EXPLORATION LICENCE NO. 244

NORTHERN TERRITORY

ANNUAL REPORT

YEAR ENDING 31 DECEMBER 1972

SUBMITTED BY

QUEENSLAND MINES LIMITED
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INTRODUCTION

The 1972 year has involved a major reassessment of all known data, pertaining to this Licence area, which was collected in previous years.

The systematic assembly of this data has enabled data gaps to be defined and has provided a feeling for the depth of exploration coverage achieved in past years.

A re-evaluation of the area has been made in light of the depth of knowledge acquired concerning the uranium mineralisation at Nabarlek. Comparisons have been made of the geology of the area with that at Nabarlek where uranium mineralisation is known.

Certain favourable features in common with Nabarlek are present within this Exploration Licence. Those areas containing such favourable features will be assigned a high priority and will be subjected to more intensive investigation.

TENEMENT

EL 244 was granted for a period of approximately 9 months from 17 March 1972 until 31 December 1972, and previously formed part of AP 2046 which expired in 1971.

The Licence comprises an area of approximately 970 sq. km.

OBJECTS OF EXPLORATION

The objects of the 1972 exploration programme were to

(1) Reappraise and reinterpret the results of the previous extensive exploration work carried out.

(2) Represent the data that was judged to be reliable in a form which could be readily utilised and convert data to metric units and scales

(3) Identify the gaps in the data previously collected.

(4) Redesign the exploration work to fill the necessary gaps and test those areas judged as being favourable for ore occurrence.

(5) Execute the redesigned programme.
WORK COMPLETED

A complete reappraisal of existing data relating to EL 244 was undertaken during 1972. Limited field inspections were carried out in the southern section of the Licence to ground confirm interpreted geological features; to check on some geological mapping undertaken in past years; to collect samples of granite for this section analysis; and to inspect the Beatrice uranium occurrence.

New geological maps were compiled on standard sized sheets using metric scales and incorporated previously mapped geology and geology interpreted from old black and white serial photos. In compiling the geological maps it was apparent that the regional geology was inadequately known. In an effort to obtain more detailed and more reliable geological base maps a contractor was engaged to provide aerial colour photograph coverage of the entire area. This colour photography together with existing maps and geophysical information is presently being used by consultants in Denver U.S.A. to produce new geological base maps of the area. The new maps will be provided on a scale of 1:25,000.

Although the Company had airborne magnetometer coverage of the area undertaken in 1970, this information was only available in the form of raw data and was of little use in that form. A contractor, Hunting Geology and Geophysics Ltd, was engaged during 1972 to reduce the data and produce the results in contour form. Contour maps are presented as overlays to the geological maps.

The initial qualitative interpretation of the analogue radiometric data suggested that most anomalies related to volcanic members of the Kombolgie Formation, and were therefore of low priority. Detailed interpretation of all data was therefore not considered justified, and only selected anomalies have been digitised. Plotting and contouring of this data will be undertaken on receipt of the 1:25,000 geological base maps.

EXPENDITURE STATEMENT

In the year ending 31 December 1972, a total of $90,625 was spent on exploration within EL 244.

SUMMARY OF PRESENT EXPLORATION SITUATION

EL 244 comprising some 970 sq. km. contains two large areas where potential host rocks to uranium orebodies are known and are not covered by the thick Kombolgie sandstone which covers the major portion of the area. New, more detailed geological maps of the Licence area will be shortly available and these will fulfill an important function in future exploration.
The areas not covered by sandstone are of prime interest since uranium mineralisation is already known at one location (Beatrice). In addition, the area has certain geological features in common with the Nabarlek area.

Additional field data is required as to detailed local geology; so geochemical prospecting has yet been undertaken; certain radiometric anomalies arising from recent interpretations are yet to be investigated.

The airborne radiometric results and aeromagnetic contour maps cover the entire Licence area.

