METALLIC MINERALS.

DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
MINERAL RESOURCES DIVISION

NORTH FLINDERS MINES LTD.
PARABARANA PROSPECT
APPRAISAL AND REPORT

CALLABONNA

Moolawatana

by

J. GORDON-SMITH
SENIOR GEOLOGIST
METALLIC MINERALS SECTION

Rept.Bk.No. 767

R3 767

15th March, 1972.

PARABARANA PROSPECT

A Department of Mines appraisal and report has lately been completed (DM.1236/71) and is summarised in the following terms.

"This prospect, which is being tested by North Flinders Mines Ltd. lies in the northeast corner of the Mount Painter Block, 100 miles east of Lyndhurst Siding in the North Flinders Ranges. It is six miles southwest of Moolawatana Homestead an the southern slopes of Parabarana Hill.

Disseminated copper mineralisation, with traces of molybdenum, occurs in altered granitic rocks to form a steeply dipping tabular deposit. Exploratory geological and geophysical work, followed by percussion and diamond drilling, carried out by North Flinders Mines Ltd. suggests an inferred tonnage of six million long tons at a grade of 0.9% copper, but the limits of the body have not been reached. The deepest intersection to date has been made by a diamond drill hole (DD3) which cuts 117ft of mineralisation averaging 1.1% copper, this includes 21ft averaging 3.0% copper.

Geological investigations show two possible mechanisms of ore formation, "porphyry copper type" or "meta-syngenetic type". There are important genetic differences between these two types but these differences do not affect the immediate exploration programme.

North Flinders Mines Ltd. encountered serious technical difficulties in their diamond drilling, the swelling property of certain bands of altered clay minerals caused particular trouble, so that out of seven holes three were abandoned without reaching their planned depths. The company is offering the Government a 10% equity interest in the property in return for drilling by the Mines Department, in further exploration work.

Economic considerations suggest that for profitable underground mining under normal commercial conditions at a rate of between 300,000 and 500,000 tons per year, a mining grade of at least 2½% copper would be necessary, subject to adjustments for alterations in the metal market and dependent also upon the actual size and other physical parameters ofthe ore body.

Thus the possibility of economic mining of copper at Parabarana under present economic conditions depends fundamentally upon the extent and continuity of the higher grade ore such as the intersection of 21ft averaging 3.0% copper obtained in DD3.

Assuming continuity, the inferred ore reserves at a grade of 3% copper defined by the present data would be of the order of one million, which would be insufficient to warrent the opening of a new underground mine in this remote locality. However, the lower limit of the mineralised zone has not been reached by drilling, further exploration must be directed towards establishing reserves of this higher grade ore. Although the existing shallow drilling does not show the presence of the higher grade ore zone in the upper levels, the possibilities, under either hypothesis of ore-genesis, of the development of a viable body of ore at depth are considered sufficiently good to justify further drilling. A programme has accordingly been proposed of three diamond drill holes (total depth 3350ft) designed to investigate the continuation of rich ore along the strike and up the dip from the intersection in the hole DD3, followed by two further holes (total depth 2650ft) to trace the richest mineralisation in the direction of its plunge. It is estimate that the cost of the first three holes in this programme will be $42,000".

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. ~~72/39~~ 767
G.S. No. 4811
DM. No. 1236/71

NORTH FLINDERS MINES LTD.
PARABARANA PROSPECT
APPRAISAL AND REPORT

CALLABONNA

Moolawatana

by

J. GORDON-SMITH
SENIOR GEOLOGIST
METALLIC MINERALS SECTION

CONTENTS PAGE

APPENDICES

PLANS AND SECTIONS

No.	Title	Scale
S9680	Parabarana Prospect Locality Map.	
S9681	Parabarana Prospect Generalised Geological Section.	Diagrammatic
72-71	Cross sections 00W	1/1 200
72	" " 400W	"
73	" " 800W	"
74	" " 1 200W	"
72-75	Longitudinal Sections on 200 and 400N.	"
72-76	Parabarana Prospect Structural Contours of Ore Zone.	"

Cross Section 00W)	Ore Reserve sections from	1/1 200
" " 400W)	North Flinders Mines	"
" " 800W)	plans.	"
" " 1200W)		"
72-117	Surface Plan, Parabarana.	1/4 800

15th March, 1972

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No. ~~72/39~~ 767
G.S. No. 4811
DM. No. 1236/71

NORTH FLINDERS MINES LTD.
PARABARANA PROSPECT
APPRAISAL AND REPORT

CALLABONNA

Moolawatana

ABSTRACT

Parabarana Prospect lies in the north-east corner of Mount Painter Block in the North Flinders Ranges, 100 miles east of Lyndhurst siding.

Disseminated copper mineralization with traces of molybdenum occurs in altered acid rocks to form a tabular deposit, dipping at approximately 50°, parallel to the foliation of country rocks of rapakivi granite and meta-sediments, and to a shear structure. Mineralization may be of porphyry copper type or may be meta-syngenetic, within the Radium Creek Metamorphics.

Mining dates from 1899 with limited production from small quartz-chalcopyrite veins. Recent mapping, I.P. and drilling by North Flinders Mines Ltd. infers 6 000 000 tons of ore @ 0.9% Cu. The deepest and best diamond drill hole (DD3), shows 117' @ 1.1% Cu which includes 21' at 3.0% Cu.

The Company seeks assistance in further proving work and offers Government a 10% equity in return for some 8 000' of drilling.

Minimum payable grade for underground mining at Parabarana is estimated to be at least 2½% Cu. Assuming minimum annual production of 500 000 tons and a life of 10 years it is necessary to determine if 5 000 000 tons at this grade could exist.

The possibility of establishing reserves of this order is sufficiently good to justify further investigation. A drilling programme, in two stages, is recommended. Stage 1, comprising three holes to depths of 950ft., 1100 ft. and 1300 ft. is designed to show the extent of high grade mineralization, near that intersected in North Flinders Mines DD3. The cost of Stage 1 is estimated at $42 000. Depending on results, stage 2 would consist of three holes totalling 4 650 feet and estimated to cost $75 000. Such a programme could indicate 5 000 000 tons and earn the Government equity.

INTRODUCTION

The Department of Mines was approached towards the end of 1971 by North Flinders Mines Ltd., who offered the Government a 10% equity interest in their Parabarana Copper Prospect in return for departmental assistance in upgrading the prospect sufficiently to attract a major company for a joint venture.

Shallow exploration by percussion drilling had intersected interesting copper values. In subsequent deeper diamond drilling, only two holes were completed successfully but one of these had made a very promising intersection. Two other holes failed to intersect mineralization at the target depths. Three other diamond drillholes had met severe technical difficulties and were abandoned before reaching their planned depths.

The Company had approached various mining organisations with offers of joint-venture participation but, under the present depressed market conditions, acceptable terms had not been agreed. Rather than allow control of the venture to pass out of their own hands, and out of the State, the Company now sought to obtain the interest and assistance of Government.

This report presents a technical appraisal of the prospect and of its potential. It is not intended as a detailed geological report of the prospect, but describes geological features which are relevent to the appraisal. Estimates for costs of mining have been prepared by the Mineral Development Engineer, and of drilling by the Chief Drilling and Mechanical Engineer. These are appended. North Flinders Mines' data and ideas have been freely drawn upon and incorporated in this report. Appropriate acknowledgements and thanks are due to their management and staff, but the responsibility for interpretations and opinions expressed herein lies with the writer.

History and Previous Reports

Early workings at Parabarana are described by Brown (1908) and by Blissett (1971).

The workings date from about 1899 and include a number of shallow shafts as well as one incline, Lee Shaft, sunk 210 feet on a dip of 25°. Seven veins are recorded, together with some disseminated mineralization. The veinstone is described as "siliceous ironstone, gossan and a little quartz, with copper glance (chalcocite), ferruginous copper ore, tile ore (cuprite) and copper carbonate".

After a diligent beginning and the production of several parcels of dressed ore, operations languished, but sporadic prospecting and tributing continued from time to time.

Parabarana formed part of Special Mining Lease 112 granted to Anaconda Australia Incorporated in 1966, but relinquished after six months and presently acquired, as part of Special Mining Lease 297, by North Flinders Mines Ltd. In 1971 several adjacent areas were consolidated into a new single lease and Parabarana became part of Special Mining Lease 558, held by North Flinders Mines Ltd.

The relevent Technical Reports, submitted as conditions of their tenure by Anaconda Australia and North Flinders Mines, are to be found in Mines Department records, Envelope 663, Anaconda Australia (Open File); and Envelopes 1221 and 1639, North Flinders Mines (Confidential).

Logistics

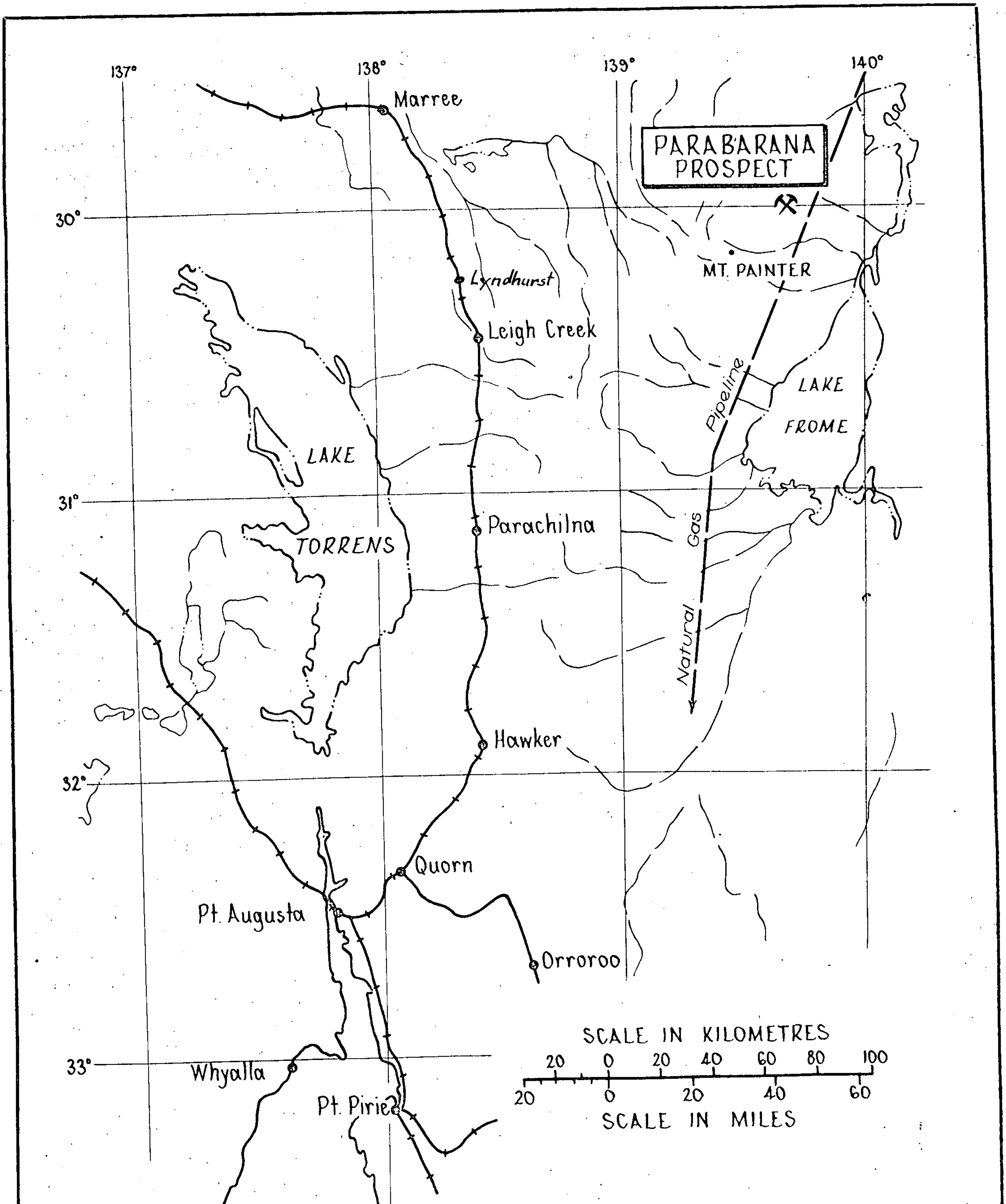
Parabarana Prospect lies in the North Flinders Ranges, near the north-eastern extremity of the Mount Painter Block and six miles south-west of Moolawatana Homestead. Access from Lyndhurst standard gauge rail siding is over some hundred miles of fair graded road following the first part of the Strzelecki Track, thence by way of Mt. Freeling, Mt. Fitton and Moolawatana Homesteads. Alternatively the "mail road" from Frome Downs and Wertaloona may be followed. There is a good airstripat Moolawatana. The nearest town is Leigh Creek at a distance of 115 miles by road.

The natural gas pipeline passes less than ten miles to the east of Parabarana; water is available from the Great Artesian Basin on the eastern boundary of the area, or from some of the exploratory drillholes which have given yields of up to 7 000 gals/hour.

Topography is juvenile with slopes up to 35° and a drainage pattern of steep seasonal torrents. Parabarana Hill, a little to the north of the prospect, reaches a height of 1 300 feet. The adjacent Lake Frome Plains to the east lie at an altitude of under 250 feet.

Geological Setting

The geology of the North Flinders Ranges has been described in detail by Coats (1971). The Mount Painter Block, in which the Parabarana Prospect lies, forms a part of the larger Mount Painter Complex.



METALLIC MINERALS SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: As shown
Compiled:	PARABARANA PROSPECT LOCALITY MAP	Date: 21 Feb 1972
Drn. R.H. Ckd.		Drg. No. S9680 Cc

1M–2.70 A1810

This comprises a thick sequence of metasediments, predominently arenaceous rocks, of unknown age, intruded by Carpentarian alkali granites. These metasediments are called the Radium Creek Metamorphics and their stratigraphy is shown in the following table:-

Radium Creek Metamorphics

pЄf		Freeling Heights Quartzite (top eroded)
		Unnamed upper member
	pЄd	Corundum Creek Schist member
		Unnamed lower member.
pЄr		Brindana Schist
pЄp		Pepegoona Porphyry
pЄa		Mount Adams Quartzite
pЄg		Yagdlin Phyllite (base not exposed)

The Mount Painter Complex was strongly folded prior to the deposition of the Adelaide System. Adelaidean sediments are thick and include a number of carbonate units and a phase of basic to intermediate volcanism. The Sturtian glaciation followed and then more sediments were laid down. The crystalline basement rocks and overlying Adelaidean sediments were strongly folded by the major Lower Palaeozoic Orogeny. Lower Ordovician granodiorites and pegmatites ("The Younger Granite Suite") were extensively intruded into the Mount Painter Complex and parts of the Adelaide System. There followed a long period of erosion. Finally parts of the region were mantled by Upper Jurassic and later sediments.

The main hypabyssal outcrops in the Parabarana vicinity are referred to the Terrapinna Granite and the Mt. Neill Granite Porphyry. The metasediments at Parabarana are referred to the Radium Creek Metamorphics, and are tentatively assigned to the Lower Proterozoic.

