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M. Varkey Eipe
J. Thevissen
B. Stainforth
M. Flook
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1. GENERAL INTRODUCTION

In February, 1977, a decision was made to establish two separate field offices (one at Mount Isa and the other at Darwin) for the North Australian operations of UGA. Among other considerations the prime factors that influenced this decision were:

(a) the increasing demands from the Westmoreland-Minad Joint Venture Project (especially during its assessment stages) that would require a field office to be established in Mount Isa,

(b) the need to carry out further investigations on lithologies/areas defined by the reconnaissance program of 1976,

(c) the increasingly favorable attitudes of the Liberal Government towards Uranium mining in Australia, giving hope that the Alligator Rivers Area will eventually open up for exploration,

(d) the need to collate and assimilate information on the Alligator River Region for:
   
   (i) securing Mineral Concessions when this region becomes available for exploration,

   and (ii) examining mining properties that could have potential for further exploration/development.

and (e) to impress upon the various government departments (including the Northern Lands Council) of UGA's sincere interest in the development of the Alligator Rivers Region and the services that UGA could offer in this regard.

Limitations aside, almost all these objectives have been achieved in 1977.
2. **AREAS INVESTIGATED**

Reconnaissance targets were selected north of Latitude 24°S. This was mainly because of the regional reconnaissance carried out earlier and to the south of this parallel by M/S Graul and Schindlmayr.

Structural units investigated are given below:-

(a) Granites-Tanami Block  
(b) Litchfield Block  
(c) Halls Creek Mobile Zone  
(d) Leopold Mobile Zone  
(e) Fitzmaurice Mobile Zone  
(f) Kimberley Basin  
(g) Birrindudu Basin  
(h) Hardman Basin  
(j) Bonaparte Gulf Basin  
(k) Georgina Basin

Some of these structural units were investigated at locations both in the Northern Territory as well as in Western Australia.
3. NATURE OF INVESTIGATIONS

All target lithologies where accessible were initially subjected to ground investigations. These included stratigraphic traverses, rock chip/soil/stream sediment sampling, and radiometric traverses. Samples were subject to chemical analysis and petrographic studies. The aim of this investigation was to assess potential of the target lithologies or other stratigraphic units encountered during traverses and also to determine the type of investigation required for each unit at a preferred location.

Target lithologies that were subjected to field checks and found encouraging were then investigated at their preferred locations with the assistance of a Helicopter. Stratigraphic traverses, rock chip and stream sediment sampling were carried out over selected horizons and anomalous areas during these investigations.

Thus this two stage approach to reconnaissance enabled targets to be investigated on a selective lithological as well as location criteria. It also enabled the best use of helicopter because of familiarisation with the outcrop pattern that was gained during the initial stage.

An Austral G.D.S. 12 spectrometer connected to a 56 cubic inch crystal and Rustrak recorder was mounted inside the Helicopter. All surveys (Total counts) were carried out at air speeds not exceeding 40 knots and at altitudes of 15 to 30m (dependant on topography, vegetation, etc.) above ground level.

Ground investigations were carried out using Austral scintillometers, spectrometers and SRAT scintillometer. The latter instrument provided better delineation and detection of anomalous areas than any of the other instruments.
4. TARGETS FOR INVESTIGATIONS

A broad outline of the major structural/tectonic units selected for reconnaissance and the lithological units investigated are noted below. Further details of the investigations of each lithological unit are provided later on in this report.

The location and extent of these major structural units are shown in Drawing No. attached to this report.

(a) GRANITES – TANAMI BLOCK

Regionally metamorphosed sediments, volcanic and granitic rocks of Archaean and Lower Proterozoic ages are included in this group. This succession constitutes the only major outcrop of basement rocks between the Arunta Block and the Halls Creek Mobile Zone. Birrindudu Basin (Carpentarian) overlaps these basement rocks to the south and west, the Victoria River Basin (Adelaidean) to the north and the Wiso Basin (Lower Palaeozoic) to the east. The south eastern boundary of the Granites-Tanami Block with the Arunta Block is not well defined and is questionable.

Several high level intrusions of granite and associated tectonism have warped and folded the Archaean sediment and volcanic succession. Notable among these intrusions are the granites of the Coomarie and Browns Range Domes.

Block carbonaceous pyritic shales of the Mount Charles Beds and the Pargee and Supplejack Downs sandstone were the primary targets for investigations. Numerous field traverses in the area where these black shale intersections in bore holes had been reported (BMR) failed to reveal any outcrops. However, pyritic argillaceous sandstones were found outcropping in the area.
Pargee and Supplejack Downs Sandstone units were selected because they mark Lower Proterozoic unconformities directly overlying the Tanami Complex.

Notable among the other units that were investigated is the Mount Winnecke Formation consisting of a thick sequence of acid lavas, interbedded tuffs and tuffaceous sandstones and siltstones of subaqueous deposition. The base of this sequence and its contacts with the intrusive Winnecke Granophyre were also investigated.

(b) **LITCHFIELD BLOCK**

Archean basement rocks consisting of anatexic granites, migmatites and schists that are located along the western margin of the Pine Creek Geosyncline are included in this Block. This basement complex draws several parallels to those of the Nimbuwah and Nanambu Complexes. Sediments of the Finniss River Group and the Daly River Basin (equivalent of the Georgina Basin) overlie the basement rocks. Earlier investigations by B.H.P. indicate the possibility of the presence of Golden Dyke Formation of the Goodparla Group in this region.

Investigations were directed at:-

(i) assessing metamorphic grades of meta sediments in the region - especially those of the western trough of the Pine Creek Geosyncline,

and (ii) the basal arkosic sediments of the Daly River Basin (equivalents in the Georgina Basin of Queensland are anomalously radioactive).

(c) **KIMBERLEY REGION**

The Kimberley Region consists of a sequence of arenites deposited during the Carpentarian in the stable basin, the Kimberley Basin, that is bordered to the east and
south by two linear and narrow belts of highly deformed Lower Proterozoic geosynclinal sediments, granites and volcanics that are known as the Halls Creek Mobile Zone. The north eastern extension of the Halls Creek Mobile Zone that extends to the southern margins of the Litchfield Block across the Victoria River Basin is known as the Fitzmaurice Mobile Zone. Though the basement rocks do not outcrop in the Kimberley Region, these mobile zones represent the oldest group of rocks between the Litchfield Block and the Pilbara Block. That these mobile belts were intermittently active well into the Palaeozoic is evidenced by the high energy sediments deposited on either side of these zones.

Detailed investigations of the Carpentarian sediments of the Kimberley Basin (BMR) indicate the provenance from an essentially granitic source to the NW and NE.

Large volume of acid igneous rocks present in the Mobile Zones enhances the uranium potential of sediments derived from them.

Investigations were concentrated on sediments of the above mentioned provenances and also at locating a sequence of quartz conglomerates (unclassified to date by BMR) underlying the oldest mapped sequence, viz. Ding Dong Downs Volcanics. It is considered that this sequence if located would be equivalent to the Witwatersrand and Blind River sequences.

A considerable amount of time was spent in investigating the Kimberley Region. Chemical analyses of almost all samples from anomalous horizons/areas (anomalous areas/horizons normally exhibit heavy mineral banding) indicate a very high Th:U ratio. Petrographic studies are indicative of an acid igneous provenance and in particular a granitic source with the sediments possibly being deposited in a reducing environment.
The remarkable absence of a major uranium bearing horizon in the Kimberley region could be attributed to any one of the following reasons:—

(i) the Carpentarian sediments of the Speewah and Kimberley Groups could have been deposited over much larger areas to the south and east of the mobile zones than that indicated by present day outcrops,

(ii) repeated tectonism and volcanicity could have denied the continuous release of U to the sedimentary pile,

(iii) the effects of Adelaidean glaciation over the region is least understood,

(iv) the majority of granites in the mobile zone on chemical analysis indicate a higher Th:U ratio sympathetic to the sediments derived from them.

(d) BIRRINDUDU BASIN

The Carpentarian sediments developed from the Granites-Tanami and Arunta Blocks are represented here. A major proportion of these sediments is marine. Terrestrial components though restricted in outcrop were the targets for investigations. Basal parts of the Gardiner Sandstone were glauconitic and samples from anomalous areas yield high Th:U ratios on chemical analysis.

(e) HARDMAN BASIN

An assymetrical basin developed on the Stuart Block and located adjacent to and east of the Halls Creek Mobile Zone is included here as the Hardman Basin. Terrestrial sediments at the base of the Elder Sandstone (Devonian) were investigated. Stratigraphically and lithologically this sandstone bears many close resemblances to that of the Ragged Range Conglomerate of the Bonaparte

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Gulf Basin. But unlike the latter, the provenance of the Elder Sandstone appears to be from the older units of the Stuart Shelf.

(f) BONAPARTE GULF BASIN
This is a northerly pitching syncline containing Phanerozoic sediments and located to the north and west of the Halls Creek and Fitzmaurice Mobile Zones. The basal and upper units of this sedimentary pile contain terrestrial sediments and these were the subjects of investigations. The oldest units, viz. the Ragged Range Conglomerate (Devonian), consists of high energy and locally derived sediments in its southern most outcrops and grades into a marine environment to the north. Where this locally derived conglomerate is located in the vicinity of granites of the Halls Creek Mobile Zone, this unit contains accumulations of uranium. But elsewhere it has a high Th:U ratio. The upper terrestrial sediments of this basin also consist of locally derived sediments from the older Carboniferous horizons.

(g) GEORGINA BASIN
This is an Adelaidean to Lower Palaeozoic succession developed extensively in the Northern Territory and Queensland. Parts of this succession developed on the Litchfield Block and Pine Creek Geosyncline, is termed as the Daly River Basin. Basal parts of this succession overlying granites of the Mount Isa Block are anomalously radioactive. Hence, the equivalent parts of the basin overlying the Arunta Block were investigated. The Mount Cornish Beds indicated encouraging U:Th ratios. Since an Exploration Licence over these beds was granted to Otter Exploration approximately two days prior to the field party reaching the area, further follow up work was not carried out. However, facies variants of these beds were investigated farther to the east in Queensland without any success.

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In the following pages, detailed descriptions are given by the geologist in charge of the investigations for areas summarized above. On the results of these investigations, where applicable, recommendations for further or follow-up work are included for the respective areas.

The order in which areas will be described is as listed below:-

I    Bonaparte Gulf Basin
II   Tanami/Birrindudu
III  Victoria River Region
IV   East Kimberley/Bililuna
V    Litchfield Complex
VI   Kimberley Basin
VII  Yampi 1:250,000 Sheet Area
VIII Halls Creek Mobile Zone
IX   Georgina Basin
I. RECONNAISSANCE IN THE BONAPARTE GULF BASIN

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I. RECONNAISSANCE IN THE BONAPARTE GULF BASIN

I.1. INTRODUCTION

The Bonaparte Gulf Basin is a north-pitching syncline of Phanerozoic sediments which are bounded to the south by Pre-Cambrian rocks, and extends northward beneath the Timor Sea. Regionally, it lies across the Halls Creek Mobile Zone between the Kimberley Block and Stuart Block. It covers the greater part of the Cambridge Gulf 1:250,000 Geological Sheet. The full sequences of sedimentation can be divided on the basis of depositional environments into two parts:

(i) 1000' of Cambrian to Lower Ordovician and Upper Devonian to Lower Carboniferous shallow marine quartz sandstone and carbonate rocks with known equivalent deeper marine grey siltstones in the Upper Devonian and Lower Carboniferous.

(ii) 7000' of Upper Carboniferous to Lower Triassic paralic sandstones and shale capped by a few hundred feet of Lower Cretaceous marine siltstones, sandstones and conglomerate.

The area was initially selected for reconnaissance due to its good lithologies, but was necessarily of low priority due to poor source areas and open structures. Reconnaissance was directed mainly at the Upper Devonian Cockatoo Formation and Upper Carboniferous Border Creek Formation.

I.2. FIELD METHODS

Fieldwork in the area was undertaken in two stages:

(a) Ground reconnaissance involving two field parties between the 11th and 14th of July, 1977. The aim of the survey was to examine selected target
lithologies and assess their potential for holding uranium. Work involved section mapping, rock chip sampling and ground radiometrics using a SRAT.

(b) Ground investigations were followed up by a helicopter assisted airborne survey. A Bell Jet Ranger contracted from Rotor Services, Darwin was used for two days (approximately four hours flying time) between . .77 to . .77. Flying height was approximately 30' using a 4" crystal connected to an Austral G.D.S. 12 Spectrometer and Rustrak chart recorder.

I.3. FIELD OBSERVATIONS

I.3.1. Upper Devonian Sequences

The Cockatoo Formation comprises about 5,000' of quartz sandstone, conglomerate, limestone and dolomite that outcrop over large areas on the Bonaparte Gulf Basin. Due to the extensive lithological variations, eight different members have been mapped. The following of these have been investigated.

(a) **Ragged_Range_Conglomerate_Member** (Dur)

This member outcrops extensively in the Ragged Range (Lisadell 1:250,000 Geological Sheet) and a short distance to the south. The conglomerate unconformably overlies Pre-Cambrian rocks in the south east and Antrim Plateau Volcanics and Blatchford Formation in the west. NE and SW parts of the conglomerate are faulted down against Pre-Cambrian rock. In the Lisadell Sheet, the length of outcrop is about 50km and its width ranges from 7 to 18km. The Ragged Range is a cuesta with gentle easterly dips. Between Flying Fox Bore and the southern outcrop it is poorly exposed. As the Ragged Range area has been extensively examined by Uranerz, who hold much of the area, the conglomerate was checked further south, to the SE of Smokey Creek Bore. Throughout
most of the outcrop the phenoclasts in the conglomerate consist of quartzite pebbles 1 - 6cm across, in a matrix of quartz sandstone. Interbedded sandstone units are a micaceous medium grained poorly sorted quartzo-feldspathic sandstone. Some beds are coarser grained with white/grey-purple bands. The conglomerate is fluviatile and appears to be locally derived from the Antrium Plateau Volcanics and Lisadell Formation. A volcanic origin is indicated by the mafic nature of the sandstone (i.e. ferruginous clays). A few beds, however, of a feldspathic sandstone (felspar content 20%) appear to be derived from a granite source. Locally there appears to be no change in lithology, except for grain size. The northern most tip of outcrop on the Lisadell sheet was investigated just west of the main highway and was found to be a massive quartzite. The conglomerate was also checked just south of the Keep River at Policemans lagoon (Auvergne 1:250,000 Geological Sheet). Here outcrops consisted of easterly dipping ferruginous (pebbly in part) quartz sandstone with mud clasts and ripple marks.

(b) **Kelly's Knob Sandstone Member**

This unit was visited in the Cockatoo Fault area, just south of the Wyndham - Nicholson highway, where it unconformably overlies Cambrian Antrium Plateau volcanics. The Kelly's Knob Member consists of coarse-grained, friable, red-purple (hematite) crossbedded sandstones with numerous small conglomerate lenses parallel to the crossbedding. A massive quartzite bed with conglomerate bands forms a good marker horizon. The presence of considerable amounts of hematite and also low total count radiometrics (maximum 40 c.p.s.) suggest that this unit has low potential for uranium mineralization (see Figure 2 for cross-section).
The contact between the Kelly's Knob Sandstone Member and the Upper Carboniferous Border Creek Formation was investigated just south of the Keep River (56050, 0220.) Auvergne 1:100,000). Conglomerate bands alternate with medium-coarse grained poorly sorted feldspathic sandstone. Ripple marks, crossbedding and heavy mineral laminations are common in the sandstone horizons. All feldspars have been weathered to clays. Most of the conglomerate, pebbles are angular, indicating relatively immature sediments. A close examination of the pebbles indicate various sources. Some quartzite pebbles of sedimentary origin are layered or laminated while others appear to be of granitic or metamorphic origin (i.e. completely re-crystallized). Although most of the phenocrysts are quartzite pebbles, some shales and schists were found. Initially it was thought that this unit was the uppermost in the Kelly's Knob Sandstone Member since it was separated from the overlying Carboniferous Border Creek Formation by a fault as mapped by B.M.R.. During a later airborne follow up survey, this unit was traced south and was found to be the basal quartz pebble conglomerate unit of the Border Creek Formation. The Kelly's Knob Member is a fine grained slightly micaceous (pebbly in part) quartz sandstone.

(c) Cecil Sandstone Member

This unit occurs only as small isolated hills in the Cockatoo Fault area. It is similar to the Kelly's Knob Member except hematite is not present and it contains a distinct granular sandstone bed with carbonate content. The unit was not considered prospective (see Figure 2).
(d) **Cockatoo Formation**

This formation was mapped (see Figure 3) 3km west of the southern tip of the Cockatoo Fault where it unconformably overlies the Hensman Sandstone. In this section the rocks consist of a coarse grained, gritty, banded (hematite) feldspathic sandstone, quartz sandstone and red hematitic sandstone. This sequence is repeated almost identically higher in the section. At the base and top of the section no outcrops occur. The hills, however, are strewn with quartz and sandstone pebbles. Although lithologies appear to be favorable for the accumulation of uranium, the radiometrics remain at background levels except for a peak of 40 c.p.s. (total count) in the gritty units.

I.3.2. **Carboniferous Sequences**

(a) **Point Springs Sandstone**

The Lower Carboniferous Point Springs Sandstone is a monotonous sequence of medium to coarse grained quartz sandstone with numerous massive hematite interbeds and hematite lenses (see Figure 1 for cross-section (985;990) Carlton 1:100,000 topographic sheet). All anomalous (total count) radiometrics recorded in this unit were associated with hematite and as a result, the unit necessarily has low potential for uranium mineralization.

(b) **Border Creek Formation**

The Border Creek Formation unconformably overlies the Point Springs Sandstone in the Weaber Range (Figure 1. 985;990 Carlton 1:100,000 topographic sheet). In this section the Border Creek Formation is distinguished from the latter unit by the presence of a buff colored muscovite siltstone and quartz pebble conglomerate at the base (unconformity). The rest of the sequence is a

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monotonous series of slightly feldspathic quartz sandstones with numerous hematite lenses. Radiometrics, as with the Point Springs Sandstone, peaked on the hematite lenses (40 - 50 c.p.s.) with similar readings recorded on the muscovite siltstone. The conglomerate is not anomalous.

I.3.3. Summary of Ground Radiometrics

Radiometric traverses were made with an Austral SG 2a scintillometer. Below is a summary of maximum radiometrics recorded in each formation investigated:

DEVONIAN:

Kelly's Knob Member - 40 c.p.s. Hematitic quartz sandstone

Cecil Sandstone Member - 35 c.p.s. Calcareous sandstone

Cockatoo Formation - 40 c.p.s. Gritty feldspathic sandstone

CARBONIFEROUS:

Point Springs Sandstone - 50 c.p.s. Massive hematitic lenses

Border Creek Formation - 50 c.p.s. Massive hematitic lenses and micaceous siltstone

Basal quartz pebble conglomerate - variable, ranging between 20 and 60 c.p.s. Average counts 40 c.p.s.

I.4. HELICOPTER SURVEY

A spectrometer survey was flown on the 6th October 1977 to examine areas not investigated on the ground due to the limited access. A limited number of hours was spent due to
the low priority of the areas. Reconnaissance was directed over the following areas. Flight charts and numbers are presented with the reconnaissance report.

(1) Carboniferous sequences at Spirit Hill

At Spirit Hill the Border Creek Formation unconformably overlies the Milligan beds (shales, siltstones). The area was of interest because stratigraphic cores from petroleum wells in the Spirit Hill area revealed the presence of carbonaceous shales in the Milligan beds. (B.M.R. Bulletin 97, Upper Palaeozoic rocks of the Bonaparte Gulf Basin) (Chart 8, Run 3)

(2) Cockatoo Formation/Border Creek Formation contact in the Keep River area

This was investigated to trace the conglomerate horizon found during previous ground reconnaissance (see I.3.1.(b) of this report).

(3) Cockatoo Fault Area

In this area a good potential target was the down faulted embayment of the Ragged Range Conglomerate at the base of the Cockatoo Formation. The Ragged Range Conglomerate appears to be locally derived and sits unconformably on Lower Palaeozoic and Proterozoic units. The target area is surrounded by down faulted lenses of Kelly's Knob aeoleonites. The Cockatoo Fault has been active several times since the Pre Cambrian, including the Upper Devonian, and rocks east of the fault (the reputed source of the Devonian sediments) are considered a possible source of U. These rocks include the co-magmatic Whitewater Volcanics and Bow River Granite, both of which are known hosts for secondary uranium in the East Kimberley area, and undifferentiated Halls Creek Group meta-sediments. Traverses were made along the fault and lithological contacts in the area. (Chart 10)
Apart from the Palaeozoic sediments, three areas of Proterozoic rocks not strictly in the Bonaparte Gulf Basin were also investigated. These include the following:-

(4) King Leopold Sandstone
This unit (quartz sandstone, feldspathic sandstone) was investigated where it outcrops 28km north of Kununurra. It is conformably overlain by the Carson Volcanics and Wharton Sandstone. Traverses were confined to rim flying the outcrop at the base of the sandstone (Chart 8, Run 2).

(5) An interbedded sequence of Lumen Siltstone, Lansdowne Arkose, and Valentine Siltstone (Speewah Group) intruded by Hart dolerite straddling the Great Northern Highway 15km west of Kununurra. (Chart 8, Run 1).

(6) The Halls Creek Fault (within Archaean meta sediments) north of the Wyndham Nicholson highway. (Chart 10)

(7) A fault bounded elongate block regionally situated between the Fitzmaurice Mobile Zone and the Sturt Block. (Chart 11)
(Auvergne 1:250,000 Geological Sheet; 15°25'; 129°30')

The area is covered by Fitzmaurice Group sediments which are faulted against younger Adelaidean sediments to the east, and also transected by numerous crosscutting faults and fault splays comprising the Fitzmaurice Mobile Zone. These sediments consist of quartz sandstones with high feldspar content, grits, siltstone and basal conglomerate (Moyle River Formation) deposited in relatively shallow water in the unstable Fitzmaurice Mobile Zone. Stagnant reducing conditions existed intermittently while these sediments were laid down. These sediments onlap inliers of Bow River Granite (radiometrically 'warm') along the centre of this elongated area.

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I.4. **SAMPLING**

A total of 14 samples (11 rock chip, 5 stream sediment) were collected during the course of ground and airborne investigations and were despatched to Pilbara Laboratories for chemical analyses. Of these, 4 were forwarded to Amdel for detailed petrographic descriptions. Sample submission sheets with thin section descriptions are presented with this report.

I.5. **DISCUSSION OF RESULTS**

Sampling during ground reconnaissance was concentrated on the Ragged Range Conglomerate and Border Creek Formation (i.e. conglomerate sequences of platform facies). Assay results from samples show consistently low U values and high Th:U ratios (>5:1). The conglomerates generally have a uniform composition of well rounded pebbles, cobbles and boulders of metaquartzite. The proportion of clasts to matrix in the Ragged Range Conglomerate varies from little or no matrix in parts of the Ragged Range to pebbly ferruginous quartz sandstone near Keep River. Red hematitic staining is common throughout the Ragged Range Member (more likely detrital than authigenic in origin), except in parts of the Ragged Range where the matrix is more feldspathic. The source for these units would be either the Bow River Granite or Castlereagh Hill porphyry (both radiometrically 'warm'). The majority of sediment, however, appears to be of volcanic (Antrim Plateau Volcanics) and sedimentary origin. (A westerly source is indicated by regional dips) Minor fragments of siltstone, mudstone and schist within the basal Border Creek conglomerate indicate varies sources. Palaeocurrent analyses (J.J. Veivers, B.M.R. Bulletin 109) show a predominant S to SE source direction. The physical character of the conglomerates indicate marine deposition.
Two samples of sandstone LIMVO5 and LIMV were collected from the Ragged Range Conglomerate for petrographic identification. The main constituents of LIMVO5 in order of abundance are quartz, feldspar, lithic fragments and mica. The wide variety of detrital fragments (tourmaline, zircon, geothite/limonite) and the presence of little intergranular clay material suggest that the sample is a greywacke. There is little direct evidence of a reducing environment and dark material is represented by widely dispersed geothite/limonite. Lithic fragments appear to be medium to fine grained metamorphic rocks (schists) but most appear to be of sedimentary origin. Chlorite forms a few small patches and these may have been derived from the original mafic detrital components or may represent the muddy matrix material the greywacke originally contained. Sample LIMVO6 is similar except it contains more micas and argillaceous material.

Two samples for identification were also collected from near the base of the Border Creek Formation (Keep River area). Sample AUMVO2 is a fine grained sandstone which originally consisted of quartz and feldspar fragments. The rock has been cemented largely by dolomite and also contains some opaque material which may be carbonaceous. Patches of green clay may consist of glauconite. Sample AUMVO5 (a lithic sandstone) contains a moderate amount of lithic fragments and there is evidence that the provenance contained argillaceous fine grained sedimentary rocks, high level igneous rocks (granophyres) and also metamorphic quartzites.

The Kelly's Knob member is not considered prospective due to the large amounts of hematite and low total count radio-metrics.

During the airborne survey only two anomalies were found which warranted ground investigations. Anomalous peaks were recorded over the Valentine Siltstone (Chart 7, Run 1, Al A2
and A3). Unfortunately the sample taken from the thinly bedded chloritic siltstones have been misplaced, and no assays are available.

The second anomaly was recorded over the Milligans beds at Spirit Hill (Anomaly A4, Chart 8, Run 3). Ground investigations, however, showed that the anomalous readings were due to gossanous material developed over the Milligans beds.

I.7. CONCLUSIONS AND RECOMMENDATIONS

Available evidence from lithologies, structures, fossils, etc. indicate that the sequences of sandstone and conglomerate are predominantly marine except the Border Creek Formation (fluvial). Due to continuous episodes of uplift and subsidence sediment was supplied to the basin throughout the Upper Devonian and Carboniferous, predominantly from the south and south east. Although a minor amount of material was derived from such favorable source rocks as the Bow River Granite, Whitewater Volcanics and Halls Creek Group, it appears that the majority included the Proterozoic quartz sandstone, carboniferous siltstones and dolomite sediments of the stable Sturt Shelf to the south east. Petrographic descriptions of horizons investigated failed to show any evidence of reducing conditions during or after deposition. These factors combined with a lack of suitable structural traps suggest that the area has a low potential for uranium accumulations. Although the broad reconnaissance survey was far from exhaustive, the chance of finding any economical uranium accumulations seems very low.
Fig. 1

Point Springs Sandstone —— Border Creek Formation

2km approx.

