E.L. 4858 - TOLMER PROJECT
PINE CREEK GEOSYNCLINE, N.T.

TOTAL MINING AUSTRALIA PTY. LIMITED
AND
PNC EXPLORATION (AUSTRALIA) PTY. LTD
JOINT VENTURE

ANNUAL REPORT FOR 1986 TO THE
N.T. DEPARTMENT OF MINES AND ENERGY

VOLUME I

R/86-22-U

P. MELVILLE
MAY, 1987

NORTHERN TERRITORY
GEOLOGICAL SURVEY

CR 87/132A

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SUMMARY

Initial ground reconnaissance covered the eastern and southern sections of the tenement where access for vehicles was evaluated and geological features checked. To date, the major work completed includes airborne geophysical surveys, both 'in-house' and contractual. Initial rock sampling for thermoluminescence studies was done concurrently with the helicopter survey.
I. INTRODUCTION

1.1 GENERAL

This report describes the exploration and associated activities carried out by the TOTAL Mining Australia Pty. Limited (T.M.A.)/PNC Exploration (Australia) Pty. Ltd. Joint Venture over E.L. 4858 (Collia) for the 1986 field season.

Plates 1 and 2 illustrate the location of the tenement geographically and in relation to the regional geology.

1.2 DESCRIPTION OF AREA

The E.L. is located approximately 65 km southeast of the Daly River Mission settlement, being adjoined to the north by E.L. 4870 (T.M.A./PNC); the southwest corner of the tenement is located 2 km due east of the abandoned Collia tin mine. All land within the E.L. boundary is part of the Fish River Pastoral Lease controlled by Tipperary Station.

1.3 LOGISTICS

Access is gained by various bush roads from Tipperary to the north and Claravale to the east; in all cases the Daly River has to be negotiated which limits the field work period. The Fish River is the major drainage flowing north to the Daly; tributaries include Lilyarba Creek. A Water Resources Measuring Station is located at the "Fish River Gorge".

Vegetation comprises savannah woodland in flat-lying areas with sparser scrubby areas over the sandstone country. Fairly thick forest covers the flat-lying Mesozoic cappings in the southeast part of the E.L.
II. PERSONNEL AND CONTRACTORS

Ground activities have been handled by Darwin and Sydney-based T.M.A. geological staff. A consultant geophysicist was hired by T.M.A. to co-conduct and organise the heliborne survey and to interpret and present all the data; he was assisted by the Darwin-based Project Geologist. The Paris-based assistant to the Exploration Manager (T.M.A. global activities) visited the project on one occasion.

Contracting work on the tenement was performed by the following:

- Rotor Services, Darwin supplied a helicopter for the gravity survey and a short duration reconnaissance trip.
- Austirex International Ltd. for an airborne magnetic and spectrometer survey over the eastern section of the E.L.
- Analabs, Darwin-Perth for geochemical analyses of rock samples.
- Adelaide University: Prof. P. Ypma and Mr. M. Hochman - thermoluminescence studies on Tolmer Sandstone samples.
III. GEOLOGICAL SETTING

3.1 REGIONAL GEOLOGY AND STRATIGRAPHY

The project area is located along the western edge of the Pine Creek Geosyncline which comprises principally Lower to Middle Proterozoic sedimentation. Many granites intrude the Lower Proterozoic rocks, both post- and syn-orogenic. To the west the zone is bounded by the Litchfield Block and to the east by the Cambrian Daly River sediments; much of the older geology is obscured by Mesozoic laterites and Recent alluvium and gravels.

Major structures include the Giants Reef Fault; lesser parallel structures, e.g. Rock Candy Range Fault, occur to the northwest. The former tends to "horsetail" west of the project area into a series of parallel structures of variable trend. Folding is common on both a small and large scale; the former is confined principally to the Lower Proterozoic. Gentle warping tends to be a feature of the Tolmer Group.

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

ARCHAEO-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 conglomerate facies, graphitic shales/schists and some carbonate rocks (Pfb).

The Chilling Sandstone outcrops in synclinally folded areas near Fletcher's Gully (Pic).

