NORTHERN TERRITORY GEOLOGICAL SURVEY

REPORT GS 80/1

GROUND MAGNETOMETER SURVEY OVER THE MUD TANK CARBONATITE OCCURRENCE

Alice Springs 1:250 000 Sheet Area SF 53-14

by

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1 INTRODUCTION

1.1 General

The Mud Tank carbonatite occurrence is located at 134°16'E longitude and 23°01'S latitude approximately 88 km north-northeast of Alice Springs.

Access to the occurrence is via Stuart Highway for 70 km (bitumen) then for 85 km along the formed Plenty Highway to Mud Tank bore thence for 5 km along a graded station track. The locality is shown on Plate 1.

1.2 Previous Work

The existence of widely scattered detrital magnetite, apatite and zircon first drew attention to this locality.

The first mention of the existance of zircons, in the area was a short note in AGGSNA Annual Report for 1940 (Anon 1941). More detailed accounts were given by Jensen (1944) and Owen (1944) who considered the carbonatite rocks to be metamorphosed sedimentary limestones. He examined the area as a possible source of phosphate.

In 1965 Bureau of Mineral Resources carried out a detailed low level airborne magnetometer survey of the area (Tipper 1966).

In 1966 Geopeko mapped four carbonate lenses which they named from east to west Enterprise 2, 3, 4 and 5 and carried out diamond drilling on Enterprise 2 and 3. The drilling consisted of three vertical holes of 30.5, 52 and 61 metres respectively and one inclined hole of 218 metres (167 m true depth) (Williams 1967). Williams considered the possibility that the carbonate rocks were in fact carbonatites but owing to the lack of fenitization and prominent banding which he regarded as relic bedding he discared this idea.

Crohn after inspecting a number of Canadian

carbonatite complexes suggested that the Mud Tank occurrences are in fact carbonatites. He and Gallatly gave a preliminary account of the occurrence (Crohn and Gallatly 1968, 1969). Subsequently Gallatly gave a more detailed account of a number of specimens from Geopeko drill cores and outcrops (Gallatly 1969).

In 1969 NTGS (then Mines & Water Resources Branch, Northern Territory Administration) carried out a further drilling program consisting of four holes. Holes A, D & E were drilled on Enterprise 3. These were inclined holes of respectively 138.7 m (106 m true depth) 153 m (117.9 m) and 89.8 m (68.8 m). One inclined hole (Hole B) was drilled on Enterprise 2. This was of 153 m or 117 m true depth. Crohn after detailed examination of core from these holes and surface specimens concluded that the Mud Tank carbonatite complex consists of three major groups of rocks with a number of minor phases (Crohn 1971). Crohn suggested that further investigations should be carried out to ascertain if vermiculite existed in economic qualities.

BMR carried out regional geological programs as well as a regional gravity survey of the area between 1968 and 1976 (Stewart et al 1976). In part of 1978 and 1979 NTGS carried out a detailed geological mapping program of the area immediately surrounding the known outcrops of carbonatites together with auger drilling at 50 m intervals along lines 100 m and in places 200 m apart. The main emphasis in these investigations was determining if the vermiculite occuring within the carbonatites could be economically mined. (Moore 1979).

Owing to the existence of magnetite-rich bands throughout the carbonatites the writer carried out a detailed magnetometer survey of the area covered by Moore's investigations with some subsequent extensions and infills in an attempt to delineate the extent of carbonatites under alluvial cover.

The details of the geologica mapping program as carried out by Moore is shown on Plate 2. This was re-drafted

from his original work but on a different grid orientation from that used in his report.

2 GEOLOGY

Most of the following discourse on the geology of the Mud Tank areas has been gleaned from Williams (1967), Crohn (1971) and Moore (1979).

It should be remembered that they all had different aims in their investigations. Williams' work was on the possibility of the deposit being an economic source of phosphate. Crohn's main objective was to prove that it was indeed carbonatite while Moore was concerned with the vermiculite.

2.1 Host Rocks

The Mud Tank carbonatites occur within the Arunta Complex a sequence of high grade metamorphic rocks forming much of the crystalline basement in central Australia.

The Arunta complex consists dominantly of gneiss-schist sequences. In the Strangways Ranges the rocks are mainly felsic and mafic granulites and amphibolites with minor marble and calc-sylicates. To the south of the prospect the rocks are leucocratic and felsic gneisses and biotite-muscovite schists. Most of the outcrops in the immediate vicinity of the carbonatite show shearing, quartz veining and other evidence of deformation.

