WEST PINE CREEK JOINT VENTURE

E.L. 4857 - TOLWER PROJECT

ANNUAL REPORT TO THE DEPARTMENT OF MINES AND ENERGY

1989

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D. HARROP
MARCH, 1990

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1. SUMMARY

Due to an exceptional wet season, field work finally commenced in mid-May; at Tolmer the campaign was terminated at the end of October. The principal activities of the year comprised detailed EM-VLF and alphaCard surveys over specific areas outlined by TOTAL's exploration efforts of the previous three years. An intensive drilling programme followed, based on a synthesis of geological mapping and interpretation of EM conductive trends and/or coincident anomalous radon zones.

Encouraging drilling results were obtained at INPUT anomaly T10. Here, zones of chloritic alteration in association with graphitic facies were intersected within the Lower Proterozoic Burrell Creek Formation. This, combined with other features of the prospective areas, has provided the encouragement to continue the exploration efforts for a further season.
II. INTRODUCTION

2.1 GENERAL

This report encompasses the exploration activities carried out over the Tolmer Project tenement Exploration Licence 4857 for the 1989 field season, jointly explored by TOTAL Mining Australia Pty. Limited and PNC Exploration (Australia) Pty. Ltd.

2.2 DESCRIPTION OF AREA

The tenement is located north of the Daly River Settlement in the Reynolds River area, centred approximately 110 km south of Darwin (refer to Figure 1).

Part of the land covered by the tenement has recently passed into the hands of the Northern Territory Conservation Commission for inclusion in the Litchfield State Park. Grazing rights are still held by the Tipperary Pastoral Co.

The tenement situations are illustrated in Figures 1 and 2, showing the 1989 and 1990 situations respectively.

2.3 LOGISTICS

E.L. 4857 can be accessed from the main Daly River road by a series of bush tracks and station roads. Depending upon the intensity of the wet season, the country can be accessible from mid-April to December.

The principal watercourse is the northwest flowing Reynolds River; this is fed by several large creeks draining the Tolmer plateau. Savanna woodland predominates with areas of open black soil plains.

2.4 TARGETS

The Joint Venture is exploring for unconformity-type uranium deposits believed to be located at or near the contact between the Lower Proterozoic Burrell Creek Formation and the Middle Proterozoic Tolmer Group.

Similarities are known to exist between the lithologies encountered in the Tolmer Project area and those occurring in the Alligator Rivers Uranium Field. Such similarities have been enhanced by the location of several zones of uranium mineralization and associated hydrothermal alteration as well as more recent drill intersections of graphitic horizons associated with intense chloritic alteration.

The Joint Venture's exploration activities are based upon the model and methods employed by explorers in the Alligator Rivers and Athabasca uranium provinces. However, it is kept in mind that local variations regarding geological, tectonic and morphological conditions can occur and that these factors may influence interpretation of the data.
III. PREVIOUS WORK

This subject was summarized in the Tolmer Project Annual Report for 1986. Reference will be made in this report to previous activities where it is relevant to current work being carried out by the Joint Venture partners.
IV. GEOLOGY

4.1 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 Archaeon 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.

Detailed geology is illustrated on the project synthesis map (Plate 1). This plan comprises a 1:100,000 compilation of the N.T.G.S. 1:25,000 preliminary geological sheets.

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

ARCHAICON-EARLY PROTEROZIOC: Litchfield Complex comprising high grade metamorphics which appear to include sediments, basic to intermediate volcanics 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) Carpentario syn-orogenic to post-orogenic granites. Represented by the Mt. Litchfield, Allia Creek and Jamine granites and the Soldiers Creek granite at Collia (Pxgl, Pxga, Pxgi and Pgs). Also the Reynolds River and Alligator Creek granites located in the northern section of the exploration area.

(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) (Puu).

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

MESOZOIC: Flat lying sediments occur as residuals, forming 'flat-top' hills and overlying either Cambrian or Tolmer Group rocks. They comprise grey, silicified, laminated siltstones, sandstones and conglomeratic sandstones. Laterite.
4.2 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 Group adjacent to the Rock Candy Fault forming an elongated domal structure thought to be underlain by Carpentarian Age 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.
V. PROSPECT EVALUATION

5.1 INTRODUCTION, METHODS AND STATISTICS

5.1.1 General

Within Exploration Licence 4857 two principal prospective zones were investigated during the 1989 field season; in order of priority these were:

- T10 INPUT anomaly,
- Hayward Creek Area III.

