DEPARTMENT OF MINES
SOUTH AUSTRALIA

Progress Report (No. 1)

on

IRON ORE PROSPECTING

SOUTHWEST AREA

MIDDLEBACK RANGE NORTH DISTRICT.

by

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IRON SECTION

GEOLOGICAL SURVEY

CONTENTS

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ABSTRACT

A zone of limonite and hematite outcrops 4 miles long has been located on the lower southwestern slopes of the Northern Middleback Ranges. Detailed mapping, Drilling and Costeaning have been commenced by the Department to evaluate the area.

The area has a potential 10-15 million tons of ore which occurs in individual bodies to a shallow depth.

1. INTRODUCTION

The Southwest Area may be defined as the western slopes of the northern Middleback Range between Iron Warrior and Mount Middleback North. The area lies on the southeastern extremities of Cooyerdoo Station with easy access from the Whyalla Kimba Road. A Departmental camp has been set up immediately north of the Broken Hill Proprietary Co. Ltd. Iron Warrior Leases approximately ½ mile from the main road.

The lower slopes of the range are covered soil and scree material to where the wind blown sand encroaches from the western plain. The vegetation is sparse on the scree material but mallee grows on the sand. The area contains numerous outcrops of limonite and hematite over a length of 4 miles.

The southwest area has been split arbitrarily into 6 prospects, five of which were located by the writer during August 1956, Prospect No. 6 being located in July, 1957. Testing was delayed until certain claims in the area were more clearly defined. Percussion Scout boring commenced on 3/4/57 at Prospect No. 2, operations were subsequently transferred to Prospect No. 3, then Prospect No. 5. Prospect No. 5 was selected for evaluation, and a

comprehensive programme of drilling and costeaning was begun. One Diamond Drill hole has been put down to test the limonite outcrop on Prospect No. 6.

The Departmental Camp is serviced with freshwater and supplies from Iron Baron Township. The cost of fresh water plus transport charges enforced the use of salt water for drilling purposes. A water bore MNPH1 was put down 2½ miles to the west and a pump jack installed. A supply of 500 gallons per hour of saline water containing 3250 grains per gallon was obtained.

2. PREVIOUS WORK AND ACKNOWLEDGEMENTS

Reports and Publications

MILES, K. R. The Geology and Iron Ore Resources of the Middleback Range Area (Bulletin 33 Geological Survey of South Australia)

McPHARLIN, D. Magnetic Observations in the Middleback Range Area (loc. cit. Appendix 1)

MILTON, B.E. Geophysical Prospecting for Iron Ore at Prospect No. 5 Middleback Range North District Southwest Area (Geol. Survey Geophysical Report 1/58, GS885).

There are other publications on the Middleback Range Districts referring to the whole area but those quoted refer to the area dealt with by this report.

Dr. Miles mentions the area briefly on P56 when discussing the reflection of alternating en echelon parallel folds as crenulations in the boundaries of the outcrops against the soil covered low land.

Mr. McPharlin's ground magnetometer surveys were concerned with the Camel Hill Line but embraced the western part of the Southwest Area.

Reference has been made to Mr. Milton's work in the text of the report.

No earlier workers have reported on detailed investigations of this part of the Middleback Ranges.

Tabulated below are the current Mining Leases and Claims covering parts of the Southwest Area.

Mineral Lease 2713	BHP Co. Ltd.	Mt. Middleback North
2721		"
2722		"
2661		Iron Warrior
2723		"
Mineral Claim 15759	J.A. Buckingham	Nth. of ML 2661
15760	"	"
15882	"	Nth. of Prospect 4
16002	"	"
16077	"	South of Prospect 5

The remainder of the area is included in the reservation from operation of the Mining Act gazetted on 13/5/48.

3. GEOLOGY

3.1. Regional Geology

The whole of the Southwest Area has been mapped by Dr. Miles as either Lower Middleback Quartzite, Talus Slope or Dune Sand.

An extract from the stratigraphical sequence published in Bulletin 33 is as follows:

Middle Pre-Cambrian or Late Archaean	Middleback Group	Upper Middleback Quartzite
		Cook's Gap Schist
		Lower Middleback Quartzite
		Middleback North Dolomite
	Gneiss Complex	

Dr. Miles designates the formation below the Lower Middleback Quartzite as Middleback North Dolomite. The dolomite in the writer's experience is restricted to relatively small areas in the Middleback Ranges.

In the areas where no dolomite occurs there is a sequence of softer rocks seldom outcropping but often in excess of 500 feet thick below the Lower Middleback Quartzite. In the writer's opinion this horizon is equivalent to the dolomite.

The "soft rock" sequence referred to above consists of interbedded schists, amphibolites and leached hematite-quartzites. All the larger bedded type ore bodies found in the Middleback Ranges occur in this basal horizon.

The regional dip of the overlying Lower Hematite Quartzite is 40^{0}-50^{0} to the east, there being numerous crenulations and minor drag folding.

3.2. Geology of the Southwest Area.

The bedding in the prospects in the Southwest area can be expected to follow the regional trend of an overall east dip, but in the softer rocks there is serious crumpling and minor folding. The incompetence of some beds makes a complex picture in some areas, but adjacent competent hematite-quartzites are usually found to follow the regional trend.

The costean cross-sections (Prospect 5) show a consistent shallow east dip 10^0 - 30^0 with intense crumpling in the leached ore horizons. The tabulation below shows approximate thicknesses of the beds and their rock types encountered while testing Prospect No. 5.

