TOTAL Mining Australia Pty. Limited

E.L.'s 4856, 4857, 4858, 4870
TOLMER PROJECT, NORTHERN TERRITORY

REPORT ON AREAS RELINQUISHED
1988

OPEN FILE

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P. MELVILLE
APRIL, 1988

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APPENDIX

Appendix 1  Thermoluminescence Sample Results
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I. INTRODUCTION

The four E.L.'s, the subject of this report, were applied for in August, 1985 and were subsequently granted in March, 1986.

The tenements are located in the Reynolds River/Daly River/Fish River area of the Northern Territory, being centred on the Daly River settlement approximately 150 km south of Darwin. They are contained within a block bounded by latitudes 14°30' - 13°00' and longitude 130°40' - 131°00', and are aligned in a north-south direction to cover the prospective contact zone between the Burrell Creek Formation and the overlying Tolmer Sandstone. All the land under licence is part of the Tipperary Pastoral Lease.

The tenements are accessible from the main Daly River-Adelaide River road and then by established tourist and/or station tracks. The areas south of the Daly River tend to be more inaccessible than those to the north. The principal drainages are the Reynolds and Daly Rivers, the latter flowing all year and thus limiting vehicular access. The climate is monsoonal with a pronounced wet season between December and March.
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II. PREVIOUS WORK

2.1 PRIVATE COMPANIES

Since the early 1970's, many exploration companies have been active in the area now covered by (and adjacent to) the Joint Venture tenements. There has been an emphasis on both uranium and base metals with most of the investigation being confined to what are now E.L. 4856 and 4857. What appears to be the most intensive work has been carried out by Keewanee Oil (Aust.) Pty. Ltd. (1970-1973), Nord Resources (Pacific) Pty. Ltd./AGIP joint venture (1977-1981) and Mobil Energy Minerals Aust. Inc./Suttons joint venture (1977-1983). Most of these activities were concentrated north of the main Daly River road and included airborne geophysics and radiometrics; extensive gridding was carried out with ground geophysical and scintillometer surveys, geochemical sampling, shallow and deep drilling (auger and percussion), geological mapping and radon surveys. Most of the drilling was on a widely spaced grid pattern and appeared to be mainly for geochemical purposes. Mobil deep drilled two of its airborne discovered anomalies: the Hayward Creek and Noltenius prospects. The former is a radon anomaly confined to a large swamdy zone in the Tolmer Sandstone. The Noltenius location is within Burrell Creek sediments adjacent to the Tolmer contact. Both Keewanee and Nord/AGIP were also prospecting for base metals.

Elsewhere in the region exploration within the Cambrian limestones of the Daly River Group has concentrated on phosphates (B.H.P. and Tipperary Land Corp.) and carbonate hosted lead-zinc deposits (CRA).

Mining activity has been confined principally to the earlier part of the century: gold at Fletcher's Gully, tin at the Muldiva-Buldiva deposits and base metals just north of Daly River Mission. More recently tin has been extracted at Collia (Collah) on the Fish River and tantalum is presently being mined near Litchfield.

2.2 GOVERNMENT AUTHORITIES

The region was originally mapped by the B.M.R. coupled with magnetic and gravity surveys. Within the last few years the Northern Territory Geological Survey has geologically mapped at 1:25000 scale the Reynolds River, Daly River and Wingate Mountains sheets. Airborne geophysics has also been done including magnetics and spectrometry.

Several stratigraphic holes have been drilled by the N.T.G.S., two on the Daly River Sheet (Compilation Sheets 5 and 9): DD 82/67 and DD 82/68. The former, 500 m deep, was collared in the Cambrian "Antrim Plateau Basalt", passing into the Hinde Dolomite and then intersecting 40 m of Stray Creek Sandstone before terminating. DD 82/68 at 100 m deep intersected interbedded siltstone/carbonate rocks/sandstone belonging to the Stray Creek Sandstone member. The only other drilling has been in the Cambrian north of Litchfield and in the Wangi Basins.
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III. GEOLOGY

3.1 REGIONAL SETTING AND STRATIGRAPHY

The Joint Venture Licences are located on the western edge of the Pine Creek Geosyncline. The main rock units are sediments ranging in age from Lower Proterozoic to Adelaidean; Carpentarian granites intrude these sediments. The Litchfield complex of Lower Proterozoic to Archaean 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):

ARCHAEOAN–EARLY PROTEROZOIC: Litchfield Complex comprising high grade metamorphics which appear to include sediments, basic to intermediate rocks and anatectic 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 Collia (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). Occurs only at the Hayward Creek Prospect (Put).