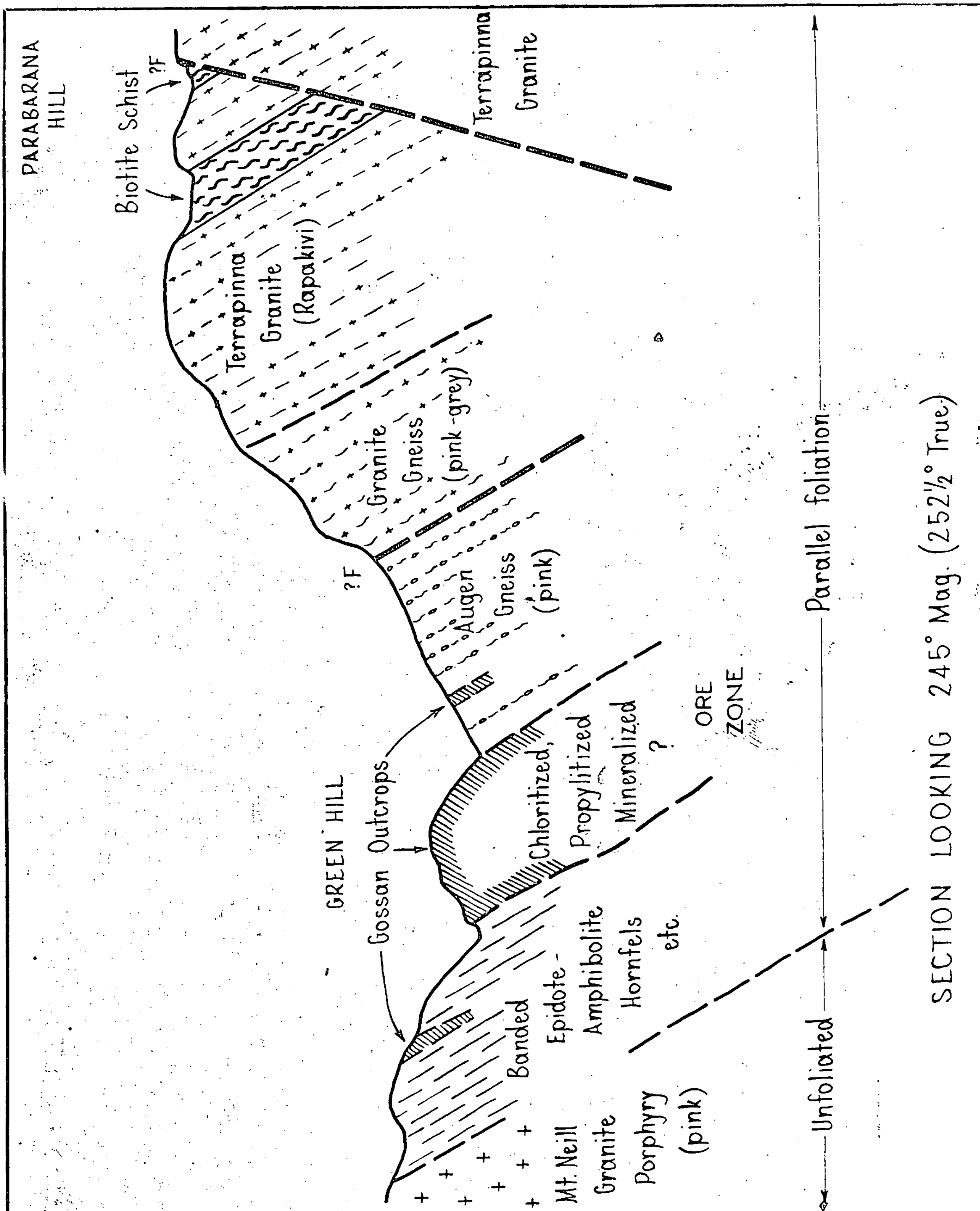
PARABARANA PROSPECT

Stratigraphy

The majority of the rocks at Parabarana are layered or foliated. Since they exhibit a consistent north-westerly dip of 50°-60° it is convenient to describe them in sequence from Parabarana Hill southwards, following the Generalised Geological Section (drawing S9681).

The summit of Parabarana Hill is composed of strongly foliated, pale grey Terrapinna rapakivi granite. Some 250 yards to the south lie two sharply defined, concordant, parallel bands of dark biotite, hornblende schist. These form a prominent double saddle on the skyline, which can be seen from the neighbourhood of Moolawatana. The portion of Terrapinna granite between the two schist bands show a very variable texture, part being sufficiently fine grained to be described as "felsite".

Farther south, the rough craggy shoulder of Parabarana Hill falls towards the lower ground of the prospect. Foliation in the granite remains prominent, but grain size progressively diminishes. There are included several narrow concordant bands of dark biotite schist. Exposures are good in the higher slopes but become more or less concealed by talus and debris as the lower levels are reached. At the "break of slope" a pink augen-gneiss succeeds the finely foliated grey granite. The junction between these two has been interpreted by North Flinders Mines Ltd. as a major north-dipping shear zone but this is not well exposed. The foliations in the pink augen-gneiss are parallel to those in the rapakivi granite to the north.



METALLIC MINERALS SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: Diagrammatic
Compiled: J. G-S.	PARABARANA PROSPECT	Date: 21 Feb 1972
Drn. R.H. Ckd.	GENERALISED GEOLOGICAL SECTION	Drg. No. S9681 Cc

1M–2.70 A1810

The next unit embraces the mineralized zone and includes prominent showings of copper staining. It is a rather sheared and well altered body of material, parts of it have variously been described as:- "extensively chloritised porphyry or gneisses (granitic) grading to chloritic hornfels and chlorite schist," "sheared and mylonitised microcline-quartz-mica gneiss," "rhyodacite", "micro-adamellite and metamorphosed acid volcanics (syenite, andesite and tuff)". It is clear that metamorphism and alteration have considerably changed the material from its original nature, but it seems probable that this itself was somewhat diverse. Mineralization shows in a prominent elongated low hill of dull green and red-stained gossanous material (the "green hill"). There are also other small lenticular outcrops of similar material along the strike of the zone and to hanging and foot wall sides of the main "green hill" outcrop.

The succeeding foot wall zone comprises finely banded siliceous epidote-amphibole hornfels rocks, these are generally agreed to be metamorphosed sediments, although their stratigraphic relationship with the remainder of the Radium Creek Metamorphics is still uncertain. The banding is conspicuous and well developed, it is parallel with the foliation in the Terrapinna Granite to the north. Some local drag-folding is recorded.

To the south metasediments are followed by the Mt. Neill Granite Porphyry, a moderately coarse grained pink granitic rock, unfoliated and showing an apparently intrusive relationship to the metasediments.

Structure

Air photographs of the Parabarana area show several well-developed families of lineations. Two strong discontinuous east-west traces are interpreted as subsidiary faults or shears, parallel to the junction between pink gneiss and grey foliated granite north of the "green hill" outcrop. These east-west traces are cut by four parallel north-west striking features. The prolongation of one of these last forms the present boundary between Tertiary sediments and basement rocks south-east of the prospect, a circumstance which suggests that these are faults on which at least some movement in an east-side-down sense has taken place in comparatively recent times. Further evidence of Tertiary or later movement is provided by the intersection of lignitic sandstones beneath granite by drill holes near the eastern margin of the prospect. It is suggested that this indicates the presence of a low angled north dipping thrust, with an east-north-easterly strike, at the eastern side of the area. As shown on Plan 72-76 the body is offset by transverse faults which would have to be accomodated in mine layout.

Mineralization

Copper staining is locally conspicuous on the outcrop. Malachite, chrysocolla, and traces of azurite coat fracture surfaces in iron-stained sheared and altered country rock. There are sparse webs of fine boxwork limonite, apparently after chalcopyrite, and traces of chalcocite can be seen in a few specimens. The old workings seem to have followed small "sweated" veinlets of quartz and chalcopyrite. No doubt where they were protected by quartz, suphides survived nearer to the surface than in the case of disseminated material, but it seems likely that most of the early production was in oxide form.

Drilling records show the water table lying at a mean depth of about 100 feet below surface in the mineralized area. Traces of native copper are recorded in some drillholes from much greater depths. All the cores examined by the writer showed only primary ore-minerals and it is possible that some of the native copper may itself be primary or metamorphic in origin.

Examination of fresh cores shows a basically simple mineralogy; the following were noted:-

chalcopyrite

molybdenite

pyrite

pyrrhotite

maghemite(?)

magnetite

Chalcopyrite forms irregular rounded blebs, small veinlets and fine disseminations. Some of its textures suggest that migration and recrystallization has taken place. Molybdenite occurs as small disseminated flakes and rosettes. It is moderately conspicuous but is only rarely present in appreciable quantities, and the higher molybdenum assays appear to lie below and sometimes beyond the boundary of the higher copper assays.

Pyrite is sparsely but widely distributed in the drill cores. Small veinlets and disseminations were seen, some of the latter in association with dark shale (?) and there are pyrite particles of framboidal shape. Concentrations of up to about 25% suphides, mostly pyrite, over widths of 10-20 feet are reported from some of the percussion drill holes.

Pyrrhotite was seen forming a massive veinlet a little less than a foot wide in the lower part of DD5.. It was associated with coarse magnetite and chalcopyrite.

Maghemite(?) and magnetite are widely distributed as disseminations and occasional small masses. These are more conspicious towards the footwall and were observed in the outcrops of the footwall rocks.

Native copper and graphite are reportedly widely distributed in small quantities.

Genesis

North Flinders Mines Ltd. suggest that mineralization is related to a body of intrusive micro-adamellite. This has been recognized by the Company during petrographic examination of selected drill cores and cuttings, and is envisaged as forming both source and host-rock for the copper. It is suggested that the micro-adamellite was intruded along an active shear zone and was subsequently mylonitized, and that the copper was derived and concentrated by the same magmatic processes as those which produced the adamellite. The whole deposit is accordingly visualised as somewhat akin to a "porphyry copper".

If this is the case, mineralization will be likely to follow the plan dimensions of the host intrusion and values may be expected to bottom down the intrusion against a rising temperature gradient. It is difficult to predict the vertical interval over which this may take place. Porphyry copper deposits are very variable in their geometry and, although they are usually described as "blanket like" deposits a few hundred of feet in thickness, at least one major example has been followed down for more than 2 500 feet.

The writer is doubtful of the competence of the suggested mechanism to form ore, and indeed of the validity of the whole conception. He suggests instead that the foliated rocks of Parabarana, including the micro-adamellite, are the products of granitization of a sedimentary pile, part of the original Radium Creek Metamorphics, and that the mineralization as it is now seen is the result of metamorphism of an originally syngenetic, strata-bound, body of suphide ores. It is suggested further that the original sequence is probably inverted and that careful examination of the banded rocks forming the present footwall may reveal recognizable geopetal structures. An interesting potential correlation exists with the mineralized Ethiudna group in the Olary Province.

Should mineralization represent a metamorphosed syngenetic body, its original dimensions will probably approximate to those of its host facies, so that a large lenticular body may be anticipated.

The small quartz suphide veins, which were the target for early mining, are visualised as the products of lateral hydrothermal migration under either theory of genesis. The two theories are further compared in Appendix I.

Exploration

North Flinders Mines' initial exploration consisted of surface mapping, geochemical sampling, photogeology and geophysical work. The work was careful and systematic. Following a successful trial in the "green hill" area, an Induced Polarisation survey was carried out over the strike length of the prospect.

Geochemistry showed concentrations of base metals around the "green hill" and smaller concentrations associated with the old dumps and workings; I.P. indicated a long well-defined anomaly extending along strike from the "green hill". A percussion drilling programme was put in hand to test the results of geophysical and geological interpretation.

32 holes have been drilled totalling 10 360 feet. Interesting copper values were intersected down-dip from the "green hill" (see the accompanying cross section). Since the width and assay values were found to improve down dip, a programme of deeper diamond drilling was commenced.

Percussion drilling results are shown in Table I overleaf.

In drilling of this sort it is often virtually impossible to detect or to prevent small amounts of caving. More serious caving is usually sufficiently obvious, but its prevention and elimination from subsequent samples may be difficult. Sampling by percussion holes, and the geological interpretation of their results, is thus open to special difficulties. The Parabarana work has evidently been done with reasonable care, and in accordance with good current practice. Statistical analysis of the results showed that these were of adequate precision for their purpose of exploration.

Diamond drilling has been attended by severe difficulties attributed to locally unstable wall conditions, due to the hydration, swelling and breakdown of some of the rock. These difficulties appear to have been aggravated by the rather limited experience of some of the drill-crew personnel.

Diamond drilling results are shown in Table II overleaf.

The core recovery in the mineralized section of DD3 was measured and found to be 82%.

GRADE AND TONNAGE

Mineralization has been traced for a strike length of over 1 200 feet between drillholes P5 and P25. The body dips at 50° in the direction 340°, and it has been followed down the dip for an inclined distance of 1 200 feet.

TABLE I PARABARANA PERCUSSION DRILLING CAMPAIGN - FEBRUARY - MAY 1970

HOLE	SECTION	POSITION CO-ORDINATES:-		EL.COL.	DIP/ AZIMUTH	DEPTH	COPPER FOOTAGE	%	MOLYBDENUM FOOTAGE	P.P.M.	REMARKS		
P1	00W	71N	00	4895.6	59/180	260	0-60	0.63	90-95	840	Cut water at 200'.		
P2		131N	03W	4895.6	70/180	300	70-155	0.52	155-160	< 100	170'		
P3		189N	00	4899.3	70/180	310	125-200	0.77	260-265	< 100	145'.		
P4		195.5N	00	4899.4	Vertical	550	170-230	0.46	200-210	2,750	165'.		
P5		287N	00	4883.5	Vertical	370	285-325	0.28			85'.		
P6	800E	247N	800E	4835.1	70/180	140					110'.	3000-4000 gph	Penetrated Sediments below granite.
P7		347N	809E	4854.4	70/180	240					143'.		
P8		450N	806E	4871.4	70/180	270					180'.		
P15		552N	802E	4889.7	70/180	320					230'.		
P9	400W	98N	397W	4877.8	70/180	85	5-45	0.64	55-60	2,200			
P10		96N	398W	4872.7	Vertical	300	0-60	0.63	60-65	850			
P11		31N	399W	4862.0	Vertical	225					100'.		
P12		179N	396W	4878.9	Vertical	240	55-130	0.88	(85-90 (115-135	1,800 4,500	50'.		
P13		271N	390W	4903.1	Vertical	375	165-315	0.94	240-255	750	95'.		
P14		364N	395W	4933.0	Vertical	500	315-460	1.09	430-435	350	70'.		
P16	5200W	1,307S	5,197W	4977.0	70/180	300					20'.		
P17		1,132.5S	5,198W	4955.3	60/180	345					128'.		
P18	5100W	788S	5,100W	5027.6	60/000	350	20-30	Tr			150'.		
P19	600W	159N	594W	4891.5	Vertical	250	135-210	0.41	190-200	< 100	70'.		
P20	800W	01.5S	800W	4901.0	Vertical	240	50-100	0.97	95-100	500	65'.		
P21		95N	803W	4928.9	Vertical	280	180-230	0.41	240-270	550	75 and 150	2000-3000 gph.	
P22		249N	795W	4941.6	Vertical	485	345-445	0.87	275-280	240	105--300	100-4.500 gph.	
P23		385.5N	800W	4946.7	Vertical	435					50	increasing with depth to 3000 gph.	
P24	1200W	140S	1208W	4974.4	Vertical	330					120'.		

P25	1200W	03N	1197W	4971.6	Vertical	260	170-190	1.02	180-185	<100	Cut water at 100'.	increasing with depth to 7000 gph.
P26		148N	1201W	4994.1	Vertical	350	310-335	Tr			145'.	increasing with depth to 8000 gph.
P27	1600W	03S	1597W	4997.2	Vertical	415	285-350	Tr			140'.	
P28		205S	1599W	5047.1	Vertical	325	150-185	0.45			210'.	
P29	2000W	210S	2004W	5156.1	Vertical	425	255-425	Tr			360'.	
P30		119S	2002W	5135.3	Vertical	435	300-435				240'.	
P31	2700W	234S	2703W	5020.6	Vertical	300					174'.	
P32	2800W	01N	2789W	5091.4	Vertical	350	305-340	Tr			205'.	

TABLE II PARABARANA DIAMOND DRILLING CAMPAIGN SEPTEMBER, 1970 - JULY, 1971

HOLE	SECTION	POSITION CO-ORDINATES:-		EL.COL.	DIP/ AZIMUTH	DEPTH	COPPER FOOTAGE	COPPER %	MOLYBDENUM FOOTAGE	MOLYBDENUM P.P.M.	REMARKS
DD1	400W	1200N	400W	5120	70/180	1058					Abandoned due to drilling difficulties.
DD2	400W	750N	400W	4972 (Approx.)	75/180	756	687-712	0.38	708-715	170	Appears to have reached footwall.
DD3	800W	950N	800W	5083 (Approx.)	70/180	1404	1064-1181	1.10	1108-1118	700	Intersection includes 21' @ 3.6% Cu.
DD4	00W	1200N	00W	4985 (Approx.)	70/180	824					Abandoned due to drilling difficulties.
DD5	2000W	300N(?)	2000W	5156' (Approx.)	Vertical	1258					Traces mazn. reported between 727' and 988', 1085' and 1250'. Does not appear to have reached footwall.
DD6	1200W	665N	1200W	5155' (Approx.)	Vertical	1352	995-1017	1.01			
DD7	1600W	567N	1600W	5210 (Approx.)	Vertical	1018					Abandoned, rods jammed, fishing unsuccessful, core barrel plus core 1018-1028, left inside.

