NORTHERN GOLD N. L.

ANNUAL REPORT FOR THE YEAR ENDING FEBRUARY 1984

EXPLORATION LICENCE 1886
HOLEY AREA NORTHERN TERRITORY

LICENCEE: Chrisp de Vries & Associates
OPERATOR Northern Gold N.L.
LICENSE L 1886
LOCATION Pine Creek 1:250,000 5052-8
Batchelor 1:100,000 5171
PERIOD February 1983 - February 1984
DATE SUBMITTED
AUTHOR B. D. Richardson

CR84/53
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SUMMARY.

Exploration Licence 1976 is located in the Howley area and is operated by Northern Gold N.L. The licence covers part of the Howley Anticline and has potential for gold mineralization associated with the hinge zone and within the flanking units of the Mt Bonne Formation.

Exploration in 1984 consisted of a RUP geophysical survey, 101m of percussion drilling, geological mapping, costeaneing and general prospecting. A possible disseminated sulphide body was located by the geophysical survey and further drilling is planned to test this anomaly.

In the 1986 season, detailed geological mapping, costeaneing, soil sampling and percussion drilling is planned to assess the Howley Anticline and other prospective areas.
INTRODUCTION

Exploration Licence 1886 is one of seventeen operated by Northern Gold N.L. in the Howley area. The Licence was first granted to Chrisp de Vries and Associates Pty.Ltd. on the 23rd January 1979, and after several reductions, it now consists of one minute with an area of 3 square kilometres (Fig. 1). Talmina Trading Pty.Ltd. the prior operators of El 1886, exercised an option to acquire 90% of the licence, and the four contained claims (MGN 377-380), from Chrisp de Vries and Associates Pty.Ltd. In December 1983, Northern Gold N.L. became the operator of all Talmina's leases in the Howley area. The licences contain large areas of the South Alligator Group of rocks which are hosts to gold mineralization in the Howley area and elsewhere.

A number of significant old mines occur in the area, the most noted of which are the Cosmopolitan, Metropolitan (Big) and Chinese Howleys, and to a lesser extent, Bridge Creek. These four occur on the Howley Anticline, a major structure in the Pine Creek Geosyncline. Gold mineralization can be traced along this fold axis, termed the Howley Line, from Cosmopolitan Howley northward through to the Bridge Creek workings and beyond. Exploration Licence 1886 occurs just south of the Bridge Creek area.
and contains rocks of the Gerowie Tuff, Mt. Bonnie and Burrell Creek Formations. There is a possibility that a repetition of the Chinese Howley stratigraphy may occur in this licence.

Work during the year consisted of a limited geophysical survey (KEMP), the drilling of two shallow percussion holes, costeaneing, general prospecting and geological mapping. An intensive exploration programme is underway at the present time.

1.1 HISTORY AND PRODUCTION

Gold was first discovered in the Howley district in 1873 when the Overland Telegraph was being constructed. Gold mining in the tenements was initiated by Chinese during the 1880's from both alluvials and reefs. The largest reef mine, the Metropolitan Howley (sometimes referred to as the Big Howley) operated between 1883 and 1903 and since that time there has been no significant production except for cyaniding of tailings. Officially recorded production from the Metropolitan Howley totals about 1,000 kilograms of gold; however old unofficial reports suggest production may have been considerably more. The workings consisted of an open cut, two three-compartment shafts to depth of 52 and 58 metre and extensive underground workings. 1,300 metres to the southeast the Chinese Howley mine was operated between
1892 and 1896 with official recorded production about 360 kilograms (ore grade 28 g/t). By 1896, problems with sulphide ore treatment, underground water, periodic flooding and mine collapses were encountered in the Chinese Howley mine. During the 1890's medium grade gold ore was produced from dozens of pits along the Howley Line northwest of Metropolitan Howley, but few records are available. At Bridge Creek, a group of small but locally very rich leads, ranging in width from 1 or 2 inches to about 18 inches, has been intermittently worked since 1873 (Walpole et al, 1968). Parkes (1892) records five shafts from 50 to 70 feet deep in this area. The total recorded production is 1190 oz, but this is known to be incomplete. Since 1960 the only work carried out in the area has been the limited testing of the alluvials.

The Howley Line is semi-continuous from the Cosmopolitan Howley prospect and is marked by numerous shafts and pits. Several intermittent sub-parallel reef systems were worked on both sides of the Howley Line.

