CONTENTS

A. GENERAL
   REGIONAL GEOLOGY 1
   MINERALIZATION 2
   PREVIOUS WORK 2
   EXPLORATION TARGETS 3

B. WORK COMPLETED
   PHOTOGEOLOGICAL INTERPRETATION 4
   EVALUATION OF PREVIOUS WORK 4
   EXPLORATION PROGRAMME 4

C. REFERENCES 6

FIGURES

FIG.1 LOCATION MAP EL 1235
FIG.2 GEOLOGY OF EL 1235 (1:500,000)

APPENDIX

1. REPORT ON THE SMALL SCALE PHOTOGEOLOGICAL TEST-MAPPING
   OF THE BENMARA AND CALVERT HILLS ELAs (NOS. 1234, 1235)
   N.T. BY R. F. LOXTON HUNTING AND ASSOCIATES; CANBERRA
   DEC. 1976.

2. PHOTOGEOLOGICAL WORK SHEET - ELAs 1234, 1235, N.T. -
   SCALE 1:83,000
ANNUAL REPORT

EXPLORATION LICENCE No. 1235 (BENMARA) N.T.

YEAR ENDED JUNE 17th 1977

Exploration Licence No. 1235 was granted to Mines Administration Pty. Limited for a period of twelve months commencing on June 18th, 1976.

The Licence comprising approximately 420 square miles is located in the Calvert Hills - Mt. Drummond area, approximately 900 kilometres southeast of Darwin in the Northern Territory near the Queensland border. (Fig. 1, Sweet and Slater).

A. GENERAL

Regional Geology

The geology of the area has been mapped by the BMR and is represented on the Mt. Drummond (E53/12) and Calvert Hills (E58/8) 1:250,000 sheets, and on the McArthur River Area 1:500,000 sheet (Fig. 2).

The geology of the area is dominated by the Murphy Tectonic Ridge. The Ridge comprises Lower Proterozoic Murphy Metamorphics which have been intruded by the Nicholson Granite Complex. Co-magmatic Cliffdale Volcanics (not present on EL 1235) overlie older phases of the granite and are intruded by younger high level phases, and their age of about 1770 m.y. defines the base of the Carpentarian System.

In the southern part of the Exploration Licence area, the Murphy Metamorphics are unconformably overlain by volcanic rocks of the Benagerie Beds, which may, in part, be equivalent to the Cliffdale Volcanics. These are in turn unconformably overlain by Adelaidean arenitic sediments - Constance Sandstone, Mullera Formation and Mittiebah Sandstone. The Proterozoic sediments are unconformably overlain by the Lower Cambrian Bukalara Sandstone, which is in turn unconformably overlain by Lower Cretaceous sediments.

In the northern part of the Licence area, the Murphy Metamorphics and Nicholson Granite Complex are unconformably overlain by the Westmoreland Conglomerate, which is in turn overlain by the Bukalara Sandstone and Lower
Cretaceous Sediments.

The main structural features of the area are the north-easterly trending basement ridge of Murphy Metamorphics associated with a gravity high, and strong faulting (Fig. 2).

Mineralization

No uranium mineralization is known on the exploration licence areas (only two previous exploration surveys have been carried out over parts of the area.) However, towards the eastern end of the Murphy Tectonic Ridge, on the Calvert Hills and Westmoreland 1:250,000 sheet areas, a number of significant uranium deposits have been discovered.

The uranium in these deposits is localized in and around faults and shears in volcanics and sandstones of the Cliffdale Volcanics, Westmoreland Conglomerate and Seigal Volcanics. The deposits occur mainly within 300 feet from surface and comprise mostly pitchblende and secondary uranium minerals, with minor sulphides associated with the pitchblende. It is considered by the author, that these deposits were formed by surficial epigenetic processes; the uranium was derived by leaching background uranium content from the granitic and volcanic rocks of the Murphy Tectonic Ridge, transported across the erosional surface by meteoric water or down dip through a suitable aquifer and deposited in favourable structural and chemical environments.

