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*Preliminary Geological Report on the
Mucketty Mangarese Deposit*

by

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*MC
3 plates*

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GEOLOGICAL REPORT
ON THE
MUCKETTY MANGANESE DEPOSIT

by

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SUMMARY.

The Mucketty manganese deposit is in the Ashburton Ranges six miles east of the Stuart Highway and 570 miles south-south-east of Darwin by road.

The Ashburton Sandstone in this area consists of two sandstone sequences separated by a limestone-shale sequence. The manganese deposit occurs at the top of the limestone-shale sequence.

The manganese deposit has a total strike length of 2000 yards but is offset into two areas by a cross-fault. The manganese has a prominent scarp face striking 310 degrees and dips north-east at 20-30 degrees.

There is a small open cut near the centre of the deposit. To the end of September, 1955, approximately 400 tons of ore averaging 66-72% MnO_2 had been carted from the deposit.

Three grades of ore are readily recognised - good (>60% MnO_2), medium (35-60% MnO_2) and low (<35% MnO_2). These grades correspond respectively to massive ore, ore with abundant residual quartz, and partially replaced sandstone. In addition there is a small quantity of high grade ore (>75% MnO_2) as pockets in the good grade ore.

The good grade ore is believed to be a replacement of siltstone and most of the medium grade ore a replacement of sandstone. The maximum thickness of good grade ore is 9 feet and average thickness approximately 4 feet.

Chip samples were taken across the lode. Ore reserves, expressed as tons/ft. down the dip, are calculated as:-

High grade ore (>75% MnO_2)	40 tons/ft.
Good grade ore (60-75% MnO_2)	850 " "
Medium grade ore (35-60% MnO_2)	7600 " "
Total (ore > 35% MnO_2)	8490 tons/ft. down the dip.

No estimate of total ore reserves can be made until the depth to which replacement has occurred is known. The deposit may be shallow and controlled by the present land surface or deeper and related to the laterite.

At present the use of the manganese ore appears to be restricted to uranium extraction.

Sites are recommended for diamond drilling to determine the depth of ore.

The other manganese deposits in the Mucketty and Renner Springs areas are briefly described.

INTRODUCTIONSITUATION AND ACCESS.

The Mucketty manganese deposit is in the Ashburton Ranges 570 miles south-south-east of Darwin. It lies on the north side of Bootu Creek six miles east of the Stuart Highway. It shows clearly as a thick black line, with north-westerly trend, on the aerial photographs of the Helen Springs 4-mile sheet, Run 10, Photo No. 5693.

The deposit is reached by a track turning off from the Stuart Highway 76 miles north of Tennant Creek and 563 road miles south of Darwin. The track would be inaccessible for periods up to a fortnight after heavy rains.

WATER SUPPLY.

During the wet season, and for a month afterwards, small holes along Bootu Creek contain water. A waterhole in a tributary creek three miles south-east of the deposit lasts at least six months after the wet but lies in a narrow gorge and is accessible only on foot.

The nearest permanent water is at Muckadse Bore west of the Stuart Highway, about fourteen miles by road from the deposit.

HISTORY OF DEPOSIT.

The imposing black wall of manganese has been known to pastoralists for many years. The difference between it and the more common laterite outcrops had been recognised but no serious attention was paid to the deposit until manganese dioxide was required for the uranium treatment plant at Rum Jungle.

In 1954 mineral leases 51E - 55E were pegged by Messrs. Doyle and Farlow to include the prominent manganiferous outcrops, altogether nearly $1\frac{1}{2}$ miles in strike length. Mineral lease ML 52E was surrendered in March, 1955.

The leaseholders commenced working the deposit in June 1955. The ore is carted by road to the uranium treatment plant at Rum Jungle. To the end of September approximately 400 tons of ore, averaging 68% MnO_2 had been carted from the deposit.

GEOLOGICAL INVESTIGATIONS.

A brief report on the deposit was written by N. Jones in March 1955. Soon afterwards leases 53E - 55E were plane-tabled and sampled by J.H. Rattigan and A.B. Clark of the Rio Tinto Finance and Exploration Co. In August, Jones plane-tabled the remainder of the deposit and carried out further sampling. Other manganese occurrences south-east of the leases were examined.

The map showing the Manganese Deposits in the Bootu Creek Area (Plate 2), was traced from aerial photographs and much of the structure shown was interpreted from the photographs. All manganese deposits shown have been visited.

The detailed map of the Mucketty deposit (Plate 3) has been compiled from Jones' survey of leases 51E and 52E and Rattigan and Clark's survey of leases 53E - 55E with additions and modifications by Jones. The baseline used in mapping leases 53E - 55E was continued for the mapping of the northern leases. For this report points of reference have been given by regarding the baseline as north-south.

ACKNOWLEDGEMENTS.

Messrs. Doyle and Farlow rendered every assistance during the investigation.

The Rio Tinto Finance and Exploration Co. made available the map and other information from the investigation of leases 53E - 55E by Rattigan and Clark. Grateful acknowledgment is made of this assistance.

A short report on the deposit by Dr. J.A. Dunn, Chief Mineral Economist, has also been of assistance to the writer.

STRATIGRAPHY AND STRUCTURE.ASHBURTON SANDSTONE.

The oldest known rocks in the area are the Ashburton Sandstone of probable Upper Proterozoic age. The stratigraphic succession in the Ashburton Sandstone in the Bootu Creek area

is shown in Table II. The thickness given, approximately 5500 feet, does not represent the full thickness of these beds. No intrusive or extrusive igneous rocks are known in the area, and there is no evidence of regional metamorphism.

CAMBRIAN.

Approximately ten miles east of the deposit the Ashburton Sandstone is unconformably overlain by Cambrian shale and limestone which dip to the east at a low angle. Ten miles to the south-west, near Banka Banka homestead, is a small outlier of fossiliferous Cambrian. It is possible the manganese deposit lies at no great depth below the erosion plane at the base of the Cambrian.

LATERITE.

The present ridge-crests and flat-tops conform to a gently undulating erosion level which is, in places, capped by laterite (e.g. Lubra's Lookout, near Renner Springs). These ridges, usually of sandstone, show evidence of lateritisation. Three miles south-east of the deposit shales are preserved to the laterite level by a capping of approximately 5 feet of billy.

The gently sloping flat-tops at the back of the manganese wall belong to the laterite surface (cross-section plate 3). There is clear evidence that above the present valley of Bootu Creek there was a broad shallow valley at the time of laterite formation. There is no local evidence of the age of the laterite; it is assumed to be of Miocene age.

