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COMMONWEALTH OF AUSTRALIA.

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DEPARTMENT OF NATIONAL DEVELOPMENT.  
BUREAU OF MINERAL RESOURCES  
GEOLOGY AND GEOPHYSICS.

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RECORDS.

1953/62

MANGANESE DEPOSITS NEAR RAGGED HILLS,  
GREGORY RANGE, NORTH-WEST DIVISION,  
WESTERN AUSTRALIA

by

H. B. OWEN

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## SUMMARY

Manganese deposits in the Gregory Range, Western Australia were examined and mapped by officers of the Geological Survey of Western Australia and the Bureau of Mineral Resources jointly. The investigation indicated the presence of 93,000 tons of manganese ore distributed between 37 separate bodies contained in 13 groups. Numerous small bodies each containing less than 200 tons of ore have not been included in the tonnage estimate.

The grade determined by chip sampling the surfaces of the outcrops is generally high. The range of composition of samples is:-

	Percent.	
Manganese...(Mn)...	47.54 to 57.79	
Iron...(Fe).....	0.71 to 7.35	
Silica...(SiO <sub>2</sub> )....	0.81 to 17.82	
Phosphorus...(P)...	trace to 0.15	

The deposits occur as replacements of silicified bands in dolomitic limestone and as fillings of irregular cavities in the limestone. A few thin deposits in the south-eastern sector of the field overlie quartzose rocks.

## INTRODUCTION

During the period 23rd September to 1st October, 1952, L.E. de la Hunty, geologist, Geological Survey of Western Australia and the writer examined and mapped numerous small deposits of manganese ore on the western edge of Gregory Range. These deposits are relatively new discoveries which had not previously been subjects of official investigation.

The party included W.L. Grayden, M.H.R., and representatives of Australian Ores Pty. Ltd. and the Northern Mineral Syndicate.

Transport from Ragged Hills air-strip to the deposits, and ultimately to Meekatharra, was provided by both organisations and Messrs. W. Blankensee and P.R. Fletcher, of Northern Minerals Syndicate, guided the party in the field. All this assistance is gratefully acknowledged.

In 1937 the Aerial, Geological and Geophysical Survey of Northern Australia surveyed and sampled lead deposits near Braeside, approximately 30 miles north of the area here under discussion, and passing reference was made (Finucane, 1938) to low grade manganese occurrences within the area then surveyed.

As a result of the inspection in 1952 de la Hunty compiled a separate report (1953) which is in agreement with this present report and contains the same figures for estimates of reserves.

