TOTAL Mining Australia Pty. Limited

E.L. 4857 - 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/86-16-U

P. MELVILLE
APRIL 1987

NORTHERN TERRITORY
GEOLOGICAL SURVEY
CR87/133A

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUMMARY</td>
<td>1</td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td>1.1 GENERAL</td>
<td>2</td>
</tr>
<tr>
<td>1.2 DESCRIPTION OF AREA</td>
<td>2</td>
</tr>
<tr>
<td>1.3 LOGISTICS</td>
<td>2</td>
</tr>
<tr>
<td>II. PERSONNEL AND CONTRACTORS</td>
<td>3</td>
</tr>
<tr>
<td>III. GEOLOGICAL SETTING</td>
<td></td>
</tr>
<tr>
<td>3.1 REGIONAL GEOLOGY</td>
<td>4</td>
</tr>
<tr>
<td>3.2 LOCAL GEOLOGY</td>
<td>5</td>
</tr>
<tr>
<td>3.3 STRUCTURE</td>
<td>5</td>
</tr>
<tr>
<td>IV. EXPLORATION ACTIVITIES</td>
<td></td>
</tr>
<tr>
<td>4.1 MODELS AND TARGETS</td>
<td>7</td>
</tr>
<tr>
<td>4.2 RADIOMETRIC AND GEOLOGICAL TRAVERSING</td>
<td>7</td>
</tr>
<tr>
<td>4.3 GEOPHYSICS</td>
<td>9</td>
</tr>
<tr>
<td>4.4 AIR PHOTO INTERPRETATION</td>
<td>11</td>
</tr>
<tr>
<td>4.5 GEOCHEMISTRY AND THERMOLUMINESCENCE</td>
<td>13</td>
</tr>
<tr>
<td>4.6 HELICOPTER RECONNAISSANCE</td>
<td>13</td>
</tr>
<tr>
<td>V. CONCLUSION</td>
<td>14</td>
</tr>
<tr>
<td>VI. EXPENDITURE STATEMENT</td>
<td>15</td>
</tr>
</tbody>
</table>

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LIST OF PLATES

<table>
<thead>
<tr>
<th>Plate</th>
<th>Description</th>
<th>Scale</th>
<th>Drg. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E.L. Location Plan. 1:500,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tolmer Project Tenement Situation. 1:100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Gravity Helicopter Survey: Residual Anomaly Contour. Northern Sheet. 1:100,000</td>
<td></td>
<td>547-019</td>
</tr>
<tr>
<td>6</td>
<td>Synthesis Map of the Tolmer Project, 1986. 1:100,000</td>
<td></td>
<td>547-046</td>
</tr>
<tr>
<td>7</td>
<td>Magnetic contour map - Total Intensity, 1:100,000</td>
<td></td>
<td>547-057</td>
</tr>
<tr>
<td>8</td>
<td>Total Count Radioelement Contour Map. 1:100,000</td>
<td></td>
<td>547-056</td>
</tr>
<tr>
<td>9</td>
<td>E.L. 4857 - Airphot Structural Interpretation. 1:25,000</td>
<td></td>
<td>547-067</td>
</tr>
<tr>
<td>10</td>
<td>Gravity Helicopter Survey: Bouguer Anomaly Contour Plan. Northern Sheet. 1:100,000</td>
<td></td>
<td>547-018</td>
</tr>
<tr>
<td>11</td>
<td>Gravimetric Interpretation from Residual Gravity Anomaly Profiles. 1:100,000</td>
<td></td>
<td>547-062</td>
</tr>
<tr>
<td>12</td>
<td>Gravity Helicopter Survey: Regional Anomaly Contour Plan. Northern Sheet. 1:100,000</td>
<td></td>
<td>547-021</td>
</tr>
</tbody>
</table>
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1.

SUMMARY

Field work commenced on the ground in mid-October as a continuation of radiometric/geological traversing programme performed in E.L. 4856. Prospecting of the unconformable contact between the Lower and Middle Proterozoic rocks will be ongoing into 1987.