Hypersthene gabbro occurs some 1.5 km to the west of Enterprise 3 with another occurrence further 2.5 km west.

There appears to be sufficient evidence to show that even if some of the host rocks were of igneous origin they are unrelated to the carbonatites.

2.2 Carbonatites

When Williams originally mapped the area he divided the carbonate rich rocks into 'micaceous marble' and 'mineralized' viz apatite rich marble.

Subsequent to the realization of their igneous origin Crohn subdivided the carbonatites into three major rock types with some minor phases. His classification is based mainly on the examination of core from NTGS and Geopeko drilling.

Crohn's classification is as follows:

a) Crystalline Carbonate Rocks with subordinate apatite, magnetite, phlogopite, chlorite and soda-amphibole.

b) Foliated Micaceous Carbonate Rocks - in addition to carbonates these contain a pale brown biotite as a major constituent. Subordinate soda-amphibole with minor apatite and magnetite might be present.

c) Feldspathic Carbonate Rocks - these consist of sodic plagioclase, clino-pyroxene, green brown amphibole, brown biotite, minor carbonates and traces of pyrite.

Minor phases in Crohn's classification include pegmatite veins, bands of coarsely grained rock composed almost entirely of amphibole and biotite in varying proportions plus in one hole only, a 30 cm band composed almost entirely of large serpentisized olivine crystals occurring at a depth of 128 metres. Crohn suggests that this olivine band might indicate a possible relationship with the rocks on the vicinity of the phlogopite mine some 22 km to the southwest of Mud Tank. Rocks at the phlogopite mine include dunite peridotite pyroxenite hyperthene gabbro, amphibolite and magnetite rich rocks.

Typical carbonatite complexes are composed of carbonate rocks in close association with complex

ultrabasic-alkali intrusions. The host rocks into which the carbonatite complexes are intruded undergo alkaline measomatism resulting in formation of characteristic fenites. In the case of the Mud Tank occurrence, ultramafic rocks are not present and neither are fenites.

It is concluded therefore that the Mud Tank occurrence is not a typical carbonatite complex but an offshoot in a form of a complex dyke composed of carbonatite rocks only.

3 REGIONAL MAGNETIC SETTING

The regional airborne magnetometer surveys carried out by the Bureau of Mineral Resources Geology and Geophysics (BMR) indicate that the Mud Tank carbonatite deposit occurs near an intersection of some pronounced magnetic lineaments. One of which is the Woolanga lineament which is a major magnetic and gravity feature defined by BMR regional mapping (Stewart et al 1976). Plate 3 which is a composite of a part of the total magnetic intensity map of the Alice Springs 1:250 000 Map Sheet (BMR Map No 53/B1-80) and a part of the Alcoota 1:250 000 Sheet (preliminary edition).

The lineaments as interpreted by the writer are indicated and are considered to represent magnetic reflection of a major regional and deep seated fault or rift system. It is thought that this sytem provided lines of weakness along which the carbonatites were injected from depth into a locally favourable near surface structures.

It should be pointed out here that the phlogopite mine referred to by Crohn also occurs right at an intersection of two major lineaments. The mine locality is also indicated on Plate 3.

The coincidence that both the Mud Tank occurrence and the phlogopite mine occur at intersection of major magnetic lineaments and the possible geological link between them suggests that further investigations in the vicinity of the phlogopite mine and possible other lineament intersections should be undertaken in future.

4 GROUND MAGNETOMETER SURVEY

The grid originally covered by the ground magnetometer survey is shown on Plate 4 together with subsequent extensions and infills. The instrument employed throughout the survey was the Geometrics Total Force Model G816 Portable Proton Magnetometer. A back-pack mode of operation was employed. Readings were obtained at 10 metre intervals along the original N-S traverses and at 20 metre spacings along the infills and extensions.

Pegging along all traverses was at 50 metre intervals and the intermediate distances between magnetic observations were stepped out.

Traverses 10 000N and 10 700N were used as base lines for drift corrections. As however successive readings at the base line stations did not vary by more than 3 to 4 nT no corrections were applied.

5 PRESENTATION OF DATA

The results as obtained in the field, were originally plotted in full at a scale of 1:2 000 and contouring was attempted. The existence of numerous spikes in areas where the magnetite rich bands of the carbonatites outcrop or come near to the surface made the contouring too complex for a meaningful interpretation of the data. However, it was noticed that some of the spikes correlated well, line to line, over distances of up to 800 metres.

