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SML 705 PARABARANA COPPER PROSPECT

REPORT ON DETAILED MAPPING CARRIED OUT IN APRIL-MAY 1972, AND A REVIEWED GEOLOGICAL INTERPRETATION FOR THE PERIOD 19/5/69 TO AUGUST 1972

Submitted by

North Flinders Mines Ltd
1972

MINES AND ENERGY
SOUTH AUSTRALIA

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TENEMENT: SML 705 Parabarana

TENEMENT HOLDER: North Flinders Mines Ltd

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SPECIAL MINING LEASE NO. 705, SOUTH AUSTRALIA

DETAILED MAPPING AND A REVIEWED GEOLOGICAL INTERPRETATION OF THE PARABARANA COPPER PROSPECT.

by

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ADELAIDE,
August, 1972

NORTH FLINDERS MINES LIMITED

C O N T E N T S :

ENCLOSURES

I INTRODUCTION

The occurrence of copper mineralization in the southern vicinity of Parabarana Hill was reported prior to the turn of the last century. Small scale mining activity began in about 1899 and continued intermittently for a period of approximately 20 years. Recorded production from this area is of the order of 250 tons of dressed oxide and secondary sulphide ores averaging about 20 per cent copper, taken chiefly from shallow pits and shafts.

Company exploration in this part of the Northern Flinders Ranges was commenced by Anaconda Australia Inc., in 1966.

In May of 1969, the mineralized Parabarana area was secured by North Flinders Mines N.L. and during the last three years, it has been the subject of a comprehensive exploration programme.

Exploration methods have included:

1) stream sediment survey for Cu, Pb, Zn and U,
2) helicopter radiometric survey and ground follow-up,
3) semi-detailed geologic mapping,
4) gridding of area 10,000 ft. x 4000 ft.,
5) petrologic study of outcrop material,
6) induced polarization survey on grid,
7) magnetometer survey on grid,
8) soil and rock chip sampling on grid,
9) rotary-percussion drilling (32 holes),
10) diamond core drilling (7 holes).

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Whilst four of the diamond drill holes achieved inconclusive results, the PDD 3 hole located an ore intersection of 18 ft. (5.5.m) of 2.5% copper plus minor molybdenum and uranium, at approximately 1,100 ft. (335m) below surface.

In reviewing the status of the Parabarana Copper Prospect early in 1972, it was considered that optimum use of outcrop data might further the understanding and interpretation of this complex geological environment.

The author undertook detailed mapping on a one hundred foot square grid during a 4-week period in April and May of this year.

The geological map and revised drill-hole cross sections are the subject of this report.

II LOCATION AND ACCESS

Parabarana Hill (latitude 29^{0} 58.8'S, longitude 139^{0} 41.9'E) is a prominent feature situated 5.5 miles (8.8 km) SSW of Moolawatana, a station homestead at the very north-eastern tip of the Flinders Ranges (see Fig. 1).

Numerous copper occurrences are found along a one mile (1.6 km) east-west zone which passes one half mile (0.8 km) south of Parabarana Hill.

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Elevation of Parabarana Hill Trig is 1,300 ft. (396 m) A.S.L. but the topography drops away steeply to the prospect area which averages about 800 ft. (244 m) above sea level. An abitrary datum approximately 4000 ft. (1220 m) above true elevation was used for the drilling programme.

Access to the Parabarana Prospect is by graded dirt tracks approaching from the eastern plains, one from Moolawatana, one from Box Bore on the main Wooltana - Moolawatana road, and a southerly one from Pepegoona Well (Fig. 1).

III TENEMENT HISTORY

Special Mining Lease No. 297 covering some 7 square miles (18 sq.km) around Parabarana was granted to North Flinders Mines N.L. on 19 May, 1969, for a 2-year term.

In March 1971, this prospecting lease was absorbed into a larger surrounding company lease, S.M.L. 558.

Recent revision of leases has resulted in the Parabarana Prospect now being covered by S.M.L. 705 (the same area as for S.M.L. 297), which lease is current until 17 May, 1974.

North Flinders Mines Limited has 100 per cent lease ownership.

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IV BIBLIOGRAPHY OF COMPANY REPORTS

The following reports have been filed by company staff, contractors and consultants during the course of prospecting at Parabarana. Most of these have been drawn on for information to assist in the mapping programme, and construction of cross sections.

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(3)	EGGINGTON, H.F. (1971)	Exploration Drilling, Parabarana Hill Prospect, S.A. (Exploration Services Co.)
(4)	MOUNT, T.J. (1971)	Mineralogical Report No. 424 Parabarana Drill Core (McPhar Geophysics Pty. Ltd.)
(5)	PONTIFEX, I.R. (1970)	Mineralogical Report No. 207 Percussion Drill Cuttings from Parabarana Prospect (Holes NFP 22, 23). McPhar Geophysics Pty. Ltd.)
(6)	PONTIFEX, I.R. (1970)	Microscopic Examination of Drill Core and Cuttings, Parabarana Hill. (McPhar Geophysics Pty.Ltd.)
(7)	PONTIFEX, I.R. (1971)	A Petrogenetic Study of Samples from DDH 3 and DDH 6, Parabarana Copper Prospect. (McPhar Geophysics Pty.Ltd.)
(8)	PONTIFEX, I.R. (1971)	Mineralogical Report No. 459 Parabarana Core Sample PDD 3. (McPhar Geophysics Pty. Ltd.)
(9)	PONTIFEX, I.R. (1972)	Mineralogical Report No. 930 Rock Samples, Parabarana. (McPhar Geophysics Pty. Ltd.)

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(10) PONTIFEX, I.R. (1972) A Petrogenetic Study of Samples from PDD 5 and PDD 7, Parabarana Copper Prospect. (McPhar Geophysics Pty. Ltd.)

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(12) WEBB, J.E. (1969) Report on Induced Polarization Surveys in North Flinders Area. (Austral Exploration Services Pty. Ltd.)

(13) WHITTLE, A.W.G. and PONTIFEX, I.R. (1970) Petrographic Examination of the Parabarana Copper Prospect, SML 297 (McPhar Geophysics Pty. Ltd.)

(14) WHITTLE, A.W.G. (1971) Mineralogical Report No. 425 Core Samples from PDD 3. (McPhar Geophysics Pty. Ltd.)

(15) WHITTLE, A.W.G. (1971) Mineralogical Report No. 429 Core Samples from PDD 1. (McPhar Geophysics Pty. Ltd.)

(16) WILSON, R.B. (1970) Summary Report on a Rotary-Percussion Drilling Programme, Parabarana Copper Prospect, SML 297, South Australia. (North Flinders Mines, Company Report)

(17) WILSON, R.B. (1971) Final Summary Exploration Report, SML 297, North Flinders Ranges, S.A. (North Flinders Mines, Company Report)

(18) WILSON, R.B. (1971) Progress Report on Diamond Drilling Programme, Parabarana Copper Prospect, SML 297. (North Flinders Mines, Company Report)

Additional supporting information has been taken from:

(19) COATS, R.P. and BLISSETT, A.H. (1971) Regional and Economic Geology of the Mount Painter Province. Geol. Survey of S. Australia, Bull. 43.

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V GEOLOGY OF THE PROSPECT AREA

(1) Local Setting

The Parabarana Copper Prospect is situated within an environment of Carpentarian (Middle Proterozoic) acid igneous rocks.

Regional mapping by Coats (19 ; also Fig. 1) has defined an area to the north and west of the prospect, as being underlain by Terrapinna Granite, and that to the south by the Mount Neill Granite Porphyry.

Separating them and interjacent to these formations, within a structurally complex pile of east-west thrust slices, is a north-dipping sheet of layered microadamellite and microgranite which has undergone varying degrees of metamorphic and hydrothermal alteration. This fine-grained, probably intrusive rock is the main host to the copper mineralization.

Because most of the exposed rock boundaries are considered to be faulted, the local inter-relationships of the various rock-types are not all known. The one definite relationship recognized is the intrusive nature of the Mount Neill Granite Porphyry into microadamellite.

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(2) Problems in Mapping

Several aspects of the Parabarana geology have presented difficulties in the selection and mapping of outcrop data likely to be most useful particularly in the interpretation of structure and drilling results and in future ore-finding.

The macroscopic similarity between Terrapinna Granite and Mount Neill Granite Porphyry for instance, is such that outcrops of these rocks may be difficult to distinguish, and indeed where chloritization is moderate to intense as in many parts of the prospect area, it is virtually impossible to do so. This applies especially to the wedge of highly chloritized granite porphyry above the microadamellite, which is tentatively regarded as Terrapinna Granite.

The effects of metamorphism, metasomatism and alteration on rocks in the Parabarana area are widespread and varied. Alteration features which might be mapped are usually gradational, intermittent, or superimposed and their accurate mapping would require the utmost detail.

Intense dynamic metamorphism associated with the thrust fault movements has resulted in cataclasis and retrograde metamorphism to such a degree in some parts, that the nature of original rock-types is all but lost.

In spite of these problems it seemed early in the mapping programme, that rock-units mapped in terms of their original type rather than their altered state, would more likely provide the clearest structural picture of the prospect and this aim has been followed.

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(3) Detailed geology

The geologic model of the prospect developed by Wilson (16, 17) and Pontifex (7) has been substantiated by detailed mapping. Some refinements in the strucutral interpretation have been adopted and a close field study of the metamorphism and alteration of microadamellite appears to have clarified the nature of epidote garnet hornfels and related rocks which earlier had proved to be problematical.

ROCK RELATIONS TABLE

WILSON AND PONTIFEX	DETAILED MAP UNITS (STRUCTURAL SUPERPOSITION)	CONTACT RELATIONSHIP
HANGING WALL ROCKS	(a) Mylonite gneiss; augen granite, amphibolite; retrograde schist (TERRAPINNA GRANITE)	
		TECTONIC (Thrust)
	(b) Chloritized porphyritic microgranite (?TERRAPINNA GRANITE)	
CHLORITIZED ZONE		?TECTONIC (Thrust)
FOOTWALL ROCKS	MAIN ORE ZONE (c) Microadamellite - altered metamorphosed, mineralized	
		INTRUSIVE INTO MICROADAMELLITE
	(d) Porphyritic microgranite (MT. NEILL GRANITE PORPHYRY)	

(a) Mylonites, cataclasites, granite gneisses and augen granites of the Parabarana Hill thrust block.

The southern slopes of Parabarana Hill exposed a suite of rocks which have developed through the extreme mechanical deformation of porphyritic granitic rocks. Coats assigned them to the Terrapinna Granite.

Usually of a bright reddish to brown colour, these are mylonite gneisses, flaser granite gneisses, and augen gneissic granites with a persistent foliation striking regularly in the north-east to east-north-east direction, and dipping at 55^{o} to 85^{o} to the north-west.

This foliated block is truncated sharply and obliquely at its base by an east-west striking thrust fault, the trace of which is exposed on the northern side of the water storage dam (300N, 600W).

Bands of coarse-grained muscovite-chlorite schist up to 40 ft. wide pass conformably through the mylonites. These schists are products of strong differential stress in which retrogressive changes in the granite have occurred (13).

Another rock-type mappable in this block, and logged in several drill-holes (see Figs. 4,5,6) is a dark coloured schistose amphibolite or amphibolitic gneiss. The continuity of this more basic rock unit is difficult to follow. An original dioritic rock-type in which case these bodies may be metamorphosed intrusive dykes, has been postulated (4,7).

A number of small pegmatitic and fine grained granitic lenses have been found cutting the gneisses. These are thought to be a late phase Mt. Neill Granite Porphyry and microadamellite respectively.

Epigenetic chlorite, calcite, micaceous hematite and quartz are common fracture fillings in gneiss.

(b) Chloritized Porphyritic Microgranite

A tapering faulted slice of pyritic chloritized porphyritic microgranite has been mapped in outcrop between the mylonite gneiss block and the underlying altered microadamellite.

Chloritization with some epidote has affected the original rock-type in all manner of degree. Residual patches of somewhat gneissic porphyritic microgranite with chloritized ferromagnesian components occur with completely chloritized rock, resembling chloritic schist.

Much of this map-unit, however, has undergone moderate chloritization, where relict pink feldspar phenocrysts in various stages of digestion, determine the original porphyritic texture.