Detailed interpretation of N.T.G.S. geophysical data including magnetometer and radiometry was performed by T.M.A. geological and geophysical staff. A helicopter-borne gravity survey was conducted prior to the commencement of ground work. The geophysical data has been integrated to produce a series of interpretative plans which will be utilized to target specific areas for further detailed exploration.
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. 4857 for 1986.

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

1.2 DESCRIPTION OF THE AREA

The tenement is located between the Daly and Reynolds Rivers, centred approximately 25 km NNE of the Daly River settlement, and 120 km south of Darwin (Daly River 1:100,000 topographic map). The northern boundary lies immediately north of the Adelaide River-Daly River road while to the south it adjoins E.L. 4958, the SW corner being approximately 8 km due east of the Day River Mission. All land is under the control of Tipperary Pastoral Company.

1.3 LOGISTICS

Access is by way of the main Adelaide River-Daly River road and then by established bush tracks. The wet season severely restricts vehicular traffic for 5 months of the year when "off-road". Vegetation comprises savannah woodland with localized patches of tropical forest lining creeks along the sandstone escarpment. Major drainage systems include the north flowing Reynolds River (top part of the E.L.) and Hayward Creek flowing south into the Daly River.
II. PERSONNEL AND CONTRACTORS

The 1986 programme was supervised by Darwin-based T.M.A. Project Geologist P. Melville. He was assisted in the field by two field assistants and, on occasions, by Sydney-based geological staff. Consulting T.M.A. geophysicist, L. Acimovic, was contracted to organize, co-conduct and interpret the heliborne gravity survey.

Visitors to the project area included Paris office geological staff C. Valsardieu and M. Mennerat and PNC geologists M. Suginoohara and G. McKay.

Contracting work was performed by the following:

- Rotor Services, Darwin supplied a helicopter for the gravity survey and short duration reconnaissance trip.

- Geospex Associates Pty. Ltd. translated onto a series of maps and to T.M.A.'s specifications, the N.T.G.S. Geophysical Data.

- Geochemical analysis of rock and stream sediment samples by Analabs, Darwin and Perth.

- Thermoluminescent studies were carried out at Adelaide University by Prof. P. Ypma and Mr. Mark Hochman.
III. GEOLOGICAL SETTING

3.1 REGIONAL GEOLOGY

The tenement is 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.

STRATIGRAPHY (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 and Reynolds River Granite (Pxgl and Pge).

(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 (+ 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 LOCAL GEOLOGY

+ Lower Proterozoic Burrell Creek Formation comprising tightly folded sequences of meta-sandstone and siltstone with lesser outcrops of intensely deformed mica schists. Thin beds of black carbonaceous shales were rarely seen. Zones of non-outcrop adjacent to the unconformity are assumed to be underlain by the more susceptible to weathering facies, i.e. siltstones, schists, etc. These areas are covered by sand or black soil swamps.

+ Middle Proterozoic Tolmer Sandstone is represented by the basal Depot Creek Sandstone, the overlying Stray Creek Sandstone and the Hinde Dolomite. This sequence dips gently eastwards towards the Daly River Basin.

+ Middle Proterozoic Uniya Tillite outcrops in the vicinity of the Hayward Creek Prospect.

+ Cambrian basalts overlie the Tolmer lithologies east of Hayward Creek forming flat-topped plateaus.

3.3 STRUCTURE

The southwards extension of the Giants Reef Fault passes west of the E.L. boundary, its identity not being so obvious in the linear strike ridges of the Burrell Creek Formation. For six kilometres south of the Daly River road a series of parallel, east-west striking faults cut across the Burrell Creek Formation; photostudies illustrate the well defined displacement of the sedimentary beds. Subsidiary faults bifurcate from the main trends - their strike predominantly NE-SW (see Compilation Sheet 2, Daly River 1:25,000). Progressing southwards the faulting rapidly diminishes.

In the Tableland Creek area several intersecting lineaments have had a pronounced effect on the trace of the Tolmer contact. North of the creek it is truncated from a N-S to an E-W trend with strong development of sheeting structures in both the Tolmer and Burrell Creek facies indicating faulting. Southwards a faulted contact is proposed giving a linear E-W trend to the contact, with this trend passing south of the Daly River road. There is no outcrop of Burrell Creek facies along this section.