PALAEOZOIC: Cambrian Daly River Group. Basal conglomerates, Antrim Plateau Volcanics (basalts) and the Tindall Limestone (Ela).
3.2 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.

3.3 GEOLOGY OF THE TENEMENTS

+ BURRELL CREEK FORMATION

The distribution of Burrell Creek sediments is variable, grading from poor outcrop in the northern half to extensive exposures elsewhere. The principal lithologies observed on surface include sandstones, pebbly in places or gritty, rare beds of conglomerate and brown to reddish, finely bedded, very micaceous siltstones. Where exposure is poor the predominant lithology is schist or siltstone. Sub-outcrop is evident in the small creeks and drainages and in drill hole cuttings. Outcrops of andalusite schists were occasionally observed, particularly where interbedded with meta-sandstones and meta-siltstones; these would form localized discontinuous exposures often showing extreme deformation.

+ TOLMER GROUP

The oldest formation of the Tolmer Group is the Depot Creek Sandstone. This facies is uniform throughout with little variation noted. It is usually a massive, fine grained quartz arenite, however well defined pebbly layers occur, up to several centimetres in thickness. Scattered millimetric pebbles have also been seen distributed randomly in the matrix. In weathered outcrop bedding can be discerned readily; in cliff exposures the bedding is less well defined. Cross bedding and ripple marks are present. Near the contact, in places, a strongly ferruginized zone occurs ranging from an intense reddish to brown colouration sometimes with laterite development. Whether this is related to the unconformity is not known but it could be a poorly developed regolith.
The Stray Creek Sandstone outcrops as a flaggy, thin bedded quartz arenite with pebbly zones. Near Prospect Hill, creek bank exposures contained greenish and grey shaley horizons interbedded with the sandstone.

**STRUCTURE**

Major structures as mapped by the B.M.R. and N.T.G.S. include the:

(i) Giants Reef Fault,
(ii) a series of converging fault zones with a NW-SE trend, and
(iii) lineaments parallel to the Giants Reef Fault including the major Stapleton Fault.

Most of the larger structures appear to have had some effect on the rocks they traverse: the Giants Reef Fault limits the Tolmer outcrop for a considerable distance; the Stapleton Fault forms a rough boundary between the Tolmer and Burrell Creek Formation on the eastern side.
IV. EXPLORATION ACTIVITIES

4.1 TARGETS AND MODELS

The Tolmer Project was chosen as an exploration target by T.M.A. because of the many geological similarities, both regionally and locally and lithologically and structurally, as the Alligator River Uranium Province some 250 km to the east.

The sequence of Lower Proterozoic sedimentation appears to have been fairly uniform across the Pine Creek Geosyncline with subsequent folding and syn-post orogenic granitic intrusive episodes. These have given rise to a series of regional synclinorium.

Middle Proterozoic sedimentation most likely covered the entire Geosyncline; this episode comprised the Katherine River and Tolmer Groups of sandstones and associated rock types. The B.M.R. have placed the former as the oldest with an unconformity separating the two groups. The Depot Creek and Kombolgie Sandstones are considered by T.M.A. to be stratigraphical equivalents supported by near identical lithological, physiological and botanical features. The only differences are in the facies variations reflecting the depositional environment, i.e. basic volcanism in the Kombolgie and carbonate deposition near the end of the Tolmer sedimentation.

The Burrell Creek Formation, which immediately underlies the basal Tolmer unit, the Depot Creek Sandstone, is the youngest phase of early Proterozoic sedimentation in the Pine Creek Geosyncline. Further to the northeast, at Rum Jungle, the Burrell Creek Formation is unconformably underlain by the entire sedimentary sequence which has been exposed around the margins of the Rum Jungle and Waterhouse Complexes; the sequence comprises, from oldest to youngest, the Namoona, Mt. Partridge and South Alligator Groups. The Cahill Formation, host to uranium deposits in the ARUF is stratigraphically equivalent to the Namoona Group; various sedimentary facies have been observed in the Reynolds River area by T.M.A. and others which may be Namoona equivalents. These occurrences include the tracts of swampy black soil and alluvium covered country north and south of Surprise Creek where bedrock drilling has confirmed the presence of various schists: chloritic and graphitic and lenses of dolomitic sediments. Near Prousts Crossing west of Surprise Creek, probable Namoona equivalents including carbonaceous shales, graphitic schists and dolomite outcrop. Folding in the region has most likely exposed these older sediments. With the intensity of prospection covering the Burrell Creek sediments it cannot be discounted that favourable lithologies could be found in these younger sediments.

