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GEOLOGY OF THE JUKES-DARWIN MINING FIELD,

S.W. TASMANIA

by

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AMG REFERENCE POINTS ADDED

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FIGURES

1. TOPOGRAPHY OF JUKES-DARWIN AREA
2. GEOLOGY - FINDONS PROSPECT
3. GEOLOGY - PRINCE DARWIN; taken from
U.S. Metals Report.
4. GROUND MAGNETIC SURVEY OF PRINCE DARWIN
Taken from U.S. Metals Report.
5. SELF POTENTIAL SURVEY OF PRINCE DARWIN
taken from U.S. Metals Report
6. GEOLOGY - LAKE JUKES
7. GEOLOGY - JUKES PTY.
8. GEOLOGY - HYDES
9. GEOLOGY - EAST DARWIN
10. SAMPLE SITES - SOUTERS ADIT (Douglas 1940)
11. SAMPLE SITES - DILLON's NO.1 ADIT (Douglas 1940)
12. SAMPLE SITES - PIERCE's ADIT (Douglas 1940)
13. SAMPLE SITES - DARWIN PTY. ADIT (Douglas 1940)
14. GEOLOGY OF JUKES-DARWIN AREA.
15. AEROMAGNETIC MAP OF JUKES-DARWIN AREA.

CONTENTS

	<u>Page</u>
1. ABSTRACT	1
2. INTRODUCTION	2
3. LOCATION AND PHYSIOGRAPHY	3
4. PREVIOUS WORK	4
5. INDIVIDUAL PROSPECTS	5
A. Findons	5
B. South Darwin	15
C. Lake Jukes	22
D. Jukes Pty.	28
E. Hydes Prospect	31
F. East Darwin	32
6. GEOLOGY	37
A. Geological Maps	37
B. The Cambrian Suite	39
(i) Felsites	40
(ii) Darwin Granite	44
(iii) Volcanics	46
(iv) Schists	48
7. STRUCTURE	49
8. GEOLOGICAL HISTORY	51
9. AIRBORNE MAGNETIC SURVEY	53
10. ECONOMIC GEOLOGY	57
11. REFERENCES	62

1. A B S T R A C T

This report is the result of field work by B.H.P. geologists during January and February, 1970. It provides detailed information on six prospects as well as general assessment.

In 1970 a new interpretation of the geology is proposed, and this is expected to affect economic considerations. Conclusions are tentative at this stage but it is hoped they will be strengthened by further mapping and petrological studies.

Cambrian acid rocks correlated with those of the Mt. Read Volcanic Arc are divided into two groups - the older felsites and Darwin Granite overlain by younger acid volcanics. The whole series was probably uplifted and received a regional N-S cleavage during the latter half of the Cambrian.

Two types of mineralisation occur separately and together. Brecciation, veining and replacement by iron oxides (and sometimes barite) appears to be confined to the granite and felsite and is possibly associated with intrusion of the granite. Chlorite-sulphide mineralisation occurs in all rock types and may be associated with volcanic exhalations.

Reinterpretation of the geological map suggests that the contacts between older and younger Cambrian rocks

are sites of copper mineralisation, which occurs in two different structural settings - a western disconformity and an eastern shear zone.

Future exploration should be directed towards these favoured areas and carried out in conjunction with drilling at recommended sites on known deposits and such geophysical investigations as the terrain permits.

2. I N T R O D U C T I O N

From the 12th January to the 13th of February, 1970 a party of four geologists and four field assistants carried out a short mapping and evaluation programme of six prospects in the Mt. Jukes - Darwin Area, south of Queenstown, Tasmania. The company holds a 50 square mile exploration licence over the area which is part of E.L. 13/65 S.W. Tasmania.

Two parties of three, consisting of two geologists and one field assistant, were each assigned three prospects to map and assess, and short visits were made by Dr. A. Grady and Dr. A. Walker. Each party with equipment was flown in by helicopter to camp sites near the prospects. Two track-cutters were employed in the latter part of the programme to open-up existing access tracks to the prospects from the Crotty road.

3. LOCATION AND PHYSIOGRAPHY

The Mt. Jukes-Darwin Area covers the southern part of the West Coast Range of Tasmania. The dominant peaks are, from north to south, Mt. Jukes (3,833'), Mt. Darwin (3,383') and South Darwin (2,250').

Mt. Jukes is approximately 7 miles S.S.E. of Queens-town.

The river valleys are deeply incised, the largest being the E-W King River Gorge, close to the northern boundary of E.L. 13/65. The area is extremely rugged with relief contrasts up to 3000 feet, partly due to the effects of Pleistocene glaciation which has left 2 glacial lakes and many steep-sided cirques (the Upper Lake Jukes Cirque has a cliff up to 1,000 ft. high.)

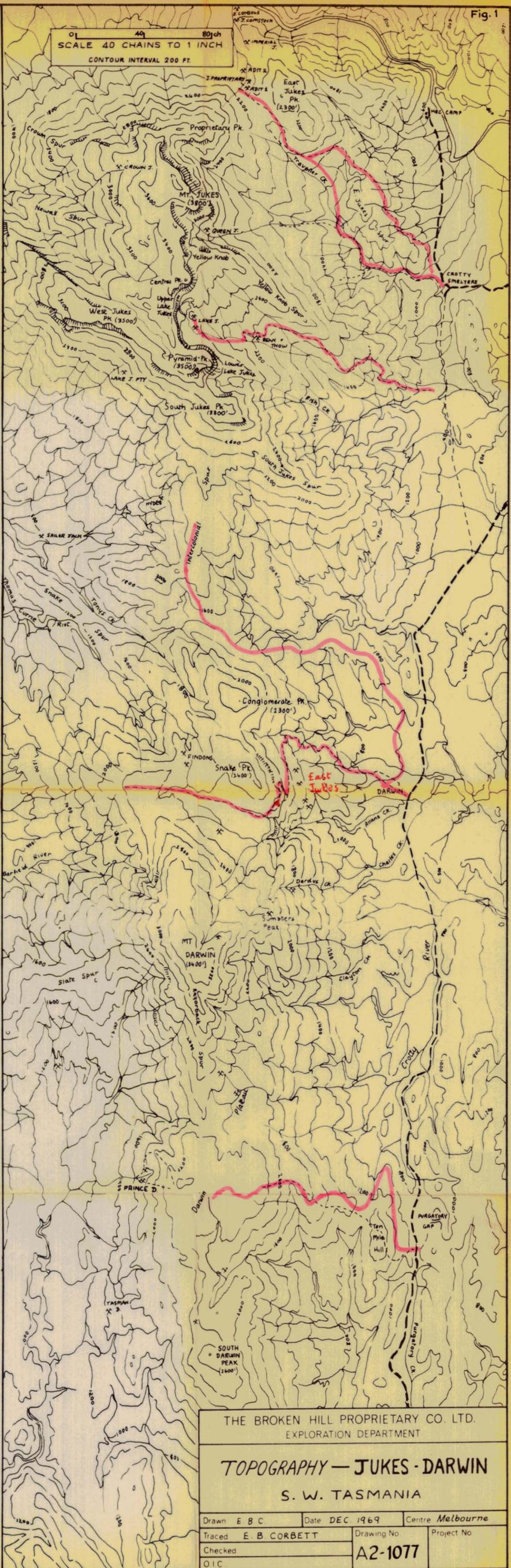
The peaks and ridges are sparsely covered with low scrub and button grass whereas the valleys and slopes are relatively thickly vegetated with small stands of forest and a tangled secondary regrowth of Banksias and vine-like Bauera, almost impenetrable in places.

The range is exposed to the often extreme and rapidly changeable weather conditions produced by the dominant westerly stream. Conditions are generally reasonable from November to February but during March-April weather becomes unpredictable until, from May on, it is impossible to plan any field work.

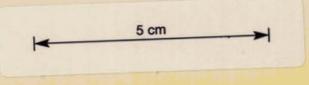
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Fig. 1

0 40 80 ch
SCALE 40 CHAINS TO 1 INCH
CONTOUR INTERVAL 200 FT



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TOPOGRAPHY — JUKES - DARWIN		
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4. PREVIOUS WORK

The copper boom in the Mt. Lyell field in the 1890's stimulated prospecting in the surrounding areas. Prospectors found signs of copper mineralisation at Mt. Jukes in 1897 and in the Mt. Darwin area in the following year. When the North Lyell Company closed its smelter at Crotty in 1903, most mining and prospecting activity ceased in the area.

Various government geologists visited the area and published reports from 1900 - 1914; the most significant report and a compilation of the early mining activity was written by Loftus Hills (1914).

Mt. Lyell Mining and Railway Co. Ltd. re-examined the old prospects in 1940 and concluded that, due to the difficult access, no further work was justified.

During the period 1956-1960 Lyell-E.Z. Explorations re-inspected parts of the Jukes-Darwin Area in brief field trips. In 1957 L.E.E. covered the entire area with an aeromagnetic survey; the rugged terrain did not permit an aero-electromagnetic survey.

Some ground geophysical and geological investigations were carried out in 1959 which was followed by two diamond drill holes in the Lake Jukes prospect with poor results.

U.S. Metals Refining Company, holding the area as an Exploration Licence - E.L. 2/64 - made two rather

brief inspections during Summer 1964/65. The results of geological and geophysical ground surveys, done over some old mining prospects, were felt to be disappointing, and no further work was recommended.

B.H.P., holding the Jukes-Darwin area as a part of E.L. 13/65 did only very limited investigations; a small geochemical stream sampling survey in the Crotty Smelter area was followed by a brief field visit which aimed to investigate a lead stream anomaly and map the area between Crotty and Mt. Jukes.

5. INDIVIDUAL PROSPECTS

A. Findons Prospect

E.B. Corbett

Location and Access

The workings are situated on the western edge of the saddle between Snake Peak and Mt. Darwin. The country is open, with button-grass and light scrub cover near the workings and bare gravelly ridges to the north-east. Slopes are not severe near the workings.

Access is most easily gained by helicopter since the area is only four or five minutes flying time from the helipad at the old Darwin townsite.

A graded foot track starting at Darwin and crossing the saddle south of Findons workings has been re-opened, along with a straight steep track with several offshoots to the East Darwin workings. Walking time from Darwin to Findons is 1½-2 hours.

A sheltered campsite has been prepared on the saddle, with a good permanent water supply.

Previous Work

In 1903 G.A. Waller inspected the area known as "Findons Section" and gave detailed descriptions and analyses for the four trenches which existed at that time. Bulk samples taken from the ore zone in each trench yielded 2.9 - 3.2% Cu, while a selected sample from a 20ft. shaft in No. 2 trench assayed 5% Cu. The shaft was full of water at the time of Waller's visit and has apparently remained so ever since.

Between 1903 and 1914 a tunnel was driven for 120 feet, starting near the creek on the northern side of the ore zone and running in a southerly direction towards a small ore body revealed in No.4 trench. A little ore was intersected but a survey by Wade in 1957 showed the adit was not driven far enough to reach the main lode.

No further mining was carried out after 1914.

In 1957 Wade sampled the Adit and Main Trench (presumably No.2) obtaining maximum values of 0.12% Cu and 0.54% Cu respectively.

U.S. Metals Refining Company sampled four trenches in 1964, the highest values obtained being 0.40%Cu (channel sample) and 1.17% Cu (grab sample). Gold occurred as traces only and the highest silver value

was 4.92dwt/ton, confirming Waller's observation that precious metal values are very low.

For some reason U.S. Metals chose to renumber the workings and their report is also confusing in that little detail is given on what was actually sampled. An S.P. survey extending 500 feet on either side of the workings (200ft. spacing, 3900ft. total traverses) gave negative results, possibly due to very wet surface conditions.

Workings after Waller (1903) Hills (1914)

U.S. Metals (1964)

Trench 1	8ft. long, 3-4ft. deep	Trench A
Trench 2	60ft. long, variable depth, 20ft. shaft.	Main Trench (B)
Trench 3	about 15 ft. long, variable depth.	Trench C
Trench 4	14ft. long, up to 4ft. deep	Trench E
Adit	126ft. long	Adit

Geology

The country rock is described by Loftus Hills and Waller as felsite, being a very hard, dense rock with scattered small phenocrysts of chloritised feldspar in a pale grey to pink, very fine-grained groundmass. Away from the ore zone the rock is generally fresh or slightly chloritised. Most outcrops are massive with blocky irregular fractures but no penetrative cleavage. Cross-fibre quartz veins are common in some areas, hematite veining rather rare.

Heavy chloritisation is generally restricted to areas of intense shearing, and mineralisation occurs only in chloritic rocks. The ore zones are elongated parallel with the regional shearing (strike $130-150^{\circ}$ True, dip steeply southwest). The cleavage orientation $330^{\circ}/60^{\circ}W$ originally mentioned by Waller has been quoted by all succeeding authors but shearing is too variable to give such precise figures.

Careful examination showed the heavily chloritised rocks do not form a continuous body but occur as a series of sub-parallel lenses. Leaching is very severe and in several of the trenches the top 18 inches of rock is pale coloured, with nothing to indicate that the rocks beneath contain about 80% chlorite and 5% sulphides. This puts a severe limitation on the usefulness of surface geological mapping since the chlorite zone can only be accurately mapped after intensive trenching or stripping the surface rocks.

Leaching by acid surface waters has also been blamed for the striking reduction in Cu content from 3% in samples taken in 1903 to 1% or less in 1964. Even in 1914 Loftus Hills considered there was less evidence of mineralisation than Waller had seen in 1903.

Chlorite rocks occur for 1400 feet along strike from small, isolated bodies on The Knob (northwest of trench No.4) to moderately chloritised rocks southeast

of trench No.1. At the southeastern end chloritisation gradually dies out towards Findons Creek but at the northwestern end chlorite bodies are clearly defined, with sharp irregular contacts against unaltered felsite.

East of the ore zone the felsites in the creek are massive, with little chloritisation or shearing. Quartz-chlorite veins and secretions up to 4 inches across are common but rarely contain sulphides. Some small patches of brecciated felsite contain hematite.

The chlorite rocks vary from fairly hard to strongly sheared. At the northwest end of the belt chlorite rocks form irregular bodies up to 4 feet wide, containing limonite and possibly sulphides. In Trench No.4 the chlorite zone is 20 feet wide, with pyrite and chalcopryrite plus secondary copper minerals concentrated over about 6 feet. Mineralisation is not intense.

Trench No3. crosses about 8 feet of chlorite rock showing limonite but little other mineralisation. In the Main Trench the chlorite zone is 20 feet wide, perhaps more since outcrop is poor on the southwest side. The richest chalcopryrite occurs just northeast of the shaft, dying out about ten feet from the shaft. The uppermost trench (No.1) shows patchy chloritisation and scattered half-inch pyrite blebs. No mineralisation was detected further south and chloritisation decreases gradually in this direction.

West of the chlorite zone and apparently overlying it, is about 30 feet of very fine-grained, cleaved felsite lacking phenocrysts and sometimes having a cherty appearance. In places these rocks contain smears and blebs of goethite.

Normal porphyritic felsite overlies the aphyric rocks and contains an irregular, probably discontinuous brecciated band parallel with the ore zone.

Summary

Pyrite-chalcopyrite and secondary copper mineralisation occurs in the centre of a belt of chloritic rocks approximately 100 feet wide and 1000 feet long, striking about 150° True and dipping $55-80^{\circ}$ SW. The belt apparently consists of lenses less than 50 feet thick, with mineralisation restricted to the central part of each lens. Deep leaching places severe limitations on surface mapping and sampling.

Adjacent Areas

Mapping was extended to cover the area between Snake Peak and the top of Mt. Darwin, see Fig.2.

(i) Snake Peak Iron Body

Felsites with crystalline groundmass and chloritised phenocrysts on the southern flanks of Snake Peak are overlain by a series of hematitic rocks.