The exploration methods employed included geological mapping, EM-VLF, radon detection (alphaCard) and scintillometry. All or some were used on each prospect and, with the exception of Hayward Creek, followed by percussion drilling.

The following table summarizes the work carried out on each prospect:

<table>
<thead>
<tr>
<th>PROSPECT</th>
<th>ALPHACARD</th>
<th>SPP2</th>
<th>EM-VLF</th>
<th>DRILLING</th>
</tr>
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<tr>
<td></td>
<td>(stations, (2 readings</td>
<td>(line km)</td>
<td>(line km)</td>
<td>(metres)</td>
</tr>
<tr>
<td></td>
<td>line km) /station)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T10</td>
<td>97</td>
<td>194</td>
<td>-</td>
<td>576</td>
</tr>
<tr>
<td></td>
<td>2.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAYWARD</td>
<td>11</td>
<td>22</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CREEK</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 1**

5.1.2 Methods

**EM-VLF**

The VLF surveys were carried out using a Geonics EM16 portable instrument. The instrument contains two crystals enabling it to receive North West Cape (NWC) and Japan (NDT); two readings, one for each station, were taken at 25 m intervals along pre-surveyed grid lines 50 m apart. In-phase and out-of-phase readings are recorded for each station. The data is plotted in both graphical form accompanied by geological observations and as contours (Fraser-Gradient method). Appendix 1 relates the specifications of the EM16.

**ALPHACARD RADON DETECTION**

Extensive and detailed radon detection surveys were carried out at Tolmer. The AlphaNuclear alphaCard system has been used successfully by TOTAL for a number of years on its various projects in the Northern Territory. The method involves the placing of small metal, foil-centred cards within a completely sealed 40 cm deep hole. The cards are freely suspended inside an inverted plastic cup. Radon daughter emanations accumulate...
on the foil portion of the card over a minimum period of 12 hours. The cards are then extracted and placed in the alphaCard reader which is programmed to give a 5 minute count; results are in counts per minute. Variables which can affect the field data include damaged cards, incorrectly sealed holes, varying atmospheric pressure and ground conditions. If doubtful results are obtained the readings can be repeated. All data is plotted and contoured.

**RADIOMETRICS**

Scintillometer surveys were run in conjunction with the alphaCard. Readings were taken both on-surface and in-ground, i.e. in the alphaCard hole. Considerable variations can exist between the two readings. Results are plotted and contoured on separate plans and integrated with all other data.

**DRILLING**

The 1989 Tolmer drilling campaign commenced on 9th September and was completed on 31st October. A total of 576 m was drilled in this 51 day period at T10. A tabulation of the drill holes can be found on Table 1, page 6.

The contractor was Rockdril Ltd. of Brisbane. A Versatile 1000 multi-purpose rig was used; all drilling was by downhole-percussion with the option of converting to coring if significant mineralization was intersected.

A production rate of 61.5 m/day was realized which was well below the quoted performance of the rig of 100-120 m per day. Many breakdowns occurred which accounted for half the number of working days. Access to sites was good and moving time between holes averaged 1/2 hour. Despite the many problems and delays the crew was efficient and hard working and back-up from their Darwin supervisor was good.

**GAMMA LOGGING**

All down-hole logging was performed by TOTAL personnel utilizing an SIE T450 portable logging unit. The equipment comprised a manual winching unit, recorder, power-pack and NaI (gamma) probe. Each hole was logged initially in the rods and then open hole. Analog charts were produced and this data was transferred on to the standard TOTAL D6 drill data forms.

