WEST PINE CREEK JOINT VENTURE

TOLMER PROJECT - E.L. 4856

FINAL REPORT

TO THE N.T. DEPARTMENT OF MINES & ENERGY

Volume 1 of 4

Text and Appendix 1

R/92-2-U

D.S. Cocquio, Editor
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1. EDITOR'S NOTE

This report recapitulates the exploration work carried out by the joint venture between TOTAL Mining Australia Pty Ltd and PNC Exploration (Australia) Pty Ltd in E.L. 4856 during the period 1986-1991. It integrates all the data presented in the annual reports to the N.T. Department of Mines and Energy, namely:


In documenting the evaluation of the various prospects the latest geophysical and geological interpretation is discussed, although in some cases earlier interpretations have also been included when they affect the presentation of drilling results.

Co-ordinate references to local grids use the latest grid systems; older references have been changed as necessary.

Only a number of key plans are included in this report. In the text they are indicated with a plate number followed by a * (e.g. Plate 5*). Reference to plates from previous annual reports are indicated with the plate number and year of the report (e.g. Plate 12-88).

The complete drill logs were included in the annual reports, as were a number of appendices not duplicated here. The reader is referred to the above reports list for this documentation.
2. INTRODUCTION

2.1 GENERAL

In 1986 a joint venture was formed between TOTAL Mining Australia Pty Limited (TMA) and PNC Exploration (Australia) Pty Ltd, to carry out exploration in the West Pine Creek region. One of the areas of interest to the joint venture, in which each company holds a 50% interest, included the ground covered by E.L. 4856.

The exploration licence was granted for a period of six years starting on 4th March 1986. The original grant covered 410 Km², or 130 blocks, in the Reynolds River area (Plate 1*).

After the first two years of occupancy, the surface of the licence was reduced as follows:

<table>
<thead>
<tr>
<th>Permit Year</th>
<th>Blocks</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>61</td>
<td>196.42 Km²</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>96.67 Km²</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>45.11 Km²</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>22.56 Km²</td>
</tr>
</tbody>
</table>

2.2 DESCRIPTION OF THE AREA

The licence is located in the Reynolds Rivers area approximately 35 Km NNE of the Daly River settlement and 110 Km south of Darwin (Reynolds River 1:100,000 topographic map). From the pastoral point of view, all of the land is under the control of Tipperary Pastoral Company.

Access is by the Adelaide River-Daly River road, and then by established bush tracks. In Tolmer Sandstone country traverses by 4WD are also fairly easy once access to the plateau is gained. The wet season, however, severely restricts off-road vehicular traffic for five months of the year.

Vegetation comprises savanna woodland with localised patches of tropical forest lining creeks along the sandstone escarpments, as well as many open tracts of black soil plains.

The Reynolds River is the main watercourse flowing north across the western part of the E.L.; several large west-flowing tributaries, including the Mistake, Surprise and Tableland Creeks join the Reynolds River.

In 1989 most of the land covered by the EL passed into the hands of the Northern Territory Conservation Commission for inclusion in the Litchfield State Park.

2.3 MINERALIZATION MODELS AND TARGETS

In the licence area the presence of Lower Proterozoic sediments in unconformable contact with overlying Middle Proterozoic sandstone provides a comparable geological setting to that of the Alligator Rivers Uranium Province. The general aim of the exploration was 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 that was employed related to possible uranium concentration around the periphery of granite intrusions, again in suitable host rocks.
the Burrell Creek Formation. The same exploration techniques were employed for location of both types of occurrences, with an emphasis on geophysics to locate possible buried granitic "domes", i.e. beneath the sandstone cover.

The joint venture's exploration activities, although based on the models developed in the Alligator Rivers and the Athabascan uranium provinces, were developed to suit variations in the geological, tectonic and morphological features specific to this project area.
3. PREVIOUS WORK

3.1 PRIVATE COMPANIES

Since the early 1970's, many exploration companies have been active in the area 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 the areas of E.L. 4856 and 4857. What appears to be the most intensive work was carried out by Keewane 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 radiometry; 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 appears to be mainly for geochemical purposes. Mobil drilled at depth two of its airborne discovered anomalies: the Hayward Creek and Noltenius (Mt. Thomas) prospects (E.L. 4857). The former is a radon anomaly confined to a large swampy zone in the Tolmer Sandstone. The Noltenius location is within Burrell Creek sediments adjacent to the Tolmer contact. Both Keewane and Nord/AGIP were also prospecting for base metals.

Elsewhere in the region exploration within the Cambrian limestones of the Daly River Group was 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.

3.2 GOVERNMENT AUTHORITIES

The region was originally geologically mapped by the BMR, which also carried out magnetic and gravity surveys. In more recent years the Northern Territory Geological Survey mapped at 1:25000 scale the Reynolds River, Daly River and Wingate Mountains sheets. Airborne geophysics was also carried out, including magnetics and spectrometry.

Several stratigraphic holes were drilled by the NTGS, 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 depth intersected interbedded siltstone/carbonate rocks/sandstone belonging to the Stray Creek Sandstone member. The only other drilling was in the Cambrian north of Litchfield and in the Wangi Basics.
4. REGIONAL GEOLOGY

4.1 STRATIGraphy

The tenement is located on the western edge of the Fine 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 ?Archaean to Lower Proterozoic age occurs to the northwest. The Cambrian Daly River Group obscures much of the Lower Proterozoic-Adelaidean rocks both west and east of the tenement area.

The following stratigraphy is based on work published by the NTGS (1983).

ARCHAEOAN - EARLY PROTEROZOIC: Litchfield Complex comprising high-grade metamorphics which appear to include sediments, basic to intermediate volcanics and anatctic granites.

LOWER PROTEROZOIC: Burrell Creek Formation (Pfb) consists of variably metamorphosed sandstones and siltstones, and includes pebble and conglomerate facies, graphitic and chloritic shales/schists and some carbonate rocks.

MIDDLE PROTEROZOIC:

i) Carpentarian synorogenic to post orogenic granites represented by the Mt. Litchfield, Allia Creek and Jamine Granites and the Soldiers Creek Granite at Collia (Pxgl, Pxga, Pxgl, and Pgs). The Reynolds River and Alligator Creek Granite located in the northern section of the Tolmer Project area are also Carpentarian (Middle Proterozoic) in age.

ii) The ?Early Adelaidean Tolmer Group is made up of four separate formations.

+ Depot Creek Sandstone: (Ptd) thickly-bedded medium to coarse quartz arenite (450m).
+ Stray Creek Sandstone: (Pts) flaggy, micaceous, ripple marked quartz arenite (300m).
+ Hinde dolomite: (Pth) dolomite, dolomitic shales and arenites, quartz arenites (+314m).
+ Waterbag Creek Formation: (Ptw) red mudstone with thin arenite layers (non outcropping) (+134m).

iii) Late Adelaidean Uniya Tillite (0-30m) (Puu)

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

MESOZOIC: Flat-lying sediments occur as residuals, forming "flat-top" hills and overlying either the Tolmer Group or the Cambrian. They comprise grey, silicified, laminated siltstones, sandstones and conglomeratic sandstones, and laterite.
4.2 STRUCTURE

4.2.1 Faulting

The principal structural feature of the region is the Giants Reef Fault which is a major tectonic feature that can be traced for over 200 Km. The Giants Reef Fault has been apparently active over a long period of time. It was active until after the deposition of the Depot Creek Sandstone in the Middle Proterozoic and has produced substantial lateral movement, up to 8 Km which is shown by displacement of the various units of the Tolmer Group. Major conjugal splay faults such as the Stapleton and Rock Candy Range faults, and many other minor ones traverse both the Lower Proterozoic and Middle Proterozoic Formations. Major low-angle thrust faulting has occurred in some areas associated with the Giants Reef Fault.

4.2.2 Folding

Folding of the Lower Proterozoic Burrell Creek Formation is generally fairly intense, with north-south fold areas trending between 340° and 350° and with steep fold limbs. Axial plane lineaments form the major deformational feature, and hence produce the most prominent cleavage. This has been complicated by the intrusion of granitic domes in some areas and by pegmatites in others. The pegmatites generally are concordant with the foliation but may also be controlled at least in part by the bedding.

The overlying Tolmer Group dips gently eastwards forming the extensive Daly River Basin. There are local variations to this regional dip which are probably due to an undulating depositional surface.

Folding is known to occur in the Tolmer Group adjacent to the Rock Candy Fault where it forms an elongated domal structure thought to be underlain by an intrusion of Carpentarian granite.

The Cambrian sediments are nearly flat lying within the E.L. area.

Regional dips are moderate to steep westerly for the Burrell Creek Formation and gently towards the east for the Tolmer Group. The regional strike is N-S to NW-SE.

4.3 GEOLOGY OF E.L. 4856

> Burrell Creek Formation

The Lower Proterozoic sequence is fairly monotonous comprising mainly silty and sandy sequences. Facies changes have given rise to some variations to the lithologies seen along the western contact, for example there is less sandstone present and the argillaceous rocks are perhaps finer grained.

Photogeology shows the bulk of the sediments forming linear north-south and north-west/south-east strike ridges; folds can be delineated quite readily and major and minor faulting is easily observed. Variations in drainage patterns represent lithological changes.
The "Fault Wedge Zone" comprises a triangular section of Burrell Creek bordered to the east and west by Tolmer Sandstone (Ptd). Both contacts are faulted, the westernmost being the NE-trending Stapleton Fault and the eastern a subsidiary structure trending almost true north and merging into the former. The southern edge of the "triangle" is a NNW linear intrusive contact; much of the non-outcrop country is granite covered by sand and alluvium. Lithologies within the wedge strike north to northwest and appear to be relatively undeformed. Reddish to brown, fine micaceous meta-siltstones with subordinate interbedded meta-sandstones occur. Along the intrusive contact the topography becomes quite rugged with more resistant hornfelsed sediments forming steep ridges; andalusite schists predominate here.

Between Back Creek and Red Rock Creek finer grained facies with minor sandstone beds outcrop. Lithotypes include brown to reddish micaceous meta-siltstone, red slaty "mudstone" and phyllites; recognition of specific lithologies is very difficult due to the deformation the rocks have been subjected to. Phototrends indicate a vague NW linear pattern in the sediments which is truncated to the SE by the Stapleton Fault and to the NW by the unconformity. Lack of the more resistant sandy strata tends to produce this more diffuse signature.

The Reynolds River granite intrudes the Burrell Creek sediments without significant contact metamorphic effect.

North of Red Rock Creek the Lower Proterozoic sediments are in both unconformable and faulted contact with the Tolmer Group. A WSW/NNE linear feature truncates the northward trend of the Depot Creek Sandstone exposing Burrell Creek sediments; these outcrops form rugged north striking ridges which eventually terminate against the Giants Reef Fault 10-15 km distant. The contact again becomes north-south and unconformable. Generally the facies represented include interbeds of both argillaceous and arenaceous rocks forming a distinct north-south linear trend; the rocks have been subjected to low grade metamorphism, are strongly cleaved and form fairly broad folds.

An area of sandstone overlies siltstone lithologies immediately north of the Red Rock camp site (AMG 937166 Reynolds River); the sandstones range from lichic to fairly quartz-rich and are characterized by uniformly low radiometric counts. This sandstone cover tends to obscure a broad anticlinal fold developed in the meta-siltstone facies.

Approximately 0.5 km southeast of the camp site an outcrop of red slaty mudstone gave some high background readings (up to 300 cps SPP2). The occurrence was localized and did not appear on adjacent traverses.

Bordering the E-W contact fault fairly abundant quartz veining is developed in the meta-sandstones, commonly along ridge summits and striking parallel and sub-parallel to the cleavage direction. Some of these veins are composed of massive white quartz, others are vuggy. Brecciation occurs, as does ferrugination with obvious sulphide relicts. Some chloritic alteration is developed in the country rock along the vein boundaries. Samples were collected for gold analysis but gave negative results.
In the extreme north of the traverse area some facies changes within the Burrell Creek are evident. Sandstones, grits and conglomerates form a well bedded uninterrupted sequence which dips west and strikes generally NNE. Photo interpretation suggests this feature could be the western limb of an extensive regional anticline. The southern end of the sequence abuts against a fault separating it from the Depot Creek Sandstone; the faulting has created a flexure in the bedding.

> Tolmer Group

Both the Depot Creek and Stray Creek Sandstone members are present in the region but only the former has been traversed. The characteristics of the contact with the Lower Proterozoic have been described under the previous heading. Regionally the Depot Creek Sandstone member forms a broad, shallow syncline; dips are known to be easterly along the western edge and many dip observations in the east confirm a shallow west dip, where not complicated by faulting. In places, e.g. adjacent to Red Rock Creek and to the northwest, the sandstone is flat lying with the result that some traverses pass "in and out" of the contact, i.e. outliers of sandstone occur within Burrell Creek outer zones.

The obvious structural feature of the Depot Creek Sandstone is its massive, blocky nature, the latter created by the joint/fault pattern. The major structures are the Stapleton and Giants Reef Faults, the former including a series of satellite structures of similar trend. The Giants Reef Zone creates a contact between the Depot and Stray Creek members along the East Branch Reynolds River. Here large areas of Stray Creek are preserved in a series of blocks bounded by variously oriented faults.

Lithologically, the base of the Depot Creek comprises a fine grained quartz arenite; persistent pebble bands and beds are fairly common especially in the northern part of the area. Local conglomerates were also observed. Sedimentary features such as ripple marks and current bedding occur throughout.

> Uniya Tillite

At AMG grid reference 043169 (Reynolds River 1:100,000 sheet) a hitherto unmapped outcrop of glacially derived sediment was located during traversing. Lithologically it is a dark coloured fine grained sandstone containing "dropstones" up to 0.5 m diameter of Depot Creek Sandstone. Only a thin layer has been preserved but the coverage is fairly extensive, being several hundred metres in area.

> Mesozoic Sediments

Localized outcrops of flat-lying lateritized sediment cap topographic highs in places, e.g. adjacent to the glacial sediments. They create mesa-type landforms mostly on the Tolmer Group sediments.
Granite

Two granite intrusives are present, located approximately 10 km apart. The northernmost is the Reynolds River Granite, the other has no formal name. Both are represented by very poor outcrop, the granite being obviously subject to rather quick weathering and decomposition; occasional exposures are seen in rapidly eroding creek beds. Generally the extent of the bodies has been judged by both photo signature and eluvial deposits on the ground surface. Satellite imagery interpretation does confirm greater known extent of the Reynolds River Granite and more or less agrees with the current interpretation. Similarly, the granitic body which underlies the Fault Wedge Zone was located reasonably accurately by gravity methods.

Outcrop observations on the Reynolds River Granite show two variants: pink and grey. The former has been described as a "porphyritic amalellite" and occurs as isolated, rounded, boulder-like outcrops; the latter is far more widespread and poorly outcropping. It is generally a hornblende-biotite granite. Observed outcrops in the Fault Wedge indicate a granite type similar to the hornblende-biotite variety.

Contact metamorphic effects were not observed around the Reynolds River Granite, however, there is an alteration aureole adjacent to the second occurrence.
5. WORK CARRIED OUT

5.1 GENERAL

Over the six year tenure exploration in the licence area was carried out along a standard "from general to detail" line of work. EL 4856 and the adjoining EL 4857 (which has the same anniversary date) were explored together as one project. As several surveys covered both tenements, there will be some overlap in the description of the exploration work between this report and report R/92-3-U which deals with E.L. 4857.

A rapid helicopter reconnaissance, mainly for logistic purposes, was carried out at the beginning of the first field season. Radiometric traversing, gridding and geological mapping followed during the first two years. At the same time the available airborne data was reinterpreted and integrated with additional geophysical surveys and air-photo interpretation.

During the second year, a comprehensive INPUT survey was flown over the whole project area and resulted in the definition of a large number of anomalies. These, together with the anomalies found during the radiometric traversing, were followed up on the ground during the subsequent years.

The most promising anomalies were the subject of further geophysical, geological and geochemical investigations and those that matured into prospects were drilled (drilling will be reported in detail under Section 6 - Prospect Evaluation).

5.2 AIRBORNE GEOPHYSICS

5.2.1 Regional Integrated Surveys

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

The NTGS survey data was acquired by TMA and passed on to a Sydney-based geophysical consultant group, Geospex Associates Pty. Ltd. for presentation as specified by the company. Consulting geophysicist for TMA, L. Acimovic, directed this work.

Detailed interpretation of all geophysical data was done by TMA geologists; this work is illustrated in a synthesised form on Plate 2*. A brief description is given below:

- **Magnetics**: a series of dykes is indicated trending subparallel to the Giants Reef Fault. The background magnetic intensity shows no variation between the Burrell Creek and Tolmer lithologies; this could indicate that the Tolmer Sandstone is "transparent".
U/Th: anomalies are widespread, not being confined to any one lithology; there is obvious structural control in places, but elsewhere other factor(s) must be involved. Known ground anomalies, e.g. Eccles II, have not been picked up, however the Surprise Creek North area has.

Gravity: carried out on a 4 km x 4 km grid with "fill-in" stations where necessary. There are several vague anomalies outlined with a pronounced NW-SE trend - these are thought to be granite intrusions. The results of the gravity survey were also presented, after proper treatment, as regional anomaly and residual anomaly contour maps. (Plates 6-86, 11-86, 12-86 and 13-86)

Radiometry: a marked contrast exists between the Tolmer Sandstone and other lithologies. The Giants Reef Fault is clearly shown as the contact between the Tolmer and Burrell Creek.

5.2.2 Residual Anomaly Contour Map

In order to obtain more information from the gravity survey, a regional interpretation was attempted using the residual anomaly contour map. This map provides Bouguer anomaly data corrected from the regional anomaly. Therefore any influence from deep seated sources has been eliminated.

The residual anomaly contour data has 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.

El's 4856, 4857 (Plate 11-86)

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

Area II Northern part (IIIn): could correspond to the deepest part of the Tolmer Basin and thickest portion of the lower Tolmer Formation. Southern part (IIIs): 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 (IIIn), 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: Possibly reflects an upthrown Burrell Creek 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.

5.2.3 Airborne Radiometric Anomalies - Ground Follow-up

In the early days, geophysical consultants had determined thresholds for the various lithological units which formed the basis for the initial interpretation of the radiometric data. The calculated figure arrived at for the Depot Creek Sandstone was subsequently considered too high by TMA and it was thought that many subtle, yet possibly significant anomalies were being overlooked. A reassessment of the data resulted in new information which was then checked out in the field. (See Plate 26-88)

Most of the anomalies checked are within E.L. 4856 with the remaining in the north of E.L. 4857. Approximately four days of helicopter transport were required for access to the majority of locations. A summary of the investigations follows:

- Photo Run 10E No. 1728, AMG 008225. Four anomalies were checked. Although Depot Creek Sandstone is indicated as being the principal lithology present, much of the geology appears to be the Stray Creek Member. Best exposures are in creeks where well bedded sandstones with occasional thin layers of shale/mudstone are exposed. The latter tend to give 75-85 cps with the sandstones at around 50 cps. More massive quartzites, probably Depot Creek, give characteristic backgrounds of around 25-30 cps.

No anomalous ground radiometric areas were located. The airborne anomalies are most likely due to the background increases within the Stray Creek Sandstone. One slight increase in background occurs on a soil covered spring.

- Photo Run 9E, No. 1610 centred at AMG 995240. Two linear groupings: one of two anomalies and the other of three; the latter trend continues some distance northwards (see below). Again, the setting has been mapped as Depot Creek but there is also considerable outcrop of Stray Creek Sandstone. Major fracture sets are NE-SW with N-S to E-W directions of lesser significance. The anomaly trends give the appearance of paralleling N-S fractures however they could be related to any of the cross fracture sets.

Radiometric backgrounds were noted to vary between 30-50 cps depending upon the lithology (Ptd and Pts respectively). Thin laminae of purplish micaceous siltstones occur exposed in the drainage channels, these give locally high readings of
80 cps. There is no ground indication of the anomalies apart from the higher background of the shaley facies within the Pts; in two cases the plots appear to correspond to outcrop positions. Elsewhere, fracture zones might be responsible for subtle radon emanation only detectable from the air.

- Photo Run 9E No. 1610 centred at AMG 005250. Three anomalies, two south of Red Rock Creek, the third on the northern bank of the creek.

As mentioned above, two of the plots line up along a N-S trend which is traceable for about 4 km. The area traversed comprises both outcrop and sand-soil-rubble cover. Background is low: 20-30 cps with no anomalies detected. There is no apparent reason for the airborne anomalies.

- Photo Run 9E, No. 1610, centred at AMG 000260. A mostly sand and soil covered area with only sparse outcrop. A partly faulted, partly unconformable contact between the Lower and Middle Proterozoic exists approximately 0.5 km to the north; INPUT anomaly SH1 is located 2.5 km to the ENE.

Three plots are located at the heads of tree-lined drainages, minor tributaries of Red Rock Creek. The area was traversed without locating any anomalous readings; various sets of fractures traverse the zone, the presence of these being the only explanation for their occurrences.

- Photo Run 12E, No. 2546, centred at AMG 005145. Comprises an area of about 2.5 km² containing 9 anomalous points; three alignments are present, all with N-S trends more or less coincident with regional photo-structures.

The easternmost line corresponds to a laterite/sand covered area in contact with outcrops of Depot Creek Sandstone - possibly fault controlled. A ground anomaly of 125 cps was located in outcrop on the northern extension of this line (AMG 001151).

The facies is similar to those seen further north, a mauve, fine grained siltstone. Here, however, the enclosing sandstones are considered to be Depot Creek.

The other airborne anomalies occur within a large, flat area totally covered by sand and soil with occasional outcrops of laterite. No ground detections were made; a fairly constant radiometric background of 70 cps was obtained. Areas of Ptd outcrop gave 40 cps.

- Photo Run 12E, No. 2546, AMG 009119. A group of three anomalies located on, or adjacent, to tributaries of Tableland Creek and possibly related to forested areas on springs or seepages. Ground investigations confirmed a high background of around 80 cps on the southermmost point; the others were not satisfactorily explained. There could be a structural affiliation with the central anomaly - its position coinciding with the intersection of variously oriented fractures.
Photo Run 11E, No. 2626. Two isolated anomalies located at AMG 042188 and 035180. The first one corresponds to a small creek with a spring covered by black soil, associated with some localized thick vegetation. The outcrop (Ptd) is 15-20 cps SPP2 with a significant rise to 65 cps on the spring. The second anomaly was located in an area of laterite cover surrounded by low relief Ptd outcrop. The sandstone has a normal background of 30 cps, whereas the laterite cover is 80-90 cps. This strong contrast would most likely account for the detection of an anomaly from the air.

Photo Run 10E, No. 1728. Centred around AMG 015210. This group is located south and southwest of INPUT anomaly SV2; it comprises a N-S trend of four points, and another of three points. The former follows the edge of a low ridge, coincident with a north-south photo lineament; on the ground exposures of Stray Creek Sandstone and shaley beds occur along this line; to the east rubble and sand obscure the sandstone. No indications of any significant anomalies were found; contrast between Pts and Ptd and possibly Pts and rubble cover may have caused the anomalies.

The points in the second group are all coincident with exposures in a main creek. A traverse along the creek confirmed exposures of thinly bedded sandstones and shaley siltstone horizons, background SPP2 values range from 50-80 cps. One interesting occurrence was located on an exposed shelf of purple fine grained sandstone; this outcrop gave 140 cps SPP2 (AMG 012211). Thin fractures with some bleaching occur on the anomalous outcrop. Background is 50 cps. Dimensions of the occurrence are limited, approximately 5 x 10 metres.

Summary

The aim of the anomaly check was to locate and assess various subtle anomalies supposedly associated with the basal Tolmer Sandstone. It appears that some of the areas were incorrectly mapped as Depot Creek Sandstone, the anomalies instead being within the Stray Creek Member and probably representing the higher radiometric background inherent to this lithology. Because the Pts outcrops are localized, probably exposed in minor fault blocks or as residuals, identification from aerial photos is impossible.

As derived from the field, the anomalous areas can be assessed broadly as follows:

- contrast anomalies; sudden variation in background between Pts and Ptd or Pts and recent cover,
- high spots within Pts (and Ptd?),
- radon-bearing springs,
- laterite,
- radon emanations along fault/fracture zones,
- no observed cause.
5.2.4 Regional INPUT Survey

During July, 1987, Geoterrrex of Sydney was contracted to carry out a regional INPUT survey covering all the J.V. tenements in the Daly River region. Twenty-one flight lines were run over E.L. 4856 covering the Tolmer Sandstone and extending east and west of the contacts; line spacing was kept at around 500 m except where fill-in traverses were added. Total flight line distance covered (approximate) is 293 km. A Catalina aircraft was used for the survey. Navigation was aided by 1:25,000 aerial photographs; a tracking camera recorded the flight paths which were matched to sets of 1:25,000 scale photo-mosaics. Correlation of the analog data charts with the flight line photos was made and the anomalies plotted.

Results of the survey were plotted onto geological maps and, combined with field knowledge gained over the previous year, anomalies were graded according to priorities. Three models were followed during the field interpretation; two indicating horizontal surface conductors (thin sheet and half-space) and one indicating sub-vertical conductors. Spatially close anomalies were grouped in "areas" generally reflecting a particular geological environment. Four areas were thus defined, the broad categories being:

- conductors in exposed Burrell Creek Formation,
- conductors along faults,
- conductors in the Tolmer Group,
- conductors in Cambrian lithologies and Cretaceous cover rocks.

Summarized below is an assessment of conductors located with the E.L. (Plate 6-87):

1

1

Burrell Creek interbedded sandstone/siltstone adjacent to unconformity.

Burrell Creek sediments: linear strike ridges of sandstone-siltstone. Quartz veins.

Flat lying Depot Creek Sandstone. East-west linear lines on photo. Some springs in this area.

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

Depot Creek Sandstone. Many photo lineaments in the vicinity.

Investigated by ground geophysics. Depot Creek Sandstone.

Burrell Creek Formation. Essentially siltstones and sandstone, however there are andalusitic mica and graphitic schists in this region.
Straddles the 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 and graphitic beds.

