PROSPECTING AUTHORITY NO. 1966
BLUE MUD BAY, NORTHERN TERRITORY
REPORT FOR YEAR ENDED JUNE 10, 1970.

Report No. 138
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By
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C. P. DUNLOP
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SUMMARY

1. A ground follow up programme of nine anomalies delineated from an airborne spectrometer survey by Geophysical Resources Development has been completed.

2. No economic uranium mineralisation has been located.

3. Anomalous radioactivity is due to thorium concentrations with minor associated uranium.

4. Thorium and uranium concentrations are related to acid volcanics, granites, laterites and minor fault types.

5. It is considered that no further work is warranted for Prospecting Authority 1966 and that it should be relinquished.
BLUE MUD BAY AND ISLANDS

1. INTRODUCTION

1.1 Location

Prospecting Authority 1966 is situated on the east coast of Arnhem Land N.T. It consists of an area in the mainland to the west of Grindall Bay, and also several islands in Blue Mud Bay including Bickerton, Burney, Bustard, Connexion, Fowler, Hawknest, Morgan, Nicol and Woodah. The area covers a total of 160 square miles. There are no permanent settlements, the closest being at Groote Eylandt about 12 miles east of Bickerton Island and at Gove about 85 miles north of Grindall Bay. There is a bush track connecting Grindall Bay with the track from Mainorou to Gove and there is another track on Bickerton Island. Access to the remainder of the area is by sea or helicopter.

1.2 Physiography

The mainland area consists of a coastal plain characterised by sand dunes on the west, the north-east and central east coastlines, a laterite plateau in the north and a basement peninsula in the south. The peninsula is one mile wide and extends six miles in a north-south direction. It has steep cliffs to the sea on the eastern side. The laterite plateau is dissected by seasonal streams flowing to the east.

In general the islands consist of a core of Proterozoic rocks around which sand deposits have formed. Where the Proterozoic rocks are exposed along the coastline they form strong resistant cliffs e.g. the north-west edge of Bickerton Island and on Bustard Island. Extensive areas of the Proterozoic rocks are capped by laterite. Bays and spits form ideal areas for sand accumulations and the best examples of this occur on Isle Woodah.

The basement rocks of the area fall within the physiographic division of the Gulf Tall described by Plumb and Roberts 1965 as "dissected hilly country with moderate to strong relief". 
The climate throughout the area is monsoonal - characterised by distinct wet and dry seasons. During the wet season (from approximately late November to early May) the prevailing winds are from the northwest and temperature, humidity and rainfall are high. About 40 to 45 inches of the total 50 to 55 inches annual rainfall, fall during this period. The dry season is characterised by southeast winds and relatively little rain. Temperatures in the area range from maximum 98 degrees in December to minimum 60 degrees in August.

Vegetation in the area varies from open semi-dense eucalypt forest typical of the Arnhem Land mainland to low scrub vegetation on the islands. Open forest areas occur west of Grindall Bay particularly in the laterite areas to the north and on the western side of the peninsula. The central areas of the islands are also covered by forest. The predominant eucalypts are stringy bark and woolly butt and stands of cyprus pine also occur. On the sandy coastal areas however the vegetation is modified by coastal factors. Low dense scrub occurs on sandhills on Isle Woodah, Morgan Island and Round Hill Island. It is also well developed near the camp area on Grindall Bay. Further from the sea behind the low scrub the vegetation changes to taller shrubs and bushes before eventually merging into forests.
2. WORK CONTENT

2.1 Preliminary Selection of Area

Prospecting Authority 1966 was chosen as suitable for uranium exploration because the mid Proterozoic rocks found in the area are time equivalents of the sequence in the Westmoreland area of western Queensland and are also similar in lithology. In 1965 secondary uranium mineralisation was recorded in coarse grained felspathic sandstones towards the top of the Westmoreland Conglomerate. It was hoped that the Groote Eylandt Beds in Prospecting Authority 1966 might prove to be a similar source. Noranda Australia Limited was granted Prospecting Authority 1966 on 11th June 1968.