Following from the above, two principal exploration targets have been outlined:

(i) the unconformity model,
(ii) the granite contact model.

Applying these to the Tolmer Project, the main points are:
(i) Unconformity Model:
- the Burrell Creek/Tolmer unconformable contact is relatively flat lying,
- the underlying sediment, i.e. BCF and ?Namoona, have suitable facies present: carbonaceous, graphitic, dolomitic,
- suitable degree of metamorphism: greenschist and minor amphibolite facies,
- abundant major structures particularly along and adjacent to the Giants Reef Fault,
- possible reactivated Archaean doming during the Middle Proterozoic,
- presence of uranium in the region: the Rum Jungle field and various small occurrences in Burrell Creek sediments,
- abundant groundwater movement,
- intrusion of Proterozoic granites giving an adequate heat source to activate and maintain convection cells which may act to concentrate uranium at physically or chemically suitable sites.

(ii) Granite Contact Model:
- intrusion of upper level granites or granitoids,
- a suitable host rock: carbonaceous shale, graphitic schist, dolomite.

Exposed granites are in evidence south of the Daly River and these intrude the Burrell Creek Formation.

4.2 GEOPHYSICS

4.2.1 Introduction

A number of geophysical surveys have been carried out over the area by either the Geological Survey of the Northern Territory or the Bureau of Mineral Resources in Canberra. These included multispectral radiation, i.e. U, Th, K and Total Count and high resolution, total intensity magnetic surveys on flight lines 500 m apart and covering around 90% of the ground held by the West Pine Creek Joint Venture partners.

A widely spaced gravity survey with stations approximately 11 km apart had also been carried out previous to 1986 by these Government agencies, and a much more closely spaced survey carried out by private interests. All this information was made available to a group of geophysical consultants, Geospex Associates Pty. Ltd. on magnetic tape. The following were produced:
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8.

1. Flight line diagrams.

2. 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)

3. Stacked profiles of the Magnetic Gradient per 100,000 sheet, i.e. the Reynolds River, Daly River and Wingate Mountains sheets.

4. 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 to 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 AGL
- 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 50 radar altimeter.
9.

+ 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.

The results of these surveys have been summarized to produce the synthesis plan (Plate 1).

A gravity survey was conducted over the entire project area extending both east and west of the Exploration Licence boundaries. This survey was carried out using T.M.A. personnel and a chartered helicopter, and covered about 2,000 sq. km with 357 stations being read on an approximate 4 x 2 km grid spacing. The control for this survey was by using aerial photograph navigation.

The results were calculated and then "levelled" to conform with both the Government survey and those surveys carried out by private companies. The results of this work are plotted on the synthesis plan in contour form. (Plate 1)

4.2.2 Magnetic Modelling

In order to establish the nature of the sources of some magnetic anomalies detected during the regional airborne magnetic survey over the Reynolds River, Daly River and Wingate Mountains 1:100,000 sheets carried out by the N.T. Geological Survey, three selected anomalous zones were chosen for the modelling of the magnetic data.

One anomalous zone occurs on the Reynolds River sheet while the other is on the Daly River sheet.

Reynolds River Sheet

The location of the airborne anomaly is shown on the synthesis plan (Plate 1). The coordinates of the centre of the magnetic anomaly are 690000E/8335000N and the position is about 3 km southeast of Mt. Tolmer.

The anomaly was detected within the area covered by the Depot Creek Sandstone, which is thickly bedded, medium to coarse grained sandstone occurring in the upper part of the Middle Proterozoic succession of the Pine Creek Geosyncline.

The anomaly is asymmetric and elongated in a NE-SW direction with negative values to the SE side. The amplitude of the anomaly is 74 nT.

Modelling of the magnetic data shows that the anomaly could be produced by a dyke-like body with a susceptibility of 0.03 S.I. units (about 1% of magnetite) and with the following configuration.
10.

Width: 100 metres
Depth to top: 100 m (below surface)
Dip: 65 - 70° south
Strike: 25 - 30°

The centre of the dyke is about 250 m south of the maximum magnetic values - or 4.750 km along profile line.

