.

Take for instance the deposits which are found in the zone of laterite. Fermor (1909) called these deposits as lateritoid and so hence forth will be referred to as lateritoid deposits. These lateritoid deposits are again not scattered randomly throughout the lateritised phyllites. Wherever they are found, they are followed in depth either by secondary deposits in the fracture or shear zones or by wad or by a zone of powdery ore. This indicates that their localisation is controlled by either the fracture or shear zone or the presence of wad or powdery ore in depth. It is found that many of the mining pits that are being worked for
the ore in the zone of laterite are aligned in a direction which is either the direction parallel to the shear zones or the strike of the phyllites. The fact was utilised by the author in locating the continuation of a deposit. In a mining lease area a pit was opened, in which the ore was found to be localised along a shear zone with almost E-W strike. The lateritoid ore in this part was not large in quantity but the breccia type of ore in the shear zone was quite considerable. The mine owner wanted to know the direction in which the deposit could possibly extend so that it could be properly developed and exploited. He was advised by the author to take a trial pit on the shear zone which was indicated in the laterite by silicification, in the same alignment as the shear zone in the open pit, but on the other side of the hill. On opening the pit some ore was found in the zone of laterite. When followed in depth the shear zone was found to contain similar type of breccia ore, indicating its continuation with the ore in the earlier pit. Five hundred tonnes of ore was mined from the pit during one season.

There are mines in which, it is found that, the laterite contains pockets and lenses of manganese ore. Below this zone of laterite lithomarge is met with but no shear zone or fracture zone can be seen. However, below lithomarge a zone of wad and powdery ore is present. This may indicate that the ore in the zone of laterite owes its existence to
the wad and lithomarge down below. The trend of the ore in the laterite is generally parallel to the trend of the wad or lithomarge below. Attempts to strike the zone of wad and powdery ore at depth in a direction normal to the trend of the ore in the laterite are found to have failed.

Some of the ore in the zone of lithomarge is found to be present in the fracture or shear zones cutting through the lithomarge and the zone of laterite. Concentration of ore has taken place in open spaces along these zones to give rise to deposits of breccia type manganese ore.

Sometimes it is also found that the manganese ores are deposited in the fractured regions along the crests of the plunging anticlines giving rise to breccia-pipe-like bodies (Park and MacDiarmid, 1964, p. 69). The form of the bodies varies with the form of the brecciated zone along the axes of the anticlines. In these cases the mineralisation has been localised and controlled by the structural features like fracture zones, shear zones or the crests of the anticlines.

The third type of deposits which are represented by the powdery ore zones are generally found below the zone of lithomarge which has at its bottom/zone of wad. In few cases the powdery ore is found to grade downwards into a richly manganeseiferous phyllite or protore. These zones are much longer than they are wide. They extend laterally, generally parallel to the strike of the rocks and taper at both the ends. It may therefore be suggested that the localisation of the powdery ore zone is controlled by the presence of bands or lenses of
prospects below it.

In summing up it can be said that the localisation of these deposits is controlled primarily by lithology and existence of ore bodies at greater depth and also by the structural controls like fracture or shear zones or the crests of the anticlines. These controls can serve as guides for prospecting of new deposits. It may be suggested that the faults and shear zones, which show occurrence of ore at the surface, will serve as useful guides for the search of ore at depth.