(c) Microadamellite

This formation, as yet formally unnamed, is of special importance as the chief host rock to copper mineralization at Parabarana.

Microadamellite and its alteration variants has been mapped in a belt from line 800E as far as line 2200W. Semi-detailed reconnaissance further west has shown the microadamellite to outcrop over a total strike length of more than one mile (1.6 km).

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This banded rock has a northerly dip of near 55°, bounded on the top probably by a now-healed thrust fault and at the bottom by intrusive Mt. Neill Granite Porphyry. The thickness of microadamellite between lines 00E/W and 800W is about 300 feet (91.5m). Apparent thickening further west is in part, at least, due to disruptions and dislocations caused by granite porphyry intrusion.

East of line 300E it is limited to small patches of outcrop, some of which is retrogressively metamorphosed beneath thrust faults to a fine quartz-sericite-chlorite schist. This type of rock occurs as far east as line 1600E.

In its freshest state, the microadamellite is a pinkish to salmon coloured, fine grained, crudely banded rock. It is everywhere fractured, and often crushed and brecciated. The most extensive exposure of the less altered microadamellite is on 'Copper Hill' (vicinity 00 E/W), and in several smaller outcrops to the west.

Thin section work by Pontifex (7, 10) and Whittle (14) shows the microadamellite to be an allotriomorphic granular aggregate of quartz, potash feldspar and sodic plagioclase, with several per cent of accessory sphene. Primary biotite, usually chloritized to some degree, is variable through the rock mass, and where it is deficient the rock is decidedly leucocratic. The plagioclase content also is variable, thus accounting for changes to microgranite and microtonalite.

The microadamellite has some of the petrological characteristics of a high-level intrusive, and it may be regarded somewhat tentatively as such. Its upper contact with the chloritized ? Terrapinna Granite is thought to be faulted, but in two road

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cutting exposures (locations 330N, 295W and 1970W, 380N) small intrusive veins of microadamellite and microgranite cut across the foliation of mylonite gneiss. It might be inferred from this relationship that the main body of microadamellite intrudes and post-dates the Terrapinna Granite.

Compositional changes through most of the microadamellite have been brought about by contact metamorphism and metasomatism as well as a superimposed phase of hydrothermal alteration and mineralization.

In a broad simplification, altered portions of the microadamellite now have been distinguished visually and mapped on the basis of a dominant epidote or dominant chlorite (and green biotite) component in the alteration assemblage (Fig.2). There is, however, overlap of most of the secondary alteration effects and the sequence of processes of alteration is still not fully recognized.

The weight of both field and laboratory evidence indicates that there have been two and possibly three phases of alteration.

(i) Contact metamorphism and calc-silicate metasomatism -

Metamorphic and metasomatic changes in microadamellite marginal to the intrusive Mt. Neill Granite Porphyry have produced a characteristic mineral assemblage consisting of epidote, hornblende (actinolite, tremolite), garnet, calcite, magnetite and sulphide.

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These rocks have been classified in Coats' mapping (Fig. 1) as 'banded, siliceous, epidote amphibolites' and by Blissett (19) as epidote - actinolite - sphene - apatite hornfels, with the petrographic inference of a metasedimentary origin. This cannot be substantiated in the field.

They might best be described as hornfels especially nearer the Mount Neill Porphyry contact, from which they grade outwards into epidotized microadamellite. Colour banding and mottling is a common feature, related partly to primary banding in the microadamellite, and more directly to relative amounts of epidote, garnet and amphibole in patches and layers alternating with less altered microadamellite.

Whether the contact metamorphic influence or the metasomatic influence has had more effect on these rocks is not clear. Whilst epidote, calcite, magnetite and amphibole can be metamorphic reconstitution products, there is evidence that epidote, calcite and quartz have been mobile and introduced into fractures.

(ii) Chloritized (epidotized) microadamellite.

Mottling in grey, greenish and pinkish tinges is typical of these rocks, where various degress of alteration have permeated the fragmented pink microadamellite.

Shearing is evident especially where chlorite is abundant and a strong fissility is developed.

The microadamellite has been in part hydrothermally sericitized and argillized and generally affected by the introduction of varying amounts of chlorite, green biotite, epidote, quartz, potash

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feldspar, calcite, apatite magnetite, primary hematite and sulphides, predominantly pyrite and chalcopyrite.

This type of alteration seems to be best developed within the top 150 feet of the unit, but it does occur in lower portions in the 'Copper Hill' area.

(d) Mount Neill Granite Porphyry

Typically this rock is a light brown weathering, porphyritic type in which large pinkish to flesh-coloured ovoid phenocrysts of feldspar (mostly microcline), are set in groundmass of fine quartz, potash feldspar, subordinate plagioclase and biotite. Chlorite, sericite and epidote are common secondary minerals. Bluish to grey quartz phenocrysts are sporadic.

Gross texture of the Mount Neill Granite Porphyry is normally homogeneous, but incipient gneissosity has developed in shear zones. Rather the rock tends to joint and in some fault zones to shatter. Veins in these fractures range from a fraction of an inch to several feet in thickness and are composed of calcite, siderite, quartz, minor chlorite and varying amounts of pyrite and chalcopyrite. These obviously post-date the granite porphyry and some pass into the altered microadamellite. They seem to be most concentrated in fracture zones striking between north-north-east and north-east.

(e) Alkaline ? Pegmatite

Pods and lenses measuring a few tens of feet, of a rock composed essentially of coarse, subhedral pink potash feldspar have been mapped in intrusive relationships to the Mt. Neill Granite Porphyry, to the epidotized (hornfelsed) microadamellite, and to mylonite gneiss in the vicinity of 700N, 650W. In the latter

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occurrence the rock is an unstressed friable, sugary, medium grained, pinkish feldspar rock with some feldspar phenocrysts and disseminated hematite, chlorite, sericite and calcite.

The rock has been described as an alkaline pegmatite, probably a late phase of the Mount Neill Granite Porphyry (9).

Secondary components mentioned above (calcite, quartz, chlorite, potash feldspar and pyrite) in fractures and cleavages, are common to other outcrops of this rock.

(f) Sedimements

Outcrops of Mesozoic and younger sediments encroach on the prospect area.

Basal mudstones, sandstones and shales of the Great Artesian Basin are in steep and overturned fault contact with chloritized, porphyritic microgranite and granite porphyry in the south-eastern part of the mapped area. Wilson (16) has reported that Cretaceous sediments were intersected below microgranite in drill-holes on grid line 800E, thus indicating post-Cretaceous overthrust movement.

Prominent fluviatile boulder conglomerates cut across the prospect area along fracture lineaments which have controlled valley development.

(4) <u>Geological Structure</u>

In this environment of massive igneous rocks, faulting has had the most obvious effects on structure, ground preparation and mineralization.

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In regional aspect, the Parabarana prospect-area is situated favourably at the convergence of three major fault systems.

Coats (Fig. 1) indicates a major fault, transverse to the general trends in the Mount Painter Block, striking into the prospect-area from the west, along which intense chloritization has occurred.

Merging with this east-west structure at the western end of the prospect-area, the Mount Adams Fault system strikes in from the south-west. This complex, steep tectonic zone has been shown by geochemical surveys to be mineralized with copper and some uranium for a distance of about 12 miles (19 km).

Mineralized faults and fractured zones striking NNE into the southern portion of the map-area (Fig. 2) form a set which when projected to the SSW, it seems likely has controlled the topographic margin of the ranges for some 10 miles (16 km) towards Pepegoona Well (Fig. 1).

The local structure of the copper prospect is dominated by east-west thrust faults. Geologic cross-sections (Figs. 3, 4, 5, 6, 7, 8) show that these faults are subparallel and that they dip at angles between 45^{o} and 55^{o} to the north.

Eastward of line 300E, the thrust slices are complicated by steep, meridional cross faults. Some of these seem to pre-date the thrust faults, but others to transect them.

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The large veined fault traversing the south-east part of the map (Fig. 2) is near vertical at the south, but it appears to flatten in successive offset segments, and becomes the overthrust structure on Cretaceous sediments, discussed by Wilson (16). There is, therefore, post-Cretaceous movement, but the relative ages of other faults in the area are not known.

A steep NNE striking fault mapped close to drill-hole NFP 20 (Fig. 2) has offset the microadamellite and the ore horizon. This apparent east-block-north horizontal movement is confirmed by structural contours in Figure 9.

A set of NW - SE geomorphic lineaments cutting through the prospect-area indicates another fracture system. These may be young mega-joints rather than faults, as displacements have not yet been demonstrated.

VI MINERALIZATION

(1) Surface Indications and weathering

Malachite stainings in outcropping rocks are common and widespread along the Parabarana microadamellite trend.

Extensive 'paint copper' occurs on fractures in the very broken microadamellite at 'Copper Hill' (vicinity OOE/W), and in several chloritic shear-cleavage zones on and nearby this hill, supergene chalcocite haloed with malachite has been the main target of early mining.

Drilling results have shown that depth of oxidation of the copper-mineralized zone varies between 50 ft. (15m) and 150 ft. (46 m) below surface. Generally sulphides in exposed rock have been oxidized but in the more massive carbonate-quartz veins where weathering has been inhibited by lack of permeability, fresh pyrite and chalcopyrite can be found.

Malachite stained outcrops often show some evidence of pre-existing sulphides. Reddish-brown limonite in cleavages and in very fine fractures, also scattered intergranular lenticles and blebs, can sometimes be identified as boxworks, but the frequent occurrence of hematite as a weathering product of biotite and chlorite makes a quantitative estimate of sulphides difficult. No doubt hematite masks the presence of oxidized sulphides in some outcrops.

It is significant that in very few places along the outcropping mineralized zone is there fair visual indication of the better primary grades intercepted in drill-holes. It is felt that this results, to some degree, from not being able to identify the extremely finely divided sulphides in weathered rock, but also that the primary copper tenor for one reason or another is improving in depth.

One reason for this may be that diminishing effects of metamorphism and metasomatism of the microadamellite away from the line of present outcrop, have deprived the rock less of fracturing ability, thus effectively increasing permeability to ore fluids.

It seems possible also that a steep chloritic zone coming in along line 100N for some distance from the west, may have impeded permeability along what is now the near surface part of the ore horizon.

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In the absence of more factual data, these suggestions are fairly subjective.

Core holes have all entered the mineralized zone below base of weathering. Rotary percussion logs (16) of several holes record the presence of native copper and secondary copper low in the oxidation zone, but there appears to be no important and consistent secondary enriched zone. Incipient chalcocite and covellite replacement around chalcopyrite and bornite and disseminated fine native copper have been reported.

(2) Ore Minerals

Petrographic and mineragraphic studies of cores and cuttings (6, 7, 10, 14) have established that the Parabarana primary ore is a complex assemblage.

Pyrite and chalcopyrite are the dominant sulphides.

Bornite, molybdenite, pyrrhotite and marcasite and unidentified uranium mineralization are subordinate, while trace amounts of galena, sphalerite and pseudobrookite have been noted.

(3) Gangue Minerals

Gangue in Parabarana ore is composed mainly of carbonate (calcite), chlorite and quartz.

Other gangue minerals are green biotite, epidote, sericite, clay minerals, orthoclase and amphibole, as well as primary hematite, magnetite and graphite.

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This is largely a hydrothermally introduced assemblage with propylitic affinities.

Where hydrothermal alteration has pervaded the host-rock, sericitization may be more pronounced, and the intensity of chalcopyrite disseminations increased.

(4) Control and Localization of Mineralization

The main copper mineralization at Parabarana occurs within a sheet-like zone of brecciated, altered microadamellite, up to 150 feet (46 m) in true width, and generally within the top most 200 feet (61 m) of the unit. Deeper mineralization was located within microadamellite in core holes PDD 5 and PDD 6 (Figs. 8 and 6).

Mineralization occurs as very fine fracture fillings, breccia fillings and stockworks with related intergranular disseminations.

The parallelism of the mineralized breccia sheet with overlying thrust faults inclined at 45^{o} to 55^{o} northward, infers a relationship to the faulting and a structural control in ground preparation of brittle microadamellite prior to hydrothermal alteration and mineralization.