Daly River Sheet

The position of the airborne anomaly is 6950000E/8465000N and is about 10 km west of the Rock Candy Range area, north of the Daly River.

The anomaly was detected within the area covered by the Hinde Dolomite and some Cambrian limestone; part of the area is covered with Quaternary alluvium. (The thickness of dolomite in drill hole 82/68 is 314 m.)

The anomaly is asymmetric and elongated in a NW-SE direction with a regional gradient of 20 nT per 10 km which has been removed from the magnetic data before modelling, and with negative values on the SW side of the anomaly. The amplitude is 39 nT.

Modelling of the magnetic data shows that the asymmetric anomaly could be produced by a dyke-like body with a susceptibility of less than 0.03 S.I. units (about 1% magnetite) and with the following configuration:

| Width of dyke: | 120 m |
| Depth to dyke: | 160 m below surface |
| Dip: | 70° to the south |
| Strike: | 150° |

The centre of the dyke is about 250 m south of the maximum magnetic value.

Comments

The preliminary conclusion from this work is that the depth to basement below the Tolmer Sandstone is likely to be within the limits required by the economic modelling. It seems that the basement/sandstone unconformity is undulating, dependent partly on the upward movement of the intruding granite bodies.

It is intended to drill one of these magnetic anomalies so that the geophysical modelling can be attuned to the actual depth to the basement. These linear magnetic anomalies are thought to possibly be due to a dolerite dyke, perhaps equivalent to the Oenpelli.

It was found that the Cretaceous capping over the Tolmer Group units gave a strong magnetic signature which may have obscured that coming from a deeper seated source.
11.

The Giants Reef Fault shows virtually no magnetic signature, and
the background magnetic intensity (Vertical Gradient) over the
sandstone is virtually the same as that occurring over the Burrell
Creek Formation. This probably indicates that the sandstone is
transparent as far as magnetic surveying is concerned, except for the
Cretaceous laterite covering.

+ U/Th

It is interesting to note that the U/Th anomalies, and also the
U anomalies, are not confined to a particular stratigraphic unit as
we had initially predicted. On the synthesis map the zones of high
U/Th ratio are marked.

It is believed that there is at least some structural control to
the U/Th anomalism. Some of the known faults are obviously anomalous
with some parts of the Giants Reef Fault being anomalous and others
not.

+ Gravity

The gravity anomalies are interpreted to be due to Carpentarian
(Middle Proterozoic) granite intrusion. From the interpretation it
seems there are a number of granite intrusions beneath the Tolmer
Group forming ridges and troughs; some are obviously related to zones
of structural deformation. These zones of weakness have become the
loci for subsequent late stage intrusions.

Conclusions

From the interpretation of all the geophysical data at hand
there are certain conclusions that can be drawn:

(i) There are a number of granitic intrusive bodies beneath the
Tolmer Sandstone probably forming ridges and troughs. Some
of these are thought to have been Archaean palaeo-
topographic highs which, because they are along zones of
structural weakness (deep seated faulting) were the loci
of later granitic intrusion in late Lower Proterozoic or
early Middle Proterozoic.

(ii) The Archaean ridges existing during the sedimentation of
the Lower Proterozoic sediments have acted as near-coast
islands around which back reef type facies of carbonaceous
and calcareous sediments have been deposited. This is
clearly seen just to the north at Rum Jungle and is
interpreted to exist beneath the Tolmer Sandstone to the
southwest.

(iii) The Giants Reef Fault, a very major structural element in
the Pine Creek Geosyncline, has afforded extensive related
faulting and structural deformation. This can be seen from
the gravity, radiometry and magnetic survey results. The
Giants Reef Fault appears to trifurcate west of the
northern boundary of E.L. 4858. Here it runs north as the Giants Reef Fault, NE as the Stapleton Fault and ENE as the Rock Candy Range Fault. This splitting up of the main fault (feathering) occurs at or near the point where the stratigraphic trend of the Tolmer Sandstone changes from N-S to NW-SE.

(iv) Uranium exists within both the Lower Proterozoic and Middle Proterozoic horizons. This is shown by the U/Th ratio, the number of U anomalies and the anomalies found by ground prospection. The U/Th anomalies often occur on the western flank of the gravity anomalies, i.e. the interpreted reactivated Archaean palaeohighs. This is important to the model which implies that the uranium generated from the sediments of the Archaean (Litchfield Block) has been trapped within the back reef facies and concentrated particularly along faults active post- and pre- the deposition of the Tolmer Sandstone.