Both on sand covered 'Surprise Creek Member'.
Contains chloritic and mica schist and graphitic beds according to drill logs (NORD Resources, 1978). Not very far north of Eccles I and adjacent to TL anomalies and radioactive springs along faulted Tolmer contact.

Located on contact in siltstone, schist sequence and minor sandstone beds. No graphitic units observed.

Investigated by ground methods. Located on fault contact of Depot Creek with sand obscured Burrell Creek sandstones.

Burrell Creek sediments west of traverse area.

5.3 AIR PHOTO INTERPRETATION

Detailed interpretation of both geology and structure was made by several TMA geologists utilising the 1:25,000 colour photo coverage. This work helped to interpret the various geophysical, radiometric and 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 faults and major fractures were reported without being differentiated.

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

The three units of the Tolmer Sandstone were coded from base to top, T1, T2, T3; the Burrell Creek, Bc; the granite intrusions and the facies interpreted as younger than upper Tolmer T3, were labelled C, whether being Cambrian or Cretaceous. (Plate 10-86)

Burrell Creek

It appears to be much more silty to the east than to the west, where it seems to contain more numerous prominent sandstone ridges.

The strike is a general regional N10-20W and the beds steeply dipping.
The tectonic pattern is much better observed to the west than to the east.

The western Burrell Creek is affected:
- by the N10E Giants Reef Fault (A) and other faults having the same orientation, which crosses over the Tolmer Sandstone,
- by numerous N70E faults which affect also the Tolmer Sandstone,
- by less numerous N45 faults in the southern half,
- by rare E-W faults in the northern part.

**Tolmer Sandstone**

Most of the E.L. is underlain by the lower Tolmer unit T1, but in the NW an area is present with the middle Tolmer T2 affected by a 30 to 40° westerly dip, differing from the general regional 5 to 15° easterly dip of T1 which exists on the western side of the E.L. Whilst the dips are well noticeable on air photo in the T2 unit, this is not the case in the T1 unit. But, to the contrary, and certainly due to different competence between those two units, the fractures and faults are well reflected in T1 unit while they are more faint in unit T2 (and this will be even fainter on the upper unit T3 when present to the south).

The T1 unit is heavily fractured and shows the following fault and fracture families:
- The NE10-15E, parallel to the Giants Reef Fault: major continuous accidents. Four can be noted, in addition to the Giants Reef Fault, (B, C, D, F).
- Numerous N70E to N100E accidents, especially well represented in the northern half and much less in the southern half. (The EW faults seem to be well marked in the T2 unit.) A major N70E fault (E) marks the northern boundary of the Tolmer with the Burrell Creek.
- Several N45 to N60 well represented in the centre and in the south of the E.L. (G, H, J, L). Some of them extend into E.L. 4857.
- Some N-S to N20W are noted all over the E.L.

**5.4 Radiometric and Geological Traversing**

Ground prospecting commenced in July 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. A base reference line was pegged at 50 m intervals to parallel the contact, the traverses extending at right angles to this line. It was commenced at Mistake Creek (Reynolds River 1:100000 sheet AMG 943231) and pegged progressively south as the traversing advanced.
Three anomalies of significance were located: two previously known (Surprise Creek North and Eccles I) and one a new discovery (Eccles II). The radiometric signature of the various rock types used to construct the detailed geological maps (Plates 3-86, 4-86, and 5-86). In areas of little or no outcrop radiometry aided in the identification of the various lithologies. Typical values are:

- Burrell Creek Formation
  - sandstone 90 - 110 cps
  - conglomerate 80 - 90 cps
  - siltstone 110 - 160 cps

- Tolmer Group
  - Depot Creek Sandstone 15 - 55 cps

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 (300-500 cps near an anomaly, 110-160 cps elsewhere). When crossing the unconformity the radiometric background drops considerably, sometimes suddenly, sometimes gradually depending upon the nature of the contact.

5.4.1 Description of Anomalies

Surprise Creek North and Eccles II matured to prospects and were drilled. Full description of the work carried out is to be found in Section 6 - Prospect Evaluation.

Eccles I (Fig. 3-87) is located adjacent to the base line approximately 1.3 km SSW of Red Rock campsite within N-S striking Burrell Creek Formation (Reynolds River 1:100,000 Sheet AMG 927160). The anomaly of 4000 cps SPP2 was apparently first discovered by Kevenee Oil (Aust.) Pty Ltd. in 1970; the anomaly has been excavated, probably with the aid of explosives.

The host rock is a medium grained quartzite, sheared and veined by quartz. The quartzite is a thin bed about 1 m wide having a very steep west dip, and is part of a sequence composed essentially of thin alternating beds of schist, siltstone and carbonaceous shales.

The Tolmer contact is 400 m to the east. The anomaly is an isolated occurrence with no apparent extensions.

The anomaly is within a more resistant belt of sediments which trend NNW and is 500 m west of the Tolmer unconformity. Local geology comprises meta-sandstones, generally fine to medium grained with more resistant lenses silicified and quartz-veined. Knotty mica-andalusite schists and fine sericitic phyllites crop out on the western side with lenses of black carbonaceous shales on the east. Structurally, a regional NNW-trending fault and several more localized E to NE faults traverse the prospect environs; S₂ is not evident though a steep easterly regional dip is proposed by the NTGS mapping. S₂ is vertical to steep west.
5.5 GEOCHEMISTRY AND THERMOLUMINESCENCE (See Plate 2* 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 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.

In the first instance, the results were inconclusive; better results were obtained from a subsequent sampling campaign carried out in 1988. Sixty samples of Tolmer Sandstone (Depot Creek Member) were selected for analysis and forwarded to Mark Hochman at Adelaide University. Details of methodology and results from Hochman’s report are included in Appendix 3 of Report R/88-14-U. The geographic spread of the samples is from around Tableland Creek north to Surprise Creek on the Reynolds River 1:100,000 sheet. Sample interval is approximately 500 m.

A significant group of anomalies was indicated for the environs of anomaly SH2: three samples to the west and three to the south. The analysis indicates a range from mild to strongly anomalous for the surface samples; several were collected from drill hole TOL-PD-28 but were not considered to be anomalous, however indications were that there had been "uranium movement along the unconformity".

Three isolated samples: Nos. 3, 27 and 37, all exhibited anomalous values. The former is Stray Creek Sandstone collected adjacent to the Surprise Creek North Prospect; here the Depot Creek Sandstone has been downfaulted bringing the Stray Creek into contact with the Lower Proterozoic.

Sample No. 27 is located about 1 km east of Eccles II and INPUT anomaly SH3. Adjacent samples were barren, however the location of 27 is significant. No. 37 was collected in the headwaters of Sandy Creek, some 2.5 km SE of the previous mentioned location. No concrete explanation can be given for this result although a major regional fault trends NNE through the sample point.

Sample Nos. 50 and 51 were collected in the vicinity of INPUT anomaly T10; 50 is considered to be strongly anomalous with 51 slightly less so. As with SH2 it is encouraging to have anomalous groups in or adjacent to the EM anomalies.

In conclusion, the TL analyses increased the prospectivity of the areas covered, especially SH2 where encouraging alteration phenomena and analytical results had already confirmed the presence of hydrothermal events and the associated mobilization of uranium.
During the radiometric traversing, samples of the basal Tolmer member were collected adjacent to the unconformity. A sample interval of about 500 m was chosen. The aim of the sampling was to determine magnesium concentration reflecting possible magnesium metasomatism in the Lower Proterozoic basement. This is a feature present in some of the Alligator Rivers uranium deposits and the alteration processes are usually reflected in the sandstone cover rocks.

Statistical analysis determined that samples over 125 ppm Mg can be considered anomalous. Only scattered anomalies were located both on the eastern and western contacts.

5.6 GROUND FOLLOW-UP OF INPUT ANOMALIES

Several INPUT anomalies outlined by the regional survey were chosen for follow-up ground geophysics; the anomalies were given priority based upon depth extension (derived from interpretation of channel response), geological setting and, to a lesser extent, accessibility. Both vertical and horizontal conductors were to be tested as well as one anomaly exhibiting both horizontal and vertical characteristics.

5.6.1 Equipment and Methods

During the 1987 field season, a number of ground geophysical methods were tested, to determine their suitability in anomaly follow-up. In subsequent campaigns only the methods that gave the best results were employed.

The following instruments were brought to the field by Geoterrex:

- One IP/Resistivity system consisting of a Phoenix 3 KVA transmitter with a Huntec Mark IV receiver.
- One Apex Parametrics Max-Min II frequency domain electromagnetic system.
- One Geonics EM37 transient electromagnetic system with a Hewlett-Packard data logging and plotting facility.

All data was plotted as the survey proceeded. Initially, the three methods were used on each anomaly to determine which gave the most useful information. The Max-Min is a comparatively rapid procedure which can be used initially to assess the characteristics of the anomaly; follow-up can be performed by the EM37 which gives greater depth penetration and more accuracy. The IP/resistivity was utilized to determine the comparative resistivities of the various lithologies and also to delineate conductive-resistive trends.

The sequence was to first run each traverse with Max-Min, then follow up with EM37 to either better delineate the results or, if no response, then to test for the presence of any deep-seated conductor. Resistivity would then be run irrespective of the results from the two previous surveys.
In 1987, two anomalies were chosen in E.L. 4856 for ground work: SH2 located adjacent to Surprise Creek and SH7 on the eastern unconformity contact about 3 km north of the Daly River road. Each was located in the field, the ground geology checked and access organized. Grids were prepared at each site prior to the surveys.

Prior to, and during the contract services, TMA staff ran VLF traverses over SH2 and SH7. Five traverses were completed, utilizing two frequencies, North West Cape and Japan.

5.6.2 Anomaly SH2

This anomaly reached the drilling stage in 1988 and therefore is described in detail in Section 6 - Prospect Evaluation.

5.6.3 Anomaly SH7

SH7 was chosen from a group of anomalies clustered along the unconformity. The setting is Tolmer Sandstone (Depot Creek Formation) in faulted contact with Burrell Creek sediments (non-outcropping). A grid 600 m in length covered the ground position of the anomaly which was located on two flight lines but separated by a non-responsive line. Channel response was 4 and 5; the trend corresponds to the faulted contact. All lines were run with Max-Min (100 m separation) which gave poor response; one line (200N) was covered by VLF which distinguished the contact. EM37 covered three lines, 600N, 400N, 200N, taking 50 m spaced readings; response was insignificant.

5.6.4 Anomaly SH1

Located at AMG 020270 Reynolds River Sheet, photos Run 9E, 1610-1611. The anomaly is situated on Depot Creek Sandstone approximately 750 m south of the Burrell Creek/Tolmer contact. The contact is faulted in an east-west direction and was extensively covered by radiometric traversing during the 1987 field season; no radiometric anomalies were discovered.

The Depot Creek member outcrops extensively in the anomaly zone occurring as a massive blocky quartzite. It is traversed by numerous NE-trending fractures.

A grid was pegged to cover the anomaly, the base line being 0.5 km north-south with 1.4 km cross lines every 100 m. A MaxMin II survey was the only activity carried out; results of the survey showed the environment to be strongly resistive with no conductors. The source of the INPUT response is not yet explained.

5.6.5 Anomaly SY2

Located at AMG 017225 Reynolds River Sheet, photos Run 10E 1727, 1728. The anomaly is situated on Depot Creek Sandstone, more or less in the central section of the plateau. The unconformity lies several kilometres both to the east and west; depth to Burrell Creek sediments is considered extensive.
Depot Creek Sandstone outcrops only over a limited area; extensive surficial deposits comprising soil, rubble and sand obscure much of the geology. Structural trends are vague due to the limited outcrop, however major directions are indicated as N-S and E-W; the anomaly plots at an intersection of two of these structures.

Due to the limited ground extent of the INPUT response, a 400 m N-S base line was pegged and five 1 km cross lines constructed. The only activity was a MaxMin II survey. The MaxMin response is rather weak and one cannot be certain whether the in-phase values obtained on several profiles for the 888 Hz frequency are due to general noise or to a weak response of a deep seated weakly conductive zone. A tentative, optimistic interpretation of those responses could indicate N-S, N20E and N10-20W "conductors". Such "conductors" could be given also by variation in the overburden.

5.6.6 Anomalies SV3, SV3a

Located at AMG 024186 Reynolds River Sheet, photos Run 11E 2624-2625. SV3 represents a mis-plot of the anomaly; SV3a was subsequently located in the correct position. Both grids are located on Depot Creek Sandstone, centrally positioned on the plateau area. The former has abundant sandstone outcrop, principally Depot Creek but with some interpreted Stray Creek on the western edge of the grid. SV3a has only minor outcrop which is concentrated on the extreme southeast corner of the grid. The remaining parts comprise recent cover of soil, laterite and Ptd boulder rubble. The latter could be of glacial origin.

The Depot Creek Sandstone comprises a fine to medium grained quartzite; the SV3 Stray Creek facies is a more laminated quartzite with some shaley interbeds. Structures are not well defined in the region due to the masking effect of the laterite and rubble veneer. A regional NW structure traverses SV3a with several localized N to NNE trends cross-cutting the anomaly.

MaxMin was conducted over SV3. Here a 500 m base line was constructed with six 1-km cross lines. The survey located an obvious anomaly on the western end of the grid which is thought to coincide with a vague but regionally extensive photolineament trending NNW. The anomaly is most obvious on the "5s" frequency showing decreasing definition with depth. On the ground the anomaly/structure may well coincide with the observed Ptd/Pts contact. As stated above, SV3 is not the true INPUT position, therefore this anomaly is not considered to have significance.

SV3a was located and gridded towards the end of the field season; it was not covered by MaxMin, however a VLF survey was conducted. Four conductors can be interpreted from the profile shapes and Fraser gradient. They could possibly be displaced by a possible N120E structure.
Conductors "a" and "b", with a general N10E direction, could correspond to a fault (conductor "a" being of better quality than "b", could correspond to a photostructure). Conductors "c", N-S, and "d", N10E, could correspond to overburden or even a fault covered by overburden (here too, conductor "c" is better than "d"). There were no obvious indications on the ground of any faulting. Geological observations have been compiled into map form.

5.6.7 Anomaly SH3 (Plate 3*)

Located at AMG 959139 Reynolds River Sheet, photos Run 12E 2548, 2549. The anomaly is situated within Burrell Creek sediments 800 m west of the unconformity and 300 m SE of Eccles II prospect. Lithologies comprise interbedded meta-sandstone and siltstone producing rugged topography with steep sided hills. Scree and soil tend to obscure much of the outcrop. The immediate area has a high concentration of fault and fracture zones with general trends in NE and NNW directions (Lower Proterozoic) and NW outcrop patterns evident in the Tolmer Sandstone.

The anomaly has limited extent, therefore a base line of 600 m was constructed (N-S) with seven 1 km cross lines; only MaxMin was run. The survey, especially in the 1777 Hz frequency, shows several parallel conductors with a N to NW trend, a direction consistent with the lithological and structural trend in the Lower Proterozoic rocks. Those conductors appear to be displaced by a N80E transverse fault. The presence of graphitic facies at Eccles II prospect and in outcrop 1 km to the south (observed 1986) would tend to assign a graphitic source to the conductors located by EM.

5.6.8 Anomalies SH4-SH5

Centred at AMG 050145 Reynolds River sheet, photos Run 12E 2543, 2544. Close proximity of the two INPUT conductors allowed both to be investigated utilizing a combined grid. A base line of 1.5 km length fully covered both zones with 100 m spaced cross lines extending for 1 km. The grid was covered by both VLF and MaxMin II and a follow-up alphaCard survey from the base line east to the unconformity.

The anomaly is situated on Depot Creek Sandstone and runs more or less parallel with the unconformity. The principal structural direction is NNE on the sandstone and NW within the Burrell Creek, the latter reflecting the regional bedding strike. The prominent photo-lineaments in the Tolmer tend to lose their identity in the Burrell Creek. Large gravity lows to the north and south represent buried to partly exposed granitic intrusives, the Reynolds River and Alligator Creek granites respectively. (See Report R3-92-U on E.L. 4857, Section 5.2.3, for definition of "Alligator Creek Granite".)
Locally the Tolmer is poorly exposed, much of it being obscured by sand and Cretaceous laterite cappings; the Tolmer itself is also being extensively lateritized in places. Good exposures of the basal Tolmer can be seen adjacent to the unconformity, the sequence is not very thick but has highly variable facies. Much of the Tolmer is a monotonous, strongly silicified quartzite which overlies the more depositionally active-regime derived sediments at the base. The latter tend to be strongly ferruginized. The unconformity is represented by a small escarpment which is, in places, disrupted by local NW faults; the underlying Burrell Creek sediments comprise fine to medium grey mauve sandstones with interbedded red slatey phyllites and reddish micaceous meta-siltstones (see Plate 4*).

The MaxMin survey failed to locate any major anomaly (Plate 15-88). The VLF survey (Plate 5*) shows two moderate, low quality, long conductors, "a" and "b" and two better, shorter ones. Conductor "a" appears to follow a breccia-rich facies near the base of the Tolmer and conductor "b" appears to correspond to a laterite cover on the Tolmer. One short conductor parallel to "a" could eventually correspond to a conductive facies in the Burrell Creek as it is located close to the unconformity but, if this is the case, it should have been detected by the MaxMin.

An alphaCard/scintillometric programme was confined to the eastern side of the grid where several airborne radiometric anomalies were located by an NTGS-sponsored survey in 1983. Values range from zero to an isolated maximum of 9 cpm. Readings were obtained at most stations indicating that the Tolmer has sufficient fracturing to allow the percolation of radon. Background is about 2 cpm; above 4 cpm is considered anomalous. There is no obvious variation between Tolmer and Burrell Creek values which is unusual. Several low order anomalies are apparent with most values being 4-5 cpm; two overlap the contact, three are within the sandstone and one in the Burrell Creek (see Plate 17-88). A combination of structure/lithology is considered responsible for their location.

Downhole scintillometer readings within the Tolmer Sandstone appear very high, whether this is due to an inherently high background within the Tolmer or is an effect of shallow level Burrell Creek sediments is not known. Contouring shows several features: the contact, high zones in the NE in Burrell Creek and several anomalous areas on the Tolmer not necessarily tied to radon anomalies.

5.6.9 Anomaly SH6

Centred at AMG 060120 Reynolds River sheet, photos Run 12E 2543, 2544. The anomaly trends northeast covering both Depot Creek Sandstone and Burrell Creek sediments. MaxMin II, VLF and alphaCard were carried out with the latter two activities being confined to the Tolmer Sandstone outcrop area only.
Structurally the area is quite complex with several major fault systems: the regional Stapleton Fault and a subsidiary structure pass along the southern side of the anomaly; complementary NW faults traverse the anomaly, one forming the contact between the Burrell Creek Formation and the Tolmer Sandstone. Various localized photostructures of N-S, E-W and NNE orientations are also evident. Geological observations were made during the VLF survey. The Tolmer Sandstone outcrop pattern is strongly controlled by the series of faults which cross-cut the area, dips are shallow westerly except where disrupted by faulting. Lithologically the sandstone is a fine grained, silicified quartzite; none of the basal facies are present. Outcrops of Burrell Creek sediments occupy approximately half the area of the anomaly; south and east of Back Creek the lithologies are primarily sandy with some interbedded meta-siltstones. To the north meta-siltstones and phyllites predominate. The Stapleton Fault truncates the outcrop eastwards - here laterite covered ?Cambrian occurs. Elsewhere much of the Burrell Creek is in unconformable contact with the Tolmer. The unconformity is not exposed. See Plate 6* for the interpretative geology of SH6.

The MaxMin survey (Plate 19-88) shows two conductive features; the Stapleton Fault zone (soil and sand covered) and another feature traversing Burrell Creek lithologies. Both are within the northern part of the grid. It does not show any well defined conductors in the southern part of the survey where the Depot Creek Member overlies the Burrell Creek.

The VLF survey (Plate 20-88) provided some conductors which are in close connection with known faults or faults inferred by geological observation and which can be explained by the existence of specific morphological patterns. It also provided, in the southeastern corner of the grid, a N30W conductor which could indicate a fault related to the major accident present on the grid or possibly a limit between a conductive facies in the sandstone to the west and a more resistive one to the east, or a Burrell Creek conductive unit. It is important to note that the southeastern end of this conductor coincides with a definite radon anomaly open to the southeast. The INPUT survey is considered to have picked up the faults rather than lithological conductors.

Radon and downhole SPP2 show the following (Plate 7*):

- coincident anomalies along the 1400N and 1500N lines which outline both the structural and lithological features,

- elongate anomalies coincident with structural trends from 800N to 1250N/1200E to 1500E. The most significant is the radon/SPP2 anomaly open in the SE corner of the grid. Strong faulting is evident on ground and there is no Burrell Creek outcropping. Heavy fracturing of the sandstone has allowed the percolation of radon.

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In 1989 the principal anomaly centred on 1400E/800N had an additional 20 alphaCard stations added, assuming a southwesterly trend. Included in that number, a repeat sample was taken on the maximum reading of 12 cps (1500E/1450N) as a check; the second result gave 3 cps exhibiting the variability that can be attained by this method.

The result of the 1989 work showed a discrepancy in both the alphaCard and SPP2 values compared to 1988. The radon anomaly was not repeated and no extension of anomalous values was obtained. No further work was carried out at SH6.
6. PROSPECT EVALUATION

6.1 METHODS

The basic methodology followed in prospect evaluation included extensive use of geophysical techniques which, together with detailed geological mapping allowed the selection of drilling targets.

The main exploration methods employed are summarized below. Further details can be found in the separate annual reports for E.L. 4856.

6.1.1 EM-VLF

The EM-VLF surveys were carried out utilizing two instruments: the GEONICS EM-16 and the ABEM WADI.

Both instruments utilize the magnetic components of the electromagnetic field generated by already-existing radio transmitters in the VLF (Very Low Frequency) band. These transmitters operate at 10-30 Khz. Conductive bodies on the surface or underground, even when covered, affect the direction and strength of the field generated by the transmitted radio signal. The instruments measure the distortion in the magnetic component of the EM field generated by the VLF transmitter.

The measured parameters are the vertical and horizontal in-phase and out-of-phase components. The transmitters used at Tolmer were: Northwest Cape Australia (NWC) 22.4 Khz, 1000KW and Yosamai Japan (NDT) 17.4 Khz, 50 KW.

6.1.2 VLF-R

The field procedure for the survey is first to locate the signal azimuth; this is done in the same way as for a conventional VLF survey. The instrument is then placed on the ground with the long axis of the instrument pointing the direction of the signal source. Two electrodes are then run out 5 m either side of the instrument, again parallel with the signal source. The first reading, the resistivity value "R", is obtained from the EM-16 part of the instrument by turning the quadrature dial until a "null" in the signal is obtained. This gives "R" in ohmeters. The second reading, the phase angle, is read from a graduated dial on the EM-16-R attachment; again, the process involves "nulling" the received signal.

6.1.3 AlphaCard Radon Detection

The AlphaNuclear alphaCard system has been used successfully by TMA for a number of years on its various projects in the Northern Territory. The method involves placing small metal foil cards in a completely sealed hole 40 cm deep. 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.

6.1.4 Radiometry

Scintillometer surveys using the SRAT SPP-2 instrument 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.

6.1.5 MaxMin II

The MaxMin ground electromagnetic surveying was carried out by a crew from Geoterrex using a 150 m separation between receiver and transmitter along profiles either 100 m or 200 m apart. Equipment used was an Apex Parametrics MaxMin II frequency domain electromagnetic system.

6.1.6 Applied Potential or Mise-à-la-Masse

If a conductor is exposed in a drill hole or in outcrop, it is possible to place an electrode in direct contact with the rock and cause the conductor to act as a large, continuous electrode. Measurements of voltage on the surface will then outline the surface projection of this continuous mass.

The method is reliant on the conductor being connected electrically either by mineralogy or water, and can be used to trace mineralization in areas lacking in outcrop or exposure, i.e. blind.

6.1.7 Drilling

Drilling campaigns were carried out in 1988, 1989, 1990, and 1991. With the exception of four holes in the first year all drilling was by down-hole percussion.

The following table summarizes the drilling statistics:

<table>
<thead>
<tr>
<th>Year</th>
<th>Contractor</th>
<th>Equipment</th>
<th>No. of Holes</th>
<th>Meterage</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>Rockdril Ltd</td>
<td>Schramm, Foxmobile</td>
<td>6, 4</td>
<td>352, 231</td>
<td>Coring</td>
</tr>
<tr>
<td>1989</td>
<td>Rockdril Ltd</td>
<td>Versatile 1000</td>
<td>24</td>
<td>1941</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>Rockdril Ltd</td>
<td>Versatile 1000</td>
<td>22</td>
<td>1528</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>Rockdril Ltd</td>
<td>Versatile 1000</td>
<td>22</td>
<td>1716</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>78</td>
<td>5768</td>
<td></td>
</tr>
</tbody>
</table>
Access to some sites was difficult and required assistance from a bulldozer.

Gamma logging was carried out by Century Geophysics (1988 only) and by TMA's own TD400 and SIE450 logging units. Polypipe was used systematically to ensure the safety of the probes in the holes. In some cases logging had to be carried out through the drill stem. Century produced combined logs showing Gamma, Resistivity, Ore Grade, and Deviation. TMA loggers employed calibrated NaI probes, producing simple gamma logs.

All drill holes were sampled for U and Th. Assaying of selected intervals for Au, Ni, Ca, Mg, Al, and As was also carried out.

Assay results are in Appendix 1.
6.2 **SURPRISE CREEK NORTH**

6.2.1 **Location**

The prospect is located about 1 km north of the Surprise Creek Campsite on the Reynolds River 1:100,000 topographic sheet (AMG 930190) in an area of both open black soil country and paperbark woodland. The main anomaly becomes periodically flooded after heavy local rain. The anomaly is bounded by the Tolmer Sandstone eastwards and low hills of Burrell Creek sandstone and siltstone to the west.