URANGESSELLSCHAFT AUSTRALIA PTY. LIMITED

BONAPARTE GULF BASIN, N.E. KIMBERLEY

Section looking West

1977 PROJECT CARPENTARIA

Prepared by: J. Thevisson; June '77
Drawing No. A4-357; Project No. A8b-8
Section looking East

NORTH

- Calcareous sandstone
- Coarse grained, crossbedded sandstone with conglomerate
- Limonitic friable sandstone
- Grey sand

SOUTH

- Coarse grained, friable, red; purple hematitic crossbedded aeolianites with numerous conglomerate lenses;
- Massive quartzite with conglomerate bands;
- Crossbedded aeolianite lenses parallel to the cross bedding.
- Red sand

Due
Cecil Sandstone Member

Duk
Kelly's Knob Member

3 km approx.
Fig. 3

BONAPARTE GULF BASIN, N-E KIMBERLEY

Section looking East

1977 PROJECT CARPENTARIA
Prepared by: J. Thevisson, June '77
Drawing No A4-359, Project No A8b-10
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Grid Ref.</th>
<th>Sample Type</th>
<th>Depth from</th>
<th>Depth to</th>
<th>Analysis in ppb/ppm/%</th>
</tr>
</thead>
<tbody>
<tr>
<td>WUV02</td>
<td>260.250.1</td>
<td>Rock Chip</td>
<td>1</td>
<td>3</td>
<td>Cl: 11, Cu: 2, Pb: 40, V: 81, Zn: 40</td>
</tr>
<tr>
<td>WUV05</td>
<td>259.650.1</td>
<td>Rock Chip</td>
<td>1</td>
<td>27</td>
<td>U: 27, Th: 4, Cu: 1, Pb: 25, Zn: 155, Zn: 10</td>
</tr>
</tbody>
</table>

Remarks:
- Cub. Pebby var. sst. Conglomerate
- Cub. Neumatic masive chlorito
d- Cub.
- Cub. Duct sampled Green j-null
- Conglomerate 30-0.5
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Grid Ref.</th>
<th>Sample Type</th>
<th>Depth from</th>
<th>Depth to</th>
<th>Analysis in ppm/ppm/%</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMV05</td>
<td>89706790</td>
<td>Rock Chip</td>
<td>5</td>
<td>25</td>
<td>20 24 68 217 470</td>
<td></td>
</tr>
<tr>
<td>IMV06</td>
<td>89906780</td>
<td>Rock Chip</td>
<td>3</td>
<td>14</td>
<td>12 5 89 177 240</td>
<td></td>
</tr>
<tr>
<td>IMV07</td>
<td>89956765</td>
<td>Rock Chip</td>
<td>2</td>
<td>14</td>
<td>15 38 39 175 100</td>
<td>Stream Sed. 25-05</td>
</tr>
<tr>
<td>IMV08</td>
<td>89956765</td>
<td>Rock Chip</td>
<td>3</td>
<td>25</td>
<td>15 14 51 193 630</td>
<td>Course carbon, poorly cemented</td>
</tr>
<tr>
<td>IMV09</td>
<td>89956765</td>
<td>Stream Sed</td>
<td>2</td>
<td>14</td>
<td>14 13 47 173 210</td>
<td>Stream Sed.</td>
</tr>
<tr>
<td>IMV10</td>
<td>89956765</td>
<td>Stream Sed</td>
<td>2</td>
<td>10</td>
<td>20 27 46 198 420</td>
<td>Stream Sed.</td>
</tr>
</tbody>
</table>
I. RECONNAISSANCE IN THE BONAPARTE GULF BASIN

APPENDIX 1:

DETAILED PETROGRAPHIC DESCRIPTIONS
AMDEL REPORT NO: MP 260/78
22 August, 1977

Urangesellschaft Aust. Pty. Ltd.,
P.O. Box 40121,
CASUARINA. NT 5792

FINAL REPORT MP 260/78

YOUR REFERENCE: Order 226
MATERIAL: 3 rocks
IDENTIFICATION: LIMV01, LIMV02, GDMV01
DATE RECEIVED: 22/7/77
WORK REQUIRED: Identification of uranium minerals

Investigation and Report by: Dr B.G. Steveson
Manager, Geological Services Division: Dr K.J. Henley

K. J. Henley
for Brian S. Hickman
Acting Managing Director

cc Urangesellschaft Aust. Pty. Ltd.,
608 St. Kilda Road,
MELBOURNE. VIC. 3004

kk.
IDENTIFICATION OF URANIUM MINERALS IN THREE ROCKS

Out of a group of ten samples submitted for petrography by Urangesellschaft (Aust.) Pty. Ltd., three were selected by the client for radioactive mineral identification (the petrography is reported in Part Report MP 260/78 of 16 August, 1977).

Each sample was crushed to -0.42mm, deslimed at 0.053mm and the -0.42+0.053mm fraction was separated in tetrabromoethane (sp. gr. 2.96) in order to concentrate uranium into a heavy product. Polished briquettes (PS 26046-8) were prepared from the >2.96 sp. gr. products and examined on the electron microprobe analyser; the results are as follows:

**LIMV01** (0.28% >2.96 sp. gr.). Uranium was located in four grains, all of which are phosphates. In three copper is also present, suggesting torbernite as the likely mineral species. In the fourth grain, uranium and phosphorus only were identified and this could be uranophanite or phosphuranylite.

**LIMV02** (49.3% >2.96 sp. gr.). There is only a two-fold concentration of uranium into the heavy product and after approximately 30 minutes searching on the electron microprobe, no uranium was located and the search was abandoned.

**GDMV01** (37.0% >2.96 sp. gr.). As for LIMV02, there is only a small concentration of uranium into the dense product and no uranium was located after 30 minutes searching with the electron microprobe analyser.

As a final check on the result for LIMV02 and GDMV01, the polished briquettes of the >2.96 sp. gr. products of all three samples were briefly autoradiographed. Blackening whatsoever was found in the autoradiographs of LIMV02 and GDMV01 but that of LIMV01 showed numerous spots and diffuse areas.
EXAMINATION OF TEN ROCKS

Sample: LIMV04; TS38345

Rock Name: Potassic volcanic rock

Hand Specimen:
The sample is a massive and compact igneous rock which has a pink although somewhat dark colour. The sample is speckled with pale phenocrysts and numerous dark green spots.

Thin Section:
An optical estimate of the constituents gives the following:

<table>
<thead>
<tr>
<th>Component</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feldspathic groundmass</td>
<td>70</td>
</tr>
<tr>
<td>Phenocrysts</td>
<td></td>
</tr>
<tr>
<td>Feldspar</td>
<td>20</td>
</tr>
<tr>
<td>Altered mafic minerals</td>
<td>10</td>
</tr>
<tr>
<td>Quartz</td>
<td>2</td>
</tr>
</tbody>
</table>

This is an extensively altered high level igneous rock of some kind. Staining tests carried out on the fine-grained groundmass material indicate that it contains abundant potassium feldspar and it seems likely that this mineral comprises more than 50% of the overall volume of the rock. The feldspar phenocrysts, however, are very largely altered crystals of plagioclase.

Feldspar phenocrysts vary from elongate subhedral crystals about 1 mm in length to more rounded and equant crystals characteristically 0.4 to 0.6 mm in diameter. Both optical examination and staining tests indicate that these feldspar crystals are altered plagioclase and in some cases evidence of polysynthetic twinning can still be discerned; most commonly, however, the feldspar is almost completely obscured by abundant sericitic alteration. One or two of the altered feldspar crystals also contain a little secondary fine-grained epidote. Quartz phenocrysts are not abundant and most are less than 0.4 mm in size. They are single unstrained crystals with rather irregular and embayed shapes. Altered mafic phenocrysts are now represented by clots and aggregates of chlorite and this is the material which causes the green spotting of the hand specimen. Most of these chloritic aggregates are 0.4 to 0.6 mm in size but some are as much as 1 mm in diameter. Most of them consist of a bright green chlorite with blue anomalous birefringence colours. Fine-grained epidote and sericite are generally associated with the chlorite. In some places the chlorite appears to pseudomorph the pre-existing mafic phase and forms tabular crystals but in other cases the aggregate of chlorite is more irregular in shape.

The groundmass is turbid and extensively altered and is a characteristic pale brown colour in plane polarized light. As far as can be determined the groundmass consists of potassium feldspar crystals with an average size of about 0.1 mm. Intergrown with these are extremely elongate and thin crystals and these appear similar to the elongate tridymite crystals observed in the devitrified tridymitic texture of altered volcanic rocks.
Other components of the groundmass are fine-grained titaniferous material and epidote.

The rock contains a small amount of opaque and semi-opaque material and some of this appears to have been derived from the alteration of ilmenite; crystals are generally up to about 0.1 mm in size.

This is a homogeneous massive rock which contains phenocrysts of plagioclase, mafic minerals and quartz in a groundmass which consists essentially of potassium feldspar. The groundmass shows the devitrified tridymitic texture characterised by thin elongate needles of tridymite. The sample is some kind of high level potassic igneous rock but the massive nature of the sample suggests that it is more likely to be intrusive than extrusive.

Sample: LIMV05; TS38346

Rock Name:
Greywacke

Hand Specimen:
The sample is a dark, purple coloured sedimentary rock which shows only a very crude foliation. The rock appears to be a relatively fine-grained sandstone.

Thin Section:
An optical estimate of the constituents gives the following:

<table>
<thead>
<tr>
<th>Constituent</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>45</td>
</tr>
<tr>
<td>Feldspar</td>
<td>20</td>
</tr>
<tr>
<td>Lithic fragments</td>
<td>20</td>
</tr>
<tr>
<td>Mica</td>
<td>5</td>
</tr>
<tr>
<td>Matrix</td>
<td>5</td>
</tr>
<tr>
<td>Goethite/limonite</td>
<td>3</td>
</tr>
<tr>
<td>Chlorite</td>
<td>1</td>
</tr>
<tr>
<td>Tourmaline</td>
<td>trace</td>
</tr>
<tr>
<td>Zircon</td>
<td>trace</td>
</tr>
<tr>
<td>?Epidote</td>
<td>trace</td>
</tr>
</tbody>
</table>

The average grain size of this sedimentary rock is about 0.25 mm and the wide variety of detrital fragments and the presence of a little intergranular clay material suggests that the sample is a greywacke or possibly a sub-greywacke. There is little direct evidence of a reducing environment and dark material in the sample is generally represented by widely dispersed goethite/limonite. This may have been derived from the alteration of pyrite and there is certainly no evidence of the presence of carbonaceous material.

Quartz, feldspar and many rock fragments range in size from about 0.1 mm to 0.8 mm and form essentially equant angular to subangular grains. Quartz is the most abundant of these and most grains are single crystals with little or no undulose extinction but there are a few strained and foliated quartzite fragments and one or two extremely fine-grained fragments which may be chert. Feldspar is present both as partly altered crystals and as notably fresh crystals of microcline. In general, the microcline tends to form relatively small grains some of which show a rather exceptional amount of
rounding. Commonly, however, the feldspar is somewhat altered and is present as angular to subangular grains. Plagioclase is present but is probably by no means as abundant as potassium feldspar.

The rock fragments are of a great variety of types most of which are fine-grained and rather dark in plane polarized light. In many instances it is difficult to distinguish argillaceous rock fragments from argillaceous matrix material and it is likely that there has been a considerable degradation of the lithic rock fragments during compaction and diagenesis of the rock and this has resulted in the deformation of these fragments so that the detrital grains tend to fit together relatively well with little easily identifiable intergranular matrix. Some of the lithic fragments appear to be medium to fine-grained metamorphic rocks (schists) but most are probably of sedimentary origin. No volcanic rock fragments were specifically identified. The sample contains fairly abundant mica fragments and these range from dark and clouded biotites to perfectly clear flakes of muscovite. The largest fragments of mica are generally about 0.3 mm in length. Some mica fragments have been deformed during compaction of the rock but most are essentially straight and have a decussate arrangement.

Chlorite forms a few small patches widely distributed throughout the rock; these may have been derived from the alteration of original mafic detrital components or may represent the little genuine muddy matrix material that the greywacke originally contained. Much of the material described in the listing as matrix may well have been a part of original argillaceous lithic fragments which have been deformed and partly degraded during the compaction of the rock. It is difficult to identify specific patches of matrix material and in many cases intergranular space is now occupied by dark semi-opaque ferruginous material (goethite or limonite). There are no pseudomorphs of this material after pre-existing pyritic fragments although it is possible they may have been derived from detrital pyrite; it seems more likely, however, that the iron oxides/hydroxides have been introduced into the rock during a period of weathering. As a result, therefore, there is little direct evidence that the rock was ever subjected to a reducing environment because characteristic authigenic minerals have not been developed.

Sample: LIMVO6; TS38347

Rock Name: Greywacke

Hand Specimen: The sample is a slightly friable sandstone partly purple in colour but elsewhere grey. The rock shows a rather indefinite banding.

Thin Section: An optical estimate of the constituents gives the following:

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>45-50</td>
</tr>
<tr>
<td>Lithic fragments</td>
<td>20</td>
</tr>
<tr>
<td>Mica</td>
<td>10-15</td>
</tr>
<tr>
<td>Feldspar</td>
<td>10</td>
</tr>
<tr>
<td>Matrix</td>
<td>10</td>
</tr>
<tr>
<td>Goethite/limonite</td>
<td>2</td>
</tr>
<tr>
<td>Titaniferous material</td>
<td>trace</td>
</tr>
</tbody>
</table>
The sample is a greywacke or a sub-greywacke and to that extent is similar to the rock described immediately above; however, this sample appears to be distinctly more micaceous and there is slightly more evidence of a genuine argillaceous matrix.

The detrital silicate minerals have an average grain size of about 0.2 mm and the rock shows a moderate amount of sorting. Quartz and feldspar are present as equant angular fragments apparently randomly intergrown. Quartz is commonly present as single crystals with a small amount of undulose extinction whereas feldspar occurs as both microcline and plagioclase. The grains of microcline are notabl clear and fresh but some feldspar grains show abundant secondary sericitization. Some plagioclase was positively identified but there is a considerable amount of partly altered feldspar which is too obscured for positive optical identification. There seems to be a clear distinction between clear fresh microcline and partly altered feldspar including some, at least, plagioclase. The rock contains considerably more mica than sample LIMV05 and much of the micaceous material is present as flakes 0.5 mm in length. In general these flakes are dark in colour and are pleochroic in shades of both brown and green. This biotite generally shows the effects of compaction and many of the flakes have a clear parallel orientation. The rock contains muscovite as well; this mineral generally forms somewhat shorter and more equant flakes than does biotite. There appear to be slight variations in the relative proportions of mica from place to place in the thin section and the rock may have some "cryptic" bedding as a result of the variation in the proportion of micas.

Lithic fragments are similar to those described in the sample above particularly in the abundance of argillaceous material. In this sample there appears to be a clearer distinction between slightly deformed lithic fragments rich in clay material and small patches of argillaceous matrix. The latter appear to contain birefringent clays (illite or sericite) whereas the argillaceous lithic material is more heterogeneous particularly in terms of the nature of the clay and the amount of fine-grained quartz involved. Some lithic fragments also contain abundant fine-grained ferruginous material and the presence of these results in the dark appearance of some parts of the thin section. The lithic fragments have clearly been partly compressed and deformed during compaction of the rock.

The sample contains little or no evidence of either carbonaceous material or of pyrite and the cementing matter observed in the thin section is almost wholly argillaceous in nature. The sample does contain a little finely disseminated secondary titaniferous material but this has probably been derived from the generation of original detrital rutile or ilmenite.

Sample: LIMV11; TS38348

Rock Name:
Very fine-grained ferruginous sandstone

Hand Specimen:
The sample is a massive and compact pink to red rock. In the cut surface it can be seen that the sample has a granular texture but it is clear that the rock is very fine-grained.
Thin Section:

An optical estimate of the constituents gives the following:

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>75</td>
</tr>
<tr>
<td>Clay</td>
<td>15</td>
</tr>
<tr>
<td>Feldspar</td>
<td>5</td>
</tr>
<tr>
<td>Iron oxide/hydroxide</td>
<td>5</td>
</tr>
<tr>
<td>Mica</td>
<td>2</td>
</tr>
</tbody>
</table>

The sample is a very fine-grained argillaceous sandstone which contains intergranular clay matrix partly obscured by relatively abundant semi-opaque ferruginous material. There is no evidence of any carbonaceous material in the sample whatsoever.

The average grain size of quartz and feldspar is about 0.06 mm and hence the sample is close to the division between a coarse siltstone and a very fine-grained sandstone. The quartz grains are mainly angular to subangular in shape with a few exceptional sub-round grains. Most of the grains of quartz are single crystals and some have rather marked undulose extinction. Compaction of the rock has been such that there are places where tangential grain contacts have been replaced by long and concavo-convex grain boundaries. In some places the grain boundaries are obscured by intergranular ferruginous material and it appears that there may have been some marginal replacement of the detrital grains by this goethite/limonite.

Feldspar is not abundant and is generally present as slightly altered grains of microcline. These have similar size and shape characteristics to the quartz grains. The feldspar appears to be distinctly less altered than in the two rocks described above and there appears to be an even greater preponderance of potassium feldspar in this sample than in the other LIMV sedimentary rocks.

Detrital mica is represented by numerous small flakes of muscovite; these tend to have a subparallel orientation but they are not sufficiently abundant to define a bedding direction. Most of the muscovite flakes are less than 0.1 mm in length.

The intergranular material is rather turbid and dark in plane polarized light and appears to consist of clay material partly replaced by widely dispersed semi-opaque ferruginous matter. The clay is generally extremely fine-grained and appears to a birefringent illite or sericitic material; the material is sufficiently homogeneous in thin section to comprise a matrix sensu stricto rather than being derived from the partial alteration and degradation of argillaceous lithic fragments. No doubt there are both types of components in the argillaceous material in this sandstone but it is felt in this rock (probably in contrast to the two described above) that genuine argillaceous matrix material is the predominant intergranular component of the sample. As mentioned above, this has been replaced by widely dispersed semi-opaque goethitic material. The iron oxide/hydroxide generally forms discontinuous films and there is no evidence of it having pseudomorphed pre-existing equant detrital phases. It is likely that the sample has been subjected to a reducing environment but this is a tentative suggestion only since there are no specifically indicative authigenic minerals.
Sample: LIMV01; TS38349

Rock Name:
Secondary sericitized rock

Thin Section:
The client describes this rock as an altered dolerite but, in thin section, the sample consists very largely of secondary sericitic material and there are no relict or pseudomorph textures to indicate the nature of the original sample.

Secondary quartz comprises about 5 to 10% of this rock and there is a small amount of limonite/goethite; Apart from these accessory components the rock contains traces of apatite and of ?zircon. The great bulk of the sample consists of a dense virtually monomineralic aggregate of a birefringent phyllosilicate here termed sericite. It is possible that some or all of this material could be talc but a precise determination would require X-ray diffraction analysis.

The sericite is generally present as randomly oriented flakes less than 0.02 mm in length. There are some flakes and aggregates of flakes as much as 0.1 mm in size but these are distinctly rare. Quartz is intergrown with the sericite and in some cases forms pools of readily identifiable quartz surrounded by gradational zones in which the quartz appears to have been largely replaced by sericite. Quartz generally forms granular aggregates of crystals less than 0.2 mm in size. Neither the texture of the quartz nor the overall shape of the aggregates of quartz in any way pseudomorphs (at least recognisably) pre-existing primary minerals.

Goethite/limonite occurs in thin cross-cutting fractures and lenses both in the sericite and in the quartz and it seems likely that this mineral is later than either of the silicates. The only mineral which may give some indication of the nature of the original rock is apatite which forms a few widely dispersed crystals. Some of these are however, as much as 0.5 mm in size. The apatite crystals are generally equant and notably irregular in shape. Such large apatite crystals are not likely to be relics of a pre-existing medium or fine-grained basic igneous rock and it seems at least possible that the sample may have been derived from some kind of medium or coarse-grained feldspathic rock (either igneous or sedimentary). This is suggested both by the presence of apatite and by the abundance of sericitic material. These interpretations are, of course, tentative since, again, it is possible that the sericite has been wholly introduced into the rock and may not be a characteristic alteration product of the pre-existing mineral.

Sample: AUMVO2; TS38350

Rock Name:
Dolomitic sandstone

Hand Specimen:
The sample is a buff coloured fine-grained sandstone which is massive and compact in the hand.
Thin Section:
An optical estimate of the constituents gives the following:

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>70</td>
</tr>
<tr>
<td>Feldspar</td>
<td>10</td>
</tr>
<tr>
<td>Dolomite</td>
<td>15-20</td>
</tr>
<tr>
<td>Opaques</td>
<td>3</td>
</tr>
<tr>
<td>Clay</td>
<td>1</td>
</tr>
</tbody>
</table>

This is a cleaner sandstone than those described above and it is free both from detrital mica and lithic fragments. Any original argillaceous matrix has now been almost completely replaced by carbonate minerals.

Detrital quartz and feldspar form equant angular to subangular grains which have an average size of about 0.08 mm. The grains show considerable evidence of compaction particularly in that long and concavo-convex grain boundaries have developed. In addition, some quartz shows thin and discontinuous authigenic overgrowths. The quartz crystals show a little undulose extinction and appear to belong to the common or plutonic variety. The feldspar grains generally consist of microcline but a little plagioclase was also identified. Both feldspars are fresh and the rock contains only trace amounts of partly altered rather turbid feldspar. These detrital components are cemented by dolomite. This mineral forms crystals up to about 0.15 mm in size but generally about 0.03 mm. In many places the dolomite crystals have extremely irregular shapes where they appear to have partly replaced adjacent detrital grains and also have penetrated between grains. It is as a result of this process that the dolomite has rather characteristic spate shapes.

The reference to clay in the listing above includes one or two small patches of a pale green clay and traces of intercrystalline clay which may be a remnant of a more abundant argillaceous matrix. The green clay tends to form equant patches up to 0.08 mm in size and these may well consist of glauconite. The remaining clay generally forms intergranular rims and elongate lenses and is generally colourless to somewhat turbid.

Opaques and traces of tourmaline occur as detrital fragments and there are a few patches of secondary opaques associated with dolomite. The latter form extremely irregular patches which are probably composed of extremely small grains. These do not show a red colouration even under high illumination and it is possible that this material is carbonaceous. Some of the opaque material is extremely ferruginous and forms loose aggregates of goethite/limonite.

This is a fine-grained sandstone which clearly originally consisted of quartz and feldspar fragments. The sample has been cemented largely by dolomite and it also contains some opaque material a small proportion of which could be carbonaceous.
Sample: AUW05; TS38351

Rock Name:
Lithic sandstone

Hand Specimen:
The sample is a buff coloured slightly friable sand. A few small white specks less than 1 mm in size can be seen in the weathered surfaces but otherwise the sample appears to be either a very fine-grained sandstone or a siltstone.

Thin Section:
An optical estimate of the constituents gives the following:

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>75</td>
</tr>
<tr>
<td>Lithic fragments</td>
<td>10</td>
</tr>
<tr>
<td>Feldspar</td>
<td>7-10</td>
</tr>
<tr>
<td>Clay</td>
<td>5</td>
</tr>
<tr>
<td>Opaques and semi-opaques</td>
<td>2</td>
</tr>
<tr>
<td>Mica</td>
<td>1</td>
</tr>
<tr>
<td>Titanium minerals</td>
<td>trace</td>
</tr>
</tbody>
</table>

The most distinctive feature of this sandstone is the apparently bimodal grain size distribution; in addition there is considerably more rounding of the grains than in other sandstones described in this collection. Some grains consist of micrographically intergrown quartz and potassium feldspar and these strongly suggest that granophyres were part of the provenance area of this sample.

The fragments of quartz, feldspar and lithic material appear to belong to two different grain size populations. There are numerous grains which range in size from about 0.6 mm to 1.2 mm and these occur in abundant material which consists of grains which commonly range in size from 0.1 mm to about 0.25 mm. The two types of grains occur randomly intergrown together and there is no stratification on the basis of grain size. Most grains of quartz consist of single crystals with little or no undulose extinction and quartzite grains have simple granular textures which are not characteristic of an particular rock type. There are one or two distinctly metamorphic quartzites but these are present in trace amounts only.

Detrital feldspars are most commonly crystals of microcline showing fairly clear cross-hatch twinning and little or no alteration. Some grains consist of rather dark and turbid potassium feldspar which includes micrographically intergrown quartz. Grains of quartz and feldspar belonging to both grain size populations tend to be subangular to round in shape and this is in marked contrast to the apparently less mature sandstones described above in this report.

The sample contains a moderate proportion of argillaceous lithic fragments which range from dense monomineralic aggregates of clay minerals to fine-grained argillaceous sandstone which have an average grain size of about 0.06 mm. Most of the lithic fragments are more than 0.4 mm in size and tend to be round to sub-round in shape.

The rock contains a little intergranular material but the wide grain size
range of the sample means that there is a fairly close fitting of the
detrital grains and intergranular material (and a little pore space)
are generally confined to a few patches less than 0.1 mm in size. These
contain small amounts of a weakly birefringent clay mineral.

The sample contains widely disseminated ferruginous opaque and semi-opaque
material and there are also places where there are aggregates of dusty
completely opaque material. This latter may be carbonaceous rather than
ferruginous but it is difficult to give an unequivocal identification by
optical means alone.

This sample consists of moderately well sorted round to sub-round grains
belonging to two grain size populations. The sample contains a moderate
amount of lithic fragment and feldspar and there is evidence that the
provenance contained ar. Illaceous fine-grained sedimentary rock, high level
igneous rocks (granophyres) and also metamorphic quartzites. In general,
the sample is distinctly more mature than sandstones described above.

Sample: GDMV01; TS38352

Rock Name:
Conglomerate

Thin Section:
The sample contains about 70% of readily identifiable detrital fragments
and most of these are more than about 0.5 mm in size. The remaining
material consists of fine-grained quartz, opaques and semi-opaques and
a moderate amount of sericitic material.

The detrital fragments range in size from 0.5 mm to about 8 mm. Two of
largest fragments in the rock are quartzite and one shows a markedly
foliated texture whereas the other has a more equigranular granoblastic
texture. Other fragments consist of single quartz crystals many of which
are strained and are clearly derived from a metamorphic provenance. Most
of the fragments are equant in size but they have irregular serrated outlines
and are angular. One fragment consists of quartz crowded with inclusions
and this may be an example of a grain derived from vein quartz. The inter-
granular material contains a mixture of detrital and authigenic components
and in some instances it is difficult to distinguish one from the other.
Quartz is the most abundant material in this part of the rock but opaques
and semi-opaques and sericite occur in significant amounts also. The
quartz is present as crystals and grains up to about 0.3 mm in size and
these generally occur with fairly abundant intergranular sericite so that
it is not possible to distinguish whether the quartz crystals are detrital
grains or whether they are part of relatively large lithic fragments. It
seems more likely to the author that much of this relatively fine-grained
quartz is of detrital origin. Sericite is present as coherent monomineralic
patches and as a web-like aggregate associated with fine-grained quartz.
The proportions and crystal size of the sericite and quartz are generally
fairly consistent from place to place in the thin section and the only
significant variation is in the amount of opaque and semi-opaque material.

It is estimated that, overall, the rock contains at least 15% of opaque
and semi-opaque material. Some of this is definitely titaniferous and
some appears still to be rutile whereas finely disseminated titaniferous
material is probably derived from the degradation of original detrital
rutile. Elsewhere opaque material forms euhedral crystals and these are
probably authigenic pyrite. Such crystals are commonly 0.3 mm in size.
and the average crystal size of the recognisable pyrite is probably about 0.15 mm. Throughout the whole of the rock there is abundant finely disseminated opaque material and this is more likely to be pyritic rather than carbonaceous. The opaques and titaniferous semi-opaques are wholly associated with the fine-grained material and it is likely that the bulk of this material is authigenic with the exception of at least some of the titaniferous material which has been derived from detrital rutile and/or ilmenite.

Minor to trace components of the rock are chlorite and a little biotite and these generally occur with the sericite. The chlorite may well be authigenic but the biotite is probably derived from a few degraded lithic fragments.

This is a rather heterogeneous metasomatised rock so it is difficult to give a coherent description. The sample appears to be a conglomerate which contains an extremely wide range of detrital material. This probably did not include very much lithic material but consisted largely of quartz. The sample contains an abundant matrix of finer grained quartz with sericite (possibly derived from an original argillaceous matrix). The sample contains abundant authigenic pyrite and a considerable amount of semi-opaque titaniferous material which is probably only partly (at most) authigenic. The presence of authigenic pyrite is an indication that at some time in its diageneric history the rock has been subjected to a reducing environment.