## LOCALITY AND ACCESS

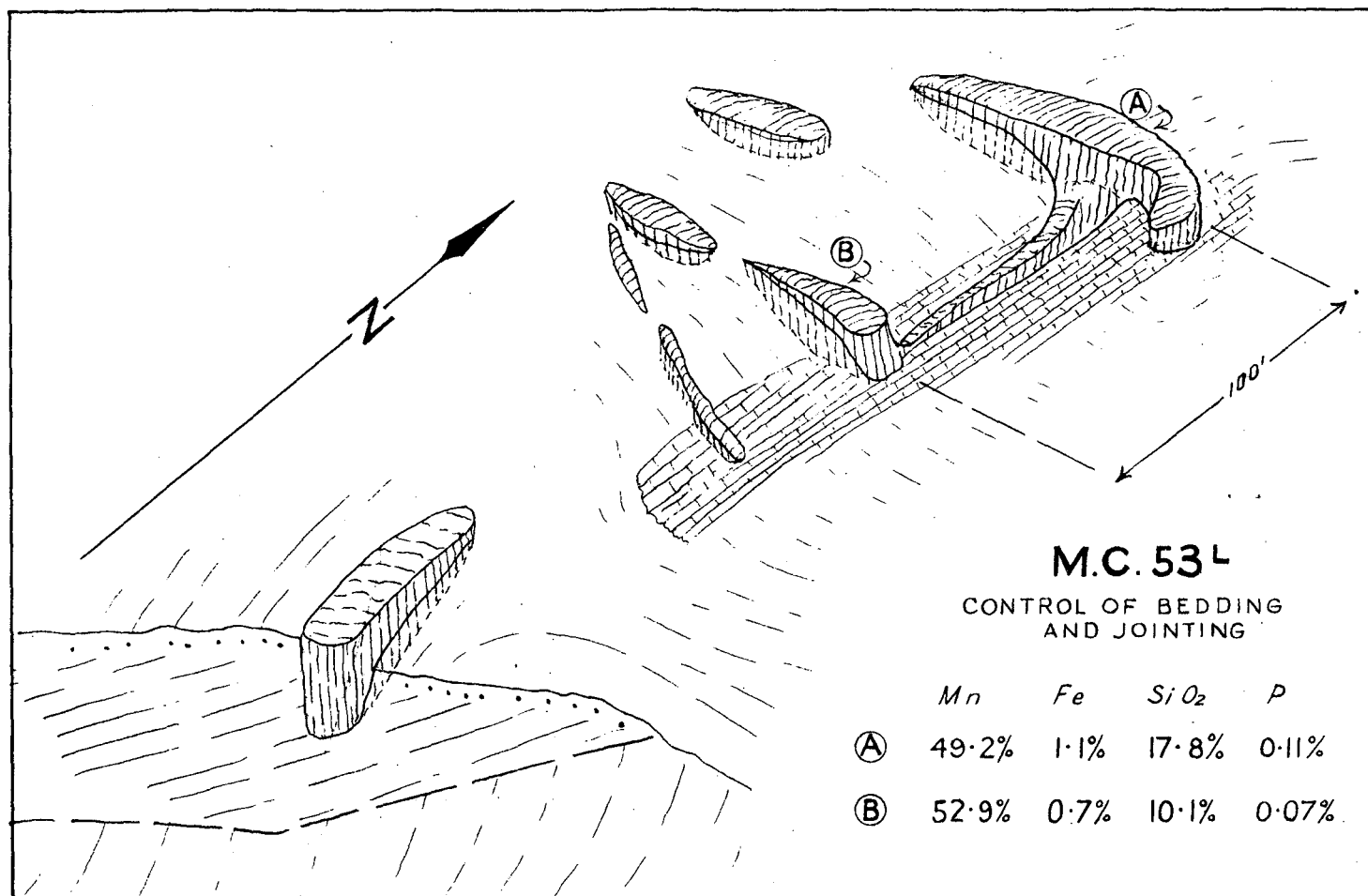
The manganese deposits occur in the south-eastern corner of Warrawagine Station in the De Grey district, which forms part of the Pilbara Goldfield. They occupy a strip approximately 25 miles long from north to south by 2½ miles wide along the western edge of Gregory Range.

The central and most important group of deposits is about 2 to 3 miles east of the Oskover River and 180 miles in a direct line east-south-easterly from Port Hedland.

A weekly air service conducted by MacRobertson-Miller Aviation Pty. Ltd. connects Port Hedland with Ragged Hills air-strip which is within 3 miles of the northernmost manganese deposit (M.C. 211). Reasonably good roads connect Warrawagine homestead with Marble Bar (105 miles) and Port Hedland (200 miles), and a station track southerly from the homestead along the course of the Oskover River to Running Waters pool (60 miles) passes within a few miles of all the deposits. Access roads between the existing track and the various deposits could be made easily across a spinifex flat.



Fig 1. *Manganese body exposed on cliff-face, M.C.53L*



**Fig. 2.** *Isometric sketch showing control of manganese ore bodies by bedding and jointing in dolomitic limestone.*

Port Hedland is the nearest port for shipment of ore from this district and it is unfortunate that the Marble Bar - Port Hedland railway which served a promising mineral province has recently been demolished. The total distance from the manganese deposits to the port is of the order of 260 miles.

### GEOLOGY

The rocks in which the manganese deposits occur are of Nullagine (Proterozoic) age and consist of impure dolomitic limestones, more or less silicified, and interbedded sandstones and quartzites. The regional strike is meridional commonly ranging between  $N10^{\circ}W$  and  $N20^{\circ}E$ . Gentle to moderate folding has taken place with the result that local dips ranging from  $75^{\circ}$  west to  $45^{\circ}$  east, were encountered in the areas mapped. Small intense structures were noted along the western scarp of the range where the limestone is well exposed in a vertical face about 40 feet high.

A well developed joint system in the limestone trends easterly and in some instances has provided favourable loci for manganese deposition.