LATE PROTERozoIC:

(i) Carpentarian syn-orogenic to post-orogenic granites. Represented by the Mt. Litchfield, Allia Creek, Jamine and Reynolds River Granites and the Soldiers Creek granite at Collia (Pxgl and Pxga, Pxgi, Pge and Pgs).

?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) (Rts).

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

+ Waterbag Creek Formation: red mudstone with thin arenite layers (+134 m) (Ptw).
5.

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

MESOZOIC: flat-lying sandstone, siltstone, etc. usually lateritized (E).

3.2 LOCAL GEOLOGY AND STRUCTURE

Rocks within the tenement are predominantly the Middle Proterozoic Tolmer Group. These form a NE-SE striking belt of sediments with a gentle easterly dip; all facies of the Tolmer Group are present grading from the massive Depot Creek Sandstone to carbonate-rich sequences of the Hinde Dolomite and Waterbag Creek Formation. The latter form very prominent linear strike ridges with pronounced dip slopes.

Limestones of Cambrian age outcrop east and west of the Tolmer sediments; other Cambrian lithologies include isolated patches of the basal Witch Wai Conglomerate and cappings of Antrim Plateau Volcanics (mainly basalts).

The Soldiers Creek Granite is present in the southwest corner; it is overlain by both Tolmer and Mesozoic sediments. Rafts of highly altered ?Burrell Creek sediments occur within the granite. These bodies have a preferred east-west orientation. The granite is the host for alluvial tin deposits which have been mined at Collia in the past.

Mesozoic sediments partly obscure the Tolmer Group and granite in the far south of the E.L.

Structurally the E.L. is quite simple. The rocks of the Tolmer Group have generally undisturbed strikes and dips; minor east-west faulting in the south and southeast.
IV. EXPLORATION ACTIVITIES

4.1 MODELS AND TARGETS

Similarities to the geological setting in the A.R.U.F. prompted T.M.A. to consider the Daly River area to be a prospective uranium province, despite some specific lithological differences. The basal member of the Tolmer Group, the Depot Creek Sandstone, has many similarities with the "Kombolgie Sandstone", the most obvious being the unconformable relationship with the underlying Lower Proterozoic sediments.

The aim of the exploration programme is to locate favourable lithologies for uranium concentration by ground radiometric and geological traversing combined with detailed interpretation of airborne geophysical and spectrometric data. The geophysics is expected to yield specific zones of interest which will be targeted for ground follow-up and possible further airborne work. Defined targets will be investigated fully during the 1987 field season.

4.2 GEOPHYSICS

Various airborne geophysical surveys have been conducted over the region, the most recent (with the exception of the J.V.) being flown by the N.T.G.S.; this included multi-spectral radiation and high resolution total intensity magnetics conducted on flight lines 500 m apart. In 1986 the Joint Venture conducted separate gravity and magnetics-spectrometry surveys over the tenement. The former covered the entire area while the latter covered that part not surveyed by the N.T.G.S., i.e. on the Jinduckin 1:100,000 sheet area which is covered by the E.L. The gravity survey results were integrated with the widely spaced stations of a previous B.M.R. survey.

The N.T.G.S. data was acquired by T.M.A. and passed on to a Sydney-based geophysical consultant group, Geospex Associates Pty. Ltd. for presentation as specified by the company. Consulting geophysicist, L. Acimovic, directed the work and has produced the following plans:

- Flight line diagrams.
- Stacked profiles of all flight lines covering the joint venture tenements and the area covered by the Tolmer Sandstone. These show the following parameters:
  - Total (cps)
  - U (cps)
  - U corrected (cps)
  - Thorium (ppm)
  - Potassium (%)
  - U/Th
  - U/K x 1000
  - Altimeter (m)
  - Magnetic gradient (nT/m)
  - Total magnetic (nT)
Stacked profiles of the Magnetic Gradient per 100,000 sheet, i.e. the Reynolds River, Daly River and Wingate Mountains sheets.

Stacked and shaded profiles of the U/Th.

The remaining 10% of the tenement area held by the joint venture was subsequently flown in 1986 by Austirex International Ltd. This was done in such a way as the match the Government flying to the west and north and plotted to be contiguous with the maps described above.

