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GEOPHYSICAL TEST SURVEY AT THE PLENTY RIVER MICA FIELD, NORTHERN TERRITORY.

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ILLUSTRATIONS.

ABSTRACT.

A method of locating mica-bearing pegmatites under soil cover would be helpful in prospecting for the valuable ruby mica of the Plenty River field, Northern Territory. To this end, two geophysical methods were tested over two known pegmatites. It was shown that the magnetic method is ineffective, but that it is possible to locate near-surface pegmatite veins using the A.C. potential drop ratio method. However, the tests were of limited extent and by no means conclusive.

The tests indicated that the pegmatites, where tested, were of very limited length. If this is typical of their occurrence a very detailed survey would be needed to prospect for them. Such detailed work would be costly and uneconomic unless areas of limited size, in which the probability of finding pegmatites is relatively high, could be selected by detailed geological examination. A geological examination would be a necessary preliminary to more extensive testing by geophysical methods.

1. INTRODUCTION

Mica is an important material used as an insulator in electrical apparatus and although for most purposes the processed micanite can be substituted, mica is essential for use in very high quality electrical apparatus. It is a strategic mineral in time of war. Australia has supplies of mica of varying quality in the Harts Range Mica Field but ruby mica of good quality is not produced in sufficient quantities.

The mica found on the Plenty River field is mostly ruby mica and, because many mica-bearing pegmatites in this area could be obscured by soil, geophysical aids to prospecting would be helpful.

No direct geophysical method of locating mica is known, but an indirect method of locating pegmatite intrusions in country rock is possible if there is sufficient contrast between the physical properties of the pegmatites and enclosing rocks. The only physical property in which a useful contrast might exist is electrical resistivity. It seemed likely that the pegmatites would have a slightly higher electrical resistivity than the country rock - a garnet-mica-felspar gneiss - which could be detected by resistivity methods. It was remotely possible that the pegmatites might be slightly more magnetic than the gneiss. An initial test was therefore planned to determine whether the pegmatites give detectable anomalies by electrical and magnetic methods.

2. PROGRESS OF THE TEST SURVEY.

The test was carried out on the recommendation of J. Horvath, a Senior Geophysicist of the Bureau, who visited the field in September, 1957. Arrangements were made for a field party which had been operating in the Waterhouse area to carry out a two-day test using magnetic and potential drop ratio methods on the return journey to Melbourne from Darwin, via Alice Springs. The party left Alice Springs on 7th November and arrived at the field on 8th November. The geophysical survey was made on 9th and 10th November and the party left the field on 11th November.

The Whistleduck and Paulina properties were surveyed, each with three traverses 100 feet apart. The area around the mines is flat and free from scrub and long grass.

3. THE GEOPHYSICAL PROBLEM

The geology of the Harts Range area, including the Plenty River area, has been described by Joklik (1955). The pegmatite intrusions of the Plenty River field occur in a country rock described as garnet-mica-felspar gneiss. The pegmatites are considered to be more resistant to weathering than the gneiss and have been found as isolated outcrops distributed over the plains. The strike of the known pegmatites varies greatly. Dip, plunge width and length are also variable, but for the most part the dip is steep, the width narrow and the length greater than 50 feet. If a pegmatite has electrical properties markedly different from the gneiss, resistivity measurements can be used to locate it if a traverse can be surveyed across the strike of the body. For the test survey over known pegmatites this presented no difficulty. The resistivity method used was the potential-drop-ratio method. Measurements were made along traverses, with electrodes at a constant spacing of 25 feet using a 500-cycle current from an isolated electrode a few hundred feet from the body to be tested. The ratio of the potentials over adjacent 25 foot intervals was measured at every 25 feet along the traverse.

Magnetic measurements were made also, in case the pegmatite was slightly more magnetic than the gneiss because of possible concentrations of biotite or muscovite.

Because the conductivity contrast between pegmatite and gneiss could not be expected to be large, it was important, for the successful use of the method, for the pegmatite to be relatively close to the surface. It is doubtful if a pegmatite at a depth of more than 50 feet could be detected.

It was decided to test two known outcropping pegmatite bodies, one at the Whistleduck No.2 mine and the other at the Paulina Mine, to establish whether any electrical and magnetic anomalies could be detected.

4. PAULINA MINE.

(a) General.