Despite having the equipment checked out by STRATALOG (Brisbane) at considerable expense, the chart recorder produced errors which distorted the measured depth of the drill holes, e.g. a hole of 100 m depth produced a log chart representing only 85 m (i.e. 85 cm at 1:100 scale). Scales had to be calculated individually for each chart and photographically adjusted to the correct length. The error was traced back to the first drill hole, precluding misuse in the field as being responsible for the problems.
DRILL HOLE SAMPLING

All drill holes were systematically sampled for U and Th; at SH2 and T10 a continuous 10 m sampling was conducted throughout the hole in addition to 1 m sampling above and below the unconformity for 4 to 5 metres. Using the gamma log and scintillometer data, further sampling of radiometrically anomalous zones was undertaken. Samples were submitted to CLASSIC COMLABS (AMDEL) for U and Th determination by XRF. Additional sampling of strongly 'kaolinized' zones within the Tolmer Sandstone was used to determine the type of clay minerals present and relate this to possible hydrothermal events.

Sampling of Mistake Creek holes was conducted on a similar basis.

SURVEYING

All hole collars were pre-surveyed on the local grids. Checks were run after completion of each hole and the coordinates recorded.

Collar RLs were calculated by clinometer from a common datum point.

5.2 T10 - E.L. 4857

5.2.1 Introduction

T10 is located adjacent to the Middle/Lower Proterozoic unconformity near Tableland Creek along the northern boundary of E.L. 4857. Preliminary exploration commenced in 1988 including EM geophysics, radon surveys and geological mapping. Additional alphaCard lines were run in the current year to check extensions of several low order anomalous trends on the eastern and southern borders of the grid.

Drilling commenced in late October on completion of the SH2 programme.

5.2.2 Drilling

<table>
<thead>
<tr>
<th>HOLE NO.</th>
<th>COORDINATES</th>
<th>DECLINATION</th>
<th>AZIMUTH</th>
<th>DEPTH (m)</th>
<th>COMMENTS</th>
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<tr>
<td>TOL-P-64</td>
<td>1400N/1000E</td>
<td>90°</td>
<td></td>
<td>108</td>
<td>Unconformity at 78 m.</td>
</tr>
<tr>
<td>TOL-P-65</td>
<td>1400N/1250E</td>
<td>90°</td>
<td></td>
<td>126</td>
<td>Unconformity at 84 m.</td>
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<tr>
<td>TOL-P-66</td>
<td>1900N/1100E</td>
<td>90°</td>
<td></td>
<td>138</td>
<td>Unconformity at 108 m.</td>
</tr>
<tr>
<td>TOL-P-67</td>
<td>1200N/1400E</td>
<td>90°</td>
<td></td>
<td>102</td>
<td>Unconformity at 68 m.</td>
</tr>
<tr>
<td>TOL-P-68</td>
<td>1400N/1200E</td>
<td>90°</td>
<td></td>
<td>102</td>
<td>Unconformity at 68 m.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TOTAL 376 m</td>
</tr>
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Five holes were drilled for a total of 576 metres; the greatest concentration being on profile 1400N. Additional holes were placed on sections 1200N and 1900N.

The position of alphaCard anomalies determined the placement of holes; these anomalies showed an intimate relationship with structural features determined from surface mapping. In the case of the 1900N profile, the proximity of a major fault and large breccia zone (collapse structure?) were also deciding factors.

The holes drilled are listed below; a description of the principal features of each hole follows:

1400N  TOL-P-64  108 metres
       TOL-P-65  126 metres
       TOL-P-68  102 metres

1900N  TOL-P-66  138 metres

1200N  TOL-P-67  102 metres

5.2.2.1 1400N Profile (Plate 4)
---------

Three holes were drilled on this section to test the origin of radon anomalies and the coincidence of EM conductors and structural features.

From west to east the unconformity was intersected at 73 m, 70 m and 81 m. The 200 m gap between TOL-P-64 and TOL-P-68 with a 3 m variation and the 50 m between TOL-P-68 and TOL-P-65 with a 13 m variation, point to a structural modification of the unconformity.

Lithologically, the Tolmer Sandstone shows much the same features as at SH2 with both kaolinized and hematized zones being noted. TOL-P-64 intersected gritty and pebbly bands between the surface and 25 m grading into a monotonous fine grained sequence of variable colour. Similarly, TOL-P-68 shows a gritty/pebbly zone to 28 m becoming finer grained to 54 m then red quartzites with coarse pebble bands to the unconformity. TOL-P-65 is collared in a gritty sequence becoming pebbly below 16 m. There appears to be a higher degree of kaolinization and hematization and a radiometrically anomalous zone within the Tolmer was encountered. The latter, at 17 m, registers 56 cps on the open hole log and 80 cps SPP2 on cuttings. A less intense peak 4 m below registered 36 cps.