Rock Type	Estimated True Thickness	
	22000'N	22700'N
8. Hematite-quartzite	Massive (? ft.)	Massive (? ft.)
7. Crumpled black soft ore interbedded with red schist	100'	140'
6. Leached hematite-quartzite	100'	130'
5. Weathered amphibolite	20'	15'
4. Ore with crumpled interbedded schist	40'-70'	80'
3. Smooth red, yellow and brown clay rock (cherty appearance)	30'	30' + (limit of data)
2. Quartzite breccia	80'-90'	
1. Limonitic clay rock and/or weathered amphibolite, secondary cherty limonite and quartz, probably thin beds of hematite-quartzite. All highly weathered.	unknown	

It is assumed that the structural conditions will be essentially similar on the other prospects. More attention will have to be paid to the effect of the outcropping pitching folds which produce the crenulated contact line of outcrop with the sand cover on the lower slopes when assessing the southern prospects. The basal horizon with fold axes striking at 15^0 to 25^0 (Magnetic) continually steps over to the east as the drag folds appear to the south. There is probably an S shaped inflexion in the concealed outcrop of the beds between Prospects 2 and 3 and again between 3 and 3a. Some significance may be attached to the fact that these inflexions are never actually seen to outcrop, detailed mapping of the range above will ascertain if the obscured areas coincide with the axes of folds.

3.3. Ore Geology

The ore occurring in this Lower Horizon of the Middleback series falls into two main classes.

(i) The type commonly outcropping which is predominantly limonitic. The limonite may be subdivided into

(a) That formed as a weathering product of, and capping, a hard hematite ore body. The dense hard hematite as found at Iron Monarch is not expected in the Southwest Area.

(b) That formed as a surface deposit on, or enrichment of, underlying rocks.

(ii) The soft sandy bedded hematite. This type of ore may be also divided into 2 classes.

(a) That formed from the leaching of silica from hematite-quartzites.

(b) The hematite which is associated with the amphibolites in an apparently interbedded relationship.

To deal with these types in turn:

(1) The limonite outcrops are the most difficult to interpret. They are often structureless masses where exposed on the surface, all relict structures being obliterated by the transformation to limonite. This soaking has been followed with no apparent change to 10 feet in costean 24300'N, while in the same costean a macroscopically similar outcrop proved to be capping weathered amphibolite.

Subsurface testing failed to trace the ore outcropping about co-ordinates 22100'N 20900'E. It must therefore be considered probable that many of this type of ore outcrops will not persist to any depth (Probably 20'-30').

It must also be remembered that many of the hard hematite ore bodies are capped with limonite similar in macroscopic appearance to the material found in this area. It is probable that many will yield no ore but all must be tested. Recently approval was obtained to test the large outcrop on Prospect No. 6. A Diamond Drillhole collared on the outcrop passed out of hard limonite at 13 feet but continued in limonitic material of probable ore grade to 85 feet.

(2)a. The leached quartzite type of ore is a sugary hematite containing varying amounts of relict silica. The leached quartzites grade from pure hematite to pure quartzite (sandy). They are difficult to sample by drilling methods as the material to be tested is very friable and will often run. They are formed by the leaching of silica from hematite-quartzite with or without the addition of further iron. The rock formed has a low specific gravity often less than the original hematite-quartzite, pores being left where the silica has been removed.

The continuity of the leaching in the beds, both along the strike and down dip is unknown.

(2)b. The hematite-amphibolite association .....

The hematite ore bodies occur as discontinuous lenses in a weathered metasediment locally known as amphibolite. They are more likely to persist in depth than the silica leached quartzites. The Iron Knight ore occurrences are type examples of the association. There is a diversity of opinion as to their origin.

4. PROSPECTS NOS. 1, 2, 3, 3a, 4, and 4 to 5

4.1. Prospect No. 1.

Location: approximate co-ordinates 7250'N to 7700'N
14800'E to 15200'E
Adjacent to M.L. 2661 (B.H.P. Co. Ltd.)
and M.C. 15760 (J.A. Buckingham.)

Description: - Several small outcrops of high manganese ore grade material occur in a zone bounded to both east and west by hematite quartzites. The area available is limited by the proximity of the adjacent claim to the north. A reconnaissance map was produced (S1769 attached) and surface grab samples were submitted for assay. Further work has been deferred until the larger prospects to the north are tested.

ASSAY RESULTS

Surface chip Sample 49.6%Fe (Mn Awaited) 8.1% Insol. A 330/58

4.2. Prospect No. 2.

Location: Co-ordinates 11150'N to 11400'N
11000'E to 11500'E

Description:- This prospect was the first to be located and as it was well clear of all claims and leases, was the first to be tested.

The outcrop is a macroscopically structureless mass of limonite with some lustrous residuals in the western part of the body. The outcrop is 200 feet long and 50 feet wide with two further outcrops to the east, large enough to warrant testing to find if the limonite is capping an ore body.

Percussion Scout Boring was recommended and eight boreholes were put down using Plant 10. The holes were all uncased, due allowance must be made for contamination of samples.