GRAVELS.

Along the valley of Bootu Creek there are extensive terraces of coarse river gravels, lying 20 to 40 feet above the present stream bed.

REGIONAL STRUCTURE.

The Ashburton Sandstone is folded into large dome and basin structures with moderate dips. Minor folds are superimposed on the major structures in the vicinity of faults.

Complex faulting is present throughout the area. Many faults strike parallel, or at a very small angle, to the bedding, and cannot be readily distinguished. Some of these faults show strongly for distances up to 20 miles and have large displacements. One such fault strikes at 340 degrees one mile west of the deposit. No correlation of beds across the fault line was possible within the area mapped. Many small faults feather from these main faults, particularly where the major faults cross from sandstone to shale.

A series of cross-faults is present, generally striking at large angles to the major faults. These faults are perhaps later than the strike faults.

STRUCTURE AT THE DEPOSIT.

The deposit lies on the south-west side of a syncline of which the long axis trends slightly west of north. The beds at the deposit dip north-east at 20 to 30 degrees. The manganese deposit conforms, in both strike and dip, to the bedding.

Faulting adjacent to the deposit is strongly shown by the quartzite and is of three types.

1. Faults striking at a small angle to the bedding of the quartzite and offsetting it at 2600 S and 2200 N. In each case there is marked overlap of the faulted ends. The irregular

distribution of manganese ore at 1800 S may be due to a fault of this type.

2. The faulting in the quartzite at the eastern end of the deposit. This type is repeated at several localities south-east of the deposit. A marked feature is the "doubling back" of one of the displaced ends in the opposite direction to the horizontal displacement of the other block. Another characteristic feature is "that although a fault may be traced to a point closer to the Manganese than the horizontal displacement of the fault, the Manganese is not displaced". This necessitates either a very sharp swing in the strike of the fault to become parallel to the bedding or a separate strike fault at or just below the manganese horizon.

3. The fault at 400 N which displaces all beds in the west block approximately 500 feet to the north (horizontal displacement appears to decrease with increasing bedding dip, suggesting a large vertical component in the fault displacement). This is apparently a late structure as it can be traced uninterrupted across the trends of other faults.

The sandstone beds 700 feet north-east of the manganese of leases 54 E and 55E are broken by several faults which trend towards but do not displace the manganese. A similar problem arises to that raised by type 2 above.

DESCRIPTION OF DEPOSIT.

The Mucketty Manganese deposit has a scarp facing south-west which lies at the edge of the sandstone forming the north-east wall of the valley of Bootu Creek. The deposit is divided into two units separated by low scree-covered ground. The main, or southern, area is a nearly-continuous manganese-capped wall 900 yards long rising from a broad scree slope. Small outcrops continue to the south-east. This part of the deposit is included by leases 53 E - 55E.

The northern area is offset to the north of the strike of the main area. The southern end of this portion is on low ground but rises gradually to a 100 foot ridge at the north-west end of the manganese deposit. The highest part of the ridge is capped by a small but prominent flat-top of lateritised sandstone. This area is included by leases 51E and 52E. Manganese crops out discontinuously over a length of 500 yards.

Much of the lower ground is covered by scree or river gravels. The broad dark-coloured scree at the foot of the manganese wall tends to give an exaggerated impression of the width of the deposit.

The vegetation of the area is dominated by spinifex and snappy gum.

DEVELOPMENT.

Development to date consists of a small open-cut into the scarp face on ML. 53 E. A rough track has been constructed to a point about 20 feet below the open cut. Approximately one-third of the production to the end of September, 1955 came from loose blocks prised from the scarp face or boulders dug out of the coarse scree at the foot of the scarp. At this date the open cut just reached the solid face after removal of a six-foot thick block that had slipped out three feet from its original position.

THE MANGANESE ORE.

In mapping the deposit three grades of ore were recognised. These were essentially covered by the descriptive

phrases - "massive ore," "sandy ore" and "dirty ore." Grab samples taken during the initial inspection of the deposit suggested that these three types had assay values in the following ranges:-

Massive ore - good grade - $> 60\% \text{ MnO}_2$
 Sandy ore - medium grade - $35 - 60\% \text{ MnO}_2$
 Dirty ore - low grade - $10 - 35\% \text{ MnO}_2$

These ore grades were confirmed by the chip samples.

DESCRIPTION OF ORES.

Good Grade ore is heavy, massive or reniform, grey to black in colour with a sub-metallic lustre and no visible quartz or mica. It is dominantly psilomelane although commonly streaked with veins of crystalline pyrolusite. Small inclusions of clay or chert are common. Indications of bedding are rarely preserved.

Rich pockets in the good ore, having much pyrolusite and a minimum of clay, are described as high grade ($> 75\% \text{ MnO}_2$).

Medium Grade ore is noticeably lighter than good grade ore. The characteristic material of this grade is grey to black in colour, and contains numerous residual grains of glassy quartz. The better ore of this type rarely contains clay inclusions and bedding is often preserved. Much less pyrolusite veining is found in the sandy ore.

Also included as medium ore are (a) partial replacement of siltstone by massive ore, (b) a light grey ore with dull lustre, weak lamination and some residual mica, and (c) a soft, sooty ore with very abundant quartz grains.

Low Grade ore is typically a partial replacement of the matrix of a felspathic sandstone by soft, sooty manganese. This ore is usually only a capping on unreplaced sandstone.

Some of the shales and siltstones 30 to 50 feet stratigraphically above the main ore horizon are partly replaced by an iron-rich manganese ore of low grade.

A large area of felspathic sandstone stratigraphically above the manganese outcrop has a black or brown-black surface staining of manganese. This material is responsible for much of the impressiveness of the deposit but has a very low manganese content, and is not included with the low grade ore.

MINERALOGY.

In the field the manganese minerals were distinguished as -

Pyrolusite - small crystals in veins through the ore with grey colour, black streak, metallic lustre and hardness of 2.

Psilomelane - forms the greatest part of the good and medium grade ore. It is amorphous, usually massive sometimes reniform and has grey to black colour, black streak, sub-metallic lustre and hardness of 6.

Wad - Soft, earthy masses in the lower grade ores with black colour and streak and non-metallic lustre. The hardness is indeterminate because of the fine grain-size.

Some of the crystalline material had a hardness of 4 and may be manganite.