There is a distinct localization of epigenetic copper sulphides within the microadamellite. The excellent fracturing ability of this fine-grained igneous rock has played a large part in this, but chemical factors also may have been effective.

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Sulphides are widespread in the overlying chloritized granite porphyry, but this is essentially pyritic mineralization.

Faults and fracture zones cutting through the Mount Neill Granite Porphyry have also localized vein-type mineralization of a comparable assemblage to that in the microadamellite breccia. These are the site of several small workings.

Drill intercepts of molybdenum and uranium mineralization exceeding 100 p.p.m. have been plotted on the cross-sections accompanying this report. The minor concentrations of these metals occur usually in two or three separate zones through the copper mineralization, and these zones when joined from drill-hole to drill-hole, also define a parallelism to overlying thrust faults. The implication here is that molybdenite and uranium minerals were localized along secondary shears or faults belonging to the main thrust fault set.

(5) <u>Source of Mineralization</u>

Several established temporal and spatial relationships contribute to an early understanding of the origin of copper mineralization at Parabarana. These are:-

(a) The Mount Neill Granite Porphyry is intrusive into the microadamellite. This event accounts satisfactorily for the metamorphism in much of the lower portion of the microadamellite.

(b) Fracture and stockwork copper mineralization is epigenetic to and therefore post-dates the microadamellite and its metamorphosed portions.

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(c) Copper-bearing vein and fracture fillings with a mineral association very similar to that in the microadamellite are epigenetic to and therefore post-date the Mount Neill Granite Porphyry.

This evidence infers that copper mineralization is related to a late hydrothermal phase of the Mount Neill Granite Porphyry intrusion, perhaps in time close to the alkaline pegmatite phase.

To what extent there was an interplay between thrust faulting and the positioning of the microadamellite sheet, or the confining of the granite porphyry intrusion, is not yet known.

Post-intrusive movement caused widespread crushing through the microadamellite, at which time a brecciated sheet parallel to superjacent faults became the principle locus for hydrothermal solutions and copper mineralization.

(6) <u>Ore Possibilities</u>

Figure 9 has been included to show the distribution of drill-hole copper intercepts, in a simple, inclined structural zone.

Approximate true widths of copper mineralization defined by one tenth per cent - plus assays show that the known thickest development of the mineralized horizon occurs along lines 400W and 800W, and in PDD 6 on line 1200W. Six holes in this vicinity cut mineralized widths of between 95 ft. (29 m) and 150 ft. (46 m).

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The coincidence of the highest grade intercepts also in this area gives the impression of a shoot development plunging to the north-west at about 40^{o} below horizontal. This may be incidental, however, in the absence of information in diamond drill holes PDD 1 and PDD 4 where host-rock was not reached, and because of the incomplete mineral intersection (top half only) in PDD 2. There is no reason to predict that the quality of the intersection in PDD 3 and NFP 14 will not be maintained or improved down-dip on lines 400W and 800W.

On this basis true ore widths of near 20 ft. (6 m) and greater with average grade upward of 1.8% copper could be anticipated.

Unless recoverable grades of molybdenum or uranium can be proved more consistent than presently indicated, these would not figure as by-product metals.

The likelihood of locating a sufficient volume of lower grade copper ore to support an underground mining operation under present conditions, seems to be remote.

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VII CONCLUSIONS

(1) Copper mineralization at Parabarana occurs within a north-dipping, sheet-like and probably intrusive body of banded microadamellite. It is overlain by 50° north-inclined thrust-fault slices of pyritic chloritized porphyritic microgranite and mylonitized gneissic granitic rocks, originally part of the Terrapinna Granite.

(2) The microadamellite host-rock is underlain, and was intruded by the Mount Neill Granite Porphyry. It became extensively metamorphosed and metasomatised, resulting in alteration to an epidote-calcite-garnet-magnetite rich rock.

(3) Following widespread brecciation and crushing in the microadamellite, phases of hydrothermal activity resulted in the introduction of a secondary mineral assemblage dominated by calcite, chlorite, green biotite and quartz. There was also some pervasive sericitization of host rock.

(4) Chalcopyrite, pyrite and bornite with minor molybdenite and uranium were introduced with the alteration minerals, predominantly into fractures and fine stockworks.

The copper sulphides were localized in a sheet-like breccia of brittle microadamellite. This mineralized horizon varies in thickness from about 40 feet (12 m) up to 150 feet (46 m). It occurs within the upper 200 feet (61 m) of microadamellite.

Copper mineralization is insignificant in the thrust block overlying the microadamellite but there are calcite-quartz veins in faults and fracture zones cutting the underlying granite porphyry.

..../25

(5) Thirty two percussion holes and seven diamond core holes have been drilled on the prospect.

Three holes on lines 400W and 800W intersected potential ore mineralization at 300 to 400 feet (122 m) and 1000 feet (305 m) below surface. There is evidence that the grade of primary copper has improved with depth.

(6) Ore widths of at least near 20 feet (6.1 m) with 1.9% to 2.5% copper are indicated.

It seems that molybdenum and uranium are present in sub-economic amounts.

(7) Due to technical problems in drilling, four of the seven diamond core holes were abandoned before reaching or prematurely to penetrating the ore zone.

(8) It is concluded that there is good exploration potential in the Parabarana area. Diamond drilling to test for extensions of the encouraging copper intersections on lines 400W and 800W is well justified.

There is also need for a more speculative approach, to investigate the prospect area where a strike length exceeding one mile with scattered mineralization has been delineated in reconnaissance.

Despite the discouraging results from a number of percussion holes to the west, and low values in P00 5 and P00 6, these holes have confirmed the continuity of the microadamellite ore horizon as a near-planar, north-dipping mineralized breccia sheet.

There is no basis for the prediction of quality of mineralization to the west. Induced polarization traverses (1, 2, 11) have defined good anomalies along this zone, but these appear to have a main source in the pyritic chloritized granite, beneath which copper sulphide mineralization, if present, would be masked.

VIII GENERAL RECOMMENDATIONS

Two approaches to the prospect are recommended.

(1) Semi-detailed diamond drill testing.

Diamond drilling on approximate 400 feet (122 m) centres is recommended to test extensions of ore intercepts down dip on lines 400W and 800W. Pre-collared vertical holes will minimize previously experienced drilling difficulties.

To commence the programme and to utilize existing facilities in fairly steep terrain, proposed vertical core hole PDD 8 should be collared on the PDD 2 platform to intersect the ore zone at approximately 950 feet (290 m) below surface.

Proposed vertical core hole PDD 9 should be drilled to test down dip from the PDD 3 intersection. In view of the steep topography and rapidly increasing elevation, PDD 9 might be collared on the PDD 3 platform to intersect the ore zone at approximately 1350 feet (411 m) below surface.

The siting of subsequent diamond drill-holes should await the results of PDD 8 and PDD 9.

..../27

(2) Exploratory drilling

In the longer term, exploratory holes should be drilled between lines 2000W and 5200W to test for mineralized microadamellite at about 700 feet (213 m) below surface. The upper 250 to 300 feet (91 m) of microadamellite would be the main target but the possibility of locating deeper mineralization as in PDD 5 (line 2000W) should not be discounted.

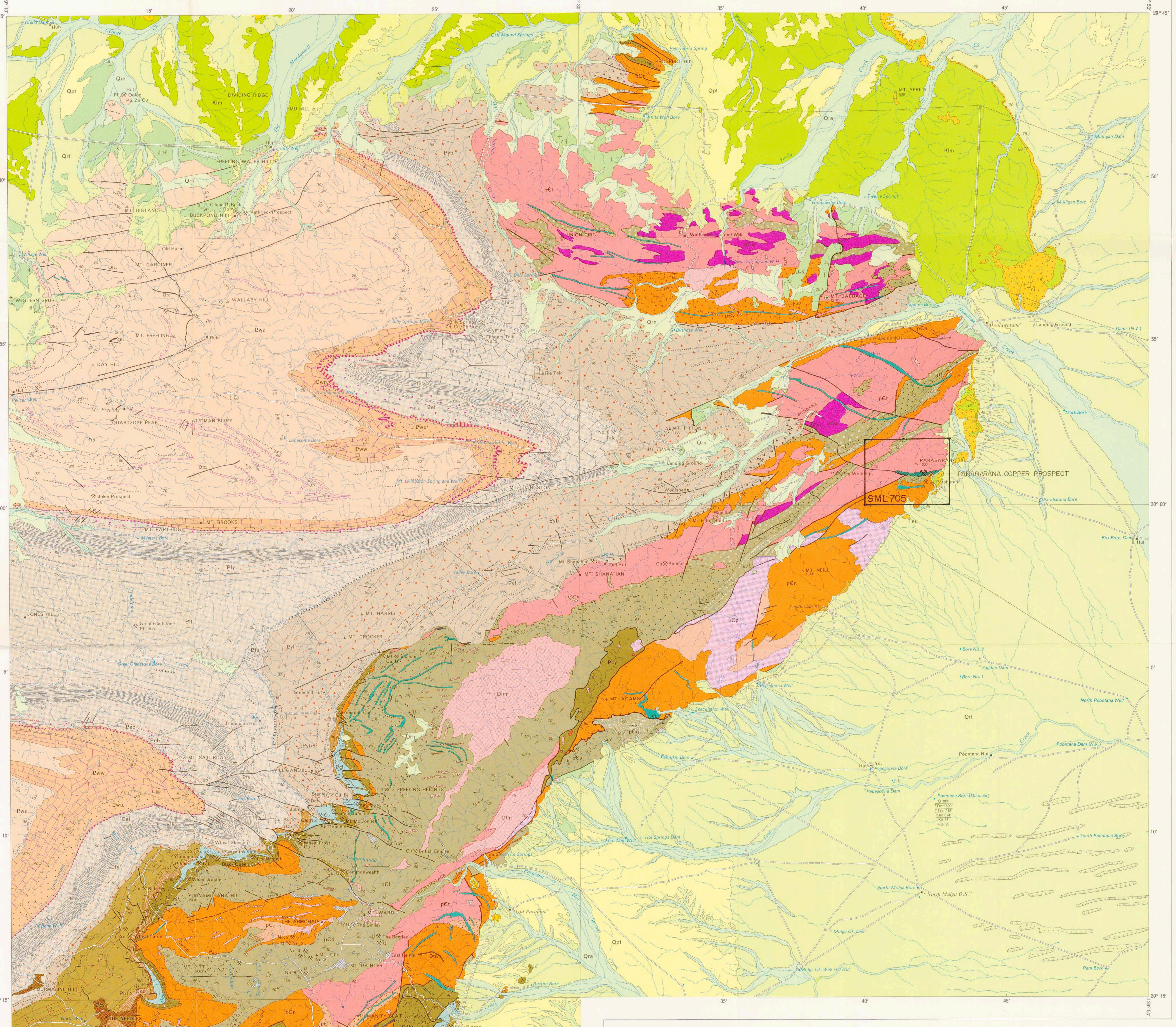
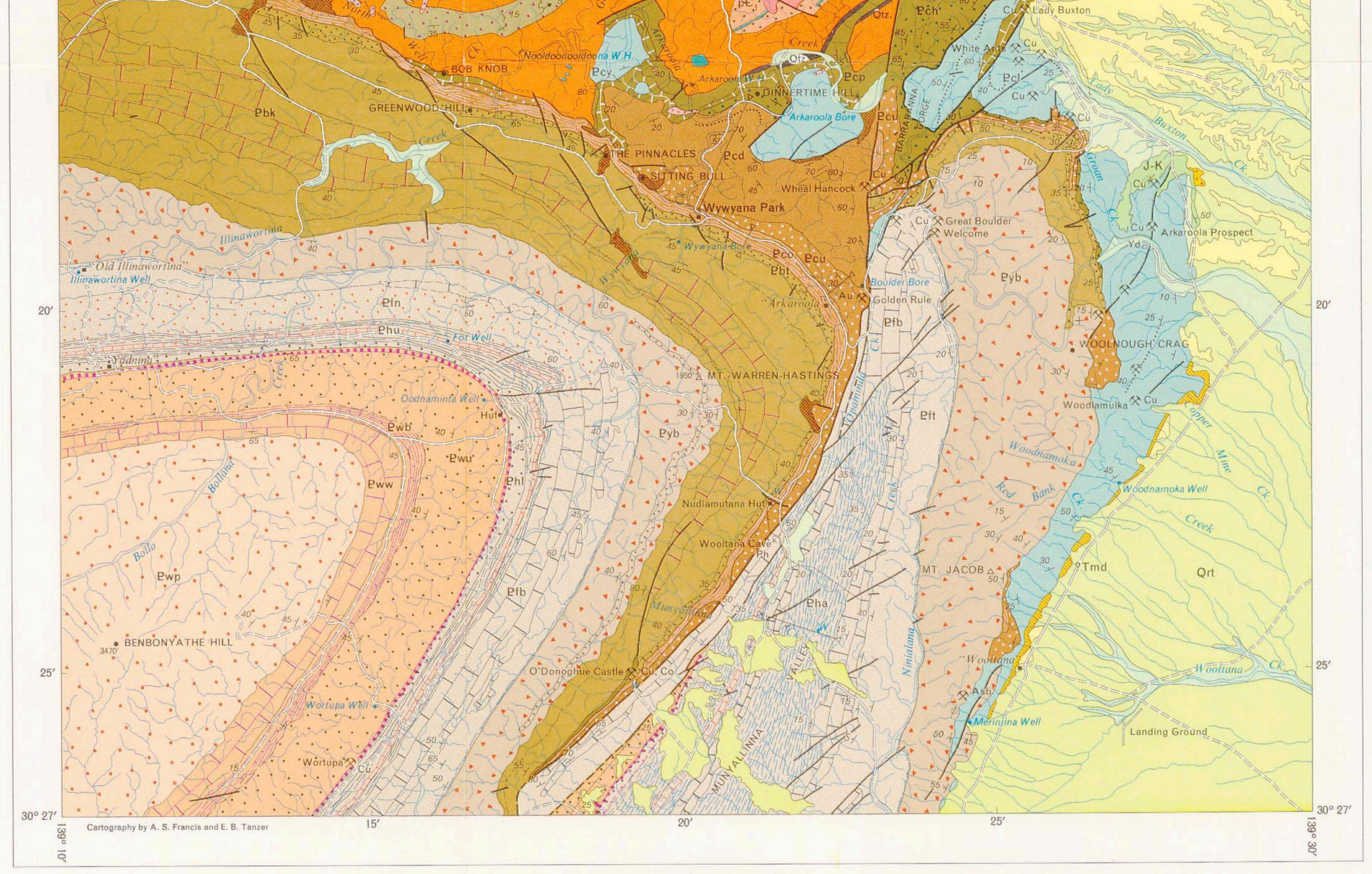
This phase of drilling would be preceded by detailed mapping, incorporating past geochemical, geophysical and percussion drilling results.