Silicification of the limestone has taken place by replacement of favourable beds, which may be several feet thick, with chalcedonic silica, either red or white. Narrow quartz veinlets are also developed in bedding planes and joints.

The manganese deposits usually rest upon or are surrounded by similar red jasperoid material and may contain small patches of completely silicified limestone which retains traces of its former bedding and joint structure.

At the northern end of the area investigated the limestone unconformably overlies vertical schists which presumably are of Mosquito Creek (Upper Archaean) age.

Along the western face the range is flanked by the broad valley of the Gokover and Davis rivers. The valley floor is covered with alluvium which includes large widely scattered boulders of gneissic granite and numerous smaller boulders of quartzite, limestone and basic lava. Outliers of the Braeside limestone form buttes and mesas rising to about 100 feet above the valley floor.

To the east the limestone is overlain by quartzose sediments which are apparently conformable and which also contain manganese deposits. Broad geological features are indicated on the locality sketch.

### The Manganese Deposits.

Individual manganese bodies are relatively small but make bold outcrops which are conspicuous features of the higher points within the subdued relief of the region. The largest single body occurs in MC 247 and measures 300 feet long by about 50 feet wide and stands 6 to 9 feet above the surrounding ground level.

Broadly, the deposits may be classified into two types, viz. (a) those of a large outcrop area, such as the example in MC 247 mentioned above, and (b) those which outcrop as long narrow reefs or pods. The former type which is conformable to bedding and probably results from the replacement of a silicified bed, is relatively thin, but the latter, occupying weathered-out joints, may persist to depths which equal or exceed the outcrop width. An extreme example of persistence to depth below a narrow outcrop is shown in Fig. 1, and a combination of both types is depicted in the three-dimensional sketch of a complicated orebody on MC 53L (Fig. 2).

Where the base of a manganese body is exposed it is seen to rest on a bedding plane against which it terminates abruptly. This observation applies to both types of orebody.

The ore is both hard and tough and effectively resisted attempts to cut sample channels in it. In outcrop it is black, sometimes slightly brownish; freshly fractured surfaces are bluish-

black and the mineral appears to be amorphous. Botryoidal forms are present but are not common. The outcrops are bouldery; fibrous and radiating varieties of manganese ore may be found filling the interstices between boulders. It is considered that the bulk of the ore is pyrolusite and that the fibrous and radiate varieties are *also* pyrolusite. A thin scale of soft pyrolusite (?) occurs in vertical streaks on steep faces where meteoric water has drained from higher parts of the outcrop. This is particularly noticeable at the overflow from shallow pools which form in small hollows on the upper surface of the ore. This is striking evidence of the ease with which manganese may be taken into solution and redeposited.

Those deposits which lie on or in the bedding are usually enclosed in an envelope of ferruginous manganese ore and limonite grading by increase of silica into jasper. This casing may be from several inches to a few feet thick. On the other hand the contact between the manganese ore of the vertical bodies and the enclosing limestone is sharper and the intervening ferruginous or siliceous coating may be little more than a thin skin.

The orebodies on MC 247 are surrounded by siliceous rocks, mainly quartzite overlying a thin bed of quartz conglomerate, but the ore rests on limestone which shows along the eastern edge of the northern body.

The limestone does not outcrop farther east and it is probable that the deposits on MC's 564 to 275 rest upon quartzite.

#### Method of Surveying and Sampling.

The deposits were surveyed by plane-table with stadia alidade. Heights of vertical or near vertical faces were measured by tape or with the stadia rod. The small outlying deposits on MC 211 and near the southern boundary of Warrawagine Station were measured by compass and pacing.

Samples were taken by chipping from vertical faces or from across the outcrop where access could not be obtained to vertical faces. Every endeavour was made to clean the face before sampling by chipping off a thin skin and to take a uniform amount of sample for each unit length, but owing to the extreme toughness of the ore this could not always be done and, furthermore, it became necessary to deviate from a straight line where this would have taken the sampling track over a smooth face which could not be broken. Sampling was the responsibility of de la Hunty but in all instances he and the writer were agreed that the samples were the most representative of the surface that could be obtained in the circumstances.