Sample: GDM02; TS38353

Rock Name:
Carbonaceous shale

Hand Specimen:
The sample is a dark grey to black fine-grained shale with a sub-conchoidal fracture.

Thin Section:
The bulk of the thin section is completely dark in plane polarized light and quartz and phyllosilicates which, which together comprise less than 25% of the rock, form elongate lenses. The sample was examined by X-ray diffractometry which showed that the sample contains abundant amorphous material. No graphite was identified.

The largest crystals of quartz and phyllosilicates are no more than 0.02 mm in size and rather turbid aggregates of these minerals typically form parallel-oriented lenses of the order of 0.05 mm in width and 0.1 to 0.3 mm in length. Quartz is clearly abundant but there is some colourless phyllosilicate (muscovite/sericite) also. The phyllosilicate typically is closely associated with the carbonaceous material and some is probably partly obscured.

In one place in the thin section there is a thin conformable veinlet which contains secondary silica (probably chalcedony). This vein is not more than about 0.05 mm in width.

The sample is a carbonaceous shale and about 70 to 80% of the thin section consists of opaque material. X-ray diffraction analysis suggests that this material is amorphous and it is likely that it is amorphous carbon rather than being extremely poorly crystalline ferruginous material.
Sample: LIMV02; TS38354

Rock Name:
Serpentinite

Thin Section:
Apart from widely disseminated semi-opaque ferruginous material and a few crystals of quartz the sample consists of a pale green aggregate of serpentine.

Quartz forms aggregates up to about 0.4 mm in size and these commonly consist of relatively large crystals which show plane extinction. Quartz probably comprises about 2% of the volume of the sample and much of the quartz (if not all) is interpreted as being a some kind of secondary material rather than a relict of the primary rock.

Goethite/limonite occurs in numerous cross-cutting fractures in the sample. In some places these fractures are up to about 0.1 mm in width but generally they are much smaller than this. There is no preferred orientation of the fractures and they have a notably irregular orientation and distribution. The remainder of the rock consists wholly of an aggregate of fine-grained serpentine within which no pseudomorphs of pre-existing material can be observed. There is some tendency in some places towards a cross-hatch lamellar kind of texture such as serpentine assumes when it is derived from the alteration of pre-existing olivine or pyroxene. Such patches are, however, not well defined in this rock and there is no evidence of the nature of the pre-existing rock apart from the overall chemistry of this sample.

The sample is a serpentinite which has probably been derived from the alteration of a pre-existing ultrabasic rock.
I. RECONNAISSANCE IN THE BONAPARTE GULF BASIN

APPENDIX 2:

FLIGHT CHARTS
II. FIELD INVESTIGATIONS OF THE TANAMI AND BIRRINDUDU

1:250,000 TOPOGRAPHIC SHEET AREA:

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A1 INTRODUCTION
A2 FIELD PROGRAM
A3 STRATIGRAPHY
A4 REGIONAL GEOLOGY
A5 FIELD OBSERVATIONS
A6 METHOD OF SAMPLING
A7 CONCLUSIONS AND RECOMMENDATIONS

B AIRBORNE INVESTIGATIONS OF TANAMI, BIRRINDUDU AND GRANITES

1:250,000 TOPOGRAPHIC SHEETS

B1 INTRODUCTION
B2 FIELD OBSERVATIONS
B3 SAMPLING
B4 DISCUSSION OF RESULTS
B5 CONCLUSIONS AND RECOMMENDATIONS
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FIGURE 2: MOUNT WINNECKE FORMATION SECTION 1

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TABLE 2: SAMPLE SUBMISSION SHEET (BIRRINDUDU 1:250,000)

TABLE 3: SAMPLE SUBMISSION SHEET (BIRRINDUDU 1:250,000)

TABLE 4: SAMPLE SUBMISSION SHEET (GRANITES 1:250,000)

APPENDIX 1: FLIGHT CHARTS

APPENDIX 2: SEMI-DETAILED PETROGRAPHIC DESCRIPTIONS
A.1. INTRODUCTION

The Archaean and Lower Proterozoic successions in the area investigated contain large volumes of Granites and acid volcanics which could be considered as suitable source rocks. Field investigations were directed at the interbedded sediments of the Tanami Complex and the Mount Winnecke Formation, the Lower Proterozoic sediments and the conglomerates of the Birrindudu Group. A relatively short amount of time was spent on calcrete areas occupying Tertiary drainage lines located at the margins of granite domes.

A.2 FIELD PROGRAM

Field program was conceived to be carried out in two stages because of the limited accessibility of this region:

Stage 1:
Ground check available outcrops of target lithologies to assess their potential for holding uranium.

Stage 2:
Helicopter survey of lithological units that could be considered as favorable host rocks as a result of ground investigations carried out in Stage 1.

A.3 STRATIGRAPHY

Stratigraphic units exposed in the area are listed below. Lithological units investigated in the field are marked thus *.

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<td><strong>BIRINDUDU GROUP</strong></td>
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<td><strong>Carpentarian</strong></td>
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<td>Quaternary</td>
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<td></td>
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<td>Cambrian</td>
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<td><strong>Lower Proterozoic</strong></td>
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<td><strong>Archean</strong></td>
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<td>Sand, silt, clay</td>
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<td>*Calcrete, laterite</td>
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<td>Sandstone, siltstone &amp; conglomerate</td>
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<td></td>
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<td>Quartz sandstone, mudstone, chert and limestone</td>
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<td>Tholeitic basalt, tuffaceous sandstone, stromatolitic chert</td>
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<td>Quartz sandstone</td>
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<td>Quartz &amp; feldspathic sandstone</td>
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<td>Stromatolithic chert, sandstone &amp; siltstone</td>
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<td>Glaucnitic sandstone, quartz sandstone, conglomerate, shale, siltstone</td>
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<td>Biotite-Muscovite Granite</td>
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<td>Biotite Granophyre</td>
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<td>Adamellite</td>
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<td>Quartz-Feldspar Porphyry</td>
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<td>Ferruginous sandstone</td>
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<td>Quartzites</td>
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<td>Acid Lavas</td>
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<td></td>
<td>Tuffaceous sandstone &amp; siltstone</td>
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<tr>
<td></td>
<td></td>
<td>Quartz sandstone</td>
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<td></td>
<td></td>
<td>Quartzite, conglomerate &amp; greywacke</td>
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<td>Quartz sandstone, greywacke, phyllite, tuff, conglomerate</td>
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<td></td>
<td>Same as above but with bonded chert &amp; acid volcanics</td>
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<td>Acid lavas, tuff, basalt, greywacke, Quartz, sandstone, shale, siltstone</td>
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<td></td>
<td></td>
<td>Siltstone, shale, chert, greywacke, basalt</td>
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<tr>
<td></td>
<td></td>
<td>Sandstone, shale, mudstone, tuff, acid porphyry, greywacke</td>
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</table>
Of the nine lithological units investigated in the area, only five units were examined in detail. Lithological units not subjected to detailed investigations are listed below:-

Tertiary    Calcrete
Carpentarian  Gardiner Sandstone
Lower Proterozoic  Pargee Sandstone
Archaean  Killi Killi Beds

These four units, with the exception of Pargee Sandstone, have been the prime targets for previous exploratory activities by other companies. The Pargee Sandstone was not examined in detail because of the paucity of outcrop and the uninteresting lithology (Quartzite - possibly marine) where exposed.

However, should some of the lithological units investigated in detail confirm (depending on the results of chemical analyses and petrographic studies) their potential for holding concentrations of uranium, the following units are proposed for a helicopter survey:-

Carpentarian - Coomarie Sandstone - West of Birrindudu Range
       NE of Gardiner Range
Carpentarian - Gardiner Sandstone - Browns Range
       Ware Range
       Birrindudu Range

A.4. REGIONAL GEOLOGY

Four major tectonic units occupy areas covered by the Tanami and Birrindudu 1:250,000 sheet areas. These are:-

(1) The Granites - Tanami Block
(2) The Birrindudu Basin
(3) The Victoria River Basin
and (4) The Wiso Basin
These four tectonic units and their distribution are shown in the sketch below.

- Wiso Basin
- Victoria River Basin
- Birrindudu Basin
- Granites - Tanami Block
The Tanami Complex forms the basement in the area and comprises mostly of metasediments (very low grade metamorphism), acid volcanics, tuffs, shales (metamorphosed to phyllite), greywacke and conglomerates of limited areal extent. The entire sequence has been folded at least twice and faulted.

The Birrindudu basin was deposited during Carpentarian in between the faulted blocks of the Tanami Complex and consists of sandstone, shale, siltstones, conglomerates, stromatolithic chert, mudstone and limestone.

The Victoria River Basin is superimposed on both the Tanami Complex and the Birrindudu Basin and consists essentially of tholeiitic basalts and intercalated sedimentary rocks.

The Wiso Basin consists of younger sediments mainly sandstones, chert and mudstones over which an extensive cover of laterite has developed. (See UG 1973)

The tertiary and quaternary eras are marked by the extensive development of a laterite profile (occasionally up to 25 m thick), accumulations of calcrete and silcrete concentrations along drainage channels and an extensive cover of aeolian sand.

A.5. FIELD OBSERVATIONS

Mount Charles Beds

Mount Charles Beds crop out extensively in the southern part of Tanami 1:250,000 sheet area. A great majority of these outcrops are capped by laterite. The most extensive outcrops of these beds are present at Mount Twigg and at Mount Charles, located on the Black Hills. (Location of Mount Charles on the BMR 1:250,000 geological map is incorrect. The correct location would be 3 km WSW of the location marked on the map.)
The prime interest in these beds stems from the report that black carbonaceous pyritiferous shales were intersected at depth in drill holes (page 14 BMR Report 174).

The sequence exposed at Mount Charles is shown in a diagrammatic cross section attached to this report. The major rock types exposed are intercalated bands of chert and shale, purple, grey and yellow colored shales alternating with bands of greywacke and basalt. The gossanous rocks reported by BMR are not true gossans indicative of sulphide mineralisation at depth. Very little box work was observed. These gossans owe their presence to the leaching of hematite and manganese veins introduced into the sediments through fault and sheared planes. A number of minor faults and drag folds were observed both at Mount Charles and at Mount Twigg within the gossanous bands. However, an altered greywacke? horizon adjacent to a gossanous band at the crest of Mount Charles exhibited cavities surrounded by ferruginous staining. These could be due to pyrite inclusions. A semi detailed petrographic description has been requested for a specimen from this horizon.

Few of the yellow colored shales at Mt. Charles exhibited purple colored bands (2 mm - 6 mm thick bands) that were normal to cleavage developed in the shales. The bedding was striking NE with nearly vertical dips. Chert bands were thin and did not exceed a thickness of 10 cm. By far the thickest horizon exposed was a greywacke unit SW of Mount Charles (approximately 7 m thick). The total thickness of shales and greywacke is estimated to be 60 m. No exposure of carbonaceous pyritiferous shales were observed at the surface.
No variations in background count rates were observed within the same lithological horizons at Mount Charles. The background count rates are tabulated below.

- Gossanous horizon .. .. .. 60 cps
- Greywacke.. .. .. .. 50 - 60 cps
- Intercalating chert and shale horizon .. .. .. 40 cps
- Banded yellow, purple and grey shales with cleavage normal to bedding .. .. .. 50 - 65 cps
- Basalt .. .. .. .. 20 - 30 cps
- Alluvium .. .. .. .. 20 - 30 cps

(b) Nanny Goat Creek Beds

The Nanny Goat Creek beds are overlain unconformably by the Carpentarian Gardiner sandstone in the west and by the Lower Proterozoic Supplejack Downs sandstone in the south. It is probably intruded by the Winnecke Granophyre. Most contacts are concealed by recent cover but, where exposed, appear to be faulted. A section was followed for about 1 km along a creek bed to the west of the faulted contact with the Supplejack Downs sandstone. The rocks consist of steep to vertical dipping units with tight minor folds. Cleavage here appears to be parallel to bedding and trends N-S. The rocks are interbedded fine grained micaceous siltstones, shales and chert bands. A sandstone was found at the faulted contact. It was a very coarse quartz sandstone with angular quartz grains. Radioactivity over these units averaged between 50 - 60 cps.

(c) Mount Winnecke Formation

A thick sequence (in excess of 1,000 m) of Lower Proterozoic lavas, arenites and tuffs of subaqueous origin has been classified by BMR as the Mount Winnecke Formation. The sequence has been classified into three units by BMR as follows:-
Plw
Plwt
Plwa

Sandstone & conglomerate
Intercalating acid lavas and tuffaceous sandstones and siltstones
Acid lavas

This classification was found to be acceptable during field investigations. A regional cross section of the Mount Winnecke Formation is attached to this report.

Field investigations were concentrated on the interbedded tuffaceous sandstones and siltstones of the Plwt unit. Traverses were taken at two locations north of Winnecke Creek as shown in the 1:100,000 map attached. The western area traversed is shown diagrammatically in Section I and the eastern area in Section II.

The western area consists of a thick sequence in excess of 800 m of alternating beds of quartz sandstones, tuffaceous sandstones and tuffaceous siltstones. The entire sequence is intruded by the Winnecke Granophyre to the west. The granophyre is considered to be comagnetic with the acid lavas of Plwa unit.

Quartz sandstones (Plw unit) essentially form a medium to coarse grained hematitic sandstone and occupy the crest of hills. Individual grains are subangular to rounded set in a matrix of altered feldspar. With a decrease in grain size and an abundance of feldspar, the quartz sandstone grades into a tuffaceous sandstone. The contact between these two units are usually gradational.

The tuffaceous siltstone, in contrast to the tuffaceous sandstone, exhibits well defined contacts with the other units and is usually pale grey and purple colored. The bedding in the siltstone is conformable to that of the
other units. A few samples collected from this horizon seem to indicate the presence of a dark green colored mineral - possibly chlorite?. Tuffaceous siltstone beds are generally 0.3 to 1.0 m in thickness, but beds exceeding 12 m in thickness were observed at two different localities. The entire alternating sequence of tuffaceous sandstones and tuffaceous siltstones is classified as Plwt unit and, in the area traversed, they attain a maximum thickness of 400 m. The Plwt unit was striking N-S and dipping 26°E in the area traversed. No interbedded acid volcanics were encountered in this traverse.

The Winnecke Granophyre encountered was a pink coarse grained adamellite. The following evidence is suggestive of an intrusive character, though a major proportion of the contact zone was covered by alluvium.

(1) Silicified quartz sandstone at the contact
(2) Contact of the granite is irregular with tongues of granite protruding into the sediment
(3) A partially drilled margin of the granite exhibiting a finer grained texture

The Winnecke Granophyre probably represents a series of comagmatic intrusives cut by aplitic and andesitic dykes. The contacts of these intrusives should be checked by a helicopter survey.

Radiometrically, no variations in background count rates were observed within the same horizon except in the case of tuffaceous siltstone units. In one siltstone unit approximately 12 m thick, the count rates varied from 60 cps to 80 cps using an Austral scintillometer. Background count rates registered by the different rock units are given below.

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<tr>
<td>Winnecke Granophyre.</td>
<td></td>
<td></td>
<td>100 to 120 cps</td>
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<tr>
<td>Plwt</td>
<td></td>
<td></td>
<td>60 cps</td>
</tr>
<tr>
<td>Tuffaceous sandstone.</td>
<td></td>
<td></td>
<td>45 to 50 cps</td>
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<tr>
<td>Plw</td>
<td></td>
<td></td>
<td>40 cps</td>
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</table>
Alluvium .. .. .. .. 30 cps
Laterite .. .. .. .. 60 to 80 cps

The eastern area is similar to the western area except for the absence of Winnecke Granophyre and the comparatively higher thickness of Plwt unit in the east.

The tuffaceous sediments (Plwt) in the eastern area are folded into a broad syncline. Unlike in the western traverse, the sediments in the eastern traverse are intercalated with acid volcanics. Except for these differences the succession of tuffaceous sediments is identical in both the traverses. Diagrammatic cross section along the eastern traverse is shown in Section II attached to this report.

Acid volcanics of the Plwa unit are slightly more mafic than those of the Quartz Feldspar Porphyries interbedded with the tuffaceous sediments of the Plwt units.

Background count rates registered over the different lithological units in the eastern traverse are recorded below.

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<tbody>
<tr>
<td>Tuffaceous siltstone.</td>
<td>.. .. .. ..</td>
<td>60 cps</td>
</tr>
<tr>
<td>Plwt (Tuffaceous sandstone.</td>
<td>.. .. .. ..</td>
<td>40 - 50 cps</td>
</tr>
<tr>
<td>(Quartz-Feldspar Porphyries</td>
<td>.. .. .. ..</td>
<td>50 - 60 cps</td>
</tr>
<tr>
<td>Plwa Acid Volcanics</td>
<td>.. .. .. ..</td>
<td>60 - 80 cps</td>
</tr>
<tr>
<td>Alluvium .. .. .. ..</td>
<td>.. .. .. ..</td>
<td>25 - 30 cps</td>
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<tr>
<td>Lateritic gravel .. .. .. ..</td>
<td>.. .. .. ..</td>
<td>60 - 80 cps</td>
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No significant variations in background count rates were observed in this traverse.
(d) Supplejack Downs Formation

Outcrops of the supplejack Downs Sandstone are limited to the NE part of the Tanami sheet area, just to the east of the Supplejack Ranges. The sandstone generally forms narrow strike ridges and broad undulating flat topped ridges separated by sand plains. Good exposures are limited to gullies and steep bluffs, gentle slopes and crests are mainly rubbly or covered with sand. Two areas of this formation were investigated. See the Tanami 1:250,000 Geological Sheet for traverse locations. The southern most area consisted mostly of a massive well sorted quartzite (≈20 cps). This unit was overlain by a fine to medium grained quartz sandstone with thin bands (≈1 cm) of hard micaceous shales and siltstones (≈40 cps). In this area, the Supplejack Formation was overlain unconformably by the Antrium Plateau Volcanics. The second area was located just south of Wilson Creek, near the unconformity with the underlying Archean Nanny Goat Creek beds. The outcrop consists of a fine to medium grained poorly sorted ferruginous quartz sandstone (≈40 cps). The beds were striking NW and dipping 40°-80° to the SE. Interbedded within this unit are thin silicified bands of quartzite (≈20 cps). Quartz veining is characteristic. Cross-bedding is common in the sandstone. The northern most extension of outcrop was checked in the hope of finding a contact with the acid volcanics of the Mount Winnecke Formation, i.e. close to possible source rocks. Much of the area, however, is sand-covered and no contact was located. The faulted contact with the Nanny Goat Creek beds is exposed along the northern edge of the outcrop area where vertical beds of sandstone abut against sheared rocks of the Archean shales and siltstones.
A. 6. METHOD OF SAMPLING

Only rock chip samples were collected for the period covering this report. No stream sediment samples or soil samples were collected because of the lateritic and aeolian sand cover over most of the lithological units, and also because of the poor development of drainage in the region.

A total of 48 samples were collected during the course of investigations. Of these, 28 samples have been forwarded to Pilbara Laboratories for Chemical Analysis and 17 have been despatched to AMDDEL for semi detailed petrographic descriptions. Four sample submission sheet are attached to this report.

A. 7. CONCLUSIONS AND RECOMMENDATIONS

Of the lithological units investigated in the area, the Mount Winnecke Formation was by far the most encouraging unit. The alternating sequence of tuffaceous (Plwt) sandstones and siltstones (in excess of 1,000 m in true thickness) could present ideal traps for concentrations of uranium. Structural traps (sheared zones, dykes, etc.) within the acid volcanics of the Plwa unit could also retain uranium at economic grades.

Should the chemical analyses of samples from these lithological units indicate higher uranium and lower thorium values, an helicopter assisted reconnaissance survey is recommended.

During field investigations covered by this report, only a minor proportion of the outcropping Winnecke Granophyre was examined. Should an helicopter assisted reconnaissance
survey eventuate for this area, then it is recommended that
the contact of comagnetic intrusives, the aplitic and
andesitic dykes within the Winnecke Granophyre be examined.

The shales and sandstones of the Tanami Complex (Mount
Charles Beds and Nanny Goat Creek Beds) registering higher
count rates could have higher thorium levels and this is
to be confirmed from chemical analyses of the samples
collected.

The Pargee Sandstone is not considered as a prospective
horizon.

Outcrops of Supplejack Downs Sandstone south of Wilson
Creek appear to be the most prospective area within this
formation. However, the mottled appearance of hematite
patches within the sandstone seems to indicate an oxidizing
environment during deposition. It is recommended that the
contacts of this sandstone with the Whitewater Volcanics
Plwa (16 km SSW of Wilson Creek Water Holes) be examined
prior to discarding this horizon as non-prospective.

Should an helicopter assisted reconnaissance survey
eventuate in this area, then it is recommended that the
outcrops of Gardiner Sandstone and the Coomarie Sandstone
mentioned under the head 3. STRATIGRAPHY be examined in
detail. These outcrops are not readily accessible by
vehicle at present.

A great majority of the calcrete horizons in the region
are siliceous and hence are not considered as prospective
horizons.

NOTE: It is understood that there is an application
(pending) for releasing parts of this region
(exact boundaries not known) as Aboriginal
Reserve.
II.B. AIRBORNE INVESTIGATIONS OF TANAMI, BIRRPINDUDU AND GRANITES

1:250,000 TOPOGRAPHIC SHEETS

B.1. INTRODUCTION

An airborne radiometric survey forms the second stage in a field program designed to follow up suitable host rock horizons initially detected on the basis of earlier ground investigations. A Bell Jet Ranger contracted from Rotor Services Darwin was used for four days (approximately 20 flying hours) between the 26th and 27th September, 1977. Flying height was approximately 50' using a 4" crystal connected to an Austral G.D.S. 12 Spectrometer and Rustrak chart recorder. The area investigated is flat to very gently undulating, and most of the outcrops are strike ridges formed mainly of resistant sandstones. The aim of the survey was to locate any anomalous horizons and follow these up with ground radiometrics and sampling. Radiometric profile charts and geological maps with sample locations and traverse paths are presented at the back of this report. Also included are semi-petrographic descriptions of selected samples and four sample submission sheets.

B.2. FIELD OBSERVATIONS

2.1. Muriel Range Sandstone

Exposures are limited in extent, forming very small strike ridges in the Iningarra and Muriel Ranges 20km south of Mongrel Downs homestead. Initially the area appeared prospective because the Lower Proterozoic sediments form a closed basin between the Tanami and Arunta complexes. It

./.
is structurally similar to the Ngalia Basin. The area is currently under application. The area, however, proved disappointing due to the extremely low and uniform radioactivity and paucity of outcrop. (Flight Chart No. 2)

2.2. Gardiner Sandstone
The Gardiner Sandstone outcrops extensively in the western half of the Tanami and Birrindudu 1:250,000 Geological sheets. Outcrops generally form small discontinuous strike ridges separated by sand plain. Radiometric traversing was concentrated on strike slope. Flying the margins of the Browns Range Dome and Coomarie Dome where the sandstone is underlain by a Lower Proterozoic unmapped biotite-muscovite granite, a probable equivalent of the Winnecke Granophyre. Radiometric profiles are low and uniform throughout (Chart Nos. 4 and 5). A section was flown across the Gardiner Range and Mt. Stubbins. No anomalous reading were recorded except for a sharp rise in background at the contact between the sandstone and underlying Archean sediments and this was attributed to 'mass effect' due to the lithological change.

2.3. Coomarie Sandstone
Outcrops of Coomarie Sandstone were investigated along the northern margin of the Coomarie Dome and just south of the Browns Range Dome. Typical low and uniform radioactivity similar to the Gardiner Sandstone was recorded and no further interest was taken (Charts 4 and 5).

2.4. Supplejack Downs Formation
Outcrops of Supplejack Downs Sandstone near Wilston Waterholes appeared the most prospective unit within this formation from earlier ground reconnaissance, and airborne follow up work was concentrated at the base of the sandstone at its contact with the Archean Nanny Goat Creek beds and Lower Proterozoic Whitewater volcanics (10km south of Wilson Waterholes). Only one anomalous peak was recorded and this was found to be due to surface laterite.
2.5. **Pargee Sandstone**

Initially strike ridges south of the Bililuna - Tanami road were flown and an anomaly was detected on the eastern limb of a NW plunging syncline near the base of the formation.

The anomaly lay in a conglomerate unit approximately 100m thick (average background 60 - 70 c.p.s. SRAT) overlain by a medium grained silicified quartz arenite (40 c.p.s.). The conglomerate consists of pebbles or granules of chert and quartzite in a medium to coarse grained poorly sorted feldspathic sandstone matrix. No evidence of iron staining or heavy minerals was present in hand specimen. Stratigraphic relations and lithologies indicate the conglomerate was derived from the Tanami Complex. The cause of the airborne anomaly was a localized patch of quartz veining within the conglomerate. Ground radiometrics directly over the vein peaked at 650 c.p.s.. The quartz was associated with a concentration of white clay minerals, possibly kaolin. The clays appear to be concentrated due to the alteration of the surrounding rock and an associated concentration of radioactive minerals from depth on the clay particles. Although minor patches of quartz veining was present elsewhere, none peaked at such magnitude (see sample submission sheets for details of assay results). A north-west belt of Pargee Sandstone outcrop was traversed (Flight Charts 3 and 4) to the southern tip of Mt. Frederick where the sandstone forms a large synclinal structure overlain by Gardiner Sandstone. Numerous traverses were made across strike to locate the conglomerate horizons. Small peaks recorded were due to gossanous conglomerates. Ground investigations showed they were iron rich, oxides often forming patches within the matrix and present as discrete grains. Clasts consisted mainly of jasper and chert in a more silicified sandstone matrix. Average background on the ground was 40 c.p.s..
2.6. Mount Winnecke Formation

The airborne survey in the Mt. Winnecke area was directed over the following areas:-

- contacts between acid lavas and tuffaceous sediments
- alternating sequences of tuffaceous sandstones and siltstones within the Plwt unit
- shear zones, faults, dykes (i.e. suitable structures) within the acid volcanics
- contact between the granitic intrusives (Winnecke Granophyre) and tuffaceous sediments
- base of the acid volcanics (contact with Plwt)

Radiometrically large variations were observed in background counts. The peaks, however, were found to be due to differences in lithological types and do not represent true anomalies. Total count radiometrics registered highest over the granophyre and peaks were recorded at the sediment or volcanic/granite contacts, or when traverses over granophyre hills. Peaks were also commonly observed at the acid lava/tuffaceous sediment contacts and tuffaceous sediment/ granite contacts. Many radiometric 'highs' were related to surface laterite. Although no distinct anomalies were recorded, three were sufficiently prominent to warrant ground investigations and a summary of these follows:-

<table>
<thead>
<tr>
<th>SAMPLE NO</th>
<th>CHART NO</th>
<th>RUN NO</th>
<th>LITHOLOGICAL UNIT</th>
<th>CAUSE OF ANOMALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plwt 1</td>
<td>6</td>
<td>1</td>
<td>basal conglomerate of acid volcanics (Plwa)</td>
<td>laterized conglomerate</td>
</tr>
<tr>
<td>Plwt 2</td>
<td>7</td>
<td>1</td>
<td>tuffaceous siltstone</td>
<td>'mass effect' due to lithological change</td>
</tr>
<tr>
<td>Plwa 1</td>
<td>6</td>
<td>2</td>
<td>acid volcanics</td>
<td>high Thorium source</td>
</tr>
</tbody>
</table>
B.3. **SAMPLING**

Six rock chip samples were collected during the course of the airborne survey. Poor drainage development and extensive laterization made soil sampling unfeasible. All samples were despatched to Geomin for chemical analyses. Assay results from these samples including the 48 samples collected during ground reconnaissance have all been received and are attached to this report. 18 samples were forwarded to Central Mineralogical Laboratories for semi-detailed petrographic descriptions.