**FUTURE EXPLORATION**

A detailed exploration programme has been designed for 1973. The programme is broadly divisible into two sections. The first section relates to regional work and will involve photogeological studies presently being carried out in Denver U.S.A., resulting in production of new geological maps; photogeological field mapping of selected areas to confirm interpreted geological areas of interest and mapping of areas where radiometric and/or geochemical anomalies are indicated. Stream sediment geochemical survey coverage is planned for those areas not covered by Kombalgie sandstone. Areas selected for more detailed mapping will not only be based on known or interpreted geology but also where reinterpretation of the radiometric data shows radiometric anomalies to be present. The broad object of this regional work is to collect sufficient data on which to classify the whole area into favourable and unfavourable zones, bearing in mind that the Company is required to relinquish fifty percent of the total area by 31 December 1973.

The regional work in addition to indicating broad favourable areas is expected to identify more specific local targets which will be subjected to detailed follow-up investigations.

Side by side with the regional investigations detailed exploration, forming the second aspect of the programme, will be carried out over targets already identified as being of interest. This work will involve the layout of grids, detailed geological mapping, ground radiometric and magnetometric surveys, radon surveys and soil geochemical surveys. If the results of this detailed surface work indicate drilling targets a programme of percussion drilling will follow.

The broad policy of the Company is to accumulate as much surface information as possible in 1973 and by the end of the year have identified a number of drilling targets. It is envisaged that the 1974 programme will involve a considerable amount of drilling, the full extent of such drilling will not, of course, be known until the end of 1973.
PROPOSED EXPENDITURE

It is proposed to spend $90,000 on exploration within EL 244 during the year ending 31 December 1973.
LIST OF MAPS AND ENCLOSURES

LIST OF MAPS IN APPENDIX II

<table>
<thead>
<tr>
<th>Enclosure No.</th>
<th>Title</th>
<th>Scale</th>
<th>Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regional Geology</td>
<td>1:50,000</td>
<td>Beatrice</td>
</tr>
<tr>
<td>2 &amp; 3</td>
<td>Airborne Radiometric Survey</td>
<td>1:50,000</td>
<td>Beatrice</td>
</tr>
<tr>
<td>4 &amp; 5</td>
<td>Airborne Magnetic Survey</td>
<td>1:50,000</td>
<td>Beatrice East</td>
</tr>
<tr>
<td>6</td>
<td>AV-4 Flight Lines, Helicopter Radiometric Survey</td>
<td>1:50,000</td>
<td>Beatrice</td>
</tr>
<tr>
<td>7-9</td>
<td>Airborne Radiometric Survey</td>
<td>1:25,000</td>
<td>Beatrice A</td>
</tr>
<tr>
<td></td>
<td>Interpretation Maps (Preliminary)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>corrected Uranium, corrected Thorium,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and corrected Uranium/corrected Thorium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LIST OF TECHNICAL REPORTS IN APPENDIX III

Report No.

1. Reduction and Interpretation of Airborne Radiometric Survey, Arnhem Land -

2. AV-4 Helicopter Spectrometer Survey -
REDUCTION AND INTERPRETATION
OF AIRBORNE RADIOMETRIC SURVEY,
ARNHEM LAND

M.L. FALVEY

QUEENSLAND MINES LIMITED

MARCH, 1973
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**INTRODUCTION**

During 1970 an airborne gamma ray and magnetic survey was flown over the Queensland Mines Arnhem Land leases (then AP 2046 & AP 2221), resulting directly in the discovery of the Nabarlek uranium deposit. The radiometric survey was designed to delineate regions of anomalous radioactivity, and to discriminate between uranium, thorium, and potassium sources. The magnetic survey was designed to provide background regional information.

A preliminary interpretation of the data was carried out by the contractor. This interpretation was considered inadequate, and a detailed interpretation was commenced in September, 1972.

**SURVEY STATISTICS**

Contractor: Hunting Geology & Geophysics Ltd.
Date of Survey: April – June 1970
Aircraft: DC-3
Airspeed: 220 km/hour (120 knots)
Altitude: 120 metres (400 ft) above ground level
Altitude Control: Radar Altimeter
Flight lines: Lines flown N-S on approximately 1/2 km (1/2 mile) and 0.8 km (1/2 mile) spacing
Tie lines: Lines flown E-W on approximately 30 km (20 miles) spacing
Navigation: Visual, based on 1:25,000, and 1:50,000 airphoto mosaics.