To the northeast of the Howley Line, other significant lines of reefs were worked, the most prominent known as the John Bull and Britannia Lines. Production usually ceased at the water table. Below the water table gold was associated with strong sulphide mineralization
causing treatment problems. The major producers along the John Bull Line were the Zapopan (2146 kgs of gold) and the Brocks Creek Mine where 40,000 tonnes of ore were crushed for a recovery of 682 kgs. of gold (17.1 g. Au/tonne) and 18,326 tonnes of tailings were treated for 147 kgs. of gold (8 g. Au/tonne).

Production from the large and intensely worked shallow alluvial fields is not recorded.

1.2 PREVIOUS EXPLORATION

After the end of mining early this century and prior to 1976, only limited exploration was conducted over the Howley area. In the period 1976 - 1981 BHP Co. Ltd. and Homestake Mining Ltd. carried out an extensive exploration programme covering the Cosmopolitan to Metropolitan Howley belt. They concluded that the resources outlined were too small for viable production rates. The tenure holdings, which consist of Gold Mining Leases and Mineral Claims over the three main deposits, were optioned to a joint venture between Peko-Walleseend and Anaconda Australia in 1982. Exploration by this joint venture is continuing at present and is concentrated at the Cosmo.

In 1980/81 Territory Mining Pty. Ltd. and Greenex conducted an alluvial testing programme, using a backhoe, over the Bridge Creek workings. The results
were not encouraging enough to continue and the licence was relinquished.

In the area covered by EL 1886, there is no reported exploration prior to the work conducted by Talmina Trading Pty. Ltd. Early in 1982, Talmina carried out general prospecting and sampling over the lease area. A number of grab samples collected along the Howley Line returned significant assay values (see Annual Report 1982/83). A percussion drilling programme followed to test the Howley Line, and 21 holes were drilled for a total depth of 747 metres. Each metre was assayed and results were generally low but significant intersections were encountered in:

- **B1**: 3m at 6.3 g/t
- **B3**: 2m at 3.8 g/t
- **B4**: 19m at 1.3 g/t
- **C4**: 5m at 2.5 g/t

The true thickness of these intersections are not known at present. The major rock types intersected were carbonaceous (?) phyllites, chloritic mudstones, black volcanic cherts and tuffaceous rocks of the Gerowie Tuff.

1. GEOLOGY

The Howley area is located within the western part of the Pine
Creek Syncline and contains rocks of Lower Proterozoic age. In the basin, granitic Archaean basement is successively overlain by: coarse clastics and carbonates of the Batchelor group; fluvial, tile and shallow water platformal clastics of the Mount Partridge group; and a heterogenous sequence of carbonaceous mudstones, acid tuffs, breccia iron formations and siltstone/greywacke turbidities of the South Alligator Group and finally the flysch sequence of the Finnis River Group. The sediments were intruded by sills of the Zamu Dolerite prior to the major phase of regional deformation, which was accompanied by greenschist facies regional metamorphism. A second, broad, open phase of cross folding is probably related to widespread granite intrusion, which occurred in the early Middle Proterozoic. Sediments of the South Alligator and Finnis River Group and intrusives of the Zamu Dolerite and Burnside Granite occur in the Mooley area. The intrusion of the granite during the Middle Proterozoic was responsible for the formation of the major structure in the area, the Howley Anticline, which has a strike length of over 20 km.

The sediments are tightly folded with the western limb dipping at 60° to 80° while the eastern limb is steeply dipping to overturned. The axis runs in a north-westerly direction curving around to the north outside the tenement area. The plunge of the axis is variable, changing from 50° to 0° in the Cosmo Howley area, to 32° N. at the Metro Howley and 50° south at the Bridge Creek working.
The oldest rocks along the Mookley Anticline are the carbonaceous shales, mudstones, iron formations and carbonates of the Koolpin Formation exposed at the Carse Mookley area. These are overlain by acid tuffs, mudstones and siltstones of the Gerowie Tuff. The Mt Bannie Formation is a transitional sequence between the Gerowie Tuff and the Burrell Creek Formations, and shows a gradual decrease in volcanic component and increase in clastic component. The Burrell Creek Formation is the basal unit of the Finnin River Group and is comprised of greywackes, siltstones, shales and minor conglomerates.

Sills of the Assu Dolerite occur along the Howley Line area and are most common within the Koolpin Formation and basal Gerowie Tuff units.