Langford (1974) proposed this type of origin for the uranium deposits of the Northern Territory, and concluded that this genesis could account for the proximity of the Rum Jungle and Alligator Rivers deposits to granitic complexes; the physical connection of the ore to an unconformity and the limited depth of the deposits, the control by fracture zones; the great variation in the habit and kinds of accompanying sulphide minerals when present; and the preference for, but not limitation to, particular types of host rock.

Previous Work

Livingstone (1956, 1957) carried out an airborne scintilllograph survey over a minor part of the northern parts of EL 1235 and ELA 1254 during a survey of the Nicholson River Region. The survey detected an area of anomalous radioactivity in the Murphy Metamorphics on ELA 1234, which warrants close examination.
Noranda (1972) carried out an airborne radiometric survey north of 18°S and east of 137°E covering parts of EL 1235 and ELA 1234. They located and tested an anomaly to the east of ELA 1234 in steeply dipping siltstones and shales of the Murphy Metamorphics. Seven vertical rotary/percussion drill holes totalling 1375 feet were drilled to a maximum depth of 200 feet. Weak uranium mineralization was intersected in three holes, the highest assay was 0.32 lbs U₃O₈/short ton.

Esso Australia Ltd. (1972) carried out a low-level/tightly-spaced airborne radiometric survey over a large part of EL 1235, in conjunction with geological reconnaissance. The programme also included a drill cutting and water sample geochemistry programme from numerous water bores drilled for the pastoral development of the area. They concluded that:

(i) The airborne survey did not locate uranium mineralization but only areas of moderate radioactivity within the volcanic rocks of the Bemmara Beds.

(ii) Geochemical considerations indicate some possibility of sedimentary and/or sandstone type deposits. Geochemical results from 15 water and 10 drill cuttings samples show anomalous uranium content; up to 1500 ppb in water and 36 ppm in cuttings. The anomalous samples come from bores roughly aligned northeast-southwest for a distance of more than 50 miles with the best anomalies lying in a zone 10 miles long near the northwestern part of EL 1235. The northeast trend is parallel to the major regional drainage lines.

Esso carried out no further work on the area.

Recent BMR geochemical surveys over the Murphy Tectonic Ridge in the southeastern quarter of the Calvert Hills sheet area have outlined an area of anomalous uranium in soil and stream sediments associated with an altered high level stock of the Nicholson Granite Complex located near a major northwest trending fault zone.

The discovery is considered significant because it indicates the potential of the granitic rocks as a source of uranium.

**Exploration Targets**

a) Hydrogenic uranium mineralization in the Murphy Metamorphics in lithological favourable zones and in and around dilatent structures, particularly at or near
unconformities with the overlying Benmara Beds and Constance Sandstone.

b) Epigenetic hydrothermal mineralization associated with the Nicholson Granite Complex.

c) Primary disseminated mineralization in high level stocks of the Nicholson Granite Complex.

B. WORK COMPLETED

Photogeological Interpretation

During the year, R.F. Loxton, Hunting and Associates completed a detailed photogeological interpretation of the area for Mines Administration Pty. Limited. A copy of the map and written report is attached (Appendix I).

The preliminary results of the interpretation indicate several important features of the geology on the Minin tenements.

(i) The Murphy Metamorphics are possibly more widespread than indicated by BMR Maps.

(ii) The Murphy Metamorphics appear to be cut by a number of major structural dislocations, which may be considered favourable sites for the formation of uranium deposits.

Following appropriate field checks, the photogeological map will form the basis of all field programmes undertaken in the area.

Evaluation of Previous Work

A thorough evaluation of previous work in the area, particularly that carried out by Esso (CR 73/103) was completed. Esso Australia Ltd. kindly agreed to make all original data from their airborne survey available to Mines Administration. The results of this work are still being evaluated and will be used in the planning of a proposed new airborne geophysics survey for EL 1235.