A factor of 9 cubic feet of ore to the long ton has been used for tonnage estimation. The theoretical figure is approximately 8 cubic feet to the ton.

#### Description of Individual Mineral Claims or Deposits.

MC 211. This mineral claim (held by A. Rieck of Ragged Hills) is  $\frac{1}{2}$  mile west from Mt. Sydney and approximately 2 miles east-south-east from the Ragged Hills airstrip.

A narrow deposit of massive manganese ore with easterly strike occurs on sub-horizontal limestone. The orebody measures 120 feet in length by a maximum width of 30 feet at the base. The average height of the crest line is 10 feet above the surrounding limestone and the deposit appears to have a flat base which is just exposed.

At this point the limestone is approximately 40 feet thick and overlies vertical crystalline schists.

It is estimated that the deposit contains 1600 long tons of ore. No samples were taken.

MC 268. Northern Mineral Syndicate. A massive manganese outcrop occurs in this claim which is  $10\frac{1}{2}$  miles south of MC 211 and about 4 miles north by west from MC 247. The base of the deposit lies conformably on limestone which dips east-south-east at  $10^{\circ}$  to  $20^{\circ}$ .

The deposit is divided into three bodies of which the southernmost is a small extension of the main body from which it has been severed by stream erosion. The main body which measures approximately 230 feet from north to south by a maximum width of 120 feet is divided into two orebodies by a sinuous zone of siliceous manganese ore which has been excluded from the quantity estimation.

Reserves are estimated at 4,300 long tons.

*Presumably MC 267*

Unpegged deposit, approximately 1 1/2 miles north of MC 247.

This deposit which contains an estimated 8,500 tons of manganese ore has not been pegged because of difficulty of access. It is approached from the western front of the range, through a narrow gorge, but it is probable that an easier and more circuitous route could be found.

The body is T shaped in plan with the head of the T, which is 120 feet long by 40 feet wide, striking north-east in conformity with the local strike of the limestone. The base of the body is well exposed along the south-eastern face where it rests upon siliceous ore containing much partly replaced silicified country rock. The leg of the T extends north-westerly for 100 feet and stands 14 feet above the surrounding limestone. A small body parallel to the head of the T extends for 120 feet from the southern side of the leg to which it is joined by a siliceous patch. The T shaped body has a total area of 8,200 square feet by a thickness ranging from 2 feet to 14 feet and averaging 9 feet. The small southerly extension is 600 square feet in area by a conservatively estimated thickness of 4 feet.

The total estimated tonnage, excluding the siliceous ore at the base, is 8,500 long tons.

Samples were chipped from various places on the vertical faces and combined as sample No. GS/K/10 which on analysis at the Government Chemical Laboratories, Perth yielded:-

Manganese...(Mn)...	54.32	per cent
Iron...(Fe).....	0.99	" "
Silica.(SiO <sub>2</sub> ).....	7.74	" "
Phosphorus...(P)...	0.05	" "

**MC 274.** Northern Mineral Syndicate. The deposits in this claim which is approximately 1 mile north-west of MC 247 comprise five small bodies exposed in the banks and bed of a creek. Although the total tonnage is small - 2,400 tons - the bodies are of interest in that four of them probably represent remnants of a large body in which control by bedding and jointing resulted in an irregular shape. The southernmost body is exposed in the eastern bank of the creek and lies in the bedding with limestone both above and below. Two larger bodies at 100 and 150 feet to the north-west and north strike at right angles to the bedding and display vertical faces of 24 feet and 8 feet respectively. The larger of these two bodies transgresses an intercalated bed of sandstone and is truncated against the upper contact of the sandstone and limestone.

**MC's 271-273.** Northern Mineral Syndicate. These adjoining claims, which are about 1 mile north-east from MC 247, embrace sixteen orebodies of which only three are of much significance.

These deposits differ from the preceding examples in that they occur in the quartzite which overlies the limestone to the east. Consequently the deposits lie flat in the bedding and all have only shallow depth. The largest body which is in MC 271 is 200 feet long by an average width of 35 feet and its maximum thickness is 6 feet. Other bodies in the area range from 1 foot to 5 feet in thickness and are associated with siliceous manganese ore of very low grade.