(v) Many faults have been defined by the U/Th and also the total count radioactivity results.

(vi) Dolerite dykes occur particularly in the Reynolds River sheet beneath the sandstone cover. In the south they may also exist but the magnetic signature is being masked by the Cambrian and Cretaceous sediments.

4.2.3 Airborne Geophysics

Interpretation of the Government geophysical plans, including the spectrometric and magnetic data.

The raw data collected by the Department of Mines and Energy in 1981 was retrieved and re-analysed. The parameters re-analysed included the following:

- Total U
- U (corrected) ppm
- Thorium ppm
- Potassium %
- U/Th
- U/K x 1000
- Altimeter
- Mag. Gradient nT/m
- Total Mag. nT

This data was presented as histograms and the results of the analysis is presented on Plate 1 - Synthesis Map at scale 1:100,000.

An EM-Input survey was flown by Geoterrex in 1987 over portions of the Exploration Licences selected by the interpretation of the above airborne data and consequent ground surveys.

This survey had the following parameters:

Recording interval: 0.2 seconds (i.e. approx. 13 m at 220 kph)

Magnetometer: Caesium vapour optical adsorption. Sensitivity 0.1 nT.

Recording interval: 1.0 seconds (i.e. approx. 60 m at 220 kph)

Data Recording: Geoterrex MADACS acquisition system. Digital to magnetic tape.

Nominal Terrain Clearance: Magnetometer sensor in aircraft at 120 m. EM transmitter in aircraft at 120 m. EM receiver in towed bird at 60 m.

Nominal Line Spacing: Traverse lines 500 m. No tie lines.

Flight Path Record: Geocam 35 mm continuous tracking camera.

Flight Path Recover: Visually to 1:25,000 black and white enlargements of low level photography.

Approximately 3,000 line kilometres were flown and after each flight the tracking camera films were developed, the analogue charts sorted and annotated.

A number of anomalies have been identified from this survey. These have been plotted on the 1:25,000 plans accompanying this report along with the flightline locations, the regional geology and structure. The areas still held under licence have been blacked out (see Plates 2 - 9).

Spatially close anomalies were grouped in "areas", generally reflecting a particular geological environment. A total of 71 areas was thus defined. Unfortunately, none of them indicates the expected occurrences of graphitic schist beneath the sandstone cover. A test flight was carried out over a known graphitic conductor in the Rum Jungle area, in order to compare the amplitude and persistency of the anomalies.

The areas fall broadly into four categories:

. Conductors in exposed Burrell Creek Formation ("basement").
. Conductors along faults.
. Conductors in Tolmer Group.
. Conductors in Cambrian Volcanics and/or Cretaceous.
The anomalies that occur in Cretaceous are generally located near the edge of a cliff; they could indicate the presence of a thin layer of Antrim Plateau Volcanics in the pediment between Cretaceous and Proterozoic Sandstones.

Some anomalies appear to line up or coincide with rivers and billabongs.

**Input Anomaly - Geological Classification**

The following is a classification and description of the Input anomalies occurring within the relinquished ground. (See Plate 1)

**E.L. 4856**

1. Burrell Creek interbedded sandstone/siltstone adjacent to unconformity.

2. On Giants Reef Fault zone near Depot Creek/Stray Creek Sandstone unconformity.

3. Straddles contact between Stray Creek Sandstone and Burrell Creek Formation. Giants Reef Fault cuts through the anomaly. Burrell Creek subcrop of mica schists which could contain carbonaceous/graphitic beds.

**E.L. 4857**

7. Burrell Creek sediments with quartz veining.


15. Folded phyllite and muscovite schist.

16. Phyllites with interbedded sandstone and conglomerate.

17. Burrell Creek sediments.

**E.L. 4858**

Nil

**E.L. 4870**

Nil

4.2.4 **Radiometric and Geologic Prospecting**

+ **Regional**

Ground radiometric prospecting utilizing SPP2 scintillometers was commenced in early June 1986. The survey was conducted with the method adopted for detailed prospection in E.L. 4460 in 1985: a base line pegged at 50 m intervals running parallel to the strike of the rock units to be traversed. The traverses would then be extended on
one or both sides of the base line depending upon the area required to be covered. Limits to the traverses would be either pre-planned or left to the individual depending upon the radiometric readings or on-the-spot assessment of the geology. Lines were spaced at 50 m intervals, corresponding to the pegs; readings were taken at 25 m spacings. Geological and other features were noted at each station.