An east west line of holes at 50 foot intervals was laid out across the outcrop. The first hole PSB 30 failed to penetrate the limonite, the material proved too hard for the light percussion rig, and drilling was stopped at 38'. A similar result was achieved in PSB 35, 50' to the west. All the other holes yielded material which was identified as belonging to the Middleback Series. The inferred strike from overlying rocks is slightly east of north with a general easterly dip. The scout bores indicate a concealed outcrop width at least 100' with a possible additional 150 feet concealed by limonite.

A summary of the results of the Percussion Scout Boring is as follows

PSB No.	Coords.	R.L.	Depth	Assay %Fe.	Assay %Insol.	Description
30	10774'N 12272'E	802'	38'	52.6	6.4	Limonite
31	10772'N 10324'E	808'	53'	48.2	12.8	Yellow ochreous clayey limonite
32	10770'N 11375'E	814'	32'	50.0	10.7	Siliceous hematite 27'-32'
33	10766'N 11424'E	820'	32'	40.2	26.7	Siliceous hematite 27'-32' (Hematite-quartzite)

PSB No.	Coords.	R.L.	Depth	Assay %Fe.	Assay %Insol.	Description
34	10764'N 11470'E	824	12'	51.9	10.0	Siliceous hematite 10'-12'
35	10776'N 11223'E	793	35'	52.8	6.6	Limonite
36	10780'N 11172'E	788	56'			0-30' Alluvial material. 30'-56' Red schist.
37	10670'N 11318'E	807'	46'	53.1	7.3	0-15' Limonite 45'-46' Red schist (vide PSB 36).

The cover is far too thick for costeaning operations to be recommended. Future testing should be directed at proving strike length (Scout Percussion Boring) and a diamond drillhole on PSB 34 would indicate the continuity in depth. The iron content of the material penetrated by PSB's 32, 33 and 34 makes this prospect worthy of further investigation.

4.3. Prospect No. 3.

Location: Co-ords. 12400'N to 12900'N
10500'E to 11100'E

Description: - This prospect has manganiferous iron ore, bedded hematite, and limonite outcropping. As with all the lesser prospects the outcrops cannot be followed over great strike length, less than 300'.

When percussion scout boring began on this prospect efforts were made to prove continuity along the strike. Continuity was indicated 100 feet to the north but not to the south. The material intersected in the northerly holes was identified as belonging to the ore horizon but the iron content was low.

Costeaning was proposed over the outcrops to obtain structural data and ascertain what lay below the float material between outcrops Further percussion scout boring was instituted to ascertain the depth of cover. These holes yielded sufficient information about the bedrock for the present and further work on this prospect has been deferred until investigation of Prospect No. 5 is completed.

A summary of Percussion Scout Borehole results is tabulated below.

PSB No.	Coords.	R.L.	Depth	Assay %Fe.	Assay %Insol.	Description
38	12131'N 10694'E	802'	31'			Rich H-Q 30'-31'
39	12041'N 10688'E	799'	25'			Hard clay rock. 15'-25'
40	12035'N 10789'E	807'	41'			Amphibolite 15'-41'
41	12024'N 10889'E	814'	30'			Surface material 0-30'
42	12493'N 10233'E	825'	33'			Lim. Schist 31'-33'
43	12488'N 10881'E	830'	55'	42.2	23.8	Lim. Schist 25'-55'
44	12486'N 10934'E	834'	50'	39.4	27.7	Lim. Schist 25'-50'
45	12483'N 10982'E	843'	15'			Lim. chert 5'-15'
46	12206'N 10699'E	806'	35'			Scree
47	13387'N 10771'E	813'	31'			Weathered amphibolite 14'-31'.
48	13382'N 10845'E	831'	28'	51.9	9.3	Siliceous hematite 10'-13'
				37.7	32.4	Leached quartzite 13'-28'. (Assay 15'-20' only)
49	12376'N 10904'E	841'	40'	39.2	27.5	Lim. schist 8-30'
50	12196'N 10892'E	838'	48'	(awaited)		Leached quartzites 15'-47'.
51	12194'N 10942'	846'	30'	34.0	33.9	Lim. Clay 0-30'
52	12199'N 10840'E	829'	24'	35.0 (14.8% Mn)	9.6	Lim. Clay 5'-20' MN Fe ore at 24'.
53	12138'N 10795'E	835'	36'	39.6	15.7	Mn Fe Clays 12'-30'
54	12141'N 10842'E	822'	31'			Amphibolite 25-31'

Recommendations as to further work on this prospect are included with those on Prospects 3a and 4.

4.4. Prospect No. 3a

Location: Co-ordinates 12850'N to 13300'N
10750'E to 11000'E

Description: - The prospect consists of several small sporadic outcrops of hematite weathered in part to limonite. The ore is similar to that exposed at co-ordinates 12350'N to 10800'E Prospect No. 3, and is thought to be the same horizon. As outcrop is very poor in the ore zone, grab samples only have been taken. A sketch map at a scale of 100' to 1" (S 1782) is appended.

It is recommended that the area embraced by Prospects Nos. 2, 3, 3a, and 4 be mapped at a scale of 100' to 1" to ascertain the relation of the prospects to each other. This mapping would be followed by a programme of Percussion Scout Boring to prove continuity along the strike between outcrops. Should continuity of a bed averaging 100 feet in thickness be indicated from Prospect No. 2, co-ords. 10600'N 11250'E, to Prospect No. 4, co-ords. 14000'N 10700'E, 3½ million tons of ore per 100' depth would be expected.