Exploration Licence 1886 contains rocks of the Gerowie Tuff along the western side, overlain by the Mt Bannie and Burrell Creek Formation to the east. The fold axis of the Mookley Anticline strikes in a northerly direction through the Gerowie Tuff, and the overlying rocks form the eastern limb of this major anticline. The rock types present are shales, siltstone, banded irons and various siliceous and tuffaceous acid volcanics. The tuffaceous component decreases eastward and is not present in the terrigenous sediments of the Burrell Creek Formation. The boundaries between the three represented Formations are transitional and at this stage they are not differentiated.
For the purpose of the map (Fig 2) the top of the Cerowie Tuff is taken as the base of the first major b.i.f. unit, which is a later unit in the area.

3. EXPLOITATION POTENTIAL

The major gold mineralisation within the Howley area is structurally controlled, restricted to the hinge line of the Howley Anticline and concentrated at the nose of tight folds e.g. Crexmo and Metro Howley. At Bridge Creek hard rock mineralisation appears to be related to the hinge line, with the greatest concentrations occurring within the carbonaceous shales of the Koolpin Formation.

Within W1 1886 the potential exists for gold mineralisation associated with the hinge line and limbs of the Howley Anticline. Results so far have indicated very low grade tin mineralisation in the areas tested but deeper drilling may define richer extensions of this resource. The licence covers rock types which appear to have a similar stratigraphic position as the Chinese and Metropolitan Howleys where mineralisation is located in and around a fold axis-saddle reef system in the Cerowie Tuff.

In the Howley area, the major exploration was concentrated along the Howley Line within the Koolpin and Cerowie Tuff Formations. The Mt Cerowie Formation has to a large extent been neglected, yet it is known to carry gold elsewhere in the Pine Creek Geosyncline. Recent prospecting by Northern Gold N.L. has
Psg1: Gerowie Tuff - felsic tuff - tuffaceous chert (competent)

Psg2: grey phyllite greywacke
chloritic mudstone tuff (incompetent)

Ps: Mt Bonnie - Burrell Creek Fm - undifferentiated


NORTHERN GOLD N.L.
EL 1886 LOCATION MAP
DRILL HOLES AND
RRMIP GRID JAN 1984

Fig 2
discovered minor gold mineralization within this Formation. Given the right structural controls and lithologies, the Mt Bonnie rocks hold good potential for hardrock gold mineralization. This Formation will be the subject of intensive exploration in the coming year.

4. WORK DONE

4.1 RMIP

In October 1983 Northern Gold N. L. contracted Scintrex Pty. Ltd. to execute a series of RAPID RECONNAISSANCE MAGNETIC INDUCED POLARIZATION (RMIP) surveys over various prospects in the Howley area. The objective of these surveys was to locate and define segregations of sulphides as gold is known to be associated with pyrite-arsenopyrite in the Howley area.

The RMIP method is a recently developed technique that has proved very successful in locating sulphide bodies beneath very conductive overburden. A brief and simple description is given below with a more complete description given in Appendix 2.

There are two significant properties of rocks and ore bodies which are great assistance in identifying zones of potential economic interest. The first is resistivity which can be described as the resistance of a rock to the passage of electric current through it.
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 RMIP, the measurement of resistivity is made with a very sensitive horizontal field magnetometer. This by virtue of the fact that current is simply the number of electrons flowing, and each of those 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 Magnetric Resistivity (MMR). Positive values define areas of relative conductors, and negative values, areas which are relatively resistant. This property can be used as a method for tracing rocks having different resistivities beneath conductive overburden, as well as to define specific conductors.

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 sulphides (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 the 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 field procedure involved the laying out of a 600 x 600m grid across the strike of the units of interest. Where possible a base line was run along the main zone of interest and cross lines taken off every 100m and extended 300m either side of the base line. Holes were dug for the electrodes, positioned 1200m apart on the base line i.e. 300m north and south of the array. Readings were taken at 25m intervals but broadened to 33m towards the end of the survey. Two operators were used and one 600m x 600m array could be read in a full day if all gridding was completed and electrode holes dug.

In EL 1886 one array was surveyed across the Howley Line and covered the percussion holes drilled in 1983. The base line, 10000 m was run north-south along the Howley Line ridge. (Fig 2).
4.2 PERCUSSION DRILLING

Two percussion drill holes, PD1 and PD2, were drilled to a depth of 49 and 51 metres respectively (Fig 2). The holes were sited 40 metres apart and drilled at an angle of 60° east and west. Hickey Drilling were employed and a Worman Investigator used. The drilling was carried out between the 12th and 13th January, 1984. A number of other holes were planned, but the very wet conditions during January prevented further drilling and the programme was postponed.