The base line on the Tolmer Project was constructed to parallel as closely as possible the trend of the unconformity.

No radiometric anomalies have been discovered in that portion of the Exploration Licences relinquished.

The radiometric signature of the various rock types has been used to construct the detailed geological maps. In areas of little or no outcrop radiometry aided in the identification of the lithologies. Typical values are:

- Burrell Creek Formation:
  - Sandstone 90-110 c/s
  - Conglomerate 80-90 c/s
  - Siltstone 110-160 c/s

- Tolmer Group: Depot Creek Sandstone less than 50 c/s.

Siltstone exhibiting reddish hematitic alteration tends to give a higher radiometric count - usually the upper end of the range given for siltstone. Similarly schists within the Burrell Creek tend to be higher. The rare outcrops of carbonaceous shales so far observed have given variable readings due, in some cases, to their proximity to anomalies.

4.2.5 Thermoluminescence Studies

Twenty-two thermoluminescence sample locations are within the area relinquished. These varied in value as can be seen from the results tabulated as Appendix I.

4.2.6 Geochemistry

Selected Tolmer Sandstone samples have been analysed for U, Th and Mg. The analyses were carried out on some samples that were initially forwarded to Adelaide University for thermoluminescence studies.

The results of the 22 samples taken in the area relinquished are shown in Appendix I.

Magnesium metasomatism has been recognized at Jabiluka as a feature of the geochemistry of the host rocks. The source of the Mg is considered to be magnesite which occurs as a principal constituent of the bedded carbonate rocks within the sequence. The Mg is dissolved, transported and redeposited during metamorphism and
hydrothermal events. Mg has been transported into the overlying Kambolgie Sandstone up to 300 m above the unconformity. This phenomenon could be applicable to the Tolmer geological environment.

Data presented by Binns (1980) and Gustafson and Curtis (1983) shows the distribution of Mg and MgO (and other elements) in the various facies at Jabiluka; only the latter presents data of actual Mg content in the Kambolgie Sandstone. Adjacent to the Jabiluka orebody, the Kambolgie contains from 0.8 to 15.6% Mg, the latter being representative of highly altered (intense chloritization) sandstone. U values range from <4 ppm in slightly altered Kambolgie up to 44 ppm in the intensely altered material.

Results obtained from the Tolmer study range from 0.008 to 0.095% Mg (sample of Burrell Creek Sandstone). The majority of values are less than 0.02%. Further analyses, especially at distance from thermoluminescent anomalies, will be required to obtain a clearer picture of the meaning of Mg values. Regarding U content, available data suggests <4 ppm to be the norm for the Kambolgie at Jabiluka; analyses for various facies of the Lower Cahill Formation away from mineralization show 3 ppm (schist), 7 ppm (carbonaceous schist) and 5 ppm (quartzite). Tolmer Sandstone samples have U values ranging between 3 to 6 ppm; many were below the limit of detection. Some could be considered anomalous. Obviously more samples are required to obtain a good statistical base.
## GEOCHEMICAL RESULTS

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<th>Sample No.</th>
<th>Location</th>
<th>Sample type</th>
<th>Description</th>
<th>U</th>
<th>Th</th>
<th>Ma</th>
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</table>

**Sample type:** R. surface rock  C. drill cuttings  Analysis methods: W. wet chemical assay  Limit of detection
**S. soil**  O. channel sample  XAS: atomic absorption spectrophotometry  Method of analysis
**W. water**  C. drill core  XRF: X-ray fluorescence
**SS. stream sediment**  D. overburden  I. inorganic chemical analysis
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<th>Location</th>
<th>Sample type</th>
<th>Description</th>
<th>U</th>
<th>Th</th>
<th>Th/U</th>
<th>Min. Th/U</th>
<th>U/Th</th>
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Sample type: R= surface rock, C= drill cuttings, S= soil, CH= channel sample, W= water, SS= stream sediment, O= overburden

Analysis methods: W= wet chemical assay, AAS= atomic absorption spectrophotometry, XRF= x-ray fluorescence

Limit of detection

Method of analysis: HW= hydrothermal alteration, SC= spatial clast, R= rock, S= soil, C= coal, W= water, SS= stream sediment, O= overburden

ORIGINATOR:
SIGNED:

GEOCHEMICAL RESULTS (metal content in ppm, Water in mg/l)