The gangue minerals that have been observed are barytes, calcite, gypsum and silica (the silica may occur as quartz or chalcedony, or both).

Barytes has been found (1) as crystals in cavities in the ore, (2) associated with travertine lime in a brecciated siltstone below the ore horizon, and (3) as a $\frac{1}{2}$ inch vein through the ore. This vein showed marked comb structure.

Crystalline calcite has not been found, but fine white travertine lime is present in several places.

Nests of gypsum crystals are growing out from the walls and roof of a cave in the ore on ML. 51 E.

Thin coatings of translucent glassy silica have been found coating fractures in the ore.

Fragments of quartz reef material are prominent in the scree below the manganese outcrop, but no quartz reef material has yet been recognised in the ore. This quartz is coated with manganese. Many of the cavities in the quartz have a regular (? rhombic) shape. They appear too regular for rock fragments and probably represent cavities left by the solution of another vein mineral.

STRATIGRAPHICAL CONTROL OF ORE.

Limestone, sandstone, and siltstone have all been replaced by manganese in the Renner Springs and Mucketty areas.

Limestone replacement, where known, is limited to a thin layer on exposed surfaces and fractures.

Replacements of sandstone always appear to retain the coarse quartz grains as residuals in the ore. The medium-grade ore at the Mucketty deposit is largely a replacement of sandstone.

Siltstone is the only rock type which has yielded specimens showing alteration to good-grade manganese ore. The replacement of siltstone by good-grade ore and the sharpness of the replacement boundary are both very marked in the manganese ore at the Renner Springs deposits.

At the Mucketty deposit specimens were obtained from the open cut, at a depth of 4 feet below the original surface, which showed residuals of siltstone in good grade ore. South-east of the Mucketty deposit, where interbedded sandstones and siltstone form the ore horizon, the siltstone is selectively replaced.

It is therefore believed that siltstone has been the favourable rock-type in the formation of good-grade ore.

The stratigraphical succession at the Mucketty manganese deposit is:-

- Felspathic sandstones.
- Interbedded sandstones and shales (some low grade ore).
- Sandstones (low grade ore and staining).
- Felspathic sandstone (sandy ore - medium grade).
- Siltstone (massive ore - good grade).
- Ferruginous shale (staining).
- White siltstone.

The base of the manganese ore, where the base is exposed, is a ferruginous chert or shale. In places this has been stained black but the manganese content is always very low.

Good-grade ore does not extend over the full length of the deposit. At several places on ML 51 E and at one place on

ML 55 E sandy ore of medium grade is seen resting directly on the ferruginous shale. Where good grade is present it lies between the sandy ore and the ferruginous shale. Surface exposures of this ore at the Mucketty deposit give no indication of its origin, but reasons have been given for regarding it as a replacement of siltstone. The maximum thickness of good-grade ore exposed is 9 feet at the open cut, but the average thickness is about 4 feet.

The basal portion of the good-grade ore often shows a marked system of parallel fractures approximately $1/16$ th of an inch apart which dip with the bedding. The surface of these fracture planes is a series of domes approximately $\frac{1}{2}$ inch in diameter and $1/16$ th of an inch in height. The structure is possibly due to contraction of the ore.

Secondary solution and redeposition have generally proceeded too far for detailed structures to be recognisable in the ore. Near the boundary of the sandy and massive ores in the open cut two types of structure were recognised:

- (1) A light-coloured sand-clay core surrounded by sandy ore with an outer ring of massive ore.
- (2) Irregular breccia-like mixtures of sandy and massive ore.

These suggest that some sandy ore has been partly converted to massive ore by solution of the residual quartz.

The siltstone remnants found in massive ore show a common orientation. Two siltstone remnants showed minor faulting with displacement of one inch.

The sandy ore, of medium grade, extends the full length of the deposit, but grades at both ends into a felspathic sandstone. At the north-west end of the deposit the sandstone lies almost at the laterite level and its matrix has been replaced by chert. The thickness of the sandy ore is 16 to 18 feet near the boundary of leases 54 E and 55 E, but the average exposed thickness would be about 9 feet.

The medium-grade sandy ore is overlain by sandstones with a more quartzose matrix. In places these have been replaced by low-grade ore immediately above the medium-grade ore. The distribution of low-grade ore appears to depend largely on variations in the proportion of felspathic material in the matrix of the sandstone.

Above the low-grade ore is a zone of sandstone with patches of manganese staining on the surface, particularly on exposed edges. The width of this sandstone averages 30 feet (including the low grade ore).

The interbedded shales and sandstones forming the higher manganese horizon are markedly lenticular and the areas of low-grade ore correspondingly irregular. This higher manganese horizon is not marked above the open cut but is prominent further to the south-east. Replacement has usually progressed further in the finer-grained beds. In this horizon the iron content of the ore appears to be much greater than in the main horizon, possibly because most exposures of this horizon lie at or very near the laterite level. This higher manganese horizon is overlain by sandstone which shows no manganese replacement.

ORIGIN OF THE ORE.

The stratigraphical control of the ore has been described above. The occurrence of the ore at the boundary between two major units in the stratigraphical succession (Table II) is almost certainly significant. Grit and pebble beds are present in the sandstone overlying the siltstone at a locality north-west of the deposit. At the ore horizon there may be a disconformity at which original sedimentary concentration of manganese may have occurred. There is little evidence of the grade of such sedimentary manganese but it was certainly much lower than the grade now exposed.

The proximity of the manganese exposures to the laterite level has already been noted. The proved association of many manganese deposits elsewhere in Australia with the laterite level suggests that at Muckety also ore is related to this level.

There has definitely been a near-surface "mushrooming" of the ore. The shallow depth of the low-grade ore has already been discussed. No fall in grade of the massive ore has been observed in the bottom of the open-cut.

A decrease in the width of the good-grade ore is indicated by the presence of the siltstone fragments in the lower part of the ore bed in the open cut.

No indications of hydrothermal mineralisation have been observed at any of the manganese deposits. Siltstone fragments in the ore show no trace of hydrothermal agencies. The presence of quartz reef fragments in the scree below the manganese outcrop has already been mentioned. The importance of faulting in the movement of manganese bearing solutions cannot be determined at present. Faulting of the favourable beds is almost certainly the explanation of the irregular ore distribution on RL 54E.

On the information available the manganese deposits appear to have been formed by secondary concentration of sedimentary manganese. This concentration is related both to the laterite level and the present-day erosion surface.

DEPTH OF ORE.