In order to remove the spike problem the results for each line were plotted in a profile form, at a scale of 1:2 000. The profiles were then smoothed of all the spikes. This was done arbitrarily i.e. by the eye-ball method. Although this method is less objective than the author would like, it did provide the required result.

Both the original and smoothed out profiles were drafted at a scale of 1:2 000 but are not included in this report.

The total magnetic intensity values were read off the smoothed profiles plotted at a scale of 1:2 000 and contoured.

The contours were then reduced to the scale of 1:5 000 and drafted. The final result is shown on Plate 5.

6 DESCRIPTION OF RESULTS AND INTERPRETATION

The major magnetic high-low closures coincide remarkably well with the outcrops of Enterprise 2, 3, 4 and 5 (east to west). Each of the high-low systems straddles a magnetic escarpment. The escarpment represents a sharp increase in magnetic readings of some 300 nT and is apparent on all the traverses with the exception of 10 600E, 10 700 and 10 800E. This feature is thought to represent a major structure (fault or shear).

The magnetic responses over or near Enterprise 2, 3 and 4 have many similarities. In each case the high-low system coincides with the outcrop; each has a secondary high to the northeast of the high-low. Enterprise 5 exhibits a high-low similar to the others but apparently without the secondary high.

Between Enterprise 4 and 5 there are two closures with higher magnetic values which are considered to be possibly due to the existence of hereto unsuspected additional occurrences of carbonatites. The closure closer to Enterprise 4 with highest values along traverse 7600E is similar in pattern to the others with the exception of the poorly developed low. It too has a secondary high to the northeast. The west closure centred at 7100E - 10 500N could possibly represent the apparently missing secondary high of Enterprise 5.

7 At present no explanation can be given as to why the secondary highs exist. If Enterprise 4 had been a single high then this phenomenon could possibly be explained by a fault running from approximately 7600E - 10 650N to

10 500E - 10 750N.

No mathematical treatment of the magnetic responses was possible in this interpretation owing to the banded nature of the occurrence, with the apparently haphazard distribution of magnetite rich bands of varying thickness and owing to the magnetite scree on the slopes of the hills containing the main outcrops.

However, from all the considerations given to the subject the following interpretation of the results is suggested.

The magnetic escarpment mentioned previously is thought to reflect a major shear (or fault) at depth and running along the whole length of the area under investigation. This structure is thought to have provided a line of weakness along which the carbonatites were injected.

It is considered that firstly the carbonatites were forced vertically or near vertically (as a series of plugs) up the postulated fault. The positions of the plugs are shown on the interpretation map on Plate 6. From the plugs the carbonatites were forced sub-horizontally in the north-easterly direction along a different line of weakness (jointing?) in a form of sills.

The model applies to all Enterprise occurrences but particularly to Enterprises 2 and 3 where the areal extent of the interpreted sill is comparatively large. There is no magnetic evidence of the existence of any carbonatites to the south of the postulated shear (fault).

The suggested model of the emplacement of the carbonatites is shown below.