Previous investigations, including trenching and drilling, were made by the Nord/AGIP joint venture in the late 1970's. Various facies previously described were intersected. The final report by Nord (1981) states that one rotary percussion hole in the "Surprise Creek area" gave a radiometric anomaly eight times the background and that another hole gave a U assay of 160 ppm in fresh graphitic schist (background values 20-39 ppm U). Precise locations were not given.

6.2.2 **Geophysics**

The joint venture conducted a radiometric survey over the anomaly in late 1986 (Plate 8-86); resistivity was also tested, but was unsuccessful due to extremely waterlogged ground conditions which caused erroneous readings.

In 1987 the grid was re-established and the resistivity re-run. Plate 8* illustrates the contoured results of the survey. The grid covers a black soil/sand swampy area adjacent to Surprise Creek North. The nearest outcrop is Stray Creek Sandstone to the east and a meta-sandstone/shaley sequence to the west belonging to the Burrell Creek Formation.

Contouring of the results shows a north-south trend which presumably coincides with lithology and/or structure. A strong resistive zone bisects the grid, with a secondary one on the eastern edge. A NW contour trend within the west rectangle of much less resistive ground could indicate a structure.

A down hole SPP2 survey was conducted concurrently with resistivity. Results, including surface readings are plotted and contoured on Plates 3-87 and 9*; there appears to be a general agreement between the two sets.

Two trends are apparent illustrated by contouring: NW-SE and NE-SW. The difficulty in interpreting this data is that the prospect area is covered by thick black soil, sand and silt at least 4 m deep; whereas the anomalies might reflect primary trends there is also a correlation with parts that become more inundated with water during flood-time. Conclusions drawn from previous work on the prospect (trenching and drilling) are that the anomalies have resulted from surface water movement transporting and depositing uranium in the organic-rich black soil of the swamp. Radioactive springs draining the faulted Tolmer contact are known in the vicinity as are some anomalous sediments intersected in drill holes.
6.2.3 Drilling

6.2.3.1 Summary

The following table summarises the drilling statistics at Surprise Creek North.

<table>
<thead>
<tr>
<th>Year</th>
<th>Hole No.</th>
<th>Co-ordinates (Local Grid)</th>
<th>Azimuth Deg.</th>
<th>Dip Deg.</th>
<th>Depth Metres</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>P-10</td>
<td>240E/150N</td>
<td>230</td>
<td>-60</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>P-11</td>
<td>220E/200N</td>
<td>250</td>
<td>-60</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>P-12</td>
<td>45E/150N</td>
<td>280</td>
<td>-60</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>P-13</td>
<td>40E/225N</td>
<td>280</td>
<td>-60</td>
<td>49</td>
<td></td>
</tr>
</tbody>
</table>

Total 4 holes for 209m.

Four shallow percussion holes were drilled, making a total of 209 m. They were drilled into two parallel conductive areas which underlie the black soil swamp which is the host of a large SPP2 anomaly (see Plate 8* and 9*).

No radiometric anomalies were intersected in the drilling, however thick carbonaceous phyllite units were intersected in TOL-P-12 and TOL-P-13. These units reached a maximum of 450 cps in TOL-P-13, and directly underlie the in-hole SPP2 radiometric anomaly, therefore must be a source for the uranium scavenged by the black soil in this area. The only alteration found in these holes was some chloritization, especially in the easternmost holes.

6.2.3.2 Drilling Details

- **TOL-P-10** (Plate 10*). Located on the eastern side of the prospect and drilled to 54 m into a well-defined in-hole radiometric anomaly and relatively conductive strata. Radiometric background was approximately 250 cps. The lithologies intersected were chloritic and carbonaceous phyllites and sandy (quartz-biotite) schists, all strongly deformed.

- **TOL-P-11** (Plate 11*). Was drilled towards the west-southwest into the same in-hole anomaly as TOL-P-10. The hole was radiometrically dead. Caving from below the casing confined logging to within the rods only. The hole first intersected quartz-biotite schists and sandstones, then grey sandy shale (ex-carbonaceous shales and sandstones).

- **TOL-P-12** (Plate 12*). Located on the western side of the prospect and drilled to 53 m towards the west into a in-hole radiometric anomaly and conductive strata. A sequence of schistose carbonaceous shales with interbedded gritty sandstones and greywacke was intersected.
- **TOL-P-13** (Plate 13*). Located north of TOL-P-12 and drilled to 49 m towards the west to undercut the strongest in-hole SPP2 anomaly. Gamma log peaks of 450 cps at 25 m and 29 m in carbonaceous phyllite directly underlie the in-hole SPP2 anomaly. The lithological sequence was schist then interbedded carbonaceous shale and greywacke.

### 6.2.3.3 Geological Synthesis

Correlation between these four holes is difficult due to the intense shearing of the beds and rapid changes in lithology. Plate 8* shows two subparallel resistivity lows extending southeast of TOL-P-10 and TOL-P-12. These are interpreted as the continuation of carbonaceous shales and phyllites intersected in the drill holes. Where these rocks are intersected by the faults inferred in the drill holes some small radiometric anomalies may have resulted.

Mobile uranium in these shear zones could be scavenged by black soils which overlie them.

Very little alteration, except minor chloritization, and mineral recrystallization by dynamic metamorphism was observed. Shearing has produced an intense schistose fabric, crenulation and quartz veining in the rocks close to interpreted faults.
6.3 PROSPECT SH2

6.3.1 Location

This prospect covers an INPUT anomaly and is located at AMG 945155 Reynolds River Sheet, photos Run 1IE 2620-2621. The anomaly is situated on Depot Creek Sandstone adjacent to the Lower Proterozoic unconformity; depth to the Burrell Creek sediments is up to 50 m in the northwestern sections of the grid as proved by drilling in 1988. The strongly faulted nature of the area may have affected and modified the position of the contact.

The anomaly was first investigated at the close of the 1987 field season when preliminary surveys were run by Geoterrex as part of a programme to test the suitability of various EM methods. Some preliminary VLF profiles were also run. This preliminary work, however, was only partly successful and failed to pinpoint the INPUT anomaly on the ground.

Further investigations were planned as part of the 1988 campaign. The position of the anomaly in a general area of interest (Surprise Creek-Eccles) and its good accessibility were the prime factors in the decision. MaxMin II, VLF and an alphaCard survey were run, the latter two being confined to that area west of the central base line; positioning of the radon survey was based on data from the EM programme. Follow-up drilling in 1988, 1989, and 1990 was based on the combined assessment of the field work.

6.3.2 Geology

Geological mapping of the SH2 area was carried out concurrently with geophysical and drilling work, mainly during 1988, 1989 and 1990. As the amount of information from surface observations and drilling increased, the geological interpretation evolved to accommodate the new data.

The drill holes description in the following section is based on the geological understanding at the time; therefore, for consistency, all different interpretations are summarized below.

6.3.2.1 Geological Interpretation, 1988 Campaign (Plate 1a-88)

North-northwest striking schists and metasandstones of the Burrell Creek Formation dip at moderate to steep angles towards the west. These are unconformably overlain by northeasterly dipping Depot Creek Sandstone. The contact strikes NW, and exhibits irregularities due to topography and cross-cutting structures.

The Depot Creek Sandstone has three distinct facies at SH2. The basal unit is a purple (haematitic) fine grained "laminated" quartzite which appears to be laminated and slumped but may, in fact, be colour banded due to iron staining. This is overlain by a sedimentary breccia unit, and then by a pebble sandstone and conglomerate unit overlain in turn by massive pink quartzite. These facies
are also present in TOL-P-16 (INPUT anomaly 2851, E.L. 4857). The breccia unit is an autobreccia comprised of "laminated" sandstone in a coarse sandy matrix. Cross bedding is also common within this unit. Large slumps composed of chaotic breccia and sandstone dykes cut through more consolidated sandstone near 9750E/9600N. These breccias must indicate a period of syndepositional tectonism and proximity of this area to active faults. The pebbly sandstone unit is regional in extent and easily mappable. It is approximately 50 m stratigraphically above the unconformity at SH2 and in outcrops elsewhere. Radiometrically the pebbly sandstone unit south of 10000N is anomalous, especially where it is close to faults; values of up to 75 cps occur in shallow pits. This effect is peculiar to SH2 and it is therefore suggested that bleaching and hydrothermal alteration of this unit may have occurred possibly due to the lateral permeability of this facies. Bleached areas with higher background SPP2 from core are present high up in TOL-D-28.

Structurally, the Tolmer appears to be gently folded and cut by north-south and east-west trending faults. The most obvious fault direction is E-W; many examples of fault planes with this orientation have been observed in the field and indicated as lineaments in air photos. A series of these faults along 10000N line are host to the very strong alphaCard anomaly. Fracturing and iron staining of the sandstone is most intense on this fault. A fault scarp near 9750E on 9600N runs NE (parallel to lithology) and is the suggested conduit for radon emanations here. In the extreme north, north-trending fault planes are exposed and these are often very low angle easterly dipping thrust faults with striations on the fault plane trending 145°.

6.3.2.2 Geological Interpretation, 1989 Campaign (Plate 2-89)

- Burrell Creek Formation

Within the mapped area the Burrell Creek maintains a consistent NW strike with generally steep dips to the west. There is insufficient outcrop to enable a clear structural picture to be made, however the rocks are known to be tightly folded from the regional mapping. Lithologies comprise thin beds of fine grained sericite schist, coarser andalusite-mica schist and fine to medium grained quartz metasandstones, the latter generally strongly cleaved. No graphitic facies were observed outcropping, however EM data suggests their presence (Plate 3-88).

- Tolmer Group

The Depot Creek Sandstone unconformably overlies the Lower Proterozoic. Good exposures of the sandstone outcrop over the grid area and have provided the following mapped sequence (bottom to top):
- Dark brown, ferruginous (lateritic) sandy facies, often gritty or pebbly. Whether this is an altered/weathered facies of the Tolmer or, possibly, a palaeosol is not known. Outcrops are sparse. One metre thickness.

- Distinctive white, pale pink or reddish, thinly bedded ('laminated') quartzite. Unusual concretionary structures are present, 1-3 cm in diameter. The thickness of this bed is variable, but can be easily traced and utilized as a marker bed. Cross bedding is common; slumping, scour and fill structures have also been observed. Commonly forms bold outcrops and cliffs; average 4 metres thickness.

- Continuous, thin (<1 metre) pebble bed. Elements from 1 cm to 4 cm in diameter and composed of white opaque quartz. An adjacent, up-dip zone of gritty to pebbly quartzite indicates active sedimentation in a turbid environment. Features such as slumping, small scale folding and breccias occur here.

- Pink, generally gritty quartzite with many pebble layers; element size generally no more than 1 cm. This is stratigraphically the uppermost facies within the mapped area.

In the 1988 report the 'sedimentary breccias' were referred to as a distinct stratigraphic unit. Subsequent examination and mapping of these have shown them to be of tectonic origin, related to faulting and/or collapse features, e.g. 9750E/9600N. This location shows a complex pattern of breccias which, when examined closely on the ground, clearly crosscut the stratigraphy. This is a zone of fairly complex faulting and these breccias are obviously related to this phenomenon.

The cliff-section between drill holes TOL-P-42 and TOL-P-43 illustrates the above breccia zone, showing it to be a slump structure. The presence of this and other breccias could possibly be related to a mechanism which has affected the underlying Lower Proterozoic.

> Structure

The most striking feature of the 1989 mapping is the 090° rotation of Tolmer Sandstone from a NW-striking, E-dipping formation to a NE striking, NW dipping one. The "hinge" coincides with a NNE fault at about 9850E/10500N; this might be responsible for rotation of the beds but only a localizing effect could be expected from this. The most likely explanation is a modified anticlinal fold which has been traversed by a network of minor faults. The surface trace of the pebble conglomerate marker bed seems to confirm this. A complicating factor, however, is an interpreted syncline indicated by the laminated sandstone; this "fold" has both limbs truncated. This superposition
of an anticline on a syncline may have originated from a series of movements during the sedimentation, i.e. warping, slumping or tilting, as the different facies were deposited. Numerous mapped faults over the small area appear to have affected all the facies and provided the present complicated environment.

The structure of the Lower Proterozoic was not studied in detail, apart from recording some measurements near the unconformity. Dips are characteristically steep with a N to NW strike. Several episodes of folding are indicated.

6.3.2.3 Geological Interpretation. 1990 Campaign

The geology of the gridded zone that covers SH2 as well as the Eccles II prospect to the south (see section 6.4.2.2) was re-interpreted and expanded in 1990. The mapping was compiled in four sheets at the scale 1:2000, the northernmost ones (sheets 1 and 2) covering SH2 prospect and the two southern ones (3 and 4) covering Eccles II.

In this report the boundary between the two prospects has been assumed, somewhat arbitrarily, to be gridline 8400N.

> Sheet 1 (Plate 14*)

Mapping of this sheet area was compiled principally in 1988 with the most northerly part, i.e. from 10000N onwards, covered in 1989.

Some remapping, however, took place over specific areas 1990 due to some doubt over interpretation of breccia zones in the 9600N profile area. In addition, the 'border area' between sheets 1 and 2 was also remapped though no significant differences were observed.

The remapping of an area west of the base line between 9300N and 9800N was undertaken to clarify structural phenomena within the Tolmer Group rocks as interpreted during initial mapping of the prospect in 1988. A circular feature as outlined by a "bedded breccia" occurs adjacent to a strongly faulted zone between 9400N and 9700N. Being the focus of closely spaced drilling, which in 1989 outlined strong chloritic alteration within graphite schist at the unconformity, it was considered a priority to confirm the existence (or not) of a "breccia pipe" or collapse structure.

Two main changes to the interpretation have been made on the basis of the above work:

- Features marked as breccia zones have, in part, been confused with the pebble conglomerate beds between drill holes TOL-P-45 and TOL-P-47. However, some brecciation does occur in the conglomerate but is not confined exclusively to it.

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- Synclinal axes mapped at 9200N and 9600N do not exist. Dip and strike variations due to faulting were probably confused with what were interpreted to be folded strata.

Following on from the first point, the conglomeratic band is an excellent "marker bed" and can be traced quite easily. Stratigraphically it is positioned just above the basal "laminated" facies, occurring as limited thickness beds within a pink silicified sandstone, medium grained to gritty with scattered pebbles in the matrix.

Breccias are present everywhere and definitely cross-cut the stratigraphy, i.e. they are not stratigraphically controlled as it had been suggested. They can be, but not always, associated with severe shattering or fracturing of the rock. Breccia elements can range in size from less than one cm to over a metre square.

+ Basal Tolmer

This comprises the so-called "laminated facies", itself a general term as variations exist within it. Basal breccias were noted in two locations as well as some spectacular slump folding. At 9550E/9700N an unusual "shaley" sandstone outcrops, thin bedded and fissile; good ripple marks occur here also. A series of sandstone "pinnacles" occur between 9400N and 9700N; these are usually considered part of the basal facies. A more compact, banded, red-white-grey sandstone is present above the base; this is the variation from which the basal Tolmer derives its identifying name. Some pebble bands do occur, these not having been previously identified.

+ Conglomeratic Marker Bed

This facies is located stratigraphically just above the basal beds although separated from them by a pink variably grained silicified sandstone (with scattered pebbles). Pebbles are of quartz and generally in the size range 1-2 cm in diameter, though larger ones have been seen.

+ Pebbly Sandstone

The conglomerate marker bed is actually part of this unit but has been considered separately because of its use in stratigraphic mapping. The pebbly sandstone is as described above and in addition has many pebbly/gritty bands extending up-sequence above the conglomerate bed. Various small-scale sedimentary structures are quite common. The facies is well bedded but does not exhibit the banding characteristic of the Basal Tolmer.

Outside the mapped area, the pebble sandstone grades into a fairly massive, pink, fine to medium grained sandstone, commonly with ripple marks.
Structure

Many measurements were taken in the field but only those which are best located to show bedding trends were plotted. The regional strike/dip is between 295°-310°/70-20° east. This trend occurs both in the west and east of the mapped area. The "central" section shows many variations; it is certainly much more complex than previously thought.

Several main flexures exist which are thought to be the result of drag associated with the many faults. The principal zones are:

- adjacent to the creek at 9700N,
- a localized flexure around the TOL-D-28, TOL-P-42, TOL-P-45 drilled area,
- 9450N-9500N centred at 9850E.

Tilting and rotation of the breccia zone just north of TOL-P-42/TOL-P-43 indicate some severe tectonism in this area, perhaps a combination of E-W and N-S faulting. Some vertical movement is suspected here along with some lateral north-south shift. The creek near the 9700N profile is thought to follow a major E-W fault as indicated by flexuring of the beds on the north side and breccias along both banks of the creek.

Minor cross faults might also exist.

Another fault, N-S, is probably located along a line indicated by a series of small scarps, eventually leading to the TOL-P-42/TOL-P-43 breccia and beyond. E-W offset is probable near 9775E/9450N. Breccias are common along this line as are some strike/dip variations.

> Sheet 2 (Plate 15*)

This sheet covers the area from 7900N to 8900N where it adjoins mapping completed in 1988. To the east and west, the coverage is limited by the extent of the surveyed grid.

Lower Proterozoic

The sequence is tightly folded, as illustrated by rapidly alternating beds of schist, sericitic meta-siltstones and fine to coarse grained sericitic quartz meta-sandstones. Colours range from yellow-brown to red in the argillaceous facies to mauve and grey in the arenites. S₀ is recognisable in some of the meta-sandstone outcrops indicating steep to vertical dips; graded bedding has also been noted, rarely. More regional trends (S₀/S₁) indicate a NW/SE strike of the beds; cross-cutting cleavage trends can be seen in rare outcrops of the schistose lithologies indicating further folding phases.
Quartz veining is fairly common from the 8800N profile and northwards, possibly indicating faulting (E-W) and/or axial planes of folds.

The southern half of the map sheet is composed mainly of Lower Proterozoic outcrops due to the eastward retreat of the Tolmer cover rocks. Good exposures can be seen on the northern slopes of the Eccles Creek Valley and along the bulldozed access road between SH2 and Eccles II. Extensive quartz and greisen veining occur in prominent coarse grained meta-sandstone beds upslope from the Eccles II prospect; the veins can be followed along strike for over 200 metres northwards as well as progressing south onto Sheet 3.

An embayment feature is outlined on 8750N profile. The shape of the embayment appears to be controlled by several fault sets which can be definitely traced within the Tolmer and Lower Proterozoic; these strike both E-W and NW/SE and have associated brecciation and severe fracturation (Tolmer) and quartz veining (Burrell Creek). Several interesting features are associated with this structure; these are described below:

- Within the embayment, very little outcrop is obvious, being mostly alluvium several metres thick. Coarse andalusite schist crops out on the southern side indicating possible nearby intrusives and/or severe deformation. This lithotype was not seen elsewhere on the map sheet.

- Graphite schist was located in bulldozed rubble at about 10000E/8770N. Though no outcrop has been located during the mapping programme, drill hole TOL-P-83 (10010E/8830N) intersected very intensely chloritized graphite schist at about 10 m depth. The siting of this hole (and others to the north and south) was based on the results of the mise-à-la-masse survey centred on the original discovery site.

- An intense "spot" radon anomaly, Robert’s Anomaly, was located 200 metres east of the graphite occurrence; this discovery, made at the end of the 1989 campaign, predated the graphite finding. The location of the radon anomaly within a creek/black soil environment tended to downgrade its importance; however, linking it with the local structural features, geophysical anomalies and the graphite/andalusite schist presence, it assumed new significance.

+ Middle Proterozoic

The distribution of the Tolmer Sandstone outcrops is highly irregular due to faulting and topography. Progressing southwards the contact steps progressively east. At 8600N the contact is at grid easting 9850E and at 8000N has shifted to 10500E.
Lithologically, the basal "laminated" sandstone is well represented, forming strongly fractured low relief outcrops. The contact with the Lower Proterozoic can be traced with reasonable accuracy but does not visibly outcrop. Ptd(ii), the pebbly/conglomeratic facies, is widespread but discontinuous along strike. Referring to Plate 15*, the trend of this lithology is very obviously controlled by the various faults which govern the trend of the contact. Much of this lithology is highly ferruginous, becoming lateritic in places.

Ptd(iii), a pink, grey and white, fairly massive quartzite forms both low relief outcrops and craggy, strongly fractured cliff-like formations. Bedding is not well developed; gritty laminae, scattered pebbly bands and ripple marks have all been observed.

Structurally, the Tolmer rocks are an east dipping sequence, averaging 10°-15°; dips and strikes vary locally around fault zones. Breccia zones are widespread, indicating the degree of faulting in the area; they traverse all facies. The majority of inferred faults have a WNW orientation and are "illustrated" on the ground by the brecciation and concentrated fracturing.

6.3.3 Geophysics

6.3.3.1 Early Surveys

In 1987 the preliminary (unsuccessful) geophysical work mentioned in Section 6.3.1 included one line of VLF and five lines MaxMin. There was poor response from both methods, the only variation was shown by the lithological change, i.e. Tolmer/Burrell Creek. One loop of EM-37 was also run over the southern end of the grid without significant results.

Further work was carried out in 1988, including MaxMin and VLF. Plots of the conductive features defined by the MaxMin and VLF are illustrated in Plates 2-88 and 3-88. The VLF interpretation shows conductors with NW-SE and N10-20W orientations. Such conductors, generally of moderate intensity, can correspond to faults and possibly to conductive beds of the Burrell Creek Formation which is not too deeply seated under the highly resistive Tolmer Sandstone. A certain number of the VLF interpretations seem to have good correspondence with a certain number of the interpreted MaxMin conductors.

The MaxMin readings show a number of interpreted conductors with either a NW-SE or a NWNW orientation, the latter being possibly the reflection of conductive beds in the Burrell Creek. It must be pointed out that some of the readings of MaxMin 888 Hz used in the interpretation of conductors could, in fact, correspond to regional noise. It is important to realise that the radon anomalies are located within two parallel NW-SE conductors.
6.3.3.2 Geophysics in 1989

The 1988 VLF survey was greatly extended in 1989.

Results were presented as computer generated stacked profiles at both 1:5000 and 1:2000 scales. These incorporated both the "In-phase" and "Quadrature" profiles from the NDT (Japan) and NWC (Australia) transmitters.

The results were also presented as contour plans of the Fraser Gradient. The values for these plans were computer generated then contoured by hand, taking into account the geology and the results of the profile interpretation.

To define those areas in which there was not only a negative in-phase value, but a large contrasting quadrature value, plans showing conductor "iso-quality" were drawn. This allowed the interpretation and subsequent plotting of the most conductive zones.

The annual report for 1989 (R/89-8-U) includes a synthesis of this work at 1:5000 scale (Plate 4-89), showing the stacked profiles and their interpretation together with the interpretation of the Fraser Gradient contour plans and the contour plans of "iso quality" superimposed.

> Stacked Profile - VLF Survey

The 1988 VLF survey at SH2 was extended in 1989. Due to lack of resources, the work was carried out in a number of stages rather than as a complete, integrated survey. This led to some discrepancies where lines of different surveys meet, however the interpretation, we believe, has not been unduly affected.

The interpretation at SH2 was carried out in the conventional way. The in-phase profiles define those zones that are more conductive than the rest. Zones in which there is a strong variance in the two values, the in-phase being negative and the quadrature being positive, mark those areas in which there is good conductivity.

The more conductive zones, not surprisingly have a northeast-southwest trend paralleling that of the Lower Proterozoic metasediments underlying the Tolmer Sandstone cover.

In the broad sense it appears that the more conductive horizons may occur within the schist units and/or perhaps at the contact between these and the metasediments. There is a weak correlation between these conductors and the alphaCard anomalies, although the maximum points in both surveys do not coincide.

In the northwest of the surveyed area the conductive zones appear as if they may occur within the schists rather than in the metasedstone.
Fraser Gradient

Values using the Fraser Gradient technique were contoured and the peaks plotted. The analysis of the results from the NDT station give, as expected, a series of northeast-southwest trending anomalies. These broadly follow the margins (crossover) of the conductive zones as defined by the analysis of the stacked profiles, and are thought to be good exploration targets for uranium mineralization below the unconformity.

In the extreme southeast of the grid there is a more complex picture shown by the Fraser Gradient curves. Here, they are not northeast-southwest trending but are turning around to a much more north-south trend. There is a highly conductive zone noted here, which is probably related to a specific, perhaps strongly folded, Lower Proterozoic unit. This zone is accompanied by very strong alphaCard results (maximum 99 cpm). To the south, at Eccles II, the Lower Proterozoic units have a N15°W trend. It is therefore thought that the conductive zones are due to lithologic differences in the Lower Proterozoic.

The contour plan of the NWC Fraser Gradient results gave a number of east-west anomalies which may indicate the presence of fault zones rather than defining lithologic differences. These do not always coincide with mapped fault zones.

The 1989 work outlined much stronger conductivity zones than the 1988 survey. Hole TOL-P-38 was drilled on one of these and minor graphite was intersected at the unconformity. This gave a slight increase in the background radiometry but is not considered anomalous.

The main breccia zones mapped within the Tolmer Sandstone at the SH2 prospect are not strongly conductive, particularly those around hole TOL-P-42 which, although they are both well exposed and on a large scale, do not seem to affect the interpretation of the VLF results. A number of holes were drilled within this breccia on the 9600N grid line and its surrounds. The sandstone here is exceedingly brecciated with voids and abundant clay development. Minor chlorite and graphite was noted in the underlying Lower Proterozoic metasediments which comprise quartz-mica schists and poorly sorted metasandstone with minor chlorite-rich schist and sandstone. These may have been the cause of the low order conductivity shown by the VLF results. No mineralized intersections were noted from this zone.

In conclusion, the following main observations can be made:

- There are strong conductive horizons within the SH2 grid, which, generally, seem to reflect the margins of a schistose horizon rather than a sandstone.

- 42 -
- The strong graphite/chlorite alteration noted in hole TOL-P-51 is not reflected as a strong conductivity anomaly but occurs instead at the intersection of a mapped fault and the axis of a Fraser Gradient VLF anomaly.

- The strong brecciation of the "breccia pipe" around hole TOL-P-42 is not evident from the analysis of the VLF data.