B.4. **DISCUSSION OF RESULTS**

4.1. **Airborne Reconnaissance**

Lithologically the basal conglomerate unit in the Pargee Sandstone appeared the most prospective unit of those investigated. Where the airborne anomaly was located lithologies (coarse grained, poorly sorted feldspathic sandstone/conglomerate) appeared favorable for hosting uranium mineralization. Chemical assay results, however, from this unit revealed only 3 ppm U with Th:U ratios of 2:1. Samples Pg2 and Pg3 taken from the quartz vein had U 50 ppm but again Thorium values were much higher (>2:1) accounting for most of the radioactivity. Elsewhere the horizon was located, it was markedly more siliceous and heavily oxidized. Due to the limited extent of favorable lithologies and overall poor assay results, the unit did not appear to warrant any further attention.

In the light of previous ground investigations and the consistently low uniform radioactivity in the airborne program the Gardiner Sandstone, Coomarie Sandstone and Muriel Range Sandstone cannot be considered as prospective horizons.
In the Mount Winnecke area few significant anomalies were
detected which warranted ground investigations. Those
sampled were found to be due to either changes in lithologies
('mass effect'), surface laterization or the radiometrically
'warm' Winnecke Granophyre. Assay results indicate low
uranium and Th:U ratios in the range of 3:1 to 5:1.

4.2. Ground Radiometrics

In the Mount Winnecke area, ground radiometrics and sampling
was concentrated on the sequences of interbedded tuffaceous
sandstones and siltstones (Plwt). See Figures 2 and 3.
From thin section descriptions these sediments (classified
as lithic sandstones, fine grained verging on siltstones)
are moderately to well sorted with sericitic ferruginous
cementing medium. All contain felsite/Rhyolite fragments
but these are reworked or detrital, not pyroclastic.
Hematite is common as discrete grains, as thin coatings on
grains or microfracture fillings, and indicate primary
oxidizing conditions throughout. Chemical analyses show
U to be in the order of 3 - 10 ppm with Th:U ratios
consistently greater than 4:1, and this is due to the common
abundance of detrital minerals such as hematite, zircon,
geothite and Leucoxene. Sample BIMV17, a lithic hematitic
sandstone was found to be possibly weakly radioactive due to
detrital metamict zircon.

Rocks sampled from the Supplejack Downs Sandstone are almost
pure quartzite and quartz cementing medium. Lithic grains,
felsite, chert and rhyolite fragments indicate a volcanic
origin. Common detrital minerals are leucoxene and
hematite (Th:U ratios of 10:1).

Samples (greywackes, shales and argillaceous sandstones) from
the Mt. Charles Beds (see Figure 4) are similar in that they
all contain quartz/sericite cementing medium, detrital
minerals such as hematite and tourmaline and ferruginous
Fig. 1
A REGIONAL CROSS SECTION OF THE MOUNT WINNECKE FORMATION

1977 PROJECT CARPENTARIA
Prepared by: M.Varkey, June '77
Drawing No.A4-319, Project No.A8b-2
Epidotized acid volcanics 50-80 cps

Acid volcanics 50-60 cps

Sandstone 40 cps

Tuffaceous siltstone & sandstone 60 cps

Sandstone 40 cps

Tuffaceous siltstone & sandstone 60 cps

Sandstone 40 cps

Tuffaceous siltstone & sandstone 60 cps

Sandstone 40 cps

Tuffaceous siltstone & sandstone 60 cps

Acid volcanics, Rhyolite porphyry 60 cps

Tuffaceous sandstone & siltstone
50-60 cps

Acid volcanics 50-60 cps

Laterite capping.
A CROSS SECTION OF THE MOUNT CHARLES FORMATION (At Mount Charles)

1977 PROJECT CARPENTARIA
Prepared by: M Varkey, June '77
Drawing No. A4-318, Project No. A8b-1
material indicating primary oxidizing environments of deposition. Sample 04B, a ferruginous argillaceous sandstone is of interest since it contains cavities that may have been pyrite nodules.

B.5. CONCLUSIONS AND RECOMMENDATIONS

Although many lithological units over a considerable area were investigated, no significant results eventuated from the survey. Airborne and ground radiometrics located only a few anomalous horizons and radioactivity was consistently due to Thorium. Most lithologies were ferruginous to varying degrees, and much of this is primary, implying oxidizing environments of deposition. Th:U ratios are high in all samples. (Detrital heavy minerals were ubiquitous in thin section.) From the combined ground and airborne reconnaissance, the economic potential of the area is considered to be low and, at this stage, no further work is recommended.
II. RECONNAISSANCE IN THE TANAMI, BIRRINDUDU AND GRANITES 1:250,000 TOPOGRAPHIC SHEET AREAS

APPENDIX 1:

FLIGHT CHARTS
Mt WINNECKE REGION, N.T.
FLIGHT PATHS
& GROUND RECONNAISSANCE

HELICOPTER MAGNETIC
TRAVERSES

- Access track
- Creek

SCALE 1:500,000
0 5 10 15 20 25 Kilometres

PROJECT 801
URANGESSELLSCHAFT
AUSTRALIA PTY. LIMITED

Date: Nov 1977, Prepared by M. Flesch
Drawing No: A4-408, Project No. 801-18
THE GRANITES AREA, N.T.
FLIGHT PATH

SCALE 1:500,000

PROJECT 801
URANSE SELL SCHAFI
AUSTRALIA PTY. LIMITED

Survey No 4-603 Project no 800-6
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Grid Ref.</th>
<th>Sample Type</th>
<th>Depth from (m)</th>
<th>Depth to (m)</th>
<th>Analysis in ppm ppm%</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAMV01</td>
<td>79.81 57.61</td>
<td>Rock Chip</td>
<td>6.70</td>
<td>9.18</td>
<td>Th: 9  Cu: 8  Zn: 17</td>
<td>Gossan zone</td>
</tr>
<tr>
<td>TAMV02</td>
<td>80.60 58.80</td>
<td>R.C.</td>
<td>3.81</td>
<td>6.13</td>
<td>Th: 11  Cu: 2  Zn: 265</td>
<td>Mt. Mt. Chalcopyrite, Brecciated Substrate</td>
</tr>
<tr>
<td>TAMV03</td>
<td>80.60 58.80</td>
<td>R.C.</td>
<td>17.14</td>
<td>19.34</td>
<td>Th: 34  Cu: 1  Zn: 947</td>
<td>Brecciated Chalcopyrite, Mt. Chalcopyrite</td>
</tr>
<tr>
<td>TAMV05</td>
<td>83.70 59.70</td>
<td>R.C.</td>
<td>2.23</td>
<td>7.30</td>
<td>Th: 30  Cu: 61  Zn: 3</td>
<td>Calcareous from Talbot Well</td>
</tr>
<tr>
<td>TAMV06</td>
<td>88.20 61.70</td>
<td>R.C.</td>
<td>2.10</td>
<td>17.15</td>
<td>Th: 17  Cu: 32  Zn: 108</td>
<td>Foraminifera sand, Supakineck</td>
</tr>
<tr>
<td>TAMV07</td>
<td>88.50 62.00</td>
<td>R.C.</td>
<td>2.81</td>
<td>9.14</td>
<td>Th: 9  Cu: 17  Zn: 6</td>
<td>Fe. Silt, marl, Chalk, Metasiltite</td>
</tr>
<tr>
<td>TAMV08</td>
<td>88.50 62.00</td>
<td>R.C.</td>
<td>2.20</td>
<td>8.14</td>
<td>Th: 14  Cu: 25  Zn: 15</td>
<td>Metasiltite, Metasiltite</td>
</tr>
<tr>
<td>TAMV09</td>
<td>88.50 62.00</td>
<td>R.C.</td>
<td>8.16</td>
<td>8.42</td>
<td>Th: 8  Cu: 22  Zn: 66</td>
<td>Foraminifera sand, S. Hotma</td>
</tr>
<tr>
<td>TAMV10</td>
<td>88.50 62.00</td>
<td>R.C.</td>
<td>3.25</td>
<td>5.66</td>
<td>Th: 5  Cu: 29  Zn: 88</td>
<td>Foraminifera sand, S. Hotma</td>
</tr>
<tr>
<td>TAMV11</td>
<td>88.50 62.00</td>
<td>R.C.</td>
<td>2.18</td>
<td>7.66</td>
<td>Th: 6  Cu: 20  Zn: 120</td>
<td>Foraminifera sand, S. Hotma</td>
</tr>
<tr>
<td>TAMV12</td>
<td>88.50 62.00</td>
<td>R.C.</td>
<td>4.36</td>
<td>9.39</td>
<td>Th: 9  Cu: 49  Zn: 87</td>
<td>Foraminifera sand, S. Hotma</td>
</tr>
<tr>
<td>TAMV13</td>
<td>88.50 62.00</td>
<td>R.C.</td>
<td>3.40</td>
<td>3.81</td>
<td>Th: 38  Cu: 14  Zn: 66</td>
<td>Foraminifera sand, S. Hotma</td>
</tr>
<tr>
<td>TAMV14</td>
<td>88.50 62.00</td>
<td>R.C.</td>
<td>5.13</td>
<td>11.31</td>
<td>Th: 11  Cu: 3  Zn: 9</td>
<td>Calcareous from Germanico, Dona</td>
</tr>
<tr>
<td>TAMV28</td>
<td>80.40 56.70</td>
<td>R.C.</td>
<td>2.11</td>
<td>7.22</td>
<td>Th: 7  Cu: 12  Zn: 220</td>
<td>Metasiltite, Metasiltite</td>
</tr>
<tr>
<td>TAMV30</td>
<td>79.00 51.80</td>
<td>R.C.</td>
<td>4.80</td>
<td>15.72</td>
<td>Th: 15  Cu: 7  Zn: 21</td>
<td>Meta. Kimbula Beda, Mt. Mt. Chalcopyrite</td>
</tr>
</tbody>
</table>

**Note:** The analysis is conducted by URGESSELLSCHAFT AUSTRALIA PTY. LTD., and the sample types include Rock Chip (R.C.) and Grid Ref. coordinates are provided.
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<tr>
<th>Sample No.</th>
<th>Grid Ref.</th>
<th>Sample Type</th>
<th>Analysis in ppm</th>
<th>Remarks</th>
</tr>
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<tr>
<td></td>
<td>South</td>
<td>East</td>
<td>U</td>
<td>Th</td>
</tr>
<tr>
<td>BIMV15</td>
<td>92605270</td>
<td>Rock Chip</td>
<td>3</td>
<td>13</td>
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<td>BIMV16</td>
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<td>R.C</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>BIMV17</td>
<td>92605270</td>
<td>R.C</td>
<td>4</td>
<td>10c</td>
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<tr>
<td>BIMV19</td>
<td>92605260</td>
<td>R.C</td>
<td>13</td>
<td>40</td>
</tr>
<tr>
<td>BIMV19</td>
<td>92605260</td>
<td>R.C</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>BIMV20</td>
<td>92605260</td>
<td>R.C</td>
<td>4</td>
<td>30</td>
</tr>
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<td>BSAV2</td>
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<td>1</td>
<td></td>
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<td>BIMV21</td>
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<td>R.C</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>BIMV22</td>
<td>92805320</td>
<td>R.C</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>BIMV24</td>
<td>92805320</td>
<td>R.C</td>
<td>3</td>
<td>35</td>
</tr>
<tr>
<td>BIMV25</td>
<td>92805320</td>
<td>R.C</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>BIMV26</td>
<td>92805320</td>
<td>R.C</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>BIMV27</td>
<td>92805320</td>
<td>R.C</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>Sample No.</td>
<td>Grid Ref.</td>
<td>Sample Type</td>
<td>Depth from</td>
<td>Analysis in ppb/ppm/%</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
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<td>------------</td>
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</tr>
<tr>
<td></td>
<td>South</td>
<td>East</td>
<td>to</td>
<td>U  Th  Cu  Pb  Zn  V  Po</td>
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<tr>
<td>Plwt 1</td>
<td>9 0 2 3</td>
<td>6 4 2 5</td>
<td>R.C</td>
<td>5  14  12  12  14  12  0.4</td>
</tr>
<tr>
<td>Plwt 2</td>
<td>9 2 9 0</td>
<td>6 4 4 5</td>
<td>R.C</td>
<td>3  14  10  10  8  12  0.3</td>
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<tr>
<td>Plwt 3</td>
<td>9 1 1 5</td>
<td>6 3 5 0</td>
<td>R.C</td>
<td>4  21  10  14  10  16  0.5</td>
</tr>
</tbody>
</table>

Remarks:
- Ferruginous volcanic condensate
tuffaceous silt
calder volcanic
<table>
<thead>
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<th>Sample No.</th>
<th>Grid Ref.</th>
<th>Sample Type</th>
<th>Depth from</th>
<th>Depth to</th>
<th>Analysis in ppm/ppm/%</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Pg1</td>
<td>7186053170</td>
<td>R.C</td>
<td>3</td>
<td>9</td>
<td>8 6 6 x 007</td>
<td></td>
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<tr>
<td>Pg2</td>
<td>7186053170</td>
<td>R.C</td>
<td>50</td>
<td>119</td>
<td>20 14 16 8 117</td>
<td></td>
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<tr>
<td>Pg3</td>
<td>7186053170</td>
<td>R.C</td>
<td>54</td>
<td>122</td>
<td>12 58 10 6 097</td>
<td></td>
</tr>
</tbody>
</table>
II. RECONNAISSANCE IN THE TANAMI, BIRRINDUDU AND GRANITES 1:250,000 TOPOGRAPHIC SHEET AREAS

APPENDIX 2:

SEMI-DETAILED PETROGRAPHIC DESCRIPTIONS
Central Mineralogical Services Pty. Ltd.

231 Magill Road
Maylands, S.A. 5069
Telephone 425659

21st September 1977

Mr. M. Varkey,
Geologist,
Urangesellschaft Aust. Pty. Ltd.,
Post Office Box 40121,
CASUARINA. N.T. 5792

PROJECT NO. A/86

REPORT CMS 77/9/8A

YOUR REFERENCE: Order Nos. 235-236

DATE RECEIVED: 9th September 1977

SAMPLE NOS.: TAMV 02-05, 07, 09-11, 13, 29 and
BIMV 15-17, 19, 22, 24, 26.

SUBMITTED BY: M. Varkey

WORK REQUESTED: Petrology

H.W. Fander, M.Sc.

Copy and Invoice to:

Dr. W.E. Schindlmayr,
Chief Geologist,
Urangesellschaft Aust. Pty. Ltd.,
608 St. Kilda Road,
MELBOURNE. VICTORIA. 3004
It was decided to prepare two separate reports on the suites of samples, since the rocks had different requirements and were from separate projects. Thus, this report is concerned with the TAMV and BIMV series, and another report (to follow shortly) with rocks COMV 01 and 02.

The descriptions are given in the accompanying tables, and a few additional comments are set out below.

**TAMV**

Two thin sections were prepared of TAMV 04 because of their differences in hand specimen, and these are reflected in their different lithologies.

All the rocks in this suite are sediments, and some show incipient to mild metamorphism, dominantly dynamic in character (with inevitable associated minor recrystallisation).

The rocks range in composition from almost pure quartzites (29) and protograywackes (09) through argillaceous and feldspathic sandstones, to subgraywackes and shales; in grainsize they span the range from medium-sand to fine silt (shale). All are ferruginous to varying degrees (except 29), and much of this (as hematite) is primary, implying oxidising environments of deposition.

Several rocks contain felsite and/or rhyolite grains, representing acid extrusives; however, the grains are generally rounded and reworked and are not evidence of contemporaneous volcanism. Some of the subgraywackes and other rocks with abundant fine matrix could contain pyroclastic material such as ash, altered and masked by ferruginous matter, but there is no evidence to support this.

Sample 03 is misleading in hand specimen; the conspicuous color banding (yellow/red) is unrelated to bedding - which is almost perpendicular to the banding - and is a type of Liesegang-ring effect of oxidation/hydration of primary hematite.

No radioactivity was detected in any sample but very low levels may be present (below the detection limit of the Geiger counter used); if so, detrital heavy minerals would be responsible.
BIMV

This suite is more heterogeneous, with sediments, a metamorphic rock and a rhyolite.

The sediments are lithic and sericitic sandstones, quite fine-grained and verging on siltstones. All contain felsite/rhyolite fragments, but these are reworked or detrital, not pyroclastic. One rock (24) is a volcanomict sandstone, i.e. a sand-size sediment consisting of detrital grains of volcanic and nonvolcanic origin, with a suspicion of finer material, possibly ash. One of the sediments (17) contains relatively abundant but fine detrital heavy minerals and may be weakly radioactive as a result - particularly in view of the presence of metamict zircon.

The metamorphic rock is a tourmaline-metaquartzite of sedimentary origin; the presence of tourmaline and altered feldspar, and their mode of occurrence, suggests metasomatism, perhaps related to a granite.

The rhyolite has rather strange fabric and lacks the usual flow-textures; it could be an intrusive, devitrified rhyolite.

H.W. Fander, M.Sc.
<table>
<thead>
<tr>
<th>Sample</th>
<th>Rock Type</th>
<th>Fabric Description</th>
<th>Minor Minerals</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>Indurated Argillaceous ?Feldspahic Sandstone Angular quartz grains, parallel muscovite flakes, sericite patches, ferruginised sericite matrix.</td>
<td>Indurated and orientated, incipiently schistose. Average grain size = 0.1mm.</td>
<td>Small detrital leucoxene &amp; tourmaline grains. ?Primary hematite.</td>
<td>Conspicuous color banding is of Liesegang-ring type - hydration of fine reddish hematite to brown limonite; not bedding.</td>
</tr>
<tr>
<td>05</td>
<td>Banded Shale More or less ferruginous layers of kaolinite, with veins and bands of coarse recrystallised kaolinite (confirmed by XRD).</td>
<td>Shale fabric disturbed by development of coarse diagenetic kaolinite.</td>
<td>Leach-cavities lined &amp; filled with silica &amp; hisingerite (FeSiO3·nH2O).</td>
<td>Interestingly, presumably diagenetic recrystallisation of primary kaolinite. Fine primary hematite, hydrated to limonite in places.</td>
</tr>
<tr>
<td>07</td>
<td>Ferruginous Siltstone. Subangular/subrounded quartz grains, argillised feldspar grains, muscovite flakes, goethite grains; goethite-quartz cement.</td>
<td>Well-defined graded bedding, fine silt to fine sand.</td>
<td>Detrital green tourmaline. More goethite- hematite in finer layers.</td>
<td>Fairly featureless straight-forward sediment. Ferruginous material is primary, oxidising environment.</td>
</tr>
<tr>
<td>09</td>
<td>Protoquartzite. Framework is 90 - 95% rounded quartz grains, 5 - 10% rounded lithic grains - felsite, chert, altered rhylolite; hematite coatings, quartz cement in optical continuity.</td>
<td>Moderately sorted/ sized. Subparallel orientation of grains.</td>
<td>Occasional leucoxene, hematite grains.</td>
<td>Felsitic, rhylolitic grains show typical extrusive igneous textures - &quot;rhyolite&quot; used in broad sense. Oxidising environment.</td>
</tr>
<tr>
<td>0</td>
<td>Metaquartzite. Dynamically metamorphosed lithic sandstone. Coarse quartz, chert, felsite, siltstone, metaquartzite grains, highly stressed; interstitial quartz, sericite.</td>
<td>Sutured interlocking grain boundaries; strong strain extinction.</td>
<td>Wispy contorted sericite patches. Interstitial and intergranular fine hematite.</td>
<td>Metamorphism is dynamic, with some recrystallisation. Microfractures, healed quartz veins. Preferred orientation is partly depositional.</td>
</tr>
<tr>
<td>01</td>
<td>Ferruginous Siltstone. Clastic quartz and muscovite grains largely obscured by fine earthy hematite matrix/cement. Coarser grains and layers.</td>
<td>Streaky hematite distribution. Poorly-defined graded bedding</td>
<td>Detrital tourmaline, fine leucoxene. Hematite veinlets.</td>
<td>Similar to 07. Ferruginous material is primary, indicating oxidising environment.</td>
</tr>
<tr>
<td>Sample</td>
<td>Rock Type - Composition</td>
<td>Fabric</td>
<td>Minor Minerals</td>
<td>Comments</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>--------</td>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td>17</td>
<td>Lithic Hematitic Sandstone. Small subrounded quartz grains, minor felsite, altered feldspar, detrital hematite; sericite matrix/cement with some quartz, fine hematite.</td>
<td>Fine-grained (0.10-0.15mm) well sorted, faintly bedded.</td>
<td>Thin heavy mineral layers with metamict zircon, tourmaline, leucoxene, hematite.</td>
<td>Possible weak radioactivity, very probably due to detrital metamict zircon. Oxidising environment.</td>
</tr>
<tr>
<td>22</td>
<td>Pebby Lithic Sandstone. Quartz, pink-red felsite-rhyolite grains, silty sericitic, ferruginous matrix. Micaceous siltstone laminations. Ferruginous impure chert pebbles.</td>
<td>High silt content; some graded bedding. Pebbles uncommon, up to 10mm.</td>
<td>Detrital hematite, minor leucoxene. Hematite-goethite microfracture fillings.</td>
<td>Felsitic and rhyolitic grains relatively common, but are reworked and thus not primary pyroclastic material.</td>
</tr>
<tr>
<td>24</td>
<td>Volcanoclastic Sandstone. Abundant rounded grains of felsite-rhyolite, sericitised ?feldspar, subrounded quartz; streaks of micaceous ?ashy material. Quartz cement.</td>
<td>Fine-grained (0.10-0.15mm) well sorted, weakly bedded.</td>
<td>Detrital hematite, leucoxene, tourmaline, zircon.</td>
<td>Abundant extrusive igneous rock fragments of rhyolitic composition; these are reworked, detrital, not pyroclastic.</td>
</tr>
<tr>
<td>26</td>
<td>Devitrified Rhyolite. Very occasional K-feldspar (??anidine) phenocrysts in devitrified, silicified groundmass with distinctive shard-like fabric.</td>
<td>No flow banding or preferred orientation or bedding - not tuff.</td>
<td>Quartz-chalcedony veins and small vesicles.</td>
<td>K-feldspar stain test positive for phenocrysts, negative for groundmass. Rock unlikely to be tuff, despite some textures, since depositional features.</td>
</tr>
</tbody>
</table>
III. RECONNAISSANCE IN THE VICTORIA RIVERS REGION

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   3.1. Southern Victoria River Region
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5. SAMPLING

6. DISCUSSION OF RESULTS

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PLATE 1: GEOLOGY OF THE WINGATE MOUNTAINS
TABLE 1: SAMPLE SUBMISSION SHEETS
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APPENDIX 1: DETAILED PETROGRAPHIC DESCRIPTIONS
III.1. INTRODUCTION

The area covers a broad region encompassing the following 1:250,000 Geological Sheets: (a) Northern Victoria River region: Cape Scott, Port Keats, Fergusson River and Delamare and (b) Southern Victoria River region: Waterloo, Victoria River Downs, Limbunya and Wave Hill. The region contains rocks of Pre-Cambrian, Cambrian, Cretaceous and Cainozoic age. The Southern Victoria River region can be divided into two main tectonic units; the Wiso Basin and the Sturt Block. The Wiso Basin consists of a sequence of flat lying to gently dipping Cambrian marine sediments and Cretaceous marine and non-marine sediments. The Sturt Block, the major tectonic unit in the district, is covered by a series of predominantly flat lying and gently folded Carpentarian and Adelaideon sediments. It is bounded to the west by the Victoria River Fault, and its northern limits are covered by extensive Mesozoic cover. Reconnaissance was directed at a basement rise in the central part of the Limbunya Sheet area. Basic tectonic units in the Northern Victoria River region include Archean basement, the Pine Creek Geosyncline, Fitzmaurice Mobile Zone, Sturt Block and Palaeozoic and Mesozoic basins. Investigations were concentrated around the Collia Fault area where the Soldiers Creek granite (high level Carpentarian intrusive granite) intrudes greywackes and siltstones (Noltenius Formation) in the south west extremity of the Pine Creek Geosyncline. Significant time was spent investigating Cambrian conglomerates along the southern margin of the Collia Fault.

III.2. FIELD METHODS

Initial preparation for the reconnaissance program involved the selection of favorable target lithologies from literature studies in September, 1977. The ground work
took place in August and involved radiometric traversing (SG 2a scintillometer), rock chip sampling and section mapping. In December, a Bell Jet Ranger was contracted from Rotor Services Darwin for one day to follow up areas inaccessible by vehicle. A 4" crystal connected to an Austral G.D.S. 12 spectrometer and Rustrak chart recorder was used in the survey.

III.3. FIELD OBSERVATIONS

III.3.1. Southern Victoria River Region

Stirling Sandstone
The Stirling Sandstone was checked where it directly overlies metamorphic basement (Inverway Metamorphics) and is overlain by a claystone-chert unit, the Margery Formation (17°23'N; 129°58'E. Limbunya 1:250,000 Geological Sheet). The Formation is composed entirely of sandstone and lithologies vary from thin bedded pink-white indurated sandstone (5% feldspar) to more massive white quartzitic rocks. Some minor conglomerate was found on the surface. Clasts consisted of rounded quartzite pebbles in a massive siliceous matrix. Total count radiometrics consistently recorded 30 c.p.s.. No contact with the basement was exposed. The metamorphics were deeply weathered reddish-brown schists and a massive chloritic basaltic rock (difficult to distinguish due to extensive weathering). Another outcrop was checked south east of Inverway Homestead, but was found to be just medium grained massive pure quartz sandstone.

Bunda Grit
This unit outcrops in a north trending anticline near the southern margin of the Limbunya sheet, just west of Inverway Homestead. The base was not exposed, but the unit was assumed to overlie the Inverway Metamorphics and it is unconformably overlain by the Stirling
Sandstone. It consists of coarse, granular quartz sandstone and poorly sorted grit layers. Total count radiometrics recorded 20 c.p.s. over all outcrop (generally rubbly surface scree). Grit particles examined in the field consisted of angular chert fragments. There appeared to be little evidence of a basement origin.