ASSAY RESULTS

Surface chip Sample	56.8%Fe	0.19%Mn.	3.8%Insol.	A 331/58

4.5. Prospect No. 4

Location: Co-ordinates 13500'N to 14100'N
10650'E to 10800'E

Description: - This prospect was one of the five first located. It consists of hematite and limonite floaters with no definite ore outcrop. There is an exposure of red schisty leached quartzite on the south bank of a wash about 13750'N. The grab sample of hematite float was taken adjacent to the above exposure. Hematite quartzite fragments were passed over as having come from further up the slope.

The sample from the south end of the prospect was taken from massive structureless limonite outcropping on the strike of the ore horizon.

ASSAY RESULTS

Floaters Nth. end of Prospect	57.3%Fe	0.30%Mn	9.7%Insol.	A332/58
Surface chip Sample	60.4%Fe	0.20%Mn	1.6%Insol.	A333/58

4.6. Area Between Prospects No. 4 and No. 5.

The major part of this area held under MC 16002 and MC 16077. The ore horizons here are mostly under sand and exposures are few. It is likely that further bodies will be found under this sand as there is no evidence for assuming a break one mile in the ore horizon.

One diamond drill hole was put down on MC 16002 by Geo. Wimpy and Co. Ltd. to test for ore on the claim.

Two holes were sited on MC 15880 to the south east of Prospect No. 5. In the writer's opinion this claim is not pegged on the basal ore horizon but higher, in the Lower Hematite quartzites.

5. PROSPECT NO. 5

Location: Co-ordinates 20500'N to 25000'N
10000'E to 11550'E

Description: - The prospect consists of two sporadic lines of hematite and limonite outcrops extending over 5000' strike length. The lower horizon outcrops as hematite liberally capped with limonite, whilst the upper rarely outcrops and consists of black sandy hematite.

The prospect was located in the first five but testing was delayed until the position of MC 16077 was determined. When two of the original pegs of the above claim were found 1000' and 2500' (approx.) to the south Percussion Scout Boring began.

5.1. Structural Geology

The regional geology shows a consistent easterly dip in the south-western part of the range, there are quite numerous drag folds with amplitudes of up to 100 feet. By inference the zone containing the ore horizons can be expected to have a similar overall easterly dip in the eastern flanks of the prospects. This is confirmed in the costeans east of the baseline (1100'E). Some minor folding is evident, but an easterly dip of 15-55° has been observed over a 200 feet thickness. A description of the rock types has been included in Section 32 of this report.

The western flank of the prospect is masked by sand and the central portion liberally capped with limonite. It is difficult to obtain structural data in this central region and more work is required to obtain a reliable section.

The predominant strike is approximately 020° (Mag.). There is strong lineation in some of the more schistose quartzites which reflects the plunge of the adjacent folds. There is far too much variation for the lineation to be directly related to the major folding.

The lineation is useful in orientation of drill cores and so placing a positive value on other data discerned.

5.2. Geophysics

Detailed magnetic and gravimetric surveys have been carried out by Messrs. Seedsman and Milton on Prospect No. 5 and a report (G.S. 885 dated 20.1.58) has been issued by Mr. Milton.

The surveys were requested to test for the following:-

(1) Possible further ore beds to the west below the wind blown sand.

(2) The gneissic-granite basement which is expected to form the western limit of the zone containing the ore bodies.

(3) The correlation between gravity profiles and known rock types in the costeans.

The surveys showed no large anomalies but they gave indications of what may be either a more dense bed or the granite contact running from 10200'E in the south (20,000'N) to 10500'E in the north (27000'N). In accordance with Mr. Milton's proposals this anomaly was tested by Percussion Boring. The hole (MNPH7) was discontinued at 128'. It is thought the bed of hematite-quartzite penetrated from 115 feet to 128 feet (plus) shows sufficient density contrast with the surrounding rocks to give rise to the gravity anomaly.

The gravity contour plan also showed a "high", centred in the scree fan coinciding with the ore zone followed by Percussion Scout Boring. (see later) MNPH's 9 and 10 are now testing the extent of this ore zone.

5.3. Sampling

A programme of sampling across the strike of all outcrops was commenced by the prospector but this was discontinued when costeaning operations began. The outcrops are often contaminated with limonite and give a false

indication of the grade of the rock below, an exception being the prominent hematite-quartzites.

It was decided to restrict the sampling to the material exposed in costeans. This work is completed and the material is now in the hands of the analysts. Results received to date are tabulated below (Appendix 4) and an assay plan (to date) at a scale of 40' to 1" ( ) is appended.

5.4. Percussion Scout Boring

The first task assigned to the Scout Drill was a line of holes at 50 foot intervals across the strike of the bedding to test the thickness of the concealed ore. Eleven holes covering a width of 600 feet were put down to an average depth of 35' penetrating the surface material and probing to identify the bedrock below.

Only one of these holes penetrated material which proved to be of ore grade (PSB56, 28-35', 62.8% iron). This hole was 150' south of the main ore outcrop (about co-ordinates 22075'N, 10950'E). It was then decided to test the continuity of this ore bed to the south. Seven holes (PSB66 - 69, 79, 82, 83) traced what has been interpreted as the hanging wall of the ore bed to 21200'N. PSB 83 (21200'N, 10900'E) intersected the ore bed from 37' to 61'. PSB's 82 and 83 were put down by the larger Scout Drill and the latter was continued to test the ore zone.