The grade and tonnage inferred from the combined percussion and diamond drill intersections has been determined, assuming continuity between adjacent intersections and a factor of 12 cubic feet of ore in situ per long ton. The calculations are shown in Appendix 4.

Cross and longitudinal sections, and a plan showing the structural contours of the ore zone, with its relation to the drillholes in the vicinity, are attached. (Drawings 72-71, 72, 73, 74, 72-75 and 72-76 respectively).

An inferred ore-reserve of some 6 million long tons at a grade of 0.9% copper is deduced from present data. Whilst it would no doubt be possible on the basis of one or other theory of genesis to extend a yet more tenuous computation of reserves, following the three generally accepted categories of 'proved', 'indicated', and 'inferred' ore reserves by a fourth, to be called perhaps 'potential ore reserves', such a computation would necessarily be weighted heavily by the single deep rich intersection in DD3, and by conjecture, so that its actual usefulness is very doubtful.

It is more valuable to consider the boundary conditions which may apply to the volume of ground open to mineralization under one or other hypothesis:-

The present ground surface is an erosion surface of no great antiquity. It is not associated with profound secondary enrichment and can have had no bearing upon physical gradients in the country rock at the time of mineralization. It may be regarded merely as a truncating surface of random orientation.

Hanging and footwalls are facies boundaries, although it is open to question whether the critical parameters were those of rock mechanics, exerting a broad tectonic control over the site of later intrusion, or those of original sedimentation, exerting a more fundamental control over ore deposition. In either case these boundaries may be expected to persist on dip and strike after the habit of facies boundaries.

To the east the mineralized zone terminates against Tertiary sandstones, its sub-surface extension may be anticipated beneath the Tertiary unconformity but it is not clear to what extent this has been complicated by later faulting.

To the west footwall metasediments extend for between 5 000 and 10 000 feet and their associated structures farther.

A very extensive body of ground is thus available for the development of ore, whether this is in the form of elongated "porphyry" stocks or of lenticular bands of sedimentary origin.

Potential

Comparative studies by the Mineral Development Engineer indicate that at present prices, for an underground mining operation remote from existing facilities, producing at the rate of some 500 000 tons of run of mine ore per year with free-milling non-complex mill-feed, a copper grade of at least 2½% is required to support profitable operations. (see Appendix 2).

At Parabarana the low-grade mineralization thus far intersected does not justify underground mining ab initio. The interest of the prospect lies in the possible extension and/or improvement of the high-grade mineralization cut by DD3. The immediate purpose of further drilling should therefore be to investigate this high grade mineralization, to determine whether it is sufficiently extensive and continuous to warrant the detailed testing entailed in a mining feasibility study.

It is possible that the shallower ore might support open-cast mining or some other low cost treatment such as heap or in situ leaching. This might be investigated if underground mining were found to be uneconomical.

SUMMARY AND CONCLUSIONS

The standard of North Flinders Mines' work is good and their data are acceptable.

The prospect lies near Parabarana Hill in a petrologicaly complex region in the rocks of the Mount Painter Block.

Mineralization occurs in a well-defined zone which is parallel to the general foliation of the layered country rocks.

There are conflicting theories on the genesis of mineralization. North Flinders Mines Ltd. believe this to be of "porphyry copper" type, related to a body of intrusive granitic rock. The author prefers to regard the sulphides as original syngenetic materials somewhat modified by metamorphism and granitization of the country rocks.

The potential expectations of ore under the two theories are not very different at this early stage in investigation.

The present inferred ore reserves are 6 million tons at an estimated grade of 0.9% Cu.

Grades over the full 117 feet width of the ore zone in DD3 average 1.1% Copper but this includes a higher grade portion, which averages 3.0% Copper over 21 feet.

A preliminary study of costs suggests that a mining grade in excess of 2½% Cu will be required.

Drilling is recommended initialy adjacent to the DD3 intersection to test for the continuity and extension of high grade mineralization.

Further surface mapping should be carried out to assist in the development of the general geological picture and to provide a firm structural framework within which drilling results can be placed.

RECOMMENDATIONS

A diamond drilling campaign of six vertical holes totalling 8 000 feet is recommended in two stages. Stage 1 consists of three holes at the following locations:-

DD8 at 500N:800W: planned depth 950 feet.

This hole is designed to test the up-dip extension of high-grade mineralization 200 feet south of the DD3 intersection and to familiarise drilling crews with local conditions.

DD9 and DD10 at 700N:1 000W; and 700N:600W: average depth 1 200 feet.

These holes are designed to test lateral extensions of high grade mineralization west and east of DD3. The three holes are estimated to cost $42 000, as detailed in Appendix 3.

The siting of the three remaining holes would depend upon the results of the first three. They would be planned to follow the thickest part of the high grade intersection down its plunge, their depths would total about 4 650 feet and they may be expected to cost about $75 000, although this estimate would be revised in the light of earlier experience.

J. Gordon-Smith

J. GORDON-SMITH
SENIOR GEOLOGIST
METALLICS SECTION

15.3.72

REFERENCES

BLISSETT, A.H., 1971. Economic Geology of the Mount Painter Province in Coats and Blissett, Regional and Economic Geology of the Mount Painter Province. Bulletin 43. Geological Survey of South Australia. Govt. Printer Adelaide.

BROWN, H.Y.C., 1908. Record of the Mines of South Australia. (4th Ed.). Govt. Printer, Adelaide.

COATS, R.P., 1971. Regional Geology of the Mount Painter Province in Coats and Blissett, ante.

APPENDIX 1

NOTES ON THE GENESIS OF THE PARABARANA MINERALIZATION

This mineralization comprises chalcopyrite and traces of molybdenite, together with a little pyrite, pyrrhotite, magnetite and maghemite (?), in rather fine grained acid rocks of variable texture and composition.

Opinions on genesis favour either "porphyry copper type" derived from and located by an intrusive micro-adamellite, or a syngenetic origin with subsequent modification by metamorphism and granitization of the country rocks.

The foremost argument in favour of "porphyry copper" origin appears to be the close spatial relationship which is claimed between copper values and the micro-adamellite host. It is suggested that this rock was intruded along an active shear zone and was subsequently mylonitized by continued movement.

Difficulties facing a genetic model of this sort centre upon the parent granitic material, whose differentiation provided the copper and the adamellite, and upon the depth of cover beneath which the intrusion must have taken place. Neither the older nor the Younger Granite Suites show the residual copper enrichments which might be expected were they the source of such parent material. Pegmetites near Parabarana, believed to belong to the Younger Granite Suite (Blissett, 1971) show no abnormal copper enrichment. Even by the Lower Palaeozoic, cover over Parabarana was still thick enough to ensure that any intrusion would be relatively coarse grained. It is plainly unlikely for this texture to have been entirely obliterated by post intrusion movement. "Mylonitized micro-adamellite" itself does not appear to be a sufficiently distinctive, characteristic material within the quite varied and altered country rocks of the ore zone for its claimed host role to have been unequivocably established. The apparent restriction of the micro-adamellite to a particular stratigraphic zone, though not in itself conclusive, is a further point against its intrusive origin. The rapid changes in grade of mineralization across the foliation and the marked assymmetry of the copper molybdenum profile are also difficulties not easily compatible with porphyry copper type origin.

In favour of a strata-bound syngenetic model is the conformity of the mineralized body, and of its compositional sub-units, with the layering of the country rocks, the presence of occasional parallel subsidiary suphide-bearing lenses in hanging and footwalls, the textures of some of the suphides and their association with rocks which appear originally to have been carbonaceous shales and acid tuffs.

It may be considered that the main objection to a syngenetic hypothesis is its displacement of the actual event of mineralization one remove further back in time and further into the mists of conjecture. In fact this objection can hardly be sustained since the suggestion is that mineralization took place with and during the deposition of one of the middle members of the Radium Creek Metamorphics, at a time when, in the neighbouring Olary Province, there are good grounds for believing that sedimentary sulphide bodies were being laid down.

The seemingly complex petrology of the ore zone rocks, the anomalous textures in some of the granites, and the sparadically distributed quartz-suphide veinlets worked by the early miners become readily interpreted in terms of a granitization front dying out across arenaceous sediments and pyroclasic rocks. Although controversy on granites is likely to enliven geological thinking for a long time to come, there is general agreement that rapakivi textures, particularly those which are directionally oriented, are difficult to derive from granite magma by normal processes. A responsible body of opinion insists that they are conclusive evidence of granitization. There is thus worthy precedent for the suggestion that in the Terrapinna Granite of Parabarana Hill and its foliated neighbours we are dealing with the products of granitization.

J. GORDON-SMITH
SENIOR GEOLOGIST
METALLIC MINERALS SECTION

APPENDIX 2

PARABARANA COPPER PROSPECT

Economic Considerations

I. Background

Deposit - The Parabarana Copper Prospect, as known at present, shows the indications of a possible low grade sulphide copper deposit of about five million tons of about 1% copper grade. The deposit is in adamellite type rock and could have an average width of about 60 feet and a length and depth of about 1100 feet each, and a general dip of about 50° into higher ground. Difficulties with swelling ground in drilling indicate that there may be a weak layer of rock about 100 feet from the deposit in the hanging wall, and several parallel faults seem to intersect and offset the deposit. There do not appear to be any other valuable metals present.

Location - The deposit is remote from normal facilities, being located on the eastern slopes of the northern end of the Flinders Ranges, about 100 miles east of Copley railway station by gravel road, with the Leigh Creek township 110 miles from the mine the only township of any size in the area. The mine is about 10 miles from the natural gas pipeline and 240 miles north of Yunta on the Pt. Pirie to Broken Hill railway.

Mining - Open cut mining of an ore body of this width and depth is out of the question because the waste to ore ratio would be over 20 to 1. Underground mining methods will have to be used but at this stage it is not known whether highly mechanised open-stope cut-and-fill mining, such as that used at

Cobar and Renison, could be used, or shrinkage or sublevel or other methods. However, considering some of the possible unfavourable characteristics of the deposit, such as displacement by faults and some weakness in the hanging wall, it is unlikely that mining costs will be as low as those experienced at Cobar where operating costs (i.e. excluding depreciation, amortization and tax) appear to be about $6.00 per ton of ore. As the grade is low, costly mining methods will have to be avoided so it is unlikely that more than 85% of the ore will be extracted i.e. a deposit of about six million tons will be required to provide five million tons of ore for the mill.

Treatment - Apart from the first 100 feet, the copper appears to be almost all present as chalcopyrite and so should be amenable to easy concentration by flotation to give about a 23% copper grade concentrate with a recovery of 90% of the copper in the mill feed.

II. Probable Income at Parabarana from Various Grades of Copper Ore.

Assumptions:-

1. Mill recoveries of 90% of the copper in the mill feed.
2. Concentrate grade of 23% copper (as chalcopyrite the main copper mineral)
3. Moisture content of concentrate of 7½%.
4. Concentrate sold to E.R. & S. Smelter at Port Kembla under their present charges and payment rates.

(The E.R. & S. Smelter at present pays at 96% of the current refined copper selling price for the copper content of the concentrate less 1.3 units per ton and charges $11 per ton of concentrate for smelting and

$1.30 per unit of copper which is paid for, for refining).

5. Transport costs from mine to Port Kembla of say $25 per ton of moist concentrates (= $27 per dry ton if moisture is 7½%).

(R.M.C. Minerals pay $19 per moist ton for freight on their concentrates from Kadina to Pt. Kembla by rail).

6. An average Australian Refined Copper selling price of $900 per ton, or $1000 or $1200 or $1500 per ton.

(The average Australian selling price of Refined Copper for January, 1972 was $929 and in the last 10 years was:

1962	1963	1964	1965	1966
$610	$610	$656	$730	$960
1967	1968	1969	1970	1971
$1043	$1117	$1347	$1305	$1032

7. One third of capital required to establish the mine to be raised from shareholders and two thirds to be borrowed at 9% interest.

Values at Parabarana of 23% Copper Concentrate

The amount of copper paid for by the Smelters, with a 23% concentrate (i.e. containing 23 units of copper), would be 23-1.3 units = 21.7 units per ton of concentrate

Smelter Charges:-

Smelting etc. at $11 per ton of material would be			$11	per ton of concentrate	
Refining at $1.30 x 21.7 units paid for	"	"	$28	"	"
i.e. Total smelter charges	"	"	$39	"	"

Transport Costs:-

Transport to Port Kembla at $25 per ton	"	"	$27	per dry ton of concentrate

Therefore, with these conditions, the value at Parabarana of copper in 23% grade concentrates at different copper prices would be:-

with a copper selling price of	$900	$1000	$1200	$1500	(per ton of (copper
the buying price would be	$864	$ 960	$1152	$1440	(" "
& payment for 21.7 units	$187	$ 208	$ 250	$ 312	(per ton of (concentrate
less Smelter charges	$ 39	$ 39	$ 39	$ 39	(" "
less Transport charges	$ 27	$ 27	$ 27	$ 27	(" "
i.e. value at Parabarana	$121	$ 142	$ 184	$ 246	(" "
or with 23% grade concentrate	$526	$ 617	$ 800	$1139	(per ton of Cu (contained in (concentrate

<u>Value of Ore</u>:-

With mill recoveries of 90%, income at Parabarana would be	$474	$ 556	$ 720	$1025	(per ton of Cu (contained in (mill feed

<u>Income at Parabarana from different grades of mill feed</u>:-

Copper selling Price	$900	$1000	$1200	$1500
Mill feed grade	Income per ton of ore			
½% Cu	$ 2.37	$ 2.78	$ 3.60	$ 5.12
1% Cu	$ 4.74	$ 5.56	$ 7.20	$10.25
1½% Cu	$ 7.11	$ 8.34	$10.80	$15.37
2% Cu	$ 9.48	$11.12	$14.40	$20.50
2½% Cu	$11.85	$13.90	$18.00	$25.62
3% Cu	$14.22	$16.68	$21.60	$30.75
3½% Cu	$16.59	$19.46	$25.20	$35.87
4% Cu	$18.96	$22.24	$28.80	$41.00

III. Possible Costs for the Parabarana Prospect

No detailed costing of a possible mining operation at Parabarana can be made at this stage because, as yet, so little is known of the details of the deposit. However, some idea of the costs which are likely to be involved can be gained by assuming different conditions which could apply and then assessing what the total costs could be for these cases.

(The assumptions are given and some details of the calculations are shown so that the effects of the various conditions can be seen and so that alterations can be made later when more is known about the deposit).

The estimations are based on the following assumptions:-

1. Ore Reserves. Three separate cases have been taken, namely ore reserves of the deposit of 6 million tons, 12 million tons and 18 million tons.

2. Recoverable Ore. It has been assumed that about 85% of the ore reserves of the deposit will be economically recoverable. The percentage depends largely on the grade and the size and shape of the ore body, the type of ground and especially on the mining method used. In general with underground mining the higher the grade of the ore the greater the extraction percentage will be because it is then worth using more expensive mining methods to win more ore and to pay extra money to extract any pillars or thin tails of ore and to keep the mine open to mine the final ore.

3. Dilution. This also depends on the size and shape of the deposit and the type of ground and the mining method. Dilution has little effect on the total metal recovered

or the total money earned, but, as wall-rock is mixed with the true ore, it decreases the grade and increases the tons of the mill feed. It increases costs by increasing the tonnage of "ore" to be transported and milled for the same amount of metal recovered. With caving and shrink-stope mining dilution can be high, however with most mining methods it can be well controlled and it has been taken as insignificant for these calculations but may have to be considered later.

4. Capital Cost. The capital cost required to start up an underground mining venture in an isolated location such as Parabarana will be high, mainly because of the extra cost of services and of establishing and running a mine township. It has been assumed for these calculations that about $18 million will be required to establish a 330,000 ton per year underground mining complex at Parabarana with about 200 personnel; about $21 million for a 500,000 ton per year mine with 300 personnel; about $24 million for a 660,000 ton per year mine with 400 personnel and about $29 million for a 1,000,000 ton per year mine with about 600 personnel.

This is based on the following information:-

"Cobar" - A 660,000 ton/year underground mine with about 15 (?) million tons of 2.1% copper ore which took about $20 million to establish with production commencing in 1966. It is near an established town with a mining background, with power, water, and a railway and bitumen road to Sydney. A total of 402 were employed in 1969 and 446 in 1970. $3 million was spent on building and renovating

160 houses.

"Renison" - A 400,000 ton/year underground tin mine with ore reserves of 16½ million tons of 1% tin ore which took about $18 million to establish including mine buildings, plant and machinery, mine development and the erection or purchase of 196 houses at the old mining town of Zeehou, 12 miles away. About 240 people were employed in 1969 but there are more now.