Photolineament study of the Tolmer Sandstone shows variable distribution; overall development of structures is poor. The major trend is east-west with minor subsidiary north-south linears. The structures traverse the contact between the Depot Creek and Stray Creek sandstones.

Bedding trends in the Burrell Creek vary from NW-SE in the north, becoming well defined north-south progressively southwards. Regional dips from the north to south are west to vertical then east indicating some broad scale gentle warping. Folding is more obvious in the northern section with some good examples illustrated on the photographs. Fold axes plunge uniformly south.
Quartz veining occurs as elsewhere. The Giants Reef Fault is marked by extensive outcrops of quartz.
IV. EXPLORATION ACTIVITIES

4.1 MODELS AND TARGETS

The presence of Lower Proterozoic sediments in unconformable contact with overlying Middle Proterozoic sandstone provides a comparable geological setting to the Alligator Rivers Uranium Province. The general aim of the exploration is to locate suitable facies within the Burrell Creek Formation adjacent to the unconformity by intensive ground radiometric prospection and by the use of various airborne geophysical methods. A second model being employed relates to possible uranium concentration around the periphery of granite intrusions, again in suitable host rocks of the Burrell Creek Formation. Identical exploration techniques are being employed for location of these types of occurrences, perhaps with an emphasis on geophysics to locate possible buried granitic "domes", i.e. beneath the sandstone cover.

No specific targets have as yet been positively defined. At this stage the outcropping unconformable contact between the Tolmer Group and the Burrell Creek Formation is in the process of being intensively prospected by ground methods. There are areas which will receive priority for the 1987 field season.

4.2 RADIOMETRIC AND GEOLOGICAL TRAVERSING

Ground radiometric prospecting commenced in October 1986 using SRAT SPP2 scintillometers. This comprised traversing the unconformity at 50 m intervals taking radiometric readings and making geological observations at 25 m stations. Traverse length varied from about 800 m to 2.0 km; average traverse length was planned at about 1 km to give adequate coverage over the exposed Burrell Creek facies, say 800 m with the balance covering the basal Tolmer. Traverses were run off a pegged reference line which had been continued from the adjoining E.L. - where necessary traverses were extended both sides to give adequate coverage.

The traversing was terminated for the year approximately 6 km south of the Adelaide River-Daly River road; this represented 10 km of line with a coverage approximating 200 km of traversing. The work was mainly achieved by two field personnel with a third from time to time.

To date no anomalies have been located by the traversing although two prospects previously investigated by Mobil exist within the E.L. These are the Hayward Creek ?radon anomaly in the Tolmer Group sediments and the March Fly (Noltenius) Prospect in the Burrell Creek Formation. The latter has yet to be covered by the regional traversing.

The radiometric signature of the various rock types has been used to construct detailed geological maps (Plates 3 and 4). In areas of little or no outcrop radiometry has aided in the identification of the various 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 15 - 55 c/s

Siltstones exhibiting reddish hematitic alteration tend to give a higher radiometric count - usually the upper end of the range given for siltstone. Similarly the mica schists within the Burrell Creek tend to be high while the limited occurrences of carbonaceous shales tend to give variable readings. Passing over the unconformity the radiometric background drops considerably.

The only anomaly so far investigated is the March Fly Prospect. This is located on the western side of the E.L. (Daly River 1:100,000 topographic sheet AMG 918942). This is one of Mobil's discoveries and is probably the Noltenius Prospect. Both auger and later percussion drilling were carried out in 1978-1979 with 385 holes drilled (mainly auger) for a total of about 1700 m. The anomalies occur within isoclinally folded sediments of the Burrell Creek Formation, specifically beds of schistose reddish micaceous siltstone. Overlying the anomalous horizon are quartz-veined sandstones, carbonaceous shales and a very dark grey quartz-rich rock. The strata is west dipping to near vertical; aerial photographs illustrate a strong well defined north-south bedded. There are several poorly defined east-west lineaments to the north and south with some visible offset.