The Paulina Mine is 6 miles north-east of the Plenty River crossing. The workings consist of an open-cut 80 feet long, 6½ feet wide and with a maximum depth of 38 feet. The pegmatite is a regular fissure vein which strikes north and dips to the east at 55°. The mine produced 2.4 tons of cut mica, valued at £4,306.

Initially, Traverses A, B and C were pegged (see Plate 1), but because Traverse C was mostly over dumps of rock it was replaced by Traverse D.

(b) Magnetic Survey.

The magnetic survey was done with a Watts Vertical Force Magnetic Balance, adjusted to a sensitivity of 30 gammas/scale division. Traverses B and D were surveyed, but no significant anomalies were found

(c) Potential Drop Ratio Survey.

A 500-cycle generator was connected to an electrode array 200 feet from the western end of Traverse B and the circuit was completed through another electrode array about 4,000 feet further west (see Plate 1). The results obtained are shown as profiles on Plate 2.

There are no features of interest on the profile for Traverse A, which was 100 feet from the end of the open-cut, nor are there any features on the profile for Traverse B, which intersected the shallow end of the open-cut. On traverse D, however, which crossed the middle of the open-cut, there is a distinct anomaly over the pegmatite. The anomaly is characteristic of a poor conductor embedded in a country rock of higher conductivity. The open cut itself may be in part responsible for the anomaly measured, but it is believed to be due mainly to the pegmatite.

The absence of anomalies on Traverses A and B is accounted for by the fact that the pegmatite does not extend as far as these traverses. If it did it would presumably have been mined before deeper excavations were made at the southern end of the open-cut.

5. WHISTLEDUCK NO.2 MINE

A. General

The identification of individual mines in the area is dependent largely on local knowledge. There are several workings at the Whistleduck Mine, and the one selected for the test survey was identified by Mr. Sneddon, a former Inspector of Mines, as Whistleduck No.2. The workings tested are probably the "main workings" described by Joklik (1955). The mine is an example of an irregular intrusion (not a fissure vein), and Traverse B crosses a relatively shallow part of a narrow open-cut.

The workings are on fairly flat ground about 6 miles east-north-east of the Plenty River crossing. The production from the main workings was 6 tons of cut mica, valued at £10,000. The mine was developed by shafts, with drives at depths of 27, 38, 50 and 75 feet. The country rock is mica-felspar gneiss but outcrops are rate. The main pegmatite strikes N55° E, dips to the south-east, and is about 10 feet thick, although small veins of pegmatite cut through the gneiss over a greater width.

Three traverses (A, B and C) were set out as shown on Plate 1.

B. Magnetic Survey.

Traverses B and C were surveyed, but no significant anomalies were recorded.

C. Potential Drop Ratio Survey.

The 500-cycle generator was connected to an electrode array about 400 feet from the pegmatite and the circuit was completed through another electrode array 4,000 feet from the mine (see Plate 1).

Measurements were made with potential electrode spacings of 25 feet, but the ground was so dry and hard that difficulty was experienced in making good electrical contact. The results obtained are shown as profiles on Plate 3.

No significant anomalies were found on Traverses A and C, but on Traverse B a distinct anomaly characteristic of a poor conductor in a medium of higher conductivity was found. As for the case of the test at the Paulina mine, the open cut itself may be responsible in part for the anomaly but the principle cause is assumed to be the pegmatite.

6. THE PROBLEM OF EXPLORATION IN NEW AREAS.

It has been shown that distinct electrical anomalies were detected over a pegmatite mass embedded in gneiss at the Paulina and Whistleduck Mines on the Plenty River field.

The tests were limited in extent and the only anomalies recorded were those over the open cuts from which the pegmatites had been mined, but which contained pegmatite under foot. The extent to which the open cuts themselves were responsible for the anomalous potential distribution cannot be properly assessed, but it is likely that the pegmatite mass below each open cut was mainly responsible. However, there is some uncertainty in this interpretation and for this reason the results of the tests are not conclusive.

Much more extensive testing would be required before the true value of the method can be assessed and tests would have to be conducted over pegmatites which have not been disturbed by mining. As a necessary preliminary to further tests, detailed geological examination assisted by air photographs is required. It is possible that a detailed geological examination would disclose pegmatites in the soil-covered regions of the Plenty River field which would be suitable for further prospecting by conventional mining methods. If so, the need for geophysical work might be eliminated or greatly reduced.