"Prince Lyell" - An underground copper mine to be established below the Mount Lyell open cut, has about 26 million tons of 1.45% copper ore and plans a production rate of two million tons per year. $35 million is being spent in the extension of the existing mine at the long established town with power, water, and road already supplied.

"Kanmantoo," an open cut copper mine near Adelaide with reserves of 7½ million tons of 1.1% copper ore is taking $10 million to establish including $850,000 in proving the deposit, $5 million for fixed plant, offices, workshops, crusher and mill and power and water connections, $2.2 million for pit plant and $1.8 million for pre-production removal of overburden; and would have taken an extra $10 million if power, water and housing etc. had not been available, according to Mr. J. Treloar, the manager.

The "Western Mining Corporation" has said that the establishment of housing and township etc. for a mine in remote areas costs about $50,000 per mine personnel.

"Hammersly" has found that it has taken about 5/8 of their establishment capital for infrastructure and 3/8 for mine development.

5. <u>Annual Cost of Capital</u> - It has been assumed that one third of the capital will be shareholders risk money which has to be paid back at the end of the mine's life and has to pay at least 15% interest per year for the life of the mine to compensate for bearing the burden of the risks of a mining venture of a fall in prices or of unforseen difficulties. The establishment of a sinking fund at 8% interest rate has been allowed for.

It is assumed that the remaining two thirds of the capital can be raised at a 9% interest rate on the reducing capital with repayment of the principal in equal annual payments. (The 9% interest on the reducing capital is approximately equal to a flat 5% on the initial sum.)

6. <u>Taxation</u> - Company tax on a copper mine has been taken at 47½% less a 20% rebate making a 38% rate.

7. <u>Working Costs</u> - Total working and administration costs of the operation have been taken at:-

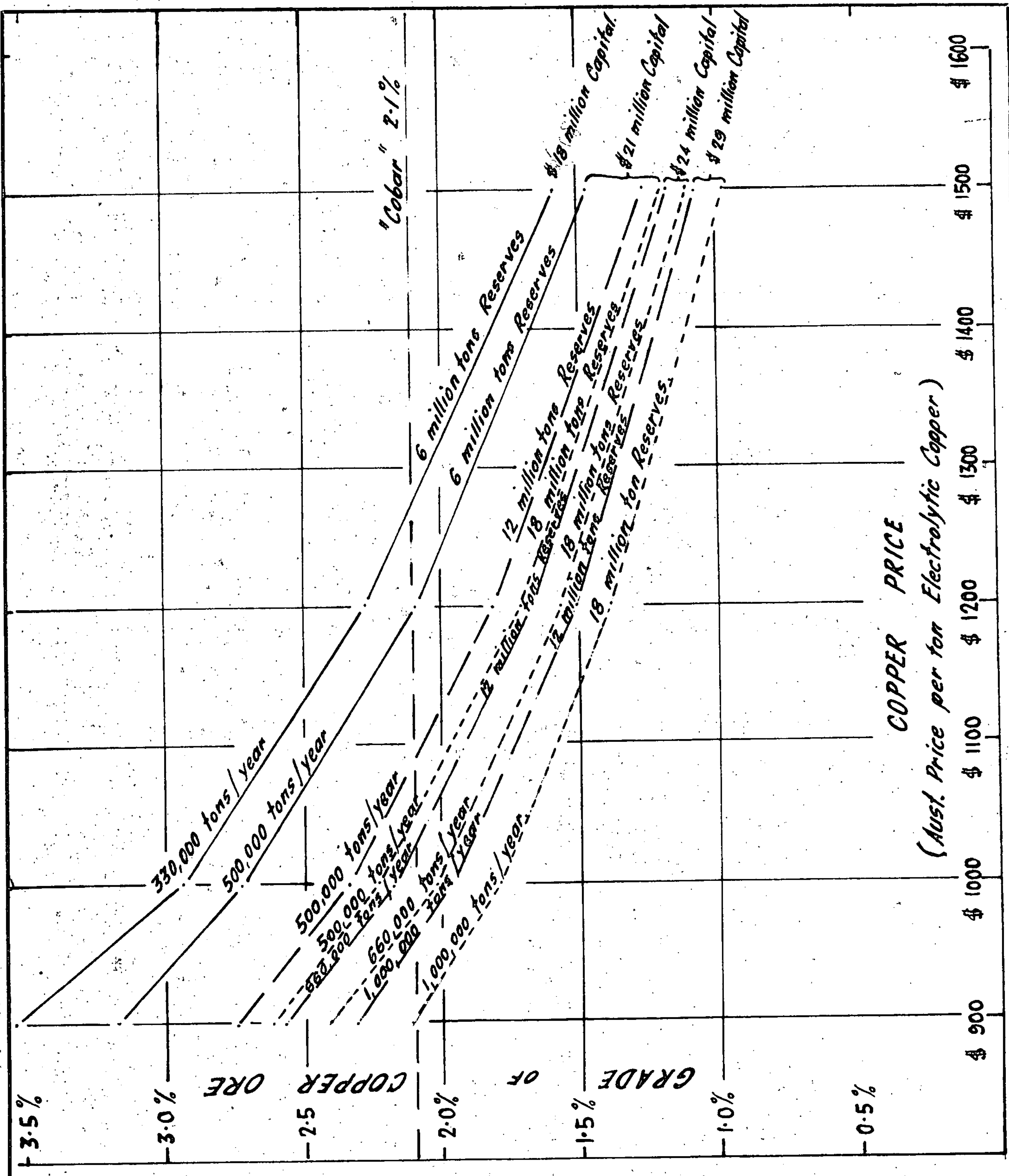
	$7.00	per ton for an operation of	330,000 tons per year
	$6.50	" " " " " "	500,000 " " "
	$6.00	" " " " " "	660,000 " " "
and	$5.00	" " " " " "	1,000,000 " " "

(These estimates are based on:-

"<u>Cobar</u>" where the working costs appear to be about $<u>6.00 per ton</u> with tonnage of 624,000 to 693,000 tons per year.

"<u>Renison</u>" with working costs which appear to be about $7.50 per ton with 400,000 tons per year production and a more complicated mill circuit.

"<u>Lake View and Star</u>" where the working costs were given as $7.40 per ton for 520,000 tons in 1969-70 and $7.60 per ton for 450,000 tons in 1970-71 and where the mining methods are more expensive.)



DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale:
Compiled: J.R. Adam. / Drn. B.S.G. / Ckd.	Date: 14th Mar '72
GRADE OF COPPER ORE REQUIRED FOR UNDERGROUND MINING OPERATIONS TO PAY 15% DIVIDENDS ON SHAREHOLDERS FUNDS	Drg. No. S 9703

1M–2.70 A1810

IV Estimated Costs for Various Sized Underground Mines At Parabarana and Grades of Ore necessary to Pay 15% Dividends on Shareholders' Funds

Ore Reserves - Tons	6,000,000			12,000,000			18,000,000	
Recoverable Ore - Tons	5,000,000			10,000,000			15,000,000	
Production Tons/yr	330,000	500,000	500,000	660,000	1,000,000	500,000	660,000	1,000,000
Life - years	15	10	20	15	10	30	22½	15
Capital $^{(C)}$ - say	$18m	$21m	$21m	$24m	$29m	$21m	$24	$29m
Annual Costs:-								
Redemption of $\frac{2}{3}$ C	$ 800,000	$1,400,000	$ 700,000	$1,070,000	$1,930,000	$ 470,000	$ 710,000	$1,290,000
Interest - 5% x $\frac{2}{3}$ C	$ 600,000	$ 700,000	$ 700,000	$ 800,000	$ 970,000	$ 700,000	$ 800,000	$ 970,000
Sum	$1,400,000	$2,100,000	$1,400,000	$1,870,000	$2,900,000	$1,170,000	$1,510,000	$2,260,000
Sinking F. for $\frac{1}{3}$ C	$ 221,000	$ 483,000	$ 153,000	$ 295,000	$ 660,000	$ 92,000	$ 137,000	$ 377,000
Capital Cost/yr	$1,621,000	$2,583,000	$1,553,000	$2,165,000	$3,560,000	$1,262,000	$1,647,000	$2,637,000
(Capital Cost/ton)	($4.90)	($5.16)	($3.10)	($3.28)	($3.56)	($2.52)	($2.49)	($2.64)
Div = 15% x $\frac{1}{3}$ C	$ 900,000	$1,050,000	$1,050,000	$1,200,000	$1,450,000	$1,050,000	$1,200,000	$1,450,000
Tax = $\frac{38}{62}$ Div	$ 550,000	$ 640,000	$ 640,000	$ 740,000	$ 900,000	$ 640,000	$ 740,000	$ 900,000
Sum	$1,450,000	$1,690,000	$1,690,000	$1,940,000	$2,350,000	$1,690,000	$1,940,000	$2,350,000
(Div + Tax/ton)	($4.40)	($3.38)	($3.38)	($2.94)	($2.36)	($3.38)	($2.94)	($2.36)
(Working Cost/ton)	($7.00)	($6.50)	($6.50)	($6.00)	($5.00)	($6.50)	($6.00)	($5.00)
(Total Cost/ton)	($16.30)	($15.04)	($12.98)	($12.22)	($10.92)	($12.40)	($11.43)	($10.00)
Grades Required to pay 15% Dividends on Shareholders' Funds ($\frac{1}{3}$ C) :-								
Copper Price								
$ 900	3.54%	3.17%	2.74%	2.59%	2.31%	2.62%	2.42%	2.12%
$1000	2.94%	2.71%	2.34%	2.18%	1.96%	2.22%	2.04%	1.79%
$1200	2.27%	2.09%	1.81%	1.68%	1.52%	1.72%	1.58%	1.39%
$1500	1.59%	1.47%	1.26%	1.19%	1.06%	1.21%	1.11%	.97%

(These values have been shown on the attached graph)

V Conclusion

This indicates that, unless the deposit is about twice the present suggested size of 6 million tons, a grade of over 2½% copper will probably be necessary for the establishment of an underground mining operation at Parabarana at the present copper price of $1,000 per ton. Even then the grade would need to be over 2% copper unless a 1 million tons per year operation can be established, and the copper price would need to average over about $1,500 per ton before a 1% copper grade deposit is likely to be viable for a large underground mine.

APPENDIX 3

Date 23/2/72

From:

CHIEF DRILLING & MECHANICAL ENGINEER:

To:

SENIOR GEOLOGIST - METALLICS:

(Copy to Drill. Supt. M.R. OBST)

Subject: Estimated Cost - Three Holes - Mineral Exploration, Parabarana

Docket Reference D.M. 1236/71

The estimated cost of drilling three holes for Mineral Exploration at Parabarana is:-

		0-400' (122m) @ $4/ft	400'-800' (122m-244m) @ $12/ft	Beyond 800' (244m) @ $20/ft	Total
Hole 1	950' (290m)	$1,600	$4,800	$3,000	$ 9,400
Hole 2	1100' (335m)	1,600	4,800	6,000	12,400
Hole 3	1300' (396m)	1,600	4,800	10,000	16,400
					38,200
			+ Mobilisation		3,800
					$42,000

This is based on the following hole construction:

1. Set 5" water pipe conductor to about 10' (3m) in 6¼" hole.
2. Set 4" Grade "A" P.V.C. tube at 300' - 400' (91m - 122m) in 4¾" D-H-H hole.
3. Drill 4¼" D-H-H or roller rock bit as far as possible and then HQ diamond core barrel to approx. 800' (244m).
4. Set NX casing and air drill with NQ core barrels through swelling clay area.
5. Set BX casing and drill to T.D. with BQ core barrels.

R.R. HANCOCK
CHIEF DRILLING & MECHANICAL ENGINEER

APPENDIX 4

Inferred Ore Reserves - Parabarana

Based on North Flinders Mines data and sections, copies of which are included, uncorrected for "assay factors".

Section Area	Intersections	Grade (1)	Block Volume (7)	Grade (2)	Total Volume	Grade (3)
00W	P1 60'x 0.63%					
	P2 85'x 0.52					
21,000sq.ft	P3 75'x 0.77		15,800,000	@ 0.846		
	P4 60'x 0.47					
	P5 45'x 0.31	0.56				
400W (4)	P9 40'x 0.64					
	P12 75'x 0.88					
58,000sq.ft	P13 140'x 1.00		32,500,000	@ 0.911	71,000,000	0.89
	P14 140'x 1.12					
	D2 25'x 0.38	0.95			Total Tonnage	
800W	P20 50'x 0.90				5,925,000	
	P21 50'x 0.41				say 6m.	
104,500sq.ft (5)	P22 100'x 0.87					
	D3 117'x 1.10	0.89	22,700,000	@ 899		
1200W	P25 20'x 1.02					
9,000sq.ft	D6 22'x 1.01	1.01				

Total Inferred Ore Reserves 5,925,000 long ton @ 0.89% Cu
Say 6 million @ 0.9%

Note 1. Weighted by lengths of intersections.

2. Weighted by areas of sections.

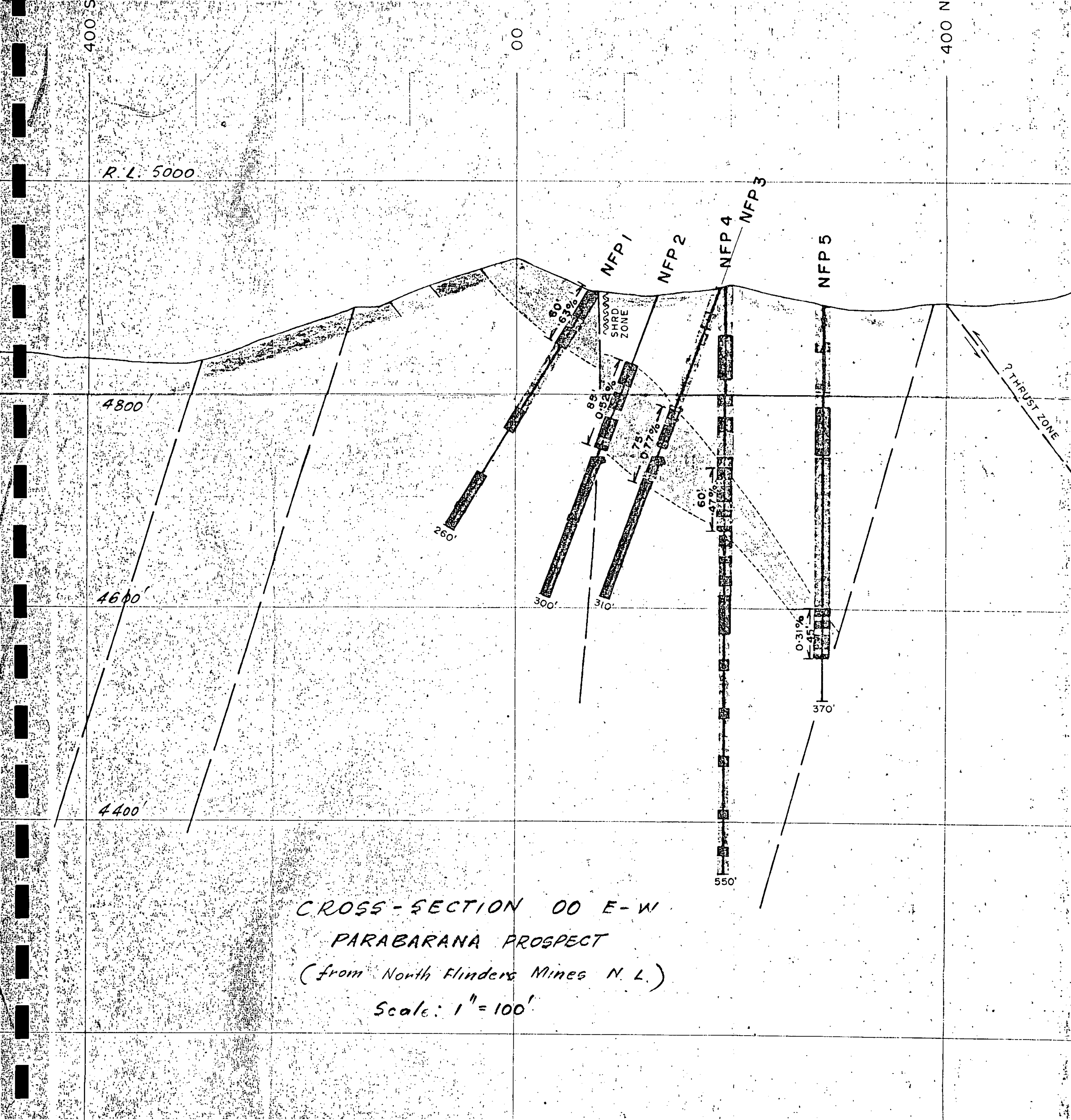
3. Weighted by volumes of blocks.