I.B. FREYTAG
Senior Geologist

GEOLOGICAL ATLAS SPECIAL SERIES

MOUNT PAINTER PROVINCE

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES ADELAIDE

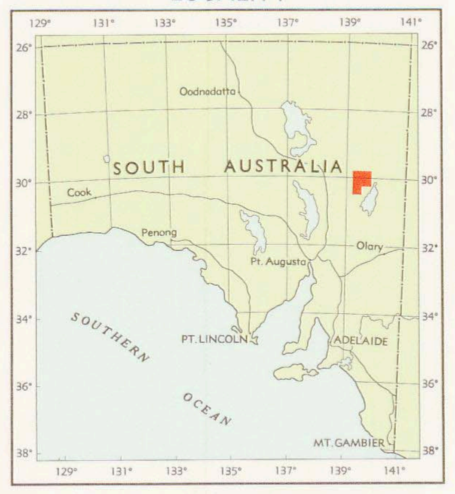
SCALE 1:125,000

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

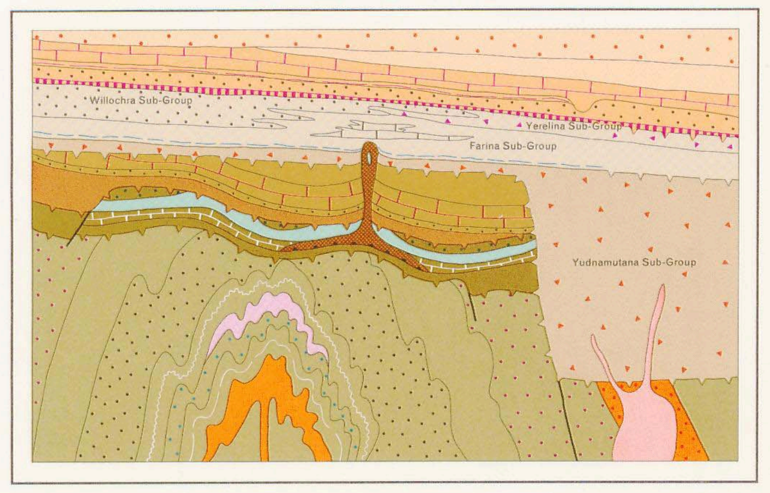
KILOMETRES 2 0 2 4 6 8 10 12 KILOMETRES

H. J. WALL, GOVERNMENT PHOTOLITHOGRAPHER, ADELAIDE

LOCALITY



ROCK RELATION DIAGRAM



REFERENCE

CAINOZOIC – QUATERNARY – RECENT	Qra	Alluvium of creek beds and flood plains.
	Qrt	Outwash, low angle slope deposits, gibbers, sand dunes.
		Scree deposits.
	Qrn	Thin alluvium of pediments, minor bedrock outcrops.
PLEISTOCENE	Qpt	High level gravels often calcreted; red-brown gypseous clay, gypcrete, mottled green clays (TELFORD GRAVEL and AVONDALE CLAY).
TERTIARY	?Tmd	Dense cream limestone and dolomite, calcareous sandstones, grits and conglomerates (?ETADUNNA FORMATION equivalents).
	Tsi	Quartzose silcrete of duricrust profile.
	Teu	MURNPEOWIE FORMATION: Cross-bedded feldspathic sandstone, minor clay, basal quartz-agate conglomerate.
PALAEOZOIC – JURASSIC-CRETACEOUS	Klm	MARREE FORMATION: Poorly outcropping grey siltstone and shale, minor sandstone, concretionary ironstone; chocolate weathering limestones near base.
	J-K	Undifferentiated sandstones: Brown-weathering sandstones and gravels, ferruginous sandstone, carbonaceous silts, porphyry pebbles (PELICAN WELL FORMATION, PARABARANA SANDSTONE). Buff-weathering sandstones, basal quartz conglomerate (VILLAGE WELL FORMATION).
ORDOVICIAN ("YOUNGER GRANITE SUITE")		Muscovite and biotite pegmatites.
	Olm	MUDNAWATANA GRANITE: Medium-grained, equigranular white granodiorite, locally with metasedimentary remnants.
AGE UNKNOWN		Soda leucogranites in diapirs.
		Amphibolites: Diorites, microdiorites and metadolerites, often retrograded to biotite or chlorite schist.
		Undifferentiated breccias: Granite breccias, chloritic and haematitic in part, locally granitised, associated uranium minerals.
PROTEROZOIC – ADELAIDEAN – MARINOAN – WILPENA GROUP	Ꝑwp	POUND QUARTZITE: Well bedded brown to grey-weathering white quartzites, thin purple siltstone with mud cracks. Minor cross-bedding and heavy mineral lamination.
	Ꝑwz	BILLY SPRINGS BEDS: Laminated green siltstones, minor dolomites and flaggy quartzites.
	Ꝑww	WONOKA FORMATION: Calcareous grey and grey-green siltstones with minor blue-grey flaggy limestones.
	Ꝑwb	BUNYEROO FORMATION: Finely laminated purple silty shales, minor dolomites.
	Ꝑwu	ULUPA SILTSTONE: Green siltstones, finely laminated silty shales.
	Ꝑwn	NUCCALEENA FORMATION: Purple shales, cream-weathering pink dolomites near base.
UMBERATANA GROUP – YERELINA SUB-GROUP	Ꝑhl	ELATINA FORMATION: Cross-bedded pink arkosic sandstone or reddish quartzite. Ripple marks.
	Ꝑeb	BALPARANA SANDSTONE: Well-bedded sandstones, minor quartz pebble beds.
	Ꝑec	MOUNT CURTIS TILLITE: Massive grey-green dolomitic greywacke tillite, minor quartzite.
	Ꝑef	FORTRESS HILL FORMATION: Laminated gritty grey siltstones, rare cobble lenses, dark massive quartzite at top, local erosion at base with associated edgewise breccias, gritty and pebbly limestones.
	Ꝑfz	TREZONA FORMATION: Grey-green silty shales, lenticular red and grey clay-flake breccia limestones.
FARINA-WILLOCHRA SUB-GROUPS	Ꝑfe	ENORAMA SHALE: Purplish green shales, minor thin bedded calcareous siltstones and red shales.
	Ꝑha	ANGEPENA FORMATION: Alternating red micaceous siltstones and red and grey dolomites, minor green silty shales. Ripple marks.
	Ꝑfa	AMBEROONA FORMATION: Finely laminated green and grey-green siltstones, minor well bedded sandy limestone.
	Ꝑhu	WUNDOWIE LIMESTONE MEMBER: Three bands of white-weathering blue-grey algal limestone, middle band represented by sandstone west of Oodnaminta Hut.
	Ꝑht	WEETOOTLA DOLOMITE MEMBER: Massive brown sandy dolomite, blue-black pisolitic limestone, pink siltstone.
	Ꝑfb	BALCANOONA FORMATION: Brown-weathering pale grey dolomite underlain by massive to thinly bedded blue-grey algal limestones.
	Ꝑfy	YANKANINNA SILTSTONE MEMBER: Thinly bedded blue-grey calcareous siltstones with thin massive siltstone interbeds; irregular well bedded buff-weathering grey limestones at base.
STURTIAN	Ꝑft	TAPLEY HILL FORMATION: Finely laminated blue-grey silty shales; includes thin alternating siltstones, yellow-weathering blue-grey dolomites, and lenticular brown-weathering gritty limestones and cobble lenses in Gladstone Anticline.
		TINDELPINA SHALE MEMBER: Finely laminated dolomitic and carbonaceous shales, thin dolomites, locally gritty and pebbly.
	Ꝑfs	SERLE CONGLOMERATE MEMBER: Boulder conglomerate and conglomeratic sandstone, minor grit and carbonaceous shale. Local unconformity.
YUDNAMUTANA SUB-GROUP	Ꝑyl	LYNDHURST FORMATION: Blue silty shales, minor green silty shales, quartzites, grits. Recurrence of boulders.
	Ꝑyb	BOLLA BOLLANA FORMATION: Massive blue-green greywacke tillite, haematitic near Wooltana; minor siltstone and quartzite.
	Ꝑyf	FITTON FORMATION: Scapolitic and amphibolitic calc-silicate rocks, minor laminated siltstones, quartzites. Recurrence of boulders.
		Coarse pebbly arkose.
		Granite conglomerate or tillite.
		Quartzite conglomerate or tillite near Prospect Hill.
TORRENSIAN – BURRA GROUP	Ꝑb₁	Unnamed: Green greywacke and siltstone, dark grey dolomitic siltstones, minor dolomite and quartzite.
	Ꝑbk	SKILLOGALEE DOLOMITE: UNNAMED MEMBER: Tremolitic marbles, amphibolites, calc-silicate quartzites, cherts, blue-grey dolomites, dolomitic shales, minor quartzites, dolomitic arkoses, conglomeratic and shaly magnesite beds west of Arkaroola H.S. Mud cracks, ripple marks. UNNAMED MEMBER: Dark grey siltstones, minor gritty arkose; dark grey dolomitic siltstones, minor white dolomites and grey-green siltstones, dark blue-green siltstones, minor dolomites and quartzites. Mud cracks.
	Ꝑbt	WORTUPA QUARTZITE: Well bedded feldspathic quartzite, minor arkosic grit and conglomerate. Ripple marks, mud cracks.
WILLOURAN – UPPER CALLANNA BEDS	Ꝑco	OPAMINDA FORMATION: Dark grey siltstones; green dolomitic shale, minor calc-silicate rocks and talcose magnesian dolomites, sandstone interbeds near top. Mud cracks, ripple marks.
	Ꝑcu	BLUE MINE CONGLOMERATE: Arkosic conglomerate, minor feldspathic quartzites and dark grey siltstones. Heavy mineral lamination, mud cracks.
	Ꝑcd	WOODNAMOKA PHYLLITE: Laminated silty phyllite with minor grit and arkose at top, well bedded gritty grey argillaceous sandstone with sedimentary breccias at base.
LOWER CALLANNA BEDS	Ꝑch	HUMANITY SEAT FORMATION: Medium-grained heavy mineral laminated sandstones with purple and blue-grey gritty shale laminations, abundant halite casts; flaggy and massive quartzites: Dark pockmarked siltstones, minor gritty quartzite, heavy mineral laminated sandstones with blue shale laminations, rare halite casts.
	Ꝑcl	WOOLTANA VOLCANICS: Melaphyres, amygdaloidal in part, minor andesite, calc-silicate metasediments, epidote quartzite; red sandstones and shales (east of Paralana Fault).
	Ꝑcy	WYWYANA FORMATION: Actinolitic marbles, amphibolites, minor calc-silicate hornfels and siltstones. Diapiric habit.
	Ꝑcp	PARALANA QUARTZITE: Medium-grained grey orthoquartzites and grey-green argillaceous quartzites, minor actinolitic quartzites, massive amphibolite. Rare heavy mineral lamination, ripple marks. SHANAHAN CONGLOMERATE MEMBER: Conglomerate, cobbles and pebbles of quartzite, granite porphyry and quartz.
PROTEROZOIC – CARPENTARIAN ("OLDER GRANITE SUITE")	p€t	TERRAPINNA GRANITE: Massive pink-weathering rapakivi-like granite, minor adamellite, augen gneiss.
	p€n	MOUNT NEILL GRANITE PORPHYRY: Massive red-weathering granite porphyry, minor adamellite porphyry.
	p€₂	Massive white-weathering dark grey microgranite.
	p€i	Massive white granodiorite.
	p€w	WATTLEOWIE GRANITE: Weakly gneissic white granite and adamellite.
	p€y	YERILA GRANITE: Lineated tabular feldspar granite.
?LOWER PROTEROZOIC – MOUNT PAINTER COMPLEX – RADIUM CREEK METAMORPHICS	p€f	FREELING HEIGHTS QUARTZITE: UNNAMED MEMBER: Medium to coarse grained sericitic feldspathic quartzites, minor argillaceous sandstones, arenaceous schists, grits, quartz and quartzite pebble beds; heavy mineral lamination, cross-bedding, ripple marks.
	p€d	CORUNDUM GREEK SCHIST MEMBER Arenaceous schists with quartzite pebble beds at top, quartzites, muscovite, biotite and corundum schists, migmatites. UNNAMED MEMBER: Medium to coarse grained sericitic feldspathic quartzites, arenaceous schist interbeds near top of sequence, quartz pebble conglomerate at base, minor argillaceous sandstone.
	p€r	BRINDANA SCHIST: Arenaceous schists, muscovite and biotite schists, minor garnet-sericitic schists, epidote quartzite, hornfels, metasedimentary amphibolites, garnet rocks.
	p€p	PEPEGOONA PORPHYRY: Recrystallised porphyritic (?) rhyolite.
	p€a	MOUNT ADAMS QUARTZITE: Medium grained feldspathic quartzites, minor grits, cross-bedding, heavy mineral laminations.
	p€g	YAGDLIN PHYLLITE: Laminated grey-green phyllites, lenticular quartzite.
		Undifferentiated quartzites.
		Banded siliceous epidote amphibolites near Parabarana Hill.
		Granitised metasediments.