III.3.2. Northern Victoria River Region

Jarong Conglomerate
The Jarong Conglomerate is a thin polymict Cambrian unit outcropping in a small area just south of the Collie Fault on the margin of the Soldiers Creek Granite. A section was traversed 5km NE of Jarong Spring (125;975 Wingate Mountains 1:100,000 topographic sheet). The base consists of a granular quartz sandstone (5-10% feldspar). Near the fault the sandstone is silicified and crossbedding and large slump structures are observed. The sandstone is overlain by approximately 30m of conglomerate. Only the clasts are visible as pebbles, cobbles and boulder scree on the hill slopes. These include predominantly large angular quartzite boulders (heavy mineral laminations) with minor boulders of granite and large stromatolites. Near the top of the section (see figure 1) is approximately 10m of thin bedded to laminated micaceous sandstone. This is capped by a deeply weathered chert horizon of the Antrim Plateau Volcanics. 3km south east of Collia Waterhole the conglomerate was found to be thickest. Sandstone matrix (ferruginous, coarse grained, poorly sorted and siliceous) was more prevalent lower in the section. The upper scarp of the section was covered by angular to subrounded clasts of quartzite with minor quartz sandstone interbeds. The quartzite clasts were of cobble and boulder size and there was little evidence of the original matrix. The Noltenius Formation was checked 8km west of Collia Waterhole where the shales are intruded on one side by dolerite and on the other side by Soldiers Creek Granite.
III.4. SUMMARY OF GROUND RADIOMETRICS

<table>
<thead>
<tr>
<th>FORMATION</th>
<th>BACKGROUND (c.p.s.)</th>
<th>MAXIMUM (c.p.s.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JARONG CONGLOMERATE</td>
<td>40 c.p.s.</td>
<td>50 c.p.s.</td>
</tr>
<tr>
<td>SOLDIERS CREEK GRANITE</td>
<td>80 c.p.s.</td>
<td>150 c.p.s.</td>
</tr>
<tr>
<td>NOLTENIUS FORMATION</td>
<td>60 c.p.s.</td>
<td></td>
</tr>
<tr>
<td>STIRLING SANDSTONE</td>
<td>30 c.p.s.</td>
<td>40 c.p.s.</td>
</tr>
<tr>
<td>INVERWAY METAMORPHICS</td>
<td>40 c.p.s.</td>
<td></td>
</tr>
<tr>
<td>BUNDA GRIT</td>
<td>20 c.p.s.</td>
<td></td>
</tr>
</tbody>
</table>

III.5. SAMPLING

11 rock chip and 1 stream sediment sample were collected during ground reconnaissance and were despatched to Geomin for chemical assaying. These results are presented in Tables 1 and 2. 6 samples were forwarded to Central Mineralogical Services for detailed petrographic descriptions (see Appendix 1).

III.6. DISCUSSION OF RESULTS

Assay results did not show any significant amounts of uranium in the samples collected (<5 ppm U). Ground radiometrics also failed to locate any anomalous horizons. Poor sorting, angular to subrounded pebbles, and poorly defined sandstone and conglomerate layers with the Jarong conglomerate indicate a non-marine environment of deposition, possibly a fluvial outwash (fan) from an uplifted block NE of the Collia Fault. Marine conditions possibly existed soon after deposition due to crossbedding in the sandstone matrix. Thin section analyses failed to recognize any radioactive constituents. Lithic fragments...
in the samples include well-bedded ferruginous quartz siltstones, orthoquartzite, argillaceous siltstones, quartz sericite schists, slates, cherts and altered granite. The provenance was one of indurated clastic sediments and very low grade sediments (Pre-Cambrian rocks of the Sturt Shelf) deposited in a neutral or slightly oxidising environment. Lithologically samples from the Bunda Grit and Stirling sandstone were of little interest. Primary iron oxides are present in most samples. Quartz is the cementing medium and apart from minor lithic fragments (i.e. felsite, rhyolite chert and ironstone) is the dominant constituent.

III.7. HELICOPTER SURVEY

A brief helicopter survey was conducted in the Wingate Mountains regions. The main target was the N-S belt of Noltenius Formation north of the Soldiers Creek Granite and, in particular, its contact with the granite and the overlying Depot Creek Sandstone and Chilling Sandstone. A few traverses were made over the Jarong Conglomerate 3km SW of Collia Waterhole and although no anomalies were registered, samples were taken and the lithologies noted. (See Flight Chart 13, Run 3) A sharp total count anomaly was recorded over the Depot Creek Sandstone near the contact with the Noltenius Formation ((392;865) Wingate Mountains 1:100,000 topographic sheet). This was due, however, to lateritized Cretaceous Mullaman Beds developed over the sandstone.

2 B.M.R. anomalies were checked in the Daly River Basin near the junction of the Flor and Daly Rivers ((805;895) and (458;720) Bowman 1:250,000 topographic sheet). Although many anomalies have been previously investigated by other companies in the Daly River drainage system, these two were of interest firstly because they were U channel anomalies and secondly because gravity shows a possible basement 'high' in the region and it was hoped that these

./. 
anomalies may be due to such outcropping basement not previously reported. The first anomaly (Flight Chart 13, Run 1) was due to laterized red sandy soil of the Cretaceous Mullaman beds (150 c.p.s. ground radiometrics) developed over limestones of the Jinduckin Formations. Although no distinct anomaly was observed in the second area, there was a sharp rise in total counts over the lateritic mesa cappings, presumably also of Cretaceous age.

III.8. CONCLUSIONS AND RECOMMENDATIONS

No further work is recommended in the Southern Victoria River region. Due to the lack of suitable source rocks, the simple structures, and low potential of the Pre-Cambrian Sturt Shelf sediments which cover most of the area, the chances of finding any economic deposits seem very low. The chances of mineralization in the Jarong Conglomerate is also unlikely. Further work, however, is recommended over areas within the Port Keats 1:250,000 Geological sheet. They were not investigated during this year's program due to their inaccessibility and a lack of time. These areas are as follows:

(1) In the SW most corner of Tipperary Station an area of Noltenius Formation sediments is intruded by Berinka volcanics, basic sills, Ti-Tree Granophyre and the Litchfield Complex. The Noltenius Formation and the Berinka Volcanics occur at the base of the Lower Proterozoic Finnis River Group which unconformably overlies the Archean Hermit Creek Metamorphics (14°15', 130°25').

(2) The Koolendong Granites represent a prospective nearby source for secondary uranium accumulations within the Fitzmaurice Group sediments. Faulted basins and
synclinal structures within the Fitzmaurice Group in
this area may provide traps within the host rocks
($19^\circ 55', 130^\circ 05'$).

(3) South of the Fitzmaurice River in the Koolendong
Valley, the Carpentarian Koolendong Granite occurs as
inliers, within an elongate fault bounded trough
unconformably overlain by the Moyle River Formation
of the Fitzmaurice Group. Here the granite intrudes
acid lavas, minor sandstone interbeds and intrusives
of the Berinka Volcanics of the Lower Proterozoic
Finnis River Group ($14^\circ 55', 130^\circ 05'$).
Fig. 1

1977 PROJECT CARPENTARIA
Prepared by: M. Flook, Sept '77
Drawing No A4-354 Project No A8c-70

SECTION ACROSS JARONG CONGLOMERATE

URANGESELLSCHAFT
AUSTRALIA PTY. LIMITED

- Contomlate, quartzite, chert, stromatolite and granite boulders
- Slightly feldspathic sandstone
- Chert contains Plateau Volc.
- Micaceous thinbedded sandstone
- Collia Fault
- Angalarri Siltstone?
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Grid Ref.</th>
<th>Sample Type</th>
<th>Depth from</th>
<th>Analysis in ppb/ppm/%</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>LME2</td>
<td>9.96</td>
<td>R.C.</td>
<td>5 to 4</td>
<td>8 12 4</td>
<td></td>
</tr>
<tr>
<td>LME3</td>
<td>9.75</td>
<td>R.C.</td>
<td>4 to 5</td>
<td>6 12 20 12</td>
<td></td>
</tr>
<tr>
<td>LME7</td>
<td>9.74</td>
<td>R.C.</td>
<td>4 to 12</td>
<td>16 20 16 0.89</td>
<td></td>
</tr>
<tr>
<td>LME8</td>
<td>9.67</td>
<td>R.C.</td>
<td>2 to 3</td>
<td>10 38 12 88 36</td>
<td></td>
</tr>
<tr>
<td>RMF9</td>
<td>9.56</td>
<td>R.C.</td>
<td>6 to 3</td>
<td>18 16 20 0.03</td>
<td></td>
</tr>
<tr>
<td>RMF20</td>
<td>9.96</td>
<td>R.C.</td>
<td>2 to 2</td>
<td>6 20 20 0.06</td>
<td></td>
</tr>
<tr>
<td>RME3</td>
<td>9.74</td>
<td>R.C.</td>
<td>3 to 3</td>
<td>6 16 10 12 0.46</td>
<td></td>
</tr>
</tbody>
</table>

Remarks:
- Laminated muscovite green schist
- Feldspathic migmatic monzogranite
- Granular slate
- Mullerina Fm. Shale
- Conglomerate
- Conglomerate
<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Grid Ref. (South)</th>
<th>Grid Ref. (East)</th>
<th>Sample Type</th>
<th>Depth from (m)</th>
<th>Depth to (m)</th>
<th>Analysis (ppb/ppm/%)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMF1</td>
<td>60077980</td>
<td>R.C</td>
<td>12</td>
<td>12</td>
<td>12 - 0.24</td>
<td></td>
<td>thinbedded white cat.</td>
</tr>
<tr>
<td>IMF2</td>
<td>60127980</td>
<td>R.C</td>
<td>10</td>
<td>10</td>
<td>8 - 0.019</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMF3</td>
<td>60507980</td>
<td>R.C</td>
<td>22</td>
<td>22</td>
<td>12 - 0.22</td>
<td></td>
<td>colorite barcolite rock</td>
</tr>
<tr>
<td>IMF4</td>
<td>57007520</td>
<td>R.C</td>
<td>8</td>
<td>8</td>
<td>8 - 0.015</td>
<td></td>
<td>5 cm memoir 5 cm cat.</td>
</tr>
<tr>
<td>IMF5</td>
<td>53507095</td>
<td>R.C</td>
<td>10</td>
<td>10</td>
<td>8 - 0.021</td>
<td></td>
<td>5 cm s.s.t. (clay)</td>
</tr>
</tbody>
</table>
III. RECONNAISSANCE IN THE VICTORIA RIVER REGION

APPENDIX 1:

DETAILED PETROGRAPHIC DESCRIPTIONS
that the original rock must have had some sort of contemporaneous cement separating the detrital grains, presumably amorphous silica; this recrystallised to quartz during diagenesis. Since the ferruginous coatings pre-date the cement, this could imply an aeolian origin.

The rock is traversed by subparallel, narrow shears containing crushed and recrystallised quartz.

FRMF5 Non-radioactive.

This fine feldspathic sandstone is similar to PCMF4 but is less ferruginous.

It is composed of small (average size = 0.1mm) subangular grains of quartz, orthoclase (15 - 20%) and micas (muscovite, + biotite); the grains are elongate, and show preferred orientation due to bedding. There are also many small sericite aggregates representing argillised feldspar, and the rock should perhaps be termed an arkose. Tourmaline is fairly conspicuous and some is detrital, some probably authigenic. Interstitial fine sericite wisps are present. The cement is quartz, but is fairly sparse because the grains are closely packed.

Pervasive but light iron-staining occurs in the cement and is primary, indicating an oxidising environment.

Faint false-bedding is visible in hand specimen, accentuated in places by lines of fine detrital opaques.

FRMF10 Non-radioactive.

This is an amygdaloidal melatryachyte, of distinctive appearance and composition.

The rock contains small, well-formed phenocrysts and, clusters of phenocrysts, of sanidine (inverted to albite in places and partly sericitised), set in a homogeneous randomly orientated mass of small feldspar (sanidine-albite) laths and crystallites, with interstitial semi-opaque hematite and perhaps ferruginous glass. There are small aggregates of hematite with euhedral outlines, possibly representing an altered ferromagnesian mineral.

The amygdales are of irregular size and shape; some are filled entirely with radiating-acicular aggregates of quartz, some contain quartz and patches of a hydrothermal clay.

Flow-banding and other directional features are absent; nevertheless the rock is probably extrusive. It resembles other melatryachytes found for instance in the Eastern Creek Volcanics (N.Q.), the Roopena-Wooltana lavas (S.A.) and others.
FRMF11 Non-radioactive.

This is best termed a quartzose ironstone, since it consists largely of iron oxides/hydroxides.

Rounded detrital quartz grains, ranging from 0.1mm to 1.0m in size, are fairly haphazardly and erratically distributed through the rock; many have thin, partial quartz overgrowths. They are embedded in fine hematite and subordinate goethite; some of this shows vague concretionary or oolitic forms but most is microcrystalline or "earthy".

The rock is believed to be a primary ferruginous sediment rather than representing an altered (weathered, oxidised) rock os different primary composition; there is no evidence, in the form of relict textures for instance, of the pre-existence of, say, siderite (or a sulphide) but such negative evidence must be treated with caution.

FRMF12 Non-radioactive.

This is a pebbly lithic sandstone, or, if preferred, a subgreywacke.

The rock is poorly sorted and contains a variety of detrital grains ranging from angular, tabular lithic fragments up to 10mm in size, to rounded monomineralic grains down to 0.1mm constituting the framework. Most of the coarser material consists of lithic grains, of well-bedded ferruginous quartz-siltstones, orthoquartzites, argillaceous siltstones, quartz-sericite schists, slates, cherts (with ?radiolaria), and altered ?granite. The smaller grains are mostly quartz, with some sericite aggregates.

The matrix is fine kaolinite-illite, diagenetically recrystallised and faintly iron-stained, and minor quartz; the rock is thus fairly friable.

Occasional detrital grains of green tourmaline, leucoxene, muscovite and altered biotite are seen. The provenance was one of indurated clastic sediments and very low-grade metasediments, deposited in a neutral or slightly oxidising environment.

LIMF3 Non-radioactive.

The two rock chips in this sample have different lithologies; one is an orthoquartzite, the other (yellow) is a leached ?ankeritic sandstone.

The orthoquartzite consists of subangular to subrounded quartz grains, with an average grainsize of 0.2mm, fairly closely sized and with a suspicion of graded bedding. The matrix/cement is a mixture of kaolinite and quartz; the kaolinite may have formed chemically or diagenetically and is composed of interstitial aggregates of randomly orientated small flakes. The quartz forms over-growths on the frame-
work grains. Occasional detrital green tourmaline grains are present.

The ?ankeritic sandstone is extensiely leached, most of the
?ankerite having been removed, leaving a residue of yellowish kaolinite
with occasional relict patches of carbonate, or voids. The framework
consists of small (average size = 0.1mm) subangular quartz grains,
cemented by quartz overgrowths; occasional feldspar grains are seen.

LIMF4  Non-radioactive.
This is a leached but well-cemented *lithic sandstone* (quartzite) with
numerous goethite-lined cavities.

The framework consists of *small* (0.1 - 0.3mm) well-rounded grains of
quartz and minor (2 - 3%) grains of fine felsite (broadly rhyolitic,
devitrified glassy material), and chert; the lithic grains are
reworked, not primary, volcanic material. Voids comprise perhaps 10%
of the rock; they have, angular, irregular outlines, and most are
empty except for thin goethite linings, but some contain limonite-
stained clay. The shapes of the cavities suggest the former presence
of a carbonate, probably ankeritic/sideritic.

The rock is well-cemented with quartz in optical continuity with the
framework grains. Apart from the secondary goethite in cavities, the
rock is devoid of primary iron oxides.

LIMF5  Possibly weakly radioactive.
This ferruginous, *lithic sandstone* is similar in many respects to
LIMF4 but has fewer cavities and contains primary hematite.

The framework of the rock is composed of small (0.1 - 0.2mm) rounded
grains of quartz, and scattered, rounded grains of felsite/rhyolite.
Small angular, goethite-lined cavities are dispersed through the rock.
There are chips and tabular fragments of more ferruginous rock composed
of quartz grains and ultrafine hematite; these fragments represented
fragmented layers or laminations of ironstone probably of contemporaneous
formation, broken up during sedimentation. There are also many smaller
grains of hematite. A few detrital tourmaline grains are seen. The
environment of deposition was oxidising.

The cement is quartz; as is the case with most of the rocks described,
clays are absent. The felsite represents reworked volcanic material.
No radioactive minerals were detected.

LIMF7  Non-radioactive.
This rock is fairly severely altered and its precise composition can
no longer be determined. Judging mainly from well-preserved relict
textures, the rock was an amygdaloidal basalt, or perhaps andesite.

Small random laths of saussuritised plagioclase are abundant, with interstitial ultrafine ferruginous altered glass, and many pseudomorphic patches of antigorite representing pyroxene. There are also goethite pseudomorphs after olivine.

Amygdales are quite numerous throughout, and are of very irregular shape, evenly distributed and without preferred orientation. They are filled with hydrothermal clays, exceedingly fine-grained, and zones of intergrown chlorite.

LIMF9 Non-radioactive.

This is a featureless orthoquartzite, exceptionally clean and practically monomineralic.

The framework is composed almost entirely of well-rounded, ovoid to subspherical quartz grains, ranging from 0.12mm to 1.8mm but fairly closely sized and averaging 0.5mm; very few grains are below 0.3mm or above 0.6mm. Isolated, rounded grains of felsite and silicified feldspar are scattered through the rock.

The grains have a very light coating of limonite, and are cemented by quartz; they are closely packed and thus there is comparatively little cement.

LIMF10 Non-radioactive.

This is a cherty quartzite, in which both detrital and chemically-formed quartz occurs, and the chert formed contemporaneously with sedimentation as silica, recrystallising during diagenesis.

Thus the framework is composed of a mixture of rounded detrital quartz grains, patches of microcrystalline quartz fragments and pellets of cryptocrystalline chert, and irregular larger patches of quartz/chalcedony in which crystallisation is clearly related to the margins of the patches, i.e. radiating-fibrous chalcedony formed at the margins and grew inwards.

The cement is quartz, pigmented with ultrafine hematite. There are patches of more compact hematite of later formation. The rock is vaguely bedded, but poorly sorted and sized.

H.W. Fander, M.Sc.
IV. GENERAL RECONNAISSANCE: EAST KIMBERLEY AND BILILUNA REGION

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1. INTRODUCTION

2. FIELD OBSERVATIONS

3. SUMMARY OF RADIOMETRICS

4. SAMPLING

5. CONCLUSIONS AND RECOMMENDATIONS

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FIGURE 2: SECTION ACROSS LEWIS SECTION

TABLE 1: SAMPLE SUBMISSION SHEETS
TABLE 2: SAMPLE SUBMISSION SHEETS
TABLE 3: SAMPLE SUBMISSION SHEETS
IV.1. INTRODUCTION

Several areas in the East Kimberley and Bililuna area were inspected briefly to assess their potential for holding uranium. Ground work included radiometric traversing, rock chip sampling and section mapping. A helicopter was used in areas inaccessible by vehicle.

IV.2. FIELD OBSERVATIONS

Elder Sandstone:

The target formation was the basal quartz cobbles conglomerate of the Devonian Elder Sandstone on the Southern margin of the Hardman Basin, a Palaeozoic sequence of shallow water marine limestone, shale and sandstone in a down faulted and folded structural basin. A section was traversed where the basal conglomerate outcrops north of Turner Homestead. Underlying the Devonian sequences was a medium grained well sorted micaceous ferruginous sandstone with minor interbedded and incompetent siltstone lenses (Cambrian). The quartz cobbles conglomerate overlies this unit with a slight unconformity. The matrix is a medium to coarse, relatively porous, poorly sorted white quartz sandstone. Ripple marks and crossbedding are common. Clasts were all rounded to subrounded quartzite (Background 20 c.p.s.). Lithologies were similar to the Ragged Range Conglomerate Member. Conformably overlying the cobble beds was a crossbedded quartz sandstone of the Elder Sandstone (Background 10 c.p.s.). The source area appears to be the Pre-Cambrian quartzites of the Sturt Shelf to the south. It was thought that a more prospective area would be on the Western Margin of the basin near Bungle Bungle outstation where a possible western source (i.e. Bow River Granite, volcanics) may be more favorable for uranium mineralization. This area was flown later in an airborne survey and results were not encouraging.
Red Rock Beds:
The Red Rock Beds were selected for investigation because they are the stratigraphic equivalents of the Kimberley Basin succession and represent the only part of this succession east of the Halls Creek Fault. It is a fluviatile sequence derived from the mobile belt and rests unconformably on the Halls Creek Group. Two traverses were made across a fault bounded massive flat topped range, approximately 10km NE of Turkey Creek (Lisadell 1:250,000 Geological Sheet). The beds consist of predominantly massive red and green quartzitic beds with interbedded shale horizons. Beds are strongly folded. To the south of this area the Red Rock Beds unconformably overly granite gneisses of the Lamboo Complex. Lithologies may vary rapidly from quartz pebble conglomerate, feldspathic sandstone, muscovite sandstone and hematitic sandstone to siltstone. (See section, Figure 1) A major fault/shear zone and resultant quartz veining have obscured outcrop in the centre of the section. Adjacent to this fault/shear zone, chloritic sandstones and shales have been isoclinally folded. This unit recorded the highest total count radiometric in the section (80 c.p.s.).

Mount Parker Sandstone:
The Mount Parker Sandstone unconformably overlies the Red Rock Beds (high angle fault contact) and consists essentially of flaggy red ferruginous quartz sandstone/quartzite and pink feldspathic sandstone. Near the fault contact with Red Rock Beds, the dip is near vertical to $80^\circ$S but changes abruptly to $40^\circ$S and finally flattens to $10^\circ$N. The cross section (Figure 1) shows the approximate situation of the synclinal axis. The rest of the section consists of a monotonous shallow dipping sequence of mottled red quartzites and feldspathic micaceous quartz sandstones. The mottling was due to irregular iron staining. No anomalous radiometricss were recorded over this part of the section (maximum 35 c.p.s.).
Hensman Sandstone:
The Hensman Sandstone sits unconformably on the Hendon Creek Formation, Whitewater Volcanics, Bow River Granite, Castlereagh Hill Porphyry and Halls Creek Group. It grades upward into the Golden Gate Siltstone. A part of this unit was investigated 10km SE of the Dunham Jump-up Prospect where the sandstone sits unconformably on the Castlereagh Hill porphyry. Lithologies were very unattractive, just massive white quartzite.

Lewis Sandstone:
The Upper Proterozoic Lewis Sandstone outcrops in a long linear belt directly overlying Lewis Granite in the Billiluna and Lucas sheets. The formation was visited near the Balgo Hills Mission turnoff on the Billiluna - Tanami Road. Here a knob of deeply weathered muscovite granite outcrops near the sandstone although the contact is concealed beneath sand cover. Beds dip 5 - 10° to the west. On the strike slope white massive quartzite boulders form the scree. Outcrop consists of well bedded ferruginous quartz sandstone. The unit was overlain by massive micaceous sandstone. Both units recorded 10 c.p.s. 9km south of the Tanami Road, where the sandstone overlies both granite (20 c.p.s.) and Archaean basement (40 c.p.s.). Both granite and schist are exposed near the contact (see Figure 2). The basal unit is a quartz pebble conglomerate. Clasts vary in size from quartzite pebbles to granular quartz grains. Minor banded chert pebbles were also present. Up the sequence the rocks become finer grained more micaceous with minor pebbles. This is overlain by a silicified quartz sandstone with minor granule sandstone bands followed by a coarse poorly sorted slightly micaceous quartz sandstone (see section, Figure 2, for details of radiometrics and lithologies). The remainder of the section consisted of quartz sandstone. Little variation in counts was observed. Background was 10 c.p.s.. Highest reading
20 c.p.s.. A helicopter assisted survey along the sandstone/granite contact failed to detect any anomalies. Contact flown for approximately 50km in the NW corner of the Lucas 1:250,000 Geological Sheet. See Flight Chart No. 12.

D-C:
On the Lucas 1:250,000 Geological Sheet, two outcrops of un-named Devonian rocks outcrop west of the Kearney Range close to the margin of the Lewis Sandstone and Lewis Granite. It consists of a poorly sorted coarse grained lithic sandstone. Rock fragments are predominantly angular small to large chert and shale with minor rounded quartzite pebbles. Background was 30 c.p.s..

Knobby Hill Sandstone:
The Devonian Sandstone outcrops extensively on the western side of the Billiluna 1:250,000 Geological Sheet. In the Falcon Hills area the formation consists of a fine to medium grained poorly sorted feldspathic sandstone. Background was 20 - 30 c.p.s..

Due to the fine grained lithology, the rocks are too far from their source to be of any economical potential. Minor quartz pebble bands in very coarse sandstone matrix were observed. Fossils include petrified wood, fish plates and plants.

IV.3. SUMMARY OF RADIOMETRICS

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<td>FORMATION</td>
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<td>D-C:</td>
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<tr>
<td>KNOBBY HILL SANDSTONE</td>
<td>20 - 30 c.p.s.</td>
<td>50 c.p.s.</td>
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**IV.4. SAMPLING**

12 rock chip samples were taken during the course of ground investigation and were forwarded to Geomin for assaying. Analysis results are presented in Tables 1, 2 and 3.

**IV.5. CONCLUSIONS AND RECOMMENDATIONS**

Due to the negative results obtained, none of the above mentioned units warrant any follow up work.
Quartz sandstone
Massive white quartzite
Coarse, poorly sorted micaceous quartz sandstone
Silicified quartz sandstone (granule sandstone)
Miccaceous sandstone, minor quartzite pebbles
Quartz pebble conglomerate (Base) 75 cps
minor chert pebbles

Fig. 2

1977 PROJECT CARPENTARIA
Prepared by: M. Flook Sept '77
Drawing No. 4A-353 Project No. A8e-69
Fig. 1

LISSADELL AREA, EAST KIMBERLEY
Section looking East

1977 PROJECT CARPENTARIA
Prepared by: J. Thevisser, June '77
Drawing No. A4-360, Project No. A86-11
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V. RECONNAISSANCE IN THE MOUNT LITCHFIELD REGION

CONTENTS

1. INTRODUCTION

2. FIELD METHODS

3. FIELD OBSERVATIONS
   3.1. Cambrian Sediments
   3.2. Helicopter Survey

4. SAMPLING

5. DISCUSSION OF RESULTS

6. CONCLUSIONS AND RECOMMENDATIONS

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TABLE 2: SAMPLE SUBMISSION SHEET (HELICOPTER SURVEY)
TABLE 3: SAMPLES FOR DETAILED PETROGRAPHIC DESCRIPTIONS

APPENDIX 1: DETAILED PETROGRAPHIC DESCRIPTIONS
V.1. INTRODUCTION

The Litchfield complex includes large areas of granitic rocks on the western margin of the Pine Creek Geosyncline. The complex probably extends southwards from the Finniss River to the Moyle River, but is divided into three by intervening areas of Palaeozoic and Cainozoic rocks. The three main masses are situated between the Finniss and Reynolds Rivers, near Litchfield homestead, and south of the Daly River in the watershed of Hermit Creek. The complex is poorly exposed except in parts of the Litchfield homestead mass. Reconnaissance was concentrated in the Litchfield homestead area, and the aim of the survey was twofold:

(1) To examine outcrops of Cambrian sediments lying directly over the granite complex.

(2) Investigate any metasediments outcropping on the margins or between the granite complexes.

It is probable that much of the Litchfield complex is anatetic granite derived from Archaean rocks such as the Hermit Creek Metamorphics. This is supported by the increase in the proportion of garnet and the presence of sillimanite and cordierite in a broad zone around the Hermit Creek Metamorphics. If this is the case, a correlation could be made with the Nimbuwapah and Nanambu complex in the Alligators Rivers region and the possibility of uraniferous metasediments around the complex must be investigated.

V.2. FIELD METHODS

Field work was undertaken in two stages. Firstly in August 1977 a field party checked the Cambrian sediments. This involved ground radiometric traversing and rock chip
sampling. In December a Bell Jet Ranger was contracted from Rotor Services Darwin to do a spectrographic survey over the Mt. Litchfield and nearby areas. A 4'' crystal attached to an Austral G.D.S. 12 spectrometer and Rustrak chart recorder was used in the survey.

V.3. FIELD OBSERVATIONS

V.3.1. Cambrian Sediments

A small pocket of Cambrian sediments was examined 4km south of Litchfield Homestead. On the Pine Creek 1:250,000 Geological Sheet the sediments are marked as an undifferentiated Cambrian sequence overlying the Proterozoic Litchfield Complex. The sediments consist essentially of a red-purply gritty arkose (background 40 - 60 c.p.s.). Grains are poorly sorted and angular with large crystalline feldspar megacrysts and micas. There appears to be little or no cementing medium and the grains appear to be held together by silicification. Lithologies and immaturity of the sediments indicate the sediments were derived directly from the underlying granite. Cross bedding and ripple marks are present. A distinctive layering is represented by alternating fine grained massive silicified layers and coarser more friable layers. Exposures are limited to a narrow strike slope which forms a breakaway. The highest total count radiometrics was recorded on a coarse granular friable feldspathic sandstone, the most basal sequence exposed (70 - 80 c.p.s.). Contacts with granite was not exposed due to the extensive soil cover.