2.2 Airborne Spectrometer Survey

Geophysical Resources Development contracted to conduct an airborne spectrometer survey over this area in conjunction with Prospecting Authority 1967. They used a Nuclear Enterprises Mark XII Spectrometer and flew at a mean terrain clearance of 300 feet. Traverses were flown approximately perpendicular to the strike and 1000 feet apart.

The results were presented in the form of radiometric contour maps of the uranium channel and profiles of the total, uranium, thorium and potassium 40 radiation. Geophysical Resources Development examined these results and selected nine anomalies which they considered were due to varying concentrations of uranium mineralisation. To each of these they accorded priority 1, 2 or 3 depending on their relative importance.
<table>
<thead>
<tr>
<th>Anomaly</th>
<th>Order</th>
<th>Location</th>
<th>Traverse</th>
<th>Suspected Rock Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB 1</td>
<td>2</td>
<td>Blue Mud Bay</td>
<td>40A</td>
<td>Grindall metamorphics</td>
</tr>
<tr>
<td>RH 1</td>
<td>1</td>
<td>Round Hill Is.</td>
<td>2-3</td>
<td>Bickerton volcanics and Grindall Metamorphics</td>
</tr>
<tr>
<td>D 1</td>
<td>3</td>
<td>Isle Woodah</td>
<td>36</td>
<td>Groote Eylandt Beds</td>
</tr>
<tr>
<td>D 2</td>
<td>3</td>
<td>&quot;</td>
<td>2-3</td>
<td>&quot;</td>
</tr>
<tr>
<td>C 1</td>
<td>2</td>
<td>Morgan Is.</td>
<td>33</td>
<td>&quot;</td>
</tr>
<tr>
<td>C 2</td>
<td>2</td>
<td>&quot;</td>
<td>39, 41</td>
<td>Grindall metamorphics</td>
</tr>
<tr>
<td>H 1</td>
<td>1</td>
<td>Bustard Is.</td>
<td>3</td>
<td>Bickerton Volcanics</td>
</tr>
<tr>
<td>J 1</td>
<td>1</td>
<td>Bickerton Is.</td>
<td>39 - 40</td>
<td>&quot;</td>
</tr>
<tr>
<td>J 2</td>
<td>2</td>
<td>&quot;</td>
<td>42</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

2.3 Ground Investigation Programme

Since Prospecting Authority 1966 and 1967 occur close to one another and as both are in remote areas and relatively inaccessible it was decided that one follow-up programme should cover both areas. As Prospecting Authority 1966 covers several of the islands east of Blue Mud Bay it was obvious that access would have to be by sea or air. Consequently, on 22nd July three geologists flew over the area to investigate the best methods available for ground investigation. Access to all anomalies in Prospecting Authority 1966 would have been possible by sea or helicopter but the Walker River anomalies of Prospecting Authority 1967 lay four miles from the coast through thick mangrove swamps. As possible landing places were available for a helicopter near all anomalies it was decided to hire a small helicopter. Helicopter Utilities of Sydney were given the contract using a three seater Bell Helicopter. As the maximum safe flying
range for return trips was fifty miles it was necessary to operate from a base camp at Grindall Point in Prospecting Authority 1966. This area was chosen because it is accessible by track from Gove where a field party was already established on the nearby Prospecting Authority 1964. Fuel and other bulk supplies were brought in by barge on September 18. On September 24 a party of three geologists and three assistants moved into the area and the helicopter programme began on October 2 and concluded on October 12, 1969.
3. GEOLOGY

3.1 Mapping

The area covered by Prospecting Authority 1966 was mapped by the Bureau of Mineral Resources in 1962 and is shown on the Blue Mud Bay - Port Langdon Geological Sheet SD 53 - 78. The area was mapped by general reconnaissance using helicopter traverses and airphoto interpretation.

3.2 Stratigraphy

The stratigraphic nomenclature used in this report conforms with that used by K.A. Plumb and H.G. Roberts, 1965. C10847/64. However the ages of the Proterozoic rocks have been altered following Walpole, Roberts and Forman (1965).