4. The adjacent P10 is sufficiently close in position and values to be omitted from the weighting.

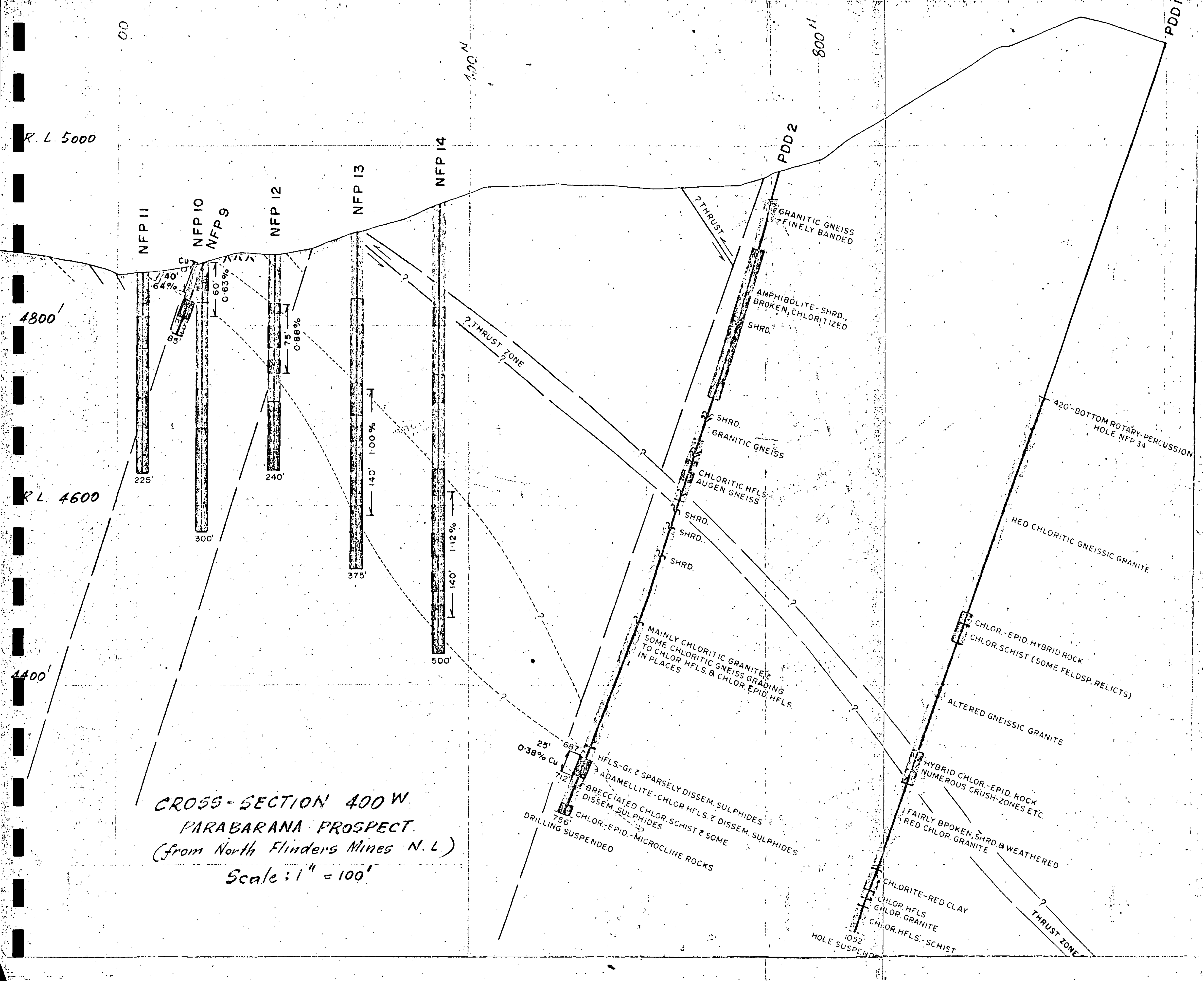
5. The section has been modified to exclude the suggested fault repetition and cut out the low-grade hanging wall material.

6. The intersection in D6 has been inserted on the section.

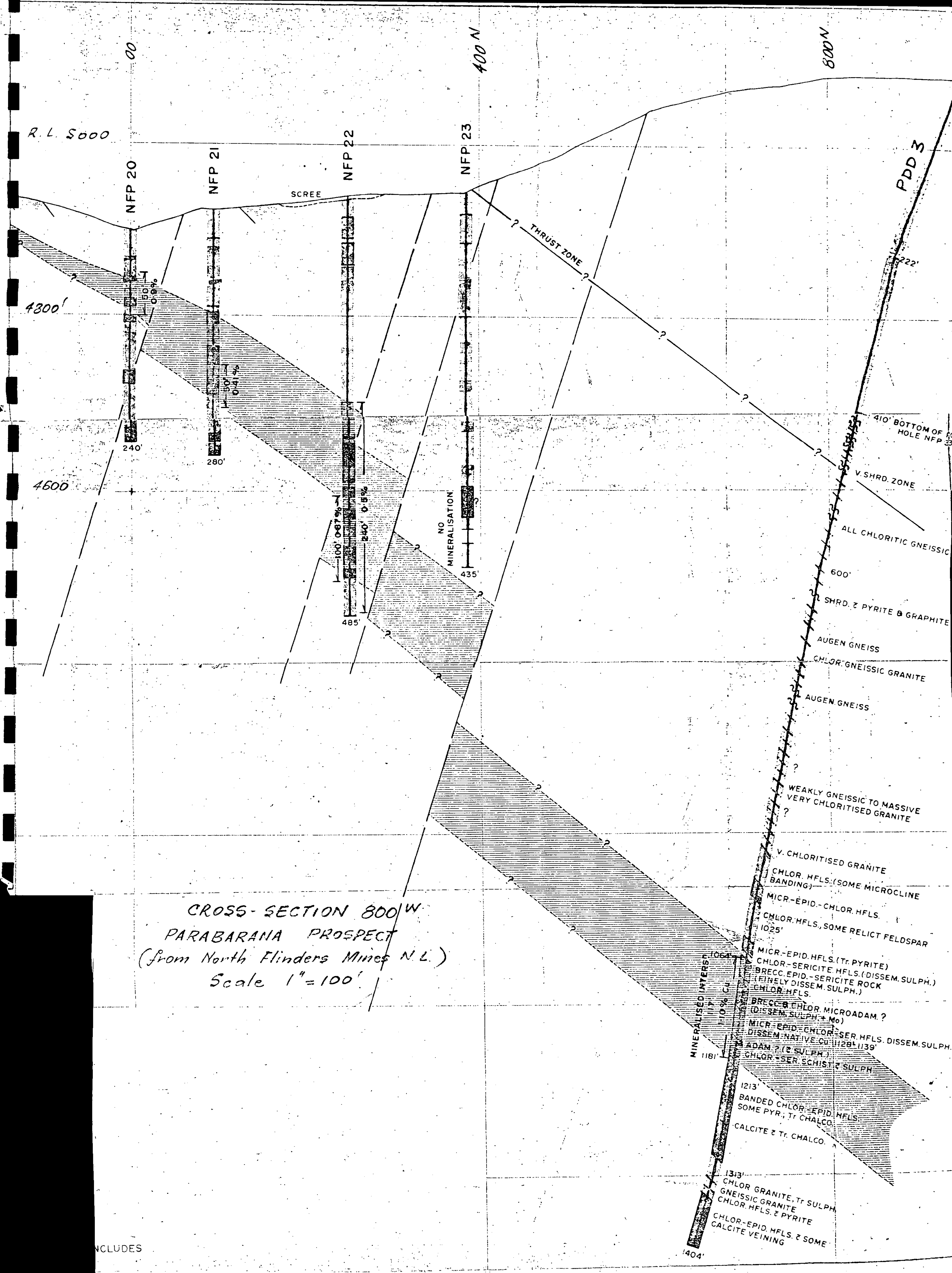
7. Body is tabular to 1st approximation, $V=(a_1 + a_2)\frac{d}{2}$



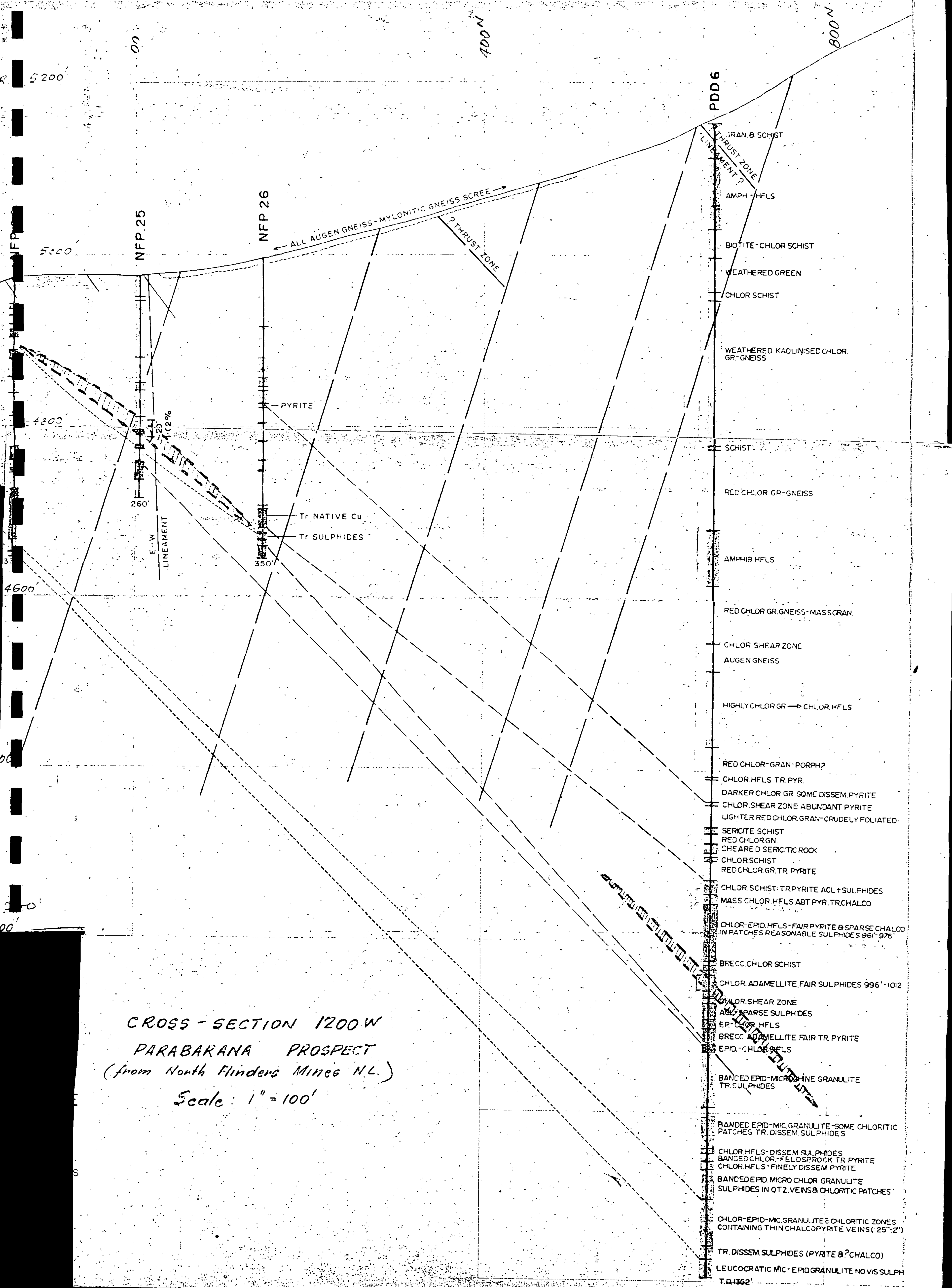
CROSS-SECTION 00 E-W
PARABARANA PROSPECT
(from North Flinders Mines N.L.)
Scale: 1" = 100'



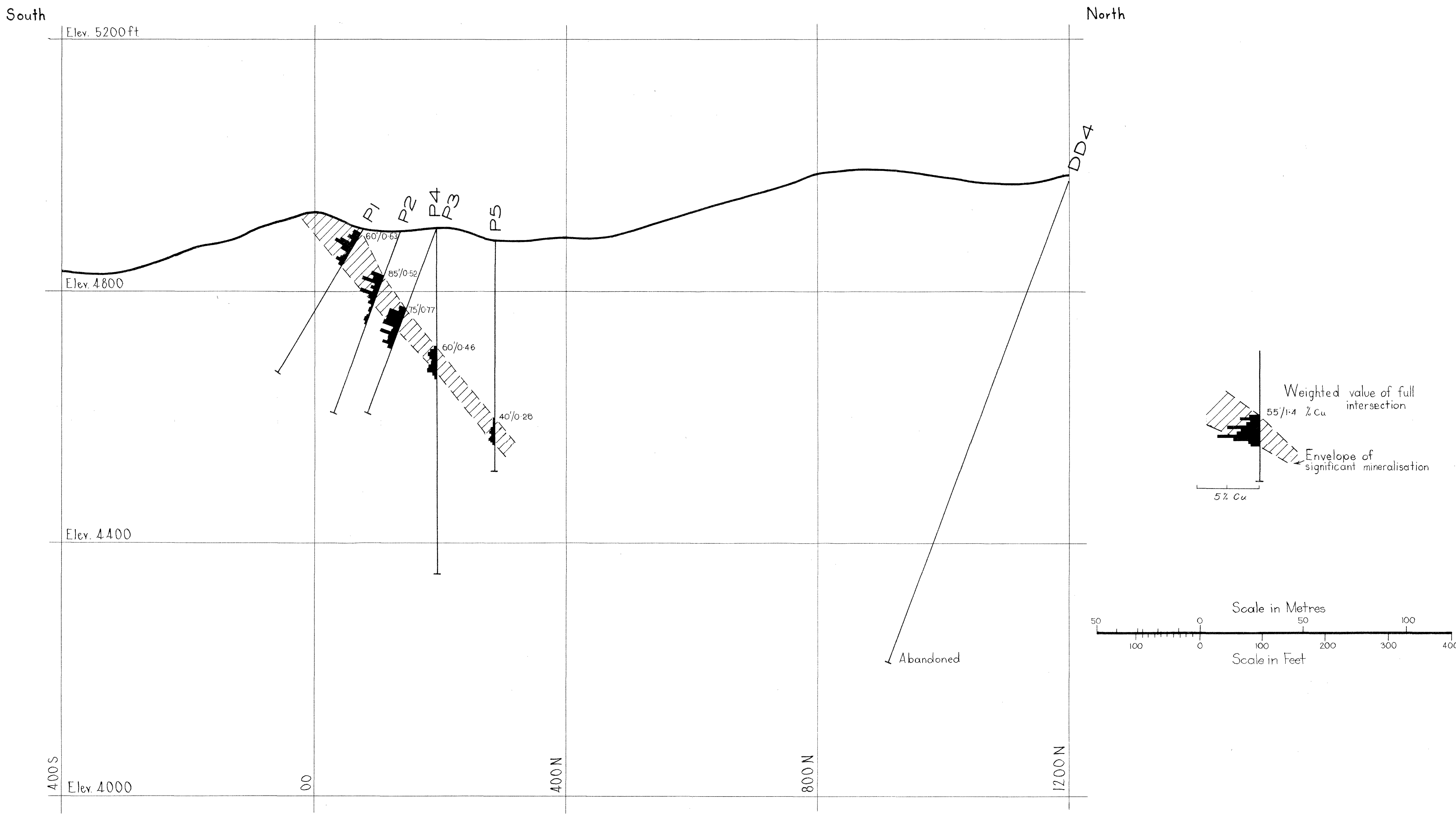
CROSS-SECTION 400 W
PARABARANA PROSPECT
(from North Flinders Mines N.L.)
Scale: 1" = 100'



CROSS-SECTION 800W
PARABARANA PROSPECT
(from North Flinders Mines N.L.)
Scale 1" = 100'