Overall, the radiometric signature of the Tolmer Group in all three holes is flat. The average count would be about 6 cps.

Radiometric and lithologic features of the Lower Proterozoic are as follows:

**TOL-P-64**

Anomalous zone from the unconformity to 7 m below with three sets of peaks over 100 cps. The lithology comprises a green, chloritic, slaty schist or meta-siltstone with some hematitic alteration and quartz veining. Weakly chloritized schistose facies and quartzite bands make up the Burrell Creek below this.
TOL-P-68

No response at unconformity; fairly flat radiometric response throughout the hole. The chloritic alteration is much less intense. Lithologies comprise green sericitic and mauve quartzites and slatey schist.

TOL-P-65

A series of peaks up to 120 cps exist from the unconformity to 9 m below. This zone consists of a grey to green chloritic sequence of slatey schist. Background is 2x that in TOL-P-64. Throughout the hole the sequence comprises slatey schist or meta-siltstone, green to grey in colour with only a few thin quartzitic bands.

Synthesis of the 1400N Line

Although similar alteration patterns exist in the Tolmer Sandstone at T10, the radiometrics are generally lower and less "spikey" than those at SH2; TOL-P-65 is the only hole exhibiting an anomaly. This could be the phenomenon giving the surface radon anomaly: the samples over this interval were damp, very clayey material, most likely from a fault zone acting as a conduit for the radon.

Both TOL-P-64 and TOL-P-68 exhibit a similar response to the 9600N holes at SH2 whereby an "anomalous zone" exists at the unconformity and adjacent to it; this is however only a very weak response by comparison. Chloritization is considered to be related to the regional metamorphic event.

5.2.2.2 1900N Profile (Plate 3)

TOL-P-66

This hole was drilled to test a radon anomaly associated with a strongly faulted zone and associated intense brecciation within the Tolmer Sandstone.

The unconformity proved to be a lot deeper than expected, given the distance to the surface expression of the contact and the RL of the collar compared to other holes drilled.

The contact was intersected twice: at 108 m and 132 m. The first is thought to be a normal unconformable situation while the lower is considered to be faulted - much quartz veining was noted in the drill cuttings for several metres above. The interpretation of this situation implies reverse faulting along the major photolineament.

Radiometrically the Tolmer Sandstone ranges from 5-20 cps, a little more variable than the other holes. There is no obvious anomalous zone within the Burrell Creek or at the Tolmer contacts. Lithologies in the latter comprise unaltered greenish to grey quartzites and grey to mauve slatey schist. The Tolmer quartzite is generally fine grained throughout with medium to gritty beds and a few pebbly layers. Colours vary from light greys and pink unaltered sandstone to red and mauve hematitic sections. Very little kaolinization is present.
5.2.2.3 1200N Profile (Plate 5)

TOL-P-67

This hole was drilled on the southern extension of a NW-trending radon anomaly and adjacent to a coincident MaxMin-VLF trend showing parallel strike with the high radon zone. The northern extension of these features was tested by TOL-P-63 and TOL-P-68. TOL-P-67 failed to intersect the source of the radon/conductor zone.

Open hole logging illustrates a flat response of 5-10 cps in the Tolmer Sandstone and similarly in the Burrell Creek Formation where 40-50 cps is the average. No peaks occur at the unconformity.

In summary, no highly encouraging features were found as a result of the T10 drilling. The lithologies present are markedly different from those at SH2 and the lack of distinctive alteration patterns is discouraging. Any future work should be concentrated on the northern end of the grid where faulting and associated brecciation could form a prospective environment. In addition, reinterpretation of the various EM data could provide additional targets. This is dealt with in Section 5.3.4.

5.2.3 AlphaCard Survey (Plate 2)

Several open low order radon anomalies occurred on the northeast, southeast and southern edges of the 1988 grid.