Mobil reporting mentions the occurrence of yellowish secondary minerals within a fine grained earthy hematite as well as a number of hot spots without visible mineralization. Drilling failed to locate any significant uranium values.

A brief reconnaissance by T.M.A. included several radiometric traverses across the prospect. Five traverses were conducted at 50 m intervals and 25 m spaced readings with values ranging up to 280 c/s but most being in the range 100-200 c/s. Selected readings taken on a more random basis gave 650 and 1150 c/s on ground. The anomalous zone extends for approximately 250 m north-south and is up to 50 m wide. The T.M.A. regional radiometric survey has not yet reached the prospect.
4.3 GEOPHYSICS

Various airborne geophysical surveys have been conducted over the region, the most recent being done by the Northern Territory Geological Survey. This included multispectral radiation (U, Th, K, T.C.) and high resolution, total intensity magnetics surveys on flight lines 500 m apart. In mid-1986 T.M.A. carried out a heliborne gravity survey, the data being integrated with previous BMR work.

The N.T.G.S. survey 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 for T.M.A., L. Acimovic, directed this work and the following plans have been produced:

- 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.

Detailed interpretation of all geophysical data has been made by T.M.A. geologists; this work has been illustrated in a synthesized form on Plate 6. A brief account is given below:

- Magnetics: outside the E.L. to the west, the Giants Reef Fault is marked by a sudden pattern change in the vertical magnetic gradient. This reflects a lithological variation - volcanic components to the west and sediments to the east and indicates considerable vertical movement along the fault.

The Cambrian limestones have a higher magnetic signature than the Tolmer, this latter group of rocks apparently being transparent to the magnetics. (See Plate 7)
U/Th: there is good correlation with the Depot Creek Sandstone, although anomalies were not strictly confined to this unit. The Hinde Dolomite has similar characteristics to Quaternary alluvium.

Gravity: carried out on a 4 x 4 km grid with fill-in stations where necessary. Integration of T.M.A. and N.T.G.S. data outline a series of troughs and ridges trending NW-SE. There is an almost continuous gravity anomaly along the western margin of the Tolmer Sandstone with a number of deeper seated ones embedded in the trend. Anomalies also occur along the Giants Reef Fault near Mt. Hayward. (See Plate 5) The results of the gravity survey were also presented, after proper treatment, as Regional Anomaly and Residual Anomaly plans.

RESIDUAL ANOMALY CONTOUR MAP

In order to obtain more information from the gravity survey, an interpretation has been attempted using the residual anomaly contour map. This map provides Bouger 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.

THE E.L.S 4856, 4857

Area I  Increased Tolmer thickness as lower and middle Tolmer are present.

Area II  Northern part (IIN): could correspond to the deepest part of the Tolmer Basin and thickest portion of the lower Tolmer Formation.

Southern part (IIS): could represent the signature of a granitic intrusive; one portion of it is outcropping to the SE.

Area III Reflect the Tolmer sequence filled together but with the outcropping Hinde Dolomite diminishing the amplitude of the low.

Area IV  Northern part (IVN): could correspond, as (IIN), to the deepest part of the Tolmer Basin with the lower Tolmer only present, but also one can envisage the presence of a granitic intrusive in the underlying Burrell Creek.

Southern part (IVS): could correspond to the thickest portion of the Tolmer sequence.
The highs are interpreted as follows:

Area A: Reflect eventually an upthrow of Burrell Creek of an eastern block along a N-S to N10E network of fractures and faults observed on the air photo interpretation.

Area B: Could correspond to the Cambrian basaltic layers overlying the upper Tolmer unit.

Area C: Could reflect the beginning of the Cambrian limestone.

Radiometry: a general blanketing effect has been caused by the Tolmer cover. The Hayward Creek Prospect, drilled some years ago by Mobil, stands out as a large cluster of anomalies. Overall, there is little correlation between U/Th and T.C., possibly indicating the anomalies to be either Th or K induced. (See Plate 8).