4.3 COSTEANING

A total of 6 costeanings were dug (900 m) using the Komatsu Hydraulic Excavator. The costeans were sited to better expose the geology and for sampling. Due to water in the trenches only one costean was sampled.

4.4

A preliminary photo-interpreted geological map was compiled (Fig 2). A limited number of traverses were walked to identify major rock units.

5. RESULTS

5.1 RRMIP

The results of the RRMIP survey are shown on Figures
3, 4 and 5 and the Discussions and Conclusions as presented by Scintrex are given in the following pages:
INTRODUCTION

The area was located on the 'Howley line' on the south-eastern section of EL 1886. From the 1300 metre current dipole in this area, some seven lines, each 600 metres long, were surveyed over an area of known geology within the Gerowie tuff unit which hosts the Big Howley and Chinese Howley deposits from which type A responses would be expected.

The specific geology of the grid area is not known to the author.

DISCUSSION

The MMR data shows remarkably little variation over the central section of the grid, particularly east of 1000E. This indicates that although the rocks may (?) be dipping, their bulk resistivity shows little variation.

The MMR data indicates, and the RPS data confirms, a marked 'break' running from about 9700E/9900N to 10000E/9800N to 10300E/9800N. This looks to be a fault, but could also conceivably be due to plunging rocks units.

The RPS data shows a number of significant above background RPS responses. The most significant are as follows:
The form of these internal polarization anomalies is such that they appear
multiple, and thus it is extremely difficult to guesstimate the depth to the
current centre of their sources, or infer their dip. On line 10100N the maximum
to the current source within zone A would be of the order of 100 metres, and in
zone B, 75 metres. (Note that if there is a dip to the source, the locations in
the above table will lie down dip of any nearer surface manifestation of the
causative zone.)

The lack of any appreciable distortion in the MMR data very strongly suggests that
the source is disseminated in nature. Very slight increases in MMR over zone A
by about 10%, suggests slight conduction, while in zone B, no conduction can be
seen. Thus the sources are type B - chargeable, but showing little interconnection -
and lying within a host having little resistivity contrast with the enclosing rocks.
The low levels of the RPS responses (although definite), imply that only 'slight'
increases in sulphide content above background may be expected (say to 2%+). Note
that this is content against background, for if the whole area contains disseminated
sulphides, these anomalies will show those areas of greatest sulphide content.

The other lesser responses centred at 9775E on 10000N and 10200E on 10100N are of

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minor interest only from a geophysical standpoint.

CONCLUSIONS

Zones A and B described above, while of low amplitude, are considered significant internal polarization anomalies. The maximum depth to the current centre (which will lie within the source and down dip thereof) is of the order of 75 metres to 100 metres. Only detailed arrays could ascertain the minimum depth to source, and the dip direction (see appendix).
The RF contour plan (Fig 4) clearly defines the axis of the Howley Anticline striking approximately north-south along the 10000 E line. The broader anomaly west of 10000 E indicates that the axis is still overturned with both limbs dipping to the west. Scintrex describe the source as 'Type B' - chargeable, but showing little interconnection - and lying within a host having little resistivity contrast with the enclosing rocks. The sources described could fit any number of models, but one possible explanation is: disseminated sulphides within the siliceous tuffaceous units or within contained quartz veining which would have a similar resistivity. Percussion drilling in 1983 went no deeper than 52 m so did not reach source depth. The drill did indicate disseminated sulphides through most of the intersections which means that the areas located are zones of highest sulphide concentrations. The dilocation as shown on Figure 5 is not indicated by surface mapping or photo-interpretation so may be caused by a sudden steepening of plunge. Detailed structural mapping in this area is required before drill sites can be sited.

5.2 PERCUSSION DRILLING

The two percussion holes PD1 and PD2 intersected
mainly mudstones. The rock has undergone Greenschist Facies Metamorphism, resulting in an olive grey to olive black fine grained chlorite-sericite rock (Appendix 3). Minor quartz stringers occur through the sequence and contain finely disseminated sulphides (pyrite). Sulphides also occur along cleavage plains and fracture surfaces. Preliminary results from the Laboratory are not significant with the highest value, 0.8 ppa (PD1, 41-42m).

5.3 COSTEAMING

The samples collected every metre from the costeam across Howley ridge, just east of the camp, generally assayed less than 0.2 g/t Au. The highest value, 5.6 g/t was collected from the hinge area, across a sheared tuffaceous zone. (Appendix A)

6 CONCLUSIONS AND RECOMMENDATIONS.

Within EL1886, known gold mineralisation is associated with the Howley anticline. Shallow shafts and limited alluvial diggings are evidence of this mineralisation.