The earlier holes were all uncased and in some instances (e.g. PSB67, 39.1% Fe) the samples have been liberally contaminated from the sides of the hole.

The light Scout Drills were then used in conjunction with the costeaning operations. All Scout Boring has now ceased on Prospect No. 5.

PSB SUMMARY

No.	Co-ords.	RL	Depth	Assay	Remarks	Purpose
55	21900'N 10850'E	823	71½		Leached quartzite (?)	Scout
56	21900'N 10900'E	825	35	62.8Fe 3.7Insol.	Hematite 28' - 35'	Scout
57	21900'N 10950'E	828	5		Scree Boulder	Scout
57a	21900'N 10947'E	828	50½		Red Schist at bottom?	
58	21900'N 11000'E	832	30		Schist	Scout
59	21900'N 11050'	839	30		Schist	Scout
60	21900'N 11100'E	846	45		Amphibolite 20' - 36'	Scout
61	21890'N 11150'E	853	51	34.3 Fe 45.4 Insol.	Leached quartzite	Scout
62	21900'N 11205'E	859	55	42.5 Fe 36.8 Insol.	Leached quartzite	Scout
63	21900'N 11275'E	870	10	32.5 Fe 25.6 Insol.	Hematite-quartzite, rich (?)	Scout
64	21900'N 11307'E	880	6½	22.7 Fe 39.6 Insol.	Hematite-quartzite	Scout
64a	21900'N 11300'E	878	5'		Hematite-quartzite	Scout
65	21900'N 11364'E	890	6	29.4 Fe 42.4 Insol.	Hematite-quartzite	Scout
66	21800'N 10900'E	828	43	60.0 Fe 6.6 Insol.	Hematite 35'-43'	Scout
67	21700'N 10900'E	827	40	39.1 Fe 37.0 Insol.	Hematite 40' (contaminated)	Scout
68	21600'N 10900'E	820	45	60.4 Fe 5.2 Insol.	Hematite 35'-45'	Scout
69	21500'N 10900'E	828	25	60.6 Fe 6.8 Insol.	Hematite 22½' - 25'	Scout
70	21050'N 10705'E	828	17	51.1 Fe 17.3 Insol.	Siliceous hematite Scree 5'-17'.	Costean
71	21050'N 10645'E	823	8	28.6 Fe 53.3 Insol.	Siliceous Hematite Scree 5'-8'	Costean
72	21050'N 10600'E	820	20	28.3 Fe 51.0 Insol.	Siliceous Hematite Scree 5'-20'	Costean
73	23293'N 11440'E	865	20		Bedrock (?) at 13'-15'	Costean
74	23297'N 10895'E	836	21		Bedrock at 15' Amphibolite 15'-12'.	Costean

PSB SUMMARY

No.	Co-ords.	RL	Depth	Assay	Remarks	Purpose
75	21055'N 10760'E	832	15		Bedrock at 8'. Smooth soft clay with yellow cherty appearance	Costean
76	22700'N 10900'E	812	15	30.4 Fe 39.8 Insol.	Limonitic schist 5'-15'	Costean
77	22705'N 10975'E	825	21		Amphibolite 3½'-21'	Costean
78	23900'N 11110'E	821	36		Yellow clay rock	Costean
79	21400'N 10900'E	831	15		Hematite-quartzite? (assays awaited)	Scout
80	23333'N 10830'E	836	70		Limonite 0 to 15' Amphibolite 15'-45' Schist 45'-70'	Testing for ore
81	23900'N 11600'E	827	6		Hematite-quartzite	Costean
82	21300'N 10900'E	833	30		Hematite 22'-30'	Scout
83	21200'N 10900'E	831	80		Hematite 37'-61'	(Scout (0-40' (Perc. (40'-80'
84	22920'N 11148'E	842	47		Yellow weathered limonite and hematite 5'-27'	Costean
85	22050'N 10805'E	818	15		Bright red clay rock	Costean
86	22045'N 10850'E	825	59		Cherty clay rock (vide PSB 85)	Costean
87	21050'N 10550'E	818	27		Hematite quartzite scree 0'-27'.	Costean
88	21105'N 10700'E	828	40	40.0 Fe 26.1 Insol.	Scree to 30'	Costean
89	21050'N 10500'E	815	78		Scree to 50'	Costean
90	23220'N 11095'E	834	37		Leached Quartzite to 35' R Fe Schist 35'-37'	Testing for ore
91	23220'N 11167'E	840	80		Ore zone 10'-45'	Testing for ore
92	23220'N 11234'E	845	81		Ore zone 7'-25' Possible second zone below 81'.	Testing for ore

5.5. Costeaning

From 26/9/57 to 13/11/57 Roche Bros. Pty. Ltd. were engaged under contract to dig 4000 feet of costeans. They employed a foreman, a ⅜ yard back-acting shovel, a small compressor and jackhammer, and two labourers. The operation consisted of stripping with the shovel to the full depth where the rock was soft, then shooting any material too hard for the shovel, removing this with the shovel, and finally hand cleaning. The operations required continuous supervision by the department to identify bedrock.

The contractors completed 3981' of costeans and these have been mapped and sections drawn at a scale of 40' to 1" ( ). Four long costeans were laid out across the ore zone, rising 2070' feet, then after a preliminary assessment the remainder of the available footage was used in short costeans over zones of probable ore.