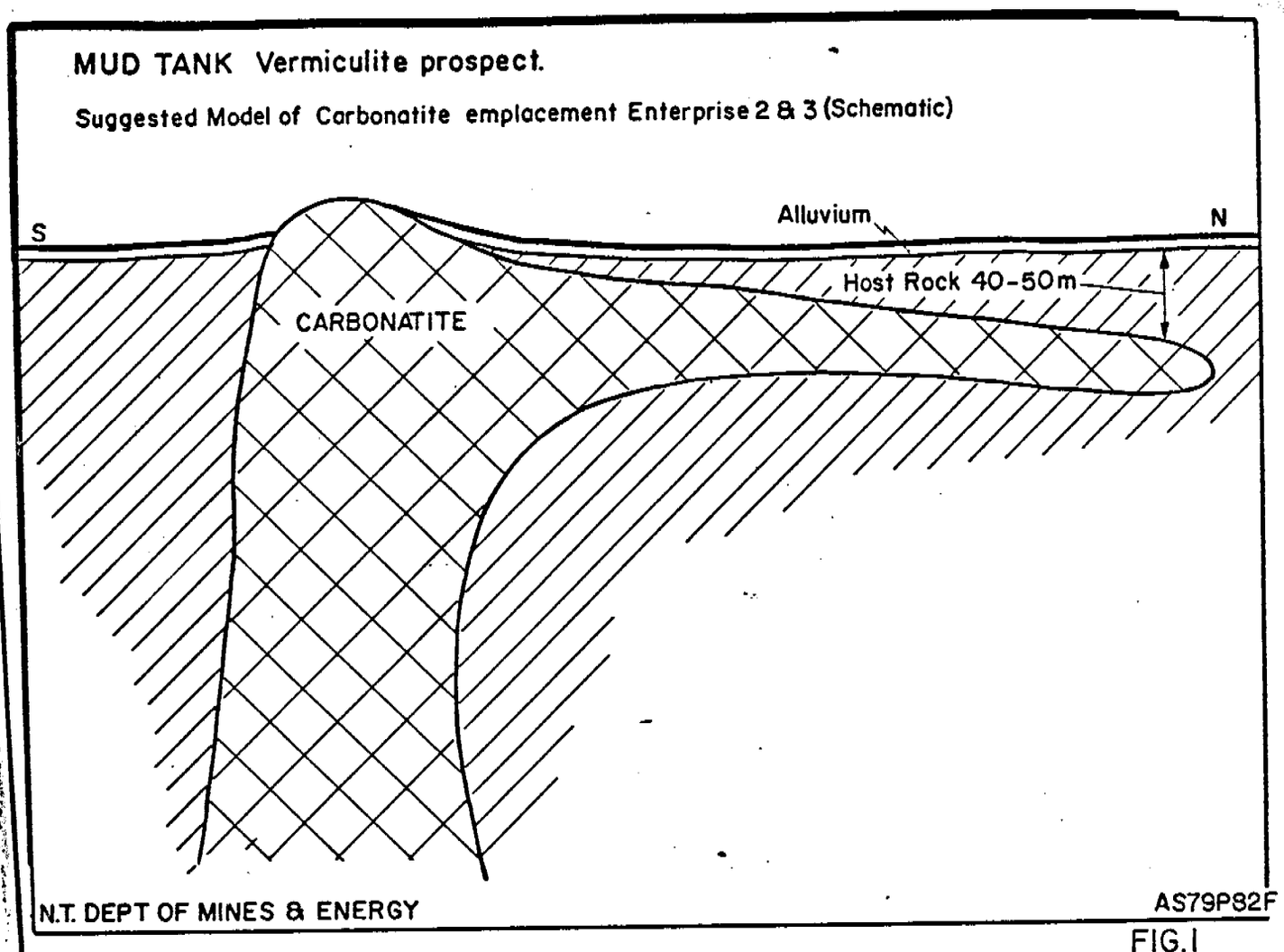

FIG.1

The areal extent of the vermiculite as obtained by Moore from the auger drilling results is shown on the interpretation map (Plate 6) together with the extent of the carbonatites as interpreted from the ground magnetics.

The latter necessarily reflects the extent of the magnetite rich rocks and not the vermiculite per se. The good correlation between the geological and geophysical interpretations on the eastern and southern flanks of Enterprise 2 for example suggests that the mica rich and magnetite rich rocks are in fact so intermingled that the geophysically

expected boundaries of magnetite rich rocks in all probability coincide also with the boundaries of mica rich rocks.

The sub-horizontal lines of weakness which enabled the carbonatites to form still-like intrusions might also enable water to seep downwards or circulate along and thus to hydrate the biotite to vermiculite.

Moore suggests that the vermiculite appears to have formed from surface weathering processes.

However, in Geopeko DDH 2 and NTGS DDH A two zones of oxidation are apparent. In Geopeko's hole the first base of oxidation is given to approximately 43 metres true depth. Oxidation then reappears at 177 m true depth and is very pronounced in the interval 120.3 to 130 m. Some oxidation is still present at 157.6 m.

In DDH A two bases of oxidation are given (Moore) first at 38 m depth and the second at 70.8 m. This could indicate that the oxidation is either patchy or layered. Thus no firm conclusions can be arrived at as to whether the carbonatites extending sub-horizontally to the north as postulated can be expected to be vermiculitic or not.

The suggestion that the carbonatites are overlain by the host rocks to the north is borne out by the fact that the auger drilling showed intermediate to mafic granulites at the coordinates 9400E - 10 700N and possible mafic granulites at 9400E - 10 800N while DDH A was well and truly in carbonatites at 9400E - 10 730N after first intersecting carbonates at approximate coordinates of 9385E - 10 750N (vertical projection) at the depth of 29 metres.