Total reserves are estimated at:-

MC 271	6,200 tons
272	1,200 "



Sample GS/M/9 taken from the largest single body on MC 273 yielded on analysis:-

Manganese...(Mn)...	55.65 per cent.
Iron...(Fe).....	2.86 " "
Silica...(SiO <sub>2</sub> )....	2.66 " "
Phosphorus...(P)...	0.09 " "

**MC 247.** This claim is held by the Broken Hill Pty. Co. Ltd. and includes the largest group of orebodies on the field. The deposits occur on high ground approximately 19 miles south of Mt. Sydney and constitute a fairly prominent local landmark.

The manganese ore has been deposited on limestone in the crest of a small local anticline with a north-north-easterly axis. The flanks of the fold on either side of the manganese bodies are occupied by a thin irregular bed of quartz conglomerate, that directly overlies the limestone, and quartzite. Only a very small exposure of the limestone may be seen along the eastern margin of the orebodies but it is probable that the whole of the siliceous base of the ore rests upon limestone.

The manganese ore has replaced the quartzose beds and probably some of the underlying limestone also, but it has not wholly succeeded in replacing the quartz pebbles of the conglomerate.

The group of deposits contains two large orebodies; the northern one measures 300 feet long by an average width of 50 feet and average thickness (height above ground level) of 8 feet. The southern deposit which is about 600 feet south of the northern one covers a larger area (23,400 square feet) but is only about half as thick.

Estimated reserves in MC 247 are

Northern body -	13,500 tons
Southern body -	10,600 "
Other small bodies -	800 "
	<hr/>
	15,100 "

Two samples taken from the northern body were analysed with the following results:-

No.	GS/M/6	GS/M/7
Manganese...(Mn)...	47.54 per-cent	54.08 per-cent
Iron...(Fe).....	1.50 " "	2.59 " "
Silica...(SiO <sub>2</sub> )....	10.88 " "	0.81 " "
Phosphorus...(P)...	0.07 " "	0.08 " "

**MC 269.** Northern Mineral Syndicate. One fairly large body and several small ones of little significance are included in this claim, which is about 2½ miles east-south-east from MC 247.

The manganese ore apparently occupies a similar position to that on the B.H.P. claim and has replaced the lowest members including the basal conglomerate of the quartzose beds which overlie the limestone. Some of the small bodies are very siliceous. The large body which has a maximum thickness of 13 feet was sampled (GS/M/8) but no samples were taken from the small thin deposits.

Reserves are estimated at:-

Large body -	10,200 tons
Smaller bodies -	900 "
	<hr/>
	11,100 "

The composition of sample GS/M/8, which was taken from the interior of a boulder about 12 inches in diameter, is :-

Manganese...(Mn)...	57.79 per-cent.
Iron...(Fe).....	2.47 " "
Silica...(SiO <sub>2</sub> )....	1.47 " "

**MC 57L.** Westralian Ores Pty. Ltd. The suffix "L" indicates that this claim which is approximately  $4\frac{1}{2}$  miles south of MC 247 is within the Nullagine district of the Pilbara Goldfield.

The largest deposit on the claim forms a low mesa circular in plan and about 250 feet in diameter.

The mesa rises from the floor of wide valley which trends northerly parallel to the general strike, and lies east of the limestone ridge which forms the western front of the range. Although the feature is only about 30 feet high its isolation and characteristic shape render it fairly conspicuous when viewed from the north or south.

Manganese ore does not occupy the whole surface of the mesa. On the north edge a segment with chord 200 feet long is occupied by siliceous ferruginous rock, and a roughly circular patch (mean diameter 105 feet) of similar rock occurs in the centre of the hill top. The vertical thickness of ore showing in the periphery of the body averages 6.5 feet.

If this siliceous patch is a thin capping on the manganese ore the deposit contains a substantial tonnage of the order of 16,000 tons. If on the other hand the siliceous ferruginous rock is not a capping but is the base of the manganese ore, the mass probably has a conical form and the ore lies on it as a ring of triangular cross-section. Under such circumstances the mesa deposit is not likely to contain more than 6,000 tons.

Limestone occurs at 500 feet west of the mesa but none was seen in the immediate vicinity of the deposits where the surface is strewn with quartzite and quartz rubble.