- The Fraser Gradient analysis tends to outline the major conductive zones shown by the phase analysis, and these seem to be related to the schist/metasedimentary contacts within the Lower Proterozoic.

- In the extreme southeast of the grid there is a strong conductive zone which is coincident with a strong alphaCard anomaly.

- A strongly conductive zone is centred on 9600E/10000N. It appears as if this anomaly occurs at the contact between a predominantly sandstone horizon with a predominantly schistose one. The anomaly extends from the Lower Proterozoic units into the Middle Proterozoic Tolmer Sandstone cover, along a mapped fault zone.

6.3.3.3 Geophysics in 1990

Like geological interpretation in 1990 (section 6.3.2.3), geophysical results were reported according to a four-sheet compilation of the SH2/Eccles II area. Sheets 1 and 2 in the north cover the SH2 prospect; sheets 3 and 4 in the south deal with Eccles II prospect.

- Sheet 1 (Plate 16*)

Being the most prospective of the sheet areas, various geophysical methods were concentrated over the already outlined zone of alteration and its probable extensions. Results of the surveys are as follows (see Plate 16*):

+ EM-VLF

Contouring using the Fraser Gradient method shows a definite north-south bias of the conductive features; this can be expected as it parallels the regional strike of the comparatively conductive Lower Proterozoic.

The Tolmer cover rocks are known from their lithological characteristics to be 'transparent' to EM geophysical procedures; their high resistivity allows the VLF method to pick up conductive elements within the Lower Proterozoic without significant interference. Contrasts of resistivity within the latter show fairly distinctively the variation of facies types.
Relating the VLF signatures to Sheet 1, the contouring outlined a corridor of comparatively intense conductive trends between 9900E and 10100E, north from 9350N. There is no direct correlation with the known subsurface chlorite-graphite zone, this being located about 100 m west; these anomalies were tested by several holes, e.g. TOL-P-50 and TOL-P-60 (1989) and TOL-P-80 (1990) without any obvious reason for their presence being found. Similarly TOL-D-28 and TOL-P-51, both having intense chlorite-graphite zones at the unconformity, did not exhibit any abnormal conductive features in their immediate vicinity.

Other geological or physical factors can be responsible for providing anomalous conductive features, for example an intense linear conductor at 10050E between 9500N and 9850N is probably related to an alluvium-filled dry wash which is known to be swampland during the wet season. Water retention in this structure, combined with the possibility of it occupying a fracture zone in the Tolmer Sandstone, would show up as a conductor.

Other phenomena in the Tolmer Sandstone, such as faults and breccia zones, could also appear as conductors.

+ VLF-R

A brief description of the operating procedure is given earlier in this report (Section 6.1.2). Problems were encountered with this method due, firstly, to the weak signal strength of the NDT transmitter and, secondly, to the difficulty of determining the “nulling point” on the phase angle dial. The NDT station was the preferred transmitter, however NWC had to be used instead due to its stronger signal transmission. The problem with the phase angle setting still remained, and this induced a certain amount of inaccuracy into the values obtained.

The purpose of the survey was to identify, at depth, the outcropping breccia zones within the mid-Proterozoic. The spatial relationship of the breccias with the alteration and possibly with the mineralized zones at the unconformity was considered an interesting combination. If the breccias represented surface expressions of collapse structures, then a mineralized fracture system could exist beneath them within the Lower Proterozoic.

The survey was initially run with NDT, eight profiles being completed at 25 m intervals with stations 10 m apart. Most of the values were highly suspect and the contoured plot failed to produce a meaningful result.

The repeat survey utilizing NWC was conducted from 9250N to 9800N at 50 m intervals and 10 m stations along-line. Plotting showed linear, grid N-S zones of both high and low resistance. Maximum values of up to 2500 ohm/metre are restricted to thin discontinuous strips 10-20 metres wide; more extensive areas with readings below 1000 ohm/metre occur, one of which corresponds to the
conductive mise-à-la-masse body. Surface features such as the breccia zones showed widely varying results. In conclusion, the survey did not distinguish structural features in the Tolmer or outline the breccia body and is therefore not considered to be a useful tool in this environment.

+ Mise-à-la-masse

Two mise-à-la-masse tests were performed on the SH2 prospect after it was proved in the previous drilling campaign that the Burrell Creek Formation contained graphite-rich beds, an observation clearly indicating that this formation has the positive characteristics to generate uranium precipitation. The mise-à-la-masse was initiated first with current injection into the graphite-rich body(ies) with the concept that such a body would show a high potential and would be easily measurable, even with the Tolmer cover, as the current was injected directly into the conductor. The results obtained were positive and showed clearly three zones worth testing by drilling, with one of them particularly attractive as it appeared to combine, in the same area, multiple anomalies and favourable conditions. The surveys carried out are detailed below.

- A first test was performed on drill hole TOL-P-51 which intersected a sizeable graphitic formation in the previous drilling campaign. This survey was done in order to follow the possible extension of the graphitic bed below the Tolmer Sandstone cover.

The current was sent between two points, A₁ and B₁, 1 km apart.

"A₁" electrode was lowered down TOL-P-51 to a depth of 17 m, corresponding to the graphitic bed location.

"B₁" electrode, considered to be set to infinity, was located at 10800E on the 9400N profile.

The potential was measured between two electrodes, M and N.

"M₁", located on 10400E, was considered as posted to infinity.

"N₁" was displaced along the E-W profile, north and south of TOL-P-51, with readings taken every 25 m along 4 profiles and stations being 12.5 m apart.

The injected current (from five 12-volt batteries) increased from 18 to 25 milliamperes during the period of the survey due to the improvement of the electrode conductivity. A conductive body, interpreted to contain graphite, was followed between profiles 9100N and 9700N. Its conductive quality was the best between 9250N and 9500N and deteriorated southward and northward. The apparent diminution of
the conductivity of the graphite conductor is certainly due to two reasons: a gradual diminution of the graphite content of the conductive body and the fact that one is gradually moving away from the mise-à-la-masse point with, additionally, a possible increase of the Tolmer Sandstone cover.

Nevertheless, the "conductor" extends further north and south with some graphite content (as encountered in drill hole cuttings and in the core of TOL-D-28) and well reflected in the higher readings on potential.

The main graphite conductor has a N-S orientation between profiles 9600N and 9250N. To the north of 9600N it appears to be truncated, then displaced by a fault N110E which has been mapped in the field and has a SW-NE orientation. To the south it takes a NE-SW direction, due either to a fold or to the presence of a possible fault, N120E, which could explain a morphological boundary of the Tolmer cliff and a termination of VLF conductors further to the southeast.

On profiles 9100N and 9200N the mise-à-la-masse conductor can be seen fitting closely with a VLF crossover or near crossover. North of 9200N the correspondence is more dubious: one can see some widespread spatial correspondence with the out of phase curve and crossovers, but certainly not with the in-phase readings. North of 9600N one can notice some loose correlation with VLF in-phase readings and crossovers.

South of TOL-P-31 the mise-à-la-masse conductor overlies a weak radon anomaly down to profile 9200N.

The analysis of the four detailed profiles, with readings taken every 12.5 m, suggests that the conductive body may have a very steep dip to the east.

- The second mise-à-la-masse test was done on the general area of 10000E/8800N. Following bulldozing work in that area, some rubble indicated the presence of a graphite-rich bed in the vicinity covered by soil or eluvium. A series of SP measurements indicated the most likely location of the subcropping conductive body. Electrode "A_2" was located in that spot (9975E/8775N), electrode "B_2" on 11000E/8800N and "M_2" on 10500E/8800N.

The injected current reached 47 milliamps; the potential readings taken from profiles 8600N to 9050N delineate a definite, narrow, N-S oriented conductive body.
In this case, one can see a very close correspondence of the mise-à-la-masse conductive body and the VLF NDT in-phase crossovers. The VLF in this instance is clearly pointing to a conductive body even when the latter is disappearing under increasingly thickening Tolmer cover to the north.

Around profile 9050N the conductive body appears to fade away (diminution of its graphitic content) while showing some thickening. It appears to stop on the possible N120E fault mentioned in the previous paragraph.

The more conductive parts of the conductor could be interpreted as a lens of graphite-rich facies which thickens to the north while apparently losing its graphite content.

The second survey continued on after the data had been interpreted and showed that the conductor was extending southward.

The results show that the conductive phenomenon has dissipated rapidly along strike, i.e. graphite content is decreasing. It was considered that sufficient ground had been covered and that adequate potential drill targets exist.

+ Conclusion

In conclusion, one can say that the mise-à-la-masse worked very well and could possibly indicate the portion of the conductor where the graphite content is minor, the proximity of the latter being the most potential zones for possible uranium concentration.

In the case of TOL-P-51, the correspondence of the mise-à-la-masse results with those of the VLF is far from satisfactory. In the second test the concordance is much better and the mise-à-la-masse is supplying additional information on the portions of the graphitic conductor where the amount of graphite could be minimal. This phenomenon, however, could be related to current dissipation along the boundary of the conductive body.

> Sheet 2 (Plate 17*)

+ EM-VLF

As on Sheet 1, the concentration of the most intense conductive anomalies seem to occur within the same coordinate boundaries. In this case, they correspond to either outcropping Lower Proterozoic or under a very thin capping of Tolmer Sandstone.
There is a significant cluster around the fault-bounded embayment at 8800N, corresponding to the mise-à-la-masse conductive body and the graphite schist occurrence. The latter is represented as a 100 m long zone, with the main body centred at 10000E/8850N; TOL-P-83 was drilled here, intersecting a very intense chlorite-graphite alteration zone at the unconformity. The southward extension of the anomaly terminates at Robert Creek; however parallel anomalies (which may be either offsets or folded repetitions) occur to the east and west. Unfortunately, none correspond to outcrops, all being obscured by alluvium or soil cover.

There is an obvious termination of the intense anomalism at about 8259N, corresponding with the Lower-Middle Proterozoic contact where it shifts to an E-W strike; this may be coincidental, as there is no obvious geological/lithological reason apparent. Projecting along strike, i.e. southwards on to Sheet 3, the anomalies would link up with the conductive zone at Eccles II, which comprises a graphitic schist/greisen association.

A thin, elongate conductor extends down the extreme eastern edge of the sheet from about 8499N to 7950N. Much of it is obscured by Tolmer Sandstone to the north and its southern extension corresponds to poorly exposed schist outcrops. It is interesting to note that this conductor, and two less extensive ones to the west, if followed along strike lead to the Palm Valley graphite schist/greisen complex (Sheet 3). The discovery of anomalously radioactive float in Palm Valley Creek and a mineralized phenomenon in the adjacent TOL-P-97 drill hole make this lithological/EM trend prospective.

+ Mise-à-la-masse

This survey was fully discussed under the Sheet 1 heading. Reference was made under EM-VLF that there is a correlation of this method with Mise-à-la-masse in the Robert Creek embayment area; this is encouraging, especially as a graphite schist occurrence is known to subcrop here. As the two procedures supply identical results, EM geophysics has been proven a useful prospecting tool for the Tolmer environment.

6.3.3.4 Radon Survey and Radiometry

An alphacard and downhole SPP2 survey based initially on the VLF results was run in 1988 over the western side of the grid, i.e. between the central base line and the unconformity. Distribution of the stations along each line was based on the VLF interpretation. Results of the radon and scintillometer surveys are contoured and appear on Plates 4-88, 5-88 and 6-88.
The strongest radon anomalies are located on and adjacent to faults; the lithologies comprise both pebbly and breccia beds within the basal Depot Creek facies. Two lines, 10000N and 9600N, both have readings in excess of 20 cpm with a 42 cpm maximum at 9800E/10000N. The 9600N feature has two low value "tails" extending north and south; these could be lithologically related.

Surface scintillometer values range from average to marginally high for Depot Creek; there is no recognisable pattern for the values when related to the geology and the alphaCard results. On the Tolmer Sandstone, highest values reach 60 cps; Burrell Creek sediments have values in the range 60 to 100 cps. Comparisons with the downhole results show similar trends but with the expected higher values; a better fit is the downhole/alphaCard trends.

Plate 3-89 illustrates the alphaCard 1989 extension survey, integrated with that of the previous year. The grid extensions to the south and north were fully covered using a 25 x 50 m separation of stations expanding to 25 x 100 m in the northwest sector of the grid. Plates 5-89 and 6-89 show the results of the extended radiometric surveys.

The distribution of radon can be attributed to several factors:

- the Lower/Middle Proterozoic unconformity,
- subcropping trends in the Lower Proterozoic, i.e. lithologies with high radiometric backgrounds or stratabound uranium mineralization,
- fault zones within the Tolmer Sandstone allowing random radon percolation,
- creek systems coincident with faults where radon-bearing waters occur.

The principal anomalies, two of which were outlined in the first survey, are spot-highs coincident with fault networks, illustrated in one case by a large zone of brecciation. Drilling of these areas in 1988 and 1989 did not provide a definitive answer on the origin of the radon; in one of the anomalous areas, however (9600N section), several intersections of strongly chloritized graphite schist were made, this facies being an indicator of a possible uranium association. The other anomaly on 10000N was closely drilled without success, intersecting relatively unaltered Lower Proterozoic metasediments; the origin of the two high readings here of 42 cpm and 24 cpm has yet to be determined.

The 'northern' grid extensions were designed to assess three features:

- The continuation of the unconformity to the southwest with possible associated radon anomalies, the prospectivity of the contact being related to anomalous thermoluminescence samples collected in 1987.
- Open anomalous trends from the 1988 programme had to be properly defined. Observable surface features such as breccias and a network of variously oriented faults are located up to 200 m north of where the 1988 surveys were terminated. These phenomena were considered to be possible loci for radon emanation along the established anomalous trend outlined further south.

- The regional EM INPUT interpretation, where the zone from T10 to SH2 shows a consistent NW trend between the two anomalies. The conductor, which forms SH2, continues in a weaker mode to the northwest coinciding with a structure occupied by Surprise Creek. The grid was extended to traverse the creek so that detailed EM VLF and alphaCard could be carried out.

No significant radon anomalies were obtained from the above surveys however the following trends can be noted:

- The 'radon background' can be taken as 1 cpm although many readings are zero.

- A broad trend of three times the background which curves from grid north around to grid west following, more or less, the strike of the Tolmer Sandstone. Within this area are some higher readings centred at 9850E/10200N and 9900E/10600N. The former, because of its proximity to faults and breccia zones was drilled, four holes being completed.

This anomaly has a well defined boundary on the eastern side more or less coincident with a NNW-trending fault while the southwestern extension is linear, possibly following the lithology. To the north it is open.

The unconformity can be traced by the contrast anomalies which discontinuously follow the contact. Values in the Burrell Creek are generally quite low: up to 3 cpm; one value of 8 cpm occurs. The survey was not consistent in extending the alphaCard into the Burrell Creek.

The "Surprise Creek trend" failed to give any conductor (or radon) signature. The sandstone cover here could be up to 100 m thick, effectively masking any conductive zones from the VLF and preventing the escape of radon to the surface.

Towards the end of the field season, extension of the grid southwards was commenced at 8950N with coverage to 8650N; a total of 147 stations were surveyed. A significant anomaly was located on the southeast corner of the extension, a maximum reading of 99 cpm being obtained.

During the 1990 campaign, the alphaCard and radiometric surveys was again extended, concurrently with the VLF-EM, southwards to Eccles II and beyond. (Plate 18*, 19* and 20*)
In the SH2 area one hundred and forty-five stations were read on lines from 8600N to 9150N, infilling all open ground out to the eastern limit of the grid at 10500E. This section of the survey was designed to cover the northern extension of a wide EM-VLF anomaly as well as "blocking out" Robert's anomaly to the east and north.

A marked "cut-off" exists to the east of 10300E. In part, this is indicated by geological mapping to be a lithological feature in the Tolmer Sandstone. In the vicinity of Robert's anomaly, however, a combination of faulting and a "tongue" of Burrell Creek sediments (including sericitic and graphitic schists) are thought to be responsible for its occurrence. A strong, adjacent EM-VLF anomaly lends weight to the importance of the radon anomaly.

The abovementioned alphaCard "cut-off" feature appears to be related (on surface) to a broad contact zone between strongly ferruginous pebbly arenite and fine grained gritty pink silicified quartzite. The latter characteristically has a background of 0-1 cpm while the former ranges from 1-3 cpm and up to 6 cpm. The radon contours also appear to follow the Fraser Gradient anomaly in a broad sense.

The final analysis of this data failed to show any significant extension to Robert's anomaly, confirming its very localized nature with probable relationship to radon-bearing damp soil within the creek. The source/origin of radon in these sites is still not known; the association with faulting and nearby "prospective" graphitic/chloritic facies in this case, still lends importance to this occurrence.

South of Robert's Creek, i.e. between profiles 8600N and 8250N, further anomalies were outlined, these being located mainly adjacent to the unconformity where the Tolmer cover is thinnest. Four "centres" occur, with maximum values ranging from 6-8 cpm against a local background of 2-4 cpm. These anomalies are coincident with EM-VLF conductors which are traceable within the exposed "Burrell Creek" and beneath the Tolmer Sandstone. Although no graphitic rocks were mapped, it is possible that soil and rubble cover combined with the steep slopes has obscured the presence of these rocks.

One radon anomaly/EM anomaly was drilled, without success (TOL-P-91, 10000E/8600N).

A parallel-trending group of conductors between 10300E and 10500E are located immediately east of the above; these were covered extensively with alphaCards showing a low-order anomalous trend which is again traceable, both in the "Burrell Creek" and under the Tolmer. Mapped Lower
Proterozoic indicates interbedded schists and meta-sandstones, while the Tolmer comprises strongly ferruginous pebbly arenite; in other locations this facies tends also to give higher radon values, perhaps representing a background characteristic.

One hundred and thirty eight readings were taken over localized areas of the Mise-à-la-masse anomaly, principally where gaps existed from previous surveys. The most impressive anomaly in this group is a 25 x 50 m area adjacent to TOL-P-83 (8850N/10010E) where values up to 9 cpm were obtained. This is an interesting result considering the presence of on-surface graphite schist rubble and a strong alteration zone present at the unconformity in the drill hole.
### 6.3.4 Drilling

#### 6.3.4.1 Summary

The following table summarises the drilling statistics at Prospect SH2. Plates 14* and 15* show the location of the drill holes.

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Total 45 holes for 374 metres
6.3.4.2 Drilling Details - 1988 Campaign

TOL-D-26 Abandoned at 3 m due to complete loss of circulation. The sandstone was very weathered and fractured due to close proximity of a fault.

TOL-D-27 (Plates 36-88 and 23*). Drilled to a depth of 39 m on a small MaxMin anomaly southeast of TOL-D-26, and approximately 60 m southeast of a strong alphaCard anomaly on line 10000N. The unconformity was not reached. The hole was abandoned due to very poor core recovery (43%), continuous caving, excessive bit wear and poor circulation. The sandstone was extensively fractured, haematitic along fractures and tectonically brecciated. A cavity from 22 m to 32 m was filled with purple haematitic clay (similar to the clays found in TOL-D-28). Dips between 40° and 75° were noted in the meagre core. No chlorite was discovered, however the clay was readily washed away.

TOL-D-28 (Plate 35-88 and 26*). The hole was situated on a very weak MaxMin 80 m east of a strong alphaCard anomaly in Tolmer Sandstone.

The unconformity was cored at 47.5 m, and then 46.6 m of Burrell Creek was drilled. The unconformity contact is irregular and possibly faulted. Hydrothermal alteration of the Tolmer and Burrell Creek Formations has taken place, especially near the contact. The Tolmer Sandstone is strongly haematitic and chloritic for 5 metres above the contact. Patches of light green chlorite commonly fill fractures and occur in the sandstone matrix. Pyrite is present as small aggregates in fractures (e.g., 46.1 m). In places the sandstone matrix is completely replaced with haematitic clays (e.g., 45.8 m) and resembles muddy sandstone.

The Burrell Creek rocks consist of very dark shale near the contact, followed by interbedded sandstones and siltstones; no graphite was positively identified. Chloritization, haematization and sericitization of the lithologies is present in varying degree to the end of the hole (where the rocks appear relatively fresh). Two chlorites are present; a black variety is common just below the contact.

Core recovery at the contact was good, and overall was 85%, any loss being due to surface weathering and the strong fracturing encountered throughout the Tolmer Sandstone.
6.3.4.3 Drilling Details - 1989 Campaign

> Drill Profile 10250N (Plate 21*)

Four holes have been incorporated on Plate 7-89 including TOL-P-41, which was drilled off-section 50 m south. Coincident structural, EM and anomalous radon features determined the siting of the various holes. The holes drilled are as follows:

10250N: TOL-P-38 102 metres
TOL-P-39 78 metres
TOL-P-40 90 metres
10200N: TOL-P-41 90 metres

- **TOL-P-38** This hole was drilled in a conductive zone as close to an ENE-trending alphaCard anomaly as the topography would allow and between two WSW-trending faults.

The Tolmer Sandstone is strongly hematized throughout; minor hematization occurs at the unconformity. The contact was intersected at 47 m; the Lower Proterozoic metasediments are predominantly quartz-sericite schist and sandstone. Chlorite and some graphite were noted between 80-100 m. Some graphite was also noted from the unconformity to 60 m.

There was no significant radioactivity recorded in the hole; the background radiometry within the Tolmer Sandstone was around 5 cps and in Lower Proterozoic metasediments around 35 cps. Note that the log was run through the drill stem only, as the hole had collapsed prior to open hole logging.

- **TOL-P-39** This hole was drilled to test a north-south VLF conductive zone where it intersects a strong ENE-trending alphaCard anomaly. An adjacent WSW-trending VLF anomaly, probably a fault, is also present.

The hole was drilled to 78 m, intersecting the unconformity at 25 m. The Tolmer Sandstone here is a hematitic quartzite with siliceous horizons and a degree of kaolinization along fracture surfaces.

The Lower Proterozoic units at the unconformity are represented by graphitic-sericitic siltstones with some dark chlorite alteration. This graphite/chlorite-rich unit must be the cause of the conductive zone detected by the VLF. The predominant lithology is, however, a sericite schist or siltstone although chlorite and graphite are appearing throughout the sequence.
No anomalous radioactivity was noted in the hole. The radiometric background of the Tolmer Sandstone is around 5 cps and the Lower Proterozoic had a radiometric background of 35 cps. Note that logging was through the drill stem as the hole had collapsed before open logging was attempted.

- **TOL-P-40** This hole was drilled to complete the E-W drill profile on the 10250N line. It was designed to test a N-S conductive axis.

The hole was drilled to 90 m with the unconformity being intersected at 37 m. The Tolmer Sandstone here is both strongly hematized and kaolinized. The Lower Proterozoic units are principally sericritic schists with a pervasive light green chlorite alteration.

There were no radiometric anomalies with the radiometric background of the Tolmer Sandstone being around 5 cps and that of the Lower Proterozoic being 30 cps. Note that the log was taken through the drill stem as the hole had collapsed prior to open hole logging being attempted.

- **TOL-P-41** This hole was drilled on the western margin of a conductive zone delineated by the VLF, and a WSW-trending alphaCard anomaly coinciding with a VLF anomalous trend.

The unconformity was intersected at 38 m. The Tolmer Sandstone was primarily hematitic with abundant kaolin development, particularly in the upper facies. The Lower Proterozoic metasediments consist mainly of chloritic sandstone and minor schists. Minor graphite was noted.

There was a wide, low order anomaly of 5 m at the unconformable contact within the Lower Proterozoic. The Tolmer Sandstone was slightly more radioactive near the unconformity (2 x bg) with peaks up to 4 x bg. None of these are significant except to show that remobilization and concentration of uranium has occurred at the unconformity.

The radiometric background within the Tolmer Sandstone was around 5 cps and in the Lower Proterozoic the background was around 25 cps. Again, all logging was carried out through the drill stem as the hole had collapsed by the time open hole logging was attempted.
Synthesis - 10250N Profile

The mapped stratigraphy of the basal Tolmer at SH2 correlates well with the drill hole lithology. The Burrell Creek facies comprise fine grained quartz-sericite schists, red to mauve in colour and fine to medium grained mauve-grey sericitic meta-sandstone. The presence of locally developed dark coloured chloritic graphite schists at the unconformity is encouraging. The pervasive, lighter green chloritization is considered a regional alteration feature.

The Burrell Creek is assumed to be dipping steeply west, possibly representing the eastern limb of a tight syncline. East-west and north-south faulting is evident in the Tolmer Sandstone, producing chaotic breccias, local tilting of the strata and small scale lateral and vertical movements. The effects of the faulting are localized so that overall the Tolmer dips gently east.

Despite having a combination of prospective features, no indications of mineralization were found in any of the holes. The conductive zone is most likely related to the combined effect of the weakly graphitic schists intersected (TOL-P-38, TOL-P-41) and the fault network and its associated brecciation. The latter have produced a favourable permeable environment for the radon gas to circulate, however the source of the gas was not found. Further conductors immediately to the south and southwest of the profile have been outlined by the Fraser Gradient method.

> Drill Profiles 9900N-10000N (Plates 22*, 23*, and 24*)

Three drill profiles comprising six vertical percussion holes will be discussed here:

9900N: TOL-P-57  84 metres
       TOL-P-58  102 metres
9950N: TOL-P-53  96 metres
       TOL-P-56  54 metres
10000N: TOL-P-54  84 metres
       TOL-P-55  84 metres

The hole pattern was centred on a local but intense radon anomaly thought to be linked to several EM conductive zones and a complex fault pattern.

- TOL-P-57 The unconformity was intersected at 49-50 m. Very kaolinized Tolmer Sandstone occurs to 14 m, limonitic and hematitic staining is present in the weathered zone. The Tolmer Sandstone becomes more hematitic below 14 m although kaolinization remains to about 22 m; the reddening of the sandstone becomes more intense with depth. Soft clayey hematitic intervals occur. The facies shown by the Tolmer Sandstone here
is hard to determine due to the alteration present; the occurrence of minor amounts of quartz fragments suggest a gritty or perhaps pebbly facies at first, becoming the banded "laminated" facies below 35 m. The latter has been identified through the presence of large percussion drill cuttings.