Even if detailed geological examination failed to disclose any pegmatites in their undeveloped state, it might be able to indicate areas of relatively small size in which the probability of pegmatites occurring under shallow soil cover is reasonably high. In this case, further geophysical testing followed by trenching to test any favourable anomalies would be warranted.

Even if it can be accepted that pegmatites in their undeveloped state would give significant anomalies it is likely that other geological features of no economic interest would also give anomalies. Therefore, if further geophysical tests are planned there are general technical factors that must be considered. These include -

(i) The geophysical survey should be made after rain, because it is easier to obtain good contacts with the ground after rain than after a long dry period.

(ii) Areas must be selected where, on geological grounds, the possibility of pegmatites occurring is reasonably good.

(iii) The strike of the pegmatites to be expected should be known approximately to ensure a favourable intersection of the pegmatite bodies.

(iv) Electrical anomalies can be caused also by other geological features such as differences of porosity and salinity of water in adjacent formations and the presence of shear zones; not all anomalies discovered could be attributed to pegmatites.

In order to make a proper assessment of the results of any further test geophysical survey in the Plenty River Mica field, it would be necessary to have facilities available for rapid testing of all the anomalies disclosed. Trenching by bulldozer may be adequate for this purpose.

7. CONCLUSIONS

The test survey was a limited one restricted to determining whether known outcrops of pegmatites produce measurable anomalies. Distinct and significant anomalies were obtained over the open cuts at the Paulina and Whistle-duck Mines and although the open cuts themselves may be in part responsible for the anomalies, it is considered that the main effect arises from the pegmatitic bodies below the open cuts, thus indicating that the pegmatites are bodies of very high resistivity in media of lower resistivity.

In 1,800 feet of traversing, no other significant anomalies were obtained, but the amount of work done was insufficient to ascertain whether any other geological features produce significant anomalies.

The tests indicated that the pegmatites, where tested, were of limited length, as no anomalies were found on traverses which crossed the line of the pegmatites beyond the limits of the open cuts in which the pegmatites had been worked. If such limited length is typical of the occurrence of pegmatites in this area, very detailed surveys would be costly and perhaps uneconomic unless areas of relatively small size could be selected by a geological survey as being particularly favourable for the occurrence of pegmatites.

A detailed geological survey with this object in view would be a necessary preliminary to more extensive test surveys by geophysical methods. Routine geophysical surveys over extensive areas would be warranted only if further tests were technically successful and if routine work could be justified on economic grounds, i.e. if the cost of finding new mica mines was small compared with the value of the production likely to be achieved.