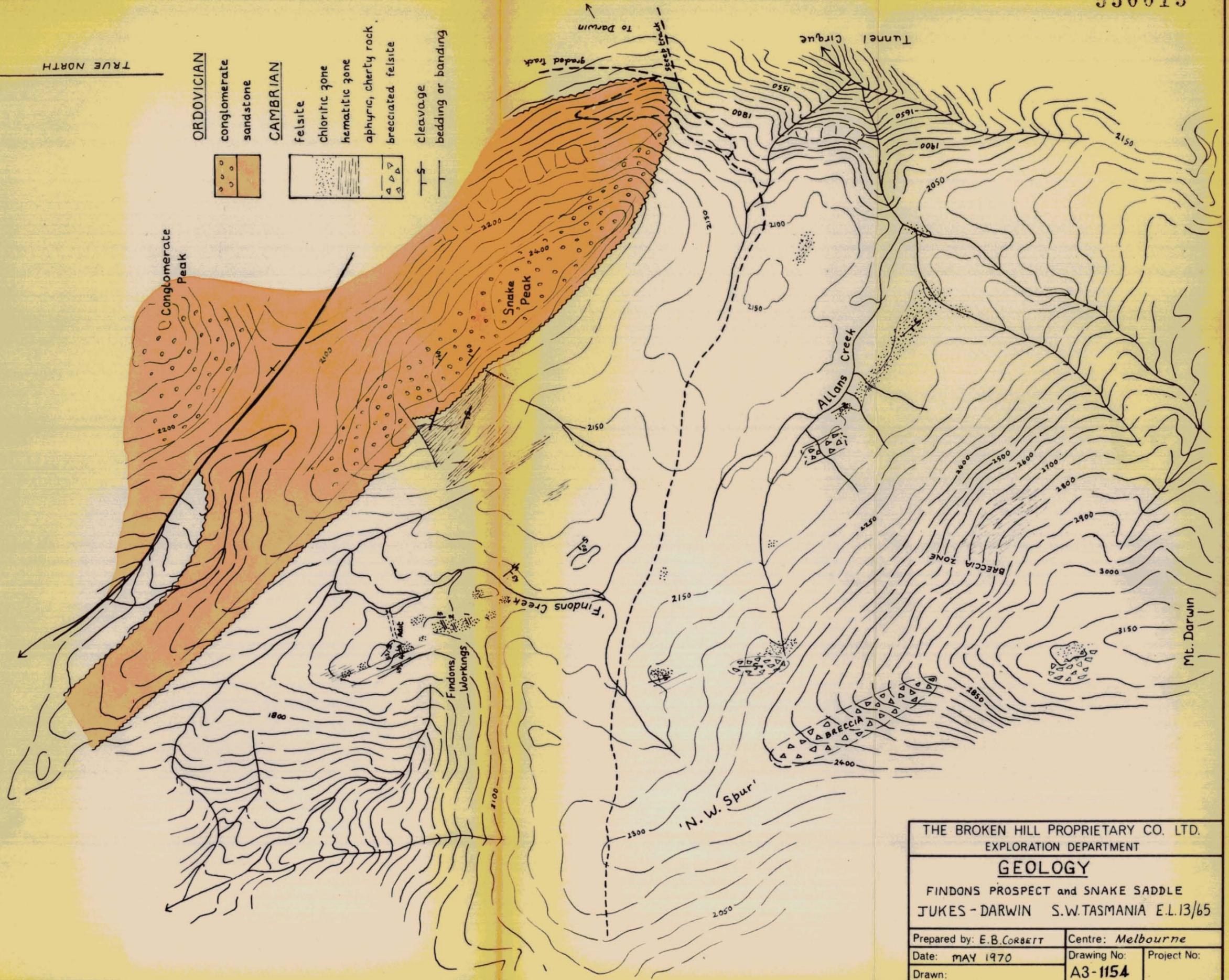
Fig. 2.

Scale 10 chains to 1 inch
Contour interval 50 feet

5 cm

TRUE NORTH

- ORDOVICIAN**
conglomerate
sandstone
- CAMBRIAN**
felsite
chloritic zone
hematitic zone
aphuric, cherty rock
brecciated felsite
- cleavage
bedding or banding



THE BROKEN HILL PROPRIETARY CO. LTD. EXPLORATION DEPARTMENT		
GEOLOGY		
FINDONS PROSPECT and SNAKE SADDLE JUKES - DARWIN S.W. TASMANIA E.L. 13/65		
Prepared by: E.B. CORBETT	Centre: Melbourne	
Date: MAY 1970	Drawing No:	Project No:
Drawn:	A3-1154	

The southernmost iron zone is about 50 feet thick, consisting of irregular hematite segregations which make up 50% or more of the rock. Breccias with angular blocks of felsite or single feldspar crystals in an iron-rich matrix are common as bands up to 18" wide. Hematite veins $\frac{1}{2}$ " - 6" wide are also abundant in places, but the percentage of rocks showing these replacements is variable.

The next zone consists chiefly of hematitic breccias with the base of the zone very irregular and in some places faulted against pale, massive felsite with hematite-quartz veins.

The thickest and most extensive iron body underlies basal Ordovician red sandstones near the top of Snake Peak, forming a conspicuous dark band 50-60 feet thick. The band tapers to the east and is cut off by a fault to the west at the head of Snake Spur. The dark rocks consist of heavily hematised felsite with many quartz-hematite-barite boxworks, rarely containing sulphides.

This body is an example of the hematite mineralisation common throughout the Mt. Darwin area. This type of body is distinct from the chlorite-pyrite of most of the prospects. So far the only sulphide found in the iron bodies is pyrite, but leaching may be significant and we have no exposures at depth.

The association hematite-barite is interesting when compared with Iron Blow at Mt. Lyell, and it is worth noting that on Intercolonial Spur there is an iron-rich zone several hundred feet wide in which barite is prominent, as veins and sheets up to 4 inches thick. A six foot vein of barite has yielded significant concentrations of chalcopyrite and secondary copper minerals. Leaching has removed all traces of sulphide from the barite at the surface.

(ii) Allans Creek workings

Two adits have been driven in the steep face of the ridge leading from Mt. Darwin towards Sumpters Peak, near the headwaters of Allans Creek.

A sheet-like fracture system parallel with the slope has isolated a two-foot thick slab very rich in pyrite. This slab has been trenched over a distance of about 40 feet and a 10 ft. adit passes through it into fresh felsite. This sulphide body is unique in the area in that sulphide occurs disseminated in felsite which is neither sheared nor altered. Pyrite occurs as veinlets and small grains and some even replaces phenocrysts. It is notable that even in fresh rocks in the adit leaching has removed surface sulphides.

50 feet lower down an adit has been driven for 130 feet towards 155°. The portal is in hard, pale felsite and dump material includes fresh felsite with pyrite and a flakey chlorite rock which is apparently barren. Loftus Hills (1914) reports a sulphide-bearing sericite-chlorite horizon 60 feet in, but no other mineralisation.

This ore body is relatively inaccessible and appears to be small. Neither primary copper sulphides nor secondary copper minerals were seen and further work is not recommended.

A 300 ft. adit has been driven on the northeast face of Sumpters Peak, reportedly intersecting 10 feet of chlorite schist carrying pyrite and chalcopyrite. Access is difficult and the workings were not visited.

(iii) North Face of Mt. Darwin

Excellent exposures on the saddle and the face of Mt. Darwin permit the mapping of a number of chlorite and chlorite-hematite zones of potential interest.

Saddle and mountain are both largely composed of fairly uniform pale, dense felsite with chloritised phenocrysts. Irregular masses of aphyric rocks, sheared chlorite rocks and coarse breccias can be traced over short distances but rock distribution in general is controlled by tectonic features and there is little evidence for an original layered sequence.

Chlorite zones are less than 100 feet wide and less than 1000 feet long. They tend to be poorly defined, partly due to leaching, and have gradational margins. The most promising are associated with pyrite-hematite veins which reach 18 inches in width and are often in the form of angular felsite fragments in an iron oxide cement.

- (a) There is a poorly defined, chlorite zone about 70 feet wide restricted to a knoll just south of the track on the eastern edge of the saddle. The felsite is rich in hematite veins which range in thickness from $\frac{1}{4}$ inch to 2 feet. Swarms of veins can generally be followed along strike for 20-30 feet. Some veins are dark, massive and fine-grained but others porous or brecciated and there is some associated pyrite.
- (b) A chlorite zone approximately 800 feet long and 70 feet wide tends towards 145° from the alluvial workings in the northern branch of Allans Creek. The belt is less than 20 feet wide at the northern end, consisting of a single darkly stained outcrop with stringers of chlorite east of the first small creek it widens abruptly to 70 feet and contains a number of 5inch breccia-type hematite veins carrying patchy pyrite. The country rock is slightly sheared and does not appear to contain sulphides.

This chlorite zone becomes diffuse and finally untraceable to the southeast, where rocks over a wide area contain a few limonite veins and chlorite patches.

- (c) A band of heavily chloritised felsite occurs on the slopes of Mt. Darwin, striking at 160° True. This band is about 100 feet thick, does not extend far along strike and is not mineralised although it does contain reef quartz. This and other areas of chloritised

and brecciated rocks on the face of Mt. Darwin indicate a zone of NW-SE shearing.

B. South Darwin

E.B. Corbett

Between Mt. Darwin and South Darwin Peak lies South Darwin Plateau, $2\frac{1}{2}$ miles long, $\frac{3}{4}$ mile wide at an average elevation of 2200 feet. Much of the plateau is underlain by Darwin Granite (Cambrian) which shows patches of hematite replacement and sheared, chloritised areas which rarely exceed 30 feet in width. The granite forms a tabular body faulted against schists to the east and felsites to the north and west. On the steep western slope below the plateau N-S striking felsites show extensive hematite-magnetite-(sulphide) mineralisation as a spectacular, discontinuous band of iron-stained rocks 5000 feet long and up to 200 feet wide. This zone was tested with several adits in the early 1900's and has since been briefly examined by several companies.

Most of the development has been in the Prince Darwin area, at the north end of the zone, where two adits were driven into precipitous slopes 400 feet below the plateau. Workings shown $\frac{3}{4}$ mile to the south on Wade and Solomons map (and wrongly named Prince Darwin) were never located and it is doubtful if they exist. The Tasman Darwin adit, over a mile south of Prince Darwin, was not located and may have collapsed; it was last seen in 1913.

Access

Access to the plateau is most easily gained by helicopter from Darwin township, flying time 4-5 minutes. A steep foot track (poorly graded) follows a spur from Ten Mile Hill to the plateau and on foot it takes 1½-2 hours to reach the plateau from the Crotty Road. Most of the plateau is covered with rough buttongrass and low scrub, affording reasonable access by foot to all parts.

A line cut by U.S. Metals from the highest point on the plateau down a NW spur towards the Prince Darwin north adit has been cleared and extended to pass the adit and join up with the No.1 E-W traverse directly above the south adit. A N-S line has been marked and cleared just below the ore zone linking traverses 1, 2 and 3. Traverses 1 and 3 have been roughly cleared up to the plateau. All these lines cross very steep country and rock climbing is necessary in places.

A new line to replace No. 4 has been cleared to the plateau to the top of the iron zone. The original traverses are shown on Fig. 3.

No lines were found in the Tasman Darwin area but access is easy from the southern end of the plateau. Exposure of the upper part of the iron zone is good at Tasman Darwin and Prince Darwin but the middle section of the belt is covered with very thick scrub.



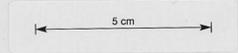
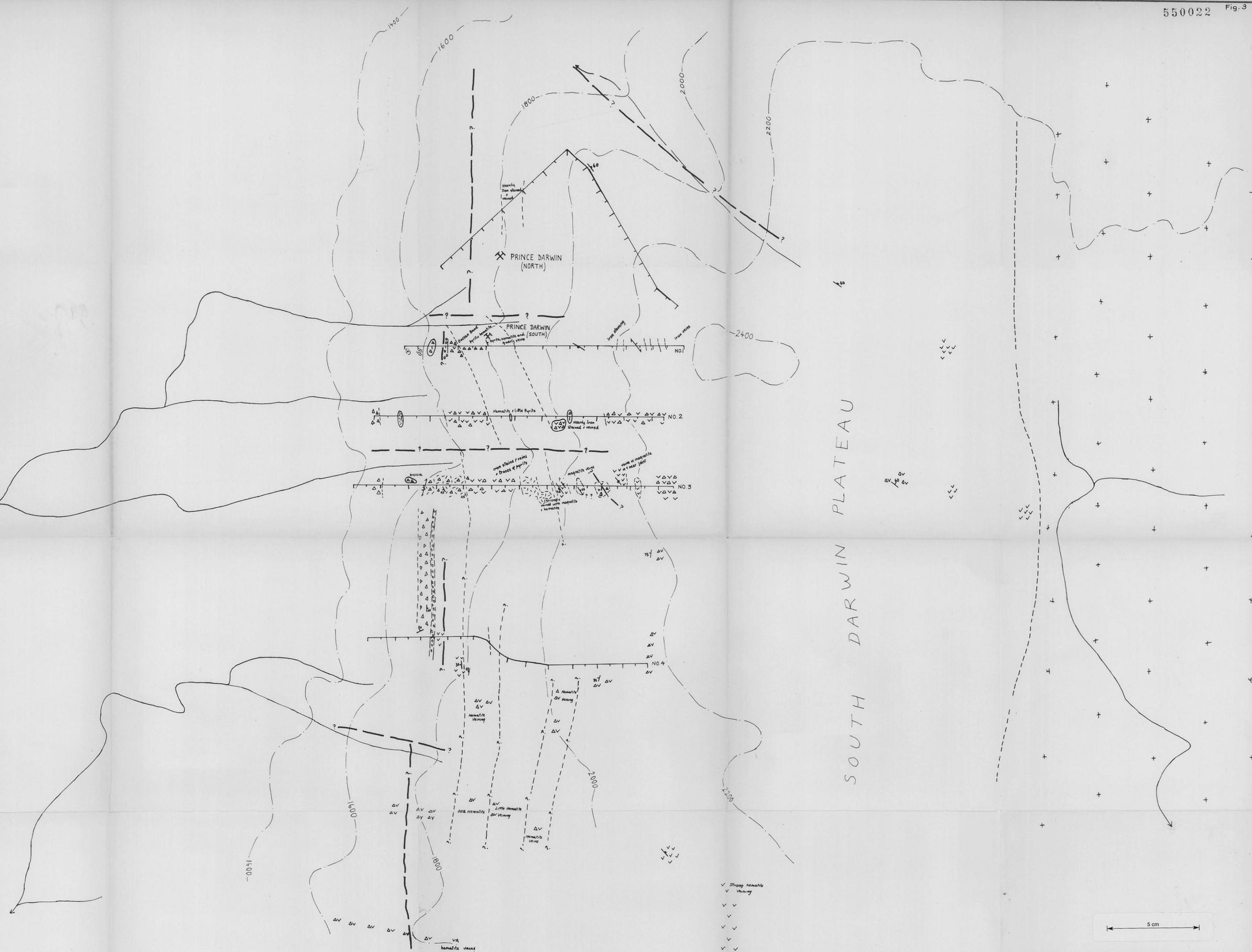
CLARK VALLEY

SOUTH DARWIN PLATEAU

LEGEND

- Fault
- - - Boundary
- Dip & Strike
- ⊕ Breccia
- ⊕ Rhyolite
- ⊕ Porphyry
- ⊕ Granite
- ⊕ Sedimentary Rocks
- + Joint
- ↗ Schistosity

0 250 500
 Scale 3 inches = 500 feet
 CONTOUR INTERVAL 200 FEET



SKETCH TOPOGRAPHIC
CONTOURS ADDED

THE BROKEN HILL PROPRIETARY CO. LTD. EXPLORATION DEPARTMENT		
PRINCE DARWIN GEOLOGY AND TOPOGRAPHY		
UNITED STATES METALS REFINING CO. 1964 REPORT		
Drawn:	Date: MAY 1970	Centre: Melbourne
Traced: E. CORBETT	Drawing No:	Project No:
Checked:	A1-1368	
D.I.C.:		

Geology

The granite of the South Darwin Plateau is flanked on the west by banded and massive acid rocks partly or wholly equivalent to the felsites on Mt. Darwin. The Prince Darwin ore occurs in a zone of chlorite-hematite replacing part of the western edge of a broad band of felsite; it is not located in the Jukes Breccia as stated by Wade and others but is overlain by a thin interformational breccia, followed by a west-dipping series of lavas and volcanics, all Cambrian in age. Locally the breccia forms a useful marker horizon but does not extend as far south as Tasman Darwin, where the felsite is directly overlain by lavas and pyroclastics.

Prospects in Detail

(i) Prince Darwin

The northern end of the ore zone is cut off by a N-W fault, and it seems unlikely that the ore reappears anywhere on the western face of Mt. Darwin. A short adit (about 85 feet) has been driven into the most northerly iron-stained rocks, with the portal in pyritic breccia and passing rapidly into hematitic felsite to the northeast. Mineralisation consists of pyrite in veinlets and coarse crystals in both breccia and felsite, and botriodal hematite and barite in felsite. Mineralisation is not at all extensive.