V.3.2. Helicopter Survey

Traverses were made over the complex and near its margin to locate any anomalies (see Flight Chart 15). No anomalies were found, although a marked rise in background counts occurred over granite outcrop. A sample of mica

./.
schist was taken from an outcrop of Hermit Creek Metamorphics in the SW corner of the Pine Creek 1:250,000 Geological Sheet. Traverses were made along an elongate valley 10km NE of Litchfield Homestead separating outcrops of Burrell Creek and Noltenius Formation. The area is held by Nord Resources and negotiations for a joint venture are currently in progress. An anomaly was recorded over a ridge of crenulated mica schist (199;925 Reynolds River 1:100,000). Ground radiometrics peaked at 150 c.p.s. (SRAT). A traverse was then flown north along the contact between the Depot Creek Sandstone and Burrell Creek Formation on the western margin of the Tolmer Plateau. A sharp anomaly was recorded and was found to be a black soil anomaly (1,000 c.p.s.).

V.4. SAMPLING

7 rock samples were taken during the course of ground investigations. These were despatched to Geomin for assaying and results are presented in Table 1. 6 samples were forwarded to Central Mineralogical Laboratories for detailed petrographic descriptions (see Appendix 1). During the airborne survey, 4 rock chip and 1 soil sample were taken. These samples have just been despatched to Geomin for assaying, but as yet results are unavailable. A record, however, of these samples is in Table 2.

V.5. DISCUSSION OF RESULTS

Assay results do not indicate any significant amounts of uranium in the Cambrian arkoses (<5 ppm U). Thin section analysis indicated the presence of iron oxides, commonly coating quartz grains or as thin heavy mineral layers suggesting an oxidizing environment of deposition. Framework grains are cemented by quartz. Little can be said
from the helicopter survey as assay results and thin section descriptions are not at hand. The origin of the Mica schist in the Nord Resources area is uncertain and more detailed work is necessary to determine this. It is possible it may be metamorphosed Burrell Creek Formation.

V.6. CONCLUSIONS AND RECOMMENDATIONS

The available evidence indicates that the Cambrian arkose is not a potential host for uranium accumulations. A lot more work is necessary in the area, particularly detailed drilling to determine the stratigraphy as most of the area is covered by Palaeozoic and Cainozoic sediments.
# Geochemical Sample Sheet

**Project:** A8  
**Area:** Litchfield  
**Map:** Reynolds Bien  
**Scale:** 1:100,000  
**Airphoto No.:** Dispatched  
**Analysis by:** Geom

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V. RECONNAISSANCE IN THE MOUNT LITCHFIELD REGION

APPENDIX 1:

DETAILED PETROGRAPHIC DESCRIPTIONS
Central Mineralogical Services Pty. Ltd.

231 Magill Road
Maylands, S.A. 5069
Telephone 425659

27th September 1977

Mr. M. Flook,
Geologist,
Urangesellschaft Aust. Pty. Ltd.,
Post Office Box 40121,
CASUARINA. N.T. 5792

Cost Code 061220

REPORT CMS 77/9/12

YOUR REFERENCE: Order No. 370
DATE RECEIVED: 12.9.77
SAMPLE NOS.: PCMF2 - PCMF6,
PCMF8, FRMF1,
FRMF10 - FRMF12,
LIMF3 - LIMF5,
LIMF7, LIMF9, LIMF10

SUBMITTED BY: Mr. M. Flook
WORK REQUESTED: Petrology
YOUR JOB NO.: A8/C

H.W. Fander, M.Sc.

Copy and Invoice to:

Dr. W.E. Schindlmayr,
Chief Geologist,
Urangesellschaft Aust. Pty. Ltd.,
608 St. Kilda Road,
MELBOURNE. VICTORIA. 3004
All samples were examined in hand specimen and thin section; staining tests were carried out where necessary, and the samples were checked with a Geiger counter (radioactivity below the limit of detection of this instrument cannot be determined mineralogically in any case).

PCMF2 (TS 22160) Possibly weakly radioactive.

Two rocks of different lithologies are in contact, one is a coarse lithic sandstone, the other is a fine ferruginous protoquartzite; they are probably part of the same unit consisting of finer and coarser sediments, as the contact is a normal sedimentary one, not an unconformity.

The lithic sandstone consists of rounded grains of quartz, feldspars, and occasional quartz-mica gneiss; the grains are lightly coated with limonite, and the cement is quartz in optical continuity with the framework grains.

The protoquartzite is a fine-sand size sediment almost in the silt range. It is composed dominantly of subangular quartz grains, occasional feldspars and mica flakes and thin heavy-mineral bands of small oxide opaque grains, leucoxene, zircon and tourmaline. All grains have a dense, fine coating of hematite, and are cemented by quartz.

The protoquartzite shows distinct false-bedding, and contains occasional coarser detritus. The possible weak radioactivity is no doubt due to detrital heavy minerals; more detailed investigation would be required to pinpoint these more definitely.

PCMF3 Possibly weakly radioactive.

This rock may be termed a gritty, lithic sandstone, ferruginous and well cemented.

Grit and coarse-sand-sized particles are dispersed through the rock, and consist of quartz, coarse feldspar (orthoclase) and relatively fresh granite (quartz, orthoclase, minor muscovite and biotite). The bulk of the framework is composed of rounded quartz grains averaging 0.5mm in size, with a matrix of fine-sand-sized grains of quartz and occasional feldspar and muscovite. Thus the provenance of the detritus is dominantly (perhaps entirely) granitic. There are layers of finer detritus similar to the matrix in the remainder of the rock.

All grains have a thin iron oxide coating and the rock is cemented by quartz overgrowths which post-date the oxide coatings. Thus both in this rock and the previous one, the environment of deposition was oxidising.
Very occasional grains of tourmaline, aggregates of leucoxene/rutile, and flakes of muscovite are seen; no radioactive minerals were detected.

**PCMF4** Possibly weakly radioactive.

This is a ferruginous, feldspatic sandstone, close to an arkose in composition, and the grain size is only marginally above that of a siltstone.

The framework consists mainly of angular to subangular quartz grains, with a 15 - 20% feldspar cleavage-fragments (orthoclase; K-feldspar stain test positive), and subparallel muscovite flakes. The grains are well bedded and closely sized; false bedding is quite distinct, and is accentuated by thin heavy mineral layers composed mainly of Fe-oxide grains, with minor tourmaline, leucoxene and zircon. Occasional thin laminae of coarser detritus occur.

The framework grains have a fine coating of hematite, indicating an oxidising environment, and are cemented by quartz. Fine, iron-stained kaolinite-illite clay is present in some interstitial spaces and is also cemented by quartz. In view of the relatively unaltered orthoclase, and the occurrence of tourmaline, the detritus probably has a "granitic" provenance.

**PCMF5** Non-radioactive.

This finely-laminated and intricately folded rock now consists virtually entirely of microcrystalline quartz but is believed to have originated as a laminated chert, totally recrystallised after folding.

The laminae, which are 0.2 - 0.3mm thick, are distinguished by traces of ultrafine pigmenting material (?leucoxene, ?hematite) which are embedded in the recrystallised quartz. These indicate that the laminae are finely and tightly folded in places, and that this folding probably occurred before the rock was lithified. The present microcrystalline mosaic quartz is not stressed, nor do the mosaics relate structurally to the folds, indicating that recrystallisation took place afterwards. Elongate voids run parallel to the folds and are lined with quartz crystals; the voids probably resulted from de-watering and crystallisation; some contain fine limonite. The recrystallisation is thus a late-diagenetic phenomenon, and the folding more in the nature of plastic deformation than a dynamic event.

**PCMF6** Possibly weakly radioactive.

This is a well-cemented, slightly ferruginous feldspatic sandstone verging on an orthoquartzite.
The framework consists dominantly of well-rounded, subspherical quartz grains averaging 0.6mm in size and closely-sorted, with occasional subrounded cleavage-fragments of orthoclase and isolated kaolinite aggregates and muscovite flakes. The framework grains have an ultra-thin (<1µ) coating of limonite, and are cemented by quartz in optical continuity with the detrital grains. Occasional small sericite flakes are embedded in the cement.

The quartz and feldspar grains are of igneous derivation and thus the rock probably had a "granitic" provenance, with an oxidising deposition of environment. No radioactive minerals were detected.

PCMF8 Non-radioactive.

This is a poorly sorted, ferruginous lithic sandstone, well-cemented and with leach-cavities.

The framework grains range in size from pebbles to medium-sand; the pebbles are subrounded and consist of "granite" (quartz, orthoclase, muscovite). Smaller grains (grit and sand) and generally individual minerals, dominantly quartz with minor feldspar (orthoclase) and muscovite. Larger grains, especially of feldspar, tend to be subangular, smaller grains, especially of quartz, are well-rounded and subspherical. The grains are coated with thin films of hematite, and cemented by later quartz; fine hematite has also stained feldspar and muscovite particles.

This sediment had a granitic source and formed in an oxidising environment. The term "granite" is used in a broad sense, without implying a mode of origin, since this cannot be determined with certainty from detrital material (unless coarse fragments such as large pebbles can be studied).

FRMF1 Non-radioactive.

This is a pure orthoquartzite, with a marked, distinct bi-modal distribution of grainsizes.

The framework is composed of well-rounded, ovoid and subspherical quartz grains, loosely packed or spaced and often not in contact (or just touching); the grains have a very light coating of limonite. The average grainsize is 0.6mm and the grains are closely sized (i.e. narrow size range).

The matrix consists of subrounded to subangular quartz grains, also closely sized (average size = 0.10mm); in places it comprises up to 50% of the rock. These matrix grains also have a very light limonite coating. The cement is quartz; it is unusually abundant, and it is evident that the matrix grains are not in contact. This indicates
VI. HELICOPTER RECONNAISSANCE - KIMBERLEY BASIN

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1. INTRODUCTION

2. GENERAL GEOLOGY

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4. DISCUSSION OF RESULTS

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VI.1 INTRODUCTION

The area of investigations is centred around Buckle Head (Figure 6.1) in the NW corner of the Medusa Banks 1:250,000 topographic sheet. The Buckle Head area is totally inaccessible to ground parties so helicopter assistance was required. The survey was based out of Wyndham, a river port 120km to the south.

The purpose of the survey was to test geological horizons higher in the stratigraphic column than those presently being investigated in our Temporary Reserves; also we decided to choose an environment closer to the known source area, i.e. NW, NE. Analysis of gravity maps available from this locality show the presence of two gravity highs (basement highs?) adjacent to and north of the Buckle Head inlier. This appeared to represent an ideal situation for evaluation of this particular environment.

VI.2 GENERAL GEOLOGY

The Buckle Head inlier occurs as a complexly faulted block within dissected plateaux of Warton Sandstone. Minor updoming may be the cause of the older rocks being exposed.

The inlier itself consists of massive argillaceous quartz sandstone with scattered quartz pebbles (King Leopold Sandstone) and a sequence of interbedded tholeiitic quartz basalts and massive feldspathic quartz sandstone (Carson Volcanics). These are the oldest units exposed on the
Medusa Banks 1:250,000 sheet area, of middle - lower Proterozoic (Carpentarian) age. The outlying Warton Sandstone consists mainly of white to buff quartz sandstones and apparently a basal conglomerate (this was not observed in the survey area). Figure 6.2 shows the geology and structure (photo-interpretation) of the Buckle Head inlier, and the location of helicopter radiometric traverses.

VI.3 HELICOPTER SURVEY STRATEGY

A Bell Jet Ranger, hired from Rotor Services Darwin, was fitted with our Austral 4" crystal and GDS-12 Spectrometer/chart recorded set up. The crystal and spectrometer were calibrated for recording continuous total count radiometrics to allow maximum sensitivity. Use of the uranium channel was thought to be too restrictive in a reconnaissance style survey such as this.

The airborne radiometric survey was designed to cover the largest area possible in the shortest time (large percentage of flying time was lost in ferrying to and from Wyndham to re-fuel). This was achieved in two stages:

(i) Rim flying of the Warton Sandstone - Carson Volcanics contacts and the King Leopold Sandstone - Carson Volcanics contacts.

(ii) Flying structural traverses along major lineaments and fault zones, which also provided numerous airborne radiometric stratigraphic sections.

This resulted in a total of 200 line survey kilometres radiometric coverage within a total area of 500 sq. km. Any radiometric anomalies located during the survey would have been followed up by ferrying two ground parties to the area the following day.

./.
VI.4 DISCUSSION OF RESULTS

Average airborne radiometric values recorded over each unit can be summarized as follows:

- King Leopold Sandstone - 75 c.p.s.
- Carson Volcanics, Basalt - 75 c.p.s.
- Fels. Sandstone - 100 c.p.s.
- Warton Sandstone - 80 c.p.s.

No anomalous horizons were detected and all minor peaks recorded on the flight charts are reflections of lower terrain clearance or statistical variations such as those caused when the helicopter banks during manoeuvre or turns.

No follow up work can be recommended.

ENCLOSURES

Figure 6.1. - LOCATION MAP OF BUCKLE HEAD AREA

6.2. - GEOLOGY AND STRUCTURE OF THE BUCKLE HEAD AREA (1:84,000)

Flight Charts - BUCKLE HEAD RUNS
1, 2 (5.10.77)
3, 4 (5.10.77)
5 (5.10.77)
VII. HELICOPTER RECONNAISSANCE - YAMPI

1. INTRODUCTION

2. GENERAL GEOLOGY

3. HELICOPTER SURVEY STRATEGY

4. DISCUSSION OF RESULTS

ENCLOSURES
VII HELICOPTER RECONNAISSANCE - YAMPI

VII.1 INTRODUCTION

Work was concentrated in two localities on the Yampi 1:250,000 topographic sheet area; firstly in the Mt. Disaster area and secondly in the McLarty Range area (figure 7.1). Both areas have very poor access so a helicopter assisted reconnaissance program was planned to coincide with the later follow up of Geometrics anomalies in our Temporary Reserves.

The Mt. Disaster area was chosen because of its potential for containing uranium related to acid-volcanicsm and later stage granitic intrusions. Extensive faulting, associated shearing and intrusion of dolerite dykes has developed may ideal structural traps for uranium mineralization. Hydrothermal solutions emanating from the granite intrusions could be channelled along these structures and also into the tuffaceous greywacks units of the Whitewater Volcanics; these units would be more porous than the rhyodacites and welded tuffs.

Reconnaissance work in the McLarty Range area was designed to test a closed synclinal basin where the Elgee Siltstone contains a prominent basal conglomerate. Strike flying of King Leopold Sandstone - granite contacts was also carried out to test an environment similar to the Pechiney uranium prospect south of Mt. Barret.

VII.2 GENERAL GEOLOGY

The Mt. Disaster area is the type locality for the Mt. Disaster Porphyry where it intrudes Whitewater Volcanics; the porphyry is intruded by a suite of granitic rocks.
which includes the Mondooma Granite, Lennard Granite, Secure Bay Adamellite and Tarraji Microgranite (Figure 7.4). The most prospective host rock for uranium mineralization, the Whitewater Volcanics, has been sub-divided into three distinct lithologies:

(i) Fine bedded tuffaceous greywacke and bedded tuff
(ii) Crystal-poor rhyodacite, ash-flow tuff
(iii) Crystal-rich rhyodacite, welded ash-flow tuff

The latter two units have been recrystallized to such an extent as to be indistinguishable in the field. There is no possibility of these rocks soaking up mineralized solutions except where they are brecciated or sheared. The most prospective unit is the bedded tuffaceous greywacke.

Of the intrusive granitoid suite the Mt. Disaster Porphyry, a porphyritic biotite micro-granite, proved to be the most prospective source for uranium bearing mineralized solutions. Background radiometrics up to 200 c.p.s. (SRAT) were recorded and one anomalous outcrop adjacent to a shear zone peaked at 600 c.p.s.. Intrusive contacts were difficult to distinguish from the air or on the ground and as a result could not be prospected in detail.

The McLarty Range syncline (Figure 7.2) has developed in sediments of the Kimberley Group. The Elgee siltstone, red-brown and grey siltstone, phyllite, sandstone and basal conglomerate was considered to be the most prospective units and several radiometric sections were flown across it. Other horizons tested in the syncline included the Warton Sandstone, Carson Volcanics and King Leopold Sandstone.
The Yampi Member of the Pentecost Sandstone, according to B.M.R. mapping, consists of pink-brown arkose and feldspathic sandstone; subsequent investigation at several localities did not verify this. Our observations was that these units consisted of silicified quartz sandstone.

VII.3 HELICOPTER SURVEY STRATEGY

Figure 7.3 shows the position of helicopter radiometric traverses in the Mt. Disaster area and the location of 20 radiometric anomalies detected during the survey. Figure 7.2 shows the location of helicopter traverses in the McLarty Range and Yampi areas.

First priority was given to the Mt. Disaster area and as a result this is where the most detailed airborne reconnaissance was undertaken. A total of ten (10) E-W orientated grid lines were flown (150 line km) and 10 structural traverses along faults, shear zones and dolerite dykes. In the McLarty Range, two airborne radiometric sections were flown perpendicular to the synclinal axis. The most anomalous units located (Elgee Siltstone) was then traversed in more detail, concentrating on the basal conglomerate and major structural features.

Strike-rim flying was carried out along the contacts of the King Leopold Sandstone with the Nellie Tonalite and Hart Dolerite, designed to locate an occurrence similar to that located by Pechiney at Mt. Barret. The Yampi Member Arkose (?) was rim flown in the Talbot Bay area.

VII.4 DISCUSSION OF RESULTS

A total of 20 radiometric anomalies were located in the Mt. Disaster area; these are summarized in Table 7.2.
Only anomalies 7, 12 and 13 warranted detailed ground investigation and these were the only locations where samples were taken (see Table 7.1). YAR 1 coincides with anomaly 12, YAR 2-4 samples taken at anomaly 13 and YAR 5-6 were collected at anomaly 7.

Anomaly 12 was found to be caused by a brecciated biotite granite (Mt. Disaster Porphyry) and a maximum total count (SRAT) reading of 600 c.p.s. was recorded. Subsequent assays were disappointing however, giving U, Th values of 9 and 28 ppm respectively. The presence of 10 ppm SnO₂ suggests that the Mt. Disaster Porphyry is the type of granitoid rock which has provided source material for the Th/Sn enriched O'Donnell Formation.

Anomaly 13 was located on a prominent quartz-vein shear zone near the contact of Mt. Disaster Porphyry, Tarraji Microgranite and Lennard Granite. Although these granitic rocks were observed nearby, they were not the cause of the anomalism; anomalous samples taken from the shear zone have been identified (W. Fander, CMS) as quartz-chlorite-muscovite schist, and interpreted as being of sedimentary origin. Thorium:Uranium ratios range from 2:1 to 3:1.

Anomaly 7 was situated on a saddle between two rounded hills of aplite granite; maximum total count radiometrics recorded was 240 c.p.s. and is considered to be due to mass effect of the hills. The sample YAR 5 of aplite contained only 8 ppm Uranium and 35 ppm Thorium. Another sample, YAR 6, of quartz-muscovite-schist contained 20 ppm and 23 ppm of uranium and thorium respectively; this was the most anomalous collected, however it does not inspire enthusiasm to conduct further work in the area.

In the Yampi and McLarty Range area no significant anomalies were found which warranted any ground investigation. In all cases where Archean meta-sediments of Proterozoic granites were intersected during the course of the survey, the radio-
metrics increased markedly, and this feature constituted the only anomalous in the area. It was decided to re-assess our line of thinking after these negative results.

ENCLOSURES

Figure 7.1  LOCATION MAP OF YAMPI AREA
Figure 7.2  GEOLOGY OF MCLARTY RANGE AREA
Figure 7.3  MT. DISASTER HELICOPTER FLIGHT LINES
Figure 7.4  MT. DISASTER GEOLOGY

Table 7.1  GEOCHEMICAL SAMPLE SHEET
Table 7.2  SUMMARY OF MT. DISASTER ANOMALIES

Flight Charts:  YAMPI RUNS 1 - 5  (14.9.77)
               MT. DISASTER LINES 1 - 11  (12.9.77)
               PROSPECTING LINES 14 & 15  (13.9.77)
               MT. DISASTER LINES 16 & 17  (13.9.77)
               MT. DISASTER LINES 18 & 19  (13.9.77)
               MT. DISASTER LINES 20 & 21  (14.9.77)
               MT. DISASTER LINES 22 - 24  (14.9.77)

CMS Petrological Report 77/9/31
KIMBERLEY BASIN, W. A.
MCLARTY RANGE AREA
FLIGHT PATHS

SCALE 1:200,000

HELICOPTER RADIOMETRIC
TRAVERSES

SECTION

PROJECT 916
URANGESSELLSCHAFT
AUSTRALIA PTY. LIMITED

Date: Apr. 1977, Prepared by: J. Thomas
Drawing No. A4-386, Project No. 916-17
Radiometric anomaly

Helicopter flight line & reference

Mt. Disaster

1977 PROJECT CARPENTARIA
Prepared by: J. Thivissen Sept '77
Drawing No. A4-350  Project No. A87-7
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<th>Sample No.</th>
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<th>Analysis in ppm/wt</th>
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<td>as above</td>
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</table>

TABLE 7.2 SUMMARY OF MT. DISASTER ANOMALIES
7th October 1977

Mr. J. Thevissen,
Geologist,
Urangesellschaft Aust. Pty. Ltd.,
P.O. Box 40121,
CASUARINA. N.T. 5792

PROJECT NO. A/8m

REPORT CMS 77/9/31

YOUR REFERENCE: Order No. 324
DATE RECEIVED: 27.9.77
SAMPLE NOS.: YAR1 - 6
SUBMITTED BY: Mr. J. Thevissen
WORK REQUESTED: Petrology

H.W. Fander, M.Sc.

Copy and Invoice to:

Dr. W.E. Schindlmayr,
Chief Geologist,
Urangesellschaft Aust. Pty. Ltd.,
608 St. Kilda Road,
MELBOURNE. VICTORIA. 3004

(Cost Code 061220)
Sample Report (Mineralogy, Petrology, Ore Microscopy)

Sample No.: CHS 77/9/31  Date Received: 27.9.77
Reference: Order No. 324, Project No. A/8m
Sample No.: YAR 1
Nature of Sample: Hand specimen

Description: SECTION No. 22300

Hand Specimen:
Pink, coarsely crystalline granitoid rock. K-stain test positive. No fluorescence. Weakly radioactive?

Microscopic:
This is a brecciated, incipiently sheared biotite-granite, and is of igneous origin.

The major constituents are microcline-perthite, cloudy, partly sericitised albite (ranging into sodic oligoclase), and quartz, in approximately equal amounts. The quartz is granulated and fairly extensively recrystallised, but the feldspars are fractured and only marginally granulated. Small strongly deformed dark brown biotite flakes occur throughout but comprise only 2-3% of the rock; they show subparallel alignment due to the shearing.

Traces of other minerals occur; some are primary, some introduced or post-magmatic, and most are closely associated with the biotite. They include occasional muscovite flakes, small fluorite patches and discontinuous veinlets, isolated euhedral crystals of metamict zircon, granular clinozoisite-epidote (in sericitised albite), and an iron-stained, semi-isotropic, decomposed mineral; this occurs in biotite, causing pleochroic haloes, and is believed to be metamict allanite (orthite) and thus weakly radioactive. Textural relationships suggest that all these minerals were affected by the dynamic metamorphism, i.e. were older.

HW. Fander, M.Sc.
Hand Specimen:
Pale brownish schistose rock. No radioactivity or fluorescence detected. K-stain test negative.

Microscopic:
In simple terms this rock is a quartz-chlorite-sericite schist, and although some aspects of the fabric suggest that it formed from, say, a porphyritic rhyolite, other evidence indicates a sedimentary origin; this evidence is stronger, and the rock is regarded as a metasediment on petrographic grounds.

There are relatively large grains and small lenses of mono- and polycrystalline, fractured quartz, apparently of detrital origin (quartz phenocrysts usually have embayments which survive mild metamorphism). Fairly coarse flakes of chlorite also form small lenses; the cleavage generally makes a high angle with the schistosity. The chlorite is probably altered biotite. The matrix is predominantly fine, foliated sericite, with fine interstitial quartz and interspersed flakes of degraded biotite.

Small grains of zircon are relatively conspicuous, and are notably rounded; leucoxene and apatite grains are also seen. They are regarded as detrital, not primary.

Some of the textural relationships suggest that there may have been two periods of metamorphism, an earlier greenschist-facies regional episode succeeded by a dynamic phase.

H.W. Fander, M.Sc.
a. Hand Specimen:

Greenish fine-grained schist. Non-fluorescent and non-radioactive (Geiger Counter). K-stain test negative.

Microscopic:

This quartz-chlorite-sericite schist closely resembles YAR 2, and, for the same reasons, is regarded as a low-grade metasediment rather than a metavolcanic type; there is evidence of two periods of metamorphism, both mild.

The rock consists largely of fine foliated sericite with interstitial quartz, occasional coarser, subradiating flakes of sericite. Lenses of quite strongly stressed mono- and polycrystalline quartz occur, and chlorite is conspicuous as pale-green "books" whose cleavage makes a high angle with the schistosity. Semi-opaque leucoxene patches are often associated with the chlorite, suggesting original biotite (leucoxene represents TiO$_2$ formed in chloritisation).

As in YAR 2, small rounded grains of zircon are relatively common (far too common for, say, a rhyolite); they are regarded as detrital, and on these grounds and on the basis of textures (and absence of certain features) the rock is more probably sedimentary than igneous. However, rocks of this type are notoriously difficult and ambiguous, and field data are often decisive in interpretation of origin.

H.W. Fander, M.Sc.
IDENTIFICATION

YAR 4

PORPHYRITIC RHYOLITE

DESCRIPTION

SECTION No. 22303

a. Hand Specimen:
Grey, fine-grained, siliceous porphyritic rock. K-stain test positive (groundmass). Non-fluorescent, non-radioactive.

Microscopic:
This is a porphyritic rhyolite, and was probably a shallow or minor intrusive, though an extrusive origin cannot be entirely discounted.

The phenocrysts are rather small and tend to be fragmentary rather than euhedral; the quartz is stressed and of irregular shape, and the feldspar (anorthoclase) occurs as cleavage-fragments. There are also heavily altered, rounded, resorbed patches of another feldspar (?plagioclase), consisting largely of sericite and clinozoisite-epidote.

The groundmass is a microcrystalline intergrowth of quartz and K-feldspar, with minute flakes of dark green biotite, occasional needles of ?hornblende, secondary fine zoisite-epidote (isolated coarser granular aggregates as well), and rare patches of fluorite. There are larger clusters and streaks of dark biotite, containing magnetite inclusions and associated metamict zircon, epidote and sphene (deuteric); traces of metamict allanite may also be present.

The fractured, stressed nature of the phenocrysts was probably caused by intrusion of a viscous mass, with brecciation of already-formed phenocrysts.

H.W. Fander, M.Sc.
SAMPLE REPORT (Mineralogy, Petrology, Ore Microscopy)

Job No. CMS 77/9/31   Date Received: 27-9-77
Reference Order No. 324, Project A.8m
Sample No. YAR 5
Nature of Sample: Hand specimen

DESCRIPTION SECTION No. 22304

a. Hand Specimen:
   Pale, pinkish, medium/fine-grained felsic rock. K stain test positive. No fluorescence or radioactivity detected.