Exploration Programme

Detailed planning of a programme and budget for the 1977 exploration field season has been completed. The details are as follows:

(i) Geological Mapping. Extensive mapping is planned to verify the photogeological interpretation. Other mapping is planned for areas associated
with airborne geophysics anomalies, and in other areas of specific
geological interest. Most mapping will be initially at 1:84,000 (photo
scale) but detailed mapping at larger scales will also be carried out.

(ii) Ground Radiometric Surveys. Ground radiometric surveys will be carried
out in conjunction with all geological mapping, both as reconnaissance
traverses and on surveyed grids in specific areas.

(iii) Stream Sediment Sampling. An intensive stream sediment geochemical survey
is planned. The specifications for the survey have been based on the
extensive regional stream sediment geochemical survey, recently completed
by the BMR on the Seigal and Hedleys Creek 1:100,000 Sheet areas to the
east of EL 1235.

The surveys will involve several hundred samples, and collection will be
carried out using a helicopter. All samples will be analysed for uranium
and base metals, and some for arsenic and fluorine.

(iv) Detailed investigations will be carried out in areas around airborne
geophysical anomalies and stream sediment geochemical anomalies. The
investigations will comprise gridding, mapping, ground radiometrics, soil
and rock geochemistry surveys.

(v) If warranted, promising prospects resulting from the proposed exploration
programme would be further investigated by percussion and diamond drilling,
down hole logging and assaying. It is anticipated that work of this
nature could commence during the current (1977) field season.

Additional work being considered for inclusion in the proposed exploration programme
includes:

(vi) New data processing, replotting and professional re-interpretation of the
Esso airborne geophysics data.

(vii) New airborne geophysics survey including magnetics and multi-channel gamma-ray
spectrometry over the balance of EL 1235, excluding the area previously
covered by the Esso survey, or alternatively,

(viii) New airborne geophysics survey over the entire area of EL 1235.
C. REFERENCES


5. BMR Explanatory Notes for Calvert Hills, Mt. Drummond, Westmoreland and Lawn Hill 1:250,000 sheet areas.


FIG. 1: LOCATION MAP EL 1235/REGIONAL TECTONIC SETTING

![Diagram of geological map showing various tectonic regions and boundaries.]

Exploration Licence
No. 1235
(see Fig. 2)

- Younger covers
- Adelaidean or Carpentarian platform cover
- Carpentarian to Adelaidean (?) platform cover
- Carpentarian orogenic domain
- Lower Proterozoic to early Carpentarian basement

SCALE
0 50 100 200 300 km

(From Sweet and Slater, 1975)
Fig. 2: Geology of EL 1235
REPORT ON THE SMALL SCALE PHOTOGEOLOGICAL TEST-MAPPING
OF THE BENMARA AND CALVERT HILLS ELA's (Nos. 1234, 1235) N. T.

Undertaken on behalf of

Mines Administration Pty. Limited

December 1976

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GA. 36/76
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>II. AIMS OF THE PROJECT</td>
<td>3</td>
</tr>
<tr>
<td>III. PROCEDURE</td>
<td>4</td>
</tr>
<tr>
<td>IV. REGIONAL GEOLOGY</td>
<td>5</td>
</tr>
<tr>
<td>V. PHOTOGEOLOGICAL RESULTS</td>
<td>7</td>
</tr>
<tr>
<td>A. The Distribution of the Various Lithological Units and their Regional Correlation</td>
<td>7</td>
</tr>
<tr>
<td>1. Basement Rocks</td>
<td>7</td>
</tr>
<tr>
<td>a. The Murphy Metamorphics</td>
<td>7</td>
</tr>
<tr>
<td>b. The Nicholson Granite Complex</td>
<td>8</td>
</tr>
<tr>
<td>2. Cover Rocks</td>
<td>9</td>
</tr>
<tr>
<td>a. The Westmoreland Conglomerate</td>
<td>9</td>
</tr>
<tr>
<td>b. The Benmara Beds</td>
<td>9</td>
</tr>
<tr>
<td>c. The South Nicholson Group</td>
<td>10</td>
</tr>
<tr>
<td>d. The Bukalara Sandstone</td>
<td>11</td>
</tr>
<tr>
<td>e. The Lower Cretaceous</td>
<td>11</td>
</tr>
<tr>
<td>f. Surficial Deposits</td>
<td>11</td>
</tr>
<tr>
<td>B. Structural Features</td>
<td>12</td>
</tr>
<tr>
<td>VI. CONCLUSIONS</td>
<td>14</td>
</tr>
<tr>
<td>REFERENCES</td>
<td></td>
</tr>
<tr>
<td>APPENDIX</td>
<td></td>
</tr>
</tbody>
</table>
I. INTRODUCTION