GEOLOGICAL BOUNDARIES

FAULTS
- NORMAL
- OVERTHRUST
- UNDIFFERENTIATED

FOLDS
- PLUNGE OF MINOR FOLD

BEDDING
- INCLINED (35)
- VERTICAL
- HORIZONTAL
- OVERTURNED
- TREND OF BEDDING
- TOP OF BED, CROSSBEDDING

CLEAVAGE
- INCLINED (60)
- VERTICAL

TYPE SECTION

FOSSIL LOCALITY
- MACROFOSSIL
- MICROFOSSIL
- PLANT FOSSIL
- FOSSIL WOOD
- ALGAE OCCURRENCE

GLACIAL STRIAE

PLATY FLOW

JOINT PATTERN

ROAD

TRACK

VERMIN PROOF FENCE

BOUNDARY FENCE

TRIANGULATION STATION

IDENTIFIED POINT

EPHEMERAL STREAM

WATER FEATURES
- BORE
- WATER HOLE (W.H.)
- WELL (W)
- TANK (T)
- SPRING (S)
- EARTH TANK OR DAM

MINE

MINERAL OCCURRENCE

COPPER	Cu	GOLD	Au
LEAD	Pb	BISMUTH	Bi
ZINC	Zn	URANIUM	U
SILVER	Ag	ASBESTOS	Asb
COBALT	Co	PHOSPHATE ROCK	Ph

Geology by R. P. Coats, B.Sc., R. C. Horwitz, D.Sc., A. R. Crawford, M.Sc., B. Campana, D.Sc., D. Thatcher, B.Sc.

Supervising Geologist Regional Surveys Division, B. P. Thomson, M.Sc.

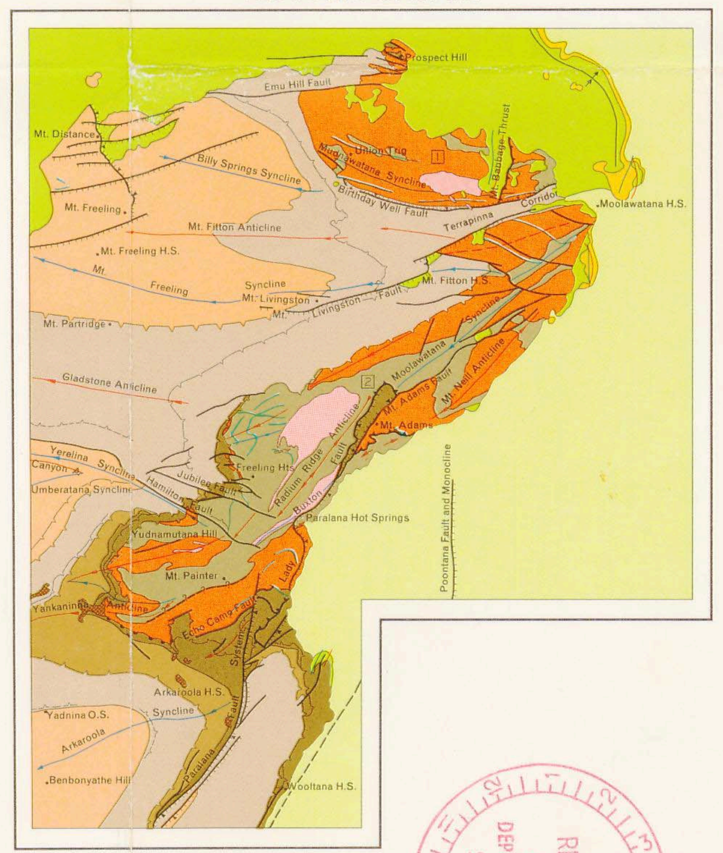
Map preparation by Cartographic Section, Department of Mines, S.A.

Compiled under the direction of T. A. Barnes, Government Geologist, Director of Mines

Issued under the authority of the Honourable R. C. DeGaris, Minister of Mines

Published 1969

TECTONIC SKETCH



Quaternary

Tertiary

Jurassic-Cretaceous

Ordovician
- Younger Granite Suite

Adelaide System
- Marinoan (Wilpena Group)
- Sturtian-Marinoan (Umberatana Group)
- Torrensian-Sturtian (Burra Group)
- Willouran (Callanna Beds)

Carpentarian
- Older Granite Suite

?Lower Proterozic
- Radium Creek Metamorphics

Amphibolites

Diapirs

Anticline

Syncline

Monocline

Faults
- Normal
- Upthrust
- Overthrust
- Undifferentiated

Decollement

Unconformity

Stratigraphic Discordance

Mount Babbage Block 1

Mount Painter Mobile Block 2

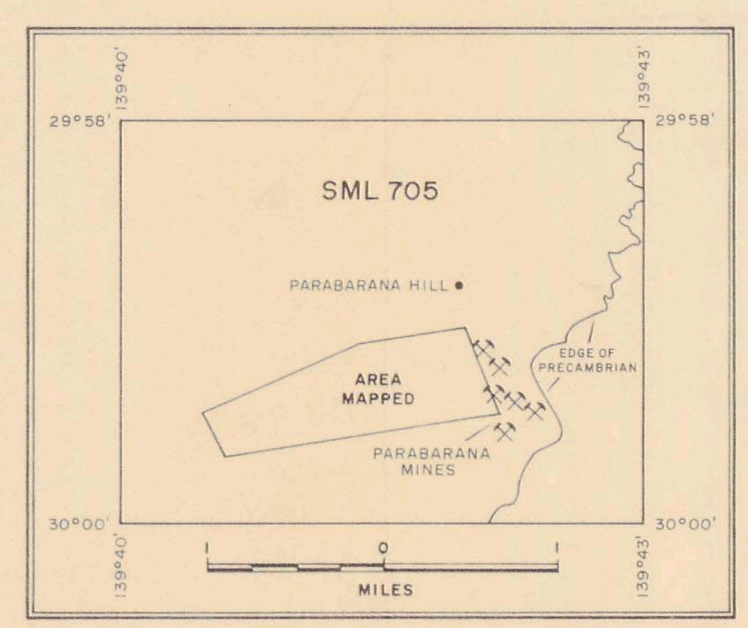
FIGURE 1

MOUNT PAINTER PROVINCE

2633-1

GEOLOGY BY R.E. READ
MAP DRAWN BY R. GERMANIS
COMPILED UNDER THE DIRECTION OF
R.B. WILSON
CHIEF GEOLOGIST
NORTH FLINDERS MINES LTD.
JULY, 1972

LOCATION



North Flinders Mines Ltd.