The additional areas of carbonatites as indicated by the ground magnetic method are considerable, especially in the vicinity of Enterprise 2 and 3.

The two closures between Enterprise 4 and 5 are also thought to contain carbonatites but with a lesser degree of probability.

7 CONCLUSIONS AND RECOMMENDATIONS

It is concluded from the results of the ground magnetometer survey of the area that the carbonatites were injected as a series of plugs along a major deep seated fault and secondly from the plugs in a form of sills along some sub-horizontal line of weakness north of this fault. The largest in area sills are located north of Enterprise 2 and 3.

Two additional zones considered to possibly contain hereto unsuspected carbonatites occur between Enterprise 4 and 5. One is a possible sill-type occurrence associated with Enterprise 5 while the other is thought to be of a small plug and sill type.

It is recommended that the existence of the zones interpretated as likely to contain carbonatites should be investigated by diamond drilling. Six holes are proposed and these are shown on Plate 6.

The holes have been designated DDH 10, 20, 30, 40, 50 and 60 in order that no confusion could arise with the holes drilled previously either by Geopeko or NTGS.

Each proposed hole is of 200 metres length and inclined at 50^{o}.

The whole assemblage of known and interpreted carbonatites is not thought to be a true carbonatite complex but a complex dyke-like intrusion and possibly represents the last stages of carbonatite intrusive activity.

There is a possibility that a geological relationship exists between Mud Tank carbonatites and the rocks at the phlogopite mine to the southwest (Crohn 1971).

As both occur at the intersections of different major lineaments (Plate 3) which in turn are interconnected it is concluded that this possibility is quite likely. It is therefore recommended that further geological and geophysical work should be undertaken in a swathe of land from Mud Tank through the phlogopite mine and extended in a straight line up to and including Burt Plains locality where geophysical investigations are taking place at present (January 1980)

and where a similar lineament pattern is apparent.

The lineament investigation should, in the first instance, consist of a study of existing geological and geophysical data. Photogeology with subsequent field check traversing is suggested as the second stage.

Another area which suggests itself as a possible location of the parent carbonatite complex occurs some 15 km south of Mud Tank where high in value magnetic anomalies interrupt the major NW-SE lineament (Plate 3).

8 REFERENCES

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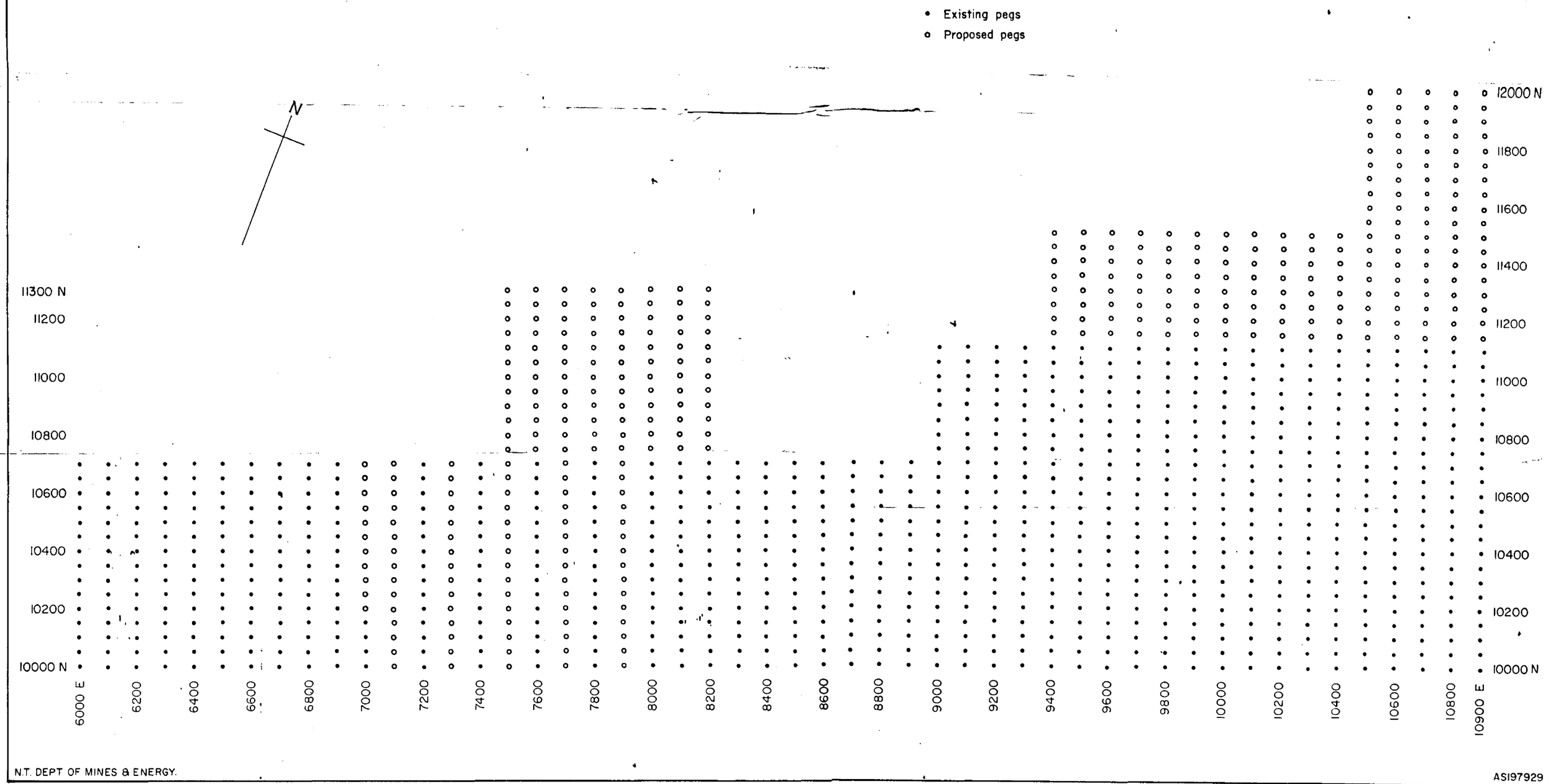
MUD TANK VERMICULITE PROSPECT