The most obvious anomaly, trending NW/SE between 1400N to 1200N, shows a relationship with a VLF conductive zone (NDT); this anomaly was chosen for drilling, three holes being collared on and adjacent to the radon hot spots (TOL-P-65, 67 and 68).

Referring to Plate 2, the main anomaly, with several values from 5 to 7 cps, extends discontinuously to the edge of the grid. An additional 10 stations were prepared to "block-out" any possible extension. None of these additional results were considered to be anomalous.

Extensions on the southern side of the grid had a two-fold purpose: to close-off existing low order anomalies (4 cps) between 1000E and 1400E and to check an area of faulting where thermoluminescence anomalies were defined in 1987. An additional 50 stations were read on the grid with a further 8 on the fault traces. Overall, results were disappointing, the majority being in the zero to 1 cps range.

The four stations located on the fault zone ranged from 1 to 7 cps; the higher values are considered attributable to outcropping Burrell Creek facies along the base of the fault scarp.
5.2.4 EM-VLF Reinterpretation (Plate 6) (B. Berthault)

VLF Stacked Profiles Interpretation

The stacked profiles map shows a definite number of crossovers from which the presence of a major conductive zone is clearly shown in the NE half of the survey, as well as a subordinate one in the SW corner. The major conductive zone separated from a more resistive unit to the west by a NW-SE oriented boundary can be interpreted as reflecting some more conductive facies with the Burrell Creek, possibly some schist-rich formation. The same consideration could apply to the SW conductive zone. The resistive formation could correspond to a resistive unit in the Burrell Creek, such as quartzites, but could also partly represent the response from the overlying Tolmer Sandstone. The NW-SE limit is concordant with the regional Burrell Creek general strike direction in the area, but also with some basal Tolmer Sandstone unit strike and possibly, in its northern part, with the general orientation of the Tolmer unconformity.

This limit can, in addition, be interpreted as having been displaced by a NE-SW mapped fault, F1, in 2 segments, AB and DC. The DC segment corresponds to a "good quality" conductor when considering the ratio out-of-phase/phase responses, a fact that could be explained either by the possible presence of a graphitic formation at the limit quartzite-schist units (already observed in the north) or by the presence of the NW-SE mapped fault, F3, which could have increased the conductivity of the conductive zone.

Whichever the previous hypothesis, it appears necessary to extend the VLF survey further to the N-NW to investigate the extension of the conductor. Should the latter extend further northwestwards with similar or higher strength as on profile 1900N, special attention should be given to that zone, closer to the unconformity, for drilling investigation if the geological surface observations confirm the potential of the possible conductor.

A second set of conductive features could be interpreted in the main conductive zone as 2 conductors, EF and GH. Hole TOL-P-68 indicated the presence of schists in the Burrell Creek in the close vicinity of EF.

Another conductive feature, J1, is shown on 3 successive crossovers in the SW corner of the survey and appears to broadly correspond to the Tolmer unconformity, south of F1 fault. J1 can represent the signature of the unconformity itself or of the contact between 2 facies of Burrell Creek and Tolmer. A subordinate conductive feature, KL, cannot be, for the moment, properly explained (without the proper information about the relief morphology of the profiles being available).

Within the 2 conductive zones one can define some portions with a "good quality" signature which could eventually correspond to graphite-rich portions of Burrell Creek schist. Such interpretation has already been put forward for the CD conductor and its immediate surroundings, but it can apply also to a series of zones generally located to the south of fault F1 and which then are displaying a general direction almost parallel to the regional strike mapped in the Burrell Creek in the SW corner of the mapped zone and which shows some 30° difference with the Burrell Creek regional strike noted north of the F1 fault.
In view of the above interpretation our drill holes performed interesting investigation but, being isolated, they have not been able to verify the presence of graphitic conductors.

It would be necessary to reconsider the present results within the ones which will be obtained in the next field campaign and to put some additional test drill holes on the present T10 survey area if no more attractive targets are defined in the 1990 extension survey.

We are thinking of one profile of short holes on 1100N between 700E and 800E and some investigation on 1500N or 1600N between 1200E and 1300E.

**The Fraser Gradient Interpretation**

The Fraser gradient interpretation is showing neither intense conductive nor resistive features but rather feeble ones on which an interpretation is tentatively put forward.