**SPECTROMETER**

The survey was flown using a four-channel differential spectrometer manufactured by Nuclear Enterprises Ltd. (NE-8420), and utilising two 6 x 4 inch thallium-activated sodium iodide detector crystals. During surveying, a time constant of 2.5 seconds was used.

Four energy channels were selected:

<table>
<thead>
<tr>
<th>Channel</th>
<th>Energy Band</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.20 – 2.90 MeV</td>
<td>'Total' count rate</td>
</tr>
<tr>
<td>2</td>
<td>1.35 – 1.65 MeV</td>
<td>40K – peak at 1.46 MeV</td>
</tr>
<tr>
<td>3</td>
<td>1.65 – 2.30 MeV</td>
<td>214Bi (U series) – peak at 1.76 MeV</td>
</tr>
<tr>
<td>4</td>
<td>2.30 – 2.90 MeV</td>
<td>208Tl (Th series) – peak at 2.62 MeV</td>
</tr>
</tbody>
</table>
The outputs from the 4 channels of the spectrometer and from the radar altimeter, were recorded as continuous analogue profiles. The data was related to ground features by a fiducial marking system, automatically synchronised with the shutter operation of a vertically mounted tracking camera.

The spectrometer response to any radioelement will depend on channel width and position. For the settings used during this survey, a potassium source will affect only Channel 1 (Total) and Channel 2 (K). A uranium source will affect Channel 1, Channel 2, and Channel 3 (U), and a thorium source will affect all 4 channels. The relative energy levels in channels 2, 3 and 4 for various sources are given below.

<table>
<thead>
<tr>
<th>Source</th>
<th>Channel 2 (K): Channel 3 (U): Channel 4 (Th)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium</td>
<td>100 : 0 : 0</td>
</tr>
<tr>
<td>Uranium</td>
<td>48 : 48 : 4</td>
</tr>
<tr>
<td>Thorium</td>
<td>20 : 40 : 40</td>
</tr>
</tbody>
</table>

REDUCTION OF DATA

The radiometric field measured above the earths surface comprises the following:

1. Regional background - non-geological, originating from cosmic and atmospheric sources.

2. Local background - geological, originating from an extensive rock unit with uniform radioelement concentrations.

3. Signal - originating from local anomalous radioelement concentrations.

In order to determine the contribution of individual radioelements to each channel, corrections must be made for background radiation, and for injection of energy from other radioelements. Equations for these corrections are:

\[ \text{Th p.p.m.} \quad N_{\text{Th corr.}} = N_{\text{Th}} - BGD_{\text{Th}} \]
\[ \text{U p.p.m.} \quad N_{\text{U corr.}} = N_{\text{U}} - BGD_{\text{U}} - k_1 N_{\text{Th corr.}} \]
\[ \text{K p.p.m.} \quad N_{\text{K corr.}} = N_{\text{K}} - BGD_{\text{K}} - k_2 N_{\text{Th corr.}} - k_3 N_{\text{U corr.}} \]

Where Th ppm, U ppm, K ppm are radioelement concentrations

\[ N_{\text{Th}}, N_{\text{U}}, N_{\text{K}} \] are observed count rates

\[ BGD_{\text{Th}}, BGD_{\text{U}}, BGD_{\text{K}} \] are background count rates

\[ k_1, k_2, k_3 \] are constants dependent on window settings utilised.
For the window settings used during this survey $k_1 = 1$ so that:

$$N_U \text{ corr.} = N_U - BGD_U - (N_{Th} - BGD_{Th})$$

For exact analysis of the source of an individual anomaly, it is necessary to use local background. However this is not a realistic basis for the reduction of an entire survey, and a regional background has therefore been used.

The radiometric field recorded over The Kombolgie Sandstone is generally smooth, with few anomalies originating from geological sources. This general level has been taken as regional background and used for the reduction of data. The amplitude of this 'background' is determined separately for each line and for each channel, thus removing the effects of variations in cosmic and atmospheric radiation, and also in calibration of the instrument. Background radiation level on the various channels was found to vary sympathetically, so that the value of, for example, $BGD_U - BGD_{Th}$ remained at about 12 counts per second.