The northern adit is separated from the main Prince Darwin adit by a precipitous creek flowing down a

fault line. Mineralisation is at a maximum round the south adit and consists of sulphides and secondary salts disseminated in massive felsite which has been extensively replaced by chlorite and iron oxides. The chloritic rocks form a zone about 200 feet wide in which mineralisation occurs as an irregular core 100 feet across. Within this core there are pyritic quartz-chlorite veins, hematite veins and chlorite-filled fractures. East of the main chlorite zone there are bands of pyritic chloritised felsite.

The adit is 135 feet long with a 20 ft. cross-cut about 85 feet in, and is mineralised over most of its length, with pyrite and copper salts abundant but chalcopyrite rare.

South of the main adit the iron-stained zone continues for nearly 2000 feet, cut by minor faults, and is then reduced to a number of magnetite-rich lenses. South of the adit sulphides and chloritisation become rare and patchy on the surface, and this is shown in the low copper values obtained by U.S. Metals for a number of surface samples. Hopefully, this is due to leaching and/or the southerly plunge of the ore body which is suggested by ground magnetic and S.P. Profiles (Figs. 4 and 5).

Ore Reserves

Assay results from the Prince Darwin south adit are quoted from Douglas (1940) as follows:

average for 90 feet - 0.608% Cu

average for 130 feet - 0.7% Cu, 2oz./ton Ag

From these figures Wade (1957) calculates reserves of 4 million tons at 1% Cu. U.S. Metals resampled the adit in 1964 and Gilfillin gives the following results:

average 0-125.5 ft. - 0.46% Cu, 2.39dwt/ton Ag,
0.08dwt/ton Au.

average 40-125.5 ft. - 0.67% Cu, 3.34dwt/ton Ag,
0.13dwt/ton Au.

Gilfillin agrees with Wade's tonnage estimate but puts the grade at not more than 0.5% Cu.

These results require further examination. On the question of tonnages Gilfillin says "The zone of greatest mineralisation is 500 feet long and 150-180 feet wide and exposed to a depth of about 200 feet". Using a conversion factor of 15 cu. ft = 1 ton on such a body must be mined to a depth of more than 700 feet, to provide 4×10^6 tons of ore. Wade apparently assumed a strike length of 700 feet, giving a depth requirement of 520 feet. Either of these depths may be reasonable but there are no facts to support such figures.

The lack of sulphides on the surface away from the south adit means that any volume calculations must be based on correlations between the amount of sulphide and the degree of chloritisation and/or iron oxide abundance. On our present knowledge the figure 4×10^6 tons is virtually meaningless, although it may prove to be conservative.

Whilst U.S. Metals' 1964 assay results are generally lower than those taken in 1940 they still appear unreasonably high. The average of all the copper values for the adit is 0.42% Cu, or 0.51% if the first 45 feet are discounted because of leaching. Gilfillin's higher figures are obtained by ignoring the low values across the end of the adit and the cross-cut, a procedure which would not seem valid when estimating total reserves.

(ii) Tasman Darwin

The area of extensive iron mineralisation west of South Darwin Peak is referred to as Tasman Darwin, named after an adit driven below the iron body in about 1900. The adit did not intersect any mineralisation (Loftus Hills 1914), was soon abandoned, and apparently collapsed.

In this area the Darwin Granite extends to the west several hundred feet below the plateau and is flanked by massive felsite containing many irregular quartz-hematite bodies. Iron enrichment extends to within 100 feet of the western margin of the felsite, which has a sheared contact with the overlying lavas and pyroclastics.

Mineralisation occurs as breccia-type replacement of felsite by hematite and quartz and as irregular magnetite-quartz veins. Hematite patches are very common but sulphides are rare and chloritisation is not extensive.

To the north the iron zone thins out beyond a large fault and pyritic, chloritic volcanics above the felsite are exposed. From the main ridge above the workings iron enrichment fades out and then reappears as the structure swings east of south under an isolated knoll of Ordovician conglomerate. Magnetite boulders are common in the southern streams.

Loftus Hills (1914) defines a number of small quartz-magnetite lodes containing pyrite and minor chalcopyrite but at present the area appears less promising than the northern part of the belt at Prince Darwin.

Ground Magnetic Survey

The U.S. Metals Refining Company conducted ground magnetic surveys over seven E-W traverses in the Prince Darwin area. The two southernmost traverses are not shown on their accompanying geological map (Fig. 3) and we did not find them in the field.

Fig. 4 (reproduced from the 1964 report) shows a NW-tending fault block containing the Prince Darwin south adit, with a high of 80,000 lying just west of the adit. South of the fault near No. 2 traverse all structures are N-S and again the high occurs a little below (east) the breccia marking the contact between felsite and volcanics. A second high is shown about 300 feet east of the first one and centred on traverse 5. The easterly anomaly may be caused by a narrow, discontinuous band of black felsite and magnetite seen in the field, but a proper investigation of this area is impossible due to very thick scrub on a rugged terrain.

Most of the contours close before the southernmost traverse, which is close to a large fault.

The ground magnetic results (Fig. 4) correspond well with the distribution of iron-rich rocks seen in the field (Fig. 3, also the band shown on the western edge of the felsites in Fig. 14) and to a first approximation they outline the area requiring further investigation. However, it must be remembered that we do not yet know if correlation exists between concentration of iron, chlorite and sulphides. If sulphides can be shown to occur consistently as a core in the iron-rich rocks we are contemplating an ore body over 2000 feet long.

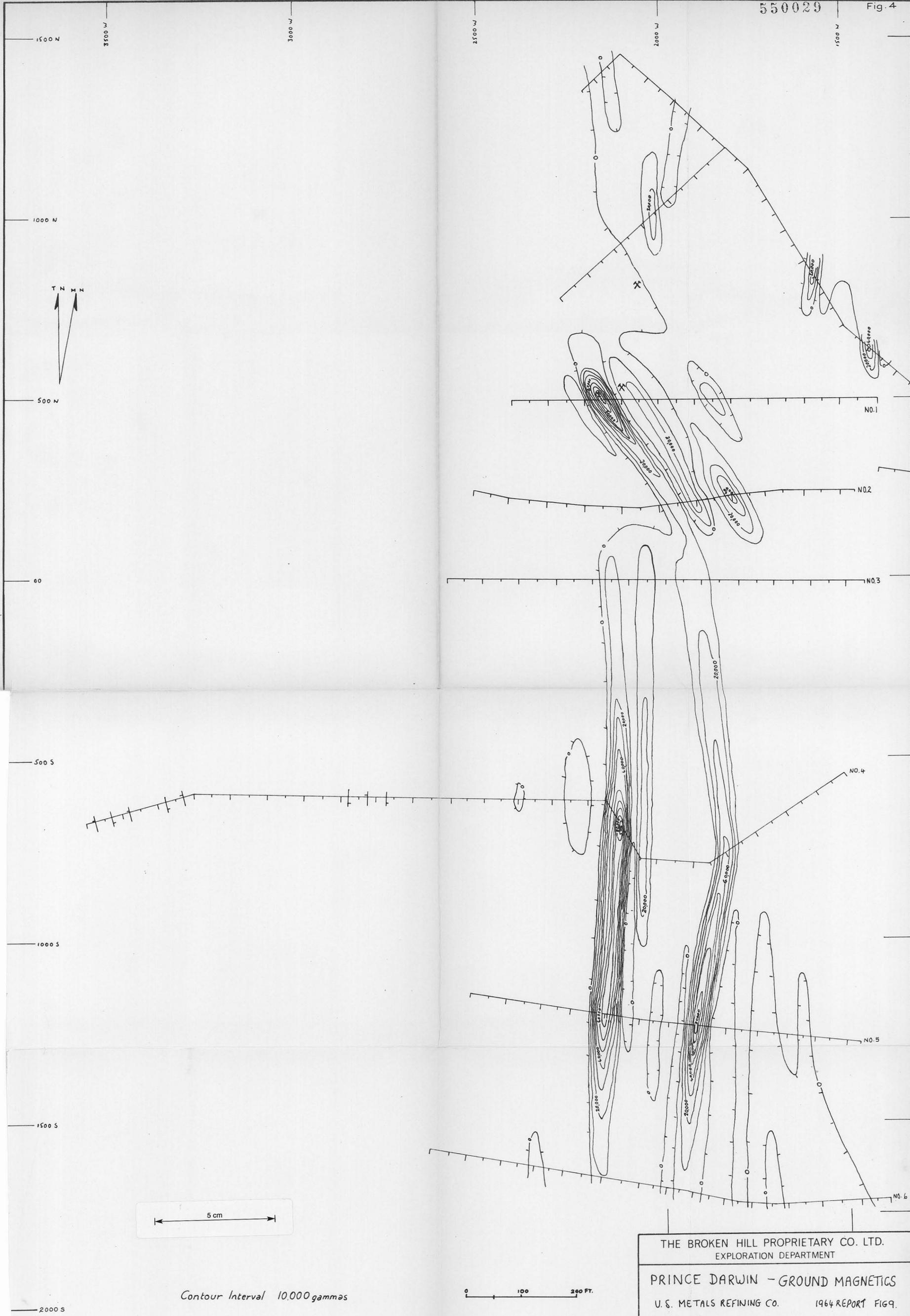
Self Potential Survey

Self potential readings were taken over the 5 northernmost traverses at the same time as the ground magnetic survey, and Fig. 5 is reproduced from U.S. Metals' 1964 report. The S.P. anomalies correspond closely to the magnetic ones, with a low of -350mv. over the Prince Darwin south adit. Trends in the contours closely match trends shown in Figs. 3 and 4.

C. Lake Jukes

E.B. Corbett

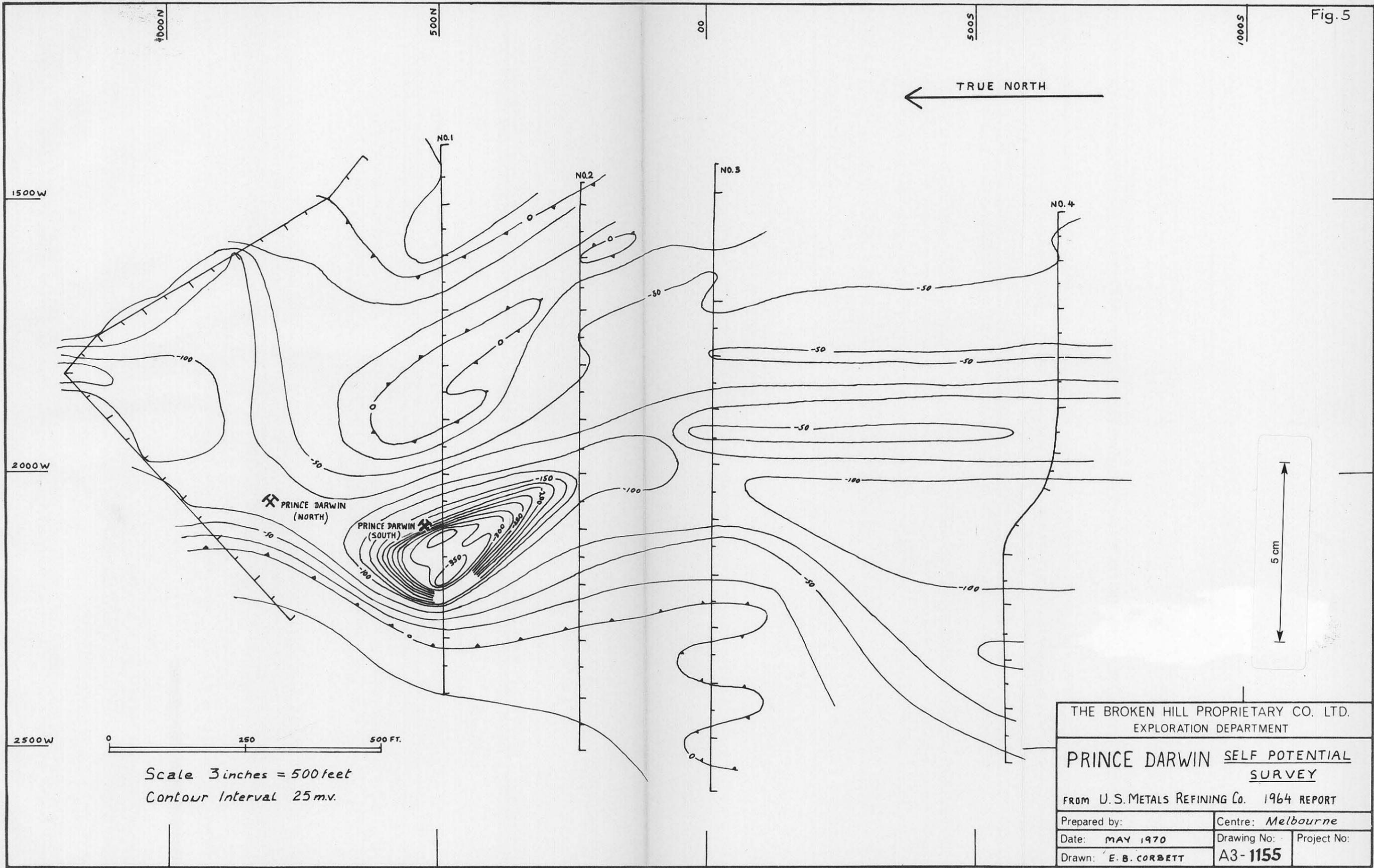
The floor of the Lake Jukes Cirque consists of several square miles of Cambrian acid volcanics, outcropping as ice-polished strike ridges dissected by the headwaters of Fish Creek. Upper Lake Jukes and Lower Lake Jukes are moraine-dammed lakes overhung by cliffs



Contour Interval 10,000 gammas

0 100 200 FT.

THE BROKEN HILL PROPRIETARY CO. LTD. EXPLORATION DEPARTMENT		
PRINCE DARWIN - GROUND MAGNETICS		
U.S. METALS REFINING CO.		1964 REPORT FIG. 9.
Drawn: R. GREENEY	Date: MAY '70	Centre: Melbourne
Traced:	Drawing No:	Project No:
Checked: E. CORBETT	A2-1078	
O.I.C.:		



THE BROKEN HILL PROPRIETARY CO. LTD. EXPLORATION DEPARTMENT		
PRINCE DARWIN SELF POTENTIAL SURVEY		
FROM U.S. METALS REFINING Co. 1964 REPORT		
Prepared by:	Centre: Melbourne	
Date: MAY 1970	Drawing No:	Project No:
Drawn: E. B. CORBETT	A3-1155	

700-1000 feet high surmounted by Central Peak, Pyramid Peak and South Jukes Peak. The cliffs mark the eastern edge of a thick sheet of Lower Ordovician conglomerate which forms all the peaks of the Mt. Jukes mass and continues north to Mt. Owen.

Access

A small helipad was constructed by L.E.E. 15 chains southeast of Upper Lake Jukes and there are a number of good campsites nearby. The area is reached by helicopter from either Crotty or Darwin (about 5 minutes flying time).

A branch of the old Crotty tram runs south from the Crotty Smelters but is impassable to vehicles north of Fish Creek. From Fish Creek a graded track runs up the southern side of Yellow Knob Spur and across the cirque to the workings near Upper Lake Jukes. Most of this track has been reopened and affords good foot access-time about 2½ hours from Crotty to the adits.

Previous Work

Mining operations began in the early 1900's and were concentrated around a steep knoll just east of Upper Lake Jukes, for convenience called here Adit Knob. Miners were originally attracted by prominent bornite and chalcopyrite exposed on the upper part of the face of the Knob.

A graded pack track was constructed, Upper Lake Jukes was dammed and a water race built to a water wheel which provided power for a five head stamper. The

battery was erected in the hope of extracting gold from quartz-chlorite veins, but was abandoned after one crushing showed gold values much lower than expected. Four adits were driven in the precipitous eastern face of Adit Knob, with a total drive distance of over 700 feet. However, little ore was encountered and work was abandoned before Loftus Hills' visit in 1913.

Despite Loftus Hills' report that no further work was warranted, in the late 1950's L.E.E. with great difficulty bored two holes below the old workings. Each hole was about 600 feet long, the southern one angled to pass a few hundred feet below the long No.1 adit. No mineralisation was intersected, and composite assays over each 200 foot interval of core show 0.02% - 0.03% Cu.