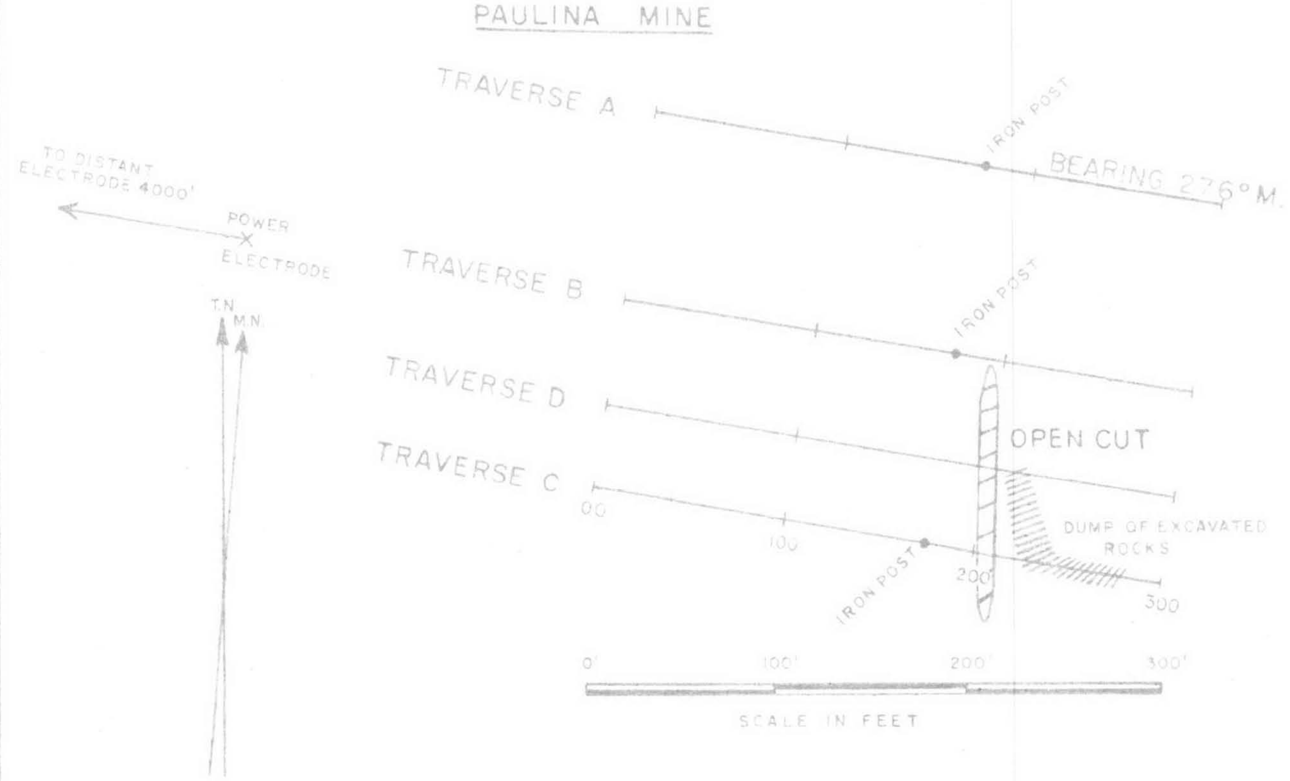
It was mentioned in the preceding section that geological features other than pegmatites might give rise to anomalies that cannot be distinguished from those due to pegmatites. Even if a relatively large proportion of the anomalies is found to be due to pegmatites it does not follow that the pegmatites discovered would contain mica of economic importance, although mining experience in the area suggests that a high proportion would.

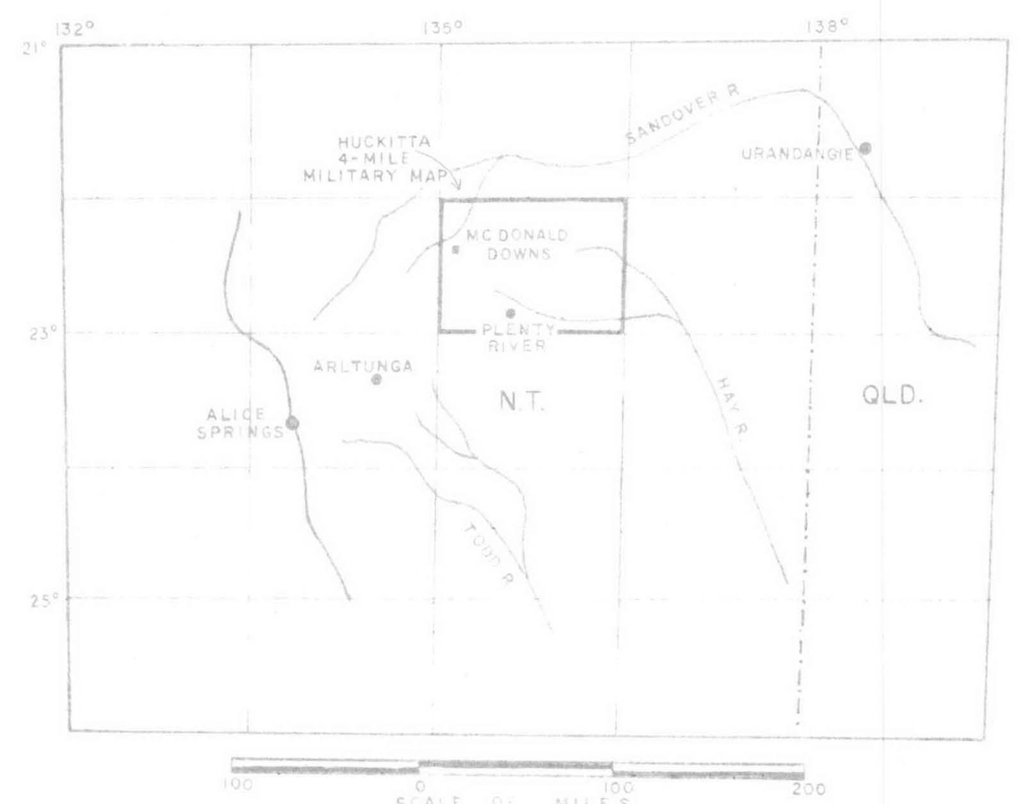
Therefore even if further extensive testing by geophysical methods should prove technically successful in discovering buried pegmatites it is possible that a routine survey of a large area would not be warranted on economic grounds.