On behalf of Mines Administration Pty. Limited a photogeological reconnaissance of an area located approximately 180 km south-west of the Gulf of Carpentaria was carried out during December 1976 by M. Coupard of R. F. Loxton, Hunting and Associates. Approximate co-ordinates of the centre of the study-area are longitude 137° east and latitude 18° south.

The study-area is referred to as the "Benmara" project area (Exploration Licences No. 1234 and 1235), and it covers some 1250 km² on the Calvert Hills (SE 53-8) and Drummond (SE 53-12) geological sheets (Scale 1:250 000).

Figure 1 shows the location of the area that was mapped.

Three physiographic regions extend across the areas as follows:

- in the north-eastern part, a series of strike ridges of Westmoreland Conglomerate (300-350m ASL) forms the western extension of the China Wall, a prominent topographic feature which has a nearly vertical scarp that is approximately 40m high.

- in the western part, lateritic cover-rocks, and strike ridges of the South Nicholson Group of rocks (275-330m ASL), form the undulating Barkly Tablelands.

- low undulating hills (230-280m ASL) in the remainder of the study-area, with occasional remnants of the South Nicholson Group of rocks rising to 300m ASL.

The study-area is drained by the Nicholson River, which flows eastwards, but in the area of study it trends in a north-north-west direction. One major tributary, the Buddycurrawa Creek, drains the south-western part of the area and the trend of its course is north-east.
Fig 1. Location Diagram
The study-area has been investigated previously by at least two mining companies, namely, Esso Australia Ltd. and Noranda Australia Ltd. Both companies failed to locate significant uranium mineralisation despite encouraging signs. To date the overall area has been mapped by the Bureau of Mineral Resources on the scale of 1:250 000. No detailed mapping of the study-area has yet been done by the Bureau, but work has commenced farther east, for presentation of maps on the scale of 1:100 000, as part of a systematic program of re-mapping of the Precambrian Rocks in the Carpentaria Province.

The results of the photogeological reconnaissance mapping are incorporated in a final work-sheet map (scale of 1:33 000) which represents the most important outcome of the study. A more specific report will be possible only after the photogeologist has investigated selected photogeological details and relationships in the field, and after this phase has been followed by the usual, routine, re-annotation of the photographs.
II. AIMS OF THE PROJECT

The photogeological project is lithostructurally oriented and the aims can be summarised as follows:

- to determine the distribution of, and the relationship between, the different geological units, with special emphasis on the basement rocks.

- to attempt to recognise, and to trace beneath the cover-rocks, fractures in the basement rocks.

The object of the exercise is to facilitate exploration for uranium ore, using as one model the "Alligator Rivers" region of the Northern Territory.
III. PROCEDURE

A total of 45 black and white photographs on the scale of 1:83 000 were used for the geological interpretation. A Zeiss mirror stereoscope that was equipped with a 6x binocular magnifying head was utilised.