**TABLE 2**

<table>
<thead>
<tr>
<th>Era</th>
<th>Age</th>
<th>Symbol</th>
<th>Rock Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cainozoic</td>
<td>Quaternary</td>
<td>Qa</td>
<td>Coastal silt, fine sand, alluvium.</td>
</tr>
<tr>
<td></td>
<td>Undifferentiated</td>
<td>Czs</td>
<td>Sand, Residual soil.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cz1</td>
<td>laterite lateritic soil, ferricrete</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Lower Cretaceous</td>
<td>Klm</td>
<td>Mullaman Beds</td>
</tr>
<tr>
<td>Precambrian</td>
<td>Upper Proterozoic</td>
<td>Pdl</td>
<td>dolomite</td>
</tr>
<tr>
<td></td>
<td>Mid Proterozoic</td>
<td>Pta</td>
<td>Groote Eylandt Beds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pli</td>
<td>Bickerton Volcanics</td>
</tr>
<tr>
<td></td>
<td>Mid or Lower Proterozoic</td>
<td>Pgc</td>
<td>Caledon Granite</td>
</tr>
<tr>
<td></td>
<td>Lower Proterozoic</td>
<td>Pld</td>
<td>Grindall Metamorphics</td>
</tr>
</tbody>
</table>
3.2.1 Grindall Metamorphics

The oldest group of rocks in the area is the Grindall Metamorphics which outcrop north of Grindall Point, on Round Hill Island and on the eastern side of Morgan Island. The rocks are metamorphosed to greenschist facies (Plumb and Rodgers) and consist of massive sandstones and quartzites and sheared chloritic schists.

3.2.2 Caledon Granite

This is a massive high level intrusive of Mid or Lower Proterozoic Age. It outcrops on Round Hill Island and Morgan Island. It takes the form of a pink hornblende biotite granite and may possibly be comagmatic with the Bickerton Volcanics (Plumb and Rodgers 1965).

3.2.3 Bickerton Volcanics

The Bickerton Volcanics are massive pink rhyolites, often porphyritic, with large ovoid felspars up to one inch in diameter. Included within the group are numerous lenticular breccia and tuff bands. A volcanic plug, situated on Round Hill Island, contains breccias, agglomerates and tuff intruded by felsitic dykes. Other outcrops occur on Bustard Island near South Bay on Bickerton Island.

3.2.4 Groote Eylandt Beds

The Groote Eylandt Beds form prominent outcrops north of Grindall Point and on most of the islands on Blue Mud Bay. At the base of the Groote Eylandt Beds there is a prominent conglomerate bed, grading through red micaceous siltstone and quartzite to a cross bedded white sandstone.

3.2.5 Dolerite Intrusive

A small dolerite sill occurs in the Groote Eylandt Beds on the east coast of Bickerton Island and Burney Island.
3.2.6 Mullaman Beds

There is a small outcrop of this group of rocks on the north west coast of Bickerton Island. The Mullaman Beds consist of a basal ferruginous sandstone, a white quartz sandstone and yellow and white claystone.

3.2.7 Cainozoic Sediments

Cainozoic sediments are to be seen in most coastal areas, and rimming the islands in Blue Mud Bay. They generally consist of a laterite horizon overlain by sand and alluvium.

3.3 Structure

This area is situated on a basement high 20 miles east of the Koolatong Fault Zone. The basement rocks are tightly folded and sheared Grindall Metamorphics which have been intruded by the massive high level Caledon Granite. The area has been stable since folding of the Grindall Metamorphics except for eustatic changes. The mid Proterozoic and younger sediments are almost horizontal probably reflecting the original sedimentary basin with little subsequent deformation. The cross bedded sandstones of the Groote Eylandt Beds display a well developed joint system.
4. HELICOPTER PROGRAMME

4.1 Procedure

Each of the nine anomalies was examined by a geologist and an assistant. The position of the anomalies was transferred from the radiometric contour maps to photo mosaics of the same scale. Each position was then transferred to 1:50,000 scale air photographs for location in the field. Each anomaly was pinpointed from the helicopter by means of the photographs and also by helicopter traverses using the GIS - 2 spectrometer at approximately 200 feet above ground surface. On the ground the anomalies were covered by compass traverses usually extending 600 - 800 yards across the area. Instruments used were Scintrex GIS - 2 spectrometers and BGS - 1 scintillometers.