The flight acquisition specifications were as listed below:

- Traverse line direction: N/S
- Traverse spacing: 500 m
- Tie line direction: E/W
- Tie line spacing: 5000 m
- Total line kms: 660 linear kms
- Survey height: 100 m AGC
- Sample interval magnetics was approximately 18 m.
- Sample interval spectrometer was approximately 54 m.

The instruments used for this survey are as follows:

+ A Scintrex V2321 alkali vapour sensor coupled to a Sonotek AADC dynamic digital compensator was used as the magnetometric system.

+ A Geometrics GR 800D 256 channel gamma ray spectrometer interfaced to 32 litres of NaI (TL) scintillation crystal. 5 channels were digitally recorded Total Count, Cosmic, K, U and Th.

+ A Deca 71 Doppler interfaced to a Tans 9447 navigation computer.

+ A Collins Alt radar altimeter.

+ A Geocam 35 mm continuous strip film tracking camera.

+ A Global GNS VLF/Omega navigational aid.

+ A ground based magnetometer to measure the diurnal variation at regular time intervals of 1 or 2 seconds.

In early June a regional gravity survey was conducted over the entire project area extending both east and west of the E.L. boundaries. This survey was carried out using T.M.A. personnel and a chartered helicopter.

The survey covered an area of about 2000 km$^2$ representing 357 gravity stations on an approximate 4 x 2 km spacing. The control for this survey was by using aerial photograph navigation.
The results have been calculated and then these results have been "levelled" to conform with both the previous Government survey and the surveys carried out by private companies, thus allowing the production of a composite contour plan of both the Bouguer and Residual Gravity anomaly.

Detailed interpretation of all geophysical data has been performed by T.M.A. geologists; this work has been synthesized and is illustrated on Plate 4. A brief account of the results is as follows:

- **Magnetics**: the Tolmer Group rocks are transparent to magnetics however, where overlain by Cambrian or Mesozoic cover, background noise tends to increase masking the response of lithologies below the Middle Proterozoic.

The Cambrian tends to have a slightly higher magnetic response than the Burrell Creek sediments west of the tenement. The Soldiers Creek Granite appears to have an extremely low background.

Linear trends outlined may be dykes or could also be trends produced by cover rocks.

- **U/Th**: Most anomalies seem to be confined to the basal Depot Creek Member of the Tolmer Group; this feature appears to be the case throughout the region. Anomalies are also associated with the Soldiers Creek Granite. These are related to the previously mentioned Burrell Creek rafts within the granite.

- **Gravity**: an intense anomaly is located in the southeast of the tenement forming part of a NE-SW trend. This anomaly probably represents a buried granitic body obscured by the thick sedimentary cover. The response is fairly flat over the rest of the licence. To the west anomalies are present over the exposed Soldiers Creek Granite.

An additional interpretation has been attempted using the residual anomaly contour map. This map provides Bouguer anomaly data corrected from the regional anomaly. Therefore any influence from deep seated sources has been eliminated.

The residual anomaly contour data have been represented along E-W profiles along which have been plotted in ordinate the gravity residual values. The plotting shows a certain number of positive and negative values organised in various shapes, the meaning of which are hereafter tentatively explained in connection with the knowledge we have about the general regional lithostratigraphy.
Five zones with consistent, more or less intense, low values are interpreted as hereafter:

Area I' Extension of the Zone III of the northern half is thought to be due to increased Tolmer thickness: lower and middle units.

Area II' Thick Tolmer west of the Rock Candy Range horst could have been affected by a downthrow movement. A granitic potential intrusion could possibly be present in the northern part of the area.

Area III' Southern extension of zone IVS of the northern area. Located east of Rock Candy Range horst, could have been affected by a downthrow movement.

Area IV' Possible thickest portion of Tolmer sequence without any Cambrian cover. The very low values encountered there are not fully understood (faulty readings or true anomaly?).

Area V' The western portion V'W corresponds to a downthrown portion of Tolmer or to granite intrusion overlain by thin carbonate layer.

The eastern portion V'E could be interpreted as the extension, below the Tolmer Sandstone, of the Colliah Granite intrusion (Soldiers Creek Granite).

Five zones with consistent high values are interpreted as follows:

Area A' Reflect Burrell Creek upthrown in the Rock Candy Range horst with the maximum intensity of movement to the NE.