Proposed Extentions to the Existing Geophysical Grid.

Scale 1:10000



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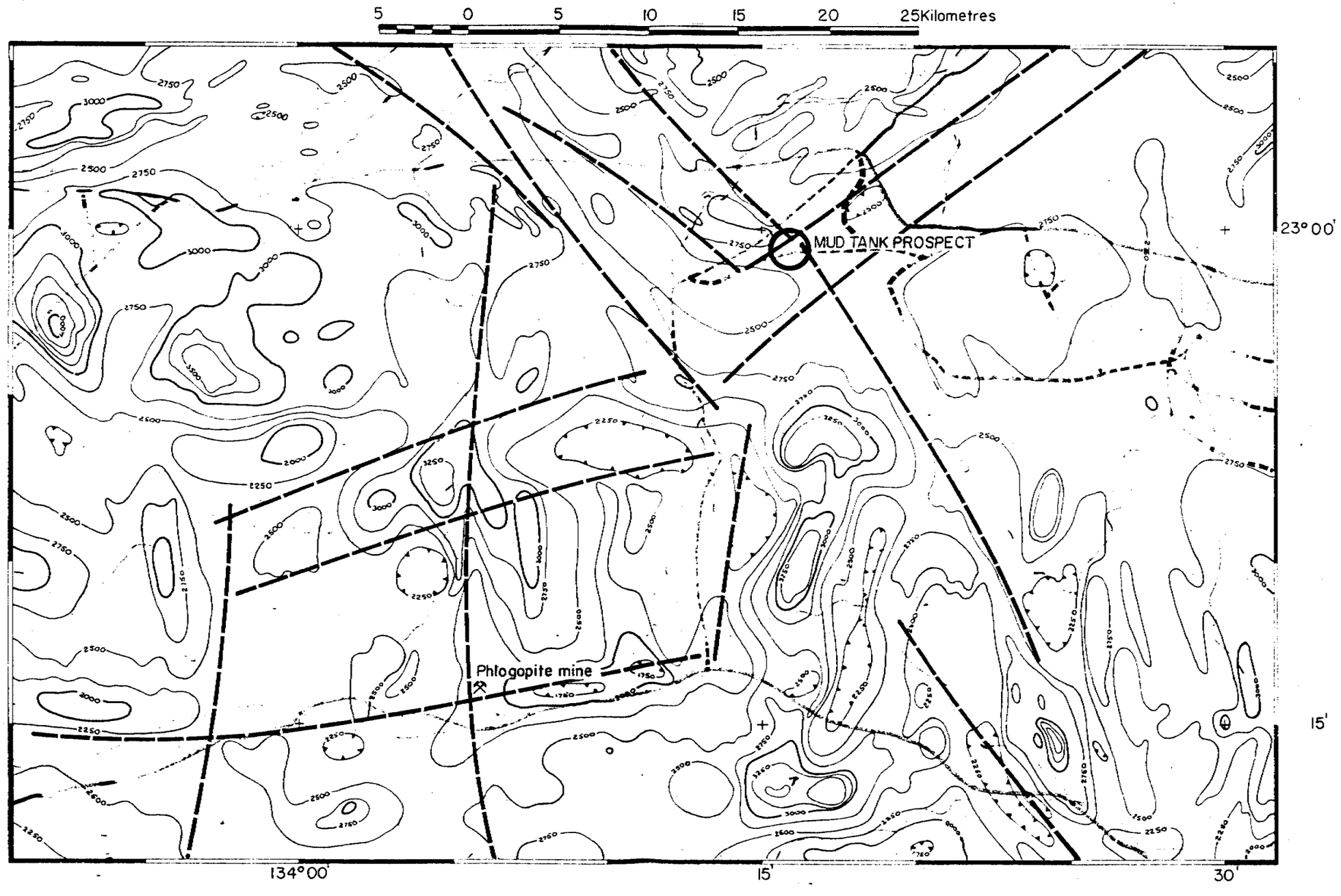
ASI97929