Geology

The geology of the area between the helipad and Lake Jukes is much more complicated than has been suggested by previous writers. Adit Knoll is particularly difficult to interpret due to variations from the general trends, lack of continuity of formations and the alteration associated with mineralisation. A simplified view is given in Fig. 6.

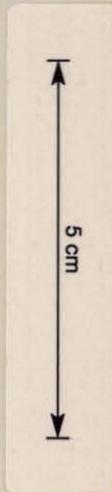
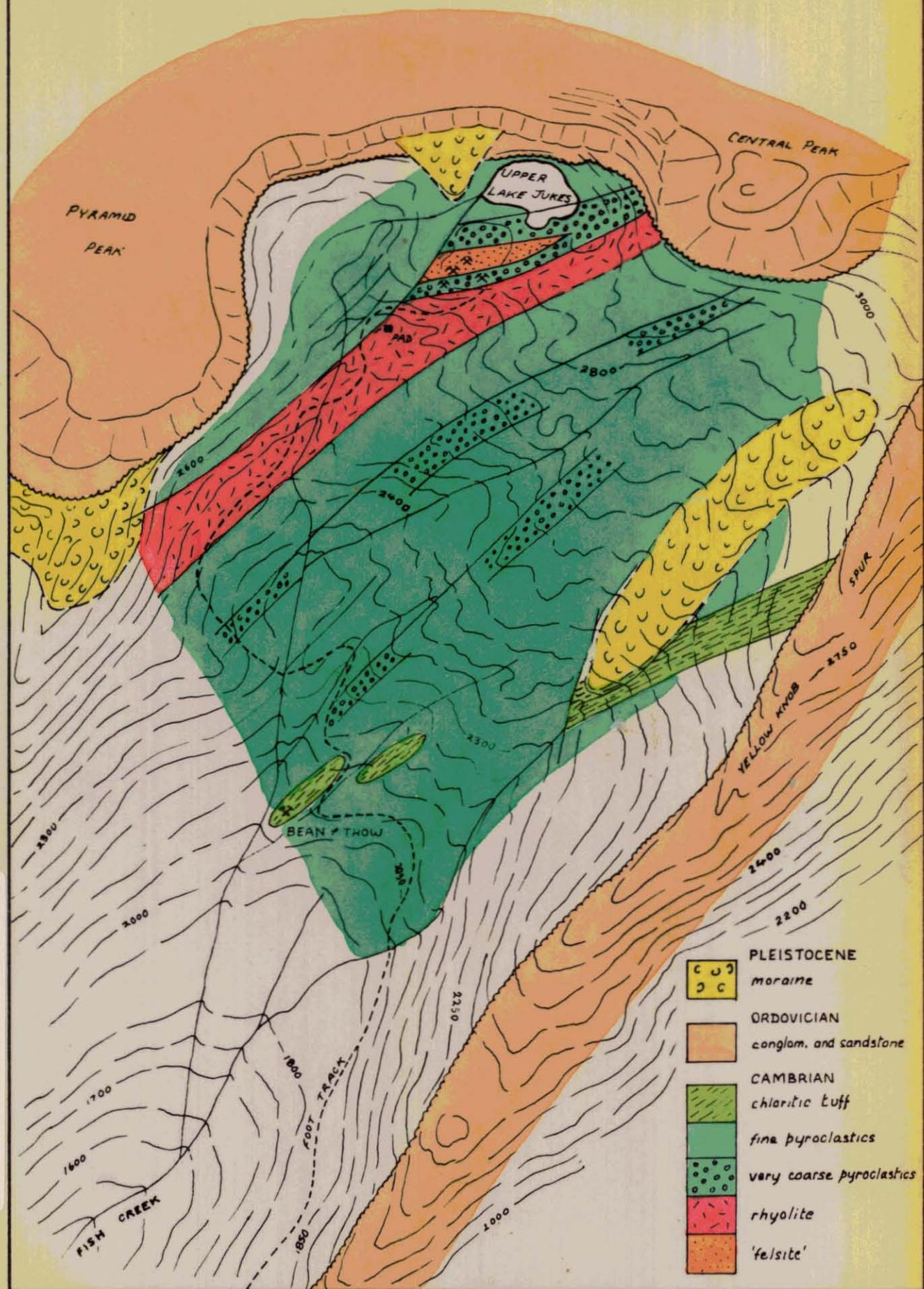
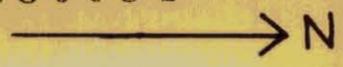
The lower eastern face of Adit Knob consists of coarse breccia with angular blocks of granite, felsite, quartz-porphry, sheared lavas and possibly tuff up to two feet across in a lava-like matrix. These rocks give

way to the north and west to banded fine tuff and fragmentals. An altered, massive pink and green porphyry similar to the Mt. Darwin felsite forms an irregular wedge containing adits 3 and 4. All the bornite and most of the chalcopyrite is associated with this rock type, chalcopyrite in particular being richly disseminated in chloritic bands which run from adit No. 3 to the summit. These bands are up to 6 feet across and contain as much as 8% chalcopyrite over distances of a few feet.

The upper part of Adit Knob consists of banded volcanics and less common fragmentals. The banding appears to be a primary texture which has been extensively deformed and brecciated. West of the summit a broad band of coarse agglomerate cuts across the northern end of the lake to meet the rhyolite (?) band which passes east of the Knob. An envelope of agglomerate appears to enclose the felsite and banded rocks of the Knob.

The southern side of the Lake Jukes Cirque is occupied by fine, sometimes banded tuffs, while the area north of the helipad consists of a series of broad bands of fine pyroclastics separated by narrow, more irregular bands of coarse to very coarse breccia. The breccias generally contain large fragments of quartz-porphyry crowded together in a pyroclastic matrix. Outcrop is good and detailed mapping is possible - several narrow agglomerate bands have been traced for half a mile or more. Rocks are generally fresh, with NW-trending

SCALE 10 CHAINS TO 1 INCH
CONTOUR INTERVAL 50 FEET



Centre
Melbourne

Date
FEBRUARY 1970

THE BROKEN HILL PROPRIETARY CO. LTD.

LAKE JUKES - GEOLOGY

Project No.

Drawing No.
A4/ 1290

shearing surfaces roughly parallel with gross compositional banding. Petrological studies should provide a good deal more information on this area.

Mineralisation

(i) Lake Jukes

Bornite-hematite veins and disseminated chalcopyrite in chloritic rocks on the upper parts of Adit Knob provide spectacular evidence of mineralisation of a type not encountered elsewhere in the Jukes-Darwin area. The two short upper adits (3 and 4) followed bornite veins - 2 feet wide and "phenomenally rich" in the case of No.3, but the veins proved to be discontinuous and very irregular. The much longer adits Nos. 1 and 2 were driven at lower levels to intersect downward extensions of the outcropping ore, but passed through barren rock. A few quartz-delesite veins were mined but proved worthless. Drill holes below the lower adits also failed to find ore, which is apparently restricted to the veins seen in outcrop. On the northern side of Adit Knob a trench and short adit also failed to produce useful ore.

(ii) Bean and Thow

45 chains east of Upper Lake Jukes several trenches crossing a band of chloritised pyroclastics constitute the Bean and Thow workings. Two trenches east of the track, each about 20 ft. long and up to 6ft. deep, expose chalcopyrite and pyrite as fillings in shear planes. Leaching is pronounced and no sulphides are visible

at the surface or in the several shot holes put into the ridge north of the track. The only analytical data is provided by a selected ore sample MEL 136 from the bottom of a trench. It assayed 0.16% Cu, 0.6% Zn, 15 ppm.As and 6.3ppmAg.

Mapping shows the chlorite band containing the workings does not persist to Yellow Knob as suggested by Loftus Hills, but is one of several lenses. The volcanics below Yellow Knob Spur half a mile north of Bean and Thow are chloritised and discoloured by limonite, but no sulphides were found.

Loftus Hills compares this deposit with Jukes Pty., but Bean and Thow would seem to be unique in the Jukes-Darwin field in occurring in recognisable pyroclastics not associated with felsite.

Conclusions

(i) Upper Lake Jukes

A great deal of effort has already been spent around Adit Knob with very poor results. Mineralisation appears to be restricted to irregular veins and fillings near the surface, and has been reasonably proved not to continue at depth. Outcrop is perfect but the very steep faces to Adit Knob are not amenable to ground geophysical methods, and no further work is warranted.

(ii) Bean and Thow

With little analytical data and strong surface leaching this prospect is difficult to evaluate. It is not so extensive as suggested by previous writers, but might still have potential. Testing by shallow drilling, initially just south of the pack track, would be worthwhile if portable drilling equipment can be obtained.

D. Mt. Jukes Proprietary

B.W. Cuffley

Access

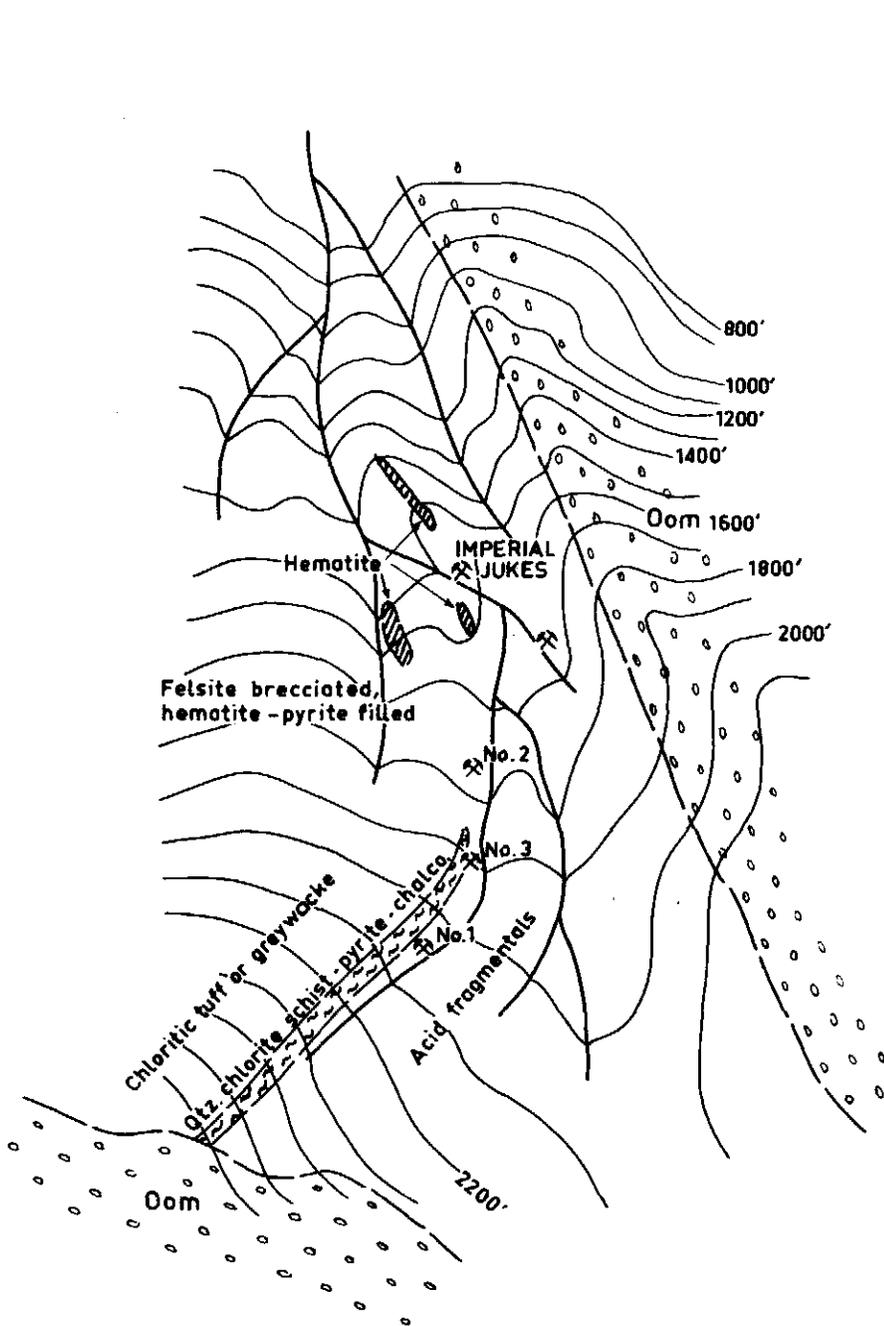
The Jukes Proprietary area is located on the northern slopes of Proprietary Peak, extending from just below the Peak (at 2600 ft.) to the King River Gorge (at 600 ft), the northern boundary of E.L. 13/65. The prospect is served by a graded foot-track (grade 1 in 9) from the old Crotty townsite. This track continues over the King River to Lynchford but that section is probably impassible and the river crossing has reportedly been destroyed.

Workings

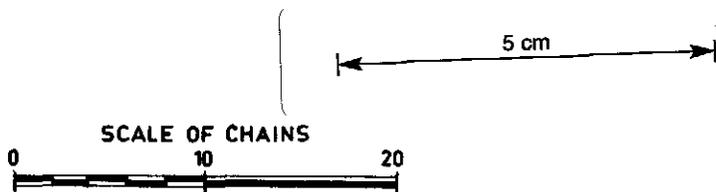
About ten adits were driven and a few trenches dug from 1897 to 1900, but the only significant copper intersections obtained were in the three Jukes Pty. adits. These were driven into an "Ironstained Zone" which is principally a N.E. trending quartz-chlorite schist zone up to 2,000 feet long and from 150 to 200 feet wide, containing disseminated pyrite and chalcopyrite. The zone is within a Cambrian complex of massive chloritic tuff or greywacke? massive siliceous 'felsite' (silicified acid volcanics?) and schistose acid fragmentals (volcanic breccia in places).

Further to the north (just north of Adit No.3) the regional trend changes to N.W. and lithology to hard massive 'felsite', brecciated and hematite-pyrite filled. Three moderately large pyrite hematite-magnetite bodies occur within the 'felsite' area, the largest being approximately 200 feet long and 50-75 feet wide. Samples taken from this body average 0.040% Cu, 0.014% Zn and 1.6 dwt/ton Ag, 0.007% Pb and 0.003% As. The hematite-pyrite veining is extensive but there appears to be little copper mineralisation associated with it. A sample of pyrite from one of these veins assayed 0.041% Cu, 0.004% Zn, 1.0dwt/ton Ag, 0.004% Pb and 0.003% As.

Adit No. 1 in the Jukes Pty. Group intersected an 18 foot zone of veins and blebs of chalcopryrite and pyrite, in dark quartz chlorite schist, from 18-36 feet. The adit was driven on in chlorite schist to 190' without any further significant copper sulphide intersections. A channel sample taken from 18-30 feet gave 0.83% Cu, 1dwt/ton Av and 2.8dwt/ton Ag (Gilfillin, 1964). A winze was sunk on the zone to 122 feet and at 52 feet a drive and crosscut were put in and the zone was found to be 24 feet wide supposedly assaying 4.10% Cu, 0.53 oz/ton Ag and 0.27 oz/ton Av. (Souter quoted by Loftus Hills 1914) A sepcimen from the dump assayed (12.4%) Cu, 0.023% Zn, 0.00% Pb and 14.3 dwt/ton Ag.



 Owen Conglomerate (middle)



Adit No. 2 was driven for 632 feet in green to red felsite with occasional blebs of chalcopyrite and pyrite. At 515 feet in, "4 foot of good ore" (Loftus Hills, 1914) was intersected and was followed by a 79 foot drive in which the "ore" soon petered out. This adit therefore intersected nothing of significance. A specimen from the dump assayed (4.3% Cu, 0.086% Zn, 0.029% Pb, and 22.8dwt/ton Ag.

Adit No. 3 was driven in a zig-zag fashion for approximately 500 feet in chlorite schist with disseminated pyrite and chalcopyrite and scattered veins and blebs of more massive sulphides. Specimens taken from one of the drives, more or less directly below the winze in No. 1 adit, averaged 1.30% Cu, 0.03% Zn, and 2.5 dwt/ton Ag. A specimen of sulphide-veined chlorite schist from the dump assayed 0.420% Cu, 0.016% Zn, 0.005% Pb and 1dwt/ton Ag.

Thus it appears that copper mineralisation at Mt. Jukes Proprietary Prospect occurs as disseminated sulphides together with relatively rich zones containing small shoots of massive sulphides within quartz chlorite schist.