Annotation of photogeological detail was onto a transparent drainage-base that was derived from the photographically enlarged Coanjula and Nicholson River topographic maps. (Original scale 1:100 000). The enlargements were prepared by Mines Administration P'y. Limited. The effects of variations in the scale of the drainage-bases and some of the photographs have been minimised where possible.

LANDSAT scenes (scale 1:1 000 000) which covered the whole Westmoreland region were observed very briefly in order to afford an overview of the surrounding areas.

One coloured version of the photogeological work-sheet map accompanies this report. Although the map represents the final outcome of the present study it should be considered to be a provisional map owing to the need for photogeological revision of some of the detail, after field-work by the writer.

* 80 per cent overlap
IV. REGIONAL GEOLOGY

Comprehensive reviews of the geology and stratigraphy in the Westmoreland Region have been given by Clavarino (1976) and Sweet and Slater (1976). Only a brief resume will be given here.

The study-area is underlain by Lower Proterozoic to Early Carpentarian schist, slate and gneiss (Murphy Metamorphics) which have been intruded by various granites (Nicholson Granite Complex). Acid volcanic rocks (Cliffdale Volcanics), that are probably coeval with granite-emplacement, are known to exist to the east, in the vicinity of the Pandanus Uranium Mine, but they have not been recognised within the area.

The Murphy Metamorphics form a basement inlier along the east-west-trending block known as the Murphy Tectonic Ridge. During the Carpentarian this ridge formed a topographic barrier between the McArthur Basin (in the north) and the South Nicholson Basin (in the south) (Metallogenic Map of Australia and Papua New Guinea, 1972).

The basement rocks are overlain unconformably by sedimentary and volcanic rocks of Carpentarian age. The correlation of these formations across the Murphy Tectonic Ridge is uncertain because of variations in thickness and lithology.

North of the Murphy Tectonic Ridge is the Westmoreland Conglomerate which is the basal unit of the Tawallah Group and the oldest Carpentarian formation that is preserved in the area. It is exposed best in the northeastern part of the study-area. The Peters Creek Volcanics, mapped farther to the east by the Bureau of Mineral Resources (1962), are apparently not exposed in the study-area.

South of the Murphy Ridge, another Carpentarian sedimentary and volcanic sequence has been mapped recently as the "Tawallah Group equivalents"
(Sweet et al, 1975). The "Benmara Beds" overlie the basement unconformably and they have been correlated with the upper part of the Tawallah Group (Smith, 1963).

Overlying the Tawallah Group unconformably is a sequence of clastic sediments of Carpentarian or Adelaidean age (South Nicholson Group), which has been divided into four units during previous geological mapping.

Lower Cambrian areniteic sediments, which constitute the Bukalara Sandstone, were deposited unconformably on the Carpentarian formations both north and south of the Murphy Tectonic Ridge.

All of the above-mentioned rock units are overlain unconformably by arenaceous sedimentary rocks of Lower Cretaceous age, which now form small mesas.

Cainozoic sediments are widespread and they cover about half of the study-area. They include laterite, sandy soil, black-soil and recent alluvium.
V. PHOTOGEOLOGICAL RESULTS

A. The Distribution of the Various Lithological Units and their Regional Correlation

The photogeological reconnaissance in the Benmara area has resulted in the differentiation of several lithological units. Their respective distributions differ only slightly from that shown in the existing 1:250 000 geological map, but considerably more structural detail is displayed in the photogeological map.

1. Basement Rocks

The small scale and the panchromatic nature of the photographs, when allied with the extensive cover of soil in the study-area, placed severe restrictions on the detailed differentiation of the basement rocks, in particular the metamorphic horizons. Field-work in conjunction with the stereoscopic study of low level photography (particularly colour photography) would definitely facilitate, and improve on, the lithological differentiation of various rock units throughout the area of interest.

The basement rocks have been divided into two units:

a. The Murphy Metamorphics. - The north-eastern and central parts of the area are occupied by a north-easterly trending belt (up to 7 km wide) of rocks which are correlated with the Murphy Metamorphics.