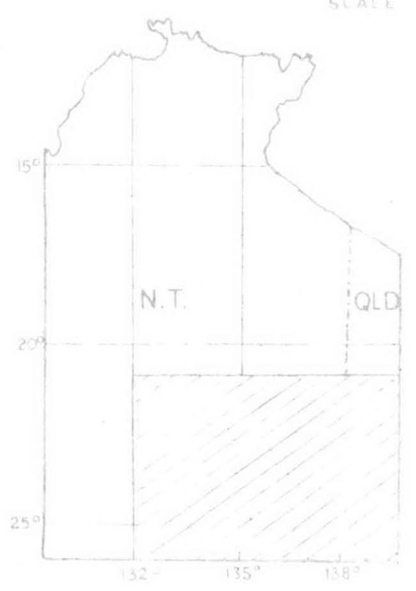
8. REFERENCE

Joklik, G.F., 1955 - The geology and mica-fields of the Harts Range, Central Australia Bur. Min. Resour. Aust. Bull.26

PLATE I







LOCALITY MAP

REFERENCE TO AUSTRALIAN 4-MILE MILITARY MAPS

GEOPHYSICAL TEST SURVEY AT
PLENTY RIVER MICA FIELD, N.T.

SKETCH MAPS OF PAULINA AND WHISTLE DUCK NO.2 MINES
SHOWING OPEN CUTS AND GEOPHYSICAL TRAVERSES

(AFTER D. COOK 7.11.57)

GEOPHYSICAL SECTION BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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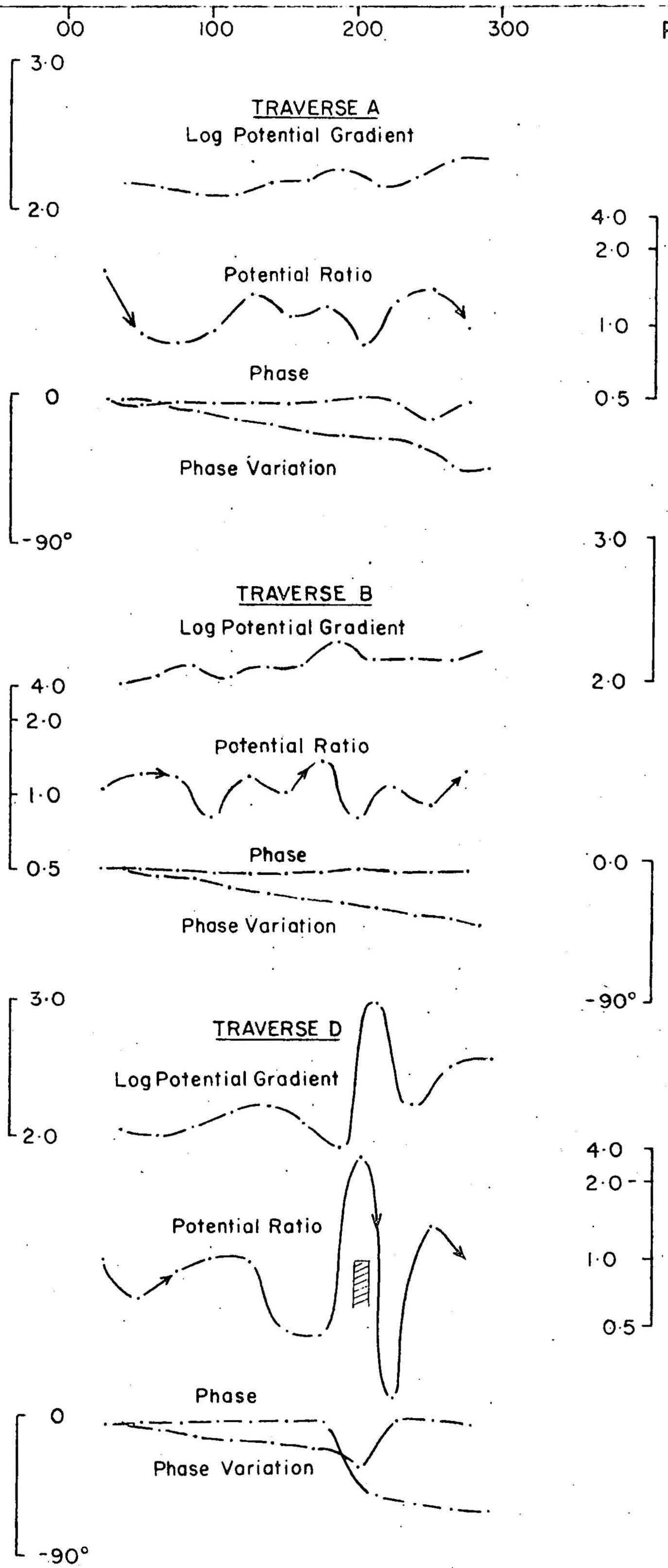
PLATE 2