Magnetometer Survey

A magnetometer survey was carried out by Rodda for Lyell - E.Z., with little significant variation in magnetic intensity over the quartz chlorite schist zone and one small anomaly over a hematite-magnetite outcrop. A weak basinal self-potential anomaly about 200 feet long occurred in the vicinity of Adit No. 1 and a curved elongated anomaly 600 feet long could not be correlated with any mapped feature.

E. Hydes' Prospect

B. W. Cuffley

The prospect area is located on the western slopes of Intercolonial Spur access by foot is arduous, involving a traverse across Snake Peake and Conglomerate Peake from the track near Findons Workings. Two small adits and a few trenches were put in during the late 1890's on a chlorite schist zone containing pyrite and chalcopyrite dissemination. The north-striking chlorite schist zone, which is bounded by chloritic tuff? or greywacke? and 'felsite' is approximately 1,500 feet long and 150 feet wide.

Workings

The Hal Jukes adit was driven for 50 feet E.N.E. in chlorite schist but only blebs of pyrite and chalcopyrite were intersected. A specimen from the mouth of this adit assayed 0.390% Cu, 0.012% Zn, 0.003% Pb and 1dwt/ton Ag. Approximately 200 feet to the south of the Hal Jukes Adit a trench exposes chlorite schist impregnated with large pyrite crystals and some chalcopyrite. A specimen assayed 0.056% Cu, 0.014% Zn and 0.003% Pb.

To the north, shots put into the creek bed by prospectors reveal good shows of chalcopyrite and pyrite in the chlorite schist zone. Specimens assayed 1.4% Cu, 0.5 oz/Ton Ag, Tr Au and (1.2%) Cu, 0.194% Pb, 0.026% Zn, 0.004% As and 6.0 dwt/ton Ag. Lower down this creek bed the Hydes Adit was driven 120 feet in a N.E. direction but it should have been driven easterly to intersect the chlorite schist zone. Subsequent to this the adit was driven a further 60 feet east with a corresponding increase in sulphides

but the adit still does not traverse the whole zone. It is stated that a bulk sample for the first 120' assayed 1% Cu (Loftus Hills, 1914).

Surrounding Areas

On Intercolonial Spur which consists of hard, massive, siliceous pink "felsite" there are small hematite outcrops (assaying 0.141% Cu, 0.006% Pb, 0.006% Zn) and veining and occurrences of pyrite-hematite similar to that found in the Jukes Pty. Area. Hematite, limonite and barite scree is scattered over parts of the Spur. A little less than a mile SE of the Hydes Adit, on Intercolonial Spur, an E-W barite lode about 2000 feet long and from 1 foot to eight feet in width (3.5 foot average) dipping at 85°S occurs in felsite. At the western end, the barite contains pyrite and chalcopyrite but the rest of the lode is completely barren. A specimen from a pit sunk on the mineralised barite assayed 1.66% Cu. A 30 foot adit was driven in a westerly direction along the hanging wall of the lode but did not intersect any further copper mineralisation. The barite lode is probably of little economic significance.

Although the Hydes prospect is of low priority it has never been adequately tested, probably mainly due to access and vegetation difficulties.

F. East Darwin

B. W. Cuffley

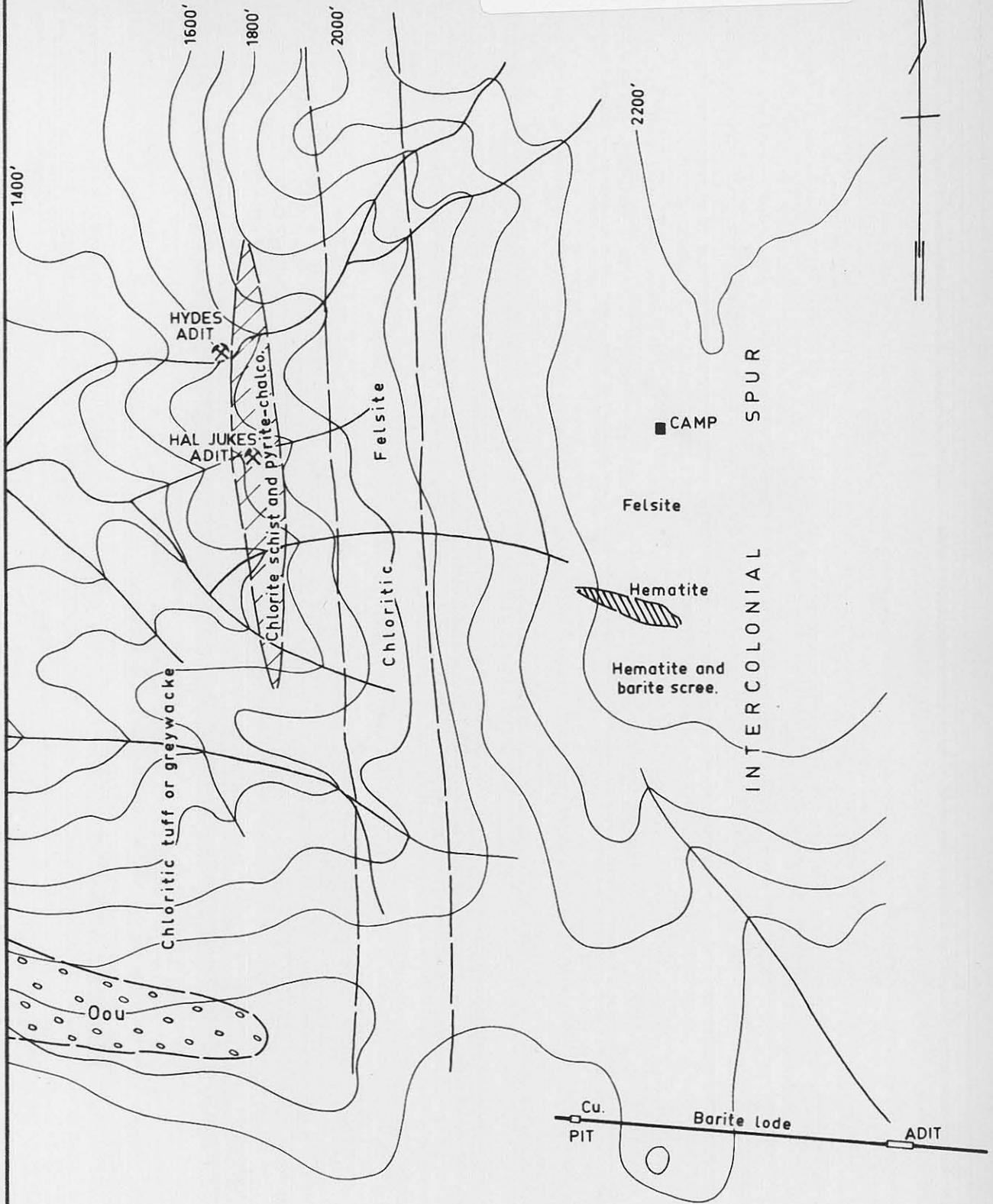
Access

The East Darwin area is located on the eastern slopes

550043

FIG. 8

5 cm



Oou Owen Conglomerate (upper)

SCALE OF CHAINS
0 10 20

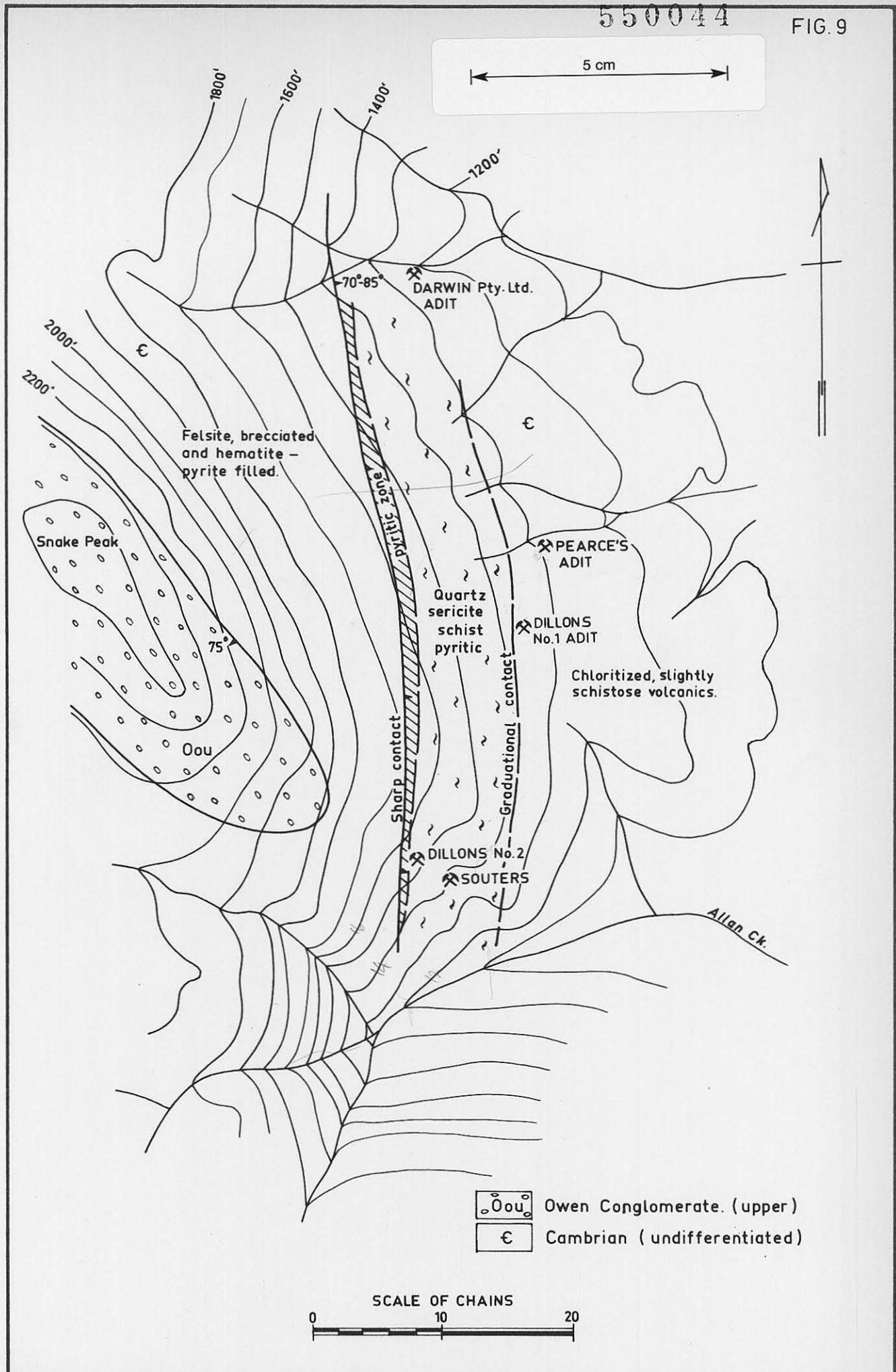
Centre
Melbourne

Date
13-5-70

THE BROKEN HILL PROPRIETARY CO. LTD.
E.L.13/65 SOUTH WEST TASMANIA JUKES-DARWIN AREA
SURFACE PLAN - HYDES (HAL JUKES)

Project No.

Drawing No.
A4/1298



of Snake Peak 700-800 feet higher than the Crotty Road, and is bounded on the south by Allan Creek. A graded track (grade 1 in $8\frac{1}{2}$) from the old Darwin townsite passes the workings on the way to the Snake Peak- Mt. Darwin saddle, and the southernmost workings are also served by a straight, steep track from Darwin. Workings are easily reached on foot from the road in about $\frac{3}{4}$ hour.

Geology

From east to west, the north striking sequence consists of dark green chloritic schists and volcanics grading into quartz sericite schists which are pyritic over most of the belt, in sharp contact with hard, massive pink felsite, brecciated and hematite-pyrite filled. Four of the adits intersected this contact (which dips steeply to the east) at different levels and it appears that the schist with the greatest pyrite concentration occurs close to the contact. On the surface the pyrite zone varies from 2-5 feet in width (where it has been exposed in trenches) but it apparently widens with depth, the lowest adit having intersected a 30-40 foot zone. The quartz sericite schist belt, in which the pyrite zone occurs, is about 3000 feet long and 350-400 feet wide, and probably extends further to the north and south of the mapped area.

Workings

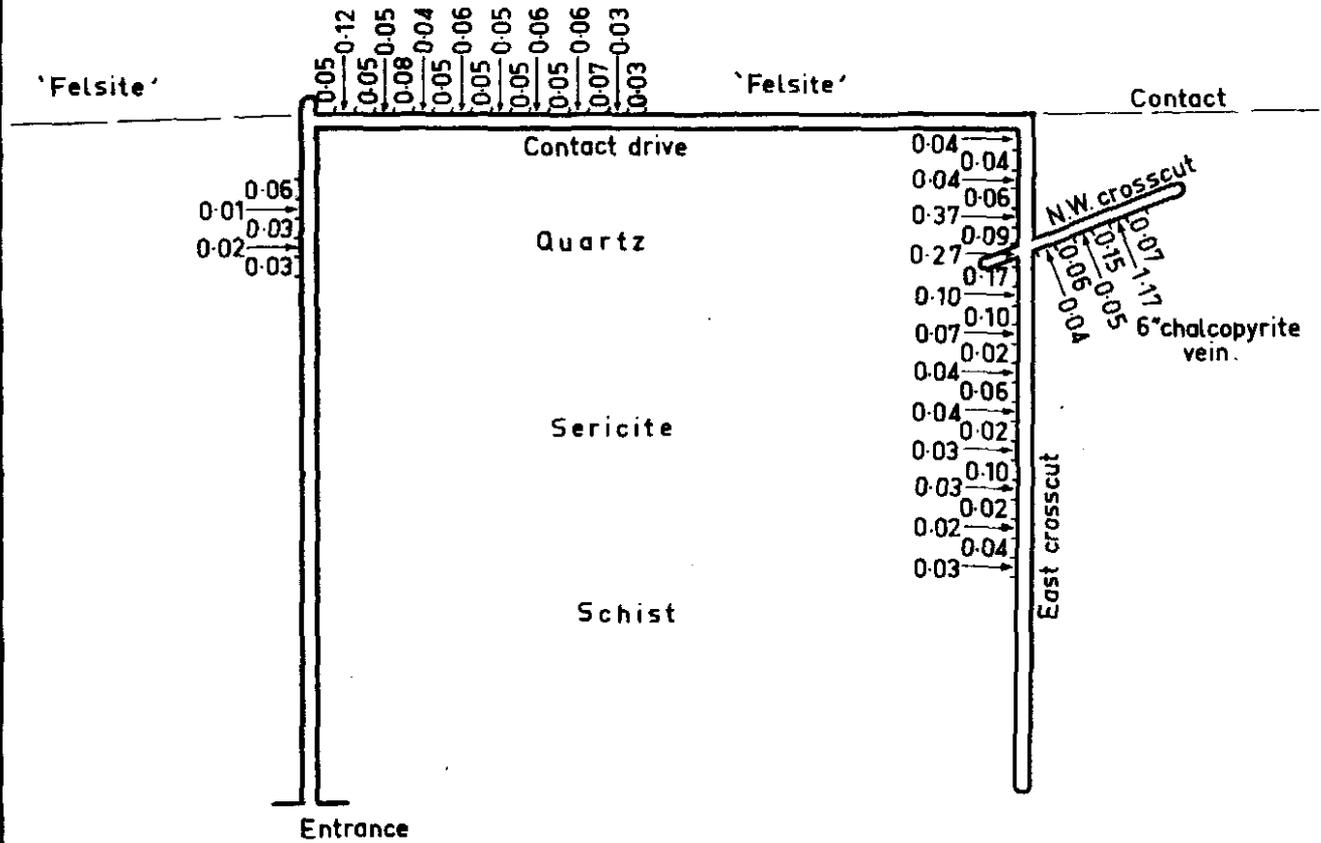
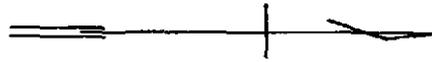
5 Adits and several pits and trenches were put in during the late 1890's.

Dillons No. 2 Adit was driven 120 feet in a westerly direction and intersected a 2 foot pyrite-chalcopyrite at 90 feet. It is stated that one ton of ore from this zone assayed 9% Cu (Loftus Hills 1914) although this is puzzling since there is very little copper mineralisation evident. A specimen taken from this zone by the author assayed 0.650% Cu, 0.272% Pb, 0.005%Zn, 3dwt/ton Ag. The adit is in grey quartz sericite schist and ends in felsite.

