E.L. 4858 COLLIERY,
TOLMER PROJECT, N.T.
ANNUAL REPORT TO
DEPARTMENT OF MINES AND ENERGY
1988

R/88-18-U

P. MELVILLE
MARCH 1989

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I. INTRODUCTION

1.1 GENERAL

This report encompasses the exploration activities carried out on E.L. 4858 during the 1988 field period. The tenement is being explored by a joint venture agreement between TOTAL Mining Australia Pty. Ltd. (T.M.A.) and the Power Nuclear Corporation of Japan (PNC).

The geological similarities of the region to that of the Alligator Rivers Uranium Field prompted T.M.A. to mount an exploration programme based on that model.

1.2 DESCRIPTION OF AREA

The tenement is situated in the Daly River region located 55 km southeast of the Daly River settlement and centred about 150 km south of Darwin. The land covered is part of the Fish River Pastoral Lease controlled by Tipperary Station. The E.L. is bounded by latitudes 13° 14' and 14° 22' and longitudes 130° 53' and 130° 58' and comprises 28 sub-blocks giving 77.4 km².

1.3 LOGISTICS

Access to the licence area is restricted to dry season conditions. Station tracks from either Tipperary or Claravale homesteads cross the Daly River which is usually impassable for 5-6 months. Much of the area is covered by woodland and scrub and is of generally low relief making vehicular traversing possible in most cases. Elsewhere ridges of the Tolmer Group are present with some flat-topped, laterite-covered hills.

The principal drainage is the north flowing Fish River, a major tributary of the Daly. This watercourse flows only during the wet season. The Collier Waterhole is the site of an abandoned tin mine.
II. GEOLOGY

2.1 REGIONAL SETTING AND STRATIGRAPHY

The Joint Venture Licences are located on the western edge of the Pine Creek Geosyncline. The main rock types are sediments ranging in age from Lower Proterozoic to Adelaidean; Carpentarian granites intrude these sediments. The Litchfield Complex of ?Archaean to Lower Proterozoic age occurs to the northwest. The Cambrian Daly River Group obscures much of the Lower Proterozoic-Adelaidean rocks both west and east of the tenement area.

The stratigraphy is as follows (from N.T.G.S., 1983):

ARCHEAN–EARLY PROTEROZOIC: Litchfield Complex comprising high grade metamorphics which appear to include sediments, basic to intermediate rocks and anatetic granites.

EARLY PROTEROZOIC: Burrell Creek Formation comprising variably metamorphosed sandstones and siltstones. Includes pebble and conglomeratic facies, graphitic shales/schists and some carbonate rocks (Pfb).

LATE PROTEROZOIC:

(i) Carpentarian syn-orogenic to post-orogenic granites. Represented by the Mt. Litchfield, Allia Creek and Jammine granites and the Soldiers Creek granite at Collier (Pxgl, Pxga, Pxgi and Pgs).

(ii) ?Early Adelaidean Tolmer Group. Comprises four formations:

+ Depot Creek Sandstone: thickly bedded medium to coarse quartz arenite (450 m) (Ptd).

+ Stray Creek Sandstone: flaggy micaceous, ripple marked quartz arenite (300 m) (Pts).

+ Hinde Dolomite: dolomite, dolomitic shales and arenites, quartz arenites (+ 314 m) (Pth).

+ Waterbag Creek Formation: red mudstone with thin arenite layers (non-outcropping) (+ 134 m) (Ptw).

(iii) Late Adelaidean Uniya Tillite (0 - 30 m) (Put).

PALAEOZOIC: Cambrian Daly River Group. Basal conglomerates, Antrim Plateau Volcanics (basalts) and the Tindall Limestone (Ela).
2.2 STRUCTURE

The principal structural feature of the region is the Giants Reef Fault which has caused obvious displacement to the various rock units it traverses. The zone extends some 30 km NE of Rum Jungle where it loses its identity under alluvial cover; southwards it extends well outside the Company's area of interest. The Giants Reef Fault is considered to be the northern extension of the Hall's Creek Mobile Zone. Parallel structures, the largest being the Stapleton and Rock Candy Range Faults and many minor ones traverse both the Burrell Creek Formation and Tolmer Group rocks.