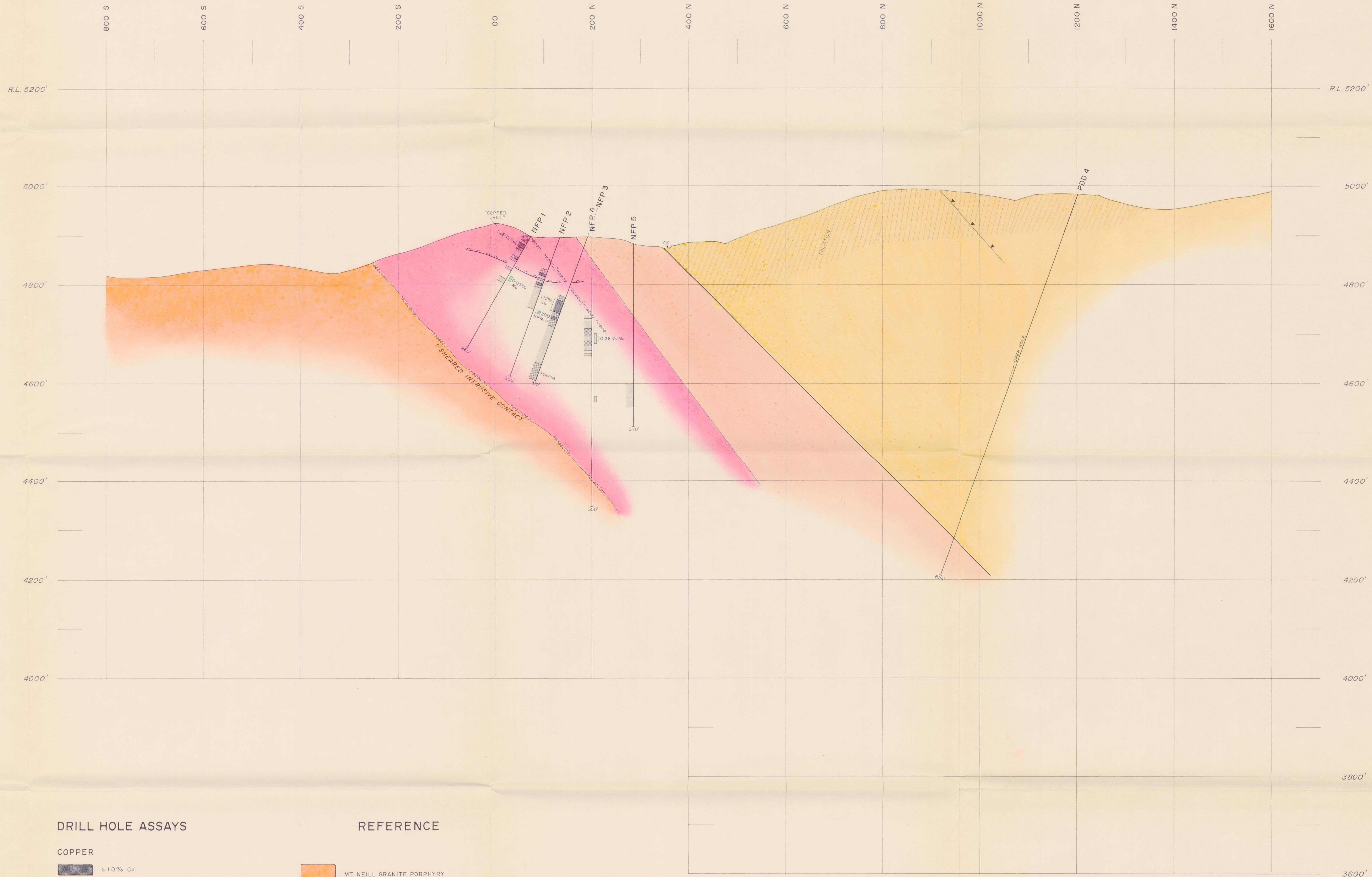
PARABARANA
COPPER PROSPECT
SML 705

REGIONAL GEOLOGY

2633-2

DRN:- R.G.	DATE:- SEP. '72	SCALE:- 1" rep. approx. 400'

DWG 705-9



DRILL HOLE ASSAYS

COPPER

- ⩾ 1·0% Cu
- ⩾ 0·5% ; < 1·0% Cu
- ⩾ 0·1% ; < 0·5% Cu

MOLYBDENUM

- ⩾ 100 P.P.M. Mo

URANIUM

- ⩾ 100 P.P.M. U

NFP 4 — ROTARY PERCUSSION DRILL HOLE

PDD 3 — DIAMOND DRILL HOLE

REFERENCE

- MT. NEILL GRANITE PORPHYRY
- MICROADAMELLITE VARIOUSLY ALTERED AND METASOMATIZED. CHALCOPYRITE IN MINERALIZED BRECCIA ZONE
- GRANITIC GNEISS, MYLONITE GNEISS
- SCHISTOSE MICACEOUS AMPHIBOLITE
- CHLORITIZED PORPHYRITIC MICROGRANITE
- BASE OF OXIDATION
- FAULT

NOTE

SOME DRILL HOLES ARE PROJECTED A SHORT DISTANCE NORMAL TO THE SECTION : (DUE TO NEW SURVEY GRID)

SCALE

100 0 100 200 300 400 500

FEET

FIGURE 3

North Flinders Mines N. L.

PARABARANA COPPER PROSPECT SML 705

CROSS SECTION OO E-W

SHOWING

DRILL-HOLES

AND

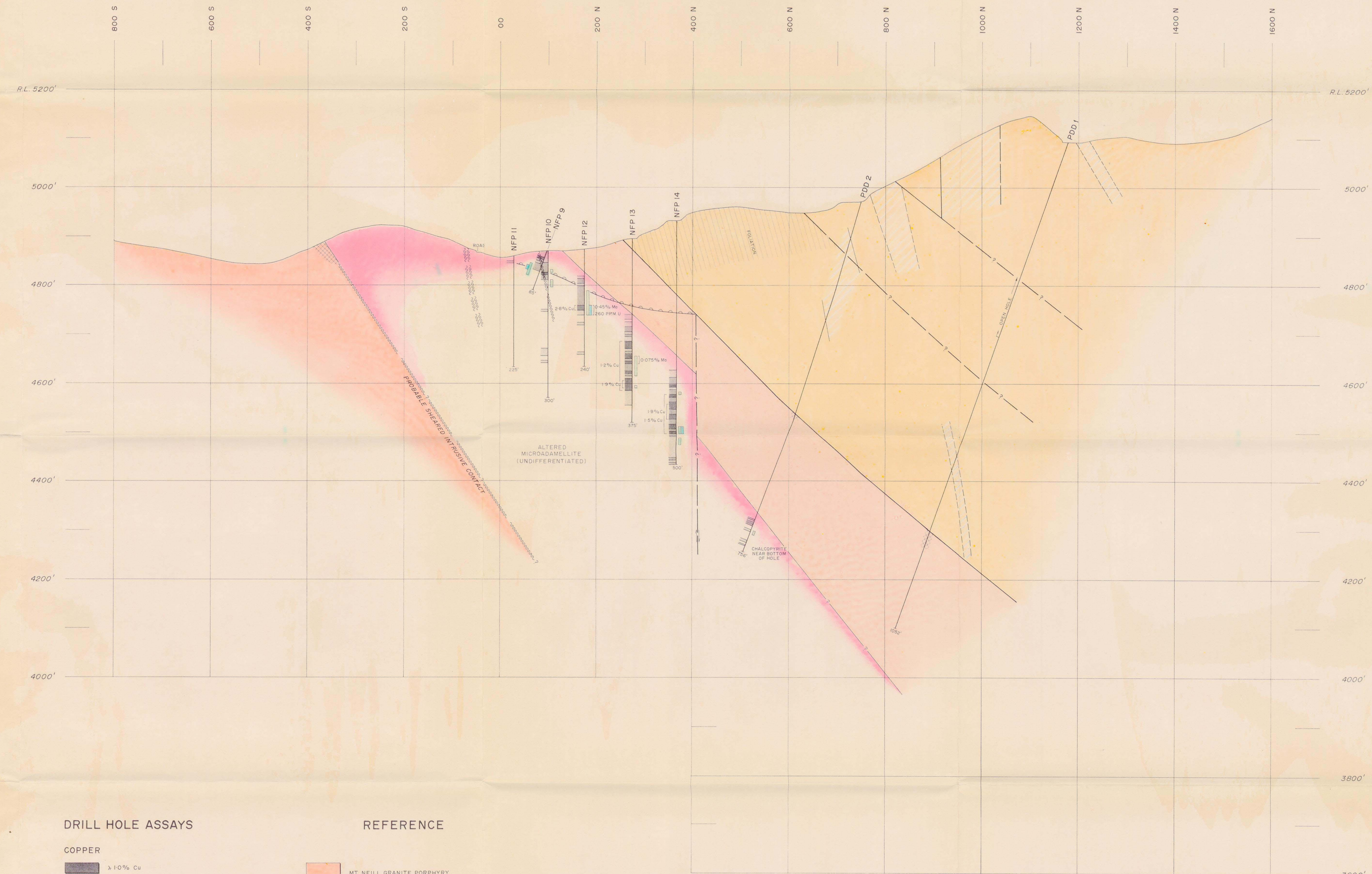
INTERPRETED GEOLOGY

BY I.B. FREYTAG

2633-3

DRN:- R.G.	DATE:- JULY '72	SCALE:- 1" rep. 100'

DWG 705-6



DRILL HOLE ASSAYS

COPPER

- ≥1·0% Cu
- ≥0·5% ; <1·0% Cu
- ≥0·1% ; <0·5% Cu

MOLYBDENUM

- ≥100 P.P.M. Mo

URANIUM

- ≥100 P.P.M. U

NFP 4 ROTARY PERCUSSION DRILL HOLE

PDD 3 DIAMOND DRILL HOLE

REFERENCE

- MT. NEILL GRANITE PORPHYRY
- MICROADAMELLITE VARIOUSLY ALTERED AND METASOMATIZED. CHALCOPYRITE IN MINERALIZED BRECCIA ZONE
- GRANITIC GNEISS, MYLONITE GNEISS
- SCHISTOSE MICACEOUS AMPHIBOLITE
- CHLORITIZED PORPHYRITIC MICROGRANITE
- BASE OF OXIDATION
- FAULT

NOTE

SOME DRILL HOLES ARE PROJECTED A SHORT DISTANCE NORMAL TO THE SECTION : (DUE TO NEW SURVEY GRID)

SCALE

100 0 100 200 300 400 500

FEET

FIGURE 4

North Flinders Mines N.L.

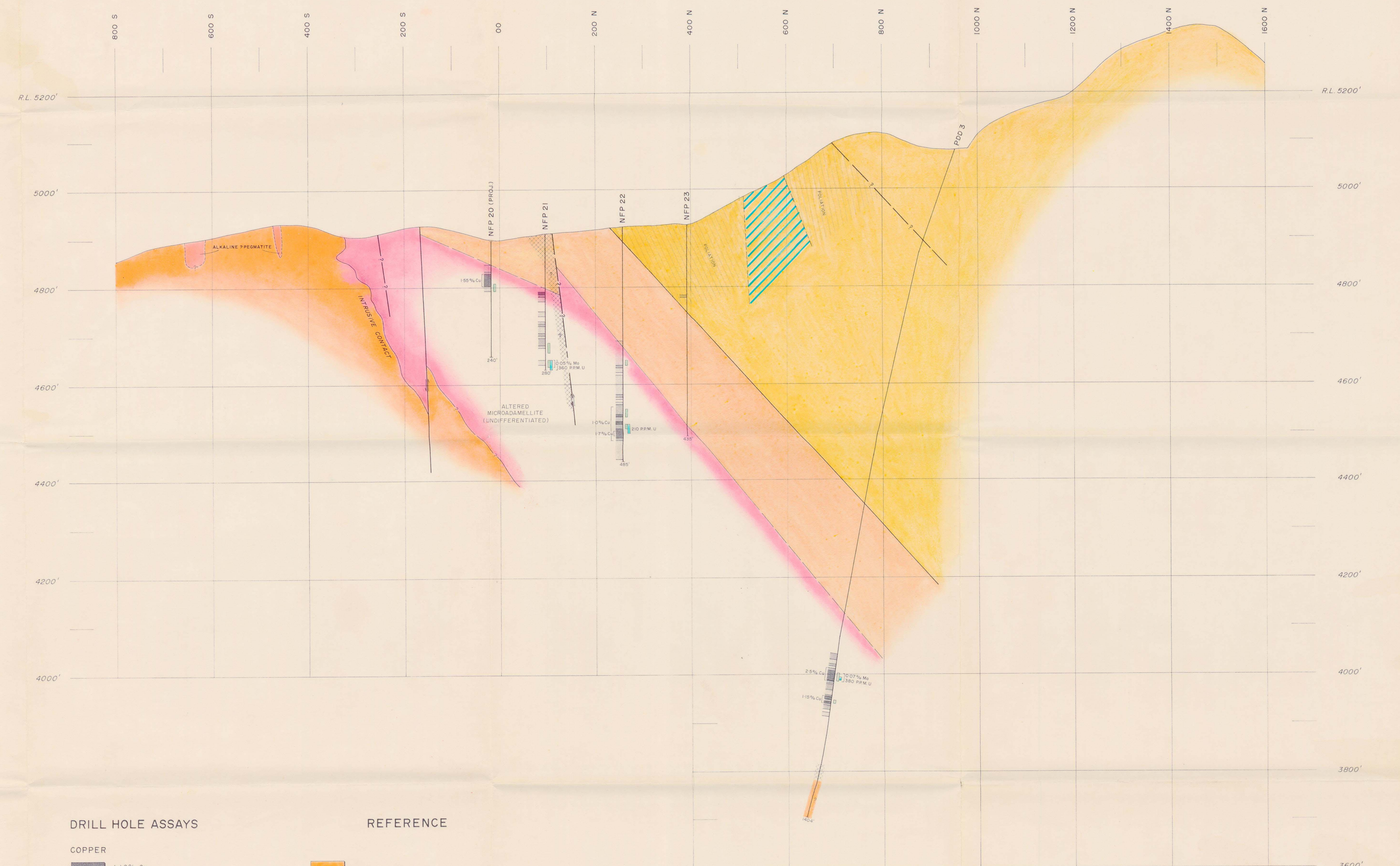
PARABARANA
COPPER PROSPECT
SML 705

CROSS SECTION 400 W
SHOWING
DRILL-HOLES
AND
INTERPRETED GEOLOGY
BY I.B. FREYTAG

2633-4

DRN:- R.G.	DATE:- JULY '72	SCALE:- 1" rep. 100'

DWG 705-3



DRILL HOLE ASSAYS

COPPER

- ⩾ 1·0% Cu
- ⩾ 0·5% ; < 1·0% Cu
- ⩾ 0·1% ; < 0·5% Cu

MOLYBDENUM

- ⩾ 100 P.P.M. Mo

URANIUM

- ⩾ 100 P.P.M. U

NFP 4 ROTARY PERCUSSION DRILL HOLE

PDD 3 DIAMOND DRILL HOLE

REFERENCE

- MT. NEILL GRANITE PORPHYRY
- MICROADAMELLITE VARIOUSLY ALTERED AND METASOMATIZED. CHALCOPYRITE IN MINERALIZED BRECCIA ZONE
- GRANITIC GNEISS, MYLONITE GNEISS
- SCHISTOSE MICACEOUS AMPHIBOLITE
- CHLORITIZED PORPHYRITIC MICROGRANITE
- BASE OF OXIDATION
- FAULT

NOTE

SOME DRILL HOLES ARE PROJECTED A SHORT DISTANCE NORMAL TO THE SECTION : (DUE TO NEW SURVEY GRID)

SCALE

100 0 100 200 300 400 500

FEET

FIGURE 5

North Flinders Mines N.L.