Details of the costeans completed are as follows:-

Costean No.	Length	Ore Intersection	Fe%	Remarks
243'N	201'	130'	50.8	
240'N	167'	76'	52.8	dug in 2 sections.
233'N	* 618'6"	140'	55.7	
230'N	45'	-	-	
229'N	146'	95'	55.1	
228'N	112'	35'	55.1	dug in 3 sections.
227'N	* 617'	60'	50.7	
225'N	48'	-	-	
22425'N	33'	30'	55.2	
22350'N	84'	50'	57.2	
222N	340'	70'	53.9	
		32'	52.1	
22125'N	120'	70'	56.8	dug in 2 sections.
22050'N	* 589'6"	120'	52.4	
		110'	50.1	
216'N	156'	130'	52.1	
211'N	113'	-	-	
21050'N	* 306'			dug in 2 sections.
206'N	82'	50'	53.3	
20450'N	203'	150'	49.9	
Total	3981'	1398'		

* Denotes original four costeans.

The costeans have proved valuable both for obtaining samples of the ore and obtaining a structural picture. In any future project of a similar nature the contracting for costeans is recommended as specialists with adequate machinery can be employed.

5.6. Percussion Boring

From the initial geological concept of a 40°-50° dip to the east angle Diamond Drillholes were proposed across the supposed bedding. The first hole did not confirm the above concept, and, also, most of the rock types encountered would not core with the Diamond Drill.

On 11.11.57 approval was obtained for 3000 feet of Percussion Boring to test the softer ores in depth. Nine Holes have been proposed to date. Five of these, totalling 959 feet have been completed. Two holes MNPH 7 (128') and MNPH8 (90'6") encountered ground too hard for percussion boring; (MNPH8 may be able to continue with a larger machine.) Two holes MNPH9 and MNPH10 are in progress at the time of writing of this report.

The following is a summary of the results of the Percussion Boring, complete logs can be found in Appendix E.

Hole No.	Co-ords.	R.L.	Depth		Remarks
MNPH2	21050'N 10650'E	823'	237'	0 - 30' 30'-235' 235'-237'	Hematite quartzite scree Clay schist(?) limonitic in part, some amphibolite. Siliceous limonite(?)
MNPH3	22045'N 11375'E	915'	116'	0 - 27' 27'- 80' 80'-116'	Silty hematite. Leached hematite-quartzite Siliceous hematite and limonite.
MNPH4	22325'N 10990'E	829'	304'	0 -50' 50'-125' 125'-304'	Hematite quartzite Leached schistose quartzite. Amphibolite and schist.
MNPH5	23030'N 11200'E	843'	167'	0 - 65' 65'-125' 125'-167'	Scree and amphibolite(?) Leached quartzite grading to ore Brown clay schist with hard patches of siliceous limonite.
MNPH6	22100'N 10965'E	829'	135'	0 - 25' 25'- 45' 45'- 75' 75'-110' 110'-135'	Silty hematite Limonite clay rock (amphibolite?) Leached hematite-quartzite. Clay schist (?) Quartzite and limonite (breccia?)
MNPH7	21220'N 10500'E	812'	128'	0 - 55' 55'-115' 115'-128'	Hematite-quartzite scree. Yellow brown limonitic clay rock (amphibolite?) Leached hematite-quartzite.
MNPH8	22080'N 11080'E	846'	90'6"	0 - 25'? 25'- 65' 65'-90'6"	Amphibolite. Leached schistose quartzite. Hematite quartzite(?)
MNPH9	21600'N 10910'E	821'	185' (I.P.)	0 - 35' 35' - 55' 55' - 80'	Scree and schist Silty hematite. Leached hematite quartzite
MNPH10	21800'N 10910'E	828'	36' (I.P.	0 - 30' 30'- 36'	Scree and schist Hematite.

MNPH2

OBJECT:- To test in depth the siliceous hematite (?) which could not be penetrated with Plant No. 10, using a Ruston Plant.

RESULT:- Penetrated siliceous hematite scree from 0-30' then clay, schist(?), amphibolite, etc., to 237 feet

The material reported as siliceous hematite in PSB's 70, 71 and 72 proved to be a dense scree body with very little clay. Samples collected contained 90% or more siliceous hematite of a very consistent appearance.

MNPH3

OBJECT:- To test in depth the ore exposed in the adjacent costean, 22050'N from 11342'E to 11403'E.

RESULT:- Silty hematite penetrated from 0-27', leached hematite quartzite (schistose) from 27'-80' then siliceous hematite and limonite from 80'-116'. The latter proved to be a quartzite breccia recemented with limonite (vide MNDD3). As the rock proved too hard for percussion boring the hole was discontinued and completed by Diamond Drilling.

MNPH4

OBJECT:- To test the lower ore horizon in depth.

RESULT:- The ore horizon proved to be a leached hematite-quartzite, with a very low iron content.

MNPH5

OBJECT:- To test for continuity along the strike of ore zone indicated in costeans to the south.

RESULT:- Penetrated leached hematite-quartzite from 65'-125' possibly ore grade material from 110'-125'. Assay results are awaited.

MNPH6

OBJECT:- To test the ore outcropping at the above co-ordinates in depth.

RESULT:- The hole ran out of ore at 25' and did not encounter further ore grade material. The leached hematite quartzite encountered from 45'-75' in probably the same bed as the ore exposed in Costean 22200'N from 10870'E to 10915'E

MNPH7

OBJECT:- To test a gravity high at the above co-ordinates.