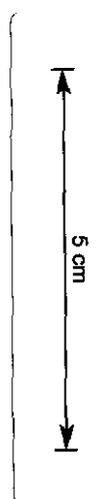
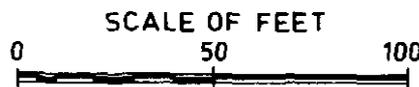
Souters Adit, which is 90 feet below and to the east of Dillons No.2, was driven west for 180 feet in grey quartz sericite schist containing blebs and veins of chalcopyrite and ended in felsite. A north drive was put in along the schist/felsite contact for 180 feet and then a 180 foot easterly crosscut was put in. A small vein carrying chalcopyrite and galena was encountered throughout the contact drive and it is stated that in the crosscut, veins of solid chalcopyrite up to 6" thick and a zone from 1-4 feet carrying chalcopyrite was intersected, Assaying up to 6% Cu and 1oz/ton Ag. (the crosscut and most of the contact drive has now collapsed. Alternatively Douglas (1940), channel sampling over 5 foot intervals, recorded poor assays throughout the workings, the maximum being 1.17% Cu in a small N.W. Crosscut off the E crosscut, (see Fig. 10 for complete results) A specimen from the dump assayed (16.6%) Cu 0.094% Zn and 1.6 dwt/ton Ag.

Dillons No. 1 Adit, which is 60 feet below and north of Souters Adit, was driven 312 feet WSW in quartz sericite schist and was ended in hard red felsite. At about 130 feet a pyrite-chalcopyrite zone approximately 28 feet wide was intersected and a 40 foot winze was sunk. It was stated that this zone will bulk 4% Cu (Loftus Hills 1914) Alternatively, channel sampling by Douglas (1940) recorded poor assays (0.31% Cu and 0.45% Cu near the winze), the maximum being 1.71% Cu from 175 to 180 feet (See Fig. 11 for complete results).

Pearce's Adit, to the NNE of Dillons No. 1 and 80 feet below, was driven 443 feet SW and then 54 Feet W in chloritic schist, collared in quartz sericite schist and ending in felsite (497 feet). At 450 feet a N-S drive with a number of east and west crosscuts was put in and revealed a pyritic schist zone up to 40 feet wide carrying chalcopyrite and a small amount of galena. A 5½ ton parcel of material taken from this and Dillons No. 1 Adit assayed 4.66% Cu and 10 dwt/ton Ag. Once again, conflicting results from channel sampling by Douglas (1940) were recorded, the maximum assays being 0.70% Cu from 10-20 feet and two 0.55% Cu values over 10' intervals in the north contact drive. (Fig. 12). A specimen taken from the contact drive this season assayed 0.700% Cu, 0.024% Pb, 0.006% Pb, 0.004% As. (See appendix for channel sample results.)



Values in % copper.

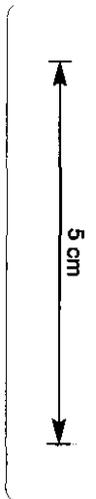
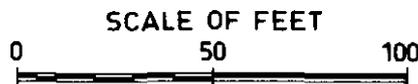
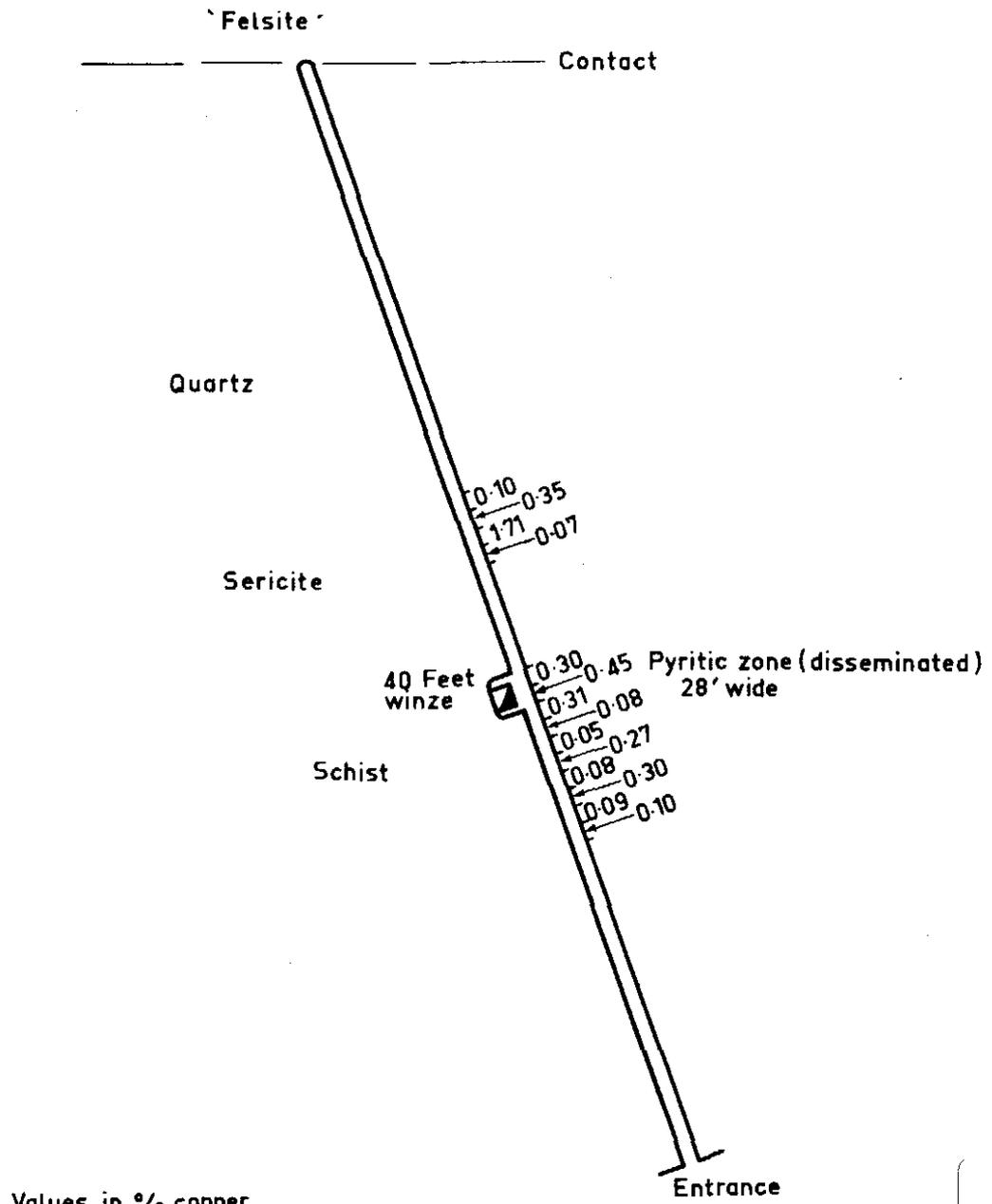


Channel sampling at 5' intervals carried out by Douglas 1940 Mt. Lyell Co.

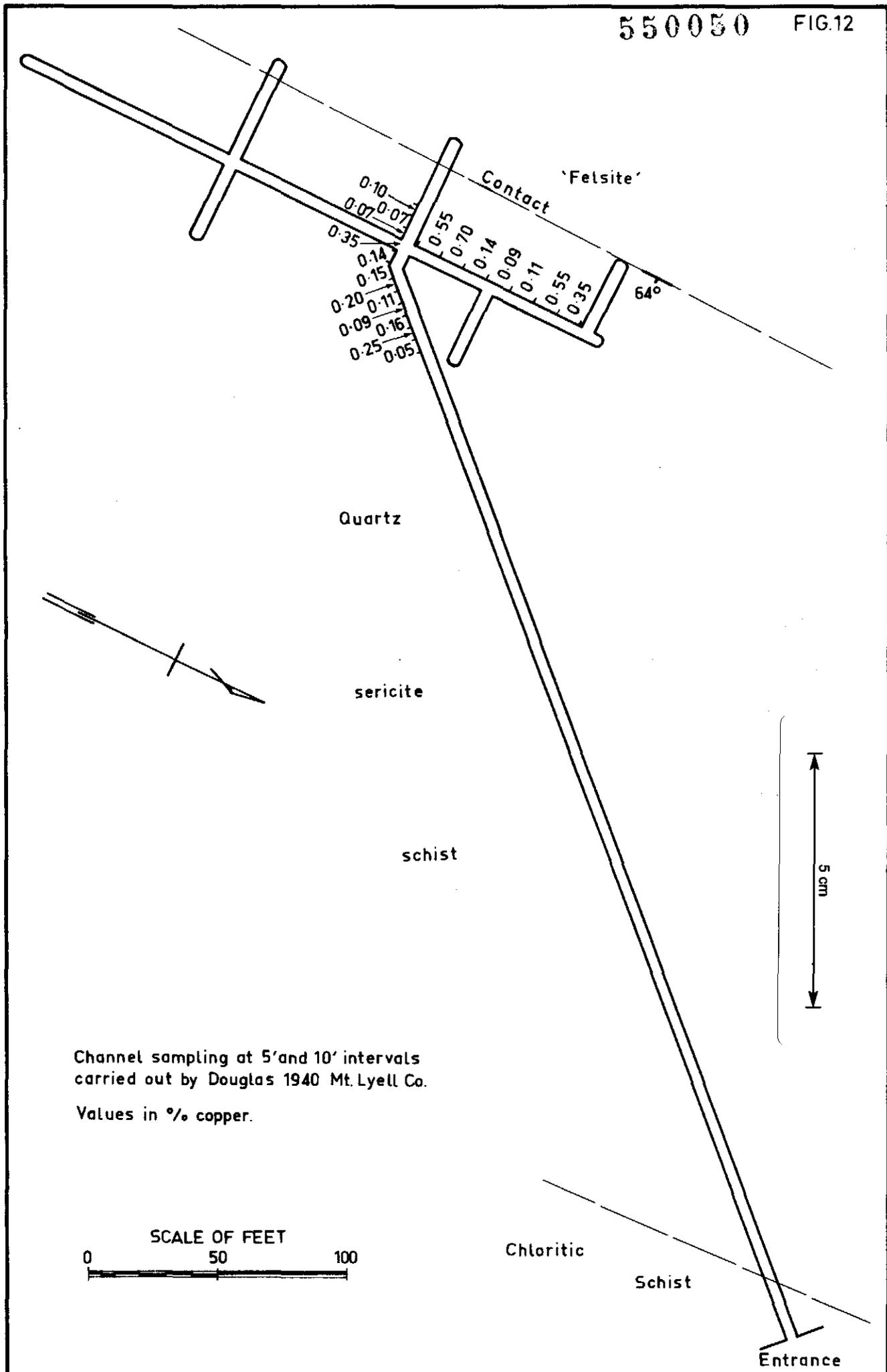
Centre
Melbourne
Date
11-5-70

THE BROKEN HILL PROPRIETARY CO. LTD.
E.L.13/65 SOUTH WEST TASMANIA JUKES-DARWIN AREA
ASSAY PLAN - SOUTER'S ADIT-EAST DARWIN

Project No.
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Drawing No.
A4/1294

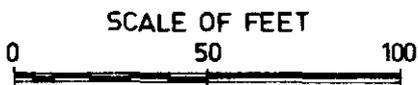


Channel sampling at 5' intervals carried out by Douglas 1940 Mt. Lyell Co.



Channel sampling at 5' and 10' intervals carried out by Douglas 1940 Mt. Lyell Co.

Values in % copper.



Centre Melbourne

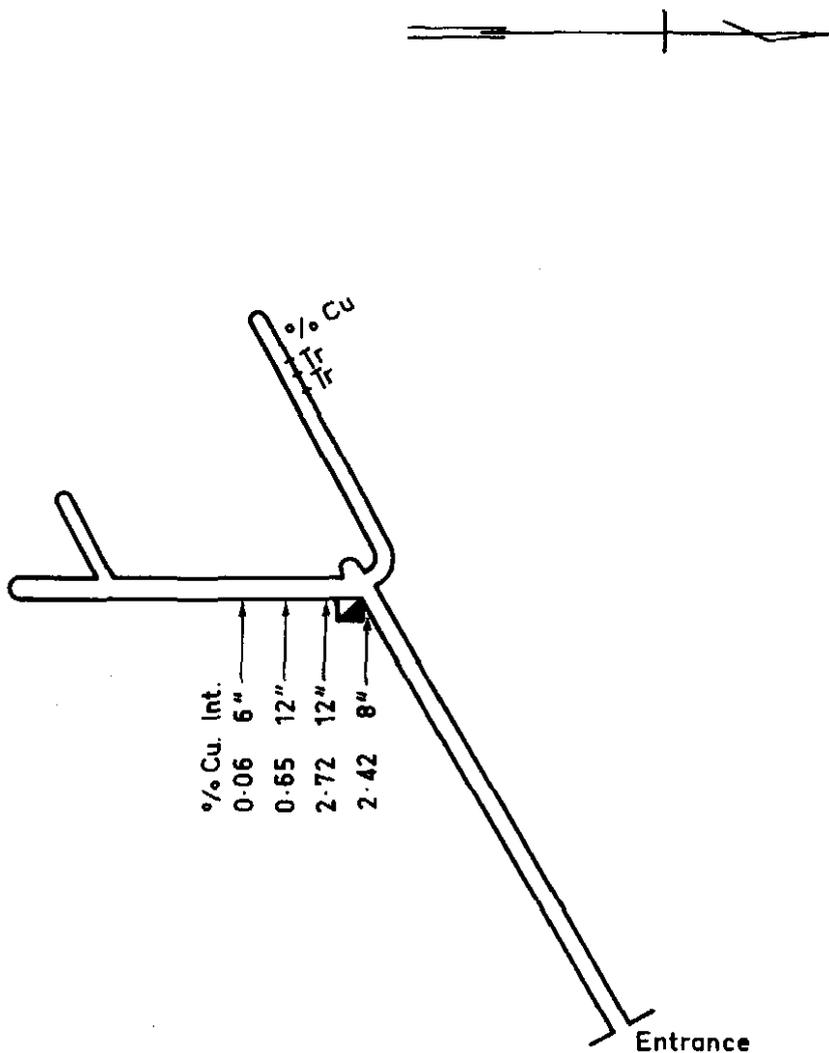
Date 11-5-70

THE BROKEN HILL PROPRIETARY CO. LTD.

E.L.13/65 SOUTH WEST TASMANIA JUKES-DARWIN AREA
ASSAY PLAN - PEARCES ADIT - EAST DARWIN

Project No.

Drawing No. A4/1296



Sampling by Douglas 1940 Mt. Lyell Co.

Centre
Melbourne
Date
11-5-70

THE BROKEN HILL PROPRIETARY CO. LTD.
E.L.13/65 SOUTH WEST TASMANIA JUKES-DARWIN AREA
ASSAY PLAN - DARWIN PTY. ADIT- EAST DARWIN

Project No.
Drawing No.
A4/1297

This adit intersects the entire quartz sericite schist belt which is here shown to be about 350 feet thick (See Fig. 9) and pyritic to varying degrees, the main concentration being near the felsite/schist contact.

The Mt. Darwin Proprietary Ltd. Adit, which is $\frac{1}{2}$ mile to the NNW of Pearce's adit in a deep gully, was driven 130 feet WSW and then 90 feet south to intersect mineralisation exposed in the creek bed above. A sample containing pyrite, chalcopyrite and some bornite? taken by the author from a trench in the creek bed assayed 8.2% Cu, 8.5dwt/ton Ag. Sporadic mineralisation was found throughout the adit in chloritic and sericitic schist, similar to that observed in the trench.

Sampling by Douglas (1940) revealed small veins rich in copper sulphides but nothing of economic significance was found (Fig. 13).

Geophysical Surveys

The B.M.R. conducted a Electromagnetic (Turam), Self-potential (S.P.) and magnetic surveys of the East Darwin area in 1959, however the S.P. survey was unsuccessful readings were erratic and no significant indications were disclosed. Three E.M. anomalies were recorded and were attributed to the sulphide mineralisation. Anomaly No. 1 occurred partly over Souters Adit and indicated that sulphide mineralisation was localised and does not extend to the south.