PARABARANA
COPPER PROSPECT
SML 705

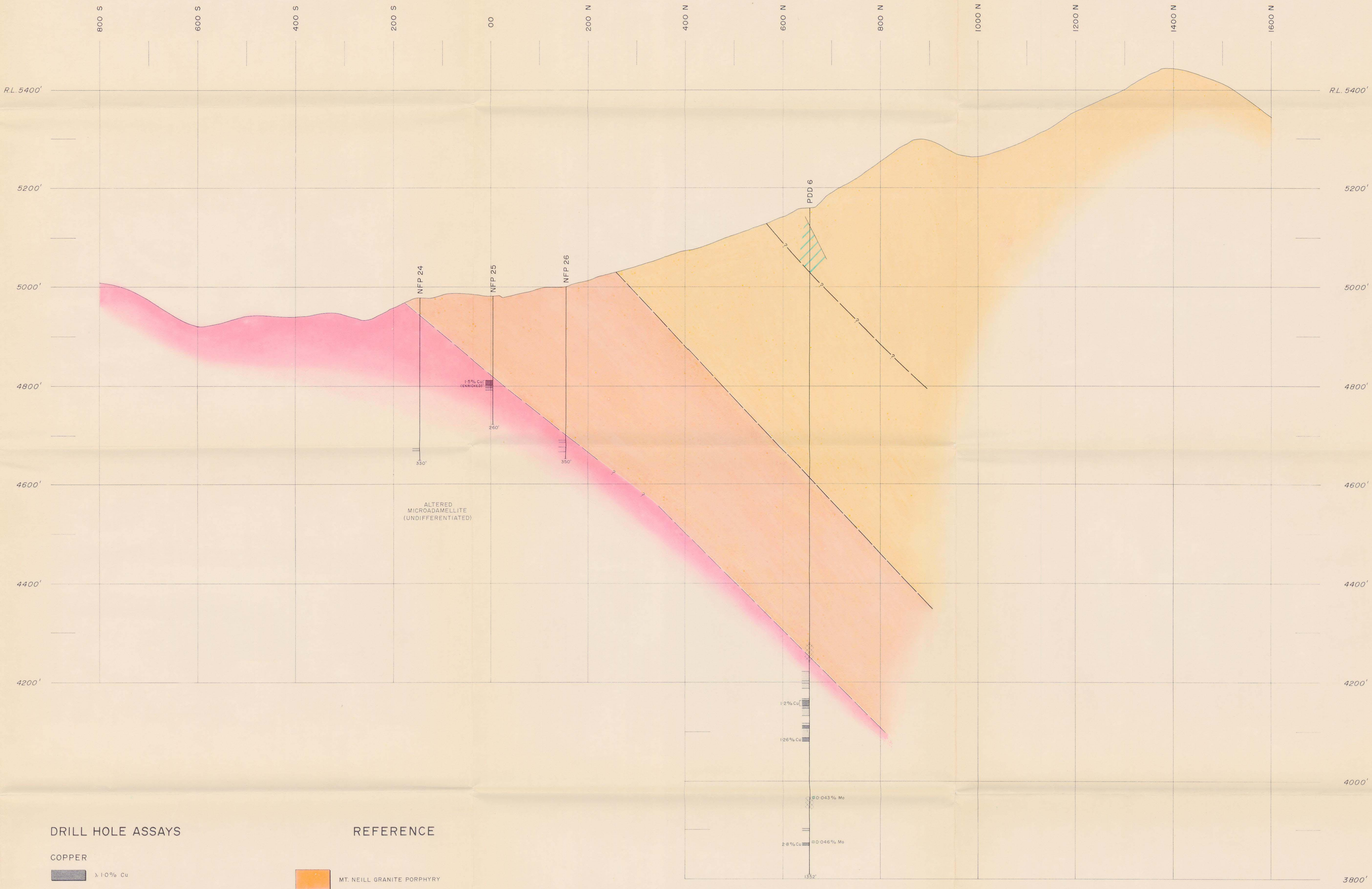
CROSS SECTION 800 W

SHOWING
DRILL-HOLES
AND
INTERPRETED GEOLOGY
BY I.B. FREYTAG

2633-5

DRN:- R.G.	DATE:- JULY '72	SCALE:- 1" rep. 100'

DWG 705-4



DRILL HOLE ASSAYS

COPPER

- ≥ 1·0% Cu
- ≥ 0·5% ; < 1·0% Cu
- ≥ 0·1% ; < 0·5% Cu

MOLYBDENUM

- ≥ 100 P.P.M. Mo

URANIUM

- ≥ 100 P.P.M. U

NFP 4 ROTARY PERCUSSION DRILL HOLE

PDD 3 DIAMOND DRILL HOLE

REFERENCE

- MT. NEILL GRANITE PORPHYRY
- MICROADAMELLITE VARIOUSLY ALTERED AND METASOMATIZED. CHALCOPYRITE IN MINERALIZED BRECCIA ZONE
- GRANITIC GNEISS, MYLONITE GNEISS
- SCHISTOSE MICACEOUS AMPHIBOLITE
- CHLORITIZED PORPHYRITIC MICROGRANITE
- BASE OF OXIDATION
- FAULT

NOTE

SOME DRILL HOLES ARE PROJECTED A SHORT DISTANCE NORMAL TO THE SECTION : (DUE TO NEW SURVEY GRID)

SCALE

100 0 100 200 300 400 500

FEET

FIGURE 6

North Flinders Mines N. L.

PARABARANA
COPPER PROSPECT
SML 705

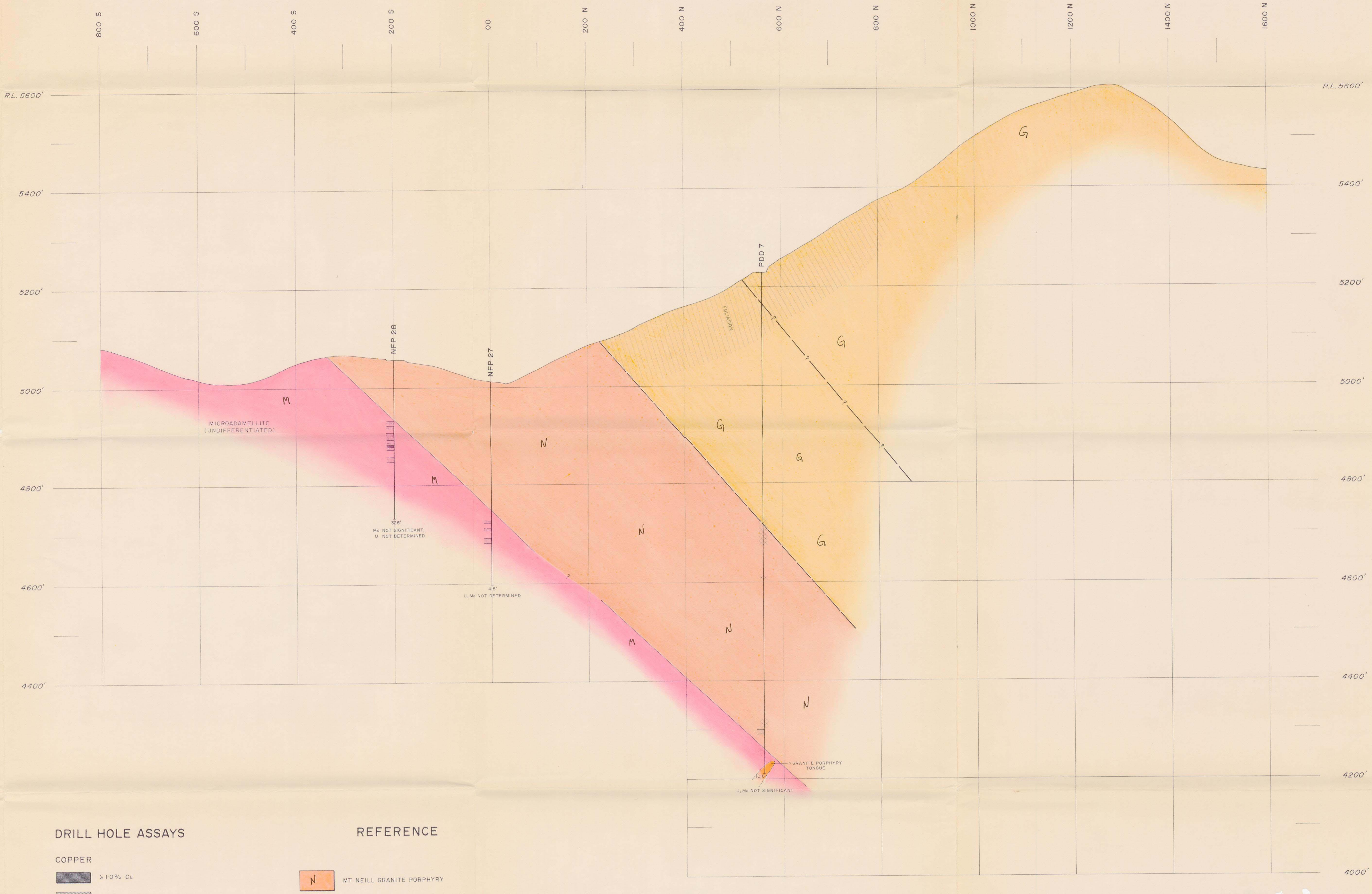
CROSS SECTION 1200 W

SHOWING
DRILL-HOLES
AND
INTERPRETED GEOLOGY
BY I.B. FREYTAG

2633-6

DRN:- R.G.	DATE:- JULY '72	SCALE:- 1" rep. 100'

DWG 705-5



DRILL HOLE ASSAYS

COPPER

- ≥ 1·0% Cu
- ≥ 0·5% ; < 1·0% Cu
- ≥ 0·1% ; < 0·5% Cu

MOLYBDENUM

- ≥ 100 P.P.M. Mo

URANIUM

- ≥ 100 P.P.M. U

NFP 4 — ROTARY PERCUSSION DRILL HOLE

PDD 3 — DIAMOND DRILL HOLE

REFERENCE

- N — MT. NEILL GRANITE PORPHYRY
- M — MICROADAMELLITE VARIOUSLY ALTERED AND METASOMATIZED. CHALCOPYRITE IN MINERALIZED BRECCIA ZONE
- G — GRANITIC GNEISS, MYLONITE GNEISS
- SCHISTOSE MICACEOUS AMPHIBOLITE
- C — CHLORITIZED PORPHYRITIC MICROGRANITE
- BASE OF OXIDATION
- FAULT

NOTE

SOME DRILL HOLES ARE PROJECTED A SHORT DISTANCE NORMAL TO THE SECTION : (DUE TO NEW SURVEY GRID)

SCALE

100 0 100 200 300 400 500

FEET

FIGURE 7

North Flinders Mines N. L.