In view of the uncertainty regarding the origin of the ore and the controls of ore distribution no firm predictions can be made of the depth to which ore will extend.

Important in any consideration of depth of ore are the lenticularity of the siltstone and its possible displacement by faulting. Any test of the depth of the deposit should be made at a point near the centre of the exposed siltstone and removed from any indications of faulting.

If ore is related to the laterite level it may be expected to extend below the level of the drainage re-entrants into the manganese wall (at least to RL 1000). If ore is mainly controlled by the present erosion surface then only a shallow depth of ore can be expected.

SAMPLING.

In view of the probable marked changes in width and grade of ore at shallow depth detailed sampling did not appear justified.

Eighteen chip samples were taken from leases 51 E - 54 E. Assay results from these samples are given in Table II. These assays were supplemented by the results of sampling by the Rio Tinto Finance and Exploration Co. on leases 53 E - 55 E.

It was noticed during sampling that exposed corners were often of higher grade than the rest of the material and such corners were avoided to give a sample more representative of the main mass of ore.

The best idea of the good grade ore is given by the 66 - 72% MnO_2 content in ore deliveries to Rum Jungle. This corresponds well with the 71.5% MnO_2 in sample A13, taken on the surface near the western end of the open cut, allowing for the slight admixture of moderate grade which can be seen in the loads.

Development has not yet reached a stage where more than grab samples can be obtained at any depth below the weathered surface. Two grab samples were taken at depth of 4 feet below the weathered face and indicate that the relation of appearance to grade which was observed at the surface holds to this depth.

<u>SAMPLE</u>	<u>PERCENTAGE</u>	
	MnO_2	SiO_2
Massive ore with some chert inclusions	75.0	7.1
Massive ore with remnants of unreplaced siltstone	56.3	14.2

ORE RESERVES

The surface distribution of good, medium and low grade ore is shown on plate 3. Outcrops of high-grade ore are too small to be effectively shown on the map. The calculated reserves of high, good and medium grade ore are given in Table III. Reserves of low-grade ore are of no economic interest and would be very small because of the shallow depth of this ore.

On available information there are perhaps 40 tons per foot down the dip of high grade ore, all on HL 53 E between 200 S and 500 S. About half of this ore occurs in a band parallel to the bedding and lying just below the base of the sandy ore. This band reaches its maximum thickness of 3 feet at the open cut. The remainder of the high-grade ore occurs as scattered pockets in the massive ore which have a greater amount of pyrolusite veining than usual. The high-grade ore could not be worked independently of the good-grade ore but could be separated from it by hand picking.

The ore reserves of the deposit are calculated, including inferred ore, as:

High grade ore	40 tons/foot
Good grade ore	850 " "
Medium grade ore	7600 " "
Total (ore 35% MnO_2)	8490 tons/foot down the dip

The problem of the depth to which ore may extend has already been discussed. In addition to uncertainty about the depth of ore no reliable indication is available as to the extent to which ore will narrow with depth.

Therefore no estimate is made of the total ore reserves of the deposit but reserves should be, at the minimum, equivalent to an average depth of 10 feet and possibly could be equivalent to an average depth greater than 100 feet.

The Mucketty deposit could prove to be one of the largest manganese deposits in Australia. A relatively small amount of testing of the depth of the deposit should enable a reasonable estimate of the ore reserves to be made.

Only a small proportion of the exposed ore is good grade. It is considered there is little likelihood that the "sandy" medium grade ore will improve at depth. The major impurity in this ore is silica, present as quartz grains, which are considered to be residual and not the product of surface agencies. The size of the quartz grains, approximately 1 mm. makes it also doubtful whether the ore could be concentrated at reasonable cost.

If, at depth, there is a considerable tonnage of massive ore with coarse siltstone remnants it might be possible to concentrate this ore to marketable grade.

USE OF THE ORE.

Specifications set for manganese ore vary with the use for which the ore is intended. The suitability of the Mucketty ore for different purposes is considered below.

METALLURGICAL ORE.

Very little ore of accepted metallurgical grade (48% MnO_2) is present. The following information is available on impurities which might affect the use of Mucketty ore for metallurgical purposes.

The iron content, of samples containing greater than 30% Mn, has been in the range 1 - 3% where determined.

Phosphorus has not been determined quantitatively but qualitative tests have shown that the phosphorus content is low, probably less than 0.1%. More information is required on the phosphorus content of the manganese.

The high-grade ore (>75% MnO_2) would probably have a silica content in the range 4 - 8%, but assays of good grade ore show up to 16% SiO_2 . The medium-grade ore has a high silica content, the "sandy" ore having 25 - 40% SiO_2 .

At present it is unlikely that the ore could be profitably worked at the Australian price for metallurgical ore.

BATTERY ORE.

The high-grade ore from the deposit may be suitable for use as battery ore. The iron content is low and no adverse impurities are known.

URANIUM EXTRACTION.

No true dioxide ore (in the commercial sense) has yet been found at the Mucketty deposit. Tests by Rio Tinto Finance and Exploration Co. have shown that there are no acid-consuming impurities in the ore.

At present good grade Mucketty ore is being bought

by Territory Enterprises Pty. because of the lack of available dioxide ore. The Mucketty deposit will not be worked if manganese ore nearer to Run Jungle or a higher grade ore at a comparable distance is discovered.

Summarizing, good and high grade ore is being sold for use at the Run Jungle uranium treatment plant. Some of the high-grade ore may be suitable for battery ore. The medium-grade ore, which forms over 80% of the ore reserves stated, has no commercial value at present.

OTHER METALS

Most visitors to the deposit have been impressed by pink stainings on the shaly inclusions in the ore. However, no cobalt has yet been determined by assay. The pink coloration is apparently due to a very slight manganese staining.

No indications have yet been found that the manganese is a cap on a primary ore deposit of some other metal. Samples A 13 and A 15 were assayed for cobalt, copper, lead and zinc without result.

RECOMMENDATIONS

Valuable information on changes in width and grade of ore will be obtained from the open cut when development is carried back into the solid face. However, before any reliable estimates can be made of total ore reserves the depth to which ore extends must be known. This can best be determined by diamond drilling.

DIAMOND DRILLING.

The first hole should test the deposit down dip from the open-cut, which is near the centre of the outcrop of good grade ore. A depth of intersection greater than RL 1010 does not appear justified.

If unwarranted by the result of the first hole, the second hole should be on the same southing but sited for a deeper intersection.