PRESENTATION OF DATA

The radiometric data is digitized at intervals of 5 fiducials, equivalent to 7.5 seconds flying time, or approximately .4 Km (¼ mile) line distance. The corrected data is then plotted directly onto the flight line plan, and forms an irregular .4 Km (¼ mile) grid. Three separate contour plans are produced - corrected uranium, corrected thorium, and the ratio of corrected uranium to corrected thorium.

Corrected Uranium: This plan reflects changes in the relative concentration of uranium in surface rocks, and is particularly useful in the delineation of anomalous concentrations of uranium. It is, unfortunately, greatly affected by variations in altitude*, and may contain uranium 'highs', directly produced by topographic highs.

Corrected Thorium: This plan reflects changes in the relative concentrations of thorium in the surface rocks, and is particularly useful understanding the regional geology. It is unfortunately greatly affected by variations in altitude*.

*NOTE: For a mean height of 120 metres (400 ft) an altitude variation of ±30 metres (100 ft) would produce a variation in measured gamma ray intensity of ±20% within the range 1.4 to 2.9 MeV, assuming an infinite slab source. For a small source the effect is significantly greater, reaching about 60% for an assumed source diameter of 8 metres.
Uranium/Thorium ratio: This plan has the advantage of almost totally removing the effects of altitude variations and also emphasises concentrations of uranium with respect to thorium.
AV-4 HELICOPTER SPECTROMETER SURVEY

Survey: Integral Spectrometer Survey of AP 2046 and AP 2221.

Date: Commencing March. 1971.

Flight Line Spacing: AP 2046 - in regions where Hunting survey located anomaly clusters, 500 ft. or greater.
- in all other regions of Myra Falls metamorphics, 1000 ft. or greater.
- Where navigation was difficult due to absence of significant physiographic features minimum spacings were not achieved, and spacings therefore averaged 600 ft. and 1000 ft.

AP 2221 - Reconnaissance traverses in northern portion only.

Flight Direction: Various, determined from availability of navigation points, wind direction, and wind speed. On high wind days, direction was parallel to wind to minimise drift.

Tie Lines: None.

Flight Height: 200 constant terrain clearance variation – + 25 ft. (normal) to + 50 ft. (v. rough topography). Additional errors – 300 ft. from start and finish of each line, errors of up to +75' (ie. 275 terrain clearance) may occur.

Survey Air Speed: Indicated instrument airspeed – 60 knots. (This is minimum speed for which Alouette II can achieve autorotation recovery, at a height of 200 ft.

Helicopter: Alouette II

Navigation: Visual; based on airphoto mosaics. Survey lines were plotted, in blue pencil on the airphotos prior to survey.

Flight Path Recovery: During flight navigation, points are marked on mosaics, in red pencil by Navigator. Fiducial numbers are marked on the navigation point, and also on all chart records.

Altimeter: Radar, calibrated prior to every sortie using the "instant hole."
Spectrometer: McPhar Geophysics AV-4

Detector: 4" x 5" NaI (Tl) crystal

Volume - approximately 80 cu. in.

Type: Integral, 4 channel.

<table>
<thead>
<tr>
<th>Channel</th>
<th>Energy Range</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.2 to 2.8 MeV</td>
<td>Total</td>
</tr>
<tr>
<td>2</td>
<td>1.3 to 2.8 MeV</td>
<td>(Th + U + K)</td>
</tr>
<tr>
<td>3</td>
<td>1.65 to 2.8 MeV</td>
<td>(Th + U)</td>
</tr>
<tr>
<td>4</td>
<td>2.5 to 2.8 MeV</td>
<td>(Th)</td>
</tr>
</tbody>
</table>

Time Constants: Determined prior to entire survey, and maintained throughout. Values used not available.

Calibration: Automatic calibration using Americium source.

Automatic temperature compensation above 60°F. This may be worked manually if desired.

Counting Rates: Noted on charts.

Weather Conditions: Not recorded.