Estimated reserves in the group are:-

Mesa deposit	6,000 tons.
Three small deposits south of the mesa	1,900 "
	<u>7,900 "</u>

One sample (GS/M/5) representing a thickness of 8 feet was taken from the south-west vertical face of the orebody, and yielded on analysis:-

Manganese...(Mn)...	50.19 per-cent.
Iron...(Fe).....	1.51 " "
Silica...(SiO <sub>2</sub> )....	9.30 " "
Phosphorus...(P)...	0.07 " "

**MC 54L.** Northern Mineral Syndicate. This claim which is about  $\frac{1}{2}$  mile south of MC 57L, contains two pod-like deposits each about 120 feet long by a maximum width 30 feet. The bodies occur on the southern slope of hill and the country rock has fallen away from the south side of each body disclosing vertical faces of 10 feet and 14 feet at the western and eastern deposits respectively. The occurrence is on the eastern margin of the limestone and it is believed that the manganese ore is resting upon this rock but the surface is obscured by quartzose detritus. Some red jasper occurs in contact with the ore on the north side.

Total estimated reserves are 2,300 tons.

Sample No. GS/M/4 taken from the vertical face of the eastern body yielded:-

Manganese...(Mn)....	51.67 per-cent
Iron...(Fe).....	7.35 " "
Silica...(SiO <sub>2</sub> )....	2.21 " "
Phosphorus...(P)....	Trace " "

**MC 56L.** Northern Mineral Syndicate. Reserves of manganese ore in this claim which is one mile south-east from MC 54L, are negligible and probably amount to less than 200 tons.

The principal deposit is approximately 200 square feet in area and rests upon siliceous rocks. Limestone was not observed in the vicinity.

**MC 53L.** Northern Mineral Syndicate. This is the southernmost claim on the field and is about 6 miles south of MC 247. The deposits occur in four groups on a line trending north-north-west from the southern boundary of the claim.

The northernmost group contains nine separate bodies but all are small and thin. They lie on the bedding of the limestone and at least one of them, which is only 2 feet thick, penetrates the limestone down dip for a short distance. Reserves are regarded as negligible, but several hundred tons of ore could be recovered when adjacent deposits are exploited.

The second group, that is the second from the northern end of the line, is about 600 feet slightly east of south from the first. The group contains two fairly large deposits of which the surface dimensions are 7300 square feet and 9000 square feet. The first mentioned is divided by a siliceous patch into two lobes of approximately equal area. The apparent thickness increases from 2 feet at the northern end to 8 feet at the south. The southern member of the group is 280 feet long by an average width of 35 feet. Similarly to the small bodies of the northern group its long axis is parallel to the strike of the enclosing limestone, but the orebody has considerable thickness. At the southern end of a vertical face of ore 13 feet thick is exposed, but the northern end is comparatively thin. There is little doubt that the deposit is controlled partly by bedding and partly by vertical jointing parallel to the strike. An average thickness of 8 feet has been assumed for the purpose of tonnage calculation. This group contains estimated reserves of 12,100 tons.

The third group is 1,000 feet south of the second and includes seven separate bodies of which five are too small to add significantly to reserves, and the sixth is estimated to contain 1500 tons. The seventh and largest body is the irregular deposit shown in Fig. 2.

Two parallel bodies which fill opened joints are connected by a thin sub-horizontal band of ore lying in the bedding. At its exposed edge the bedded ore is only 1 to 2 feet thick. It extends westerly down the gentle dip and is concealed beneath limestone.

Reserves in the third group are estimated at 3,100 tons of which slightly more than half is contained in the seventh deposit, from which two samples GS/M/2 and GS/M/3 were taken, and analysed with the following results:-

No.	GS/M/2	GS/M/3
Manganese...(Mn)....	52.87 per-cent	49.21 per-cent
Iron...(Fe).....	0.71 " "	1.05 " "
Silica...(SiO <sub>2</sub> )....	10.06 " "	17.82 " "
Phosphorus...(P)....	0.07 " "	0.11 " "

The fourth and southernmost group comprises eight small bodies occupying a circular area 500 feet in diameter. This group is about 1000 feet south-east from the third group just mentioned. The manganese ore is associated with siliceous sediments and contains siliceous patches which seriously reduce the tonnage of ore. One body with a maximum thickness of 10 feet was sampled (GS/M/1.) Reserves contained in this body are estimated at 1800 tons, but the smaller deposits within the group have not been included.