Further holes should be drilled (a) on the same southing as DD No. 2 but to intersect at greater depth, (b) to determine the depth of ore below outcrops at a lower topographic level (c) to check the existence of the inferred good grade ore on RL 52 E.

RECOMMENDED DRILL SITES

No. 1 hole - location 400 S 230 E
direction vertical
approx. depth 80 ft.
expected intersection 60 feet down dip
(RL 1010)

No. 2 hole - (subject to success of DDH No. 1)
location 400 S 230 E
direction vertical
approx. depth 100 feet
expected intersection 120 feet down dip
(RL 990)

Sites for other holes suggested are:

- (a) location 400 S 360 E
direction vertical
approx. depth 150 feet
expected intersection 220 feet down dip (RL 940)
- (b) location 650 S 320 E
direction vertical
approx. depth 80 feet
expected intersection 105 feet down dip (RL 990)
- (c) location 150 N 370 E
direction vertical
approx. depth 80 feet
expected intersection 100 feet down dip (RL 980)

APPENDIX I.

OTHER MANGANESE DEPOSITS IN THE BOOTH CREEK AREA.

Discontinuous manganese outcrops occur at or just below the base of the Upper Sandstones for a distance of 8 miles around a synclinal structure (Plate 2).

DEPOSIT A.

Two small manganiferous outcrops half a mile north-west of the main deposit contain medium and low grade ore. Reserves are negligible.

DEPOSIT B.

A small outcrop in a gully shows manganese ore 10 feet thick including a one-foot band which may be good grade. The visible tonnage is very small. Two very small manganese outcrops are present between this outcrop and HL 55 E.

DEPOSIT C.

Medium and low grade manganese outcrops for a distance of half a mile. The manganese has a maximum thickness of 4 feet. No good grade ore is present. South-east of this deposit the manganese horizon is soil-covered for 2 miles.

DEPOSIT D.

This deposit occurs on a low rise surrounded by alluvium and is crossed by an old road from Banka Banka to the tableland country to the east. No structure is revealed in the outcrop, which may contain 3,000 tons of medium-grade ore above the level of the plain. A small tonnage (less than 50 tons) of good-grade ore was observed. If this deposit resembles others in the area in which good grade ore is overlain by medium-grade ore it could contain a considerable tonnage of good-grade ore.

DEPOSIT E.

The deposit is a thin band of siltstone partially replaced by manganese and overlain by felspathic sandstone with a small amount of manganese staining. Only low-grade ore is present.

DEPOSIT F.

This deposit consists of two hills capped by lateritised sandstone and with a west-dipping manganese bed outcropping on the eastern side of hills. Both to north and south the manganese is sand covered.

The deposit was pegged in 1954 but the leases were surrendered because the lessees considered the ore was of lower grade than the Mucketty deposit. Three samples were taken described as sandy, massive and micaceous ore, the sandy ore overlying and the micaceous ore underlying the massive ore. Assay values were as follows:

<u>Sample</u>	<u>% MnO₂</u>	<u>% Fe</u>	<u>% SiO₂</u>
Sandy ore	58.3	1.0	24.3
Massive ore	79.5	0.8	2.5
Micaceous ore	54.8	0.6	21.5

The sample of massive ore is certainly better than the average grade of massive ore but ore from this deposit appears comparable to that at the Mucketty deposit. Approximately 500 tons of good grade ore are exposed and this ore may form a band 2-4 feet thick extending for more than 400 feet on each of the two hills. This deposit definitely warrants further investigation.

Further deposits may occur north of deposit E. This is suggested by photo-interpretation but no ground search has been made.

APPENDIX II.

THE RENNER SPRINGS MANGANESE DEPOSITS.

Three manganese deposits are known in the Renner Springs area. All lie west of Renner Springs, and all are accessible by a track from Renner Springs which runs first south-west and then north west. Leases have been pegged on all the deposits by Messrs. Doyle and Farlow. The most convenient reference to the deposits is by lease number.

ML 47 E.

This deposit lies on the north bank of Hunter Creek 12 miles west of Renner Springs (16 miles by track). It has been mapped by Rattigan and Clark of Rio Tinto Finance and Exploration Co.

The manganese ore at this deposit is a replacement of siltstone, cropping out as several irregular blows with a general north-westerly trend. The ore at this deposit appears to be related to the present ground surface with a probable average depth of less than ten feet. Both grade and width are likely to decrease with depth.

The massive ore contains 70-80% MnO_2 but much of the ore contains fragments of unreplaced siltstone. This ore with remnants would average approximately 50% MnO_2 . Ore reserves ($>35\%$ MnO_2), on surface indications, are of the order of 4,000 tons per vertical foot, of which one quarter would be good-grade ore. At least one third of the medium-grade ore could be upgraded by handpicking.

Although very much less impressive in appearance than the Mucketty deposit this deposit may have reserves of good grade ore more than half of those at the Mucketty deposit.

ML 48 E.

Two small outcrops on the bank of a tributary creek near its junction with Hunter Creek, approximately one mile south-east of ML 47 E. There is a very small tonnage of good-grade ore and perhaps 500 tons of medium-grade ore of which half may be suitable for handpicking to good grade.

ML 49 E - 50 E.

These two adjoining leases, 12 miles by track from Renner Springs, include several low rises of manganese partially replacing siltstone and cherts. There are pockets of medium-grade ore, but the deposit, as a whole, is of low grade.

This area also has good prospects offurther discoveries of manganese, particularly north toward Powell Creek.

TABLE I.
STRATIGRAPHICAL SEQUENCE IN THE ASHBURTON SANDSTONE,
FOOTU CREEK AREA.

Formation	Approximate Thickness in feet	Description of Units
		(Overlying beds now known)
Upper Sandstone	2,000+	Quartz sandstone with some felspathic sandstone
	150	Soft sandstone with shales
	200	Felspathic sandstone with interbedded shale in lower part (manganese horizon)
	100	Siltstone and shale with shaly limestone near base
	20	White silicified sandstone (quartzite)
	30	Chocolate sandstone
	400	Limestone with some shales
	C.700	? (probably mainly shale)
	350	Shale and sandstone
Lower sandstone	1500	Quartz sandstone and grit
		(underlying beds not examined)

TABLE II.

ASSAYS OF CHIP SAMPLES, MUCKETTY MANGANESE DEPOSIT.