GEOPHYSICAL TEST SURVEY AT
PLENTY RIVER MICA FIELD, N.T.

POTENTIAL DROP RATIO PROFILES AT PAULINA MINE
POTENTIAL ELECTRODE SEPARATION 25 FEET

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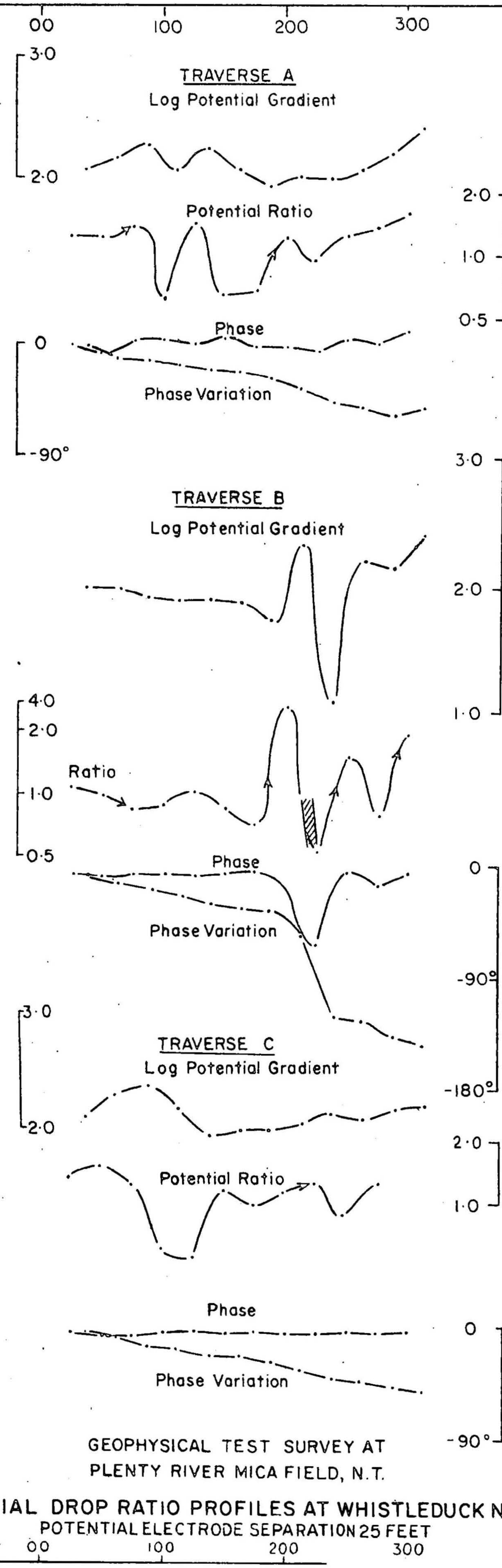
PLATE 3



GEOPHYSICAL TEST SURVEY AT
PLENTY RIVER MICA FIELD, N.T.

POTENTIAL DROP RATIO PROFILES AT WHISTLEDUCK NO.2 MINE

POTENTIAL ELECTRODE SEPARATION 25 FEET

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