The strongest Anomaly, No. 2, occurred over Dillons No.1 and Pearce's adits and is stated to indicate a zone of disseminated sulphides 700 feet long and 80 feet wide (B.M.R. 1959). It is suggested that Dillon's No.1 and Pearce's adits would have adequately tested the

anomaly and, considering the poor results obtained from channel sampling by Douglas (1940) the East Darwin sulphide zone is probably of little value.

The weak anomaly No. 3 was attributed to pyrite mineralisation, as seen in costeans in the area.

The magnetic survey did not reveal anything of interest, and anomalous values were probably caused by scattered hematite occurrences.

Conclusions

The East Darwin prospect, consisting of a zone of pyritic quartz sericite schist containing small shoots and zones of massive and concentrated disseminated pyrite with some chalcopyrite and minor galena, has been previously investigated by Lyell-E.Z. Exploration and U.S. Metals Corp. and considered by both to be uneconomic. This conclusion was based on channel sampling of existing adits and an Electromagnetic survey (Turam).

6. GEOLOGY

A. Geological Maps

The first geological map of the whole Jukes-Darwin Mining field was published by Loftus Hills in 1914, and has formed a basis for subsequent work in the area. Loftus Hills showed the distribution of the Cambrian acid suite, Lower Ordovician siliceous sediments and the overlying limestone with an accuracy which has required only minor revision. The granite of the South Darwin plateau was the only rock unit differentiated within the Cambrian suite although a number of rock types are referred to in his reports on the various prospects.

John Bradley's 1" Jukes and Darwin sheets, which accompanied his 1954 report, differentiate Cambrian rocks in much greater detail than has been attempted by any other geologist. However, his work is very subjective, being dominated by the need to prove theories of granitisation. Bradley's maps are very difficult to interpret, often inaccurate and of little use to geologists in the field.

In the late 1950's Mt. Lyell geologists Solomon and Wade produced a geological map which included the Jukes-Darwin area, and with slight modifications this map has been used by L.E.E. and U.S. Metals Refining Co. A version of this map, with some changes in the Grotty area following mapping by Corbett in 1969, was presented by Meyer (1969) and has been the main reference for B.H.P. geologists in the current period.

This map goes further than Loftus Hills in subdividing the Cambrian rocks into three units - granite, feldspar porphyry (and quartz-porphyry) and undifferentiated sediments and volcanics. Unfortunately it also perpetuates the geological and geographical errors of Solomon and Wade's work in the South Darwin area. These errors include inaccuracies in the felsite-granite and granite-Jukes Breccia boundaries, the name "Prince Darwin" given to a non-existent workings half way between Prince Darwin and Tasman Darwin areas, and the marking of South Darwin Peak half

350055

Fig 14

SCALE 40 CHAINS TO 1 INCH
CONTOUR INTERVAL 200 FT

5 cm

QUATERNARY

 Moraine

ORDOVICIAN

 Conglomerate & sandstone

 Breccia

CAMBRIAN

 Sericite schist

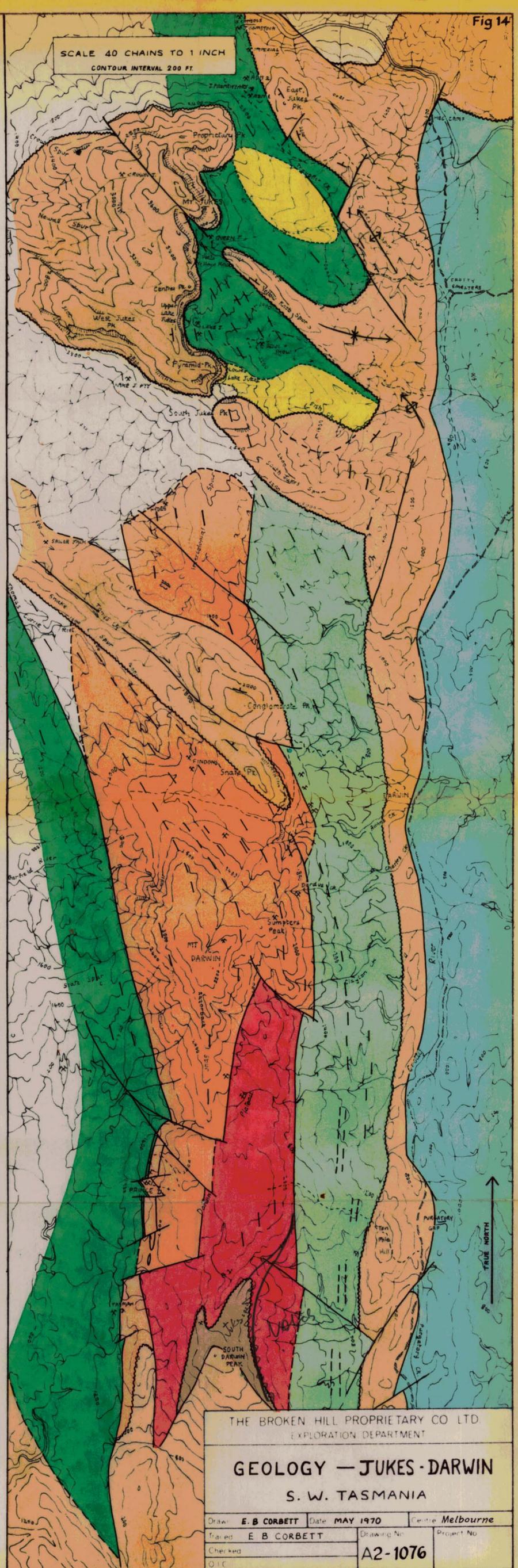
 Pyroclastics & lavas

 Felsite

 Granite

ORDOVICIAN - DEVONIAN

 Sediments



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GEOLOGY — JUKES · DARWIN
S. W. TASMANIA

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a mile north of its true position.

Campana and King made a significant advance in 1963 when they placed the acid Cambrian rocks in a new group, the Mt. Read Volcanics, distinguishing them from the essentially calc-alkaline Dundas Group rocks. Their mapping did not extend south of Queenstown but all the Jukes-Darwin Cambrian rocks may be assigned to the Mt. Read Volcanics.

Fig. 14 is presented as a result of current work. It is based on very incomplete information and will certainly require revision when further work is done, particularly in the critical area of Intercolonial Spur-South Jukes Peak. It does however point up a number of features which have previously been ignored and leads to a rather different interpretation of the factors influencing mineralisation.

B. The Cambrian Suite

The oldest rocks exposed in the area are a series of pyroclastics, lavas, extrusive and possibly intrusive porphyries. These rocks are pre-Ordovician and are assumed to be Cambrian. On the most recent evidence from Rosebery similar rocks range from Lower to Middle Cambrian.

All these rocks are acid in composition, rarely containing ferromagnesian silicates other than chlorite, which is generally secondary. Similar rocks in the

Queenstown area are often described as keratophyres or quartz-keratophyres, and Solomon (1960) cites some chemical evidence for this, but it would seem that the terms have been used far too extensively. We must await chemical and petrological data, but most of the Jukes-Darwin rocks appear to be normal acid rocks not related to the spilite suite.

Total thickness of the suite is unknown, since mapping is not sufficiently detailed to reveal the effects of folding, but it is probably in excess of 10,000 feet.

As with the Mt. Read Volcanics elsewhere, stratigraphy is difficult to establish. Bedding is generally obscured by shearing and original rock types are sometimes unrecognisable after alteration. Direct evidence of age relationships is rare.

The succession proposed below differs rather radically from previous opinions and is tentative at best - clearly a great deal more evidence is required and it is hoped this will come from mapping and petrological studies.

(i) Felsites

In order to remove genetic implications we revert to the old term "felsite", used to mean massive, very fine-grained rocks with quartzo-feldspathic groundmass

and with or without phenocrysts.

Felsites form a broad belt of high country from Intercolonial Spur to South Darwin Peak. If we assume the felsites are continuous beneath younger rocks on Conglomerate and Snake Peaks the belt is at least 7 miles long and up to $1\frac{1}{2}$ miles wide.

Most of the felsite is pink, but some is green due to chloritisation and grey in fresh specimens. Phenocrysts up to 2mm. across are never abundant but their presence is characteristic. In hand specimens phenocrysts appear to be angular, altered feldspar but quartz may also occur. The rocks are irregularly jointed but rarely have a penetrative cleavage.

Iron oxides are abundant in some places. On the north face of Mt. Darwin, on Snake Spur and the lower parts of Intercolonial Spur patchy, highly irregular replacement of felsite by massive, fine-grained hematite is widespread. These main areas rich in hematite have been described (p7-9) but swarms of hematite veins occur in zones a few inches to several feet wide and 10-50 feet long throughout the felsites. The veins may consist of hematite alone or hematite plus quartz, but they commonly contain fragments (1-3 cm long) of angular felsite in a fine hematite matrix. Unlike the diffuse replacement patches the veins are usually sharply defined, although they may be irregular in shape. Pyrite is a minor component in some of the veins.

There is a spectacular 40-50' wide zone of breccia-type veins crossing the lower part of Razorback Spur. An adit on the eastern face of the spur was apparently driven to intersect this zone, but no useful sulphides were encountered. The early prospectors showed interest in the iron-rich zones as sources of hematite, but concluded they were of uneconomic grade, despite the need for an iron-rich flux at the Crotty Smelters. The iron zones have apparently never been considered as gossans.

The iron-rich body exposed off the western edge of the South Darwin Plateau (Prince Darwin - Tasman Darwin) shows massive replacements, iron-breccia veins and quartz-magnetite veins. Heavy replacement of felsite by chlorite occurs in the same area.

Barite is associated with hematite rich zones on Snake Peak, where it is uncommon, and Intercolonial Spur, where it constitutes up to 15% of the rock in places.

Bradley (1954) suggested that iron enrichment only occurred very close to the Cambrian-Ordovician contact, but it is apparently much more widespread than that. The association or otherwise of iron and sulphide mineralisation has yet to be demonstrated.

The most notable alteration of the felsites is chloritisation, which varies from slight in the massive rocks to extreme in areas such as Findons workings

where the rocks are schistose. Chloritisation is clearly of economic significance, since it is usually associated with sulphides which may have been introduced by the same fluids which brought about the alteration. Alternatively the greatly increased schistosity of the chloritised rocks may have provided channels for mineralising solutions. It should be noted that the Prince Darwin ore body is generally not schistose, while some small workings in the head of Allans Creek have sulphides in fresh, massive felsite but not on the adjacent chlorite rocks.

It is suggested that the felsites can be regarded as a unit in which original variations have been smoothed over by metamorphism and/or metasomatism. They present a remarkably uniform appearance over a very wide area on and around Mt. Darwin with no large scale discontinuities. A number of minor variations are discussed below.

There are several impressive breccia zones 50-100 feet wide and several hundred feet long on the northern face of Mt. Darwin blocks of felsite are contained in a sheared chloritic matrix, with or without glassy quartz crystals. These breccias have been called pyroclastics (e.g. by Solomon) but in several cases they appear to be tectonic rather than clastic in origin. Invariably the breccias give way along strike to normal or aphyric felsite and just south of Snake Saddle a breccia body shows transitional stages as it merges into cleaved felsite. Breccia bodies may be as thick as they are long and show no structures such as bedding or erosional surfaces to support a sedimentary origin, although such features could be

obscured by shearing and chloritisation.

Banded, aphyric rocks occur within the felsites on Snake Spur, west of Findons Prospect and on Mt. Darwin and are particularly prominent along the western edge of South Darwin Plateau. Apparently they pass along strike into normal felsite and it is suggested they are relics of the original textures in a sequence of volcanics which are now largely converted to massive rocks.

In considering the felsites to be older metamorphosed volcanic pile underlying the younger, more variable volcanics of the Clark Valley and Lake Jukes Cirque the author differs from previous workers who have mapped the felsite as feldspar porphyry (presumably a single intrusion) or as volcanics not differentiated from those to the east and west.

(ii) Darwin Granite

The Darwin Granite outcrops as a tabular body between South Darwin Peak and Sumpters Peak. With the Murchison Granite it has become a famous bone-of-contention although few have studied it in much detail. Bradley (1954, p.235) stated "It is indisputable that the granite complex is a metamorphic one and the Darwin Granite is a metamorphosed conglomerate." This has not been supported by later writers, and there seems little reason to suggest there is anything abnormal about this granite.

The Darwin Granite contains pink and white phases which have been mapped and described by various authors. It is generally rather fine-grained, with clear quartz, white plagioclase and/or pink orthoclase and rare biotite. It is usually somewhat sheared.

Alteration and mineralisation is very similar to that seen in the felsites. Sulphides, notably pyrite, are associated with heavy chloritisation in some areas, most of which have been tested with trenches or shot holes. Iron enrichment is not so extensive as in the felsites, and occurs mainly as irregular hematite and/or magnetite veins and patches up to 30 feet across, scattered sparsely throughout the granite.

One or more strips of schistose rocks within the granite have been noted by various workers. One narrow belt of very sheared rocks, possibly volcanics, was seen by the author but not followed out. The significance of these inclusions is debatable and they should be mapped and identified before any conclusions are reached.

Contacts are poorly exposed and have been interpreted as faults (Fig. 14) but it is possible that at least the western contact is the edge of the original intrusion and the apparent lack of alteration is due to the similarities in composition between felsite

and granite. Loftus Hills (1914) interpreted the Prince Darwin body as a contact metamorphic deposit, perhaps with more certainty than the evidence warrants.

(iii) Volcanics

The felsite-granite mass of Mt. Darwin-South Darwin is flanked on either side by banded acid rocks which originally formed a thick pile of lavas and pyroclastics. As yet no normal sediments have been identified, but the volcanics have not been mapped west of the high country, and sediments have been reported beyond Slate Spur.

Prince Darwin - Tasman Darwin To the west of South Darwin Plateau the ore-bearing felsites are overlain by quartz and feldspar porphyries, banded aphyric rocks and pyroclastics(?) of unknown extent. Most of these rocks are sheared and original 'bedding' structures are rarely observed. One contact between fine volcanics and sheared porphyry dips vertically and is cut by the regional shearing at a low angle.

The Prince Darwin north adit is collared in a coarse breccia containing fragments of felsite or lava and a few quartz crystals in a chloritic, sparsely mineralised matrix. The breccia is about 30 feet thick at Prince Darwin and continues south at least as far as traverse No.4, where it is narrower and finer-grained. It does not appear in the Tasman Darwin area. This breccia, wrongly identified as

Jukes Breccia by Wade, marks a disconformity between the ore-bearing felsite and the overlying volcanics. It contains pebbles of hematite derived from mineralised parts of the felsite or granite or both. As far as is known the overlying volcanics do not show hematite-magnetite mineralisation. It may also be significant that the first 20 feet of felsite below the disconformity is not mineralised, suggesting a period of leaching with possible secondary enrichment of the Prince Darwin ore.

Lake Jukes Cirque In the area east of Upper Lake Jukes relatively undeformed acid volcanics are well exposed and can be mapped in some detail (Fig. 5 is a simplified version). Contacts are nearly parallel with regional cleavage although discordances are seen in detail. In this area the volcanics appear to be largely (or possibly all) pyroclastics, including narrow bands of very coarse agglomerate(?).

The Lake Jukes ore is concentrated in massive, partially chloritised rock (and its sheared equivalent) described by Loftus Hills as granophyre and similar in hand specimen to the felsites on Mt. Darwin. The coarse breccia surrounding the granophyre contains felsite and granite(?) fragments and might be evidence of a disconformity.

Jukes Pty. Workings The author (E.B. Corbett) is not familiar with the detailed geology of this area, but the situation appears to be similar to that at Lake Jukes - i.e. the ore is associated with the chloritic parts of a massive felsite body, surrounded by variable volcanics.

(iv) Schists

At the East Darwin workings chlorite and sericite schists are in contact with the cleaved and altered eastern edge of the Mt. Darwin felsite. The original nature of the schists has never been proven and there appear to be two possibilities on structural grounds. The schists are almost certainly continuous to the south where they are represented by sparse outcrops on the track from Ten Mile Hill. North of East Darwin they may swing round the head of Intercolonial Spur but it is more likely that they find their unaltered equivalents in the Lake Jukes Cirque. In either case it seems probable the schists are altered acid volcanics. Much more work will be necessary to establish their age relations with the surrounding rocks.

4. STRUCTURE

Two major structural elements dominate the southern part of the West Coast Range; a fundamentally important N-S trend and superimposed NW-SE structures.