Folding is present both on a small and large scale. The Burrell Creek sediments are tightly folded with fold axes striking generally N-S. The overlying Tolmer Group dips gently eastwards forming the extensive Daly River Basin. Folding occurs in the Tolmer adjacent to the Rock Candy Fault forming an elongated domal structure thought to be underlain by Carpentarian granite. The Cambrian sediments are nearly flat lying.

Regional dips are moderate to steep westerly for the Burrell Creek Formation and gently eastwards for the Tolmer Group. Strikes are N-S to NW-SE.

2.3 GEOLOGY OF E.L. 4858

+ Burrell Creek Formation

Only selvedges of the Lower Proterozoic remain, either as strongly altered rafts within the younger Soldiers Creek Granite or as thin strips preserved along the contact with the Tolmer Group. Several observations were made during the various helicopter surveys (1986, 1988); some of the 'rafts' were prospected to ascertain radiometric backgrounds; the composition of these bodies comprises highly altered and veined schists and quartztitic rocks; many aplitic/pegmatitic variants of the granite intrude them. Black tourmaline is common in the intrusives; andalusite occurs in the altered sediments.

Adjacent to the Tolmer Group outcroppings a thin wedge of Burrell Creek is preserved between it and the Soldiers Creek Granite. These outcrops have been looked at in the field in the southern part of the E.L. several kilometres north of the Collier Waterhole. Along the granite margins good exposures of the intrusive contact can be seen with granitization and partial ingestion of the Burrell Creek; this zone is only a few metres wide passing into unaltered meta-sandstones and schists.

+ Tolmer Group

The mid-Proterozoic sandstones outcrop regionally as NW trending, NE dipping strata. The best exposures are present in the Fish River Gorge to the north where both the Depot Creek and Stray Creek members can be seen. The upper member, the Hinde Dolomite, is present in the NE corner of the licence comprising
dolomites, dolomitic sandstones and shales. Structurally, the Group is undisturbed with fairly constant strikes and dips. Some regional photo lineaments trend parallel with the strike and are responsible for some displacement. Minor faults have been observed in some of the work areas (SV10) showing localized cross-strike displacement.

Uniya Tillite

Some terraces of unconsolidated pebble/boulder deposits were seen during contact traverses. One example occurs on a flat section of ground between outcrops of Burrell Creek and Tolmer. The pebbles up to 12 cm diameter occur as a thick veneer on soil; they are very rounded and smooth and resemble similar deposits in the norther E.L.s which have been mapped as till.

Mesozoic

Sections of what are considered to be Mesozoic sediments outcrop on the two INPUT anomaly areas explored during the season. The basal unit is a ferruginous sandstone often containing large to boulder-size rounded clasts of Depot Creek. Similar facies seen in E.L.s 4856 and 4857 are mapped as part of the Uniya Tillite, therefore its status here must remain in question.

Overlying the 'boulder sandstone' are several metres of laminated, silicified siltstone with some thin layers of meta-sandstone. This, in turn, is covered by a thin laterite layer.

Granites

A small portion of the rather extensive Soldiers Creek Granite is present within the E.L. forming an intrusive contact with the Lower Proterozoic, discussed above, and unconformable with the overlying Depot Creek Sandstone. The granite is described as a post-orogenic granitoid comprising a coarse grained muscovite-biotite adamellite and granodiorite. Certain phases of the granite have produced disseminated cassiterite mineralization which has been concentrated later by weathering processes. The gold deposits at Fletchers Gully which occur in carbonaceous facies of the Burrell Creek Formation could be related to the granite.

