A REPORT ON
RMIP SURVEYS
CARRIED OUT AT REDBANK, NORTHERN TERRITORY
ON BEHALF OF
TECHNOMIN AUSTRALIA N.L.
IN ASSOCIATION WITH
HUNTER RESOURCES LIMITED
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NORTHERN TERRITORY GEOLOGICAL SURVEY.
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SUMMARY

At Redbank in the Northern Territory, RMIP surveys were carried out over Sandy Flat, Bluff, Titled’s Flat and Airport Mountain. Other than a reaffirmation of the signature over the Sandy Flat pipe, no unambiguous signatures considered characteristic of pipes were located over any other site. However, a number of responses of secondary interest were defined which are worthy of further investigation by percussion drilling by virtue of their association with known conductor axes which themselves are associated with known pipes, or by virtue of their shape and amplitude.

The majority of induced polarization anomatism occurred in association with moderate increases in resistivity. These are considered to be variations in sulphide [or mafic mineral] content within the Gold Creek Volcanics. However, since our experience is limited, this should not be assumed.
INTRODUCTION

At the request of Mr. J. Rowntree, Chairman of Technomin Australia N.L., Scintrex Pty. Ltd. carried out a series of RMIP surveys over various prospective areas at Redbank, Northern Territory.

The field work was carried out between 31st August and 6th October, 1986. The crew consisted of Mr. P. Brown, BSc., senior operator, and Mr. P. Boyd, BSc., assistant operator. Local assistance in gridding was provided by personnel from the Redbank camp.
GEOLOGICAL-GEOPHYSICAL BACKGROUND

RMIP test surveys carried out at Redbank in late 1979 gave a significant and diagnostic signature over the Sandy Flat pipe, particularly for a 'small' current dipole of 1000 feet. A summary of the conclusions of the test work are as follows:

1. Although the Sandy Flat pipe was seen on 1000 feet, 2000 feet and 3000 feet dipole spacings, the pipe was best seen at 1000 feet.

2. The MMR conductors had a much greater strike length than the pipe, and had a grid 120° strike from the east west current dipole and north south from the north south dipole.

3. The maximum polarization occurred on the flank of the MMR conductor close to, but not coincident with, the intersection of the two axes referred to in [2] above.

4. A possible geological interpretation of these facts is that the pipe was punched up on, or close to, the intersection of two steep angled faults trending grid 0° and 120° within the semi-horizontally layered Gold Creek Volcanics.
THE PARAMETERS CHOSEN FOR THE 1986 RMIP SURVEY

Since the pipes are expected to be 'small', close line spacing of 25 metres with reading intervals of 12½/25 metres was chosen. The current dipole chosen was 500 metres approximately mid way between the 1000 feet and 2000 feet current dipoles used for the 1979 test survey work at Sandy Flat.

A 3 Hz frequency was chosen as per the 1979 test survey.
COMMENTS ON THE MEANING OF THE RMIP PARAMETERS
WITH RESPECT TO THE REDBANK PIPE PROBLEM

The current dipole is placed at right angles to the survey lines, and will emphasise resistivity differences running within approximately ±30° of the current flow. Since the volcanics covering the area are semi-horizontal, the MMR can be expected to emphasise open shears or alteration zones within steeply dipping discontinuities having a strike within a ±30° angle to the approximate north south current flow. It should be noted that the 120° angle noted for the east west current flow in the 1979 tests at Sandy Flat will not be shown up by a north south current flow except perhaps as a discontinuity.

While the resolution at 25 metre line spacing will give good detail for small sources, the 500 metre electrode separation used would tend to depress resolution for bodies having a diameter along the current flow direction of 100 metres or less.
SANDY FLAT

DISCUSSION OF RESULTS
[Arrays 1-6, overlap array 7]

The site of the Sandy Flat pipe is marked by a strong localised conductive axis seen best on array 7W at 1762E/1212N. [This feature equates with the north south 1000 feet array run in 1979.] In a local context, it can be seen that the area lies in a broad resistivity low, oval in shape having a north south direction of about 100 metres ±25 metres and an east west dimension of 150 metres ±25 metres. This is greater in extent than the [known] pipe. The internal polarization high has an irregular circular form, and like the 1979 data, lies just to the west of the conductor axis.

Comments on the locations of Existing Mines

Prince Mine is located at about 1105E/1300. This lies to the north of the junction between semi-continuous conductor trends of 340° and 30° [±], and approximately 50 metres from each [see interpretation plate]. While there is no actual RPS centred on the old mine [or at least, where it is said to be located] a weak RPS is centred 25 metres [±] north thereof.