RESULT:- This hole was discontinued at 128'. The hematite quartzite encountered from 115' to 128' + is thought to cause the gravity anomaly.

MNPH8

OBJECT:- To test the lower ore horizon down dip.

RESULT:- Penetrated the ore horizon from 35'-67'. Assays are awaited.

MNPH9 - In progress

OBJECT:- To test the ore horizon followed by Scout Boring below the scree fan. This hole has also been recommended as the centre of a small gravity high.

RESULT:- Penetrated ore horizon from 35'-55'. The hole has now reached 185 feet(1.5.58) without penetrating a lower zone of ore.

MNPH10

OBJECT:- To test the ore horizon followed by Scout Boring below the scree fan.

RESULT:- Penetrated hematite ore from 30' to 36'. Hole in ore and in progress (1.5.58)

5.7. Diamond Drilling

After preliminary scout boring the two methods of evaluating Prospect No. 5 selected were Costeaning in conjunction with Diamond Drilling. Where taken, the prevailing dip was 30° - 50° east. Consequently one angle Diamond Drill hole at Co-ords 22075'N 11100'E depressed 45° west was proposed and three more foreshadowed. The results from this first hole caused further angle holes to be deferred.

The expected intersections in MNDD2 did not eventuate and apparent continuity with the surface was lost at 40 feet. The remainder of the hole passed through rocks which either do not outcrop or have been altered beyond recognition at the surface. On completion of MNPH6 and MNPH8 it became evident that the ore horizon was dipping flatly to the east, and the zone of leached quartzite from 40 feet to 73 feet 10 inches penetrated in MNDD2 was in fact the same material that outcropped as limonite in the costean and on the surface.

The Diamond Drill was then placed over MNPH3 which had proven too hard for Percussion Drilling with Plant 44, a light rig. This hole, MNDD3,

reached 300 feet in quartzite breccia and leached hematite quartzite. Again the nature of the rock has changed so much in depth that correlation of hand specimens between material from the drill hole and the adjacent costean is unreliable.

Ninety feet of brecciated quartzite was encountered in the drill hole, but none has been seen in the costean. The brecciated quartzite has been encountered further to the west in MNDD2 from 161 feet to 251 feet 8 inches, and MNPH6 from 125(?) feet to 135 feet.

Hole No.	Co-ords.	R.L.	Depth		Remarks
MNDD2	22075'N 11100'E	848'	304'		Bearing 270° depressed 45°.
				0 - 40'	Soil and weathered amphibolite.
				40'-73'10"	Silica Leached quartzite
				73'10"-153'6"	Red and brown (limonitic) schist.
				153'6"-229'	Hematite quartzite, mostly breccia.
				229'-274'8"	Schist grading to limonitic chert in places.
				274'8"-280'9"	Hematite-quartzite
				280'9"-304'	Weathered amphibolite.
MNDD3.	22045'N 11375'E	915'	300'	0 -116'	See MNPH3
				116'-183'	Quartzite breccia
				183'-300'	Hematite-quartzite leached in part.

MNDD2

OBJECT:- To intersect the ore zone outcropping 150 feet to the west down dip.

RESULT:- Penetrated leached hematite-quartzite grading to ore from 40' - 73'10".

MNDD3

OBJECT:- To complete MNPH3 which encountered rock too hard for Percussion Boring.

RESULT:- Penetrated quartzite breccia from 116' to 183', then hematite-quartzite, leached in part, from 183' to 300'.

5.8. Results

Detailed evaluation has been restricted to the western portion of Sheet 57-255. Boreholes and costeans indicate a continuous bed of ore from 21050'N to 22200'N, termed the Lower ore horizon. The thickness of the bed averages 25' and to date 350,000 tons of ore have been indicated with probable additions of 350,000 tons for every 100' the bed can be traced down dip, probable maximum 250 feet (MNDD3).

The Upper ore horizon has only been intersected in three places but is estimated to yield a similar tonnage of ore. This testing has not advanced enough to quote firm figures.

Deeper testing with both diamond and percussion drills has failed to locate any ore below 70', about 22000'N. The western holes that reached over 150' in depth all encountered a cherty limonite and or limonitic clay rock. There is no similar rock type visible in the costeans or outcrops.

The extent of surface alteration of the exposed beds has made surface to underground correlations extremely difficult. The drill holes have in general confirmed the general easterly dip although it is shallower than expected.

The testing has been mainly of an exploratory nature to assess the potential of the Prospect. The original estimate before testing began was 10 million tons per hundred feet of vertical depth (this figure embraced Prospect 6.). The results to date have confirmed the estimate of the horizontal width of the ore zones on sheet 57-255.

The ore potential of the western portion of this sheet remains of the order of 4 million tons per hundred feet depth but the shallow dips will restrict the depth of the ore. Further north the dips are steeper and better tonnages are likely to be found.

5.9. Recommendations

5.9.1. Location of the basement contact.

It is imperative that the base of the Middleback Series be located to define the western limits of the Southwest Area. As mentioned earlier the eastern or upper limits of the ore bearing formation are well defined while the lower parts of the prospect are obscured by sand.

The Geophysical Survey located anomalies which could be construed as the contact with the basement but these suggestions have yet to be tested in the central area of the prospect. Where tested to the south, hematite-quartzite was found to cause the anomaly.

It recommended that a line of percussion holes be placed to the west at 400' intervals to test the material below the sand. The line be placed at 22100'N and be continued until the granitic complex is encountered.