Shallow percussion drilling in 1983 intersected some low but persistent gold concentrations in rocks straddling the anticline axis. An REMP survey indicated a possible disseminated sulphide source 100m below the surface and this anomaly will need to be tested
in the 1984 season.

To date, the mineralization along the Howley anticline has not been tested systematically. To adequately test this zone a programme of sampling, costeaging and detailed structural mapping is proposed for the coming season. Percussion drilling will follow over the most prospective areas.

Away from the Howley Line exploration will consist of systematic sampling, geological mapping and costeaging to see if any gold bearing structures occur paralleling the main anticline. The estimated expenditure for the 1984/85 season is $30,000.


Vanderplanck, A., 1965
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THE PRESENT APPLICATION
OF THE MAGNETIC INDUCED POLARIZATION (MIP) METHOD
IN THE TIME AND FREQUENCY DOMAIN

INTRODUCTION

Since the Magnetic Induced Polarization (MIP) method was introduced into
Australia some six years ago, very considerable field experience has been
gained. The purpose of these comments is to discuss the application of the
method, the form of the responses observed, and how the standard anomaly forms
are generated. This is a simple non-mathematical description designed to enable
the geologists to visualise just how the energising and induced polarization
currents flow in the ground, and how to interpret these in a qualitative sense,
for it is the geologist who is far better qualified to interpret this data in
a structural context. It is the author's opinion that MIP data is more often
than not, simpler and more diagnostic to interpret than EIP or EM data in the
conductive conditions which exist over much of Australia's land mass.

The uniqueness of the MIP Method ......

It is essential to grasp the very basic differences between the magnetic mode
of acquiring induced polarization data (MIP) and the more conventional electrical
mode (EIP). As even geophysicists of some experience have had difficulty in
appreciating the full significance of this method, it is necessary to state in
simple terms some of the unique attributes of the method.

1 - Conventional EIP data monitors ONLY the current flow AT THE SURFACE
generated by the storage of charge (IP effect) WITHIN the body. With
MIP both the current flow OUTSIDE, but more importantly INSIDE the chargeable
source, are DIRECTLY MONITORED. Thus the external (EIP) polarization from mineralisation NEED NOT NECESSARILY COME TO THE SURFACE for it to be monitored.

2 - In conventional EIP, the transfer of the induced polarization signal from the source mineralisation to the surface involves a considerable loss of energy by "friction" and "chemical reactions" en route, whereas for MIP, as the movements in current at depth are monitored from depth via their associated magnetic fields, very much less loss of energy is involved. Thus, the fall off in response with distance from a chargeable source is very much less as seen with MIP than that seen with EIP.

3 - With conventional EIP methods, the external induced polarization effect is monitored via two potential electrodes placed some distance apart (commonly 25 to 100 metres), effectively averaging the response over this distance. However, as the MIP sensor is about 60 centimetres in length only, in the MIP method it is essentially a point source measurement which improves resolution very considerably.

4 - Where conventional EIP techniques are applied to highly conductive overburden/oxidation regions, the multi-layering within this zone very considerably reduces or even eliminates the EIP signal en route to the surface. With MIP, both primary and secondary (IP) current flow within this zone has NO MATERIAL INFLUENCE on the data. Thus the problems of "masking" are eliminated with MIP.

5 - As the EIP induced polarization signal flows from source to surface, the medium through which it passes not only reduces its amplitude (see 2 above), but also modifies the form of the signal. Thus the decay form observed at the surface will tend to be that of the medium rather than the source. However, as the MIP monitors the magnetic field from the decay within the source itself, no such distortion in the internal polarization decay form can be expected.

6 - The EIP method is essentially a measurement of absolute levels of apparent resistivity and chargeability as observed at the surface. However, the MIP
method measures the relative properties of chargeability and resistivity, and is thus more sensitive to these differences.

7 - In the EIP method, the electric field is often severely distorted by local and often insignificant inhomogeneities in resistivity. However, as the primary (resistivity) and secondary (IP) magnetic field measurements are summed over a large volume of rock, they are not distorted or masked by local inhomogeneities.

4 Definition of Terms . . . .

Before going into the detailed qualitative discussion of the principles of operation, it is best to define the terms used in the description.