On this basis, two other weak polarization responses of about the same order, warrant investigation. Both lie close to the 30° trending conductor axis. These are 1150E/1350N and 1125E/1325N. Both have a secondary priority.
Discussion of anomalous responses outside known areas

The MMR data shows a narrow range in values of ±20% of normal [with the rare exception such as the Sandy Flat conductor]. This is considered a minor variation in background only.

To the south-south-west and south-south-east of the Sandy Flat pipe, two low amplitude conductor axes were recorded trending north south [±] centred at 1725E/1100N and 1825E/1150N. Both may represent minor steep angled shears in the Gold Creek Volcanics, however, neither have significant polarization associated with either their axes or flanks, and are thus not considered of significance.

To the south-east of the Sandy Flat pipe, two oval shaped internal polarization responses striking approximately 030° were defined at approximately 1950E/1175N and 1080N/1950E. Both these zones, however, are contained wholly within a broad resistive area, and are thus considered to be due to disseminated sulphides within the Gold Creek Volcanics.

To the north of the Sandy Flat pipe an amorphous circular increase in chargeability was defined centred at about 1700E/1350N. Again the lack of a clear conductor in the vicinity may downgrade the feature, however, lying as it does along strike of the broad low resistor axis associated with Sandy Flat may enhance its interest. Percussion drilling at 1725E/1375N is warranted on a secondary priority basis.

Some 300 metres west of Sandy Flat pipe a prominent conductor axis was recorded between about 1450E/1100N and 1450E/1275N. The amplitude of +20% MMR, while weak to moderate only, contrasts well when compared to the background of −20%[±]. While there is no polarization associated directly
with the feature, a broad zone 75 metres north south and 100 metres east west with a maximum at 1550E/1125N could be of interest, and thus percussion drilling centred at 1550E/1125N could be considered as a target of secondary priority.

An interesting series of sharp minor polarization axes were recorded as follows: 1150E/1000N, 1212E/1050N, 1225E/1100N to 1250E/1150N. These features lie subparallel to minor but prominent conductor and resistor axes trending grid 40°. The chargeability is associated with a resistor axis, and as such, it could be due to disseminated sulphides associated with silicification. Clearly this feature is not circular associated with a conductive section therefore its origin is probably chargeable material within the Gold Creek Volcanics. However, the geological map shows a creek which runs subparallel to these 40°[±] trends which may imply the presence of a 'closed' fault within the underlying volcanics. Thus, any one of these maxima could be tested and/or the high at 1400E/1225N which could also be associated with the strong north south trending conductor logged between 1450E/1150N and 1450E/1275N.

On array 6E within an area showing intersecting weak conductor axes having 240° and 30° trends, anomalous chargeabilities were recorded from about 1100E-1175E on line 1350N to south of 1050E to 1150E on line 1200N. The polarization reaches 0.5° RPS above local background at several points. A site at 1125E/1250N on a conductor axis is suggested as a first priority drill target.
CONCLUSIONS

Based on the 1979 test surveys at Sandy Flat, together with the subsequent drilling programme, the target sought would be expected to have the following characteristics:

1. be located at, or close to intersecting high angle shears denoted by MMR conductors
2. be polarizable, perhaps of uneven shape
3. but not contained within resistive material

On these criteria only, the anomaly on array 6 is of primary interest and a percussion drill site could be considered at 1125E/1250N.

Other targets of lesser priority are:

- 1725E/1375N: disseminated source north along strike of MMR conductor associated with Sandy Flat.


- Small anomalies at 1150E/1350N and 1125E/1325N are worthy of consideration as secondary priority targets as they are coincident with the conductor axis which may[?] be related to the Prince Mine.
BLUFF

DISCUSSION OF RESULTS

[Array 11]

A single 500 metre array was run at Bluff. No information is available on the location of the known mineralisation with respect to the geophysical grid.

The main feature seen on the MMR data is a circular low amplitude resistivity low extending from line 2575N to 2725N and from 6175E to 6275E with a centre at about 6225E/2675N. This feature shows no truly distinctive polarization which would imply that should sulphides be present they must be either in oxide form, or if as sulphides, with little contrast above background.

Significant polarization was recorded in the north-eastern extremity of the array. However, as this is associated with rocks of higher resistivity, silicified disseminated pyrite within the Gold Creek Volcanics is the likely source.

No recommendations are made for further work.
TITLEY'S FLAT

DISCUSSION OF RESULTS
[Arrays 21-35]

Fifteen detailed arrays were run on a 25 metre x 12\frac{1}{2} metre grid between 2850N and 3850N and from 3100E to 4200E using a 500 metre current dipole.