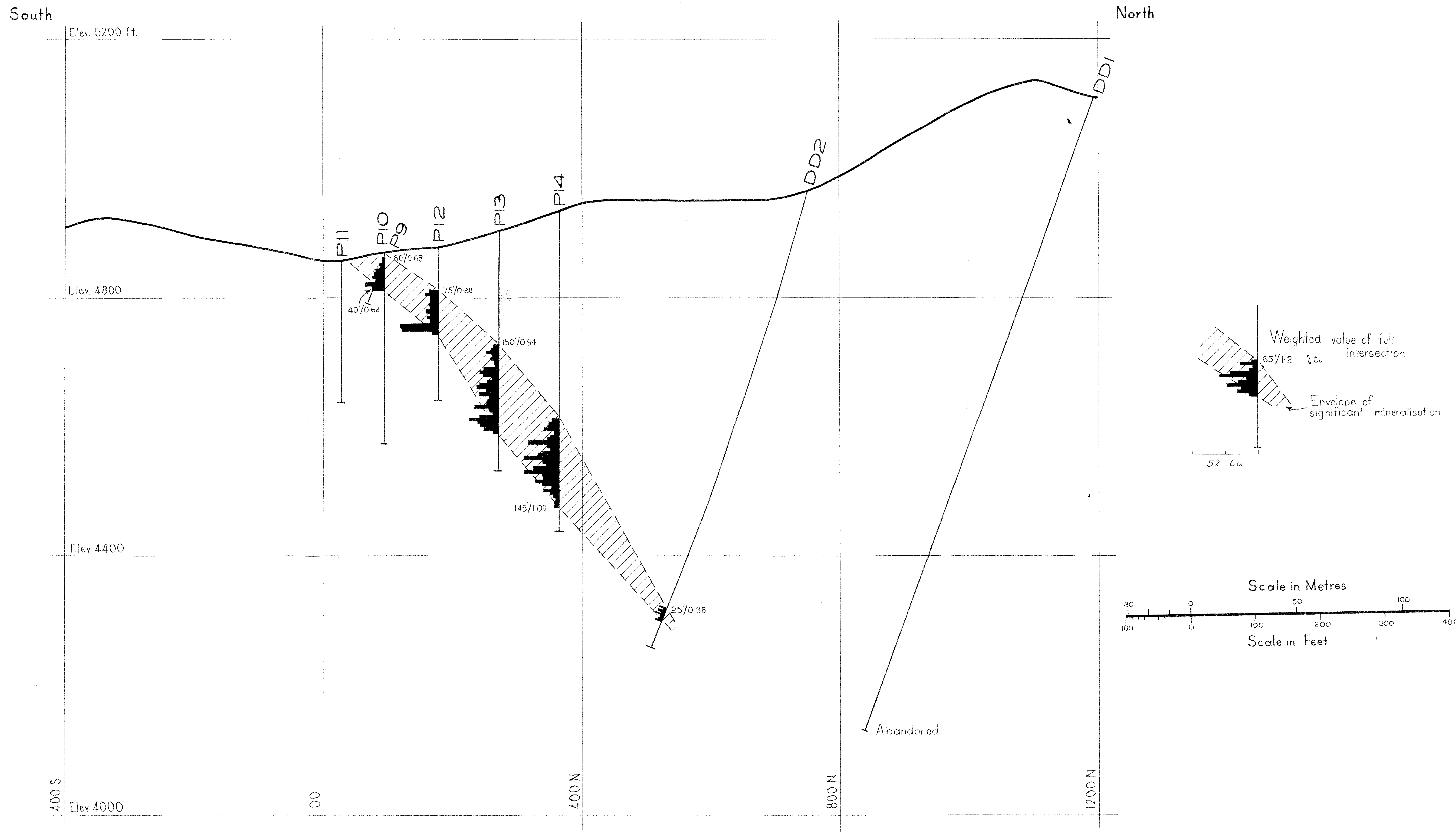
CROSS - SECTION 1200 W
PARABAKANA PROSPECT
(from North Flinders Mines N.L.)
Scale: 1" = 100'



DEPARTMENT OF MINES — SOUTH AUSTRALIA

PARABARANA PROSPECT
SECTION OOW
(NORTH FLINDERS MINING LTD)

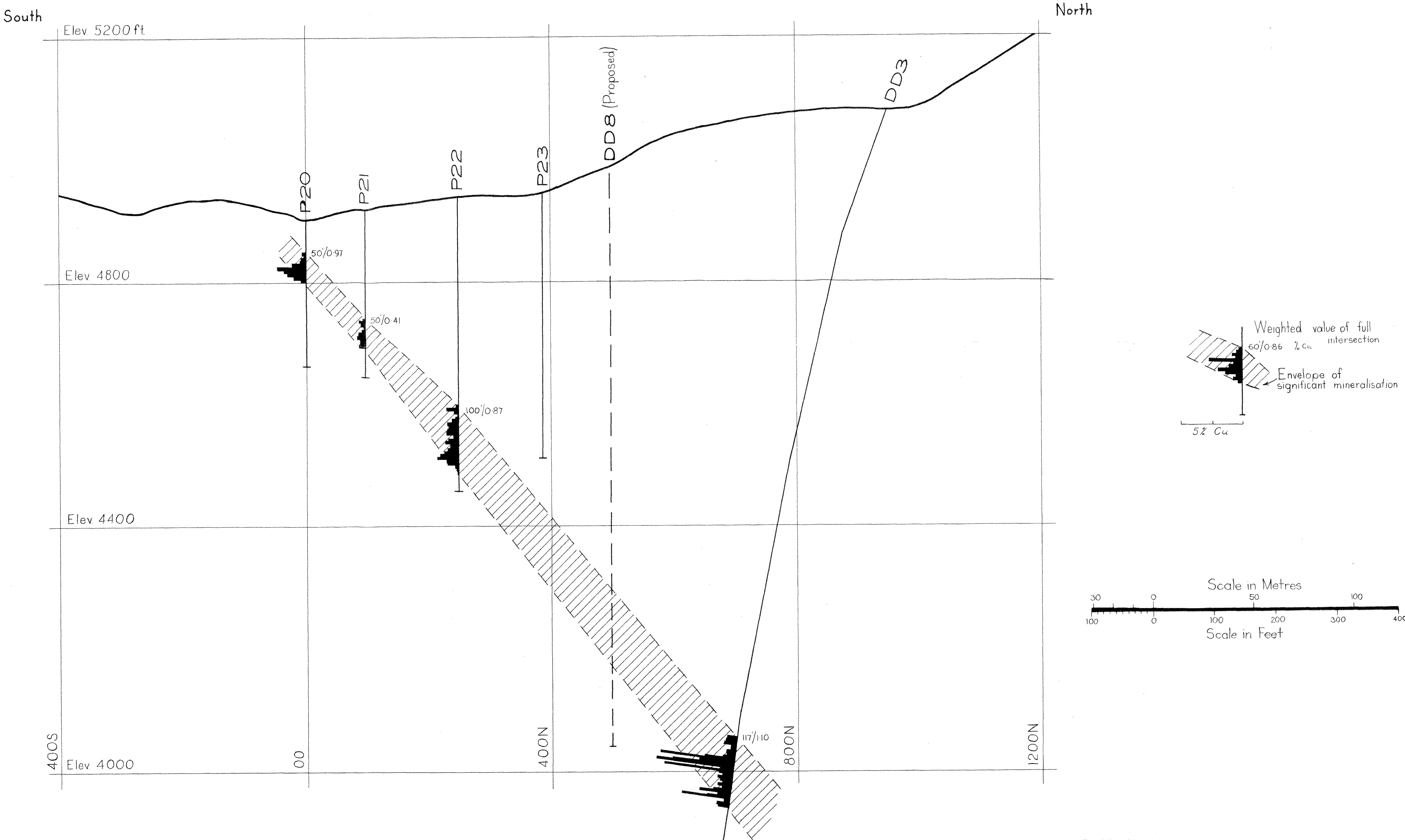
MINERAL RESOURCES DIVISION	Drn. J. G-S.	SCALE: 1" = 100' (original)
	Tcd. A. McL.	72 - 71 Cd
	Ckd.	
Director of Mines	Exd.	DATE: 22 FEB 1972



DEPARTMENT OF MINES — SOUTH AUSTRALIA

PARABARANA PROSPECT
SECTION 400W
(NORTH FLINDERS MINING L.T.D.)

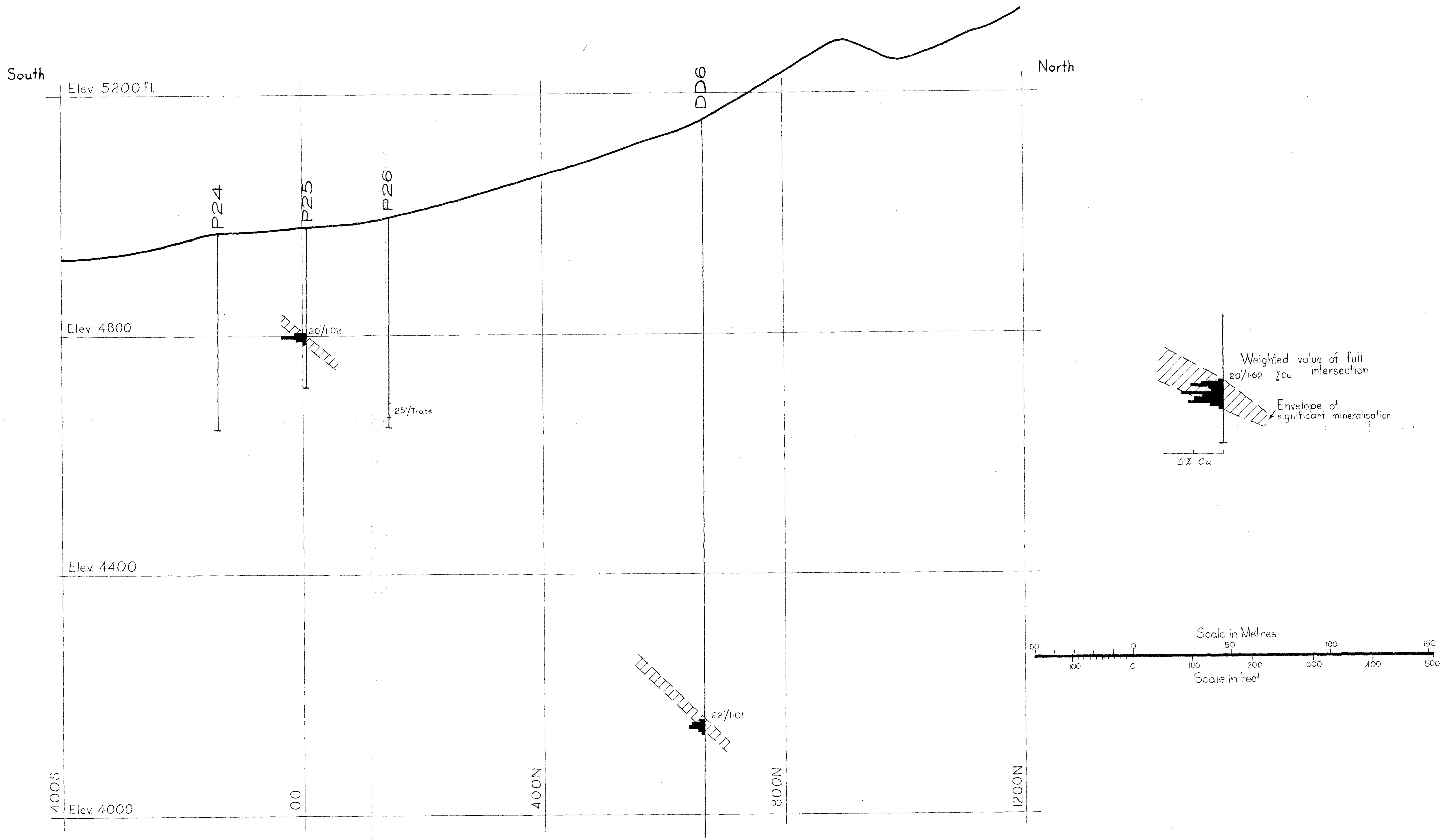
MINERAL RESOURCES DIVISION	Drn. J.G-S.	SCALE: 1" = 100' (original)
	Tcd. A. McL.	72 - 72 Cd
	Ckd.	
Director of Mines	Exd.	DATE: 22 / 2 / 72



DEPARTMENT OF MINES — SOUTH AUSTRALIA

PARABARANA PROSPECT
SECTION 800W
(NORTH FLINDERS MINING L.T.D)

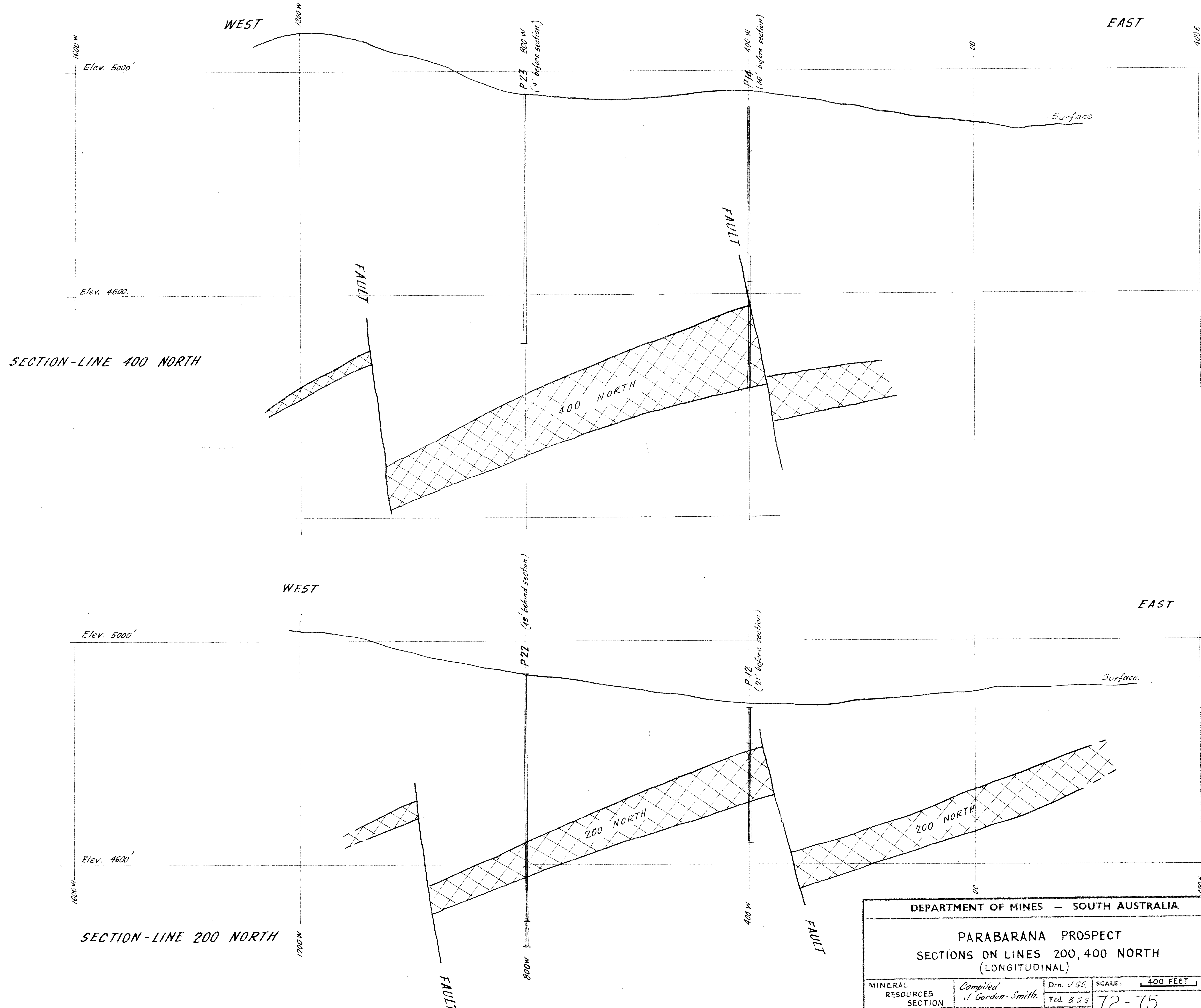
MINERAL RESOURCES DIVISION		Drn. J. G-S.	SCALE: 1" = 100' (original)
		Tcd. A. McL.	72 - 73 Cd
		Ckd.	
Director of Mines		Exd.	DATE: 22 FEB. 1972



DEPARTMENT OF MINES — SOUTH AUSTRALIA

PARABARANA PROSPECT
SECTION 1200W
(NORTH FLINDERS MINING L.T.D.)