Plate4

MUD TANK
VERMICULITE PROSPECT
Regional Magnetic Setting
Scale 1:250000



CONTOUR INTERVAL 250nT, modified from BMR F53/B1-80 & -144'

MAGNETIC LINEAMENT

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PLATE 3

MUD TANK

VERMICULITE PROSPECT

LOCALITY MAP

Scale 1:250000

5 0 5 0 15 20 25Kilometres

TO SANDOVER HWY.

NEW WELL

MUD TANK

PLENTY HWY.

PLENTY HWY

WOOLONGO BORE

MUD TANK PROSPECT

WEST BORE

STUART HWY

N

THE GARDEN

41 KMs to Alice Springs

N.T. DEPT. OF MINES & ENERGY

AS 79 P 81 D

Plate I

MUD TANK

VERMICULITE PROSPECT

GROUND MAGNETOMETER SURVEY

TOTAL INTENSITY

Contour interval 100nT SCALE 1:5000

250 0 250 500 750metres

Plate 5

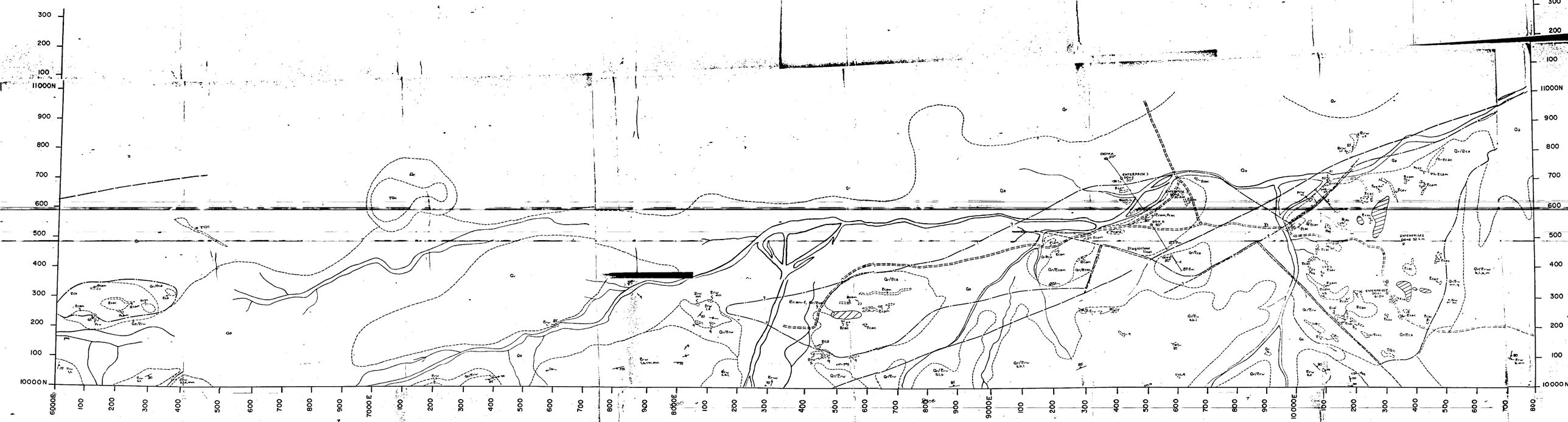
MUD TANK

VERMICULITE PROSPECT

GEOLOGICAL MAP
after D.H.Moore

SCALE 1:5000

25 0 250 500 750 metres



LEGEND

QUARTERNARY	Qa	Alluvium
	Qc	Colluvium
	Qr	Red Soil
TERTIARY	TQC	Calcrete, Silcrete
ADELAIDEAN	Eca	Carbonatite, undifferentiated.
	Ecav	Carbonate-Rich Mica Rocks.
	Ecac	Micaceous Carbonate Rocks.
	Ecam	Carbonate-Magnetite Rocks.
	Ecaf	Feldspathic Carbonatite.
	Ecau	Ultramafic Carbonatite.