Comments on the location of existing mines

Redbank: A prominent [if discontinuous] conductor was noted between 3350E/3200N and 3337E/2925N. The Redbank deposit is located at about 3415E/3085N[±], some 40 metres east of the conductor. While there is a distinct RPS anomaly of 0.3° associated with the deposit it is small, and can only be identified after the fact!

Other anomalies of low amplitude in similar situations are 3425E/2900N, 3350E/3125N, both could be considered as possible targets of secondary importance.

Azurite: This deposit has absolutely no induced polarization signature. This may be because it is wholly oxide, or very small with respect to the 500 metre current dipole, or shows no contrast to background. Of importance, however, is the fact that the site lies 25 metres [±] west of a most prominent conductor axis. While no significant, or even low amplitude RPS anomaly can be seen near the pipe, a series of responses including one at 3800E/3150N is considered a worthy target for further investigation by percussion drilling on a secondary priority basis.
Discussion of anomalous responses outside known areas

The MMR data displays a series of moderate conductor axes trending within ±30° of grid north south. These are thought to represent high angle discontinuities within the Gold Creek Volcanics. It should be noted that high angle discontinuities in the east west direction will be visible only as 'breaks' in the continuity of the north south grain imposed by the north south electrodes.

As argued above, pipes are expected to occur close to intersections of shears, and be slightly to moderately conductive in relative terms. A study of the induced polarization data has revealed no truly obvious circular polarizable features having these characteristics, although a number of anomalous responses occur. These are invariably associated with weakly resistive features, which on past experience, are probably due to disseminated sulphides within the Gold Creek Volcanics.

As secondary targets then, a number of polarizable sources could be considered for further consideration for drilling.

By and large, however, the range in values of 0.1° to 0.3° can be attributed to variations in sulphides and/or mafic mineral content within the underlying rocks. Most features seen within this background have very shallow origins – between 25 and 50 metres.

The most striking induced polarization response was seen in the north-west corner of the area from 3400E/3850N to 3375E/3575N. Values of up to 1.0° RPS were recorded in a complex north south striking series of individual axes associated with a weakly resistive section. The source could be fault controlled silicified disseminated sulphides, or merely significant
variation of sulphide content within the Gold Creek Volcanics. Percussion drilling could be considered at 3375E/3750N and/or 3375E/3700N but on a secondary or tertiary interest basis only, as these are definitely not pipe-like targets.

One of the few possibilities of a circular structure was located with higher values of +0.4° above background at 3862E and 3900E on line 2900N, and on line 2975N at 3900E ±25 metres. This feature lies close to a possible high angle discontinuity [80° grid]. As a secondary interest only, percussion holes could be considered at 3862E and/or 3900E on 2900N.

A broad horseshoe shaped series of anomalous polarization was noted from 3975E/3275N to about 3950E/3400N and then to 4025E/3425N and to 4075E/3375N. Since it lies across a possible 060° ± grid discontinuity [as gauged from MMR], it may be worth investigating further on a secondary basis with a percussion hole at 4075E/3375N [40 metres]. The polarization, however, is invariably associated with resistive sections.

CONCLUSIONS

1 The MMR shows only minor variation in background [±10%] with resistive axes being -25% and conductor axes occasionally reaching +50%. The north south[±] grain has been emphasised by the north south current dipole.

2 The bulk of the ±0.2° change in induced polarization from the 0.1° background can be put down to compositional changes in background.
3 Such significant polarization responses as there are, are invariably associated with resistive features and are thus considered to be due to variations of chargeable material including disseminated sulphides within the Gold Creek Volcanics.

4 Targets of secondary to tertiary interest are as follows:

- percussion holes could be considered on a north-south resistive polarizable ridge at 3375E/3750N and/or 3375E/3700N as a secondary target.

- a possible circular structure [but with resistive polarization] is considered worthy of consideration as a secondary drilling target at 3862E and/or 3900E on line 2900N.

- a large horseshoe shaped target related to a discontinuity could similarly have interest as a secondary drilling target at 4075E/3375N [to 40 metres]. Again, however, the polarizable source is resistive.

- Two low amplitude targets in similar situations to Redbank can be considered as secondary targets, namely 3350E/3125N and 3425E/2900N.

- An anomalous internal polarization response at 3800E/3150N was recorded east of a conductor axis associated with the Azurite pipe.
AIRPORT MOUNTAIN

DISCUSSION OF RESULTS

[Arrays 41-44]

The area was covered by four arrays, array 41 having a current dipole of 500 metres, array 42 425 metres, and arrays 43 and 44, 600 metres. The grid employed was 25 metre lines with 20 metre station intervals along lines.