Microscopic:
   The fabric of this rock is uniform and the composition simple, and it may be classified as a granite-aplite (i.e. an aplite of granitic composition).

   The rock has a faint preferred orientation, mainly due to lines of granular quartz; this feature is more evident on a K-stained cut surface and is probably of no significance. The main components are small, subhedral to anhedral quartz grains (many appear spherical) and irregular to micropoikilitic microcline crystals, with subordinate, fairly severely altered albite patches; alteration was fairly selective and almost confined to the albite, in the form of sericite and zoisite-clinozoisite.

   Small rather poorly developed dark biotite flakes are present in traces throughout, and occasional euhedral zircon crystals are seen.

   The paucity of minerals other than quartz and feldspars, and the uniformity/grainsize (0.1 - 0.3mm) of the rock, suggests an aplitic phase.

H.W. Fander, M.Sc.
Sample Report (Mineralogy, Petrology, Ore Microscopy)

Job No. CMS 77/9/31 Date Received: 27.9.77
Reference Order No. 324, Project No. 8/Am
Sample No. YAR 6
Nature of Sample: Hand specimen

IDENTIFICATION

YAR 6
QUARTZ-MUSCOVITE SCHIST

DESCRIPTION

SECTION No. 22305

a. Hand Specimen:
Grey, banded, fine-grained siliceous rock. K-stain test negative. No fluorescence or radioactivity detected.

Microscopic:
This is a quartz-muscovite schist which has undergone two phases of metamorphism. The first was a low-grade (greenschist facies) regional metamorphism of a laminated sediment and the second was the dynamic metamorphism of the resultant schist.

The rock is composed largely of muscovite, as substantial bands of small interleaved flakes; there are also occasional aggregates of coarse flakes, and these are bent and deformed. Fine interstitial quartz occurs throughout, in varying amounts, and some bands are more quartzose than others. Lenses of quartz mosaics are also present, and these are deformed, disrupted and show strain-extinction.

Very thin parting-planes of leucoxene occur, with veinlike habit, and they may actually be veinlets though this is unusual. Films and veinlets of fine hematite and goethite occur in places, not throughout the rock, and suggest a purely local source for the Fe and not a general Fe-staining due to weathering.

The original rock was a semi-pelitic fine sediment, probably in the nature of a laminated siltstone. There is no petrographic evidence to support an igneous origin.

H.W. Fander, M.Sc.
VIII. Reconnaissance in the Halls Creek Area

1. Introduction

2. General Geology

3. Helicopter Survey Strategy

4. Discussion of Results

Enclosures
VIII. RECONNAISSANCE IN THE HALLS CREEK AREA

VIII.1 INTRODUCTION

Ground reconnaissance and prospecting was carried out in the Halls Creek and Margaret River areas from 25.9.77 to 30.9.77, but due to inaccessibility of some localities, it was necessary to obtain helicopter support for two days (3.10 to 4.10). At this time the GDS-12 spectrometer/chart recorder and Austral 4" crystal were employed in the helicopter and used to locate Pechiney's Mt. Barret uranium prospect.

The Pechiney prospect was located in gossans at the unconformity between King Leopold Sandstone and Bow River Granite. During this survey, two other anomalies were located in similar gossans; one of these was already costeaned, presumably by Pechiney (Figure 8.3), but no mineralization was observed. Maximum radiometrics recorded (SRAT) was 2,000 c.p.s. at the Pechiney prospect and up to 300 c.p.s. over the other gossans located.

Following these investigations the helicopter was used to prospect all conformable contacts at the base of the King Leopold Sandstone; this included contacts with the Bow River Granite, MacIntosh Gabbro, Violet Valley Tonalite and Halls Creek Group.

A brief helicopter survey was conducted over the Saunders Creek Dome (near BP Minerals conglomerate prospect), checking for any sedimentary units within the underlying Ding Dong Downs Volcanics; an older conglomerate in this sequence may be correlatable with the Witwatersrand Conglomerate, and hence would be more prospective for uranium.
The Moola Boola Formation was prospected by ground mapping traverses and also helicopter strike-rim flying. Numerous radioactive pebbly quartz-sericite sandstones were located and sampled.

An arkosic (?) unit at the base of the glacial Egan Formation was also prospected in the Margaret River area near Louisa Downs Station.

VIII.2 GENERAL GEOLOGY

(1) Saunders Creek Dome: this structure believed to be of Archaean age outcrops in an upfaulted block within Biscay Formation geosynclinal sediments. The dome has a core of altered basic volcanics and greywackes (Ding Dong Downs Volcanics) which is overlain by the Saunders Creek Formation, consisting essentially of quartz sandstone, basal conglomerate and minor phyllite. The basal conglomerate contains significant amounts of uranium in the form of brannerite, but assays show there is an even higher percentage of thorogummite and thorium rich heavy minerals. Older, and perhaps more prospective, conglomerates were not located in the Ding Dong Downs Volcanics.

(2) Moola Boola Formation: this unit outcrops in a triangular fault bounded block 5km east of the Halls Creek township. A ground traverse (Figure 8.4) shows that the formation, described as being predominantly sandstone and feldspathic arkose, is in fact a sequence of chloritic shales with lenses of arkosic sandstone. This is observed in the northern part of the outcrop area where the shales form a distinct broad flat valley; towards the south, feldspathic
sandstones become more predominant and numerous radio-active pebbly quartz-sericite sandstones are also observed. This radioactivity has been subsequently confirmed to be due to thoriferous heavy mineral accumulations (maximum Th:U ratio was >100:1, MBS 2).

(3) Louisa Downs Group: The Egan Formation, the basal member of the Louisa Downs Group, outcrops in several areas near Margaret River 90km south of Halls Creek. The Adelaidea sequence is predominantly glacial, but there is a basal, green arkose which unconformably overlies the Bow River Granite at one locality south of Louisa Downs Station. It was thought that the arkose may be locally derived from the radiometrically "hot" Bow River Granite, hence it could be a prospective target for sedimentary uranium accumulations.

(4) Pechiney Uranium Prospect: The Pechiney Uranium prospect is located 25km south west of Mt. Barret at grid co-ordinates 557-701 (Mt. Ramsay 1:250,000 topographic sheet).

Secondary uranium mineralization, meta-torbernite and carnotite (?) occurs disseminated in a gossan/laterite developed at the unconformity between the King Leopold Sandstone and the highly kaolinized Bow River Granite. Because of alteration and shearing it is difficult to identify lithologies; the gossan may be derived from Luman Siltstone underlying the King Leopold Sandstone, it could also possibly be derived from shales of the Moola Boola Formation. B.M.R. has mapped the MacIntosh Gabbro in this area, but during the brief investigation, it was not observed.

Pechiney has drilled one vertical hole through the King Leopold Sandstone and several inclined holes through the gossan; another hole was drilled several...
hundred metres from the sandstone escarpment where outcrop was obscured by soil cover. We have no information on what these holes intersected. The prospect appears to be very small and visible mineralization is restricted to the gossan.

VIII.3 HELICOPTER SURVEY STRATEGY

Our helicopter mounted GDS-12 spectrometer and Austral 4" crystal were used primarily to locate the Pechiney prospect and to follow up with strike-rim flying prospective areas of similar geological type. There was also a possibility that the host rock at the Pechiney Prospect may have been altered Moola Boola Formation shales, hence the helicopter was used to prospect the only known outcrops of Moola Boola Sediments east and north of Halls Creek.

Several traverses were flown across the Saunders Creek Formation and the Ding Dong Downs Volcanics as well as rim flying the contacts inside the Saunders Creek Dome.

VIII.4 DISCUSSION OF RESULTS

Tables 8.1 and 8.2. show assay results from selected samples taken during the helicopter survey. The most interesting assay is that of MBS 1, which was collected from the Moola Boola Formation near the contact with the Halls Creek Group. The sample is identified (N. Pander, CMS) as geothite derived from a rock of intermediate to basic igneous origin, perhaps a dolerite. In the field, dolerite dykes are commonly observed intruding the Moola Boola Formation (Figure 8.4) and generally they are highly altered. The uranium:thorium ratio is >1 and the sample
is enriched in vanadium (this is to be expected from a basic rock). Anomalies located over similar gossanous rocks in the Kimberley show the same trend in relative uranium and vanadium enrichment, and it is noted that in most cases dolerite is closely related. Uranium values are not high enough to encourage further work in this area. All other anomalies found in the Moola Boola were caused by thoriferous heavy minerals.

The same applies to HCR 5, collected from the Saunders Creek Formation, which is described by W. Fander as a pebbly meta-quartzite with conspicuous heavy mineral banding. These heavy minerals are the primary cause of anomalism as there is a proven broad correlation between radioactivity and abundance of heavy minerals. Assays indicate a Th:U ratio of 63:1. Another anomaly of interest detected during the survey was located in an altered porphyritic rhyolite from the Biscay Formation (Archaean?). Although the Th:U ratio was 6:1, Fander has noted the presence of fluorite and deuterically introduced biotite which are known accessory minerals in some uranium deposits.

Samples were collected from Louisa Downs Group (MRR 1) and Glidden Group (MRR 2) but neither contained any radioactive elements. The Egan Formation (MRR 1) was prospected for a basal arkose which unconformably overlies Bow River Granite. This was not located by the author, only a sequence of hematitic lithic sandstones and shales was observed at the base of the Egan Formation. No anomalous radioactivity was located in the field. A brecciated argillaceous chert collected from the Maddox Hills area (MRR 2) showed evidence of upplaced pyrite, but only a slight increase in background radioactivity was observed. Flagging tape placed at regular intervals in the surrounding area suggests activity by another exploration company.
Samples were taken by Mr. Varkey at the Pechiney prospect but to my knowledge they have not been submitted for assay or petrological work.

Apart from the Pechiney prospect, no suitable environments for accumulation of uranium were observed in the Halls Creek Area. The Pechiney prospect appears to be only of academic interest.

ENCLOSURES

Figure 8.1  LOCATION MAP OF HALLS CREEK AREA
Figure 8.2  GEOLOGY OF HALLS CREEK AREA
Figure 8.3  GEOLOGY OF MARGARET RIVER AREA
Figure 8.4  SECTION ACROSS MOOLA BOOLA FORMATION

Table 8.1  GEOCHEMICAL SAMPLE SHEET (MT. RAMSAY)
Table 8.2  GEOCHEMICAL SAMPLE SHEET (HALLS CREEK)

Flight Charts: MOOLA BOOLA N/SAUNDERS CREEK
                 DING DONG (3.10.77)
                 MOOLA BOOLA S/BISCAV (3.10.77)
                 PECHINEY-SPRINGVALE FAULT (8.10.77)

CMS Petrological Report  77/10/14
SECTION ACROSS Moola Boola Formation
NE of Halls Creek, W.A.

1977 PROJECT CARPENTARIA
Prepared by: J. Theivson, June '77
Drawing No. A6-412, Project No. A6b-25
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<th>Grid Ref.</th>
<th>Sample Type</th>
<th>Depth</th>
<th>Analysis in ppb/ppm/%</th>
<th>Remarks</th>
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<td>Rock chip</td>
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<td>Hematite lithic sandstone, argillaceous of st ( brecciated)</td>
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<td>Depth to</td>
<td>Analysis in ppm</td>
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Mr. J. Thevissen,
Geologist,
Urangesellschaft Aust. Pty. Ltd.,
P.O. Box 40121,
CASUARINA. N.T. 5792

REPORT CMS 77/10/14

YOUR REFERENCE: Order No. 327,
Project No. A/8M,
Cost Code No. 061220

DATE RECEIVED: 13th October 1977

SAMPLE NOS.: MRPI, 2; HCRI - 6,
MRN2, 3; MBS1, 2

SUBMITTED BY: Mr. J. Thevissen

WORK REQUESTED: Petrology

H.W. Fander, M.Sc.

Copy & Invoice to:
Dr. W.E. Schindlmayr, Chief Geologist,
Urangesellschaft Aust. Pty. Ltd.,
608 St. Kilda Rd., MELBOURNE. VIC. 3004
Thin sections were prepared and examined and are described below. The off-cuts were checked for radioactivity with a Geiger counter (see explanation in report CMS 77/9/30 - M. Varkey).

MRR1 (TS 22443) Radioactivity negative (i.e. not detected).

This is a fine-grained lithic sandstone, containing ultrafine hematite throughout; this is primary and indicates an oxidising environment. The rock was very probably subaqueously deposited and is faintly layered.

The framework consists of subangular quartz grains, with minor grains of chert and of sericite aggregates (some are shale, some may be altered feldspar), siltstone, and occasional muscovite flakes. There are dispersed, isolated heavy-mineral grains of oxide opaques, green tourmaline and zircon.

The framework grains have a thin coating of ultrafine hematite, with interstitial cementing quartz and clay (illite). The faint layering is caused by slightly coarser bands of quartz and by subparallel alignment of long axes of framework grains. Little can be stated about the provenance, though it was partly sedimentary.

MRR2 No radioactivity detected.

This is an impure, argillaceous chert; it is faulted, brecciated in places, with minor displacement.

The rock consists mainly of ultrafine, almost isotropic cherty quartz, with embedded small clay (illite-sericite) flakes with parallel orientation, uniform throughout. There are small authigenic quartz veinlets. In addition, quartz-filled fractures are common; where two parallel fractures are close together, the intervening rock consists of small angular breccia-fragments. A few angular spaces, formed by fracturing, contain small matted acicular aggregates of zeolite (probably thomsonite). Some goethite staining has occurred adjacent to veins and along slightly more argillaceous bands (more permeable).

It is possible that traces of ultrafine (?framboidal) pyrite may have been present, as suggested by relict features; this would have been syngenetic, indicating a reducing environment. The rock was of mainly chemical origin.

HCR1 No radioactivity detected.

This is a feldspathic metaquartzite; there is good evidence of metamorphism, mainly dynamic; however, relict clastic features are still recognisable, though modified.
The rock is composed mainly of quartz, with minor feldspar (10 - 15%, mainly albite), as modified detrital grains; rounded outlines are preserved though grain margins are granulated and recrystallised in places. Albite twin-lamellae are kinked and displaced. The original rock must have been a coarse-grained feldspathic sandstone.

Interstitial spaces contain microcrystalline quartz, and subparallel flakes of muscovite and minor chlorite formed from primary clays. There are occasional, fragmented heavy mineral grains, of sphene, oxide opaques and zircon.

The fabric of the rock is almost gneissic, but the metamorphic grade was low, the effects being mainly dynamic, with some recrystallisation. The provenance was broadly igneous.

HCR2 Possible weak radioactivity detected.

This is an indurated gritty quartzite with conspicuous heavy-mineral banding; induration is sufficiently strong as to be on the verge of metamorphism.

The framework consists of occasional grit-sized subangular to subrounded metaquartzite grains, scattered through an evenly-sized mass of quartz grains (average size - 0.5mm) which show strong strain-extinction. The conspicuous, parallel heavy-mineral bands are up to 3mm thick, but heavy minerals are also dispersed through the rock and are not confined to the bands. Apart from isolated tourmaline and zircon grains, the only heavy minerals present are magnetite (almost entirely oxidised).

The matrix/cement is quartz and sericite, which forms interstitial aggregates and small flakes fringing framework grains. Fine goethite occurs, and the environment of deposition was probably oxidising.

HCR3 No radioactivity detected.

This incipiently metamorphosed rock is best termed a gritty metaquartzite; the grade of metamorphism was low and mainly dynamic, not far beyond "load" metamorphism, and thus clastic features are preserved.

The framework is composed of coarse-sand and grit-size, irregularly shaped subangular quartz grains, with occasional metaquartzite and siltstone particles. Some quartz grains are marginally or wholly recrystallised to fine mosaic quartz. Oxide opaque (?magnetite) heavy-mineral grains are interspersed, and do not form layers. The matrix/cement is fine quartz, and sericite fringes framework grains (but has subparallel orientation). Fine authigenic green tourmaline has developed in sericite aggregates in places.

The presence of ultrafine pigmenting goethite in the matrix suggests an oxidising environment.
HCR4  No radioactivity detected.

Because of the thorough recrystallisation of the matrix and other factors, it is evident that the rock is metamorphosed (greenschist facies) and is a sericite-chlorite metaquartzite; despite the abundance of micas the rock is not schistose, mainly because of coarse detrital quartz which has not been comminuted or recrystallised.

The original sedimentary framework consisted of rounded quartz, chert and metaquartzite grains, occasionally up to grit size. These are now strongly stressed but more or less intact because of the incompetent matrix, originally argillaceous but now composed of small interleaved flakes of sericite and pale chlorite. Heavy-mineral grains are dispersed through the rock without forming distinct layers; they include oxide opaques, zircon, tourmaline, and isolated ?cassiterite (the identification is doubtful because very few grains are present, and confirmatory chemical analysis is needed).

Owing to the metamorphism, very little can be said about the depositional environment or provenance.

HCR5  Very weakly radioactive.

Examination of the hand specimen shows that this is a pebbly sandstone rather than a conglomerate, since pebbles are < 50% of the rock. It is incipiently but definitely metamorphosed and is thus a pebbly metaquartzite.

The main constituents, forming the original framework, are elasic grains ranging from medium- to coarse-sand size, and pebbles. Most are strongly stressed quartz, but there are also lithic particles, including magnetite- chert, siltstone, magnetite-sericite schist and altered porphyritic rhyolite. Uneven, contorted bands of heavy minerals (perhaps lenses or scour-channel fillings) are conspicuous; they consist dominantly of oxide opaques (oxidised magnetite) with minor altered ilmenite (brown leucoxene) and a trace of zircon.

The matrix is fine quartz intergrown with sericite, more or less schistose. The abundance of magnetite in this sample (and others) is probably due to the magnetite-rich schists and cherts.

HCR6  K-feldspar stain test positive. No radioactivity detected.

This is a sheared porphyritic rhyolite, with biotite and fluorite.

Small phenocrysts of sanidine-anorthoclase are common, quartz less so; they have irregular, granulated margins, and the quartz shows strainextinction. They are set in a medium- to fine-grained, holocrystalline groundmass of quartz, microcline and subparallel laths of albite. The rock was mildly sheared and microfractured, and deuteric minerals were
introduced, including fine flakes of very dark biotite, and small and large patches of blotchy purple fluorite.

The rock was very probably a shallow or minor intrusive, verging on a microgranite; the preferred orientation of the fabric and the mild shearing may be intrusive, rather than tectonic, features.

MBN2 No radioactivity detected.

This is a metasomatized siltstone, in which abundant muscovite has developed replacively.

The siltstone is composed of small subangular to rounded quartz grains, with thin intergranular films and coatings of goethite. Coarser, fine-sand sized quartz grains are scattered through the rock. There are thin but well-defined, parallel heavy-mineral layers; their composition contrasts strongly with those in previous layers. Magnetite is absent, but mauve zircon (hyacinth) is plentiful, with minor tourmaline and leucoxene, possible sphene and rutile.

Throughout the rock, irregular patches of muscovite have formed; some of these are fine sericite-like aggregates, others are quite coarse single flakes. They have a distinctive silvery appearance in hand-specimen. The flakes are randomly orientated and cut across detrital grains and grain-boundaries, replacing parts of the rock.

MBN3 No radioactivity detected.

This is a ferruginous siltstone, incipiently metamorphosed; it resembles MBN2 in many respects, though much more ferruginous and finer-grained. It appears to have been weakly metasomatised and then deformed.

The framework consists of small, rounded quartz grains, with coatings and intergranular films of ultrafine hematite and fine interstitial sericite (recrystallised clay). There are distinct mica-rich layers or bands, composed of fine and relatively coarse flakes of sericite and muscovite; particularly the coarser flakes seem to have developed by replacement. The bands themselves are folded and crenulated, and the whole rock (i.e. the thin section) shows fairly tight folding.

Small heavy mineral grains are randomly scattered through the rock, and are mainly green tourmaline, with some oxide opaques. Small lath-shaped goethite pseudomorphs occur, of unknown origin.

MBS1 No radioactivity detected.

This is essentially a goethite rock representing completely altered, oxidised material whose origin can be deduced only from rather poorly-
preserved relict features, and is thus to a certain extent speculative.

The rock is believed to have been of intermediate to basic igneous origin, perhaps in the nature of a dolerite. It now consists of pseudomorphs of earthy to compact goethite, interstitial quartz, and oxide opaques. The pseudomorphs are lath-shaped or prismatic, with relict cleavage in places, and suggest derivation from feldspars and ferromagnesian minerals. The oxide opaques are evenly dispersed through the rock, and are skeletal and euhedral, typical of altered igneous magnetite. The quartz is regarded as secondary.

The relict fabric is random and medium to coarse, and typical of doleritic/microgabbroic rocks.

MBS2 Very weakly radioactive.

This is a sericitic quartzite with very conspicuous heavy-mineral banding.

The framework consists of medium- to coarse-sand sized subangular quartz grains with occasional grit-size fragments and rare lithic grains (altered felsite and porphyry). Fine sericite, representing recrystallised clay, is intergrown with quartz, forming the matrix/cement; it is goethite-stained in places.

Heavy mineral grains are scattered through the rock and form thick layers of fairly closely-packed grains; these are almost entirely oxidised magnetite, with minor leucoxene and traces of zircon.

The rock is indurated but not metamorphosed. The environment of deposition was probably neutral or perhaps slightly reducing; little can be said about the provenance.

In all these rocks which are weakly radioactive, no discrete uranium mineral was seen, nor were minerals such as zircon sufficiently abundant. Thus further investigations (polished sections, autoradiography etc.) would be required to pursue this problem; the extra expenditure may not be warranted at this stage, depending on circumstances and actual U analyses.

There is a broad correlation between radioactivity and abundance of heavy minerals; since these are predominantly oxide opaques, the U/Th occurrences are logically associated with these minerals, and there is a wide variety of possibilities.

H.W. Fander, M.Sc.
IX. RECONNAISSANCE OF WESTERN AND SOUTHERN MARGINS OF THE

GEORGINA BASIN, NORTHERN TERRITORY

IX.1 INTRODUCTION

A: Western Margin
The Tennant Creek Block, in the western margin of the Georgina Basin, is primarily comprised of Lower Proterozoic sediments and volcanics of the Warramunga Group, and a suite of undifferentiated Lower Proterozoic granitic intrusions. These units were the subject of a brief reconnaissance survey (21.8.77 to 23.8.77) which involved mapping stratigraphic sections and rock chip sampling; an outcrop of Rising Sun Conglomerate (Adelaidean) was mapped near its contact with quartz-feldspar porphyry (undiff. carpentarian). Investigation of the Morphett Creek Formation conglomerate member was attempted, however suitable access could not be found and work was deferred to a later date should the opportunity arise.

B: Southern Margin
Reconnaissance work (24.8 to 5.9.77) was concentrated on the Upper Proterozoic sedimentary sequences overlying the Arunta Block. Units investigated in detail were Upper Proterozoic Mt. Cornish Formation (fluvio-glacial), Elyuah Formation (mainly arkoses), Grant Bluff Formation (sandstones) and Lower Cambrian Mt. Baldwin Formation (red beds). The survey comprised of stratigraphic - radiometric section mapping, rock chip sampling and stream sediment sampling; this included a preliminary investigation of the Arunta Complex high grade metamorphics and granites to assess their source rock potential.

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An airborne (helicopter) stream sediment sampling program was planned for the Elyuah Range area, but had to be abandoned because fuel was unavailable.

IX.2 GENERAL GEOLOGY

The Warramunga Group is the lowermost Lower Proterozoic sequence resting unconformably (?) on Archaean basement in the Tennant Creek Area. Basal proterozoic units have long been regarded fossil time markers (IAEA - SM - 183/35) and have been used to locate uraniferous conglomerates. These uraniferous conglomerates only form in environments which are non-oxidizing; in other words exploration should be concentrated on stratigraphic units below the oldest red beds.

The basal part of the Warramunga Group consists of greywacks siltstone (PW1) unconformable on Archaean garnet gneiss. The overlying Bernborough Formation is mainly acid lava, tuff and greywacke, and includes the Whippet Sandstone Member which consists of quartz and feldspathic sandstones with minor pebble beds. These beds occur directly below hematite environment in the basin. If the Bernborough Formation is pyritic it could prove prospective for uraniferous conglomerates.

The middle units of the Warramunga Group (PW7, PW2) were investigated in three mapping sections (Figures 9.4, 9.5 and 9.6). PW2 consists essentially of red, brown and white laminated and sometimes block siltstones, minor greywacke and hematite shale. PW7 is mostly red-brown laminated siltstones, massive hematite beds (up to 2m thick), purple quartz greywacke and coarse granule sandstone. Intrusive granitic rocks are rarely observed in outcrop, except in gullys, and are generally found as sand covered flats.
The youngest unit investigated was the Adelaiden (?) Rising Sun Conglomerate which outcrops 17km SE of the Tennant Creek township. One mapping traverse only (Figure 9.10) was completed across the unit and hence it is difficult to draw conclusions as to its uranium potential; it has been suggested (pers. comm. M. Varkey) that uranium mineralization has been observed in the unit. The Rising Sun Conglomerate rests unconformably on a "quartz-feldspar porphyry" which has (according to W. Fander) characteristics of both tuffs and lavas. The rock is more accurately termed a rhyolitic tuff-lava which has been extensively leached and silicified giving it the appearance of an intrusive. Contacts with the Rising Sun Conglomerate were not observed; the conglomerate consisted only of scattered pebbles and cobbles, chiefly of sandstone and "quartz-feldspar porphyry". These pebbles occur scattered across a small valley between hills of Warramunga Group sediments and the Lower Proterozoic igneous rock (silicified by major quartz vein/fault). The composition of the pebbles suggests they come from locally derived material. Jaspilites of unknown age are associated with several small quartz veins cutting the "quartz-feldspar porphyry".

Between the northern margin of the Arunta Block and the southern margin of the Georgina Basin, the author has investigated a series of Upper Proterozoic and Lower Cambrian sediments. The Archaean (Arunta Complex) was checked at Mt. Cornish Bore (Figure 9.7); at the unconformity between the Archean and the overlying Mt. Cornish Formation a sample of brecciated, sheared MnO₂ stained granite was collected. Most other Archaean rocks observed in the area were gneissic granites.

The Mt. Cornish Formation, according to B.M.R. mapping (Bull. 111) is probably glacial; the formation was checked at two localities and in both cases the sequence was completely different. At the Mt. Cornish Bore locality (Figure 9.7) it consists mainly of quartzite, feldspathic granular sandstone (HUR 1, W. Fander believes it to be
aeolian), angular quartz-pebble conglomerate, siltstone-shale and minor geothite beds. No similar sequence was observed in the Huckitta 1:250,000 sheet area. At one other locality (Figure 9.9) the Mt. Cornish Formation can be easily recognized as a glacial sequence. Here it consists of a basal, green silicified siltstone (with small angular rock fragments) overlain by a pebble/boulder bed and a varve-like sequence of red and green laminated micaceous siltstones.

The Elyuah Formation was mapped at the eastern end of the Jervois Range near Lucy Downs Station (Figure 9.8). It outcrops as a 10 metre high scarp at the base of the cliff forming sandstone of the Grant Bluff Formation. The mapped section consisted of granular coarse grained arkosic sediments (sometimes resembling schist due to abundance, >20% of muscovite) capped by angular quartz-pebble conglomerate (similar to that observed at the Mt. Cornish Bore). These sediments are resting conformably on a siltstone-shale sequence, partially obscured by scree, which is possibly Mt. Cornish Formation.