On the aerial photographs the identification of these rocks was motivated by their dark tone, a few light bands, a finely developed foliation, (vertical, or dipping steeply to the north-west) and by their topographic expression in the form of low rises. A "dendritic-angular" rather than a normal dendritic pattern of drainage is associated with the metamorphic rocks. Apart from a few good exposures in the extreme north-eastern part of the study-area, and also in the area between the Benmara Fault and the Little Pandanus Creek,
the metamorphic rocks are exposed very poorly. The existence of the Murphy Metamorphics in the southern part of the area is by inference only.

The lithotypes reported by Noranda Australia Ltd. to be present near their drilled radioactive anomaly, Number 30, comprise a varying succession of sandy-siltstones, siltstones, and shales, with subordinate chloritic horizons. The photogeological evidence indicates that similar horizons may exist south of the Benmara Fault, along an east-north-east-trending belt 2,5 km wide, about 8 km west of the Black Waterhole on the Nicholson River.

The relationships that were mapped under the stereoscope between the Murphy Metamorphics and the Nicholson Granite Complex were actually inferred on the basis of subtle variations in tones and textures, because extensive soil-cover straddles the contact. Faulting along south-easterly and north-easterly trends appears to have controlled the contact between the two formations in certain places. No direct evidence of contact-metamorphism was recognised, but this should not be interpreted as a negation of its existence.

b. The Nicholson Granite Complex - Most of the northern part of the study-area is occupied by granitic rocks which have been recognised on the aerial photographs on the basis of tones, textures and patterns. In the areas of good exposure, in the north, the main criteria of recognition were the fine dendritic drainage, the light-toned soil halo that surrounds individual outcrops, the occasional bouldery nature of the outcrops, and the knobblly topography. Many individual outcrops do not exceed 0.3 km in diameter, but they were identified confidently in a general sense, notwithstanding the small scale of the prints and the diminutive size of each outcrop under the stereoscope.

East of the study-area, on the Seigal geological map-sheet (scale 1:100 000), nine lithological phases have been recognised in the equivalent igneous unit (Sweet et al, 1975). This breakdown includes adamellite, granite, muscovite-granite, and dyke variants. The photogeological mapping, using the high-flown, small-scale panchromatic photographs is, however, very limited as regards
the distinction of sub-phases within the Nicholson Granitic Complex. A few circular features were recognised on the photographs in the south-western part of the area, but the degree of confidence is too low to allow a decision whether or not they reflect high-level granitic stocks. In the northern and western parts of the area numerous quartz veins have trends which range between east-south-east and south-east. Inclusions of metamorphics rocks in the granite, mapped here, may in fact be only highly fractured granite.

2. Cover Rocks

a. The Westmoreland Conglomerate. - The rocks in the north-eastern part of the study-area are correlated with the Westmoreland Conglomerate, which is the basal unit of the Tawallah Group. The unit corresponds with rugged topography and it is characterised by deeply dissected valleys and strike ridges. The lithotypes appear to be fairly uniform and they impart on the aerial photographs a light tone and a very coarse texture. The Westmoreland Conglomerate rests on the basement rocks unconformably. An arcuate south-east-trending fault, 35 km long, appears to postdate the unconformity. The general strike of the beds varies in the range east to east-south-east, and the dips are gentle and towards the north-east. Open folds with axes which follow a south-east trend, are possibly a consequence of the faulting that took place along the same general trend. Transcurrent movement is indicated by the displacement of a small dyke of basic rock which penetrates the Westmoreland Conglomerate about 18.5 km due north of the Black Waterhole. It is interesting to note that the geological environment that exists here is similar to that at the Redtree Joint Zone (Hills et al., 1975), farther east.

b. The Benmara Beds. - In the southern part of the study-area, small exposures of interbedded (?)tuffaceous) sediments, and light- to medium-toned "plugs" of finely fractured rocks are correlated with the Benmara Beds. Farther north, away from the main exposures of these beds, a light-toned bed which dips gently to the south-west rests unconformably on the Murphy
Metamorphics. This bed has been included with the Benmara Beds on the basis of textural similarities. It was previously mapped by the Bureau of Mineral Resources (1963) as Constance Sandstone and field-work is needed to solve the discrepancy.