The most prominent feature is the north-south alignment of elongate formations parallel with a variably developed regional cleavage. The cleavage is thought to represent the axial surface of the first phase of deformation responsible for the complex anticlinorial structure of the range, and is likely to be Cambrian in age.

The second phase of deformation occurred after deposition of the Owen Conglomerate, probably during the Devonian, and consists of a N-S anticline steeply overturned to the east (at least in the Crotty area) and complicated by a series of superimposed NW-trending faults and folds also most strongly developed in the northern half of the area. Associated with this deformation is a major structural break along the eastern edge of the range, separating overturned Lower Ordovician conglomerate and sandstones from the gently folded Ordovician to Devonian sediments of the King Syncline.

Solomon suggests movement may be extensive on a decollement at the base of the Ordovician series and there is evidence of this in a flat-lying thrust under Proprietary Peak.

Evidence for a pre-Tabberabberan (pre-Devonian) anticlinal structure in Cambrian rocks is sparse although angular unconformity between Cambrian and Lower Ordovician rocks is quite clear. We have an apparent symmetrical arrangement of volcanics around the Darwin Granite, which may be interpreted as a N-plunging anticline. Closure of this structure has yet to be shown. Wrap-around may occur on Intercolonial Spur, but it is also possible the felsite continues north to Upper Lake Jukes or even Jukes Pty. The cleavage parallel with the axial plane of the anticline is bent towards the northwest in the area where northwest cross-folds are best developed in overlying rocks.

Extreme shearing in a N-S belt along the eastern edge of the granite and felsite may be associated with the overturning of Tabberabberan structure and is expected to be of economic significance.

8. GEOLOGICAL HISTORY

It is suggested that an early-formed volcanic pile (or possibly a largely intrusive mass) was metamorphosed and/or metasomatised to a rather uniform texture and composition and intruded by granite; the metamorphism may have been caused by the granite intrusion but little evidence for this has been found. The altered rocks, now called felsite, and the granite both received magnetite-hematite mineralisation and the whole complex was subject to uplift and erosion. Minor breccia were deposited on the disconformity (or unconformity), followed by a thick pile of acid volcanics in which pyroclastic rocks probably predominate.

Late Cambrian(?) tectonic activity was responsible for a prominent N-S cleavage, possibly with an associated anticlinal structure. Irregularities in the uplifted and eroded surface were filled with a coarse breccia derived from Cambrian rocks (the Jukes Breccia) at Mt. Jukes, South Darwin Peak and Mt. Sorrell before the whole range was covered by Lower Ordovician siliceous conglomerates and sandstones derived from a Precambrian terrain. Sedimentation continued into the Lower Devonian.

The Middle Devonian Tabberabberan Orogeny produced a broad anticlinal structure in the West Coast Range, overturned on its eastern edge with superimposed NW-tending faults and folds. Basement sinking to the east produced a broad synclinal structure in

Ordovician to Devonian sediments, and there is a major break between this structure and the rising West Coast Range anticlinorium. Some cleavage of fine-grained rocks occurred during this orogeny.

9. AIRBORNE MAGNETIC SURVEY

The Jukes-Darwin area was covered as part of the magnetic survey carried out over an area approximately corresponding with the present boundaries of E.L.13/65.

Aeromagnetic contour maps show very few topographic features and those which are shown appear to have been taken from photo mosaics and are badly distorted. Because of these difficulties the aeromagnetic maps were not used by field parties.

In Fig. 15 topographic features have been superimposed on aeromagnetic contours as accurately as possible. Initially the aeromagnetic map was reduced from its stated scale of 30ch. = 1 inch to 40ch. = 1 inch and laid over the 40 chain topographic sheets, but this method gave a very poor fit and after trial and error topographic features were enlarged by a factor of 6/5 and superimposed on the magnetic contours.

Fig. 15 shows the following:

(i) A N-S ridge of high values over the Cambrian rocks from South Darwin Peak to the King River. Palaeozoic sediments to the east and west are shown as parallel troughs.

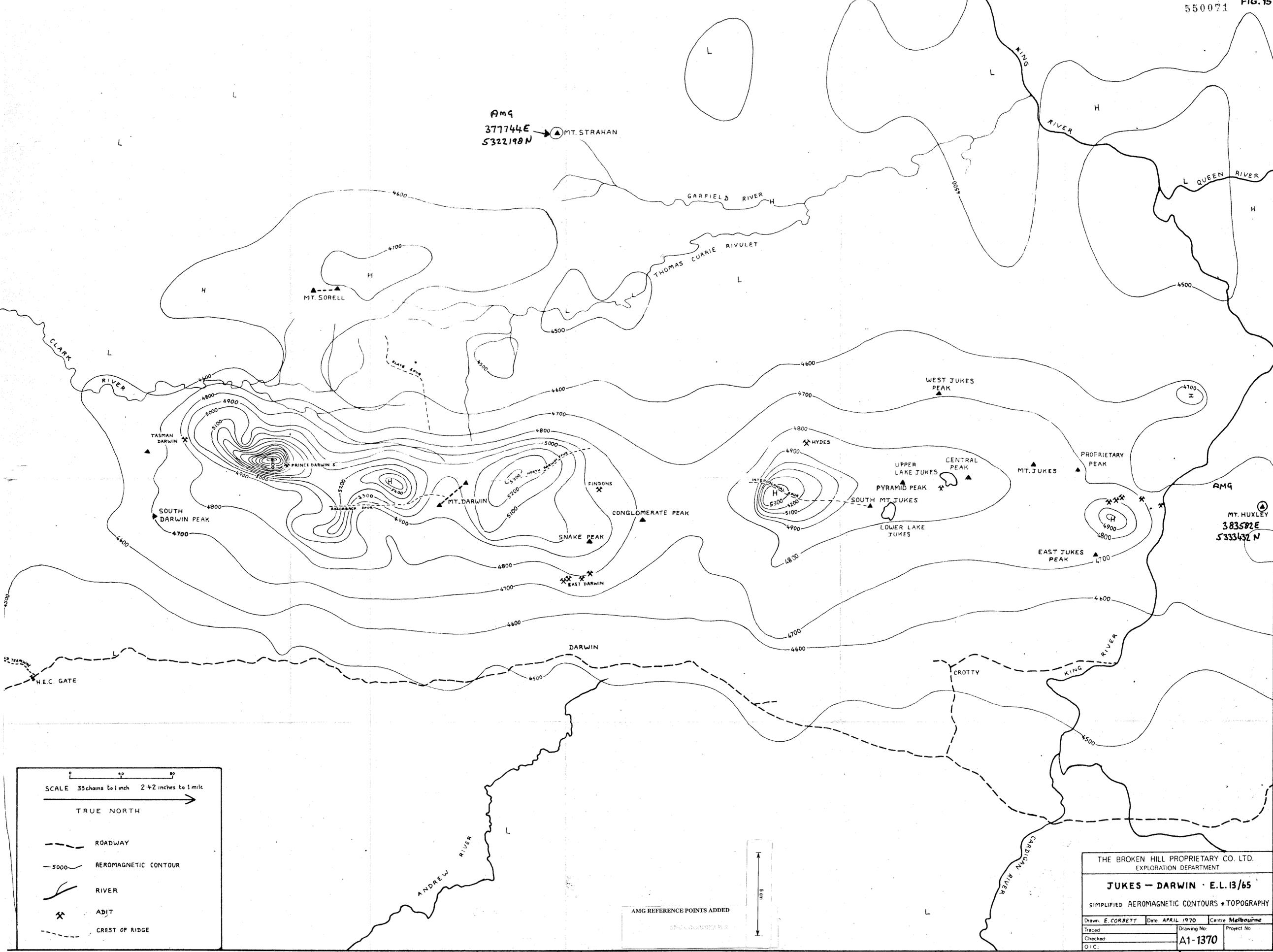
(ii) Within the high area there are a number of peaks:

(a) A peak of 5000 in the saddle between Proprietary Peak and East Jukes Peak. The high is centred slightly east of a line of prospects running down the King Gorge.

This is perhaps surprising since iron-rich bodies are known at the surface just west of the workings.

AMG
377744E
5322198N

AMG
MT. HUXLEY
383582E
5333432N



0 50 100
SCALE 35 chains to 1 inch 2.42 inches to 1 mile

TRUE NORTH →

- ROADWAY
- 5000- AEROMAGNETIC CONTOUR
- ~ RIVER
- ✕ ADIT
- - - CREST OF RIDGE

AMG REFERENCE POINTS ADDED

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EXPLORATION DEPARTMENT

JUKES - DARWIN - E.L. 13/65

SIMPLIFIED AEROMAGNETIC CONTOURS + TOPOGRAPHY

Drawn E. CORRETT	Date APRIL 1970	Centre Melbourne
Traced	Checked	O.I.C.
Drawing No. A1-1370		Project No.

- (b) A peak of 5300 on the lower part of Inter-colonial Spur. This corresponds well with known outcrops of felsite rich in hematite.
- (c) A NNW-tending high of 5300 along the prominent Spur running north from Mt. Darwin. This spur is underlain by breccias and felsite which, while containing numerous hematite veins, would not seem to be richer in magnetic elements than the surrounding rocks. Possibly the anomaly is caused by iron-rich zones exposed on the northern face of Mt. Darwin, although similar bodies below Snake Peak are not anomalous. Alternatively the source of the anomaly may be somewhere on the rugged western face of Mt. Darwin.
- (d) An irregular high of 5500 over Razorback Spur. The Spur is crossed by a number of broad iron-rich breccia bands which may explain the anomaly, but it may be significant that ~~the peak is well to the west of the spur,~~ assuming topographic features have been accurately located.
- (e) A very strong peak of 6100 centred just south of the Prince Darwin south adit. This peak clearly corresponds with the iron-rich parts of the ore zone as shown by the ground magnetic survey but rather surprisingly the anomaly tails off towards the Clark Valley and the iron-bearing felsites south of Tasman Darwin are not included.

This magnetic pattern has been interpreted as showing an iron-rich body outcropping at Prince Darwin and plunging south. More detailed information is provided by the ground magnetic survey conducted over seven traverses in the Prince Darwin area by U.S. Metals Refining Co. in 1964 (Fig. 3. in this report).

(iii) The areas showing relatively low magnetic responses within the Jukes-Darwin ridge correspond reasonably well with areas where Cambrian rocks are covered by thick siliceous conglomerates - Mt. Huxley, the Mt. Jukes mass, Conglomerate Peak and the area south of South Darwin Peak.

(iv) Changes in trend of the magnetic contours support the existence of faults previously known on geologic grounds. This is particularly so in the Razorback-Prince Darwin area.

Three conclusions of possible economic significance can be drawn from the aeromagnetic map, although they are rather negative.

(i) The areas of known chlorite-pyrite-chalcopyrite mineralisation are not associated with magnetic highs. These areas are East Darwin, Findons, Hydes and Lake Jukes.

(ii) Where chlorite-sulphide mineralisation is associated with iron-rich zones (Jukes Pty. and most notably Prince Darwin) oxidation of magnetite and hence magnetic response is expected to be very variable in detail. Caution is necessary in correlating magnetic anomalies with sulphide mineralisation.

(iii) The potential importance of the western edge of the felsite in the Mt. Darwin area is supported to some extent by the presence of magnetic highs west of Razorback Spur and possibly west of "North Darwin Spur".

10. ECONOMIC GEOLOGY

Almost all attempts to predict the occurrence of economic deposits in the Jukes-Darwin area have been based to greater or lesser degree on assumed similarities between this area and the valuable Mt. Lyell ore bodies to the northwest.

Certainly there are broad similarities between the areas - both consist of sheared Cambrian acid volcanics overlain by Owen Conglomerate which exhibits complex overturned folding and cross-folding. There are also significant differences and these will become more apparent as both areas are better understood.

A number of "rules-of-thumb" can be used to explain the positions of various ore bodies at Mt. Lyell and these have exerted undue influence on thinking in the Jukes-Darwin Area.

(i) Ordovician - Cambrian Contacts

Nearly all Mt. Lyell ore bodies are located near the contact with the Owen Conglomerate. This rule could be universally applied only if the ore were stratigraphically controlled and Cambrian and Ordovician rocks were reasonably concordant. However, at least some ore bodies seem to be structurally controlled, to that it is only in certain positions that the contact will be significant, notably where it is overturned against the Lyell Shear. At Jukes-Darwin we have contacts in at least three different structural settings.

(ii) Lyell Shear-Northwest Fault Intersection

This is a possible interpretation of the position of some of the Mt. Lyell ore bodies. At Jukes-Darwin the shearing is apparently distorted by the northwest structures, which are mainly mapped in the Conglomerate. None of the known deposits can be associated with these structures.

(iii) Mineralised Cherts

Several minor Lyell ore bodies occur in chert, most notably the Tasman Lyell silver-lead body. No cherts have been observed at Jukes-Darwin.

(iv) Zoned Ore Bodies in Schists

At Mt. Lyell (e.g. West Lyell Open Cut) the chalcopyrite occurs in sericite-schists, surrounded by pyritic chlorite-schist. At Jukes-Darwin sericite-schist occurs at East Darwin, where the situation may resemble that at Lyell, although the felsite contact might be the most important structure at East Darwin.

Elsewhere there is little evidence of such zoning, although this might be difficult to see in the field.

(v) Hematite-Barite Lodes

The bonanza Iron Blow Lode had a hematite-barite capping. Apparently the only such occurrence at Jukes-Darwin is on the lower part of Intercolonial Spur. This area has been reported as having little potential, but might bear further investigation in view of the strongly leached nature of the outcrop.

(vi) Bedded Ore in Sediments

This type of mineralisation is important at Rosebery, but sediments, and particularly black shales, are rare or absent in the Jukes-Darwin area.

The brief mapping already carried out in the Jukes-Darwin field has pointed up a number of differences between this area and Mt. Lyell. The Mt. Lyell Cambrian Rocks may be grouped as:

- (i) sediments - cherts, shales, rare limestone.
- (ii) quartz-sericite and quartz-chlorite schists (altered volcanics?)
- (iii) acid lavas and pyroclastics, generally altered.
- (iv) spilite suite volcanics, generally intermediate composition.

In the Jukes-Darwin area groups are:

- (i) quartz-sericite and quartz-chlorite schist (East Darwin).
- (ii) acid porphyries and pyroclastics, often little altered.
- (iii) massive feldspar porphyry (felsite)
- (iv) granite

Previous interpretations of known mineralisation in the Jukes-Darwin field have generally assumed the proximity of the Owen Conglomerate to be of prime importance. East Darwin, Findons, Lake Jukes Pty. Lake Jukes, Queen Jukes, the Jukes Pty. mines and possibly Tasman Darwin may all be explained on this hypothesis.

It is difficult to explain why this flat-lying contact should be important and it is now thought the association is fortuitous. Reference to the modified geological map (Fig. 14) immediately suggests another explanation for the mineralised areas. It appears that the margins of the felsite body are important areas of mineralisation, with two different types of mineralisation occurring in different structural settings.

(a) Prince Darwin-Tasman Darwin type

Copper sulphide-pyrite-chlorite mineralisation occurs near the upper edge of the felsite body, 20-30 feet below the disconformity. Heavy hematite-magnetite replacement occurs in the same area but may or may not be associated genetically. The leached(?) zone at the top of the felsite may indicate secondary enrichment of the ore.

Hydes mine would seem to occur in a similar position, but more information will be necessary to confirm this.

The Lake Jukes copper ores, although occurring in an area of pyroclastics, are mainly restricted to a small body of felsite ("granophyre" of Loftus Hills) on "Adit Knob".

From the information available the ore bodies between Proprietary Peak and the King River apparently occur at the edge of a felsite body, but possible this is an association of the second type, described below. As in the other case, iron mineralisation is also present.

(b) The Eastern Shear Zone

South of Mt. Jukes felsite and then granite are in contact with altered rocks described as quartz-sericite and quartz-chlorite schists. Felsite and granite are cleaved near the contacts and the whole zone appears to be one of intense shearing, possibly close to the axis of the major anticlinal structure.

The East Darwin ore occurs on the felsite-schist contact, and is not associated with iron mineralisation.

Mineralisation not associated with felsite margins

A number of small prospects have been developed in chloritised rocks within the granite and felsite but of these Findons is probably the only one with any potential. Iron-(barite-sulphide) bodies within the felsite are a different type of mineralisation which has yet to be proved economically significant. A little sulphide mineralisation occurs in sheared volcanics, e.g. Bean and Thow.

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