Sample No.	True width in feet.	Percentage		
		MnO ₂	Fe	SiO ₂
A1	13	23.7	13.3	N.D.
A2	14	37.4	6.6	38.7
A3	11	46.9	N.D.	N.D.
A4	10	46.4	"	"
A5	5	56.4	"	"
A6	4	55.9	"	"
A7	5	58.8	2.7	"
A8	5	44.5	2.4	"
A9	12	10.9	N.D.	"
A10	7	36.0	"	"
A11	5	64.0	"	"
A12	12	4.7	"	"
A13	9	71.6	1.3	13.4
A14	3	78.7	1.2	4.3
A15	7	50.3	1.1	33.4
A16	3	58.8	1.8	16.0
A17	7	33.2	1.0	27.2
A18	32	6.6	N.D.	N.D.

TABLE III.

MUCKETTY MANGANESE DEPOSIT.

Ore reserves expressed as tons per foot down the dip.

LEASE	OUTCROPPING ORE			CONCEALED ORE	
	High Grade	Good Grade	Medium Grade	Good Grade	Medium Grade
51E	-	-	900	-	300
(52E)	-	(a)	300	(b) 200	700
53E	(c) 40	(d) 400	1100	250	100
54E		(e)	1800	(e)	200
55E		(e)	1600	(e)	600
TOTAL	40 tons/ft.	400 tons/ft.	5700 tons/ft.	450 tons/ft.	1900 tons/ft.

Total all grades 8490 tons/ft.

NOTE:

- (a) A small quantity (Perhaps 40 tons) of good-grade ore occurs in the scree on ML52E.
- (b) A quantity of good grade ore may lie beneath the gravels on the south-eastern portion of this lease. The quantity stated is very approximate.
- (c) Includes high-grade pockets in good-grade ore.
- (d) An estimated 1500 tons of good-grade ore are in the larger boulders in the scree.
- (e) There are pockets of good-grade ore on these leases but nothing of workable extent has been observed.

Appendix III

EXAMINATION OF MANGANESE SPECIMENS FROM MUCKETTY, N.T.

The specimens examined were selected from a group of samples submitted by J. Firman. Seven polished, and eight thin sections were examined; X-Ray diffraction was used to confirm the identity of the manganese oxide.

The only manganese oxide in the ore is pyrolusite, which occurs as stellate clusters of acicular crystals, large irregular crystalline grains, and as extremely fine-grained, apparently isotropic aggregates having a colloform texture. X-ray powder photographs were taken of all three forms which confirmed their identification as pyrolusite. The very low background fluorescence of the photographs with Cu K radiation shows that the iron content of the pyrolusite is very low.

The ore occurs in a quartz sandstone containing siltstone bands; the grain size of sandstone ranges from 0.01 to 1.0 mm.; the grains are not very well sorted, and their shapes vary from angular to well rounded. The siltstone bands consist of even-sized angular quartz grains 0.06 mm. across; replacement by manganese has been most extensive in these bands.

The ore forms infillings between the grains, and consists mainly of the colloform variety (Fig. 1), which shows the typical banding and the radial cracking resulting from syneresis. The crystalline grains merge imperceptibly into the colloform bands (Fig. 2), and are probably formed by a process of devitrification of the original colloid. The stellate groups of acicular crystals, which appear to be due to a later phase of the mineralization, are extensively replacing the grains of the sandstone (Figs. 3 and 4); residual fragments of quartz are included in the replacing crystal aggregates, and these fragments are in optical continuity with the unreplaced parts of the grains.

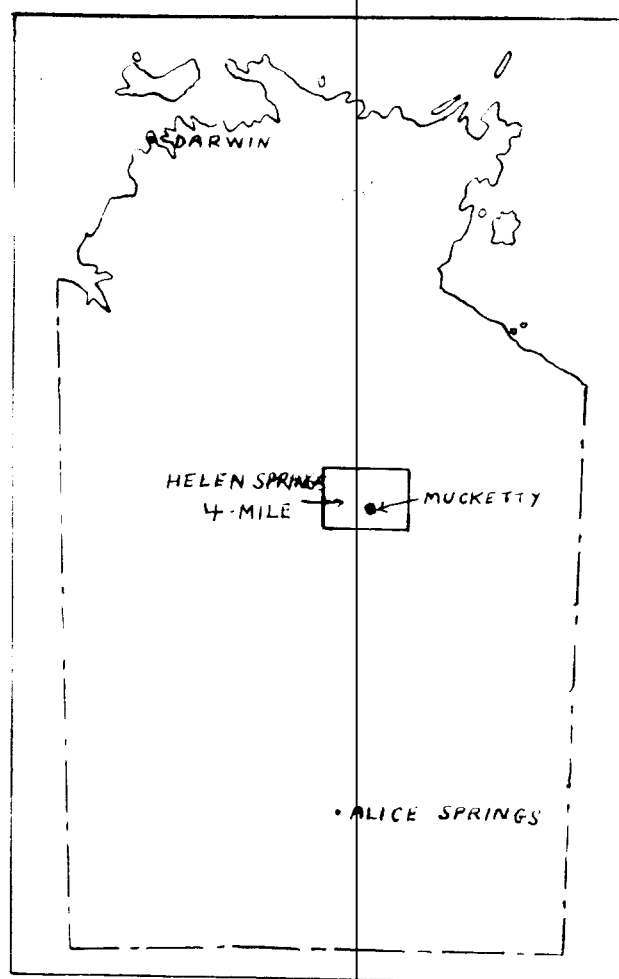
The rock labelled D7, felspathic sandstone, consists of subangular quartz grains ranging from 0.02 mm. to 0.8 mm. across, some of which contain small crystals of tourmaline. An occasional grain of chalcedony occurs in the rock but no feldspar was seen. The matrix is principally a colloidal clay material showing typical colloform banding, occasionally a small blade-like crystalline area is developed exhibiting a strong parallel cleavage and straight extinction.

In hand specimen the clay mineral fills geodes which range up to 10.0 mm. across and which vary from a pure white colour to a reddish brown. The rock could be correctly termed an argillaceous quartz sandstone.

(W. M. B. Roberts)

5/3/56.

N



MAP SHOWING RELATION TO AUSTRALIAN
FOUR MILE SERIES.