Field observations of the granite were discussed earlier under the Burrell Creek heading.
TOTAL Mining Australia Pty. Limited

III. EXPLORATION ACTIVITIES

3.1 INTRODUCTION

The principal aim of the 1988 programme within E.L. 4858 was to carry out ground geophysics over conductive zones as defined by the aerial INPUT survey and to follow-up with drilling at some later stage if warranted.

3.2 MODELS AND TARGETS

The joint venture is exploring for unconformity-type uranium concentrations believed to be located at or near the unconformable contact between the Lower and Middle Proterozoic formations.

Similarities have been initially recognized between the lithologies encountered in the Tolmer Project Area and those from the Alligator Rivers Uranium Field. Such similarities have been enhanced with the discovery of uranium mineralization at several locations within the Burrell Creek Formation. These occurrences have related, typical hydrothermal alteration patterns and some lithological associations which add weight to the exploration concepts employed.

The exploration activities are conducted keeping in mind the models of concentration and association and the methods of investigation used in the ARUF and Athabasca uranium provinces. However, taking into account the presence of subtle variations and differences in the geological, tectonic and morphological factors within the region, the approach taken to the planning of various field investigations and the interpretation of data is flexible.

3.3 METHODS OF INVESTIGATION AND EQUIPMENT

Systematic work over the defined EM conductors involved initial location with the aid of aerial photography and 1:100,000 topographic maps. Those inaccessible by 4-WD vehicle were reached with the aid of a helicopter, a Bell Jetranger from Rotor Services, Darwin. Once the conductive zone had been identified the area was gridded, usually with 100 m spaced cross lines and 25 m intervals marked along these lines. The general sequence of activities on each grid within the E.L. are as follows:

- initial MaxMin - Geoterrex, Sydney,
- VLF - TOTAL staff,
- geological mapping - TOTAL staff.

During the campaign the MaxMin ground electromagnetic surveying was carried out by a crew from Geoterrex using a 150 m separation between receiver and transmitter along profiles either 100 m or 200 m apart. Equipment used was an Apex Parametrics MaxMin II frequency domain electromagnetic system.
The MaxMin survey was performed only on two INPUT anomalies located on thin Cretaceous sediments overlying the Depot Creek Member of the Tolmer Sandstone. It was ascertained that the method was unable to define a target below a thickness of overlying facies greater than that of the Depot Creek. The latter, with a maximum thickness in excess of 400 m, is already the absolute maximum through which the MaxMin can "see" even when considering the most favourable hypothesis.

The purpose of the ground EM MaxMin survey was to determine the presence and location of conductive belts, possibly corresponding to facies of graphite-chlorite schists within the Burrell Creek Formation below the overlying Depot Creek Sandstone. Our detailed survey of the Burrell Creek Formation outcropping near the Depot Creek unconformity has confirmed the presence of such favourable facies, most often accompanied by uranium mineralization or anomalous radioactivity (e.g., Eccles I and II) in the northern licences of the project area.

The MaxMin survey has provided two types of anomaly:

- some responses corresponding to wide, shallow "bad quality" conductors,
- some responses which could correspond to more deeply seated conductors.

The interpretation of the MaxMin anomalies has been done considering also the limit of mapped geological facies and/or the structural features recorded during the systematic survey of the gridded area.

VLF was run over as many lines as possible on each grid; its purpose was to define the presence of shallow conductive zones such as overburden, to help in the interpretation of the MaxMin responses, and to outline structures which affect both the Tolmer Sandstone and underlying Burrell Creek Formation. The equipment used is a Geonics EM16 unit, manually operated.

The survey was run on the Japan (NDT) and North West Cape (NWC) transmitters to obtain information on both N-S and E-W sets of faults. Unfortunately, the North West Cape Station emitted very irregularly which did not enable us to obtain values on every reading location of the grid and so get systematic information on the E-W oriented faults. Attempts will be made during the 1989 campaign to complement the readings from the North West Cape emitter and to work on a closer grid when detailed readings appear necessary.