MINERAL RESOURCES DIVISION		Drn. J. G-S.	SCALE: 1" = 100' (original)
		Tcd. A. McL.	72 - 74 Cd
		Ckd.	
Director of Mines		Exd.	DATE: 22 FEB. 1972



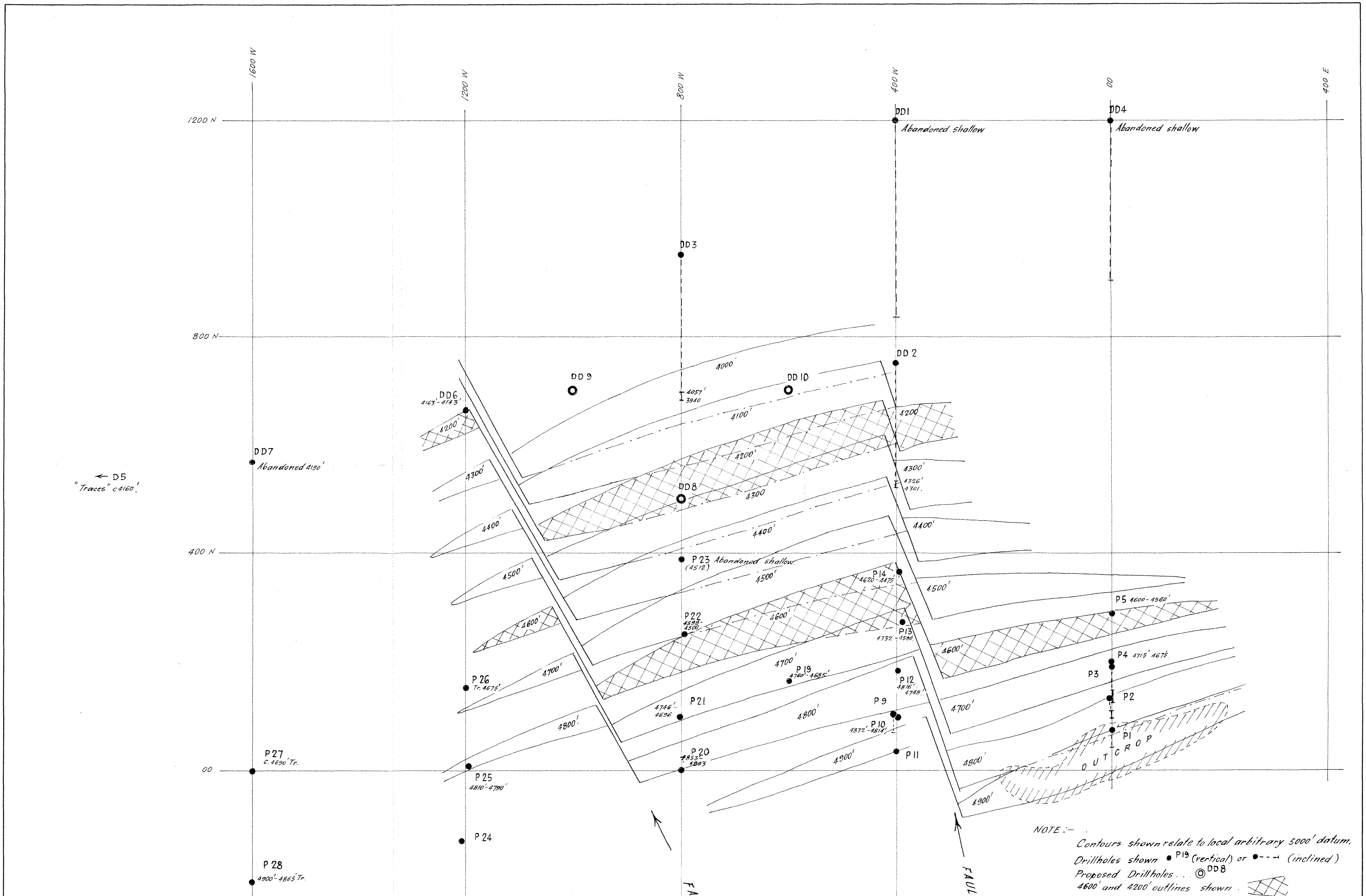
DEPARTMENT OF MINES — SOUTH AUSTRALIA

PARABARANA PROSPECT

SECTIONS ON LINES 200, 400 NORTH

(LONGITUDINAL)

MINERAL RESOURCES SECTION	Compiled J. Gordon-Smith.	Drn. J.G.S.	SCALE: 400 FEET
		Tcd. B.S.G.	72-75 Cd
		Ckd.	
Director of Mines		Exd.	DATE: 21st February 1972

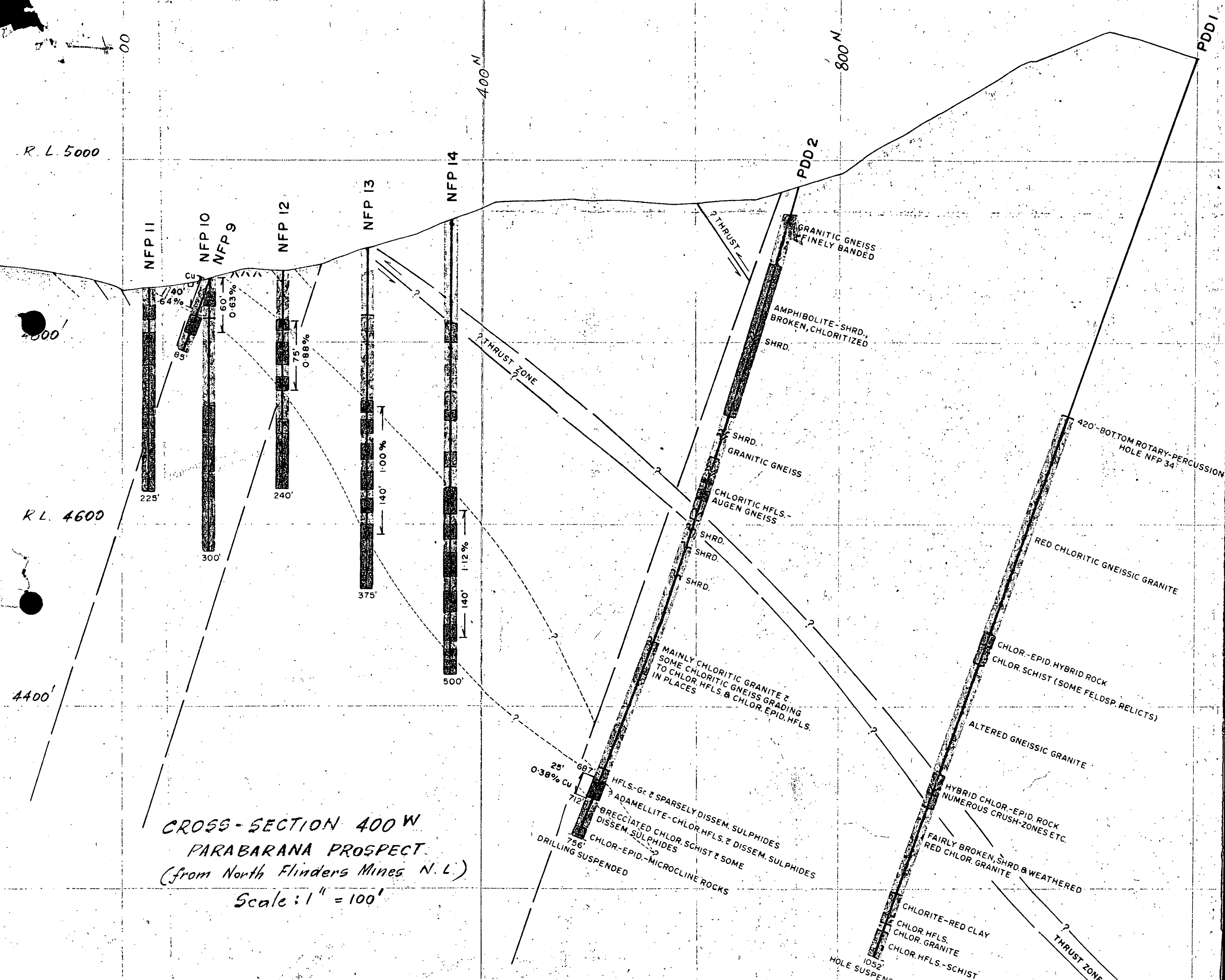


DEPARTMENT OF MINES — SOUTH AUSTRALIA

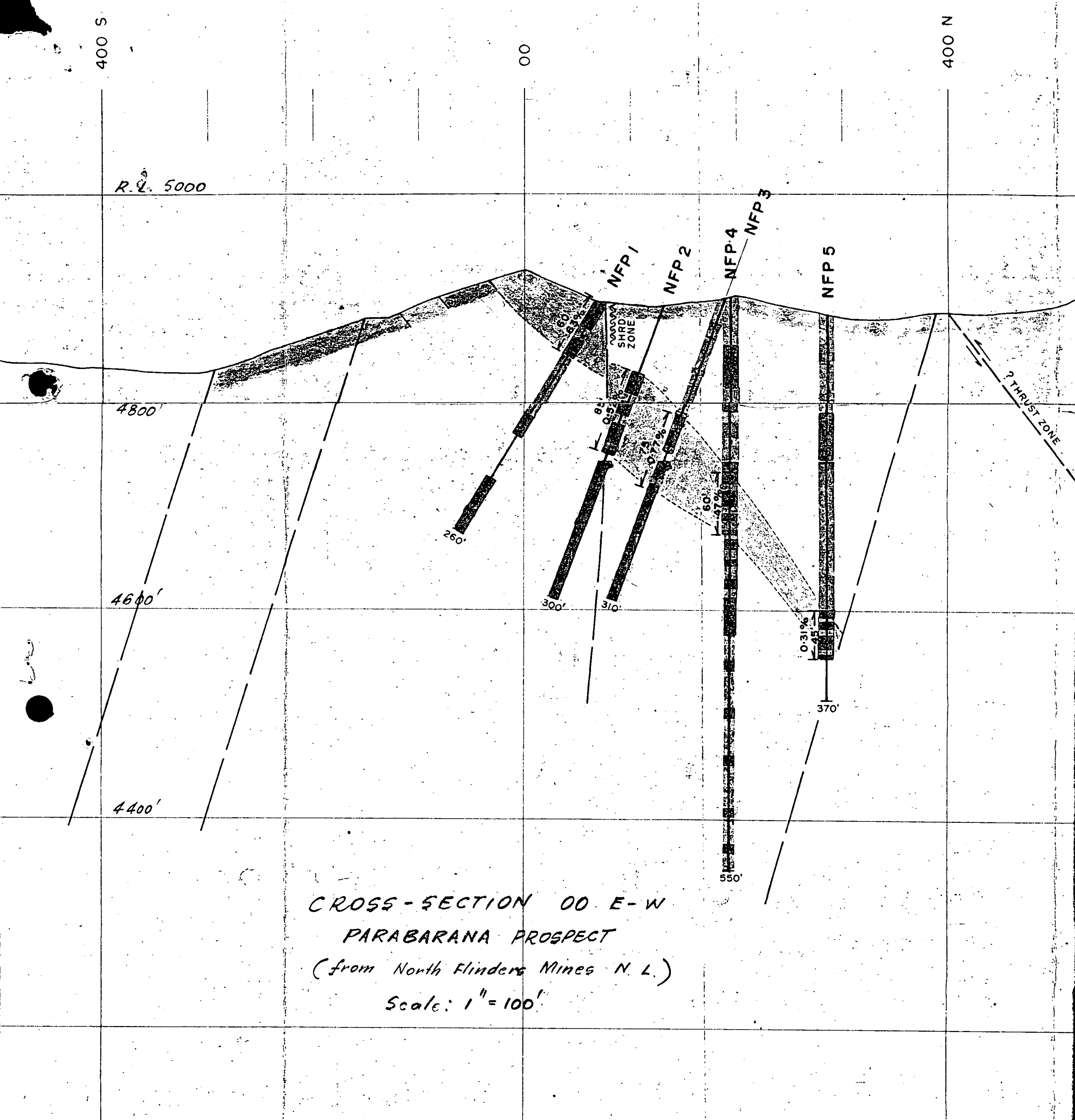
PARABARANA PROSPECT
STRUCTURAL CONTOURS
OF ORE ZONE

MINERAL RESOURCES SECTION	Compiled :- J. Gordon-Smith	Drn. J.G.S.	SCALE : 100 FEET
		Tcd. B.S.G.	72-76 Cd
		Ckd.	
Director of Mines		Exd.	DATE : 21st February 1972

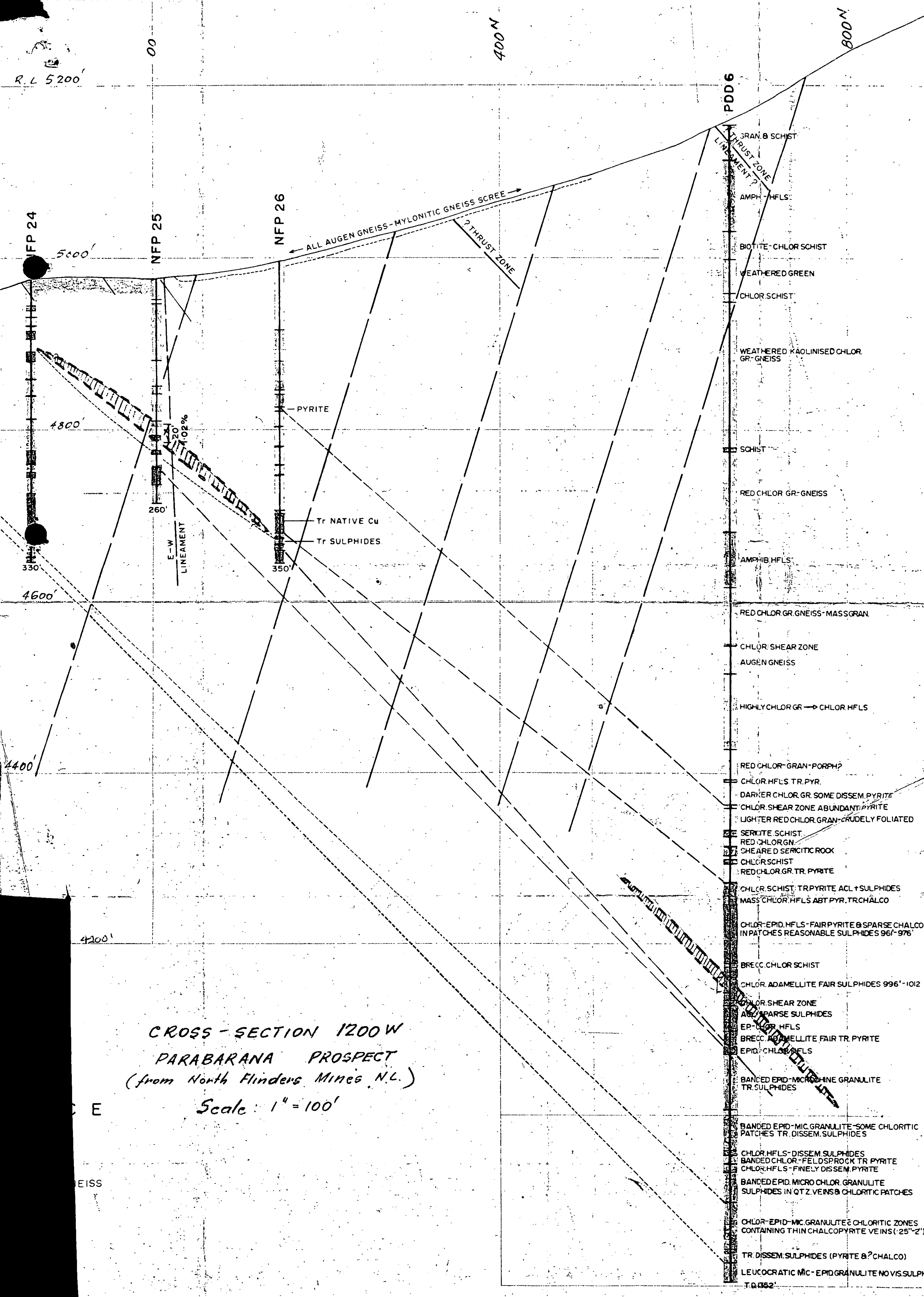

N
BASELINE 00
BASELINE 5S
R O A D
OUTCROP
LEGEND
Percussion Drillhole
Diamond Drillhole
Proposed Diamond Drillhole
SCALE IN METRES
200 0 200 400 600
400 0 400 800 1200 1600 2000
SCALE IN FEET
AFTER NORTH FLINDERS MINES N.L. DRG.Nº 297-100
DEPARTMENT OF MINES — SOUTH AUSTRALIA
PARABARANA COPPER PROSPECT
SURFACE PLAN
MINERAL RESOURCES SECTION
Director of Mines
Drn. J.G-S.
Tcd. A.G.R.
Ckd. L.V.W.
Exd.
SCALE: AS SHOWN
72-117 Cc
DATE: 14TH MARCH 1972