Some conductive features as I'J', G'H', C'D', broadly correspond to ones already previously underlain.

Other weak conductors, such as L'K', could reflect the presence of the mapped F2 fault within the conductive zone of Burrell Creek as long as the Tolmer Sandstone is not too thick. By analogy, one can imagine that similar features to the southeast of L'K' could reflect also the presence of N20-30E faults, having affected the Burrell Creek basement only, such as M'N' and P'O'.

When considering the northeastern termination of those Fraser gradient series of weak conductors, one may postulate the presence of an interpreted N40W accident, F5, within the conductive unit of the Burrell Creek with the same orientation as the regional Burrell Creek strike, a situation which has been encountered in many instances.

The north-northeast major brecciated area is not shown clearly in our VLF survey, except for rather strong negative readings in the in-phase. But the profiles are rather too short and will have to be extended toward the east, west and north as a priority matter in the next field season.

**5.3 Hayward Creek**

The Hayward Creek prospect was first investigated by MOBIL in the late 1970's after being outlined as a large airborne radiometric anomaly. Ground investigations showed a large radon anomaly produced by spring water seeping from a prominent fault zone separating the Tolmer 'Stray Creek Sandstone Member' and Permian glacial sediments. A deep drilling programme by MOBIL failed to locate the 'at depth' source of the radon.

The Joint Venture (TMA/PNC) widened the exploration area and conducted detailed radon and scintillometric surveys. EM-VLF and MaxMin traverses were also run. Apart from the obvious anomalies covering and adjacent to the swamp, several low order radon 'highs' were located, the most promising being on Depot Creek Sandstone cover to the west. These anomalies appeared to coincide with major structures; their position relative to the unconformity was also of interest. Regionally, one of these structures could be traced southwest towards the March Fly uranium prospect.
A limited programme of follow-up alphaCard was carried out, principally to fill-in the rather wide station separation of the initial survey (Plate 7). On-ground assessment of the first programme showed a relationship between anomalous radon with creek systems presumably carrying radon-enriched waters and muddy black-soil alluvium.

An additional 11 stations were added to the grid in an attempt to 'close-off' and better define the anomalies. Several stations were deliberately placed adjacent to the creeks in the black soil to test the response. The result of the survey confirmed the direct relationship with the creek/fault system; readings elsewhere were insignificant, i.e. within the outcropping areas of the Tolmer Sandstone where escape of radon is prevented due to the impermeable, non-fractured nature of the rock. No prospective significance is given to the radon-bearing features of the Hayward Creek region. If a mineralized source exists within the Lower Proterozoic, then the thickness of the cover rocks would be too restrictive. No further work is planned.
VI. DISCUSSION AND CONCLUSIONS

The 1989 exploration programme involved the investigation of two separate prospects in varying degrees of detail. T10 will be further prospected in 1990. No further work at the Hayward Creek prospect is planned.

The T10 prospect failed to provide encouraging results despite having similar surface characteristics to SH2. The five holes drilled intersected an unaltered sequence of Lower Proterozoic rocks which, lithologically, differ from those at SH2. There is an absence of the strongly sericitic sequence known at SH2, the facies being more 'slatey' than 'schistose'; also, no indications of Mg-chlorite alteration or graphitic schists have, as yet, been intersected. Gamma logging indicates the lithologies to be essentially radiometrically 'flat'.

A limited programme is scheduled for 1990 and will be centred on the extensive breccia zone and related faulting near TOL-P-67. Additional drilling is planned after reinterpretation of the EM data.

The limited amount of follow-up radon surveying at Hayward Creek is considered sufficient to confirm that the area has no further interest to the Joint Venture.
VII. PROPOSED 1990 PROGRAMME - TOLMER PROJECT E.L.'S 4856, 4857 AND 5586

In 1990, it is expected that further development work will be required on each of the SH2, T10 and March Fly anomalies. This will include drilling of the anomalies to outline their potential for finding reserves of economic ore grade mineralization. An allowance of 3,000-3,500 m of drilling has been made for this follow-up work.

It is planned to carry out detailed mapping of the unconformity, the Lower Proterozoic metasediments and the Tolmer Sandstone between SH2 and T10. Special emphasis will be placed on the delineation of alteration patterns, the brecciation pipes and the alphaCard anomalies within this NW-SE trending zone.