The Burrell Creek Formation intersected in this hole comprises grey to mauve coloured sericite schists with minor quartzite bands. Minor chlorite alteration was noted at various localized intervals. The alteration appears to correspond to radiometric peaks both with the scintillometer readings on the cuttings and down-hole logging, e.g. 63-66 m, 70 m and 73-75 m; the dominant lithology here is quartzite.

The Tolmer is essentially "flat" radiometrically with an average of only 10 cps. No mineralization was intersected. The abovementioned "peaks" are very low order but do illustrate a relationship between lithology and alteration.

- **TOL-P-58** The unconformity occurs at about 75 m. The down-hole radiometric survey indicates only a marginal rise in cps between the lower Tolmer and the Burrell Creek Formation. Scintillometer values are more or less constant throughout with only a very minor increase in the Lower Proterozoic.

The Tolmer, on the basis of down-hole radiometry, can be subdivided into three zones: 0-20 m of very dark brown quartzite, pebbly or gritty, some kaolin; 20 to about 60 m variably coloured, bedded quartzite, possibly the 'laminated' facies; 60 m to the unconformity: red to mauve, very hematitic quartzite.

There is a gradual rise in the radiometric readings adjacent to the unconformity with an average of 50 cps within the Burrell Creek; a small "peak" of 70 cps occurs at about 93 m. The Lower Proterozoic samples have been extensively contaminated with Tolmer cuttings. The lithologies are mauve to grey sericitic schists and quartzites throughout; alteration is minimal.

- **TOL-P-53** The unconformity was intersected at 46 m. The Tolmer Sandstone comprised two pebbly bands up to 20 m thick with interlayered, more massive quartzite. Variable hematitic alteration is present. Interbedded meta-sandstones and schists were intersected in the Lower Proterozoic. An increase in the radiometry was noted at about 80 m in a hematitic and slightly graphitic sericite schist. Localized twice-background intersections appear in the Tolmer.
- **TOL-P-56** This hole was abandoned at 54 m due to excessive caving in muddy friable sandstone. There was an anomalous zone of radioactivity between 24 and 29 m corresponding to a water flow, probably containing dissolved radon gas.

- **TOL-P-54** Unconformity at 39 m marked by a strong peak in the gamma log of 100 cps. The anomaly is related to an increase in U and Th on and adjacent to the contact. Elsewhere the radiometric readings are flat.

The Tolmer is homogeneous, variably ferruginized quartzite with some pebbly layers. The Burrell Creek is predominantly red-mauve sericitic quartz meta-sandstone. Minor chlorite was noted. Quartz veining is present around 65 m.

- **TOL-P-55** Drilled adjacent to the radon anomaly and the abandoned diamond hole TOL-D-27. The unconformity was reached at 48 m, considerably deeper than TOL-P-54 further east, i.e. away from the contact. The Tolmer consists of massive quartzite with a local pebbly layer grading into the 'basal' laminated quartzite; brecciation is considered to occur over most of the intersected Tolmer. The Burrell Creek is mainly sandy in composition with fairly frequent bands and beds of quartz-sericite schist.

Radiometry was flat with typical responses from the two major lithologies.

+ **Synthesis Profiles 9900N-10000N**

The drilled area comprises a combination of features: alphaCard anomalies, EM conductors (VLF, MaxMin) and a faulted environment. This zone was drilled after a series of holes was completed at the 9600N section; holes were planned around and east of the main alphaCard anomalies with the thought in mind that the radon source could be adjacent and not directly under the surface expression due to the regional dip of the beds. Also more emphasis was placed on locating the holes at or near the surface traces of the conductive zones as defined by the Fraser Gradient and, if appropriate, fault zones.

Chloritic alteration occurs in some of the holes though it is not intense. No graphitic schists were encountered. Minor peaks occur in TOL-P-54 within the Burrell Creek on the unconformity; TOL-P-53 contains a peak about 30 m below the contact. A small peak occurs in the Tolmer Sandstone in the abandoned hole TOL-P-54; the "kick" corresponds to a damp, strongly hematitic zone at about 24 m. This could indicate a zone of radon anomalous within a fault or fracture.
The positions of the unconformity in the various holes indicates an initial 1:6 dip as measured from the surface expression of the contact. This is calculated from holes TOL-P-53, TOL-P-55 and TOL-P-57. The position of the unconformity in TOL-P-58 at approximately 75 m shows a 25 m drop over 75 m from TOL-P-57. The slight difference in collar elevation would not account for this variation. The presence of a fault mapped in 1988 has obviously accounted for a vertical drop of 10-12 metres.

> Drill Profiles 9550N - 9635N (Plates 25*, 26*, and 27*)

Of the two sites chosen to first test the SH2 anomaly in 1988, the 9600N profile was the most successful with TOL-D-28 drilling through the unconformity to intersect very strongly chloritized and graphitic metasediments within the Lower Proterozoic sequence. In addition, the Tolmer Sandstone also contained chlorite and elevated uranium values in breccias adjacent to the unconformity. This discovery led to the more intensive drilling programme of 1989 where much of the work was concentrated on and near this profile.

Altogether, eight holes were drilled on 9600N (including one abandoned) with an additional four holes on closely adjacent sections; all are tabulated below:

**Profile 9600N (west to east) (Plate 26*)**

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<td>TOL-P-48</td>
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**Profile 9635N (Plate 25*)**

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**Profile 9550N (Plate 27*)**

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The holes to the north and south of the central profile were designed to test the extension of the alteration 'envelope' and the graphitic facies. The principal features of each hole are discussed below followed by a synthesis of the results.

**TOL-P-44** This hole was drilled on a MaxMin anomaly very close to the outcropping unconformity. The hole was drilled to 66 m with the contact between the Tolmer Sandstone and the Lower Proterozoic metasediments being very shallow, occurring at only 9 m.
The Burrell Creek facies are predominantly sandy with only minor schist interbeds. A greisen vein is present at 50 metres.

- **TOL-P-43** This hole was drilled in the centre of a major alphaCard anomaly and at the margin of a major breccia zone within the Tolmer Sandstone. The hole was drilled to 60 m with the unconformity being intersected at 8 m.

Here the Tolmer Sandstone is partly conglomeratic and exhibits some evidence of quartz veining. The Lower Proterozoic facies at the unconformity is slightly graphitic but is principally a ferruginous sericite schist. Apple-green chlorite is pervasive throughout the sequence.

This hole was logged both through the drill stem and in open hole. No specific anomalousism was noted. The Lower Proterozoic metasediments gave a background radiometry of around 50 cps.

- **TOL-P-42** This hole was drilled adjacent to TOL-D-28 and designed to intersect the alteration and graphitic beds found in that hole. TOL-P-42 was centred on a northwest-trending MaxMin conductor.

The hole was drilled to a depth of 102 m, intersecting the unconformity at 32 m. The Tolmer Sandstone here was strongly hematized and kaolinized with chlorite alteration being observed from 13 m to 32 m. The Lower Proterozoic units consisted of graphite-chlorite schist and sericite schists at the unconformity. The chlorite was predominantly the bright green variety lower in the hole. Much of the Lower Proterozoic lithology at depth becomes more sandy with varying amounts of chlorite.

There were a number of minor anomalies found within the Tolmer Sandstone, one at 5 m of 42 cps on a background of 7 cps, a small one at 20.5 m and another at 23 m. There was a slight increase in the radioactivity at the unconformity up to 82 cps on a background of 30 cps. An anomaly occurs within the Lower Proterozoic units at 65-66 m of 125 cps in what is described as a mauve, quartz sandstone with bands of green chlorite-sericite schist. Chemical analyses showed the anomalies were due to thorium which ranged from 6 to 44 ppm. Little variation was noted in the uranium values.

- **TOL-P-48** The original site for TOL-P-48 (9850E/9650N) was abandoned due to the inability of the rod truck to get on-site. The new site was not ideal to test for extensions to the chlorite-graphite facies, however it was drilled but eventually abandoned at 72 m due to severe collar washout.
- **TOL-P60** The unconformity was intersected at 66 m. The Tolmer comprises a 'kaolinized' zone from the surface to 15 m; hematitic quartzite with decreasing kaolinization occurs to 30 m; the grainsize is medium grained, with isolated pebble bands. A monotonous red-brown to brick-red, very hematitic, clayey quartzite extends to the unconformity. The down-hole radiometric log indicates a very flat response. A higher radiometric signature is indicated adjacent to the unconformity; the geological log identifies this zone as being within the Tolmer Sandstone; a maximum of 44 cps is reached.

Apart from some small localized spikes in the Burrell Creek, the response is fairly flat as well as being only marginally higher than that of the Tolmer Sandstone: average of 35 cps against 10 cps in the latter. The Burrell Creek facies are indicated as being principally sandy with only minor interbeds of schist. Light green sericite/chlorite alteration is present while the more important, darker green chloritization is absent.

- **TOL-P-49** This hole was abandoned due to excessive caving within the highly altered Tolmer Sandstone.

- **TOL-P-50** The unconformity was intersected at 80 m. The Tolmer Sandstone is strongly altered to clay and, towards the unconformity, there was an obvious increase in the hematization.

The Lower Proterozoic sediments below the unconformity are mainly sericitic sandstone and schist which are affected by minor chloritization and the development of graphite in places.

There were no radiometric peaks. The radiometric background throughout the Tolmer Sandstone was around 8 cps, while in the Lower Proterozoic it was around 40 cps.

- **TOL-P-45** This hole was drilled on the western margin of a conductive zone and within the main alphaCard anomaly. It was drilled 35 m north of hole TOL-P-42 to investigate the graphite- and chlorite-rich horizon intersected in that hole at and near the unconformity.

The hole was drilled to 84 m with the unconformity being intersected at 33 m. The Tolmer Sandstone is strongly kaolinized with some chlorite alteration noted near the unconformity. The Lower Proterozoic unit at the unconformity is strongly graphitic with an association of dark green chlorite. Most of the Lower Proterozoic units are altered to give chlorite schists and sandstones.
There was an increase in the radiometry at the unconformity within the Lower Proterozoic with a peak of 94 cps on a background of around 30 cps. There was also an interesting small peak within the Tolmer Sandstone at 14.5 m in a very strongly hematized quartzite. Chemical analyses of the cuttings showed an enrichment of both Th and U at the unconformity. Thorium within the Lower Proterozoic averages around 35 ppm and uranium 4 ppm - the "enriched zone" has Th at twice background and U up to three times background.

TOL-P-59 The unconformity was intersected around 48 m. The Tolmer Sandstone comprises a pale pink to white kaolinized zone to 14 m; pebble and gritty beds are present. A pebbly hematitic/kaolinized zone extends to 18 m followed by pebbly, very hematitic, brick red quartzite becoming finer graded to 31 m.

From 31 m to about 39 m a conglomerate band is present grading into medium grained quartzite, pink to red in colour. This facies continues to the unconformity.

Radiometrically the Tolmer Group Sandstones average about 10 cps, however several above background zones occur throughout, with a maximum of 30 cps.

The unconformity is marked by an 88 cps peak with a 7 m zone to 70 cps. This corresponds to a graphite/chlorite alteration intersection, however its precise thickness and intensity is masked by severe contamination of Tolmer cuttings. Thorium values are not anomalous but uranium shows twice background over 2 metres.

TOL-P-46 This hole was drilled to complete the north-south profile, centred on TOL-P-42 and to trace the chlorite-graphite- rich horizon noted in both TOL-P-42 and TOL-P-45. The hole was drilled to a depth of 84 m with the unconformity being intersected at 40 m.

The sandstone was in some places kaolinized and in others hematite staining was extensive. The Lower Proterozoic units were strongly chloritized sericite schists and sandstones. A graphitic bed occurs about 10 m below the contact with associated dark green chlorite alteration.

Only a slight radiometric increase occurs at the unconformity in a weakly chloritized greenish mauve meta-sandstone. There is no apparent increase in either U or Th values.
- **TOL-P-47** This hole was drilled to investigate the southward extension of the graphite-chlorite zone intersected in TOL-D-28 in which a localized anomaly was found in both the Tolmer Sandstone and the Lower Proterozoic adjacent to the unconformity. TOL-D-28 was drilled on an interpreted conductor which was eventually explained by the intersected graphite horizon.

TOL-P-47 was drilled to a depth of 84 m with the unconformity being intersected at 45 m. The Tolmer Sandstone is strongly kaolinized in places. Pebble conglomerate bands occur but for the most part, the unit is a saccharoidal, hematite stained quartzite. Near the unconformity the sandstone becomes chloritic in part. The Lower Proterozoic at the unconformity was a strongly chloritized graphite schist.

Two main anomalous zones are present: one at the unconformity (44-46 m), the other from 62-68 m. Uranium values indicate a three times background enrichment at the unconformity but nothing elsewhere. Thorium shows a marked local increase within both anomalies - up to twice background. One sample in the central part of the Tolmer Sandstone intersected, shows an anomalous value of 38 ppm Th (elsewhere <4-4 ppm).

+ **Synthesis, Profiles 9500N - 9635N**

The detailed drilling pattern centred on the 9600N profile was designed to follow up the significant intersection of graphitic schist and associated chloritic alteration made in TOL-D-28. The profile of five completed holes and TOL-D-28 has given a good cross section showing the limits of the alteration and faulting/brecciation. The adjacent sections, 9635N and 9550N, have proved continuation of the prospective features giving an open strike length of 85 m N-S and just over 100 m in width.

Lithologically the Tolmer Sandstone is predominantly a fine grained quartzite of variable colour; hematization is widespread but, for the most part, is not thought to be hydrothermally induced. Finely divided clay was observed in outcrops but its subsurface occurrence has not been determined. Chloritic alteration was observed in a few holes on and near the unconformity within heavily fractured and brecciated quartzite. Brecciation of the Tolmer can be observed in surface outcrops and is considered to occur in some drill holes where cavities and water flows exist.

Within the alteration zone enrichment of both uranium and thorium occur. Background values appear to <4 ppm U and 4-6 ppm Th in the Tolmer and 4 ppm U and 30 ppm Th in the Burrell Creek (Note: not a statistical analysis). Maxima of 18 ppm U and 14 ppm U (TOL-D-28 and P-45 respectively) occur at or near the unconformity illustrating a concentrating process in association with proposed hydrothermal activity. The former value was recorded in
brecciated, chloritized Tolmer Sandstone; the other is present within chloritized graphitic schist. Thorium also shows some enrichment which is not necessarily coincident with uranium. (Refer to the geochemical plots in Appendix 1 which show clearly the U/Th relationship.)

The mechanisms responsible for the 'unconformity phenomena' at SH2 are not clearly understood; it is considered that a combination of events has occurred involving uranium and thorium and the accessory elements cobalt, arsenic and nickel. It is clear from the presence of anomalous amounts of these metals that a hydrothermal event has taken place; this is supported by the presence of intense dark chloritization (magnesium metasomatism, up to 3.06\% Mg) mostly affecting the Lower Proterozoic but also observed in the Tolmer Sandstone. The presence of high thorium can be explained by local enrichment at the unconformity, eg, the introduction of additional Th during the hydrothermal activity up to 30-35 ppm Th on to background values.

The analytical data show that generally Th relative to U is higher in terms of ppm measurement and that the two elements coexist in this geological environment. It has also shown that in areas of hydrothermal alteration, Th can become anomalous in the sandstone cover rocks implying mobility of Th under certain conditions.

The unconformity U/Th phenomenon at SH2, whether in the presence of observable alteration effects or not, can probably be attributed to a hydrothermal event involving mobilization of both elements. The graphical presentations of the analytical data shows anomalous uranium to be independent of anomalous thorium, though both still having a spatial relationship. This observation at least suggests that neither are associated with refractory-type mineralization.

> Drill Profile 9375N (Plate 28*)

Three holes were collared on or adjacent to this section.

TOL-P-51  66 m  
TOL-P-52  66 m  
TOL-P-61  66 m

Several prominent EM conductors, both MaxMin and VLF, trend north-northwest (i.e. parallel with the Lower Proterozoic strike) and intersect at right angles a major east-west fault. Both TOL-P-51 and TOL-P-52 were collared on the trace of the fault where the interpreted conductors intersect it; TOL-P-61 was placed a little further west, though not in the most appropriate position due to topographic problems.

- TOL-P-51 The Tolmer Sandstone is generally hematized throughout, becoming more intense towards the unconformity. The latter was intersected at 17 metres.
A thick graphitic-chloritic zone was intersected immediately below the unconformity, perhaps the most important intersection at SH2. The graphite-rich facies extends from 17 to 21 metres and a chloritized schist to 28 metres. Associated with this alteration is anomalous total uranium and thorium giving a radiometric maximum of 215 cps. The associated chloritization is dark green to near black in colour, implying the magnesium-rich hydrothermal type found on the 9600N profile, particularly in TOL-D-28 and adjacent holes.

The maximum radiometric peak is directly associated with the strongest alteration. Analysis of the cuttings has shown above background thorium content both near and away from the unconformity, while the strongest uranium values occur exclusively within the alteration zone adjacent to the contact.

- **TOL-P-52** The unconformity was intersected at 34 m. No radiometric anomalous was found. The Tolmer Sandstone here was typically strongly hematitic and saccharoidal in nature, becoming more hematitic towards the unconformity.

The Lower Proterozoic consists of dark green chloritic sandstone with interbeds of graphite schist becoming less chloritic away from the unconformity.

There is a slight increase in the background radiometry at the unconformity.

- **TOL-P-61** The unconformity occurs at 22 m. The Tolmer comprises a kaolinized zone to 8 m, a kaolinized hematitic interval to 16 m grading to red-brown and brick-red hematitic quartzite to the unconformity. The Tolmer Sandstone radiometric SPP2 background recorded from cuttings is fairly high at about 50 cps; this is also apparent from readings on outcropping ferruginous quartzite; pebbly and/or brecciated in places. The down-hole log averages 20 cps with a high zone of 40 cps 1.5 m wide corresponding to a red muddy interval.

The unconformity is marked by a peak of 82 cps dropping back over 2.5 m to an average 35 cps. Local variations represent lithological changes. The Burrell Creek is essentially quartzitic with some minor alteration, usually pale green ?sericite. Zones of bleached white and very pale green quartzite occur in a couple of intervals; their significance is not known but they could be hydrothermally altered.

The site for TOL-P-61 was chosen to check the extent of the intense chlorite/graphite phenomenon intersected at the unconformity in TOL-P-51. Due to access problems the most suitable sites could not be drilled; the two holes are about 50 m apart across strike and each shows different lithological characteristics.
Synthesis - Profile 9275N

Good results were obtained in all holes, although the only indication of mineralization was in TOL-P-51. Both TOL-P-51 and TOL-P-52 had significant lithological intersections: graphite schist and hydrothermally induced, dark green magnesia-rich chlorite, both grading into, at depth, pervasively chlorite-rich metasediments and schist. TOL-P-61 had only very minor graphite, however an interesting bleached zone was present in the metasediment facies. The lithology is pale green to white in colour with, possibly, sericitic alteration. This type of feature has not been observed at Tolmer before. Its presence in this environment could have some significance.

If the graphite-chlorite horizons are continuous lithological features, then the TOL-P-51 occurrence would add a further 175 metre strike length to the prospective zone.

6.3.4.4 Drilling Details - 1990 Campaign

The individual drill holes will be described section by section, progressing from north to south; the geology and radiometry of each hole will be described, followed by a synthesis and general conclusions.

The sections to be described are listed as follows:

9700N  TOL-P-85, TOL-P-86
9500N  TOL-P-87, TOL-P-88
9450N  TOL-P-79, TOL-P-80
9350N  TOL-P-77, TOL-P-78
9300N  TOL-P-76
9200N  TOL-P-79
9100N  TOL-P-84
8650N  TOL-P-83
8700N  TOL-P-81, TOL-P-90
8658N  TOL-P-82
8600N  TOL-P-91
8400N  TOL-P-92

Drill Profile 9700N (Plate 29*)

TOL-P-85 9700N/9810E Depth 78 metres, Water at 46 m. Unconformity intersected at 33 metres.

The hole was sited just north of the profile of holes which first gave indications of significant chloritic alteration at SH2 (TOL-D-28, TOL-P-42, etc.). Both this and TOL-P-86 were collared on a small area which gave low order radon anomalies in conjunction with Fraser Gradient and "cross-over" VLF anomalies and Mise-à-la-masse conductors. The area is intensely faulted with much brecciation.
The Tolmer Sandstone consists of pebbly pink to mauve sandstone and pink to red laminated sandstone extending to the contact. Very red hematitic sandstone occurs on and above the latter.

A 5-metre chlorite alteration zone extends from 33 to 38 metres; graphite occurs in the first 3 metres but is not abundant. The chlorite imparts a dark green-grey colouration to the samples. Lighter green chlorite extends throughout the sequence. Below the altered schists the rocks become typical red to mauve schist and meta-sandstone.

Radiometry shows a low response throughout the sandstone averaging about 15 cps. There is a well-developed series of peaks extending from 29 metres to 35 metres, i.e. the Tolmer and the Lower Proterozoic above and below the unconformity. The strongest peak, at 34 metres, gave 150 cps. Elsewhere in the Lower Proterozoic, radiometric variation reflects lithological changes.

- TOL-P-86 9700N/9885E Depth 96 m, Water at 34 m. Unconformity intersected at 49 metres.

The Tolmer sequence is as follows:

0 - 7 m  pink fine grained sandstone
8 - 20 m  pink to red, pebbly to conglomeratic
21 - 35 m  variably coloured sandstone with a few pebbly laminae
36 - 49 m  "laminated" basal sandstone. Rare pebbles. Very hematitic last 4 metres.

The Lower Proterozoic is very altered at the unconformity with 4 metres of dark green-grey chlorite (+ graphite) schist. The chloritization remains fairly intense to about 58 metres but is diminishing over this interval. Quartz veining is present 58-60 metres. Below the altered zone, the sequence comprises interbeds of schists and meta-sandstone. Quartz veining occurs at the bottom of the hole.

The Tolmer Sandstone Group shows some radiometric variability with localized intervals of higher background; the maximum is a peak of 83 cps at 34 m. The unconformity is well marked at 48 m with a background increase from 30 cps to 70 cps. The alteration zone is not noticeably anomalous as it was in TOL-P-85. Further above background peaks occur at 68 m (minor quartz veining with chlorite) and 92-94 m (pale coloured quartz-meta-sandstone with quartz veining).

> Drill Profile 9500 (Plate 30*)

- TOL-P-87 9500N/9825E Depth 78 m, Water at 40 m. Unconformity at 36 m.
The Tolmer Sandstone is very weathered and clayey to about 14 m; some white clay zones extend to 19 m with very fine sand zones. Very red to brown hematitic sandstone with some quartz pebbles extends to 33 m with a slight colour change to the contact.

No alteration occurs at the unconformity; the first lithology intersected is a quartz-rich, light coloured meta-sandstone which extends for several metres. The usual sequence of red to mauve coloured lithologies continues to the bottom of the hole with occasional lighter coloured bands of quartz meta-sandstone. Some quartz veining occurs at 57 metres.

Radiometry for TOL-P-87 gives a fairly flat response for both major lithological units. A peak at 34.5 metres corresponds with Tolmer Sandstone when compared to the geological log, but the chart seems to indicate it being at the unconformity. The anomaly rates at just over 100 cps. Further above background features occur at 53 m - 94 cps (mauve, fine grained meta-sandstone) and at 71.5 m - 155 cps (mauve, medium grained meta-sandstone). No alteration is visible in either case.

TOL-P-87 was sited on the western edge of the mise-a-la-masse conductive trend, coinciding with a NW-striking VLF anomaly. TOL-P-88, described below, is located on the eastern side of the above trend but does not have an associated VLF phenomenon.

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**TOL-P-88**

9500N/9880E  Depth 90 metres, Damp throughout. Unconformity intersected at 42 metres.

The Tolmer Sandstone stratigraphy intersected is as follows:

- **0 - 10 m**  red to pink sandstone with a few pebbly bands
- **10 - 13 m**  conglomerate
- **13 - 15 m**  massive pink sandstone
- **15 - 29 m**  reddish brown to mauve sandstone with pebbly laminae
- **29 - 42 m**  variably coloured "laminated" sandstone. Few pebbles.

The Lower Proterozoic comprises a green-grey chloritic (slightly graphitic) schist from 42 - 46 m. The sequence then becomes red to mauve in colour with schists and thin sandstone lenses to 51 m. Below this the lithology is predominantly a fine to medium grained meta-sandstone with bands of light green sericite throughout. Minor chlorite is present. The meta-sandstones range from fine sericite-rich types to medium grained, light coloured, quartz-rich variants.

Radiometry of TOL-P-88 shows a series of peaks within the Tolmer Sandstone, and a background higher than average. Several damp clayey zones could be carrying
radon-enriched groundwater; this feature has been observed in other holes but not to the same extent. The peaks are located at:

- 9.5 m 100 cps
- 17.0 m 92 cps
- 27-27.5 m 89 cps
- 30.5-31.0 m 80 cps
- 35-36.0 m 99 cps

Background is approximately 20 cps.

At the unconformity (41.0 m on the log) an approximate 3 metre interval measures just over 100 cps. Background remains high in the schist lithologies, around 80 cps, dropping to 60 cps in the sandy facies. A peak of 100 cps at 87 metres corresponds to a veined, quartz-rich band with some chloritic alteration.

• Drill Profile 9450N (Plate 31*)

- TOL-P-79 9450N/98755E Depth 84 m Water at 24 m. Unconformity intersected at 38 m.

TOL-P-79 is sited on the eastern limit of a weak N-S trending Mise-a-la-masse anomaly coinciding with a localized, similarly trending, VLF conductor. Re-mapping of the area shows an inferred fault and adjacent breccia zone.

The Tolmer Sandstone intersected comprises a conglomeratic/pebbly facies (as mapped), underlain by a pink sandstone (thin bed), laminated basal facies becoming very red and hematitic toward the unconformity. An interesting feature of the final 8 m of Tolmer Sandstone is the abundance of green chlorite alteration and associated pyrite; possibly a similar occurrence to that seen in TOL-D-28 which showed a very fractured, brecciated, altered zone within the basal Tolmer Group.