Energisation: - The process by which current is introduced into the volume of rock which is the subject of the survey. Primary Current Flow: - The flow of current through this medium as a result of this energisation. Primary Magnetic Field \( (H_p) \): - The magnetic field generated by virtue of the primary current flow in the subsurface.

Induced Polarization Effect: - The "condenser like" storage of energy on an electronic/electrolytic boundary, for instance on sulphide/electrolyte boundaries.

Internal Polarization: - The induced polarization effect within the body, which is the source of all induced polarization phenomenon, whose discharge is always in the OPPOSITE DIRECTION to the primary current flow which caused it.

External Polarization: - The induced polarization effect which flows outside or external to the causative source which is always of the same sign as it is in the same direction as the energising primary current. Secondary Magnetic Field \( (H_s) \): - This is the magnetic field caused by the flow of secondary currents within (internal) and outside (external) of the causative source.

Decay Form \( (\Delta M) \): - This term describes the decay of the energy stored within the body. It may be more rapid than "normal" or slower than "normal". (A detailed description follows on Page 9).
Comparison of the Electrical and Magnetic Modes of Acquiring Induced Polarization Data ....

By far the most meaningful way in which to visualise the nature of MIP (and indeed EIP) data, is to consider the energy storage concept and to look at the primary current flow pattern and the resultant equipotential field caused by this energising current, and then the consequent secondary current flow pattern and its associated secondary potential field caused by the decay of the energy stored on electronic/electrolytic contact boundaries, which is known as induced polarization. As this is most easily visualised in the time domain, this description is confined to that domain.

Energisation Process ..... Normally current is applied to the volume to be sampled by means of two electrodes placed semi-parallel to the expected strike of the target mineralisation. In the diagram shown in Figure 1, the fine solid lines represent the current flow pattern so generated. The dashed faint lines represent the equipotential surfaces (lines in the section).

In the electrical mode, the two potential electrodes (see Figure 1) will measure the resistivity of a volume of material defined by the equipotential surfaces which are always at right angles to the current flow.

Energy Storage Process ..... The material through which the current passes will store some portion of the energy in a way determined by the properties of the storage material. The amount of energy stored will depend on the total area of the sulphides (or graphite etc.) presented to the current, and thus, the greater this surface area with respect to the volume of material, the greater will be the energy stored. Finely disseminated material will store substantially more energy than coarse grained material.

The Discharge of Stored Energy ..... On cessation of the energising current flow, the energy stored by the chargeable source will discharge internally within the source as shown by the solid arrows in Figure 2, and externally around the body in the medium surrounding the source as shown by the solid heavy lines in Figure 2. These currents are respectively known as internal and external current flow. The former is of negative sign as it is in the opposite direction to the original energising current, and the latter is of positive sign as it is in the same
SCINTREX

EIP & MIP
DISCHARGE OF INDUCED POLARIZATION

MIP Sensor

Sum of internal and external fields

MIP potential dipole

Disseminated chargeable source

Magnetic field due to external polarization (\(H_{\text{e}}\))

Magnetic field (\(H_{\text{i}}\)) due to internal polarization

Internal polarization

External polarization

Secondary equipotential surface

Fig 2.
direction as the energising current.

In the electrical mode, only the discharge external to the body is investigated. In Figure 2 the thick solid lines show this discharge together with the equipotential surfaces (thick broken lines) which this current imposes. As with the charging process these surfaces must be at right angles to the current lines which impose them. The potential electrodes will therefore measure the stored energy (chargeability) as seen via the secondary equipotential field. It is important to note that (i) this is NOT the same volume as the resistivity measurements and (ii) it is NOT the original IP signal as stored by the body, but a measurement distorted and processed by the environment through which it has passed.

In the magnetic mode a very sensitive magnetometer (Scintrex MFM-3) is used to "sense" the horizontal component of the magnetic field due to the current flow both inside and outside of the source material. This is possible because each electron which flows in the ground carries with it an associated magnetic field. This magnetic field will pass unhindered through the environment and thus both the discharge internally and externally to the source can be monitored on the surface.

The Form of MIP Anomalies ....

In the MIP method, the energising field is normalised with respect to the energising current electrodes. Details of this procedure are given later in this paper. In the description Figures 3 to 6, the magnetic field due to the primary passage of the energising field $H_N$, can be regarded as "relative bulk conductivity" plotted upwards. In these figures, internal polarization (which is negative in sign because it flows in the opposite direction to the energising current), is plotted upwards, while external polarization (which flows in the same direction as the energising current and is therefore positive in sign) is plotted downwards.