LOCALITY MAP MANGANESE DEPOSITS RENNER SPRINGS - MUCKETTY

SCALE
0 2 4 8 Miles

ML47E
Hunter
ML48E
ML49E-50E

Renner Springs

Helen Springs

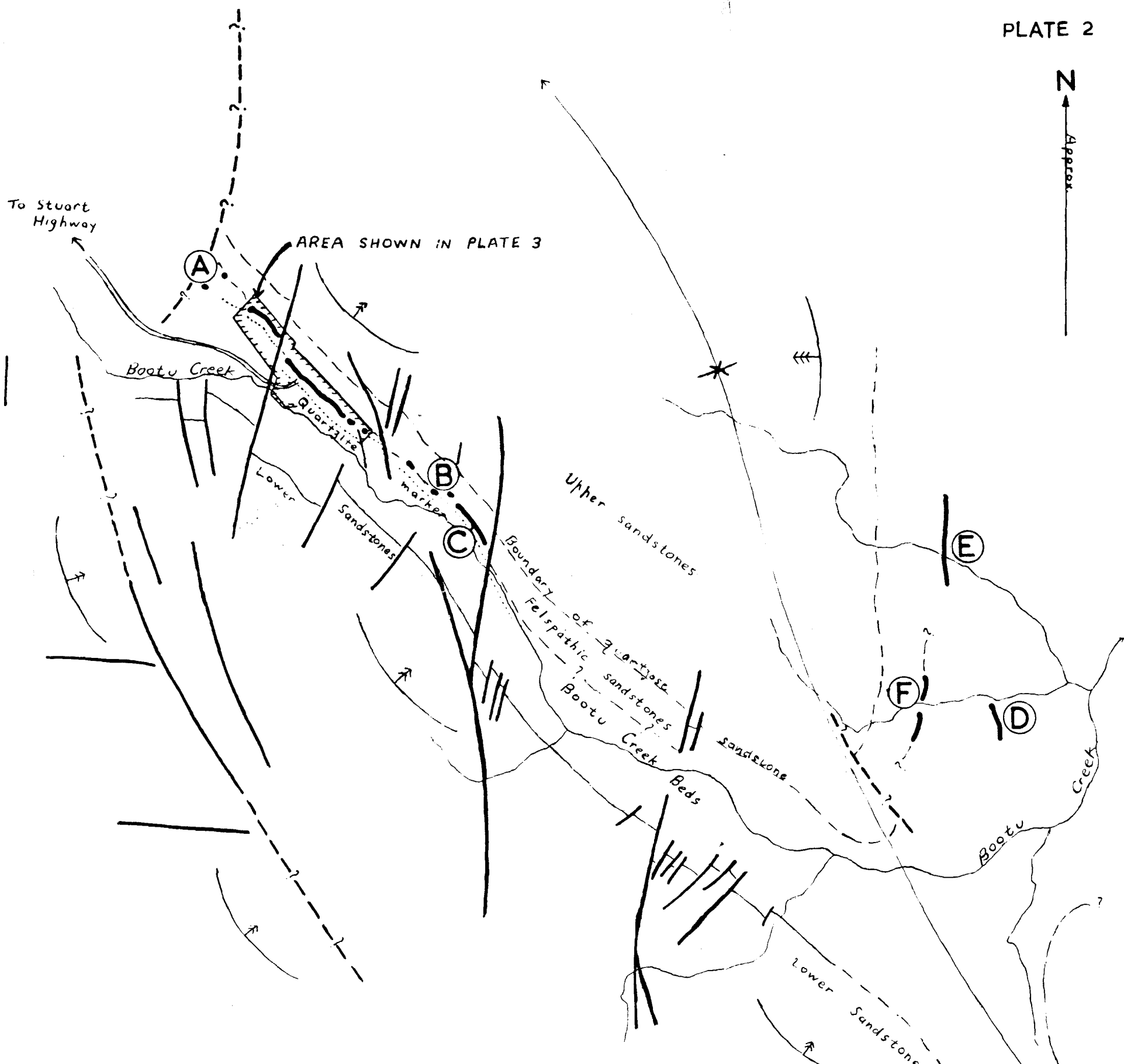
Mucketty

AREA SHOWN IN PLATE 2

ML51E
ML53E-55E

Bootu Ck.