PARABARANA COPPER PROSPECT SML 705

CROSS SECTION 1600W

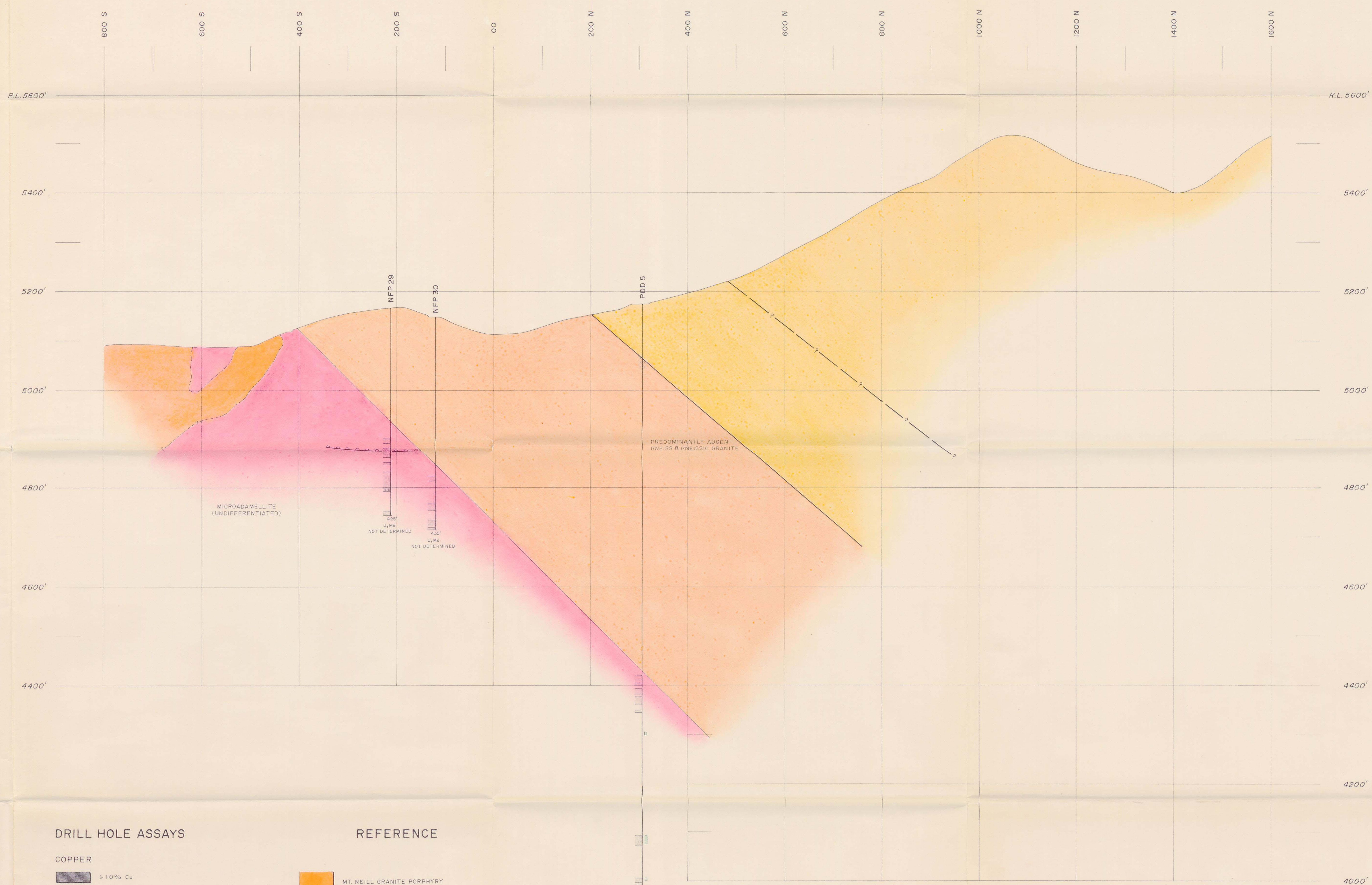
SHOWING **DRILL-HOLES** AND INTERPRETED GEOLOGY

BY I.B. FREYTAG

2633-7

DRN:- R.G.	DATE:- JULY '72	SCALE:- 1" rep. 100'

DWG 705-7



DRILL HOLE ASSAYS

COPPER

- ≥ 1·0% Cu
- ≥ 0·5% ; < 1·0% Cu
- ≥ 0·1% ; < 0·5% Cu

MOLYBDENUM

- ≥ 100 P.P.M. Mo

URANIUM

- ≥ 100 P.P.M. U

NFP 4 ROTARY PERCUSSION DRILL HOLE

PDD 3 DIAMOND DRILL HOLE

REFERENCE

- MT. NEILL GRANITE PORPHYRY
- MICROADAMELLITE VARIOUSLY ALTERED AND METASOMATIZED. CHALCOPYRITE IN MINERALIZED BRECCIA ZONE
- GRANITIC GNEISS, MYLONITE GNEISS
- SCHISTOSE MICACEOUS AMPHIBOLITE
- CHLORITIZED PORPHYRITIC MICROGRANITE
- BASE OF OXIDATION
- FAULT

NOTE

SOME DRILL HOLES ARE PROJECTED A SHORT DISTANCE NORMAL TO THE SECTION : (DUE TO NEW SURVEY GRID)

SCALE

100 0 100 200 300 400 500

FEET

FIGURE 8

NFM North Flinders Mines N. L.

PARABARANA COPPER PROSPECT SML 705

CROSS SECTION 2000W

SHOWING

DRILL-HOLES

AND

INTERPRETED GEOLOGY

BY I.B. FREYTAG

2633-8

DRN:- R.G. | DATE:- JULY '72 | SCALE:- 1" rep. 100'

DWG 705-8

2800 W
2600 W
2400 W
2200 W
2000 W
1800 W
1600 W
1400 W
1200 W
1600 N
1400 N
1200 N
1000 N
800 N
600 N
400 N
200 N
00 B/L
200 S
400 S
600 S
800 S
1000 S
1200 S
1400 S
1600 S
1800 S
2000 S
PDD 6
4250 100' INC. 3' of 2·8%
PDD 7
4270 COPPER ZONE NOT REACHED
PROMINENT PHOTOLINEAR
SCREE SLOPE
4200
4300
PDD 5
4395 (i) 55'
(ii) 60'+
Cu<1%
4400
p€fg
4500
4600
4700
4800
4900
5000
p€t
POSSIBLE ZONE OF DISLOCATION
NFP 26
40'+
NFP 27
4780 30' Cu<1%
4820 20' INC. 3' of 1·5% (ENRICHED)
NFP 25
VERY WEAK COPPER MINERALIZATION
NFP 24
4945 VERY WEAK COPPER MINERALIZATION
NFP 29
4895 80' Cu<1%
4915 65' INC. 3' of 1·4% Cu (SECONDARY)
SURFACE TRACE TOP OF MICROADAMELLITE
p€m
p€n

REFERENCE

QUATERNARY

	AREA OF NO OUTCROP, COVERED BY SCREE AND SOIL
Qac	ALLUVIAL BOULDER TRAIN

CRETACEOUS

Ksh	SHALE, SILTSTONE - LIGHT GREY, CALCAREOUS, PYRITIC; SECONDARY GYPSUM (BULLDOG SHALE)
Kss	SANDSTONES (UNDIFFERENTIATED) - FINE TO COARSE, KAOLINITIC OR CALCAREOUS (PARABARANA SANDSTONE)
Km	MUDSTONE (BASAL UNIT) - LIGHT GREY, UNBEDDED, PYRITIC, ? CARBONACEOUS

PRECAMBRIAN

	ALKALINE ? PEGMATITE - PINKISH, K-FELDSPAR RICH, FRACTURED ROCK WITH CALCITE FILLINGS. ? LATE PHASE PODS, LENSES OF MT. NEILL PORPHYRY
p€n	MICROCLINE PORPHYRY, PORPHYRITIC MICROGRANITE - BOLD OUTCROP, LIGHT BROWN WEATHERED, GENERALLY CHLORITIZED, SERICITIZED. LARGE FRESH MICROCLINE PHENOCRYSTS, MINOR QUARTZ. (MT. NEILL GRANITE PORPHYRY)
	LOCALLY EPIDOTIZED PORPHYRY
p€m	MICROADAMELLITE - PALE PINKISH, BANDED, FINE GRAINED, MORE OR LESS HYDROTHERMALLY ALTERED ROCK. EXTENSIVELY FRACTURED, WITH COPPER MINERALIZATION
	? RETROGRADED MICROADAMELLITE - FINE GRAINED QUARTZ MUSCOVITE CHLORITE SCHIST. DISSEMINATED SULPHIDE
	ALTERED MICROADAMELLITE - CHLORITE DOMINANT, MALACHITE COMMON
	ALTERED MICROADAMELLITE - EPIDOTE CALCITE DOMINANT. HORNFELSED WITH AMPHIBOLE, GARNET, MAGNETITE NEAR CONTACT WITH MT. NEILL PORPHYRY
p€tg	MYLONITIZED GRANITE, FLASER GRANITE GNEISS, GNEISSIC GRANITE, MINOR AUGEN GNEISS - REDDISH-BROWN WEATHERING, BOLD OUTCROP. (CATACLASTIC-METAMORPHOSED ? TERRAPINNA GRANITE)
	COARSE MUSCOVITE - CHLORITE - BIOTITE SCHIST (RETROGRADED GNEISS)
	SCHISTOSE MICACEOUS AMPHIBOLITE
	INTENSELY CHLORITIZED GNEISS
p€t	CHLORITIZED PORPHYRITIC MICROGRANITE - DARK-WEATHERING, FRACTURED, WITH CHLORITIZED GROUNDMASS, CORRODED K-FELDSPAR PHENOCRYSTS. (? ALTERED TERRAPINNA GRANITE)
	INTENSELY CHLORITIZED MICROGRANITE GRADING TO CHLORITE SCHIST

40	STRIKE AND DIP OF METAMORPHIC
70	STRIKE AND DIP OF CLEAVAGE, FRACTURE CLEAVAGE
	STRIKE OF VERTICAL CLEAVAGE
55	STRIKE AND DIP OF BEDDING
75	STRIKE AND DIP OF OVERTURNED BEDDING
55	STRIKE AND DIP OF IGNEOUS BANDING
60	STRIKE AND DIP OF PROMINENT JOINTING
	STRIKE OF VERTICAL JOINTING
F	ESTABLISHED FAULT (TRACE OF)
	TRACE OF MAJOR THRUST FAULT (POSITION APPROXIMATE)
?	TRACE OF INFERRED FAULT
	LINE OF SHEARING USUALLY WITH CHLORITIC DISLOCATION SCHISTOSITY
	INTENSELY BRECCIATED OR CRUSHED ROCK
Q	QUARTZ VEIN
C	CARBONATE VEIN (SMALL)
	CALCITE-SIDERITE-QTZ. VEIN (LARGE) OFTEN WITH PYRITE, CHALCOPYRITE
	CLAIM PEG
NFP 4	ROTARY PERCUSSION DRILL-HOLE (VERTICAL)
NFP 3 70°	ROTARY PERCUSSION DRILL-HOLE (INCLINED)
PDD 7	DIAMOND DRILL-HOLE (VERTICAL)
PDD 3 70°	DIAMOND DRILL-HOLE (INCLINED)
	OLD WORKINGS (PITS, SHAFTS)
	COSTEAN
X MAL	MALACHITE

GEOLOGY BY I. FREYTAG

MAP DRAWN BY R. GERMANIS

COMPILED UNDER THE DIRECTION OF
R.B. WILSON
CHIEF GEOLOGIST
NORTH FLINDERS MINES LTD.

MAY, 1972

SCALE 100 0 100 200 300 400 500 FEET

FIGURE 9

North Flinders Mines N. L.

PARABARANA COPPER PROSPECT
SML 705

STRUCTURAL MAP WITH COPPER INTERSECTIONS

2633-9

DRN:- R.G. | DATE:- JULY '72 | SCALE:- 1" rep. 100'

DWG 705-2