The results of both EM surveys are presented together with their interpretation in the various plates. Plate numbers are referred to in the individual descriptions of each anomaly.

Technical specifications of the EM equipment can be found in Appendix 1.
3.4 INPUT ANOMALIES

3.4.1 T52

Located AMG 098135 Wingate Mountains sheet, photos Run 9 6752, 6753. Another group of conductors on flat lying Cretaceous sediments. T52 is a SE extension of SV10, some 2.5 km away. Geologically the setting is identical to SV10 (Plate 7) except with better exposure of the lithologies within a central drainage system. Several parallel WNW photo-structures traverse the anomaly but any effect they have is mostly obscured. Some brecciation within the Depot Creek Sandstone is most likely related to the most northerly fault system. Conglomeratic lenses are present indicating possible basal facies of the Tolmer.

The interpreted MaxMin conductors show a N-S direction with some short ones N10E and one almost NW-SE. The VLF conductors, of generally weak quality, show the same general orientation plus an E-W direction obtained from readings taken on the NW Cape station and parallel to the creek pattern (as for the N-S also) (Plates 8 and 9).

It is our opinion that some of the EM responses are caused by laterite and are unlikely to be related to deep seated conductors; however one conductor outlined by Geoterrex (J. Peacock) is interpreted to represent a different source, possibly structural.

3.4.2 SV10

Located AMG 075155 Wingate Mountains sheet, photos Run 9 6752, 6753. Comprises three conductors coinciding with a topographical high of laterite and ?Cretaceous sediments overlying Depot Creek Sandstone (Plate 4). The younger stratigraphy is identical to T52. The underlying Depot Creek strikes NW with shallow NE dips; several regional lineaments and some more localized fault zones traverse the sandstone. Remnants of Burrell Creek sediments occur in linear ridges adjacent to the Tolmer Sandstone but usually surrounded by granite. Observed outcrops are strongly metamorphosed or granitized. Three structures are evident within the grid: on the western side a N-S fault is intensely quartz veined; a fault between 1800N and 1900N shows lateral and vertical displacement of the sandstone outcrop and on the east side a major NW lineament has been partly obscured by the Cretaceous cover. There are no observable local effects of the latter except for slight variations in bedding strike on the east and west side.

VLF and MaxMin give a number of interpreted conductors with orientation N10W to N45W.

Some of the conductors correspond to lithological limits and, in one case, a fault. The other conductors are located on the laterite covered portion of the grid and could be due to overburden features underlying the laterite (Plates 5 and 6) or structural zones within the Middle Proterozoic.
IV. CONCLUSIONS

The ground EM surveys have outlined various conductive trends on the two INPUT anomalies investigated. Interpretations by both T.M.A. and Geoterrex have come up with several models which indicate a range of causes for the various conductors: the laterite/Cretaceous cover rocks can provide surficial anomalies of which some are indicated; mapped faults are another cause. Others are less clear and may require further definition.

Both Burrell Creek Formation and the Soldiers Creek Granite outcrop to the west; depth to Burrell Creek is unknown but may not be great. Gravity contours suggest a shallow granite body sloping gently to the east. Therefore deeper conductors may either be faults in the Depot Creek Sandstone or possibly of lithological origin within the Lower Proterozoic.

Any future work on SV10 and T52 will involve a radon/radiometric survey. The Burrell Creek outcrops will require prospecting where they are intruded by the granite and overlain by the Tolmer Sandstone.
V. EXPENDITURE STATEMENT

Period 4.3.88 to 3.3.89

Please note that E.L.'s 4856, 4857, 4858, 4870 and 4958 are considered as a project for expenditure commitment purposes (Ref. letter from Department of Mines and Energy, UM:may:NH22:152 of 20.6.88).

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APPENDIX 1

EM-16 VLF Electromagnetic Unit
Description and Operation
I. PRINCIPAL OF OPERATION

1.1. General

The EM-16 is a receiver which measures two aspects of a "very low frequency" (VLF) electromagnetic field. The field is transmitted by various military and time standard transmitters located throughout most of the world. Any conductors (such as metallic mineral deposits) located in this homogeneous field will "distort" the field, and the EM-16 is designed to measure the amount of "distortion".