Priority Targets

(a) SH2 and its SE extensions (E.L. 4956)

(b) T10 and its NW extensions (E.L. 4957)

(c) March Fly extensions to the known mineralization (E.L. 4857)

SH2 - E.L. 4856

From the work carried out in 1989 it seems that a conductive zone exists between SH2 and T10. This zone in the north is coincident with the so-called Surprise Creek North member, consisting of graphite/chlorite schists and carbonaceous shales. These units also exist at Eccles II and Tableland Creek where carbonaceous schists are known to occur. A number of well defined breccia pipes at both SH2 and T10 associated with the alphaCard anomalies have made this conductive trend worthy of further consideration. It is planned to carry out systematic mapping as well as alphaCard and radiometric surveying along this conductive trend.

VLF, EM-16R and Mise a la Masse surveys will be conducted at SH2 in 1990.

Drilling of EM-16 and alphaCard defined anomalies at SH2 will continue in 1990.

ECCLES II - E.L. 4856

Detailed geological mapping, aided by percussion drilling, is needed to evaluate the low grade uranium mineralization at Eccles II. As mentioned above, the Eccles II prospect occurs on the NW-SE trending zone of conductivity which links SH2, Eccles II and the T10 anomalies.

T10 - E.L. 4856-4857

Anomaly T10 has some of the parameters exhibited by East Alligator orebodies. There is a distinctive airborne EM-INPUT anomaly with a number of NW-SE trending ground MaxMin anomalies. The latter appear as if they may be due to lithologic, rather than structural features, as they have the same strike as the Burrell Creek Formation to the north where graphite schists have been noted.
T10 has been disrupted by major faulting both N-S and E-W. The E-W fault defining Tableland Creek has offset the unconformity between the Lower and Middle Proterozoic several kilometres towards the east. Thermoluminescence anomalies occur along this faulted unconformity.

The alphaCard anomalous at T10, although not of a high order, is continuous over 150-200 m and appears elongated along a structural feature.

The limited drilling carried out at T10 in 1989 was positive in that intersections of chlorite alteration haloes were made. In 1990 it is planned, therefore, to carry out further drilling in the T10 area on conductors defined by VLF to evaluate the potential for finding economic mineralization.

MARCH FLY

The March Fly prospect consists of a number of thin, high grade intersections of primary uranium with little surface expression. The host rock is a strongly heterogeneous, faulted and strongly folded sequence of metasediments which contain graphite schist and carbonaceous shales. This sequence has been intruded by quartz tourmaline and pegmatitic dykes.

It seems from the work carried out so far in the March Fly prospect that the anomalous zone is linear N-S and has been offset by subsequent faulting.

It is thought that, although the mineralization noted to date is thin and vertical, it is rich (several percent U metal) and, therefore, in association with another deposit in the area may have economic significance. At present the mineralized trend has been investigated by widely spaced drill holes only in the north. No drilling has been carried out to investigate the potential of the mineralized zone south of the offsetting transverse fault. It must be remembered that when the mineralization is so rich (up to 11% U) the volume of ore needed to make an economic mine is not great. It must also be remembered that this high grade mineralization may "make and break" both along strike and vertically and hence be more difficult to evaluate.

In 1990 it is proposed to drill widely spaced drill profiles on the southern extension of the known surface anomaly to evaluate the potential for finding further high grade uranium mineralization. The purpose of this drilling is to define the limits of the known mineralization. 700 m of percussion drilling has been allocated for this purpose.
TOTAL MINING AUSTRALIA PTY. LIMITED

1990 BUDGET PROPOSAL

PROJECT: TOLMER

PROJECT MANAGER: PAUL MELVILLE

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### VIII. EXPENDITURE STATEMENT

For period 1st March, 1989 to 28th February, 1990

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APPENDIX 1

Specifications of the EM-16 VLF Machine
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.
APPENDIX 2

Geochemical Analyses of Drill Holes - 1989
GEOCHEMICAL ANALYSES TOL-P-68

- Uranium Mobile
- Thorium
APPENDIX 3

Drill Logs - Holes TOL-P-64 to TOL-P-68