The Benmara Beds are regarded as broad equivalents of the upper part of the Tawallah Group (Smith, 1963), largely because of similar lithotypes, and similar structural relationships relative to the Gold Creek Volcanic Member of the Masterton Formation in the Calvert Hills geological sheet.

c. The South Nicholson Group. - In the southern part of the study-area the Murphy Tectonic Ridge appears to have been covered progressively by clastic sediments which rest unconformably on the metamorphic rocks and which have been divided into three units. Dips are opposed on either side of the Murphy Tectonic Ridge and gentle folding appears to be a characteristic structural feature of these rocks, which have strikes which trend north-east.

The gently undulating Constance Sandstone at the base of the Group forms a plateau, which has on its upper surface a medium to dark tone and a fine texture with no drainage. On the scarp, however, the tone is light. The formation lies unconformably on the Murphy Metamorphics and the Benmara Beds. About 4 kilometers north of the Black Waterhole is a small ridge of light-toned sandstone, about 100m wide, which has been previously correlated with the Pandanus Siltstone Member. However faulting in this area suggests that it may be a down-thrown block of Constance Sandstone.

The Mullera Formation forms extensive outcrops in the south-western part of the study-area. The best exposures are located 18 km south of the Benmara Homestead. Here soft sediments with a dark tone (shale and siltstone) alternate with more resistant members (sandstone).

Fourteen kilometres southeast of Benmara Homestead, the contact between the Mullera Formation and the underlying Constance Sandstone is
seen (on the photographs) to be conformable. Elsewhere in the southern part of the study-area lateritic soil masks the contact and the relationship.

The Mittiebah Sandstone rests conformably on the Mullera Formation. It has been used as a marker horizon because of its characteristic photo-expression, which is not unlike that of the Westmoreland Conglomerate, and which contrasts strongly with the underlying formation.

d. **The Bukalara Sandstone.** - In the north and south of the study-area a sandstone unit forms a strongly jointed plateau which has a light tone. It is easily mapped where no soil cover exists and it has been correlated with the Lower Cambrian (?) Bukalara Sandstone.

e. **The Lower Cretaceous.** - Light-toned, flat-lying strata overlie, predominantly, the Westmoreland Conglomerate in the north-eastern part of the area, and the Mullera Formation in the south. The sequence is correlated tentatively with a siltstone and sandstone series of Lower Cretaceous age, as mapped by geologists of the Bureau of Mineral Resources.

f. **Surficial Deposits.** - Extensive laterite cover (Cz1) imparts a very dark tone on the aerial photographs. The laterite forms a plateau with a strong escarpment overlooking the granites in the western part of the area. The laterite may have formed on Lower Cretaceous sediments. Small mesas of laterite occasionally cap the Nicholson Granite Complex. Extensive areas of light-coloured soil have been mapped as "Czs" and recent alluvium "Qa". Of interest is the reflection of structural features through the surficial deposits. While it is possible, in this particular instance, to map linear features through laterite, it is far more difficult to do so through soil-cover; possibly because of the transported nature of the latter.
B. Structural Features

The photogeological reconnaissance reveals effects of a number of tectonic events within the study-area. The drainage pattern was used as a guide during the photogeological study and it was found to be mostly controlled by structure. The main, and the oldest, tectono-thermal event appears to have taken place during the Lower Proterozoic, although no detailed age dating is available. It preceded the intrusion of the younger phases of the Nicholson Granite Complex and the extrusion of the Cliffdale Volcanics. The latter unit has been isotopically dated at 1700 +/- 20 m.y. (Sweet et al, 1975).