The enclosed Figure 3 demonstrates the theoretical form of an MIP anomaly from a source which has no electrical contrast with the enclosing material, but has the property of retaining charge. (In nature such anomalies are in fact observed from the ilmenite fraction within heavy mineral deposits in beach sands.)
SCINTREX

TYPICAL M.I.P ANOMALY FORMS

THEORETICAL MODEL

CHARGEABLE SOURCE
NO RESISTIVITY CONTRAST

TYPE A

CHARGEABLE SOURCE
RESISTIVE SOURCE

NOTE:
+ External current flow into plane of paper
. Internal current flow out of plane of paper

+ Geological cross section

Fig. 3
Energisation is along strike, into the plane of the paper. In all figures the current flow direction is represented by arrows, with dots representing current flow out of the plane of the paper, and crosses represent the current flow into the plane of the paper.

In Figure 3, over the source, the magnetometer will "see" a surplus of internal (negative) current flow, while on the flanks of the body, the external (positive) current flow will become predominant. The "head and shoulders" MIP anomaly shown is always seen over all sources. It is the distortions in shape, form and zero level that yield vital information as to conductivity of the source, conductivity of the environment above and about the source, the depth to the source and the nature of the mineralisation in and around the source.

**TYPE 'A'** (Figure 3) ..... shows the typical anomaly form over a chargeable source which is more resistive than the surrounding medium. In such cases the normal "head and shoulders" anomalies coincident with a depression in the $H_N$ are observed. An example of such an anomaly form is chalcopyrite/pyrite in quartz veins itself within a more resistive conductive rock unit.

**TYPE 'B'** (Figure 4) ..... In this case the chargeable source has no resistive contact with the enclosing material. This example is very similar to the theoretical model. An example of such an anomaly form would be over disseminated sulphides within a homogeneous rock unit.

**TYPE 'C'** (Figure 4) ..... In this case the source of the chargeable material is itself more conductive than the enclosing rock type. When the observed $H_N$ values are less than 180% - 200%, a normal "head and shoulders" anomaly is observed over the source. In practice, observed $H_N$ values rarely exceed 150% of normal.

**TYPE 'D'** (Figure 5) ..... In this most important anomaly form which invariably is associated with massive sulphides which are both conductive and electrically continuous, a massive sulphide must be surrounded by a disseminated halo within more resistive host rocks. In this case the disseminated sulphides will naturally store the induced polarization charge far more efficiently than the massive electrically continuous core. Thus, on completion of the energisation process,
SCINTREX

TYPICAL M.I.P ANOMALY FORMS

TYPE B
CHARGEABLE SOURCE
HOMOGENOUS

TYPE C
CHARGEABLE SOURCE
CONDUCTIVE

NOTE:
+ External current flow into plane of paper
• Internal current flow out of plane of paper

Fig 4.
he charge stored within the disseminated halo will preferentially discharge through the conductive massive sulphide core. This effect has NEVER been observed where $H_N$ values have been less than 180% of normal. This anomaly form ues its high $H_N$ and coincident predominantly external (positive) current flow, s diagnostic when observed. An example of such a response is the Mt. Windarra yrrhotite/nickel/copper deposits in Western Australia.

YPE 'E' (Figure 5) .. A distorted MIP response curve is generated when a polarizable body is located on a contact between rocks of quite different resistivities. This is rather common in Western Australian nickel deposits. In such a case the return polarization current flow will be concentrated in the ore highly conductive rock type instead of being symmetrically distributed on both sides of the body. The resultant MIP response is an asymmetric curve, with its internal (negative) maximum lying on the more resistive side of the body and the external (positive) current peak lying on the more conductive side. Sometimes the asymmetry is so large that the 'crossover' is almost directly over the polarizable body. The $H_N$ peak is shifted over the conductive rock side of the polarizable body.

Composite Anomalies .....

can readily be appreciated, the above examples 'A' to 'E', represent singleimple bodies. In the field, more often than not, the sources vary in composition and therefore in chargeability and resistivity across strike, along strike and over dip. For example, while the form of Type 'C' and Type 'D' anomalies are very different in appearance, the geological situation which gives rise to them requires relatively little change in conductivity to materially change their form from 'C' to 'D'.