4.4 AIR PHOTO INTERPRETATION

Detailed interpretation of both geology and structure have been made by several T.M.A. geologists utilizing the 1:25,000 colour photo coverage. This work will be required to help interpret the various geophysical-radiometric-geochemical data and to target areas worth of more intensive ground work.

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.

**Burrell Creek**

The regional strike of the Burrell Creek beds show a N10-30W in the northern half and a N10-30E in the middle and souther parts. Between the 2 different strike orientations, a tight folding can be clearly seen as a Z-shaped fold with a N30W axis (Z).

The Burrell Creek beds are affected by an intense tectonism.
12.

(a) Numerous N70 to N100E which continue across the Tolmer Sandstone.

(b) N10E fracture of the Giants Reef Fault family.

(c) N60E crossing into the Tolmer.

(d) Rare N45 in the northern half.

(e) N10 to N30W in the northern part coming across into the Tolmer with an inflexion to N45W.

**Tolmer Sandstone**

The 3 units of the Tolmer Sandstone are represented and a younger formation, more flat lying, can be seen to the east.

The lower sandstone is present alone in the northern part and the 3 units in the southern part. Between the two, a zone without outcrop where it is more likely that T2 and T3 could be present under younger layers or soil cover.

T1 strikes N30E (very little dip observable unlike T2 which, with very thin bedding, provides numerous dip observations). The magnitude of the dip must be between 10 and 15° toward the east.

The T3 unit has the same strike orientation as T1 and T2 on the middle portion of the E.L. but shows a very distinctive change in the SE corner where T3 has a N60E strike and a 5 to 10° dip to the SE, implicating the presence of a main N-S structure (A) to the west and of another N60E (C) to the north.

The tectonic pattern observed in the Tolmer can be described as follows:

(a) Major N-S in the central portion A, A', B.

(b) Numerous N70E to N100E affecting, in priority, T1, with less intensity T2, to almost disappear in T3 except for the central part of the E.L. where the density of these faults is maximum in the 3 units.

(c) N10 to 20E faults almost on strike in T1 and T2 (D). It is expected that some of those faults are bounding an upthrown eastern block giving a sort of monoclinical structure. A main N10E fault (E), parallel to the Giants Reef Fault, is noticed in the NE corner, extension of fault noted on E.L. 4856.

(d) N45 to N60, essentially in T1, in the northern part and rarely in T2.

(e) N30W in the southern and northern part, but absent in the centre.

(f) N45W affecting the northern tip of T3 (F) and T1 in the north (G).
4.5 GEOCHEMISTRY AND THERMOLUMINESCENCE  (See Plate 6 for Sample Sites)

Analytical work comprised U, Th and Mg determinations on selected samples of basal Tolmer Sandstone and mobile U on sediments from streams draining the contact. Duplicate rock samples were sent to Adelaide University for thermoluminescence studies. This method uses artificial thermoluminescence to detect palaeoradiation 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 Kambolgie. 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. Although none have been recorded in outcrop, such facies could exist beneath the Tolmer Sandstone cover. So far only 19 samples have been analysed, which represent approximately 130 km strike length of sandstone cover, 2 of these being from E.L. 4857. Much more intensive sampling is planned for the 1987 field season which will give a good understanding of the distribution of the Mg content and its possible relation to geological and geophysical factors.

A similar situation exists with the uranium analyses. Insufficient samples have been collected for any concrete conclusions to be drawn. Further stream sampling is planned.

4.6 HELICOPTER RECONNAISSANCE

Prior to the commencement of field work a helicopter was used to assess the accessibility of the licence area for vehicles, to check the terrain for landing sites for the planned gravity survey and to gain an overview of the geology.
V. CONCLUSIONS

Exploration activities within the tenement are ongoing. At the end of the field season no anomalies had been located by the regional traversing, however the March Fly Prospect was looked at briefly and will be followed up in more detail in 1987. The geophysical data will be utilized to outline further areas of interest. To date no firm conclusions can be drawn from the work completed.
## VI. EXPENDITURE STATEMENT

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TOLMER PROJECT
TENEMENT SITUATION