1.2. Detailed

VLF transmitters operate on a single frequency within the range 15-25 KHz. The coverage of a number of stations is shown in Figure 1. The vertical antenna of a VLF station produces a homogeneous, horizontal magnetic flux density at a large distance from the station. The magnetic field is horizontal and perpendicular to the direction of propagation of the electromagnetic field.

Any conductor (preferably steeply-dipping and whose strike points towards the transmitter) lying in the horizontal magnetic field produces a secondary field, of different magnitude, direction and phase to the primary field. Their combined effect produces a resultant field which in this case is polarised into a single vertical plane, and can be described by an ellipse. This effect is called elliptical polarisation. Any spatial component (e.g. vertical component) of the resultant field can be separated into a real component (in-phase with primary field) and an imaginary component (90° out of phase with primary field). The angle between the minor axis and the vertical in the vertical plane is called the tilt angle.

The EM-16 is designed to measure two parameters:

(a) the vertical in-phase (real) component of the resultant field as a percentage of the primary horizontal field,

(b) the vertical out-of-phase (imaginary or quadrature) component of the resultant field as a percentage of the primary horizontal field.

Two mutually orthogonal receiving coils, are built into the handle of the EM-16. A.C. compensators (bridges) are used to make measurements of signals.

The vertical in-phase component as a percentage of the primary horizontal field is directly related to the tangent of the tilt angle of the vertically polarised ellipse. The latter is easily determined by tilting the axis of the vertical-coil (in the plane of polarisation) until a null signal is obtained. The null occurs when the vertical coil axis is perpendicular to the major axis of the polarised ellipse. The tilt angle can be read in degrees from vertical or directly as a percentage.

The vertical out-of-phase component is the remaining signal in the vertical-coil when the first null condition is obtained. It is measured by using a percentage of the signal from the reference horizontal-coil (which monitors the primary horizontal field) to obtain a sharpened null in the vertical-coil. This percentage is read from an adjustable "quadrature dial".
II. SPECIFICATIONS

Source of Primary Field: VLF transmitting stations.

Transmitters Used: Any desired station frequency can be supplied with the instrument in the form of plug-in tuning units. Two units can be used at one time. A switch selects either station.

Operating Frequency Range: About 15-25 kHz.

Parameters Measured: (1) The vertical in-phase component.
                      (2) The vertical out-of-phase component.

Method of Reading: In-phase from mechanical inclinometer and quadrature from a calibrated dial. Nulling by audio tone, volume adjustable.

Scale Range: In-phase ± 150%
             Quadrature ± 40%

Readability: ± 1%

Reading Time: 10-40 seconds depending on signal strength.

Operating Temperature Range: -40 to 50°C.

Operating Controls: ON - OFF switch
                    Battery test push button
                    Station selector switch
                    Volume control
                    Quadrature dial
                    Inclinometer dial.

Power Supply: 6 size AA (penlight) alkaline cells.
              Life about 200 hours.

Dimensions: 42 x 14 x 9 cm (16 x 5.5 x 3.5")

Weight: 1.6 kg (3.5 lbs.)

Instrument Supplied With: Monotonic Speaker
                          Carrying Case
                          Manual of Operation
                          3 plug-in tuning units
                          Set of 6 batteries.

Shipping Weight: 4.5 kg (10 lbs.)