During the course of this tectono-thermal event, the suite of rocks that is now represented by the Murphy Metamorphics was folded isoclinally and it was metamorphosed to greenschist facies. Intrusive activity followed, and it was possibly coeval with the uplift which produced the Murphy Tectonic Ridge. The latter remained a basement high throughout most of the Proterozoic, and it exerted a strong (barrier-type) influence in the deposition of the cover rocks.

The photogeological evidence reveals that at least three stages of deformation postdate both the basement and the cover rocks. The earliest produced gentle folds which trend north-east (030°-040°), parallel to the Murphy Tectonic Ridge. A large structural dome which affects the Constance Sandstone, as exposed in the southern part of the area, probably belongs to this period. Associated faulting and fracturing is indicated by numerous lineaments, which are common in the central and southern parts of the study-area. No relative movements have been measured, but in a general sense, effects of faulting appears to decrease upwards, i.e. the younger Proterozoic sediments are disturbed to a lesser degree than the older sediments.

The second apparent stage of deformation produced east-north-east-trending faults (070°-080°). The Benmara Fault belongs to this period, and it is occupied by a prominent quartz vein, and by a dyke of basic rock,
18.5 km north of the Black Waterhole. Other, subordinate, tension faults with similar trend are present in the Mittiebah Sandstone 12 km south of the Benmara Homestead.

The third stage of deformation generated, mostly, south-east-trending (130°) fractures and some gentle folding. The most prominent jointing, observed in the Bukalara Sandstone, is correlated with this phase. In the northern part of the study-area are strongly silicified fractures (quartz veins) up to 8 km in length. The dyke of basic rock that was mentioned above belongs to the second deformational phase and it is transected by a smaller dyke that is related to the third phase of deformation. A lateral displacement of 0.4 km is indicated.
VI. CONCLUSIONS

The photogeological reconnaissance mapping of the Benmara and Calvert Hills Exploration Licences in the Westmoreland Region, Northern Territory, has led to the recognition of a number of lithological units and deformational episodes.

The basement rocks have been mapped as undifferentiated metamorphics, and granite, whilst the cover-rocks were divided into six units.

The mapping on the scale of 1:83 000 generally confirms the existing regional mapping (scale 1:250 000), but it includes significant modifications. Field-checking should be carried out to confirm the stereoscopic identification of the lithological units. The stereoscopic study of large scale colour photography (e.g. 1:25 000) combined with field-work would allow the most satisfactory appraisal of the area, and the step is especially recommended for the lithological differentiation of the basement rocks.

The uranium potential of the area is considered to be favourable in relation to the Alligator Rivers Region model. Uranium source-rocks may lie within the Nicholson Granite Complex, the Clifftdale Volcanics or the Benmara Beds, and uranium could conceivably have been leached and deposited in favourable structural and lithological zones within the Murphy Metamorphics.

South of the Benmara Fault, the Murphy Metamorphics contain shaly horizons which are regarded as being potentially favourable host rocks for uranium. The recognition of similar horizons was attempted elsewhere, but the attempt failed because of the small scale of the photographs.

Tensational structures include the north-west, north-east, and east-north-east trending faults as shown on the photogeological map. These may have been channelways for mineralising solutions, as well as sites of deposition of uranium minerals.
North of Noranda's "Anomaly 30", the photogeological mapping reveals a lithological similarity with the Redtree Joint Zone, where uranium minerals occur in an altered basic dyke in the Westmoreland Conglomerate.

Throughout the area, the creeks, especially when traversing the Murphy Metamorphics south and south-east of the Benmara Homestead, appear to contain some calcrete. Such bodies of calcrete could be mineralised with uranium, but individually they would be of limited extent and interest.
REFERENCES


LIST OF AERIAL PHOTOGRAPHS USED

Black and white photographs on the scale of 1:83 000

Source: Division of National Mapping

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