Conversely, the alteration in the Lower Proterozoic is less intense, extending for only 4 m below the contact. No graphite was noted. Severe contamination occurred throughout the rest of the hole due to caving of the hole within the Tolmer. The lithologies consist of red/mauve and grey schists and meta-sandstones. Radiometry shows a fairly flat response throughout, without any notable response over the "chlorite zone" or unconformity.
- TOL-P-80  9450N/9970E  Depth 102 m, Water table around 50 m. Unconformity intersected at 63 m.

The hole was sited on a VLF conductor, 100 m east of the mise-a-la-masse trend. It was collared in a massive pink sandstone bed and passed through many pebbly layers and conglomeratic beds and into the laminated basal facies. Several metres of red, very hematitic sandstone are present at the base of the Tolmer Group with, possibly, some chlorite alteration.

Below the unconformity, there was a great deal of Tolmer Sandstone contamination due to drill hole caving; near the unconformity the schist is strongly chloritic, merging into the monotonous sequence of sericite schist and meta-sandstone. Chloritized fragments in all the cuttings to the bottom of the hole were regarded as contamination.

Radiometry is flat throughout with the exception of two peaks in the basal Tolmer Group within 4 m of the contact: 46 cps and 59 cps.

> Drill Profile 9350 (Plate 32*)

- TOL-P-77  9350N/9825E  Depth 60 m, Water at 14 m.

Drilled approximately 40 m south of TOL-P-51. Both TOL-P-77 and the following hole, TOL-P-78, were sited on the margins of the Mise-a-la-masse conductive body, corresponding to a VLF trend and low order radon anomalies.

The unconformity was intersected at 18.5 m. The Tolmer Sandstone occurs as the laminated basal facies becoming very hematitic and clayey towards the contact. The Lower Proterozoic comprises a strongly chloritic green schist from 18.5 m to about 23.0 m with a little graphite. This grades into a fairly monotonous sequence comprising red/mauve and grey interbedded sericite schist and meta-sandstone. Some green chloritic schist occurs at first but this is suspected to be contamination from the contact zone. Some pale green sericite and whitish talcose material occurs in minor amounts throughout. From 54-60 m, the hole intersected a light coloured, fine to medium grained, quartz-rich meta-sandstone.

- TOL-P-78  9350N/9860E  Depth 60 m. Unconformity at 24 m.

The Tolmer Sandstone comprises a very hematitic and clayey sandstone from the unconformity upwards to 16 m, grading into a vari-coloured, laminated facies to 13 m, then a ferruginous pebbly sandstone to surface. The Lower Proterozoic is very altered from the contact to 30 m, comprising, at first, a graphitic-chlorite schist grading to a dark green chlorite schist with decreasing graphite content. The alteration zone rapidly loses
Intensity and the lithologies become typical red, grey and mauve sericitic schists with interbedded meta-sandstones. Minor green sericitic alteration exists as coatings on schistosity planes and fractures.

Neither of the above holes intersected any mineralized phenomena. Some peaks between 80 and 100 cps NaI appear on the chart within the Tolmer Sandstone above the contact, and at the interface in both Tolmer and Lower Proterozoic. The "kicks" at the contact, best illustrated in TOL-P-78, seem fairly typical of the SH2 drill holes whereas peaks in the Tolmer Sandstone seem typical only where strongly hematitic (and damp to wet) sandstone is intersected. Some of the strongest peaks in both holes were recorded in the latter lithology: 95 cps at 4.5 m in hole TOL-P-78 and 145 cps at 8.5 m in hole TOL-P-77. Some peaks were also recorded above and just below the unconformity: 92 cps and 115 cps. Elsewhere the hole is radiometrically flat.

Drill Profile 9300N (Plate 33*)

TOL-P-76 9300N/9825E, vertical, depth 60 m. hole dry. Unconformity intersected at 16 m.

An intense green-grey alteration was encountered in the Lower Proterozoic from 16.5 m to 20.5 m; the alteration appears to be chloritic only, without graphite content. A slight rise in radiometry exists in the Tolmer Sandstone on and just above the contact; here the Tolmer Sandstone is intensely ferruginized, damp and very clayey. The laminated basal facies occurs up to the collar containing minor amounts of limonite and white clay (?kaolin).

The Lower Proterozoic contains coarse mica flakes for several metres below the contact. The alteration zone quickly dissipates, the facies becoming typically pink to red in colour. Meta-sandstones predominate with fine grained red sericitic and pale coloured, more quartz-rich, types being present. Occasional thin beds of sericite schist and red meta-siltstone occur. At the base of the hole, a coarse meta-sandstone is present. Very minor sericitic and chloritic alteration is widespread.

Radiometry is as follows:

Tolmer: 35-40 cps rising to 50-65 cps above the unconformity.

Lower Proterozoic: 60-80 cps, the lower values reflecting quartzose meta-sandstone.

Drill Profile 9200N (Plate 34*)

TOL-P-89 9200N/9825E Depth 72 m. No water, but damp from 19 m. Unconformity intersected at 23 metres.
TOL-P-89 was collared in pink, pebbly sandstone. Siting of the hole was based on VLF and mise-a-la-masse data showing grid N- and NE-trending conductive anomalies. An inferred east/west fault passes just north of the hole.

The basal laminated sandstone extended from 11 metres to the unconformity where it becomes very ferruginous (hematitic) for several metres.

No alteration exists in the Lower Proterozoic at the contact, the lithologies having the typical red to mauve colour and consisting of sandy sericitic schist and fine grained meta-sandstone. The sequence throughout comprises schistose lithologies in the main with only localized beds of fine-medium grained meta-sandstone. Quartz veining is present at 35 m, 49 m, 63 m and 70 m.

Radiometry shows a flat response in the Tolmer Sandstone with a 10 cps average; the only exception is an isolated peak at 19.5 m of 55 cps. The unconformity is marked by a 100 cps zone from 22-23 metres. Lithological variations characterize the log elsewhere to the bottom of the hole.

+ Synthesis - Profiles 9200N to 9700N

This group comprises 10 holes drilled during the campaign with an additional 15 having been previously completed in 1988-89. The principal role of this work was to outline and evaluate the chloritized graphite schist horizon initially located by TOL-D-28 and later TOL-P-51. Placement of the 1990 holes was governed by several factors:

- previous knowledge of the area from drilling, regional geophysics, etc.,
- more recent data gained from detailed ground assessment, principally EM geophysics and mapping.

The end result was that the presence of uranium mineralization within this block was not verified despite the further intersections of alteration and suitable host lithologies within the underlying Lower Proterozoic. These phenomena occur in the majority of holes drilled and are present along the full strike length of the area tested. The alteration is essentially a dark green Mg-chlorite which, characteristically, occurs within the more graphitic horizons, being fairly pervasive. There are exceptions, i.e. non-graphitic schist and rarely meta-sandstone, but in these cases the alteration is less intense. This chloritization was also noted within the basal Tolmer Sandstone, especially near the unconformity, in TOL-D-28 (1988) and, more recently, in TOL-P-87; the latter example has associated finely disseminated pyrite present. From drill core evidence
(TOL-D-28), this phenomenon in the Tolmer Sandstone is confined to areas of intense fracturing and brecciation; in the case of TOL-P-87 the hole was collared on an E-W fault and the intersection was made where the fault trace cross-cuts the unconformity. Similarly in TOL-D-28, where brecciation and faulting are evident in surface exposures, the fault trace must cross the hole adjacent to the contact. In both holes the chloritic alteration extends into the Lower Proterozoic.

Another interesting feature worth noting is the presence of radiometric anomalies within the Tolmer Sandstone. This is not widespread, occurring fairly randomly throughout the drilled area, although on section 9350N both TOL-P-77 and TOL-P-78 exhibit this feature. Geochemical analyses for U and Th have not been systematically carried out over these anomalies, therefore it is difficult to say that they are related to elevation in background of either element. On site, high SP2Z values in these intersections correspond in some cases to damp or wet ground, often clayey, or associated down-hole with cavernous zones. This set of features would suggest a radon source for the anomalies, or for some of them at least; the presence of cavernous and collapsing ground implies fault zones acting as conduits for radon-bearing groundwater. Another hole which has widespread anomalism in the Tolmer is TOL-P-88; here the situation is less clear with anomalies between 90 and 100 cps in apparently non-faulted, homogeneous sandstone.

Apart from localized peaks at the unconformity, the Lower Proterozoic failed to show any significant anomalism. On sections 9500N (TOL-P-87 and TOL-P-88) and 9700N (TOL-P-86) there are minor anomalies within quartz-veined meta-sandstone; geochemical analyses suggest an elevated Th content relative to U (e.g. U > 4 ppm, Th 55 ppm, TOL-P-86) which might account for the result but looking elsewhere where Th values are as high (in relation to U), there is no corresponding peak in the down-hole log.

> Drill Profile 9100N (Plate 35*)

- **TOL-P-84** 9100N/9940E Depth 60 m Water at 43 m. Unconformity intersected at 12 m.

The hole was sited on a combination of VLF conductor and radon anomaly occurring within a weak conductive zone as detected by the mise-a-la-masse survey.

The Tolmer Sandstone comprises red, laminated sandstone with abundant hematite, limonite and white clay. Isolated quartz pebbles are present.
At the contact unaltered Lower Proterozoic medium grained meta-sandstones are present, passing into red/mauve sericite schists and sandy schist. The only alteration is pale green sericite.

Radiometry does not distinguish the unconformity, which is most unusual. Two low order peaks of 100 cps and 80 cps correspond to a dark colouration within red-brown schist at 22-24 metres; this was also recorded on SPP2 with 155 cps. A noticeable drop of the background occurs at 40 metres where schists give way to meta-sandstone.

Drill Profile 8850N (Plates 18-90 and 36*)

- TOL-P-83 8850N/10010E Vertical Depth 60 m Dry hole. Unconformity at 10 m.

Drilled on a combination of features: a radon anomaly and a VLF conductor coinciding with the eastern edge of the mise-à-la-masse trend. The hole is adjacent to the location where graphite schist float was found.

The Tolmer Sandstone outcrops as a highly ferruginous, almost lateritized, pebble sandstone with relatively high scintillometric readings. Cuttings gave up to 90 cps. Several metres of highly chloritized graphite schist occur at and below the contact with dark green chlorite schist persisting to about 20 metres. This occurrence would be the best example of alteration seen in the Lower Proterozoic in any holes drilled. Scintillometric readings were not anomalously high, up to 130 cps, but do reflect a surface background of 90 cps.

The green chlorite schist came up in all the cuttings, most likely as contamination. Below the alteration zone the more typical red to mauve colour of the lithologies prevailed, comprised of interbedded schists and meta-sandstones.

Down-hole radiometry reflects the high background. A peak to 90 cps corresponds to a cavernous hematitic clay zone in the Tolmer, as do other smaller peaks. The unconformity is marked by a small peak over 100 cps and two others between 13 m and 16 m, up to 140 cps. The background then ranges from near 80 cps to 100 cps. No significant anomalies occur.

Synthesis - Profiles 8850N to 9100N

TOL-P-83 and TOL-P-84 respectively were drilled on EM-VLF anomalies thought to be coincident with beds of graphitic schist. TOL-P-83 intersected a very promising sequence of Middle and Lower Proterozoic lithologies including graphitic schist, while TOL-P-84 registered a flat radiometric response within unaltered rocks.
The environment in which TOL-P-83 was collared has been documented elsewhere in this report; the result from the hole points to a similar prospective zone to that discussed in the first part of this synthesis. A very hematitic and radiometrically anomalous Tolmer Sandstone facies overlies a dark coloured, intensely chloritized graphite schist which extends for about seven metres down-hole; a high background (SPP2 and down-hole log) is present throughout. Uranium values are elevated over the contact zone (in both Tolmer and Lower Proterozoic) while thorium tends to remain stable with comparatively low values.

> Drill Profile 8700N (Plate 37*)

- **TOL-P-81 8710N/10155E** Depth 60 m, Dry hole

Sited in the immediate vicinity of the Robert's Creek radon anomaly. Faulting in a NW/SE trend is evident immediately west of the drill hole location and Robert's Creek is, most likely, one of the many regional fractures which cross-cut the lithologies. In addition, the irregularity of the unconformity one hundred metres to the west suggests some fault control.

The Tolmer sequence in TOL-P-81 comprises:

0 - 6 m: pink sandstone with a few pebbly laminae.

6 - 14 m: principally red hematitic sandstone. Some "laminated" fragments suggest the basal facies.

14 - 16.5 m: very hematitic, red sandstone.

The Lower Proterozoic shows only limited alteration at the contact with a grey-green chlorite schist containing minor graphite. Within a metre the alteration has disappeared and a red/mauve sericite schist occurs.

Schists and meta-sandstones are interbedded in the sequence intersected to the end of the hole. Minor quartz veining is present at 26 m, 50 m and 63 m. Some light coloured quartz-rich meta-sandstone is evident interbedded with the more common reddish, fine grained variants.

Radiometry (NaI down-hole) shows a higher background than that encountered elsewhere, averaging 60 cps. Two zones just go "off-scale": 42.5-43.1 m, 100 cps and 47.3 m, 105 cps. Both are in a light coloured, "bleached" meta-sandstone or quartzite.
- TOL-P-90  8675N/9959E  Depth 54 m  Dry hole
  Unconformity intersected at 8 m.

The hole is located on a strong VLF Fraser Gradient anomaly, coinciding with the eastern edge of the mise-à-la-masse trend. Low order radon anomalies surround the hole collar. The outcrop position of the unconformity is only a few metres to the north.

The hole collar is in the basal laminated facies of the Tolmer Sandstone. The sandstone is fairly weathered with hematite and some limonite. Below the unconformity the Lower Proterozoic comprises a coarse grained quartz meta-sandstone; fine to medium grained, red/mauve meta-sandstones remain the predominant lithology in the hole with only thin interbeds of sericitic schists.

Radiometry shows a fairly flat response throughout; the Tolmer Sandstone averages 15 cps while the Lower Proterozoic averages 50-65 cps. Maxima reach 80 cps at the unconformity and 80-90 cps in places throughout the hole. No alteration was noted at the contact.

> **Drill Profile 8658 (Plate 38*)**

- TOL-P-82  8658N/10195E  Vertical  Depth 72 m
  Unconformity intersected at 31 m.

The Tolmer sequence comprises vari-coloured sandstone with scattered quartz pebbles to 14 m depth underlain by the laminated facies which extends to the contact. The latter becomes very red and hematitic towards the base with, possibly, a little chlorite alteration.

There is no well developed alteration within the Lower Proterozoic at the unconformity. Very minor amounts of green chlorite and sericite are present which continue throughout the hole. The major lithotypes are typical, being red-mauve schists and variably grained meta-sandstones.

Down-hole radiometry exhibits a very flat response for the Tolmer with the characteristic sudden rise at the contact from 16 cps to about 70 cps. The Lower Proterozoic is "spikey" and varies from 50 cps to a maximum of 80 cps.

> **Drill Profile 8600N (Plate 39*)**

- TOL-P-91  8600N/10000E  Depth 60 m  Dry hole
  Unconformity at 16 m.

The hole was collared in thinly laminated basal Tolmer Sandstone adjacent to some brecciated zones. Several VLF trends are evident in the vicinity as well as low order radon anomalies. An E-W fault disrupts the surface trace of the unconformity immediately south of the collar position.
The intersected Tolmer Sandstone facies comprise a red, hematitic banded sandstone becoming pink to mauve towards the contact. Weathering in the upper section has produced limonite staining and white clay development.

The Lower Proterozoic shows a little alteration at the unconformity. The facies are dark coloured with some chlorite and possibly minor graphite. The remainder of the sequence comprises a monotonous series of red/mauve fine grained meta-sandstone, sericite schist and sandy schist. Rarely, the sandstone beds are light coloured and coarser grained with a little apple-green sericitic alteration.

Radiometry shows a very low background for the Tolmer Sandstone of about 5 cps. There is an anomalous zone between 18-22 m ranging from 60-84 cps; this coincides with the unconformity and several metres below. The facies are grey sericitic schists with some dark chlorite and lighter green sericite. The counts rapidly decrease when sandy units appear. The remaining log averages about 40 cps illustrating the predominant sandy facies in the hole.

- **Drill Profile 8400N** (Plate 40*)

  - **TOL-P-92** 8400N/10050E Depth 54 m Dry hole. Unconformity at 4 metres.

Collared in ferruginous, laminated basal Tolmer. The unconformity was intersected in the collar-pipe section of the hole, therefore no lithological observations could be made; the surface position of the contact is located 50 m west of the hole.

No alteration was noted in the Lower Proterozoic adjacent to the unconformity. The lithologies comprise mauve, fine to coarse grained meta-sandstones with minor interbedded schists.

Radiometry shows only the Lower Proterozoic with a range of 30-90 cps. No anomalous zones are evident.

- **Synthesis - Profiles 8400N to 8700N**

Several features were tested here involving five percussion holes. The Tolmer cover proved to be fairly thin, generally between 3 and 10 metres thick. TOL-P-81 and TOL-P-82, positioned on an E-W fault adjacent to the Robert's Creek anomaly, failed to locate any mineralized phenomena, but did intersect a very weakly chloritized schist bed (with minor graphite) at the unconformity. TOL-P-90, TOL-P-91 and TOL-P-92 were collared on EM anomalies, the former two
more or less along strike from TOL-P-83. Radiometry was generally flat with only minor response adjacent to some weak chloritic alteration in TOL-P-91 (schist/meta-sandstone interbeds). TOL-P-92, drilled immediately into unaltered meta-sandstone at the unconformity, failed to locate any altered Lower Proterozoic.

6.3.4.5 Drilling Details 1991 Campaign

The 1991 drilling campaign concentrated in Eccles II. Only one hole was drilled in prospect SH2, to test a strong mise-à-la-masse anomaly. Hole TOL-P-83, drilled vertically in 1990 was thought may have missed the main conductor so it was decided to drill an angle hole. (Plate 36*)

- TOL-P-115

  Co-ordinates 8850N 9985E
  Azimuth 045° magnetic
  Declination -60°
  Depth 84m
  Radioactivity Nil

The hole intersected very hematitic chlorite and graphite schists beneath the unconformity with the Depot Creek Sandstone of the Tolmer Group, which adequately explains the presence of the mise-à-la-masse anomaly. No variation in the background radioactivity and hence no uranium mineralisation was noted in the hole.
6.4 ECCLES II

6.4.1 Location

Eccles II is located at AMG 955140, Reynolds River 1:100,000 topographic sheet and was discovered by TMA geologists in mid-1986 during a creek traverse. The anomaly is contained within the Burrell Creek Formation about 700 m from the Tolmer unconformity. The anomalous zone is interpreted as being stratabound, confined to well-bedded brown and reddish micaceous meta-siltstones with maximum SPP2 readings of 4200 cps (Plate 9-86). Overlying the main anomalous zone are thin alternating beds of siltstone and graphitic shale giving up to 500 cps. These are in turn overlain by an arenaceous facies. Along strike the anomaly tails off upslope and is obscured by alluvium and gravel in the other direction. No further anomalies were found in the area during the regional traversing.

6.4.2 Geology

Geological mapping of the Eccles II area was carried out concurrently with geophysical and drilling work, mainly during 1988 and 1990. As the amount of information from surface observations and drilling increased, the geological interpretation evolved to accommodate the new data.

The drill holes description in the following section is based on the geological understanding at the time; therefore, for consistency, the different interpretations are summarized below.

6.4.2.1 Geological Interpretation, 1988 Campaign

In 1988 geological mapping was conducted over an area 350 m x 300 m in conjunction with a VLF survey. The results of the mapping are shown in Plates 22-88 and 23-88.

The area consists primarily of schists (carbonaceous and micaceous) in the north, overlain by metasandstones and conglomerate and micaceous schists in the southwest, all dipping approximately 50° towards 240°Mag, except where faults have caused rotation. The anomaly is within light green, chloritic and sericitic schists with a few interbeds of carbonaceous shale. Granite pegmatite bodies occur parallel to strike, along a probable fault trend. The pegmatite near TOL-P-8 is the largest in the area. These bodies are characterised by areas of no outcrop with orange micaceous soils, or by local development of tourmaline in schists. A pegmatite body is indicated along strike in the southeast corner of the grid within schists.
Structurally the area is cut by northeast- and north-trending faults mappable in outcrop. One of these faults is marked by schist-specular haematite breccia which is not radioactive. A downhole SPP2 and alphaCard anomaly here may be related to this faulting but no evidence was found for this correlation in surface prospecting. The axis of a tight anticline extends throughout the eastern half of the area, and plunges 17° to 315°Mag.

6.4.2.2 Geological Interpretation. 1990 Campaign

The geology of the gridded zone that covers Eccles II as well as the SH2 prospect to the north (see section 6.3.2.3) was re-interpreted and expanded in 1990. The mapping was compiled in four sheets at the scale 1:2000, the northernmost ones (sheets 1 and 2) covering SH2 prospect and the two southern ones (3 and 4) covering Eccles II.

In this report the boundary between the two prospects has been assumed, somewhat arbitrarily, to be gridline 8400N.

> Sheet 3 (Plate 41*)

This sheet covers from the boundary of Sheet 2 south to 6800N. The principal features of this sheet are the Eccles II prospect and the Palm Valley chloritic-graphitic schist outcrops.

+ Lower Proterozoic

Almost the whole area is occupied by Burrell Creek sediments which form steep-sided hills, some with flat, plateau-like summits. The general strike is 330°Mag with generally steep dips of the strata, both to the east and west; the sequence is tightly folded. Faulting undoubtedly occurs but is difficult to recognize. The tight folding with the constant repetition of the beds may be a factor in masking structures; in addition, the lithological monotony makes it difficult to choose distinct marker beds which could be used to determine structure.

The lithologies comprise argillaceous through rudaceous variants. The most common are:

- reddish, sericitic meta-siltstone and fine grained sandstone, generally intimately interbedded;

- darker coloured sericite schists and sericitic andalusite schists with crystals to several centimetres. Graphitic and chloritic schists are limited to several specific areas.
fine to medium grained sericitic meta-sandstones (quartzites), ranging from impure to fairly pure quartz-rich variants. Also gritty to conglomeratic facies which outcrop more commonly near the present day contact with the Middle Proterozoic.

Late stage quartz veining is prominent especially adjacent to fold axes. Greisen veins are also fairly common and can be quite extensive, up to several hundred metres in length. In places they grade into quartz with only subordinate mica. The vein systems are far more widespread than was realized previously.

Effects on the country rock as a result of these intrusives have been observed. Greisenization of meta-sandstone facies occurs, i.e. high mica content and silicification. Andalusite content could be partly due to veining as well, although the metamorphic effects of the folding are the prime cause. Some reddish altered sediment was observed near veining at 10250E/7200N.

The coincidence of intensive veining and carbonaceous-graphitic rocks is interesting. The two appear to occur within a zone of intense folding between 7000N and 7600N and centred around 10300E. A smaller, isolated outcrop is present between 7000N and 10000E/7100N. These outcrops, in addition to graphites known from the Eccles II uranium prospect, confirm a very widespread occurrence of these facies within the Burrell Creek Formation.

The geological setting of the Eccles II prospect was enlarged upon during the 1990 programme of mapping. Much of the hillside, and therefore the potential strike of the mineralized lithologies, is covered with thick boulder rubble which obscures completely the relevant outcrops. The roadworks and the drill pad for holes TOL-P-95 and TOL-P-96 provided exposure which aided the interpretation of the local geology. The bulldozer cut revealed the presence of greisen veining and chloritized lithologies with SPF2 values to 800 cps (compared with 140-200 cps obtained during the alphaCard survey).

The prospect geology comprises thin alternating beds of fine to coarse grained, fairly massive meta-sandstones with interbedded schists. The entire sequence is heavily veined by quartz-stringer swarms and associated coarse grained greisen bodies; these features are broadly stratabound although the strike and dip of individual quartz veinlets can vary. The mineralized sequence comprises non-outcropping fine sericite schists, graphite and chlorite schists and interbedded red meta-sandstone bounded to the west by a fault/greisen body association. The lithologies dip west, being on the west limb of a localized anticlinal structure; the fold axis is centred on a prominent quartz-veined, coarse meta-sandstone bed which forms the spine of a steep ridge paralleling the mineralization. The abovementioned fault trends uphill forming a peculiar topographical feature; discontinuous traces of the greisen can be followed for several hundred
metres along this structure to about 8100N; parallel veins occur to the east though these are not as extensive. Movement on the fault is considered to be vertical with east block down.

The only surface expression on the south side of Eccles Creek is poorly outcropping interbeds of schist and meta-sandstone, trending upslope in a southeast direction. Abundant quartz and some greisen rubble are scattered over the hillside, indicating the possible presence of a continuation of the mineralized sequence. A drill hole, TOL-P-94, was collared at the base of the hill to test the potential; results will be discussed in Section 6.4.4.3.

+ Middle Proterozoic

Outcrops of Tolmer occur mainly in the northeast corner of the mapped area. The dominant facies is the basal "laminated" sandstone with some pebble and gritty laminae. Small outliers were mapped adjacent to the contacts.

The Tolmer reappears between 6800N and 6950N, just within the mapped area. Here the contact is faulted, forming a NE/SW to N/S relationship with the Burrell Creek. Small outliers were also mapped as indicated. On two traverses, 7700N and 7500N, the unconformity was located by walking off the end of the grid and estimating the distance from the 1050E peg. On 7700N the contact was only 50-75 m grid east while at 7500N about 250 m grid east.

> Sheet 4 (Plate 42+)

Much of the sheet area comprises Tolmer Group rocks which have been subdivided into three sub-units; all belong to the Depot Creek Sandstone. The Burrell Creek Formation outcrops over a limited area in contrast to Sheet 3; the western and northern fringes of the mapped area are composed of these rocks.