Sample GS/M/1. yielded:-

Manganese...(Mn)...	51.54 per cent.
Iron...(Fe).....	1.68 " "
Silica...(SiO <sub>2</sub> )....	7.70 " "
Phosphorus...(P)...	0.15 " "

Total reserves contained within MC 53L are, taking the groups of deposits in order from north to south:-

First group.....	small
Second " .....	12,100 tons

Third. group.....	3,100 tons
Fourth " .....	1,800 "
	<hr/>
	17,000 "
	<hr/>

This total does not include 14 small bodies.

Deposits on Southern boundary of Warrawagine Station.

Three flat-lying deposits occur on the easterly slope of hill in rough quartzite country about 6 miles south of MC 53L. Access is difficult.

Two of the deposits are only about 3 feet thick and the other is approximately 9 feet in thickness. Estimated tonnages of the three deposits are:-

Northern body	1,400 tons
Central "	1,300 "
Southern "	1,900 "
	<hr/>
	4,600 "
	<hr/>

The deposits were measured roughly by compass and pacing and no samples were taken.

Origin of the Manganese Ore.

The manganese ore is of secondary origin and is probably derived by solution from the impure limestone with which it is now associated.

It appears that the manganese accumulated into workable deposit by replacement of silicified beds in the limestone and by the infilling of joints and solution cavities which may have had silicified margins.

Silicification and manganese deposition did not take place contemporaneously. Some of the interbedded sandstones contain sharply angular blocks of silicified limestone indicating that silicification took place during Nullagine time.

The manganese deposits occur at such the same general level which suggests that they formed on a land surface of low relief with sluggish drainage which prevented the rapid dispersal of manganese bearing solutions.

### ACKNOWLEDGMENTS

Mention has already been made of the valuable assistance rendered by both Westralian Ores lty. Ltd. and Northern Mineral Syndicate. If the transport provided by these firms and the local knowledge possessed by their representatives had not been available the survey would have required a much longer period in the field.

The writer is also indebted to Mr. W.L. Grayden, M.H.R. for arranging accommodation in Perth and arranging transport onwards from there and for assistance in the field. Mr. de la Hunty's willing cooperation is also gratefully acknowledged.

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# SUMMARY OF RESERVES

<u>Tenement</u>	<u>Approx. locality</u>	<u>Tons</u>	<u>Remarks</u>
MC 211	Half mile west of Mt. Sydney	1,600	Compass & pacing only
MC 268	4 miles north-west of MC 247	4,300	Contained in four bodies
-	1½ miles north of MC 247	8,500	Access somewhat difficult
MC 274	1 mile north-west of MC 247	2,400	Maximum thickness 24ft. Reserves in two bodies.
MC 271) MC 272) MC 273)	About 1 mile north-east from MC 247	{ 6,200 1,200 800	{ Figures exclude much siliceous ore.
MC 247	About 19 miles south of Mt. Sydney	25,100	Mainly contained in two bodies
MC 269	2½ miles east-south-east from MC 247	11,100	One body with maximum thickness of 13 ft. contains 10,200 tons.
MC 57L	4½ miles south of MC 247	7,900	Tonnage difficult to estimate may lie between 7,900 & 15,000 tons.
MC 54L	About half mile south of MC 55L	2,300	Two bodies approximately equal.
MC 56L	One mile south-east from MC 54L	-	Less than 200 tons
MC 53L	Six miles south of MC 247	17,000	Calculated reserves are contained in five separate bodies. Fourteen small bodies, not included, might yield an appreciable tonnage.
-	Southern boundary of Warrawagine Stn. about 6 miles south of MC 53L	4,600	Access difficult. Compass & pacing survey of deposits only.

# GEOLOGICAL SKETCH MAP of GREGORY RANGE MANGANESE FIELD

WESTERN AUSTRALIA

## Reference

RECENT		Alluvium
TERTIARY		Oakover beds : limestone
PROTEROZOIC		Dolomitic limestone
		Quartzite
ARCHAEOON		Gneissic granite, metamorphic rocks.
		Manganese deposit with Mineral Claim Number