	Prw	Leucocratic Biotite and Garnet Gneisses Minor Mafic Amphibolite: Retrogressed Granulite.

- Dip and Strike of Metamorphic Foliation.
- Dip and Strike of Igneous Foliation.
- Strike of Vertically Dipping Foliation.
- Foliation with Trend, Plunge and Vergence of Associated Minor Fold Axis
- Foliation with Trend and Plunge of Associated Lineation.
- Geological Boundary, position approximately.
- Fault, position approximate.
- Fault, probable.
- Carbonatite margin, position approximate.
- Trench, showing trench number.
- Diamond Drill Hole, inclined.
- Diamond Drill Hole, vertical.
- Zircon diggings as at October 1978.
- Track.
- Creek, wide, narrow.
- Photolinear

Plate 2

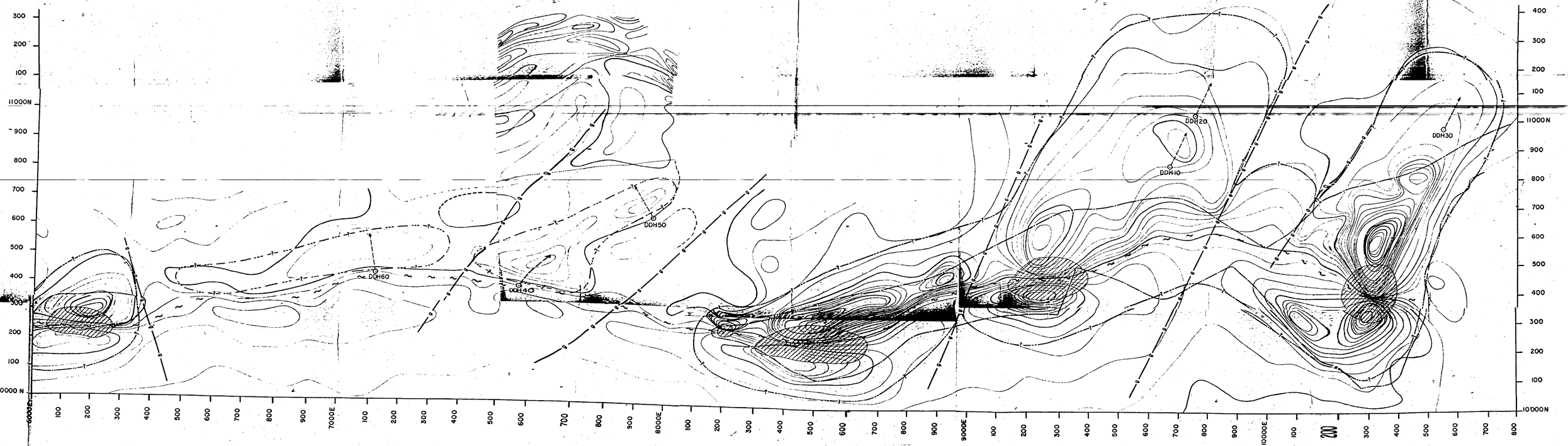
MUD TANK

VERMICULITE PROSPECT

GEOPHYSICAL INTERPRETATION

SCALE 1:5000

metres 250 0 250 500 750 metres



LEGEND

- Fault, interpreted from Geophysical data.
- Carbonatite margin, interpreted from Geological data.
- " " " " " Geophysical data.
- Geological boundary.
- Shear line.
- DDH — Proposed Diamond Drill Hole.
- Interpreted Plug Part of Carbonatite intrusion.

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