5.9.2. Proving ore in known ore beds.

Future drilling operations should be directed at testing the ore horizons between the costeans. Percussion boring is recommended with Diamond Drilling only to be used when hard hematite-quartzite is encountered.

5.9.3. Geophysical Testing.

It is recommended that the gravimeter and magnetometer traverse lines be continued to the north at 200 foot intervals from 2300'N to link up with those on Prospect No. 6.

5.10. Prospect No. 6

Location:- Co-ordinates 25000'N to 28000'N
11500'E to 12750'E

Description:- The ore outcropping on this prospect is a hard brown limonite. The prospect has been mapped at a scale of 100' to 1" by D.B. Asthana, Geologist, along the ore zone. Further mapping is required to embrace ore showings to the north as far as the southern outcrop of the Mt. Middleback North dolomite and a hematite outcrop about co-ords. 28000'N 14000'E.

Geology:- This prospect differs from the others in that there is a major syncline with shears striking approximately 020° running through it, and there is no evidence of hematite visible on the surface. An outcrop of massive limonite occurs on the east limb of the above syncline. There is a small gravity high where the limonite would be expected to occur, obscured by soil, on the west limb of the fold.

Geophysics:- Four traverse lines have been run with the gravimeter. These show the larger gravity highs to occur over the major hematite quartzite outcrops indicating these are the most dense rocks near the surface. Further lines have been pegged but the survey has not been completed.

Testing:- As the continuity in depth of limonite is suspect a preliminary diamond drill hole, MNDD4, co-ordinates 27289'N 12561'E, has been collared on the main outcrop. This reached a depth of 183'9" passing out of limonite into hematite quartzite at 85 feet and into fresh green amphibolite at 162 feet. The dip of the bedding in the hematite-quartzite is 35^{0} to 45^{0}, probably west by correlation with the surface mapping. The nature of the limonite changes rapidly in depth from hard brown to softer yellow brown, there being only small patches of hard core below 13 feet.

Conclusions & Recommendations: - The limonite outcrop does not cover hematite where tested by MNDD4. The larger gravity anomalies do not lie on the main limonite outcrops.

It is recommended that the geological mapping be continued to include the overlying hematite-quartzites and the dolomite to the north.

A Percussion Borehole should be placed at 26930'N 12220'E on the gravity high which is adjacent to a limonite outcrop mapped by Mr. Asthana.

A Percussion Bore be placed on the small gravity anomaly centred at 27180'N 11600'E. Should this hole prove the continuity of the limonite it would then be necessary to test near the axis of the syncline.

6. RESULTS

The field prospecting carried out by the writer, assisted later by Prospector Morley, has produced a discontinuous line of outcrops from the northwest corner of the Iron Warrior leases to the north-west slopes of Mt. Middleback North.

The field mapping, scout boring and costeaning all produced evidence in support of the probability of a workable ore body existing in the area. Where detailed mapping has been attempted (mainly on Prospect No. 5) a zone of ore bearing rock was traced more than 3000 feet along the strike. The mapping showed only poor exposures of high grade material, most of which is limonite at the surface. These exposures fall in what has been interpreted as the line of strike of the lower ore horizon. Outside the limonite outcrops exposures are few in the softer rocks. Where hematite-quartzite is exposed ore type rocks are apparently missing.

Geophysical testing has not been of great assistance because the ore is non magnetic and does not have a good density contrast with the host rocks.

The deeper testing instituted so far has failed to locate any ore below the lower ore zone and has indicated that it dips at approximately 30^{0} into the range to the east.

Testing has not advanced far enough to compute tonnage figures of ore proved or indicated.

The area has a potential of 10-15 million tons of ore at a shallow depth. The ore is in lenticular bodies of ½ to perhaps 2 million tons.

7. RECOMMENDATIONS

7.1. Specific Recommendations made when dealing with individual prospects are briefly recounted:-

Prospect No. 1 - No action - defer until larger prospects tested.

Prospects No. 2, 3, 3a and 4

(1) The four prospects be grouped and examined together.

(2) They be mapped at a scale of 100^{0} = 1".

(3) Percussion Scout Boring be used to trace the beds below cover between outcrops.

(4) Geophysical Testing (see 7.2. below)

Prospect No. 5

(1) A Line of Percussion Boreholes be placed at 400' intervals west from the baseline at 22100'N to locate the basement contact.

(2) Testing of the known ore horizons be continued to evaluate the prospect.

(3) Geophysical ground gravity and magnetic traverses be continued to the north of 23000'N to link up with those on Prospect 6.

Prospect No. 6

(1) The detailed mapping be extended to the north and north-east.

(2) The geophysical anomaly centred at 26980'N 12220'E should be tested with a Percussion Borehole (feet).

(3) A Percussion Bore hole should be placed on or slightly east of 27180'N 11600'E to test for the limonite on the west limb of the mapped syncline.

7.2. Geophysical Testing in the South West Area

East-west scout gravity traverses are recommended over the upper reaches of the sand and onto the lower slopes of the range at approximately 500 foot intervals. Over Prospects Nos. 2-4 these lines should be spaced so that at least one line traverses the outcrop on each individual prospect. From these results it should be possible to assess whether further, more detailed traverses can be used to trace the bedding below areas of sand and scree.

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GEOLOGIST

RCM:AGK
14/5/58.