Banka Banka



MANGANESE DEPOSITS
BOOTU CREEK AREA

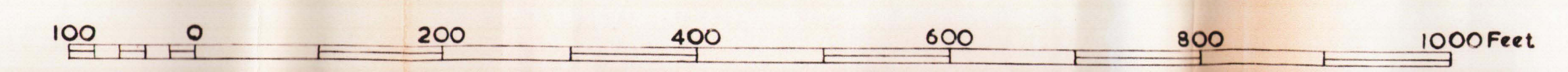


- REFERENCE
- Bedding
 - Faulting
 - Mn. deposits

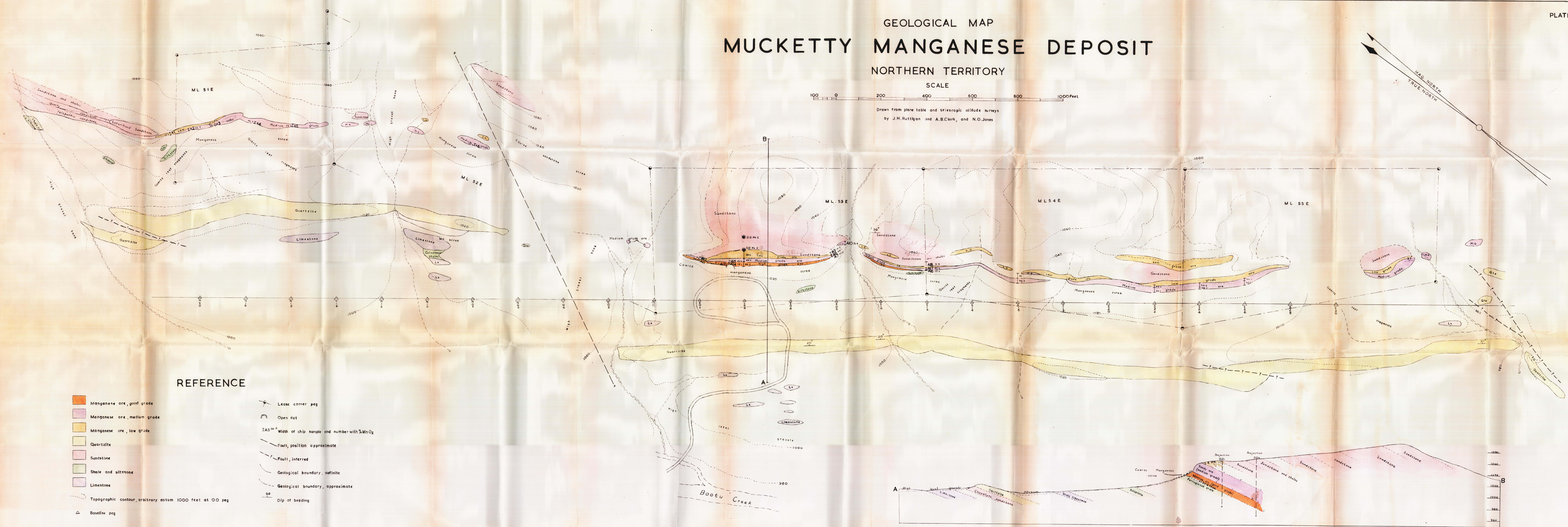
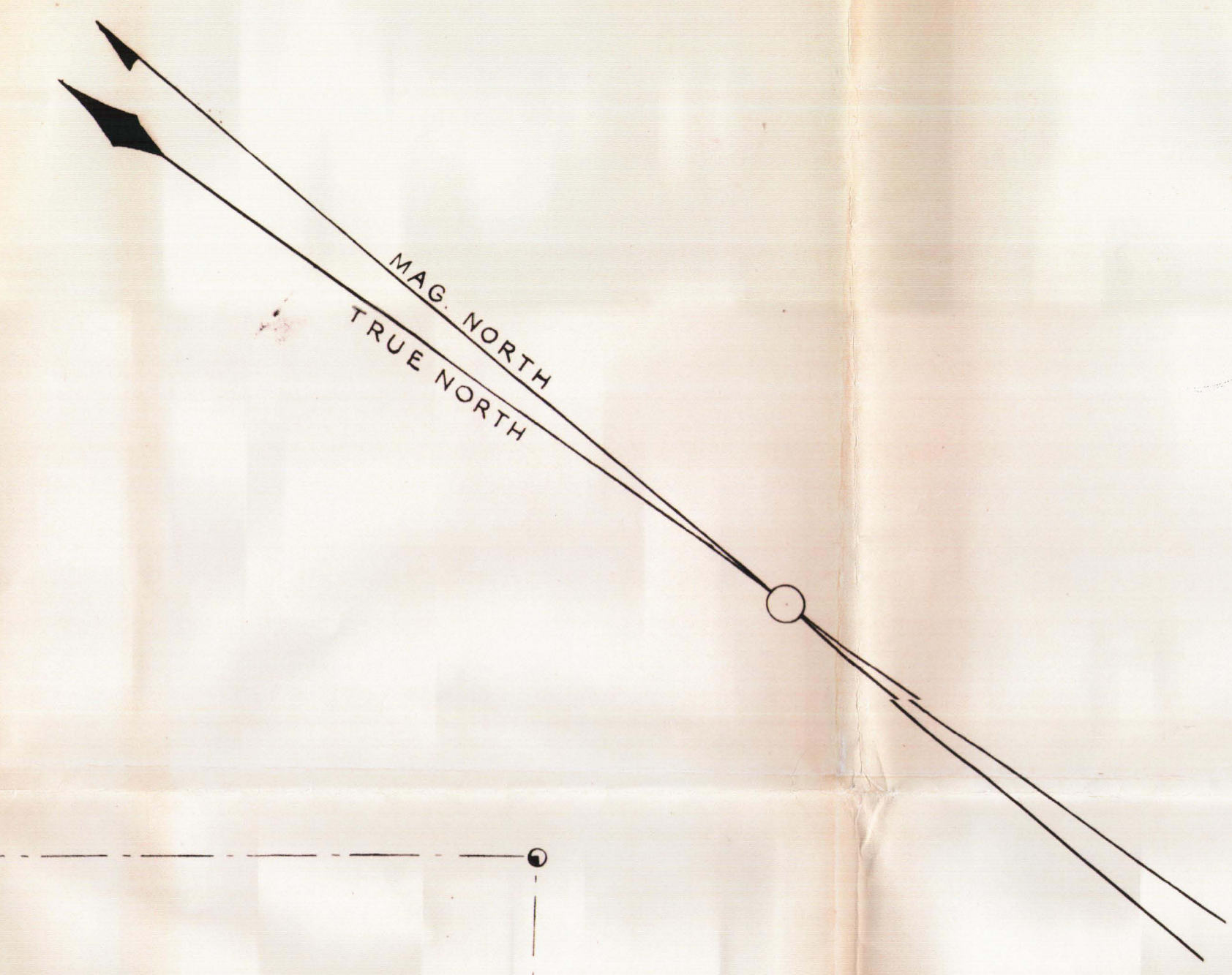
GEOLOGICAL MAP MUCKETTY MANGANESE DEPOSIT

NORTHERN TERRITORY

SCALE

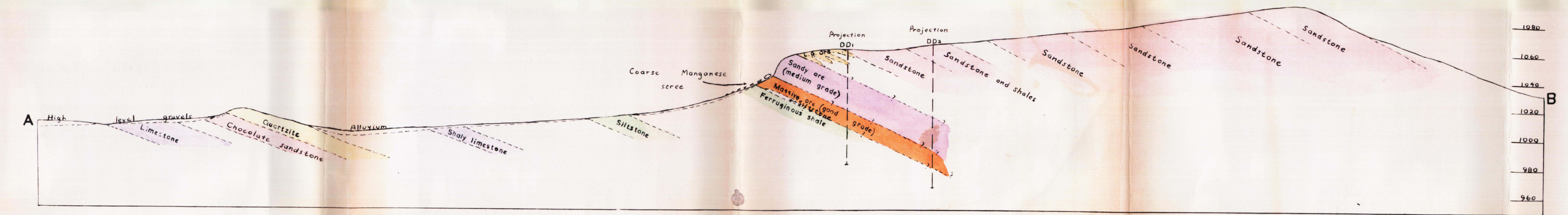


Drawn from plane table and telescopic alidade surveys
by J.H. Rutledge and A.B. Clark, and N.O. Jones



REFERENCE

- Manganese ore, good grade
- Manganese ore, medium grade
- Manganese ore, low grade
- Quartzite
- Sandstone
- Shale and siltstone
- Limestone
- Topographic contour, arbitrary datum 1000 feet at 00 peg
- Baseline peg
- Lease corner peg
- Open cut
- IAS ^{1/4} Width of chip sample and number with %MnO₂
- Fault, position approximate
- Fault, inferred
- Geological boundary, definite
- Geological boundary, approximate
- Dip of bedding



CROSS SECTION A-B

SCALE