+ Lower Proterozoic

Generally poorly outcropping in the mapped area. On the western edge of the grid, thin sandstone beds crop out, commonly quartz-veined with some greisens; schists and meta-siltstones tend not to outcrop but can be traced by surface rubble. The beds are tightly folded with three fold axes indicated; strikes vary from grid north (310°-315°) to NNE (320°-325°). A slight flexure appears to exist with a strike change from NNE to NNW.

On the northern part of the map, the Lower Proterozoic comprises a steeply west-dipping sequence of mica schist and andalusite schist with thin sandy interbeds. Quartz veining and greisen are also present. The strike of the beds again shows a flexuring from grid north to NW indicating probable drag into the east-west fault.
+ Middle Proterozoic

Covers 90% of the sheet area showing a regional grid-north strike and generally shallow east dips. Except where previously mentioned, the contact is unconformable; a minor fault occurs on the contact on the 6300N profile. A broad subdivision of the Tolmer has been made on lithological variations as follows:

- 'Laminated' facies: banded, thinly bedded red/white sandstone, generally fine grained and free of pebble laminae. One fragment of this facies was found in creek rubble in which large quartz clasts were observed. This would be the 'basal breccia' observed elsewhere near the 9600N profile.

- Two facies variations were observed: a very ferruginous, ?lateritized, fine to medium grained pebble sandstone, very brecciated in places, and a pink to white, fine to medium grained silicified sandstone, in places with abundant lenses of pebbly and conglomeratic material. The second facies shows many features associated with a turbid sedimentary environment.

- Massive, white to pink, usually silicified, fine to medium grained sandstone. Rare pebble component.

+ Structure

The Lower Proterozoic is typically tightly folded; quartz and quartz-greisen veining crop out adjacent to fold axes. Dips are steep both east and west.

Tolmer rocks are undeformed apart from the faulted area on 6300N. Here the beds have undergone local rotation from approx. N-S to E-W with north dips. Adjacent to many of the regional lineaments which traverse the sandstone, fairly intense shattering has taken place; this feature is more prevalent in Ptd(iii). Elsewhere, especially in the vicinity of the faulted "unconformity", breccia zones are widespread in Ptd(i) and (ii).

6.4.3 Geophysics

6.4.3.1 Early Surveys

Initial work on the prospect in 1986 was confined to gridding and radiometry.

Work carried out in 1987 included an alphaCard survey over alluvium and soil cover and backhoe trenching to locate possibly obscured mineralized extensions (see Fig. 4-87). Forty-six alphaCard stations were drilled to 40 cm, all in unconsolidated material. Highest values were recorded adjacent to the original discovery point with a maximum of 136 cpm; the next highest readings on nearby stations were
25, 17 and 14 cpm. There was a general decrease away from these. On the southeast bank of the creek opposite the anomaly, values ranged between 1 and 3 cpm rising gradually towards outcropping meta-siltstones on the hill slope.

Backhoe trenching totalled 82 m. The trenches were located to obtain a sub-surface exposure of the anomalous zone, to check the geology below the alluvial cover and to define any anomalous trend. Each trench was mapped and scintillometer readings were taken at 50 cm intervals along the bottom (see Fig. 5-87). Trench 1 contained good exposures of the sediments and was anomalous for most of its length; trench 2, located 8 m to the east, was in soil and trench 3 similarly. Away from the base of the hill slope there is obviously a very rapid thickening of soil and alluvium. In places the trenches were 2.5 m deep without exposing bedrock. Trench 4 was unsuccessfully excavated on the southern side of the creek; the dry unconsolidated gravels kept caving so the work was abandoned.

The anomalous lithologies exposed in trench 1 showed a pervasive and strong hematitic alteration with the mineralization cross cutting both argillaceous and arenaceous facies. Despite high readings no secondary uranium minerals were observed.

Further work was carried out in 1988, extending the alphaCard grid and complementing the geological mapping with a VLF survey. Two transmitters were used: Japan (NDT) and North West Cape (NWC).

The lines for NDT were plotted east-west (longitudinal conductors) and those for NWC were plotted north-south (latitudinal conductors); graphical plots for the VLF are illustrated on Plates 24-88 and 25-88.

The VLF on NDT is sigmoid in shape and mostly parallel to lithology. It is strongest in the extreme southeast of the grid. Small northeast-trending anomalies on NWC seem to be broken by this main trend. This anomaly is therefore interpreted as a fault zone. Other supporting evidence is the occurrence of pegmatites, strong cleavage development, termination of the alphaCard anomaly and air photo lineaments.

The marked linearity of the Eccles II radiometric anomaly, both surface and downhole, suggests that it is structurally controlled and dips towards the west. A large quartz blow and tourmaline in schists at 9940E/10290N probably represents a subcropping pegmatite along a fault.
6.4.3.2 Geophysics in 1990

Like geological interpretation in 1990 (section 6.4.2.2), geophysical results were reported according to a four sheet compilation of the Eccles II/SH2 area. Sheets 1 and 2 in the north cover the SH2 prospect; sheets 3 and 4 in the south deal with Eccles II prospect.

Scintillometric prospecting did not define any further anomalous zones on or adjacent to known graphite schists occurrences, however, dark grey silicified boulders found along the Palm Valley Creek bed gave SPP2 values to 320 cps (approx. 7350N/10250E). No outcrop source was found.

> Sheet 3 (Plate 43*)

The regional VLF survey was the only geophysical activity concerning Sheet 3. The survey was run in several stages. The whole area was initially covered with the WADI instrument on a 10 m x 50 m spacing; malfunctioning of the computer during dumping caused a loss of about 50% of the data pertaining to some of the most difficult country on the entire grid. This section was eventually repeated using the EM-16 but with much wider spacing (25 m x 100 m) because of time limitation.

The two major conductive anomalies discovered by the follow-up survey, Eccles II and Palm Valley, were re-run at 50 m spacing to produce better definition. INPUT anomaly SH3 is thought to correspond to these conductors, though there is a discrepancy in the Geoterrex plot.

The conductor outlined over the Eccles II uranium prospect rates as the most intense and extensive within the entire surveyed grid. Knowledge of the geology through mapping (1986, 1988 and 1990) and drilling (1988, 1990) explains the presence of a conductive phenomenon, though such an obvious one was not expected. Similarly, the Palm Valley trend is well illustrated as a strong linear anomaly following a wide, fairly extensive outcrop of chloritic-graphite schist. The geology of the two conductors is identical.

Much of the Eccles II conductor is obscured by thick gravel deposits and sand from Eccles Creek, principally between 7625N and 7725N; in addition beyond these limits, outcrop is poor due to boulder deposits (on the north side) and scree and soil on the south side. The value of the VLF method is obvious in such cases, the Tolmer cover not being the only factor in masking anomalies.

The Palm Valley anomaly shows good correlation with the mapped geology. The centre of the contoured feature is located just north of Palm Valley Creek about 40 metres from the drill hole (TOL-P-97) collar. The southern extension of the conductor appears as an elongate, thin 'tail' which cross-cuts the lithology; this is probably a

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function of contouring error induced by survey spacing. A small cliff-like outcrop of graphite schist at 7100N shows up as a conductive anomaly separated from the main zone by resistive ground; mapping however, shows the graphite horizons to be continuous.

A smaller graphite schist outcrop, also with associated quartz and pegmatite veining (10000E/7050N), shows an offset in relation to the position of the VLF conductor. The apparent minor discrepancies between outcrop position and interpreted conductor cannot be explained; a graphitic outcrop should show up as a conductive body directly. There must be other factors involved which create these variations, both in the field and in plotting the data.

Several smaller anomalies, subparallel to the lithological strike, occur within the same broad belt containing the graphitic facies. Mapping shows andalusite schists with minor interbeds of meta-sandstone but no lithologies that are obviously conductive. This group exhibits a sharp termination at 6900N, coincident with a regional E-W fault which brings the Tolmer into contact with the Lower Proterozoic; movement is vertical with south block (Tolmer) down.

* Sheet 4 (Plate 44*)

The sheet comprises data from the EM16 instrument on a 25 x 50 m spacing. Conductors were identified in both the exposed "Burrell Creek" and Tolmer Sandstone. They have a common apparent strike, being N-S (grid NE). The majority occur within (or beneath) the Tolmer cover, commencing adjacent to the unconformity and extending into the cover rocks; one subsidiary conductive phenomenon transgresses the contact for a short distance.

Between 6600N and 6850N an extensive, quite broad conductor flanks the unconformity; it extends north as a series of localized and discontinuous spot anomalies. Outcrop is poor and available lithological evidence failed to identify a conductive facies.

A smaller conductor is located between 6050N and 6175N, wholly within the Lower Proterozoic; it is most likely fault-associated as no graphitic facies was mapped here.

6.4.3.3 Radon Survey and Radiometry

The original alphaCard anomaly and surface SPP2 are coincident and linear north-south and extend for 100 m. Some high counts are present under the alluvial cover to the northeast of the alphaCard high. Also, higher background on SPP2 and chloritic alteration of the schists extends to the northwest and southeast under Discovery Creek and confirm to lithological strike. However, this lithological extension was tested in TOL-P-9 where only very low grades were found (0.031-.038%U). A strong VLF anomaly trends parallel to strike and marks precisely the southern-most boundary of the alphaCard anomaly.
The area was surveyed in greater detail in 1990, when radon surveys were recommenced at the start of the campaign, initially infilling and extending the previous years work. As the VLF-EM proceeded south to Eccles II and beyond, all principal conductive zones were plotted and further alphaCard stations planned. Profiles of stations covered the width of the conductor, up to 50 metres each side, and similarly were extended along strike (generally north-south) so that full coverage of the anomaly and adjacent ground was achieved.

Referring to Plates 18*, 19* and 20*, the ground covered is patchy and irregular in places. The selectiveness of the survey was necessary due principally to the large size of the grid; radon surveys are labour intensive and time consuming, making full coverage of the area impossible in one field season. Experience of previous years has shown that it is not necessary to achieve blanket coverage but to selectively delineate zones according to their geophysical characteristics.

The 1990 alphaCard programme was planned to achieve the following:

- Extend south from Robert's Creek, covering the Tolmer Sandstone specifically where mapped faults and EM conductors were delineated.

- Cover selected conductors over exposed Lower Proterozoic facies especially around the Eccles II Prospect and Palm Valley trend.

- Cover selected conductors south of Eccles II, both within Lower Proterozoic and Tolmer Sandstone.

The results of the surveys are discussed below.

- The Eccles II EM anomaly and adjacent area was covered fairly extensively, especially along the interpreted extensions of the mineralized zone. In addition, the Palm Valley and 'Bower Bird' graphite-schist/pegmatite outcrops were also covered.

A total of 108 stations covered the Eccles II prospect in an elongate 750 metre long (N-S) area. Highest values obtained are 117 cpm and 106 cpm (7750N) located on the 1988 drill bench where mineralized outcrops occur; these confirm similar values from previous surveys. The sharp cut-off on the south represents thick alluvial and gravel cover of Eccles Creek and the flat, soil covered area which extends to the base of the hill (7600N profile). Radon values again increase upslope forming a broad, moderately anomalous area 200 m along strike and up to 150 metres in width.

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North of 7750N, radon readings decrease rapidly to 14 cpm (drill bench, 7800N) and 11 cpm (7850N). It should be noted here that the former value was obtained prior to bench preparation; approximately 1.5 m of loose rock and soil were removed so that a much higher reading would be obtained considering the strong mineralization found in TOL-P-96 and the 800 cps SFP2 readings occurring on the bench floor. This is a good example of where a relatively thin cover can obscure important mineralization or potentially mineralized lithologies.

Four short profiles cover a 150 metre strike of the Palm Valley graphitic zone; although the area of interest was larger, time constraints prevented an extension to this survey. Values up to 10 cpm were obtained on two lines with several of 6 cpm and one 8 cpm. Drill hole TOL-P-97 justified exploration of this zone with a minor but significant intersection of weak uranium mineralization (78 ppm).

The most southerly group of readings extend from 7150N down to 6400N, covering a series of parallel EM conductors, both within exposed "Burrell Creek" and beneath Tolmer Sandstone. In addition, a localized batch of 13 stations centred on 10350E covered an EM anomaly well within the Tolmer; here an extraordinarily high reading of 108 cpm was obtained in a damp creek bed. Surrounding radon values are insignificant. Follow-up investigations showed a typical occurrence of damp, black, vegetation-rich soil accumulating around a seepage area in heavily fractured Tolmer Sandstone. Scintillometer readings of several hundred counts confirmed a local anomalous zone intimately associated with soil deposit. Outcrop readings in the vicinity were normal for Tolmer: 25-30 cps.

The more intensively covered area extends along the unconformity and beneath the Tolmer. Fairly detailed mapping failed to locate a cause for the conductive zones, except for the Bower Bird graphite schist outcrop, although here, as previously mentioned, there was not a good correspondence. alphaCard profiling commenced here and was extended continuously southwards to cover as much area as possible. Some trends were established which contained isolated maxima of 6 to 7 cpm; overall, though, there does not seem to be anything encouraging, except possibly in the vicinity of graphite schist outcrops.
### 6.4.4 Drilling

#### 6.4.4.1 Summary

The following table summarises the drilling statistics at Eccles II. Plates 15* and 41* show the drill hole locations.

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<th>Co-ordinates (Local Grid)</th>
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<th>Dip Deg.</th>
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Total 29 holes for 2191m

Two percussion holes and one diamond hole to 94 m were drilled in 1988 to undercut coincident and very strong alphaCard and SPP2 anomalies and test lithological control of the mineralisation. TOL-P-8 intersected a thick anomaly with a 6.5 m intersection at 939 ppm Eu average grade above the 500 ppm cut-off. The mineralisation was in chloritic schist with minor carbonaceous shale and fine sandstone. Further drilling along lithological strike and downdip, gave mixed results. TOL-P-9 gave a total of 1.4 m above 300 ppm eU cut-off at 386 ppm average grade.
The aim of the drilling campaigns in 1990 and 1991 was to upgrade the Eccles II mineralization and, hopefully, to delineate sufficient reserves to justify the application for an Exploration Retention Lease. This, unfortunately, did not eventuate.

6.4.4.2 Drilling Details - 1988 Campaign

- **TOL-P-8** (Plate 45*). Drilled towards the northeast to a depth of 83 m, it was designed to undercut the strong surface alphaCard anomaly. A thick anomaly was intersected between 19 m and 36 m. Intersections calculated at 1000 ppm, 500 ppm and 300 ppm cut-offs were 2.4 m at 1383 ppm, 6.5 m at 947 ppm and 10.3 m at 767 ppm average grades respectively. The implied dip of the mineralisation (correlated from the surface anomaly) is 50°, which is close to lithological dip. The anomaly is above the drilled water table (78 m) but below the hydrostatic water level.

The lithologies intersected in the hole are predominantly carbonaceous shale and chloritic siltstones and schists separated by two main sandstone units. Pegmatite veins are present between 46 m and 70 m. The anomalies were found in the chloritic schist intervals although the carbonaceous shales has very high background.

The chloritic alteration is very strong in the anomalous zone and some grey vein quartz is present probably indicating hydrothermal activity. Carbonaceous shale interbeds below 70 m gave a positive reaction with acid, however no dolomite chips were present.

- **TOL-P-9** (Plate 46*). Drilled 22 m to the southeast of TOL-P-8 parallel to lithological strike and located on an alluvial flat. The hole was drilled to 60 m and intersected anomalous strata between 6 m and 25 m with a similar log signature as in TOL-P-8, however the grades were low. Average grade at 300 ppm cut-off was 386 ppm over 1.4 m. Unfortunately only a log through the drill rods was possible due to caving of weathered rock and alluvium from the top of the hole.

- **TOL-D-25** (Plate 45*). A fully cored hole to 93.8 m was drilled 19 m behind TOL-P-8 at an inclination of 80°, intending to intersect the downdip extension of the mineralisation. Core recovery was 100% except for some losses at the surface. Only the SPP2 log from core is available for the hole due to failure of the logging equipment.

The expected mineralisation between 42 m and 65 m with a peak at 53 m was not found. In fact, there were only background values in the core, with increases of 20% on the SPP2 log between 48 m - 50 m, and 56.5 m - 58.5 m in slightly chloritic graphitic shale and granite pegmatite respectively. A chloritic sandy schist between 44 m and 48 m was radioactively dead.
The lithological correlation with TOL-P-8 is good down to 51 m where a six metre thick greyish green mudstone is unfamiliar. If the sandstones between 62 m and 75 m are equivalent to the lower unit in TOL-P-8, then the thickness of schists which host the anomaly in TOL-P-8 is much reduced in TOL-D-25. The lithologies present were micaceous metasiltstones, phyllites, mudstone, carbonaceous shale and fine to coarse greywackes. A pegmatite vein at 66 m can be correlated with outcropping pegmatite at the surface.

**Geological Synthesis**

Lithological correlation between TOL-P-8 and TOL-P-9 is quite good with the sandstone and schist units and pegmatites in the same relative positions in both holes. Therefore the anomalous strata in TOL-P-9 are most likely complete compared with TOL-P-8 although directly overlain by alluvium.

The results of the drilling suggest that structure is the controlling influence on the mineralisation, and that a sequence of schists and carbonaceous shales are the host rocks.

The drill holes at Eccles II were drilled into southwesterly-dipping schists and sandstones on the western limb of a northwesterly plunging anticline. TOL-P-8 was drilled at an acute angle to the alphaCard anomaly which trends northerly. This trend is parallel to some fault trends in the area, and may therefore be a fracture zone.

Although TOL-P-9 was drilled to test the southeast extension of mineralisation from TOL-P-8 the interpretation of this data is hampered by thick alluvial cover.

The pegmatite is an important control on mineralisation. TOL-D-25 was drilled closest to and on the opposite side of the pegmatite body from TOL-P-8, and it was radiometrically dead. VLF and alphaCard data suggest that the pegmatite may delineate a fault which has abruptly terminated the mineralisation southwards.

**6.4.4.3 Drilling Details, 1990 Campaign**

In 1990, a further five holes (one abandoned at the collar) were drilled in Eccles II.

- **Drill Profile 7800N (Plates 23-90 and 48*)**
  - TOL-P-95 9908E/7800N Depth 60 m Water from 35 m. Azimuth 225°. Dip -50°.
Both TOL-P-95 and TOL-P-96 were drilled on the 7800N drill bench, the former to the west and TOL-P-96 to the east. TOL-P-95 was planned to intersect, at about 20 m, an anomalous zone located by SPP2 on the drill bench. Up to 850 cps were measured within a red meta-sandstone adjacent to a wide zone of greisenization.

Only very minor radiometric anomalies were intersected between 12 and 27 metres with a maximum of 370 cps on a background of 180 cps. Lithologies were principally sandy with minor interbeds of meta-siltstone. Greisen veining occurred from 14-16 m; below were minor quartz veinlets with some hematitic staining. Some black tourmaline was identified.

Below the anomalous zone, a monotonous strongly chloritized meta-sandstone/quartzite sequence is present, devoid of any mineralized phenomenon.

Highest counts on the down-hole log were 180 cps at 24.8 m and 185 cps at 20.5 m.

- TOL-P-96 9908E/7800N Depth 90 m Dry hole. Azimuth 45°. Dip -60°.

TOL-P-96 was drilled east to test both the EM-VLF conductive zone and some moderately high radon values. Several zones of weak to moderate mineralization were intersected in a wide zone from 8 m to 48 m and some isolated sections from 54-58 m, 64 m and 73 m; the latter were quite weak associated with some minor hematitic material and pale green sericitic alteration.

The strongest anomaly, located between 12 and 15 metres, comprises soft, powdery, micaceous siltstone with some hematization associated with the 4200 cps maximum. Elsewhere SPP2 values range from 600 cps to 1500 cps, down to 48 m with a varied lithology comprising interbedded, mainly chloritic, meta-siltstone, meta-sandstone/quartzite and graphite schists. Minor quartz veining and hematization are present in places.

Below the anomalous sequence, the metasediments are identical with a fairly high background of 300 cps SPP2 to about 70 metres, dropping to 200-230 cps to the end of the hole. A swarm of greisen veins is located between 59 and 74 metres. Further graphite schists were intersected from 80-83 m. Radiometry was slightly higher in association with these features.

Downhole radiometry confirmed the SPP2 values. Maxima of 4600 cps and 440 cps (in rods) occurred from 11-14 m; 1500-1600 cps from 22-26 m; 2000 cps at 34.3 m and 1400-1500 cps from 38-40.5 metres. Background for this interval was above 500 cps.
+ Synthesis - Profile 7800N

The 7800N section initially had only one hole planned to test the VLF conductor in combination with the interpreted strike of mineralization intersected in TOL-P-8 (7750N profile). The bulldozed excavation for the drill site exposed radiometrically anomalous ground (discussed elsewhere in this report) which necessitated a change in the drilling strategy, hence an additional hole, TOL-P-95, was drilled to the west to undercut these surface anomalies. The mineralization in TOL-P-95 appears to be fault controlled, the structure being illustrated by quartz and greisen veining within a chloritic-sericite quartzite bed. West of the structure there is a sudden drop in the radiometry and no further mineralized phenomena. This is obvious on the 7750N section, where diamond hole TOL-D-25 was drilled west of the greisen-filled fault zone and failed to intersect any anomalies, whereas TOL-P-8, 25 metres east, located ore grade mineralization in identical lithologies.

The principal controlling mechanism is not clear as several could be responsible; in TOL-P-96 four apparently mineralized sections are evident, all occurring within a sequence having a high radiometric background. Greisens occur east and west, with the mineralization being confined to these bodies. Three of the anomalies giving up to 6,800 cps NaI occur within a fine grained meta-sediment with sericitic alteration (minor graphite in one); these occur at depths of 11 to 15 metres, 23 to 26 metres and 34 to 36 metres. The fourth occurs within a chlorite-graphite schist, between 42 and 45 metres. No evidence of faulting (e.g. quartz, ferrugination) is associated with the anomalies so the control is considered to be lithological on the localized scale with a broader control exerted by the presence of the greisen bodies (which themselves are probably fault controlled). The presence of graphitic horizons has, no doubt, an involvement in the mineralization process.

> Drill Profile 7600N (Plates 24-90 and 52*)

- TOL-P-94 7600N/9813E Depth 78 metres Water at 19 m. Azimuth 45°. Dip -60°.

TOL-P-94 was collared in Lower Proterozoic lithologies 100 m SE of the Eccles II drill bench. An intense, elongated NW/SE EM-VLF anomaly and associated radon highs occur north and south of the initial discovery; two points along this trend were chosen as suitable sites.

The hole intersected mainly meta-sandstones, strongly chloritized below the weathered zone. Quartz veining, sometimes with greisen zones, occurs throughout. Strongly graphitic schists were intersected at 15-17 m, 21-23 m and 30 metres. No anomalies were located in association with either the quartz/greisen veining or the graphitic beds.

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Radiometry shows little variation throughout; 25-31 metres has several small peaks above 100 cps corresponding to a darker chloritic zone with some hematite and graphite. Chloritic schists intersected from 38 m-43 m show a higher radiometric background than the meta-sandstone units.

- **Drill Profile 7355N (Plate 47*)**

  - **TOL-P-97**  Eccles II, Palm Valley. 10282E/7355N. Azimuth 60°. Declination -60°. Depth 90 m.

  Drilled on a N-S trending VLF anomaly in the vicinity of outcropping graphite schist and an alphaCard anomaly. Abundant carbonaceous schist which has been intruded by veinlets of microgranite. Various amounts of chlorite- and graphite-rich schist. Some chlorite-rich sandstone. The anomaly is very narrow and sharp and may be related to a pegmatite vein intrusion.

  TOL-P-97 should be regarded in the broader context of the Eccles area; the similarity in the geology combined with a weakly mineralized intersection increases the prospectivity of the entire region.

6.4.4.3 **Drilling Details - 1991 Campaign**

- **Drill Profile 7800N (Plate 48*)**

  Two holes were drilled in 1991 on profile 7800N: TOL-P-103, 25m east, and TOL-P-104, 25m west of the 1990 mineralised hole, TOL-P-96. These holes were sited to test both up-dip and down-dip extension of mineralization already known to exist.

  - **TOL-P-103**

    Co-ordinates 9934E 7800N
    Azimuth 045° magnetic
    Declination -60°
    Depth 90m
    Radioactivity:
    At 23.4m Peak 1: maximum 160cps 0.4m >100cps
    At 35.8m Peak 2 maximum 172cps 1.1m >100cps
    Total >100cps 2.4m cumulative

    Note: This hole was logged through the drill stem in a dry hole.

    The hole intersected mainly sericitic sandstone/quartzite with two minor intersections of pegmatite/greisen. Minor carbonaceous sandstone was also intersected, no chloritic alteration was noted.

    There was a low order radiometric anomaly intersected from the surface to 15m. This corresponds to the up dip extension of the broad but low-grade mineralisation found in hole TOL-P-96 in 1990.
- TOL-P-104

Co-ordinates 9884E 7800N
Azimuth 045° magnetic
Declination -60°
Depth 90m
Radioactivity:
At 46.4m Peak 1: maximum 1150cps
At 40.7m Peak 2: maximum 970cps
Total >500cps 3.9m cumulative between 39.4 - 46.7m

Note: This hole was logged through the drill stem in a dry hole.

See Appendix 1 for results of analyses of percussions chips taken from this hole.

This hole was drilled 25m west of TOL-P-96 to test the down-dip extension of mineralisation intersected in that hole. TOL-P-95 was drilled essentially down-dip in an unmineralized unit. The hole intersected abundant carbonaceous and chloritic units which were intruded by greisen or pegmatite veins.

The radioactive anomaly occurs in a strongly carbonaceous and black chlorite-rich hornfels or indurated fine grained sandstone. It is thought to be the down-dip extension of mineralisation found in hole TOL-P-103. It is a stronger, more defined radioactive anomaly than the near-surface anomaly in TOL-P-103 and there are numerous intrusive pegmatite veins. It is interesting to note that immediately west of hole TOL-P-104 a lens of black graphite schist, exposed in the fresh bulldozed cut, only has background radioactivity. This lens of graphite schist is approximately 2m wide and can be traced for around 10m only and is illustrative of the nature of the facies variations in the area.