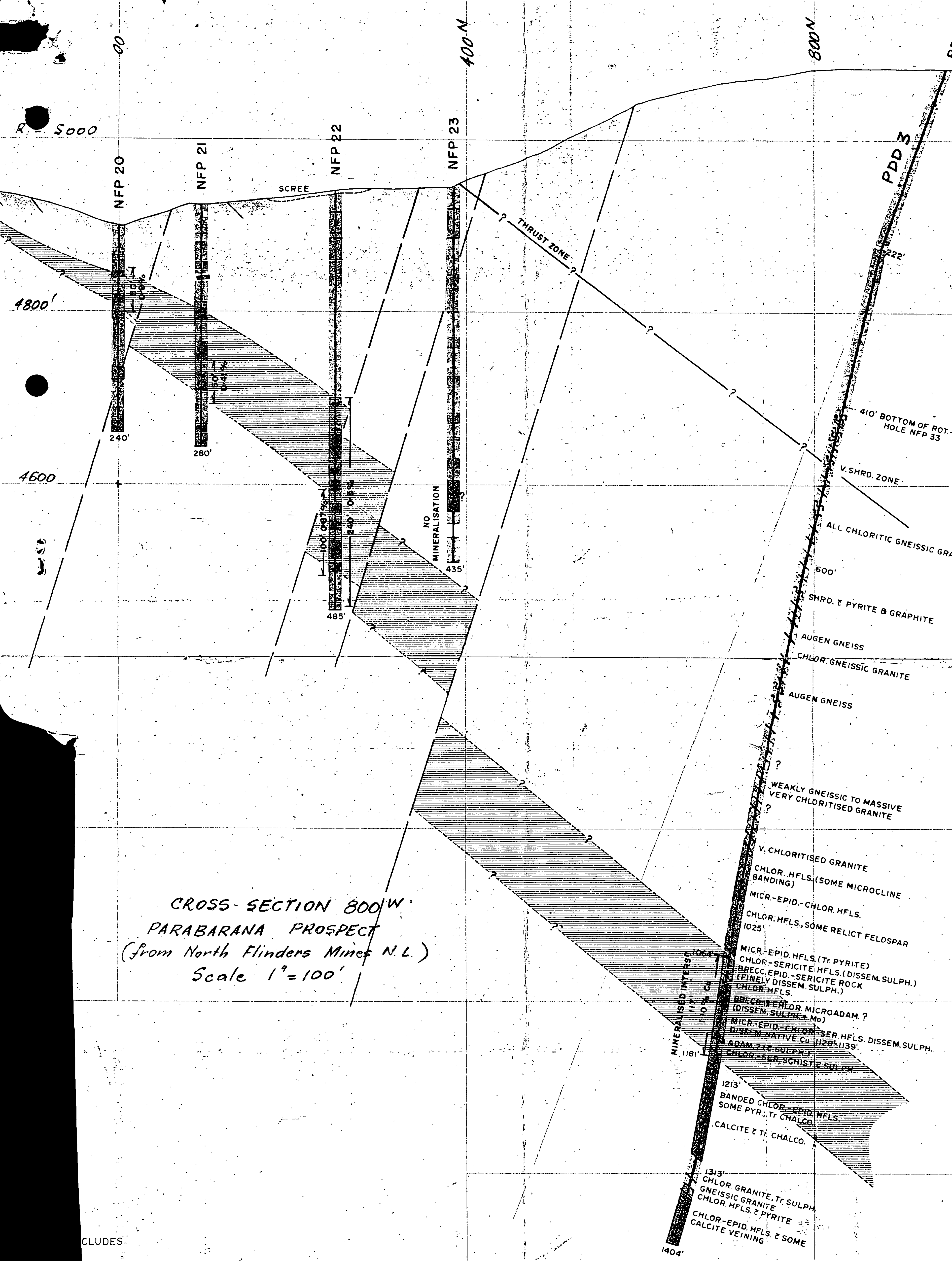


CROSS-SECTION 400 W
PARABARANA PROSPECT
(from North Flinders Mines N.L.)
Scale: 1" = 100'

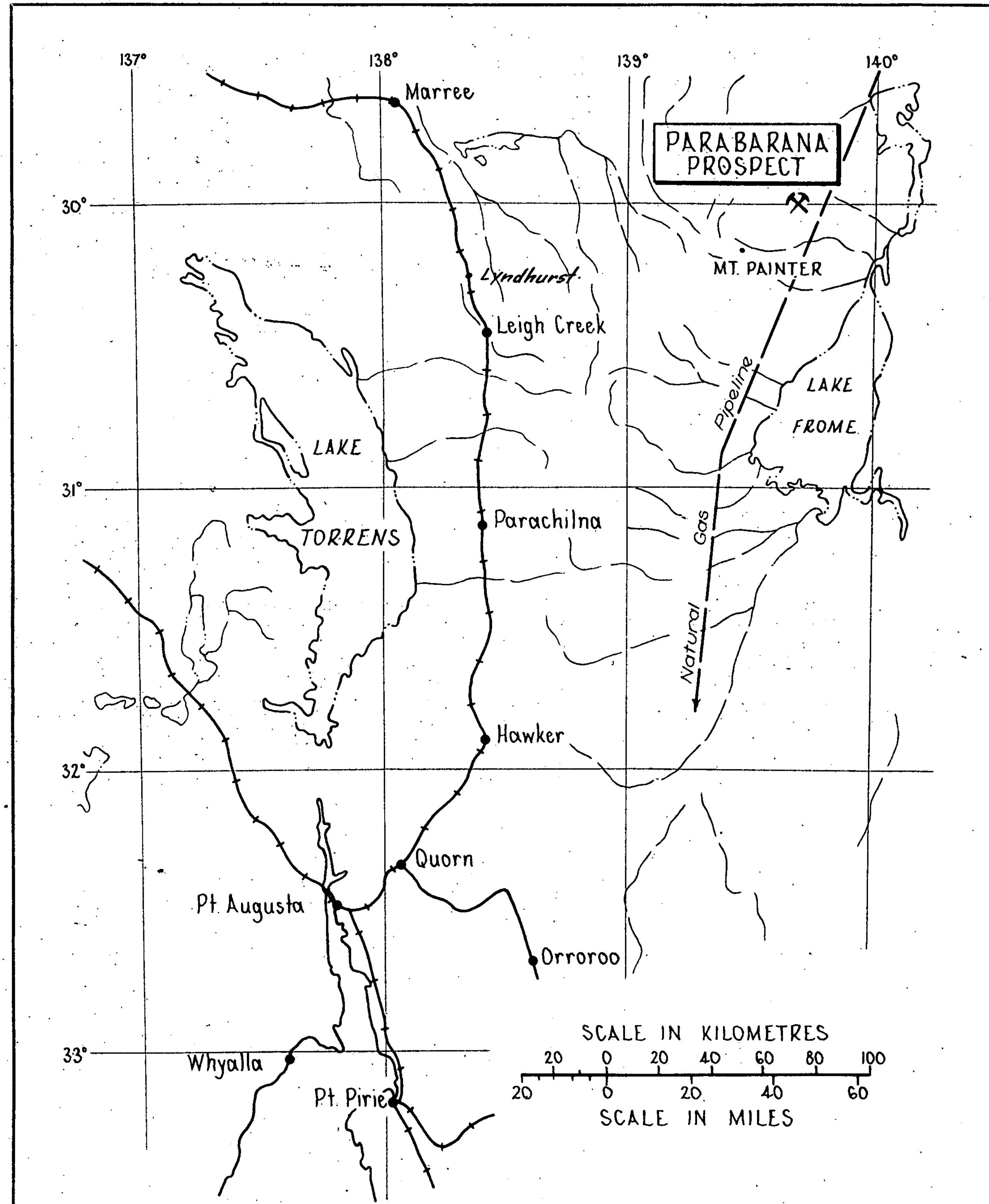


CROSS-SECTION 00 E-W
PARABARANA PROSPECT
(from North Flinders Mines N.L.)
Scale: 1" = 100'


R.L 5200'
00
400 N
800 N
PDD 6
NFP 24
NFP 25
NFP 26
5000'
4800'
4600'
4400'
4200'
ALL AUGEN GNEISS - MYLONITIC GNEISS SCREE
? THRUST ZONE
THRUST ZONE
LINEAMENT ?
E-W LINEAMENT
PYRITE
20
4.02%
260'
Tr NATIVE Cu
Tr SULPHIDES
330'
350'
GRAN. & SCHIST
AMPH.-HFLS.
BIOTITE-CHLOR SCHIST
WEATHERED GREEN
CHLOR. SCHIST
WEATHERED KAOLINISED CHLOR. GR.-GNEISS
SCHIST
RED CHLOR GR-GNEISS
AMPHIB. HFLS.
RED CHLOR. GR. GNEISS-MASS GRAN.
CHLOR. SHEAR ZONE
AUGEN GNEISS
HIGHLY CHLOR GR → CHLOR. HFLS
RED CHLOR-GRAN-PORPH?
CHLOR. HFLS TR. PYR.
DARKER CHLOR. GR. SOME DISSEM. PYRITE
CHLOR. SHEAR ZONE ABUNDANT PYRITE
LIGHTER RED CHLOR. GRAN-CRUDELY FOLIATED
SERICITE SCHIST
RED CHLOR. GN.
SHEARED SERICITIC ROCK
CHLOR. SCHIST
RED CHLOR. GR. TR. PYRITE
CHLOR. SCHIST TR. PYRITE ACL + SULPHIDES
MASS CHLOR. HFLS ABT PYR. TR. CHALCO
CHLOR-EPID. HFLS-FAIR PYRITE & SPARSE CHALCO IN PATCHES REASONABLE SULPHIDES 961'-976'
BRECC. CHLOR SCHIST
CHLOR. ADAMELLITE FAIR SULPHIDES 996'-1012
CHLOR. SHEAR ZONE
SPARSE SULPHIDES
EP-CHLOR. HFLS
BRECC. ADAMELLITE FAIR TR. PYRITE
EPID.-CHLOR. HFLS
BANDED EPID-MICROCLINE GRANULITE TR. SULPHIDES
BANDED EPID-MIC. GRANULITE-SOME CHLORITIC PATCHES TR. DISSEM. SULPHIDES
CHLOR. HFLS-DISSEM. SULPHIDES
BANDED CHLOR.-FELDSPROCK TR PYRITE
CHLOR. HFLS-FINELY DISSEM. PYRITE
BANDED EPID. MICRO CHLOR. GRANULITE SULPHIDES IN QTZ. VEINS & CHLORITIC PATCHES
CHLOR-EPID-MIC. GRANULITE c CHLORITIC ZONES CONTAINING THIN CHALCOPYRITE VEINS (·25"-2")
TR. DISSEM. SULPHIDES (PYRITE & ? CHALCO)
LEUCOCRATIC MIC-EPID GRANULITE NO VIS. SULPH
T.D. 1152'
CROSS - SECTION 1200 W
PARABARANA PROSPECT
(from North Flinders Mines N.L.)
Scale: 1" = 100'
E
EISS

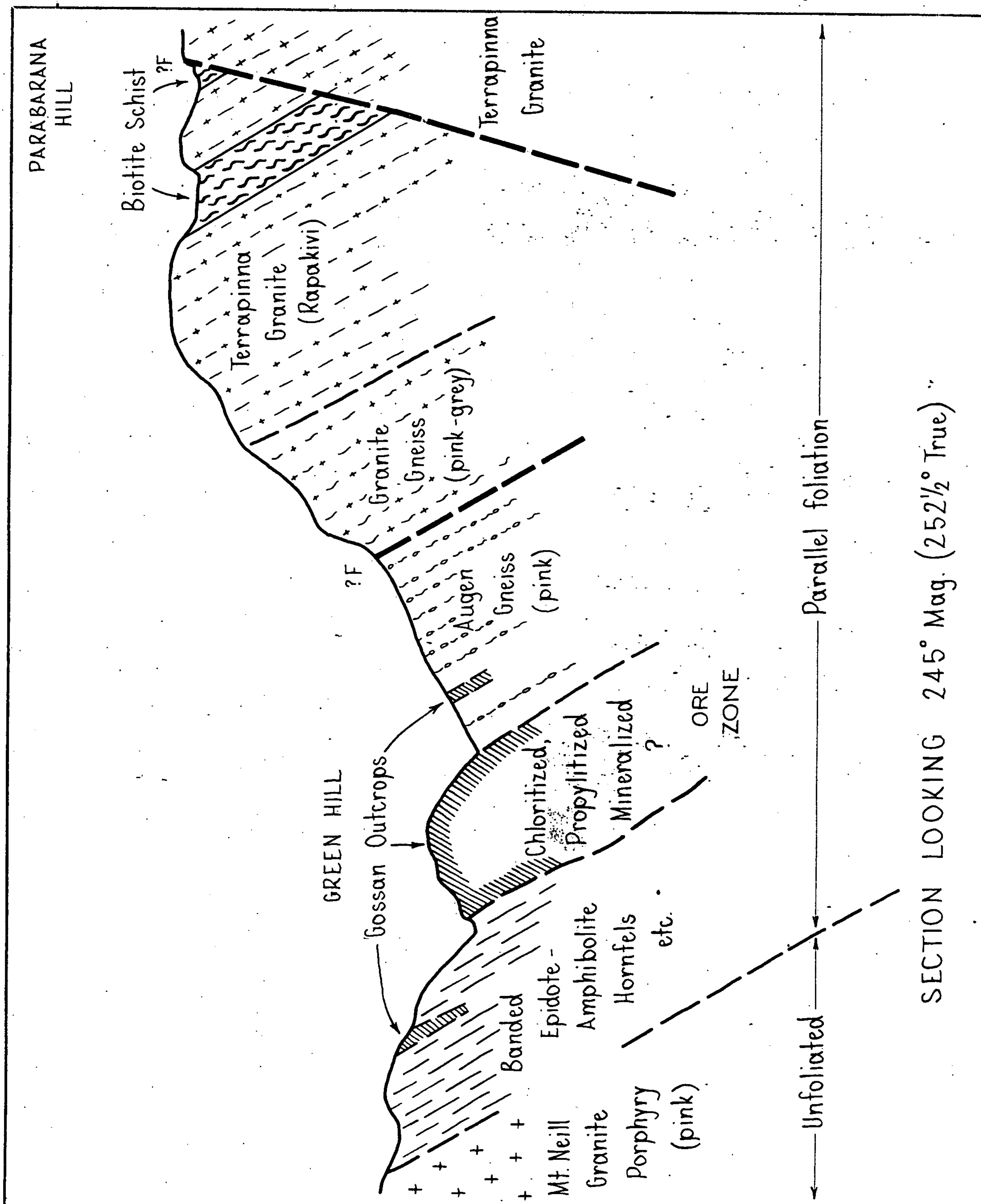


CROSS-SECTION 800 W
PARABARANA PROSPECT
(from North Flinders Mines N.L.)
Scale 1" = 100'



METALLIC MINERALS SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: As shown
Compiled:	PARABARANA PROSPECT LOCALITY MAP	Date: 21 Feb 1972
Drn. R.H. Ckd.		Drg. No. S9680 Cc

1M-2.70 A1810



METALLIC MINERALS SECTION	**DEPARTMENT OF MINES – SOUTH AUSTRALIA**	Scale: Diagrammatic
Compiled: J. G-S.	PARABARANA PROSPECT	Date: 21 Feb 1972
Drn. R.H. Ckd.	GENERALISED GEOLOGICAL SECTION	Drg. No. S9681 Cc

IM–2.70 A1810