The Oorabra Arkose Member of the Elyuah Formation was mapped at its type locality, N-E of Oorabra Rockhole, where it conformably (?) overlies glacial rocks of the Mt. Cornish Formation (Figure 9.9). The unit is a monotonous sequence of coarse grained angular and poorly sorted micaceous arkoses, with minor schistose bands and conglomerate bands; it appears to be locally derived from nearby granites.

The Grant Bluff Formation is characterized by a prominent marker bed of "pitted" quartzite. This is a cliff forming unit which occurs near the base of the formation and overlies a thin red + green laminated siltstone and a dolomitic sandstone. The "pitted" quartzite is succeeded by a thick monotonous sequence of dolomitic sandstones and interbedded fine grained flaggy quartzites. Minor gypsiferous bands are located at the contact of siltstone and dolomitic sandstone.
The Mt. Baldwin Formation was checked at one locality near Elkedra Yard. Ripple marked red quartz sandstones predominated with minor grey-green glauconitic quartz greywacke.

IX.3 SUMMARY OF GROUND RADIOMETRICS

The tables below summarize the ground radiometrics recorded (SG 2a) over lithologies investigated along the western and southern margins of the Georgina Basin:

**TABLE 9.3 A: WESTERN MARGIN**

<table>
<thead>
<tr>
<th>UNIT</th>
<th>RADIOMETRIC BACKGROUND</th>
<th>MAXIMUM RADIOMETRICS</th>
<th>LITHOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>WARRAMUNGA GROUP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PW 2</td>
<td>35 - 40</td>
<td>60</td>
<td>brown and white banded siltstone</td>
</tr>
<tr>
<td>PW 7</td>
<td>35</td>
<td>40</td>
<td>grey quartz greywacke</td>
</tr>
<tr>
<td>QUARTZ-FELDSPAR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PORPHYRY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PfP</td>
<td>35 - 40</td>
<td>60</td>
<td>rhyolitic tuff-lava</td>
</tr>
<tr>
<td>RISING SUN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONGLOMERATE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pur</td>
<td>35</td>
<td>35</td>
<td>unconsolidated pebbles</td>
</tr>
</tbody>
</table>

**TABLE 9.4 B: SOUTHERN MARGIN**

<table>
<thead>
<tr>
<th>UNIT</th>
<th>RADIOMETRIC BACKGROUND</th>
<th>MAXIMUM RADIOMETRICS</th>
<th>LITHOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARUNTA COMPLEX</td>
<td>80</td>
<td>600 (U)</td>
<td>brecciated, sheared, MnO₂ stained granite</td>
</tr>
<tr>
<td>JINKA GRANITE</td>
<td>140 - 150</td>
<td>180</td>
<td>biotite granite</td>
</tr>
<tr>
<td>MT. CORNISH BEDS</td>
<td>30 - 40</td>
<td>250 (U)</td>
<td>green siltstone</td>
</tr>
<tr>
<td>UNIT</td>
<td>RADIOMETRIC BACKGROUND</td>
<td>MAXIMUM RADIOMETRICS</td>
<td>LITHOLOGY</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------</td>
<td>----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>ELYU AH FORMATION</td>
<td>40</td>
<td>60</td>
<td>granular arkose</td>
</tr>
<tr>
<td>OORABRA ARKOSE</td>
<td>140</td>
<td>350 (Th)</td>
<td>coarse grained arkose</td>
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<tr>
<td>GRANT BLUFF FORMATION</td>
<td>25 - 30</td>
<td>40</td>
<td>quartz sandstone</td>
</tr>
<tr>
<td>MT. BALDWIN FORMATION</td>
<td>50</td>
<td>60</td>
<td>red sandstone</td>
</tr>
</tbody>
</table>

IX.4 DISCUSSION OF RESULTS

A: Western Margin

Basal Proterozoic units, such as the Warramunga Group, have long been regarded as fossil time markers and have been used to locate uraniferous conglomerates. These conglomerates form in non-oxidizing conditions and hence exploration should be concentrated on stratigraphic units below the oldest red-beds. The basal portion of the Warramunga Group, the Bernborough Formation and the Whippet Creek Member, may conform to these conditions. As yet only preliminary 1:250,000 geological mapping has been completed by the B.M.R. and information on the Bernborough Formation is limited. Past work has been concentrated on Mining districts and much of it is dated pre-1960. Time and circumstance (vehicle breakdown) did not allow investigation of the basal Warramunga units this year, however the group is worthy of at least preliminary investigation in order to test their potential for uranium mineralization.

Ground radiometric survey, Table 9.3, did not reveal any other encouraging horizons which could warrant further work. The possible exception is the Rising
Sun Conglomerate (believed to contain uranium) which was not adequately tested. A possible source rock for the conglomerate (Pfp, quartz-feldspar-porphyry) assays 2 ppm uranium and 62 ppm thorium, which is not encouraging.

B: Southern Margin
A maximum total count radiometrics (SG 2a) of 600 c.p.s. was recorded in brecciated granite of the Arunta Complex. A sample, collected near the Mt. Cornish Bore, of this granite assayed 160 ppm uranium and 71 ppm thorium; also a water sample collected from Mt. Cornish Bore (W.E. Schindlmayr, 1973) contained 800 ppb uranium. This indicates that the Arunta Complex at this locality is significantly enriched in uranium, and hence is a prospective source of uranium for sediments derived directly from it. These Archaean granites warrant further sampling to test if they have consistently anomalous uranium values.

The basal unit of the Mt. Cornish Formation, a green silicified siltstone assayed 82 ppm uranium and only 17 ppm thorium. Because of its small areal extent, the Mt. Cornish is perhaps less prospective than its lateral equivalent further east, the Field River Beds, which are more extensive. The Field River Beds have been investigated by M. Schwabe, apparently with disappointing results (pers. comm. M. Varkey). Further work may still be warranted, particularly where the unit occurs along the margins of the Arunta Complex.

In the Elyuah Range area, the Oorabra Arkose, which appeared very prospective from field observations, assayed only 8 ppm uranium and 63 ppm thorium. This arkose is locally derived from the Jinka Granite which appears to be enriched in thorium. It is difficult to recommend further work on this unit following these poor assays.
ENCLOSURES

Figure 9.1  LOCATION MAP
  9.2  GEOLOGY OF TENNANT CREEK AREA
  9.3  UPPER PROTEROZOIC AND LOWER CAMBRIAN ROCKS ALONG THE SOUTHERN MARGIN OF THE GEORGINA BASIN
  9.4  TENNANT CREEK SECTION (IVANHOE)
  9.5  TENNANT CREEK SECTION (WARREGO)
  9.6  TENNANT CREEK SECTION (GECKO)
  9.7  MT. CORNISH SECTION
  9.8  JERVOIS RANGE SECTION
  9.9  OORABRA ROCKHOLE SECTION
  9.10 RISING SUN CONGLOMERATE

Table 9.1  GEOCHEMICAL SAMPLE SHEET (TENNANT CREEK)
  9.2  GEOCHEMICAL SAMPLE SHEET (HUCKITTA)

C.M.S. Petrological Report  77/9/5
URANGESSELLSCHAFT®
australia pty. ltd.

Locality Map
North Australia
Reconnaissance

SCALE 1:5,000,000
Fig 9.1
ADALIAIDIAN

Rising Sun Conglomerate

CARPENTARIAN

Undifferentiated granite rocks

LOWER PROTEROZOIC

Greywacke siltstone, greywacke, tuff,
mudstone conglomerate.
Shale, greywacke, argillite.
Local metamorphic slate bands.

Major operating mines

= TCR1 Rock chip sample location A number

-> Mapping section

--- Highway

--- Access road to mines

TENNANT CREEK AREA
N.T.

GEOLOGY AND AREAS INVESTIGATED

SCALE 1:500,000

PROJECT 801

URANGESSELLSCHAFT
AUSTRALIA PTY LIMITED

Date: Nov. 1971, Prepared by J. Thormann
Drawing No. AA-401, Project No. 801-2
SOUTHERN MARGIN OF THE GEORGINA BASIN, N.T.

EXPLORATION ACTIVITY

- Rock chip sample (MUR1)
- Stream sediment sample (MUR1)
- Mapping section

- Creek
- Access road
- Homestead
- Mine
- Cu (Copper)
- W (Scheelite)

SCALE 1:500,000

PROJECT 601

URANGESSELLSCHAFT
AUSTRALIA PTY. LIMITED

Date: Nov. 1977, Prepared by: J. Thirssen
Drawing No: A4-4GS Project No: 601-5
SOUTHERN MARGIN OF THE GEORGINA BASIN, N.T.

GEOLOGY

LOWER CAMBRIAN TO UPPER PROTEROZOIC
- M'Baldaun Formation
- Grant Bluff Formation
- Elyon Formation and Oodera Arkose Member

UPPER PROTEROZOIC
- M'Cormack Formation

LOWER PROTEROZOIC
- Oneper Granite
- Jerwa Granite
- Jukka Granite
- Marshall Granite

ARCHAEOAN
- Undifferentiated Arunta Complex

Creek
Access road
Homestead
2 Mins. Cu (Schechter) W (Schechter)

SCALE 1:500,000
0 5 10 15 20 25 Kilometres
MAPPING SECTION IN THE TENNANT CREEK AREA

8Km East of Ivanhoe Mine

Fig. 9.4

1977 PROJECT CARPENTARIA
Prepared by: J. Thevissen Sept '77
Drawing No. A4-348 Project No. ABC-64
MAPPING SECTION IN THE TENNANT CREEK AREA

3 km North of Gecko Mine

1977 PROJECT CARPENTARIA
Prepared by: J. Theissen Sept '77
Drawing No. A4-346 Project No. A0c-62
Sketch only (not drawn to scale)

- Alluvium/screed

**ADELAIDEAN?**
- Rising Sun Conglomerate

**LOWER PROTEROZOIC**
- Quartz-telepar-porphyry
- Warramunga Group (PwG)
- Siltstone, greywacke
- Jasplite (Unknown Age)
- Quartz vein

URANGESELLSCHAFT
AUSTRALIA PTY. LIMITED

1977 PROJECT CARPENTARIA

**RISEING SUN CONGLOMERATE**
(East of Nobles Nob) Fig. 3.10

Prepared by: J. Thevissen Sept. '77
Drawing No: A4 - 352 Project No: A8c-68
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<th>Sample Type</th>
<th>Depth from</th>
<th>Depth to</th>
<th>Analysis in ppm/ %</th>
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<td>Rock Chip</td>
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<td>6</td>
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<tr>
<td>CR5</td>
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<td>2</td>
<td>6</td>
<td>62.23 20 20 20 16</td>
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</table>

**Remarks:**
- Ferromagnesian amphibolite
- Porphyritic rhyolite
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<th>Sample No.</th>
<th>Grid Ref.</th>
<th>Sample Type</th>
<th>Depth from</th>
<th>Analysis in ppm/oz</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
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<td>JR 1</td>
<td>21 15 7 0 4 5 3</td>
<td>Rock Chip</td>
<td>100 71</td>
<td>71 69 44 56 34 24</td>
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<tr>
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<td>113</td>
<td>68 8 20 20 2 2</td>
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<td>21 18 5 0 4 3 6</td>
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<tr>
<td>6</td>
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<td>7</td>
<td>21 17 2 0 3 7 4</td>
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<td>1 17 17 20 16 26 32</td>
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| 3          | 21 19 0 0 4 3 8 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 4          | 21 18 7 0 4 3 9 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 5          | 21 17 8 0 4 3 3 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 6          | 21 17 7 0 4 3 1 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 7          | 21 16 4 0 4 2 4 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 8          | 21 15 5 0 3 9 7 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 9          | 21 15 4 0 3 9 7 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 10         | 21 15 6 0 3 6 9 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 11         | 21 17 0 0 3 7 0 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 12         | 21 17 2 0 3 7 3 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 13         | 21 17 1 0 3 7 9 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 14         | 21 17 4 0 3 7 9 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 15         | 21 17 0 0 3 4 3 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
| 16         | 21 17 4 0 3 4 3 | "          | 1 16 0.89 | 8 22 22 20 | - 25 cps |
Central Mineralogical Services Pty. Ltd.

231 Magill Road
Maylands, S.A. 5069
Telephone 42 5659

19th September 1977

Mr. J. Thevissen,
Geologist,
Urangesellschaft Aust. Pty. Ltd.,
Post Office Box 40121,
CASUARINA, N.T. 5792

REPORT CMS 77/9/5

YOUR REFERENCE: Order No. 314
DATE RECEIVED: 5th September 1977
SAMPLE NOS.: Rock Chip Samples
TCRI - 5, HURI - 11
SUBMITTED BY: Mr. J. Thevissen
WORK REQUESTED: Petrology

H.W. Fander, M.Sc.

Copy and Invoice to:

Dr. W.E. Schindlmayr,
Chief Geologist,
Urangesellschaft Aust. Pty. Ltd.,
608 St. Kilda Road, MELBOURNE. VIC. 3004
All sixteen samples were thin-sectioned, and off-cuts were checked with a Geiger counter. In addition, K-feldspar staining tests were carried out to locate K-feldspar, K-glass and volcanic material containing these components.

TCR1 (TS 22120)

Red-brown, fine-grained bedded sediment.

This is a well-bedded, ferruginous, argillaceous siltstone; the ferruginous material is believed to be primary rather than a weathering phenomenon.

The rock consists of silt-sized angular quartz grains, mica flakes, diagenetically recrystallized clay (now illite) and abundant fine earthy hematite. This is very evenly distributed but is more abundant in some layers than in others, resulting in color variations. The matrix/cement is clay and hematite.

There are thin (0.1 - 0.3mm) intercalations of layers of coarser detritus, consisting of fine-sand sized angular quartz grains, muscovite flakes, and heavy-mineral grains, including zircon, oxide opaques, and leucoxene.

Small veinlets of silica cut the rock, and have caused adjacent bleaching due to removal of hematite.

No radioactivity was detected, but the thin layers containing heavy minerals could contain traces of radioactive minerals whose mass effect would be detectable.

TCR2

 Pale, fine faintly banded sediment with dark spots.

This is a homogeneous, rather featureless siltstone, with relatively abundant oxidised pyrite; the lack of iron-staining is unusual.

The major component is quartz (65-70%), as silt-sized angular grains. Sericite makes up most of the remainder, occurring as small stubby flakes with random to subparallel orientation and probably developed from primary clay during diagenesis. Very fine irregular grains of cream/light brown opaque material are present throughout and are thought to be leucoxene of authigenic or syngenetic origin (precipitated). There appears to be little cement, and the cohesiveness of the rock is mainly due to compaction.
There are numerous small (10-100μ) pseudomorphs of goethite/hematite after euhedral pyrite, randomly scattered through the rock. Larger clusters (up to 3mm) are also present, surrounded by coarser, clear quartz, probably formed as nodules. The pyrite is syngenetic-diagenetic. No radioactivity was detected.

TCR3

Brown, medium-grained clastic rock. K-stain test negative.

This is a lithic, volcanomict, sandy siltstone; it is compacted and may be incipiently metamorphosed. The classification indicates that over 50% of the rock is in the silt size-range, and that it contains lithic and volcanic (re-worked) material (mostly in the sand size-range).

The sand-size particles are fairly evenly dispersed through the rock and do not form separate layers; they comprise subangular quartz, quartzite, chert, shale/fine schist, and grains of felsite representing devitrified felsic lava. These commonly have subparallel orientation, and the quartz shows strain extinction. A few of the larger quartz grains are embayed and have characteristics typical of phenocrysts in rhyolites.

The bulk of the rock consists of abundant, fine, orientated sericite flakes with interstitial goethite, containing small embedded quartz and lithic grains. The fabric is weakly schistose. Iron oxide pseudomorphs after pyrite crystals are fairly common throughout.

The provenance of the constituents was igneous and low-grade metamorphic, with evidence of a rhyolitic source. No radioactivity was detected.

TCR4

Brown, gritty sediment. K-stain test negative.

Although in hand specimen this rock appears to a sediment, it is believed to be a sheared, altered porphyritic rhyolite. Due to alteration and ferruginisation, a number of vital and diagnostic details have been obscured or destroyed, but surviving data favour an igneous origin.

There are large (up to 3-4mm), strongly embayed quartz phenocrysts, showing strain-extinction, microfracturing; some are recrystallised. Smaller phenocrysts are common, and most have a thin rim of cloudy quartz (due to fine inclusions) in optical continuity - a typical igneous feature. Angular patches of random sericite flakes are present
throughout, almost certainly representing sericitised feldspar phenocrysts. The groundmass is fine quartz and sericite with goethite films and small pseudomorphs after pyrite.

It is thought that the rock incorporated xenoliths of shale/siltstone (strongly Fe-stained); quartz veins were also present, but are now sheared, disrupted and fragmented.

The rock appears too coarse to be a lava, and may have been an intrusive rhyolite. No radioactivity was detected.

**TCR5**


This is a porphyritic rhyolite or a rhyolitic tuff-lava (i.e. with characteristics of both tuffs and lavas), extensively leached and silicified.

The rock consists of angular and splintery fragments of phenocrysts, of quartz and sanidine/anorthoclase, quite fresh but stressed and micro-fractured, set in a groundmass of microcrystalline quartz. The whole rock is laced with irregular silica veinlets; some of these follow perlitic cracks, others are subparallel fracture-fillings. There are also porous and cellular silica patches representing a completely leached mineral, perhaps another species of feldspar.

The groundmass was quite possibly originally glassy, as suggested by relict textures.

Limonite-stained kaolinite veins cut the rock, and parts of the rock are lightly iron-stained. No radioactivity was detected.

**HUR1**


A very heterogeneous rock, in terms of textures and structures in particular; the scale of the hand specimen is too small to determine the correct relationships between the various portions of the rock, and thus the interpretation is tentative. Introduction of MnO₂ (black), and alteration, has also obscured some details.

The rock is believed to be a brecciated and mylonitised coarse granite, in which much of the finer interstitial matrix is altered to silica and clays; MnO₂ veinlets and patches have formed in coarser portions. Relatively unaltered fragments of coarse microcline-quartz intergrowths have survived but are strongly stressed. Coarse areas consist of such
composite fragments, and of individual coarse irregular fragments of stressed quartz and microcline. There are veinlike masses of fine mylonite composed of splinters of the same minerals in a semi-isotropic matrix of alteration-products; this veinlike distribution is typical of mylonitic material, which appears to be mobile and capable of being "intruded". A medium/fine-grained portion is a microbreccia or coarser mylonite, also composed of splinters of highly-stressed quartz and microcline in a semi-isotropic matrix, with minor MnO₂.

Other interpretations are feasible, but would depend on examination of different specimens and knowledge of the field occurrence. No radioactivity was recorded.

HUR2

Brownish-grey siliceous sediment. K-stain test negative.

This is a thoroughly indurated protoquartzite verging on an orthoquartzite.

The framework consists dominantly of well-rounded subspherical quartz grains, occasional felsitic grains, isolated chert grains, and very irregular patches of fine, vermiciform kaolinite aggregates. Most of the quartz grains have a thin surface film of ultrafine hematite; this predates the cement, and indicates oxidising conditions in the environment of deposition. The rock may be of aeolian origin.

The cement is quartz, in optical continuity with the framework grains and both cement and grains show mild strain-extinction, which thus postdates the lithification. Some of the kaolinite is believed to represent cavity-fillings (?leach-cavities), some is probably detrital feldspar altered in situ.

The framework grains are closely sized in the medium-sand range, but there are occasional grit-size (2-4 mm) subrounded quartz grains. The felsitic material is fine-grained (?devitrified felsic glass), the grains small and well-rounded, i.e. thoroughly reworked and possibly recycled.

HUR3

Coarse clastic, micaceous rock.

This rock is classified as a feldspathic greywacke, although the term is not entirely satisfactory.

The framework consists of coarse and fine, angular and irregular fragments of strongly stressed quartz, albite (with peculiar "chequer"
Winning), muscovite schist, coarse muscovite flakes, quartz-muscovite, metaquartzite, and quartz-albite composites. There is a faint preferred orientation of the framework grains.

The matrix/cement consists of the same minerals, as finer grains, and small flakes of biotite as well as goethite patches; in places there are patches, and networks of veinlets, of carbonate.

Because of the coarse, angular nature of the grains and the freshness of the albite, the provenance must have been nearby, and was dominantly granitic/pegmatitic material, with a subordinate meta-sedimentary source. The carbonate may well be later - unrelated to deposition. No radioactivity was registered.

HUR4

Brown, medium-grained micaceous sediment. K-stain test positive.

This is a micaceous, feldspathic sandstone, no far removed from a feldspathic greywacke though lithic grains are rare.

The rock is well-bedded, due to the abundant of well-aligned mica flakes. These are mainly muscovite, with subordinate degraded biotite, totalling 15 - 20% of the rock. Angular to subangular quartz grains form the bulk of the rock, and cleavage-fragments of K-feldspar and plagioclase comprise 10%. Some of the muscovite flakes are up to 10mm in length (i.e. diameter) though only 0.05mm thick.

The grains are closely packed and there is very little matrix/cement; it consists of degraded, squeezed mica flakes and goethite films. The rock is moderately well-sorted.

Detrital heavy mineral grains include green tourmaline, and cloudy leucoxene aggregates; both are relatively common. No radioactivity was detected. The provenance of the rock was mainly igneous, possibly also low-grade metamorphic, and the environment of deposition was probably oxidising.

HUR5

Pale, medium/fine-grained siliceous rock. K-stain test negative.

This is a medium-grained orthoquartzite, with very minor kaolinised feldspar. It is not unlike HUR2 but contains no lithic fragments, nor are the quartz grains coated with hematite.

The framework consists almost entirely of well-rounded, subspherical quartz grains with an average size of 0.3-0.4mm (excluding overgrowths), and occasional kaolinite aggregates. These represent feldspar
(kaolinised in situ?) and are evidently leached out in places; the cavities so formed, are partially re-filled with MnO₂ and silica (forming dark streaks in the rock). The framework quartz is mainly of igneous derivation, containing trains of fluid inclusions or small rutile needles.

The cement is quartz, as overgrowths in optical continuity, but grain outlines are clearly seen because of submicroscopic impurities on the surface. The rock is well-indurated and slightly stressed.

### HUR6

Pale, fine detrital sediment. K-stain test positive for some grains.

This is a fine, feldspathic sandstone verging in composition on an arkose; the rock is well laminated, though this is not so obvious in hand specimen.

The framework consists of small (average size = 0.07 - 0.08mm) sub-rounded to rounded quartz grains and subangular cleavage-fragments of microcline and plagioclase; the feldspar content is about 15% (arkoses contain > 25%). The grain size is close to that of a siltstone, and in fact some finer layers are silty. Other minor framework components include chert grains and kaolinite aggregates or small pellets.

Slightly coarser and finer layers alternate; some of the finer layers contain concentrations of heavy minerals, chiefly leucoxene. Occasional thin flakes of muscovite are scattered through the rock, with parallel orientation. Heavy mineral grains are relatively common throughout, and include leucoxene, zircon, tourmaline (green, zoned). Occasional small pellets of pale green ?glauconite are seen; a more positive identification is not possible.

The cement is quartz, in optical continuity with quartz grains; limited goethite-staining occurs in some layers (perhaps representing Fe released from decomposition of oxide opaques - e.g. ilmenite). The provenance of the rock was granitic. No radioactivity was detected, but if present elsewhere in the rock, is probably due to detrital heavy minerals.

### HUR7

Brownish, coarse siliceous sediment. K-stain test positive.

This is a gritty, feldspathic, sandstone, thoroughly cemented and indurated. A distinctive feature is the presence of elongate and thin tabular lithic grains.
Much of the coarser, grit-sized material is lithic: there are tabular masses (with rounded ends) of chert - some containing decomposed carbonate rhombs - and of silica-cemented siltstone, as well as large, rounded grains of microcline and polycrystalline quartz. These are set, rather haphazardly, in sand-size grains of the same components, generally as rounded, more equidimensional grains. Goethite occurs as interstitial material and as pseudomorphs after carbonate rhombs.

The cement is quartz for the most part, with chalcedony in some places, goethite in others. The siltstone fragments are fairly distinctive, containing many heavy mineral grains (leucoxene, tourmaline, zircon opales); these fragments could be related to HUR6 with replacement of detrital feldspar by kaolinite and silica. No radioactivity was detected.

**HUR8**


Although this appears to be a granite, certain features suggest that it may have had a sedimentary origin and may thus be a granitised sediment. Textural relationships are somewhat obscured by fracturing and intergranular alteration.

The composition of the rock is very simple; the only major minerals are microcline and quartz, in approximately equal amounts. Both are stressed and microfractured, occurring as anhedral patches up to 5 - 6mm in size, with interlocking boundaries. The microcline contains inclusions of quartz and sericitised ?plagioclase, and occasional muscovite which appears replacive and of later formation. Interstitial brownish, fine sericite has formed.

There are occasional grains of tourmaline, opaques and ?zircon; these are irregular to rounded in shape and may well be of detrital origin; however, field relationships will probably determine whether this rock is of sedimentary or magmatic origin. Radioactivity was not detected.

**HUR9**

Pale, fine-grained siliceous rock. K-stain test positive.

This is an indurated siltstone with occasional coarser particles, up to small pebbles in size.

The siltstone consists of angular and splintery small quartz grains, and mica flakes, in a matrix/cement of ultrafine clay (kaolinite-illite) and quartz. Occasional small pellets of siltstone occur, representing material formed contemporaneously ('mud-balls') and deposited with the coarser detritus.
Coarser lithic fragments of various rocks are embedded in the siltstone; they include rounded pebbles of fresh biotite granite (quartz, microcline, albite, biotite), and smaller, tabular grains of quartz-muscovite schist, muscovite-metaquartzite, muscovite schist (from a banded, foliated sequence of greenschist-facies metasediments).

The presence of coarse igneous and metamorphic rock fragments, and siltstone pellets, in such a fine rock suggests unstable conditions; the rock may even be of fluvioglacial origin.

**HUR10**

Pale, fine micaceous ?sediment. Strongly positive K-stain.

This rock is believed to be a micaceous arkose; it is however, very well indurated and is quite difficult to distinguish from a quartz-feldspar-mica schist and its origin may have to be resolved from field data.

The major constituents are subangular fragments of quartz and microcline, sericite aggregates (altered plagioclase?) and subparallel muscovite flakes. The quartz and feldspar grains show strain-extinction, the muscovite flakes are buckled and kinked (on a small scale) and there is little doubt that the rock has been compacted, perhaps incipiently metamorphosed. Occasional tourmaline grains are seen.

The rock is cemented partly by fine interstitial sericite, but mainly by contact-cementing (so-called 'welding') of adjacent grains, giving an indurated fabric. There are occasional layers of fine muscovite.

Relict rounded (abraded) outlines are detectable in some grains, and strengthen the interpretation that the rock is essentially a well-compacted sediment, of granitic provenance. No radioactivity was recorded.

**HUR11**

Brown, fine-grained sediment. Faint positive K-stain.

This is a ferruginous, micaceous siltstone, well-cemented and indurated.

The framework consists of silt-size, subangular to subrounded quartz grains and argillised feldspar fragments (feldspar may have been more plentiful originally), small subparallel flakes of muscovite, biotite and chlorite, and irregular grains of goethite of detrital origin. The grains are closely sorted and their long axes are bedded.

The framework grains are coated with thin films of goethite and
cemented with fine interstitial quartz. Heavy mineral grains (apart from goethite) include green tourmaline, zircon and leucoxene.

The sediment was deposited in an oxidising environment, and its source was granitic. No radioactivity was detected.

H.W. Fander, M.Sc.