In the interpretation of MIP therefore, the electrical characteristics of known Type Deposits' similar to those being sought, together with local informations to the possible range of structure in the area, is of primary importance. In other words, geological input is often of greater importance than quantitative sophysical data.
SCINTREX
TYPICAL M.I.P. ANOMALY FORMS

TYPE D
CHARGEABLE SOURCE, VERY CONDUCTIVE WITH
DISSEMINATED HALO

TYPE E
CHARGEABLE SOURCE ON CONTACT BETWEEN
TWO ROCK TYPES OF DIFFERING RESISTANCE

NOTE:
+ External current flow into plane of paper
- Internal current flow out of plane of paper

Fig. 5.
APPENDIX 3
<table>
<thead>
<tr>
<th>m</th>
<th>type</th>
<th>recovery</th>
<th>log</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>orange brown shales, shiloe, -</td>
<td>surface material</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>greenish grey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>greyish olive fine siltstone - for lamination strong cleavage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14-15</td>
<td>possible thin qf stringer - gradual darkening of samples to grey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16-17</td>
<td>minor qf stringer - laminite coating cleavage faces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>olive grey for qf - poor cleavage - usual foliation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>possible chlorite-mica - carbonaceous in part - minor chips of spotted silt for qf - bits (chert) rock</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ex tuffaceous shiloes - faint appearance trace</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dense py</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>dark grey black, very for qf stlit - qf - biotite?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>very for dense py throughout - fracture planes on mino</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>qf veins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28-29</td>
<td>qf stringer - narrow - 1cm? - very fine dense py</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>m chlorite - qf foliated rock - ex chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39-40</td>
<td>minor qf stringer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>slight increase py towards 204</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

log ged BR...  
drillers Hickey  
rig worker angle 60°W  
INVESTIGATOR
<table>
<thead>
<tr>
<th>m</th>
<th>type recev</th>
<th>log</th>
</tr>
</thead>
</table>
| 0-1 | PERCEPTION | orange-brown - brown - pale brown - for grn silites -
| | | silicified in part. weathered zone - laminated clean
| | | light olive brown to lt. due grey, for grn silites -
| | | silicified in part. |
| 5 | | dark yellowish orange - fa to md grn - qt. rise? mol.|
| 8 | CALPS | weathered - weak foliation - no cleavage - qt. tuff? |
| | | light olive grey for - md grn silites - cleavage-foliation |
| | | minor silicified - qt. stringers - weathered oxidized zone |
| 19 | | core water table |
| | | olive grey to olive black - very fragran - chloritic |
| | | mudstone - chlorite - remites - qt. - possible limesimple |
| | | trace cream pyrite throughout |
| 22-23 | minor qt. stringers |
| | | 28-29 |
| | | 32-34 |
| 37-38 | | with durem py along qt. |
| 51 | | 50-51 |

logged: BR.  
drillers: Henry  
rig: 9A  
angle: 60° E  
100
MINES DIVISION

IN REPLY
PLEASE QUOTE

PBH:MB:258
2.4 n(8)

Talmina Trading
C/- 24 Pett Street
ALAWA NT 5792

Attention: Mr B Richardson

Dear Mr Richardson

RE: ASSAY OF 75 SAMPLES FROM HOWLEY RIDGE AND XRD SCAN ON YELLOW MINERAL

Please find attached reports on the above two subjects.

Yours sincerely

PHIL HEARSE 20.9.83
for Chief Metallurgist
METALLURGICAL SERVICES BRANCH REPORT

Title: Assay of 75 Samples from Howley Ridge

Job No.: 37/83/84

Client: Talmina Trading

Location: Howley Ridge

Lease No.: EL 1886

Date Samples Submitted: 16 August 1983

Report:
The assay results show that most of the samples are less than 0.2 g/t gold.
The exceptions are:

<table>
<thead>
<tr>
<th>SAMPLES</th>
<th>Au g/t</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC 21</td>
<td>1.4</td>
</tr>
<tr>
<td>BC 22</td>
<td>0.2</td>
</tr>
<tr>
<td>BC 25</td>
<td>5.6</td>
</tr>
<tr>
<td>BC 26</td>
<td>0.7</td>
</tr>
<tr>
<td>BC 33</td>
<td>0.5</td>
</tr>
<tr>
<td>BC 59</td>
<td>0.5</td>
</tr>
<tr>
<td>BC 72</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Title: Identification of yellow mineral

Job No.: 39/83/84

Client: Talmina Trading

Location: Howley Ridge

Lease No.: EL 1886

Date Samples Submitted: 16 August 1983

Report:

The sample was identified by x-ray diffraction techniques as pyromorphite [Pb₅ Cl (PO₄)₃].