III. FIELD PROCEDURES

3.1. SELECTION OF TUNING UNITS

Plug-in tuning units are designed to tune the EM-16 to the particular frequency of the desired transmitting station. The ranges of each VLF transmitting station shown in Figure I. are regarded as conservative. In Australia we have the use of 3 main stations:

NWC (22.3 KHz) - North West Cape, Western Australia
NDT (17.4 KHz) - Tokyo, Japan.
NPM (23.4 KHz) - Hawaii.
- Five frequencies: 222, 444, 888, 1777 and 3555 Hz.
- Maximum coupled (horizontal-loop) operation with reference cable.
- Minimum coupled operation with reference cable.
- Vertical-loop operation without reference cable.
- Coil separations: 25, 50, 100, 150, 200 and 250 m (with cable) or 100, 200, 300, 400, 600 and 800 ft.
- Reliable data from depths of up to 180 m (600 ft).
- Built-in voice communication circuitry with cable.
- Tilt meters to control coil orientation.
SPECIFICATIONS:

Frequencies:
- 222, 444, 888, 1777, and 3555 Hz.

Modes of Operation:
- MAX: Transmitter coil plane and receiver coil plane horizontal (Max-coupled; Horizontal-loop mode). Used with reference cable.
- MIN: Transmitter coil plane horizontal and receiver coil plane vertical (Min-coupled mode). Used with reference cable.

Operating Frequencies:
- 25, 50, 100, 150, 200, 250, 500, and 1000 kHz (MMD) or 100, 200, 300, 400, 800, and 800 ft. (MMD). 
- Coil separations in V.L. mode not restricted to fixed values.

- In-Phase and Quadrature components of the secondary field in MAX and MIN modes.
- Tilt angle of the total field in V.L. mode.
- Automatic direct readout on 90 mm (3.5") edgewise meters in MAX and MIN modes. No nulling or compensation necessary.
- Tilt angle and null in 90 mm edgewise meters in V.L. mode.

Repeatability:
- ±0.25% to ±1% normally, depending on conditions, frequencies and coil separation used.

Transmitter Output:
- 222 Hz: 220 A/m²
- 444 Hz: 440 A/m²
- 888 Hz: 880 A/m²
- 1777 Hz: 1777 A/m²
- 3555 Hz: 3555 A/m²

Receiver Batteries:
- 8V trans. radio type batteries. Life: approx. 35 hours, continuous usage.
- 12V 8Ah Gel-type rechargeable battery. (Charger, supplied.)
- Reference Cable:
- Light weight 2-conductor polyvinyl cable for minimum friction. Alternative cable at extra cost. Please specify.

Voice Links:
- Built-in intercom system for voice communication between receiver and transmitter operators in MAX and MIN modes, via reference cable.

Indicator Lights:
- Built-in signal and reference reading lights to indicate correct readings.

Temperature Range:
- -40°C to +80°C (-40°F to +180°F)

Receiver Weight:
- 8 kg (18 lbs.)

Transmitter Weight:
- 13 kg (28 lbs.)

Shipping Weight:
- Typically 80 kg (176 lbs.) depending on quantities of reference cable and batteries shipped. Shipped in two field shipping cabinets.

Specifications subject to change without notice.

APEX PARAMETRICS LIMITED
200 STEELCASE RD. E., MARKHAM, ONT. CANADA, L3R 1G1

Phone: (416) 495-1812 Cables: APEXPARA TORONTO Telex: 5222 4096 APEXPARA M4HN
GROUND SURVEY SPECIFICATIONS

EM SYSTEM: Apex MAXMIN II
3555 Hz
1777 Hz
888 Hz
444 Hz

COIL SEPARATION: 150 metres
STATION SPACING: 25 and 50 metres

MAXMIN 888 HZ PROFILES

Grid notation refers to Local Grid
Vertical scale 110 percent per cm
Base value = 0 percent
Out of phase =

Max Min Conductor

CR89/217

JOB NO: 4-984
Surveyed by GEOTERRIX PTY LTD, MAY-JUNE 1988
Compiled by GEOTERRIX PTY LTD, Sydney, NSW.
Processed using the ECS GEOMET system

TOTAL MINING AUSTRALIA PTY LTD
TOLMER NT
MAXMIN 888HZ PROFILES
SV10 PROSPECT

547-200 DATE: 13-FEB-89