Because of the steepness of the hill it was not possible to drill further to the west without major earthworks.

+ Synthesis - Profile 7800N

There is an apparent stratigraphic control to the mineralisation intersected on profile 7800N. The mineralisation occurs on the west limb of an anticline, hosted by an alternance of chlorite/graphite schist and chlorite sandstone, with numerous pegmatite/greisen veins intruding the sequence.

+ Drill Profile 7850N (Plate 49*)

Two holes (TOL-P105 and 106) were drilled on profile 7850N to test the northward extension of the mineralisation noted on profile 7800N.
- TOL-P-105

Co-ordinates 9904E 7840N
Azimuth 034° magnetic
Declination -60°
Depth 90m
Radioactivity maximum at 50.3m 300cps
Total 1.1m >100cps between 50.2 - 54m

This hole was planned to be collared further to the west, but the topography was too steep to allow this without extensive earthmoving works.

The hole intersected an interbedded sequence of carbonaceous sandstone with minor chlorite and sericitic sandstone intruded by pegmatite/greisen veins. The minor mineralisation intersected was hosted by a sericitic sandstone containing small euhedral authigenic tourmaline crystals. The presence of tourmaline implies the near proximity of an intrusive greisen/pegmatite vein.

As indicated above, only minor radioactivity was found associated with a sericite schist. Although this is anomalous it is not of economic significance.

- TOL-P-106

Co-ordinates 9936E 7850N
Azimuth 041° magnetic
Declination -60°
Depth 90m
Radioactivity maximum at 39.8m 165cps
Total 2.9m >100cps cumulative

This hole intersected mainly a fine to medium-grained sericitic sandstone similar to the lithology described in hole TOL-P-103.

A mineralised phenomenon was intersected associated with grey chloritized sericite schist with minor hematite staining.

+ Synthesis - Profile 7850N

Weak uranium mineralisation was again intersected on the west dipping limb of an anticline. The host lithologies were interbedded graphite/carbonaceous schist and sandstones intruded by numerous pegmatite/greisen veins.
- Drill Profile 7700N (Plate 50*)

Two holes were drilled on profile 7700N in 1991 to test the southern extension of the mineralisation intersected in holes TOL-P-8 and 9 as well as a major VLF anomaly (see plate 14-91). It was planned to drill further to the west but this was prevented by the Eccles Creek itself. The drill samples from hole TOL-P-108 were strongly contaminated due to the collar blowing out as the hole was collared in creek alluvium.

It is thought that a major dextral block fault centred on Eccles Creek may have lateral movement of around 50m although this is not evident from the geological plan.

- TOL-P-107

Co-ordinates 9875E 7700N
Azimuth 047° magnetic
Declination -60°
Depth 84m
Radioactivity maximum at 7.3m of 285cps.
Total 4.5m >100cps between 3.8 - 104m

Hole TOL-P-107 intersected mainly a sericitic sandstone and chlorite sericite schist. There was a small low-grade radiometric anomaly hosted by an iron-stained sericitic schist between 0 and 12m. This anomaly was broad, but of low grade.

- TOL-P-108

Co-ordinates 9000E 7700N
Azimuth 045° magnetic
Declination -60°
Depth 66m
Radioactivity Nil

This hole was drilled almost entirely in a green sericite/chlorite schist. It is thought to have intersected the anticlinal axis and continued down the east-dipping limb as shown on the section.

No radioactive anomaly was intersected and there was not even a lithologic variation in the radioactivity down the hole. Changes to the lithology noted were quite subtle however.

+ Synthesis - Profile 7700N

It is thought that a dextral block-fault represented by Eccles Creek has moved the southern block towards the west by around 50m. Hole TOL-P-108 has a similar lithology to TOL-P-103.
Drill Profile 7650N (Plate 51+)

Only one hole was successful on profile 7650N. Hole TOL-P-109 failed because it was collared in the thick alluvium of Eccles Creek which kept caving in. Hole TOL-P-114 was drilled, however the sample recovery was very poor due to caving in within the thick alluvium at the collar. The hole itself was successful and a radiometric log was possible.

- TOL-P-109

Co-ordinates 9840E 7650N
Azimuth 045° magnetic
Declination -60°
Depth Abandoned due to caving at the collar

- TOL-P-114

Co-ordinates 9865E 7650N
Azimuth 045° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

This hole was drilled to test any possible southern extension to mineralisation known at the Eccles II Prospect. The hole intersected a monotonous sequence of sericite sandstone and sericite schist intruded by minor pegmatite/greisen veins. There was no variation in the background radioactivity recorded throughout this hole.

Synthesis - Profile 7650N

TOL-P-114 tested the west-dipping limb of an anticline which, north of the Eccles Creek, was variously mineralised but here exhibited no trace of anomalous uranium mineralisation. It was intended to drill further to the west to test the strong VLF anomaly but the thick unconsolidated alluvial sand made setting a collar pipe successfully almost impossible without great expense.

Drill Profile 7600N (Plate 52+)

Two drill holes (TOL-P-110 and 111) were drilled on profile 7600N to test a graphite/chlorite sandstone and schist facies thought to occur in the same stratigraphic horizon as the mineralisation at Eccles II as well as the cause of a strong northeast-trending VLF anomaly.

These two holes, together with TOL-P-94 drilled in 1990, test the west-dipping limb of an anticline in which the lithofacies is rich in graphite and chlorite, and is intruded by numerous pegmatite/greisen veins.

No radioactive anomalism was noted in these holes.
- TOL-P-110

Co-ordinates 9840E 7600N
Azimuth 043° magnetic
Declination -60°
Depth 66m
Radioactivity Nil

This hole intersected a sequence of graphite and chlorite-rich schists and sandstones which were silicified in places. It is now thought this hole may have drilled the east limb of the anticline, which would explain the monotonous lithologic sequence.

- TOL-P-111

Co-ordinates 9790E 7600N
Azimuth 045° magnetic
Declination -60°
Depth 78m
Radioactivity Nil

The hole intersected broad sequences of graphitic sandstone and schists on the west dipping limb of an anticline. This would adequately explain the strong VLF anomaly in the area. However, there was no increase in the radiometric signature even where the sequence was cut by intruding pegmatites and/or greisens.

+ Synthesis - Profile 7600N

Profile 7600N has adequately tested the very strong VLF anomaly which traverses the alluvium of Eccles Creek and passes through the Eccles II Prospect. Unfortunately there was no evidence of any enrichment in uranium above the background levels associated with this lithological unit on the southern side of Eccles Creek (fault).

> Drill Profile 7350N (Plate 53*)

This hole was drilled from the same drill pad of the 1990 hole TOL-P-97, but with an azimuth of 045° to intersect the strike of the sequence at right angles. This hole was to test the strike extension of the mineralisation intersected in TOL-P-97.

- TOL-P-112

Co-ordinates 10280N 7350N
Azimuth 045° magnetic
Declination -60°
Depth 72m
Radioactivity Nil
The hole intersected abundant rich carbonaceous, graphitic and chloritic schists but there was no increase in the background radioactivity. Pegmatite/greisen was intersected intruding the graphitic sandstone and schists.

> **Drill Profile 7400N (Plate 54*)**

Two holes were originally planned for this area but due to the disappointing results in holes TOL-P-112 and 113 the hole at 7375N 10275E was cancelled.

- **TOL-P-113**

  Co-ordinates 10300E 7397N
  Azimuth 045° magnetic
  Declination -60°
  Depth 66m
  Radioactivity Nil

This hole was drilled to test the along strike extension to a sharp radiometric peak intersected in 1990 in hole TOL-P-97. The hole was collared in a creek because of access difficulties. It intersected various strongly graphitic sandstones, chlorite schist (green Fe-rich chlorite) and sandstone, and minor sericite schist.

A minor radiometric anomaly was intersected at 57.5m associated with graphite in a chloritic sandstone; this was of any economic significance.

> **Drill Profile 7950N (Plate 55*)**

- **TOL-P-116**

  Co-ordinates 9925E 7950N
  Azimuth 045° magnetic
  Declination -60°
  Depth 84m
  Radioactivity:
  At 20.8m Peak 1: maximum 450cps
  At 26.5m Peak 2: maximum 200cps
  At 54.8m Peak 3: maximum 160cps
  Cumulative >100cps = 3m

The hole intersected a number of strongly graphitic zones, abundant chlorite and sericite schist and minor greisen/pegmatite veins. The mineralisation occurs in sericite/chlorite schists rather than graphite schists as one would expect. The radiometric anomaly like elsewhere at the Eccles II Prospect is low grade but relatively thick.
- TOL-P-117

Co-ordinates 9950E 7950N
Azimuth 045° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

Significant intersections of chlorite and graphite schist were made, intruded by one pegmatite/greisen dyke. However, no radioactive anomalies were recorded above an increase in the background. The depth of weathering was generally to 30m, but in specific rock units such as the graphite schist, extended so the bottom of the hole, i.e. 42m below the surface. Hematite was the main iron oxide noted.

- TOL-P-118

Co-ordinates 9975E 7950N
Azimuth 047° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

The hole intersected thick sequences of graphite and chlorite schist but like in TOL-P-117 there was no variation in the radioactivity above the background.

+ Synthesis - Profile 7950N

There was a distinct decline in the intensity of pegmatite/greisen intrusions in this section as compared to the others further south. The mineralisation intersected in hole TOL-P-116 although not economic was of interest as it shows that mineralisation occurs at various stratigraphic levels and makes and breaks along the strike although none of the intersections are of economic significance.

> Drill Profile 8050N (Plate 56*)

This profile was drilled to test the VLF conductor which passes through the Eccles II prospect.

- TOL-P-119

Co-ordinates 9975E 8050N
Azimuth 045° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

This hole is the most westerly drilled on section 8050N. It intersected abundant hematitic chlorite schist which from other holes is interpreted as having originally been a graphite/chlorite schist. No radioactive anomalous was recorded. The graphite unit is the cause of the VLF conductor traced from the Eccles II prospect.
- TOL-P-120

Co-ordinates 10000E 8050N
Azimuth 045° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

This hole intersected thick units of chlorite schist and also of a quart muscovite greisen/pegmatite. The quartz muscovite greisen/pegmatite intrusions here were both numerous and thick, this is in contrast to that intersected on the 7950N section to the south. This indicates just how irregular these intrusions are. The weathering was again very deep (30m vertically). No anomalous radioactivity was recorded.

Drill Profile 8200N (Plate 57*)

It was planned to drill two holes on this profile to cover the VLF-defined conductor along strike from the Eccles II prospect. The access road was too steep for the rig and water truck to negotiate and so the hole at 8200N 10050E was cancelled.

- TOL-P-121

Co-ordinates 10025E 8200N
Azimuth 045° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

The hole intersected predominantly a hematitic medium to coarse-grained poorly sorted sandstone, however, chlorite schists interbeds are common.

These schists were totally oxidised (hematized) to the bottom of the hole. No significant radiometric anomalous was noted in the hole although there is some lithologic differentiation possible from the radiometry. The chlorite schists are slightly more radioactive than the chloritic sandstones and there is a higher radioactive background near the surface. This may be due to the increased hematitic content.

Drill Profile 8300N (Plate 58*)

This profile was drilled to investigate a strong VLF anomaly below the Depot Creek sandstone unit of the Tolmer Group.
- TOL-P-122

Co-ordinates 10050E 8300N
Azimuth 045° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

The unconformable contact between Burrell Creek Formation and Tolmer Group (Depot Creek Sandstone) was at 3m. The underlying chlorite/sericite schist unit was strongly hematized. There was no radiometric anomaly with the radiometric signature showing no variation above background from the various lithologies.

- TOL-P-123

Co-ordinates 10075E 8300N
Azimuth 043° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

The unconformable contact between the hematized Tolmer Group (Depot Creek Sandstone) and the underlying hematite/chloritic schist and sandstone of the Lower Proterozoic was intersected at 10m. This contact is clearly undulating, varying from 0m in hole TOL-P-124 to 10m in TOL-P-123, a distance of only 25m.

There is a minor increase in the radiometric response directly below the unconformity which may relate to a higher content of hematite.

- TOL-P-124

Co-ordinates 10100E 8300N
Azimuth 043° magnetic
Declination -60°
Depth 84m
Radioactivity Nil

This hole intersected predominantly a sericitic sandstone to 60m then a chlorite schist to the bottom of the hole.

Specular hematite was noted within the sandstone of the Lower Proterozoic between 20 and 30m.

+ Synthesis - Profile 8300N

The strong broad VLF conductor can be explained by the abundant hematized chlorite schist and sandstone sequence beneath the Depot Creek Sandstone.
APPENDIX 1

Geochemical Assay Results
1988 CAMPAIGN

(Includes Also Assays from E.L. 4857)
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**Sample Type:**
- R: Recline rock
- C: Drill cuttings
- N: Silt
- W: Water

**Analysis Methods:**
- W: wet chemical assay
- AAS: atomic absorption spectrophotometry
- XRF: X-ray fluorescence
- F: fluorometric chemical analysis

**Limit of Detection:**
- Au: 0.05 ppm
- Ag: 0.01 ppm
- Ni: 0.05 ppm
- W: 0.05 ppm

**Method of Analysis:**
- XRF

**Date dispatched:** 24/6/88

**Results rec'd:** 15/7/88
### GEOCHEMICAL RESULTS

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**Analysis methods:**
- W: wet chemical assay
- AAS: atomic absorption spectrophotometry
- XRF: X-ray fluorescence

**Limit of detection:**
- Au: 0.05 ppm
- Ni: 0.05 ppm
- Co: 0.05 ppm
- Pb: 0.05 ppm
- Zn: 0.05 ppm
- Cu: 0.05 ppm
- Ag: 0.05 ppm

**Method of analysis:**
- XRF, FAAS, XRF, XRF
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Sample type: R - surface rock, S - soil, W - water, CC - drill cores, O - overburden
Analysis method: W - wet chemical assay, AAS - atomic absorption spectrophotometry, XRF - X-ray fluorescence
Limit of detection: U - 0.05 ppm, Th - 0.01 ppm, Au - 0.01 ppm, Ni - 0.01 ppm, Co - 0.01 ppm
Method of analysis: T - neutron activation analysis
## Geochemical Results

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<th>Fe (mg/kg)</th>
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<th>As (ppm)</th>
<th>Cu (ppm)</th>
<th>Mg (mg/kg)</th>
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### Notes
- **Sample Type:**
  - R: surface rock
  - S: soil
  - W: water
  - SS: stream sediment

- **Analysis Methods:**
  - W: wet chemical assay
  - AAS: atomic absorption spectrophotometry
  - XRF: X-ray fluorescence

- **Limit of Detection:**
  - Fe: 4 mg/kg
  - Ni: 0.01 ppm
  - As: 0.01 ppm
  - Cu: 0.1 ppm
  - Mg: 1000 mg/kg
  - Al: 1000 mg/kg
  - V: 10 ppm

- **Method of Analysis:**
  - W: wet chemical analysis
  - AAS: atomic absorption spectrophotometry
  - XRF: X-ray fluorescence
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<th>U (mg/l)</th>
<th>Ni (ppm)</th>
<th>As (ppm)</th>
<th>Au (ppm)</th>
<th>MgO</th>
<th>Al₂O₃</th>
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Sample types: R. surface rock
C. drill cuttings
G. channel sample
W. wet chemical assay
Analysis methods:
S. soil
CH. channel sample
AAS. atomic absorption spectrophotometry
C. drill core
XRF. x-ray fluorescence
Method of detection:
W. water
SS. stream sediment
O. overburden
I. fluorometric chemical analysis
Method of analysis:

Limit of detection:
- U: 20 mg/l
- Ni: 1 ppm
- As: 0.1 ppm
- Au: 0.01 ppm
- MgO: 0.05%
- Al₂O₃: 0.02%
- V: 0.1 ppm
- U/Th: 0.1
- SP 3.2: 0.02%
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<th>Sample type</th>
<th>Description</th>
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<th>Ni (ppm)</th>
<th>As (ppm)</th>
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**Sample Type:**
- R: surface rock
- S: soil
- W: stream sediment
- C: drill cuttings
- CH: channel sample

**Analysis Methods:**
- W: wet chemical assay
- GC: gas chromatography
- AAS: atomic absorption spectroscopy
- XRF: x-ray fluorescence
- ICP-MS: inductively coupled plasma mass spectrometry

**Limit of Detection:**
- U: 1.0 ppm
- Cu: 0.01 ppm
- Ni: 0.001 ppm
- As: 0.01 ppm
- Au: 0.001 ppm
- Mg: 100 ppm
- Al: 500 ppm
- V: 100 ppm

**Method of Analysis:**
- F: flurometric chemical analysis
- AAS: atomic absorption spectrophotometry
1989 CAMPAIGN
GEOCHEMICAL ANALYSES TOL-P-39

--- Uranium Total --- Thorium

Metres

0 20 40 60 80 100 120

U ppm Ptd Pfb

7 6 5 4 3 2 1 0

Th ppm

35 30 25 20 15 10 5 0
GEOCHEMICAL ANALYSES TOL-P-40

U ppm

Ptd > Pfb

Th ppm

0 20 40 60 80 100 120

Metres

--- Total Uranium  + Thorium
GEOCHEMICAL ANALYSES TOL-P-42

- Ptd > Pfb

-- Uranium Total  - thorium
GEOCHEMICAL ANALYSES TOL-P-47

U ppm

0 20 40 60 80 100 120

Metres

Ptd Pfb

Th ppm

0 10 20 30 40 50 60 70

--- Uranium Total

++ Thorium
GEOCHEMICAL ANALYSES TOL-P-48

U ppm

Th ppm

0  10  20  30  40  50  60  70  80

Ptd

--- Uranium Total

--- Thorium

Metres
GEOCHEMICAL ANALYSES TOL-P-51

U ppm

Ptd

Pfb

Th ppm

0 20 40 60 80 100

0 20 40 60 80 100

Metres

--- Uranium Total

+ Thorium
GEOCHEMICAL ANALYSES TOL-P-53

- U ppm
- Th ppm

Ptd > Pfb

- Uranium Total
- Thorium
GEOCHEMICAL ANALYSES TOL-P-57

\[ \text{U ppm} \]

\[ \text{Th ppm} \]

\[ \text{Metres} \]

- Uranium Total
- Thorium

Ptd
Pfb
1990 CAMPAIGN
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**Sample types:**
- R: rock sample
- S: soil
- W: water
- MP: stream sediment
- O: orebody

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

**Limit of detection:**
- 4 ppm

**Method of analysis:**
- XRF, AAS
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Analysis methods: W: wet chemical assay, AAS: atomic absorption spectrophotometry, XRF: x-ray fluorescence

Limit of detection: 0.001, 0.1, 4, 10, 0.01, 2

Method of analysis: XRF, XRF, XRF, AAS, AAS, AAS, FA, XRF
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**Sample type:**
- R: surface rock
- S: soil
- W: water
- C: channel sample
- CC: drill core
- SS: stream sediment
- O: overburden

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

**Limit of detection:**
- U: 4
- Pb: 4

**Method of analysis:**
- XRF XRF
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**Sample type:**
- R: rock
- R & soil: R and soil
- W: water
- S: surface soil
- R & water: R and water
- S: surface soil
- R: rock

**Analysis methods:**
- W: wet chemical assay
- W: atomic absorption spectrometry
- XRF: X-ray fluorescence

**Limit of detection:**
- 4 ppm for Zn
- 4 ppm for Pb

**Method of analysis:**
- XRF for Zn
- XRF for Pb
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Sample types: R: sample rock, C: drill cuttings, Analysis methods: W: wet chemical assay, Limit of detection: Method of analysis:
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Sample type: R: surface rock
C: drill cuttings
5: soil
W: water
GL: stream sediments
G: geologically

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

Method of analysis:
1: X-ray diffraction analysis

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Sample types: R, rock; C, drill cuttings; S, soil; W, water; CC, drill core; SR, stream sediment; O, overburden.

Analysis methods: W, wet chemical assay; AAS, atomic absorption spectrophotometry; XRF, X-ray fluorescence; XRF, X-ray fluorescence.

Limit of detection: 4, 4, 0.1, 4, 4, 10, 0.01, 2.

Method of analysis: XRF, XRF, ICAP, AAS, XRF, AAS, AAS.
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Analysis methods: W. wet chemical assay, AAS. atomic absorption spectrophotometry, XRF, x-ray fluorescence.

Limit of detection: U, Th.
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Sample type: A, ionexchange rock; B, drill cuttings; C, drill cuttings; Analysis methods: W, wet chemical assay; AAS, atomic absorption spectrophotometry; XRF, x-ray fluorescence; Method of analysis: I, neutron activation analysis; Limit of detection:
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**Sample types:**
- R: surface rock
- S: soil
- C: drill cuttings
- CI: channel sample
- W: water
- SS: stream sediment
- O: overburden

**Analysis methods:**
- W: wet chemical assay
- AAS: atomic absorption spectrophotometry
- XRF: x-ray fluorescence
- I.R.: infrared analysis

**Limit of detection**

**Method of analysis**
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Note: Sample types: R, surface rock; S, soil; W, water; C, drill cuttings; CC, drill core; SS, stream sediment; Q, overburden.

Analysis methods: W, wet chemical assay; AAS, atomic absorption spectrophotometry; XRF, X-ray fluorescence; I, fluorimetric chemical analysis.

Limit of detection: 4 ppm.
## GEOCHEMICAL RESULTS

### MINATOME AUSTRALIA PTY. LTD.

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### Sample Types:
- S: soil
dc: drill cuttings
- C: channel sample
- DR: drill core
- W: water
- SS: stream sediment
g: overburden

### Analysis Methods:
- W: wet chemical assay
- AES: atomic absorption spectrophotometry
- XRF: x-ray fluorescence
- ICP: inductively coupled plasma

### Limit of Detection:

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Sample types: R, surface rock; C, drill cuttings; S, soil; W, water; G, ore; C, drill core; G, ore; O, orebodies. Analytic methods: AAS, atomic absorption spectrophotometry; XRF, x-ray fluorescence; ICP, inductively coupled plasma. Limit of detection: <4.

Method of analysis: ICP, inductively coupled plasma chemical analysis.
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Sample type: R, surface rock; C, drill cuttings; A, drill core; S, soil; W, water; SS, stream sediment; O, overburden. Analysis methods: W, wet chemical assay; AAS, atomic absorption spectrophotometry; XRF, X-ray fluorescence. Limit of detection: <0.01 ppm. Method of analysis: I, instrumental chemical analysis.
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Sample types: R, surface rock; C, drill cuttings; S, soil; W, water; SS, stream sediments; O, overburden.

Analysis methods: W, wet chemical assay; AAS, atomic absorption spectrophotometry; XRF, X-ray fluorescence.

Limit of detection: 1 ppm for most metals.

Method of analysis: XRF, XPS, ICPMS.

Minatome Australia Pty. Ltd.
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<th>Sample Type</th>
<th>Description</th>
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<th>Th</th>
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**Sample type:**
- R: surface rock
- S: soil
- W: water
- SS: stream sediment

**Analysis methods:**
- W: wet chemical assay
- AAS: atomic absorption spectrophotometry
- XRF: x-ray fluorescence
- ICP: inductively coupled plasma

**Limit of detection:**
- Cu: 0.1 ppm
- Ni: 1 ppm
- Mg: 10 ppm
- Zn: 0.01 ppm
- Ag: 2 ppm

**Method of analysis:**
- XRF: x-ray fluorescence
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Sample type: 
- C: drill cuttings
- d: drill core
- M: stream sediment
- O: overburden

Analysis methods:
- W: wet chemical assay
- AAS: atomic absorption spectrophotometry
- XRF: X-ray fluorescence

Method of analysis:
- XRF

Limit of detection:
- H: 11
- H: 10
- C: 0.1
- C: 10
- D: 0.01
- D: 0.01
- A: 1

Equipment:
- 1: 1

Units:
- ppm: parts per million
- g: grams
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Sample type: Drill cuttings

Method of analysis: U and Th by XRF
Mobile U by ICP
GROUND SURVEY SPECIFICATIONS

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

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

MAXMIN 1777 HZ PROFILES

Grid notation refers to Local Grid
Vertical scale: 20 percent per cm
Base value: 0 percent
Out of phase: --

TOTAL MINING AUSTRALIA PTY LTD

TOLMER NT
MAXMIN 1777 HZ PROFILES
SH3 PROSPECT

547-207 DATE: 13-FEB-89

Surveyed by GEOTERRAX PTY LTD, MAY-JUNE 1988
Compiled by GEOTERRAX PTY LTD, Sydney, NSW.
Processed using the ECS GEONEST system
NOTE: Refer to text for Tolmer facies description.

- Middle
  - Depot Creek Sandstone
  - Proterozoic Tolmer Sandstone
- Lower
  - Meta-sandstone and Proterozoic Rurrill Creek Formation
  - slatey phyllites

- INTERPRETED TRANSVERSE FAULT
- INTERPRETED GEOLOGICAL FAULT
- V.I.F. CONDUCTOR (Cross Over Interpretation)
- V.I.F. CONDUCTOR (Fraser Gradient Interpretation)
- MAX - MIN INTERPRETED CONDUCTOR
- RADON ANOMALY
Interbedded Schist & Meta-Sandstone.

- Massive pink grey and white, fine to medium grained 'litharenite'. Rare pebbly laminae. Cross bedding and ripple marks.

- Proterozoic
  - Pebbly quartz arenite and conglomerate. Light to dark brown and very ferruginous. Cross bedding and slump.

- Lower
  - Plane to massive grained, quartz-rich, sericitic amphibolite rocks. Minor quartz-carbonate and limonitic matrix. Grey-green chloritic alteration where indicated. Alteration as for above.

- Proterozoic
  - 'Burnell Creek Formation'
  - Schist. Fine to medium grained, variable composition: quartz-felspar, sericite, epidot and phyllicitic matrix.

- Intrusive
  - Quartz-black tourmaline vein.

- Lower Proterozoic
  - Granodiorite porphyrite vein.
NOTE: Gomna Log Scale - FSD = 500 cps