The MMR shows a range of +50% to -50%, but the bulk of the data ranged from 0 to -25%. The MMR data gives an extremely complex form and can be broken up by a series of 'lineaments' into zones having similar characteristics. The strike of individual events has a range from grid north south to 030° grid, while the 'lineaments' have two preferred directions, namely approximately 030°[±] and 130°.

With the exception of the lineament bounded block centred at 5250E/5400N, the MMR is characterised by minor resistor axes against background.

The observed changes in MMR could merely represent minor compositional changes within the Gold Creek Volcanics.

The induced polarization data shows a distinct correlation between minor resistivity axes and minor polarization axes. Thus the anomalous polarization appears to represent compositional changes within the Gold Creek Volcanics rather than polarization features due to circular pipes. There are no clear circular features, and in fact no polarization values associated with conductor axes.
The sole exception to the above was an anomaly centred at 5350E/5200N which forms part of a low amplitude RPS "ring" [see interpretation plan]. This feature lies close to a north-west discontinuity in the MMR data. This site is suggested as a possible drill site of secondary/tertiary interest.

CONCLUSIONS

The data at Airport Mountain shows a complex MMR and RPS pattern. This is interpreted to be due to compositional changes within the Gold Creek Volcanics as, [i] these features are linear and [ii] show a correlation between high resistivity and polarization. A number of anastomising 'breaks' in the MMR data trending approximately 030° and 130° grid, imply steep angle faulting within the Gold Creek Volcanics.

No signatures considered to be due to pipes were defined with the sole exception of an anomaly at 5250E/5200N which could be percussion drilled on a secondary/tertiary basis.

Respectfully submitted on behalf of:

SCINTREX PTY. LTD.

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APPENDIX: 1

DATA ACQUISITION AND PRESENTATION
DATA ACQUISITION AND PRESENTATION

Data Recorded:

The following parameters were recorded:
- $H_p$, the incident magnetic field due to the current flow in the current dipole.
- RPS, the magnetic induced polarization effect at each station by reference to the Relative Phase Shift of the primary and third harmonic.
- PFE, the magnetic induced polarization effect by reference to the Percent Frequency Effect observed from the relative amplitudes of the first and third harmonic.
- The offsets for RPS and PFE for each array.
- The energising current ($I$) and the frequency of energisation.

Data Processing:

The data has been computed and the following parameters have been calculated for each station.

MRR       Magnetometric resistivity
HN        Normalised horizontal magnetic field
Hu        Geometric factor
RPS       Relative Phase Shift (in °)
PFE       Percent Frequency Effect (in %)
HSQ/I     Secondary field (derived from RPS)
HSP/I     Secondary field (derived from PFE)
PFE/RPS   ratio, an indication of the presence of coupling.
Data Presentation:

The data has been displayed in table form with the selected parameters of MMR, RPS and HSQ/I being shown in computer printergraph format by array.

In addition MMR and RPS have been contoured and presented at the scale of 1:2500. An interpretation plan has been prepared.

The contour plans show the array numbers. The centres of the arrays are shown with a circle, while the suffix to the array number denotes the position of the electrode wire with respect to the array. The size of the current dipole is given in hundreds of metres by the figure below the array number.
APPENDIX 2

BRIEF DESCRIPTION OF METHOD AND MEANING OF PARAMETERS
METHOD

A brief and simple description of the method is given below for those unfamiliar with the basic principles behind the Rapid Reconnaissance Magnetic Induced Polarization (RRMIP) method. However, it is strongly recommended that the enclosed appendix be studied in detail for a more complete description of the method, and for those who are to make a geophysical assessment of the data, it is recommended that the papers referred to in the appendix be read also. The references therein give the current major papers dealing with MMR and MIP methods by various authors.

There are two significant electrical properties of rocks and ore bodies which are of great assistance in identifying zones of potential economic interest. The first is resistivity. This can be described as the resistance of a rock to the passage of electric current through it. Obviously those sections which are less resistive will allow greater quantities of current to flow than those which are more resistive. Massive sulphide zones, fault zones, zones of deeper and more intense oxidation and graphite horizons, are examples of units which will allow greater quantities of current to pass. In RRMIP, the measurement of resistivity is made with a very sensitive horizontal field magnetometer. This senses the volume of current flowing in the section below by virtue of the fact that current is simply the number of electrons flowing, and each of these electrons carries a magnetic field with it as it moves. Thus the magnetic field observed by the magnetometer is proportional to the current flowing through the volume of overburden and rock below the sensor. This measurement is called Magnetometric Resistivity (MMR). Positive values define areas of relative
conductivity, and negative values areas which are relatively resistive. This property can be used as a method for tracing rocks having different resistivities beneath conductive overburden, as well as to define conductors which may of themselves be of potential economic interest.