Area B' Could correspond to the presence of the Hinde Dolomite or some Cambrian limestone layers more than to a possible upthrow of Burrell Creek.

Areas C' and E': Area of Tolmer Basin without outcrop, could correspond to basaltic lavas (under the laterite and soil cover).

Area D' Reflect here to an upthrow of the geological sequence in a horst pattern with middle Tolmer outcropping.

Radiometry: No anomalies are present. Radiometric signatures tend to reflect lithological variations. Faulting tends to show up as distinct trends on the radiometric contour plans; these are concentrated principally along the margin of the Granite/Tolmer contact.
4.3 AIR PHOTO INTERPRETATION

This interpretation was carried out in order to define in detail the structural system affecting the sandstone as the expected ore concentrations are known to be closely linked with faults having affected the Lower Proterozoic basement as well as the Tolmer Sandstone cover. The photo study noted also the general structural pattern of both the basement and the Tolmer Sandstone cover, as well as the major lithological changes within this formation.

Both the faults and major fractures have been reported without being differentiated.

The dip of the beds has been reported as often as possible, and the outcropping beds outlined, in order to materialise as clearly as possible the folded structures.

The 3 units of the Tolmer Sandstone have been annotated from base to top, T1, T2, T3; the Burrell Creek, Be, the granite intrusions and the facies interpreted as younger than upper Tolmer T3 labelled C, whether being Cambrian or Cretaceous.

The E.L. is underlain by T3 unit in its northern and northeastern area, by T2 unit towards its western limit and by horizontal, younger facies in its southern portion.

The general regional strike of the Tolmer unit is N45W with northeasterly dip.

No folds are noted except for one isolated possible syncline to the north with a N50W axis.

The western limit of the Tolmer Formation, in proximity with the Collia granitic intrusion, is strongly fractured and faulted with N-S to N10W, N45 to N60E and EW accidents. The remainder of the E.L. displays E-W, N60 to N70E and N60W faults with some N10E and N10W shorter ones.

4.4 HELICOPTER RECONNAISSANCE

In conjunction with ground reconnaissance a heliborne inspection of the E.L. formed part of a complete appraisal of the project area.

4.5 THERMOLUMINESCENCE STUDIES AND GEOCHEMISTRY

Analytical work comprised U, Th and Mg determinations on selected samples of basal Tolmer Sandstone member. Duplicate rock samples were sent to Adelaide University for thermoluminescence studies. This method uses artificial thermoluminescence to detect paleoradiation or cumulative radiation effects within the quartz grains of the sandstone. If significant amounts of uranium (more than 10 ppm) have resided in the sandstone over a sufficient length of time (upward of 100 Ma) then this will result in major radiation damage to the host quartz lattice which will still be present even if the causative uranium has been leached. These studies have been performed on several Middle Proterozoic basal sandstones including the Athabasca and Kombolgie.
The presence of magnesium metasomatism has been recognized at Jabiluka both in the Cahill Formation and the Kombolgie. The source of the magnesium is considered to be the Mg-containing carbonate facies within the Cahill; the Mg has been leached and redistributed, probably during metamorphism and hydrothermal events. The application of this method as an exploration tool at Tolmer assumes the presence of Mg-carbonate-rich beds within the Burrell Creek Formation. Although none have been recorded in outcrop, such facies could exist beneath the Tolmer Sandstone cover.

Nine samples have so far been collected from and adjacent to the E.L. These have been processed at Adelaide University. No significantly anomalous samples have yet been identified. Three specimens were forwarded to Analabs for U, Th and Mg. Uranium was below detection limit, Th about background, and Mg values from 75–100 ppm. Further, more intensive sampling will be carried out in 1987 including sediment collection for mobile uranium determination.
V. CONCLUSIONS

Exploration activities within the tenement are ongoing. More work is planned for 1987 including further geophysics and groundwork. To date no firm conclusions can be drawn on the potential of the exploration licence, although particular areas have been delineated for the follow-up ground traversing which will concentrate on geological mapping and radiometrics.
VI. EXPENDITURE STATEMENT

E.L. 4858 – 1ST MARCH, 1986 TO 28TH FEBRUARY, 1987

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