The second and more significant property is known as induced polarization. This phenomenon involves the storage of some of the electrical energy at the grain boundaries of sulphide(or graphite) grains, and the water contained between grain boundaries in rocks and ore bodies. If a pulsed current is used, the sulphide (or graphite) zones will charge during periods of current flow, and discharge during periods when the current ceases to flow. It is this discharge of stored energy which is the induced polarization effect, and the magnetic sensor is sufficiently sensitive to define these minute magnetic fields. The magnetic induced polarization effects are measured in terms of Relative Phase Shift (RPS). Positive values denote internal polarization from within sulphides or graphite, while negative values generally denote the discharge of the polarization effect external to the source.

The reason for a magnetic sensor being used rather than simple electrical contact with the surface of the ground is that the conductive surface areas effectively mask the major changes in resistivity (MMR) beneath the conductive surface layer, and invariably either completely short out the induced polarization effect, or render it unrecognisable against background noise. The current is injected into the ground through current electrodes placed from 1 to 3 kilometres apart. These large current electrodes enable current to penetrate
the weathering into the fresh rocks below that hold the sulphides which are the subject of our exploration search.

THE PHYSICAL MEANING OF RRMIP PARAMETERS

A summary of the main characteristics of each of the features highlighted in the interpretation map follow in order that the reader can fully appreciate the geological implications of the data.

Conductor Axes
These represent the axes of the MMR conductor. To be significant they must have (i) a significant cross-sectional area conductivity contrast with the immediate enclosing rocks, and (ii) a significant strike length with respect to the current dipole used to energise the array. A diminution of either (i) or (ii) with respect to background resistivity of the rocks, or current dipole respectively, will result in a diminution of the observed response.

One further consideration with respect to the magnitude of the response is that should the current dipole be 'small' and the conductivity width of the overburden 'great', then a diminution of response will occur also. (For details see MIP appendix, page 12, fig. 7.)

One major point to bear in mind is that horizontal layering will not be observed on the MMR, while lateral changes will be emphasised.
Resistor Axes

These represent the axes of the significant MMR resistors, which in turn represent the area of the most resistive rock units. All the remarks above for conductors apply to the resistor axes.

Contacts

Where significant gradients are observed in the MMR data, a line has been drawn along the inflexion point (or approximately so, allowing for various 'local' distortions). This line will, for vertical dipping bodies show the approximate location, and certainly the strike length of major rock type changes.

Dislocations

These are located on the interpretation maps to emphasise a significant along strike discontinuity in both MMR and RPS features. They represent faults, flexures in strike direction or perhaps lensing of significant resistors and conductors.

Internal Polarization Axes

These represent above background zones of anomalous internal polarization. They are caused by segregations of sulphides, graphite and more rarely, by serpentine, mafic mineral content and magnetite.

These features can be distorted by electromagnetic coupling, by current channelling, particularly when MMR curves show a steep (25° to 30°) angle with the energising current, and by wire effects should the energising frequency be excessive with respect to the conductivity width of the overburden.
On the flanks of arrays, the precise location of the axes may not necessarily be mapped, but can be inferred. In such cases additional limited detailed work is required. Where this is done, the axes can be identified.

Significance of the Three RRMIP Parameters, MMR, RPS and HSQ/I

As discussed elsewhere, the positive MMR values denote the relative bulk conductors, while the negative values denote relative bulk resistors. The positive RPS values emphasise internal polarization within low current density areas. (Please refer to the papers for further explanation.)
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SANDY FLAT
NR. REDBANK - N.T.

RMIP SURVEY
MMR CONTOURS

SURVEYED AND COMPILED BY SCINTREX.

OCTOBER 1986
SCALE 1:2500m
Job No. NT-047R

CR 87 / 155 PLATE 2M
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SANDY FLAT
NR. REDBANK - N.T.

RMIP SURVEY
RPS CONTOURS

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OCTOBER 1986
SCALE 1:2500 m
Job No. NT-047R

PLATE 2R
**NOTE: RX-1 USED**

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BLUFF
NR. REDBANK - N.T.

RMIP SURVEY
RPS CONTOURS

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OCTOBER 1986
SCALE 1:2500m
JOB No. VT-047R
PLATE 3R

CR87/155