4.2 Description of all Anomalies

4.2.1 Note on Standardisation of Instruments

Considerable variations occurred in the counts recorded by the three GIS - 2 spectrometers, for the same radioactive material. For the work carried out in this programme, the spectrometer which on 0.30 threshold gave a reading similar to that of the two BGS-1 scintillometers was taken as standard. The counts of the other two spectrometers have been altered to correspond with the other three instruments.

4.2.2 Anomaly BB1 - Priority 2

This anomaly is ascribed to concentrations of radioactive minerals such as zircon or monazite in sands and gravels adjacent to an intrusive stock of the Caledon Granite which is exposed nearby on the wave cut platform. The anomaly covers an area of approximately 300 yards square where the count rises to 70 - 90 counts per second compared with a background of 35 - 40. No outcrop could be seen.

This anomaly was the only one not reached by helicopter as it was accessible by vehicle and then on foot from the camp site.
4.2.3 Round Hill Island RH1 - Priority 1

This anomaly has a peak uranium value of greater than 90 counts per second (as recorded by the airborne survey). The contrast and steepness of the anomaly was enhanced by the small size of Round Hill Island and the low radiation background of the surrounding sea. As this anomaly appeared the most significant the whole island was examined. However thick thorny undergrowth and craggy outcrops made systematic traversing difficult.

The main geological features of Round Hill Island are steeply dipping sandstones and quartzites of the Grindall Metamorphics which have been intruded by granitic rocks forming part of the Caledon Granite. Both the Caledon Granite and the Grindall Metamorphics have been intruded by a plug of volcanic breccia and agglomerate of the Bickerton Volcanics. A zone of crushing and intermingling occurs between the plug and the Grindall Metamorphics. Late stage felsitic dykes are observed dissecting both the plug and the adjacent granite.

The anomaly is due to high background radiation in rocks of the igneous complex (particularly the Bickerton Volcanics) making up the core of the island and forming a large topographic high. The agglomerate breccia and granite give constant radiation values between 80 and 120 counts per second. Testing with the spectrometer indicates that thorium is the main source of radiation. The radiation in the Grindall Metamorphics is between 15 - 40 counts per second.

Anomaly RH 1 is of no economic significance.

4.2.4 Anomaly D1 - Priority 3

This anomaly is situated on the east coast of Isle Woodah. The island has very low topographic relief, with wide beaches and extensive back dune areas. Several small deeply weathered outcrops of flat dipping siliceous grit of the Groote Eylandt Beds were observed in the area of the airborne anomaly. These outcrops gave between 20 - 30 counts per second against a background of 5 - 10 counts per second for sand covered areas.
4.2.5 Anomaly D2 - Priority 3

This anomaly is situated on the northern tip of Isle Woodah. In the area of the anomaly no basement rocks were observed. Small patches of laterite gave between 20 and 30 counts per second with a few to 40 counts per second. The adjacent extensive sand cover gives a background of 5 - 10 counts per second.

4.2.6 Anomaly C1 - Priority 2

This anomaly occurs on the northern end of Morgan Island. In the vicinity of the anomaly a deep gully has cut through the flat lying sandstones and conglomerates of the Groote Eylandt Beds exposing the granitic basement (Caledon Granite). These granite outcrops give counts of 50 - 60 counts per second while the surrounding Groote Eylandt Beds give 15 - 25 counts per second.

4.2.7 Anomaly C2 (A) - Priority 2

This anomaly occurs within steeply dipping east west striking pink felspathic siltstones and sandstones of the Grindall Metamorphics. Average background total count was 40 counts per second. The only increase in count was found along strike joints or faults in one locality where 2 to 3 inch width of dark chloritic schists showed an increase up to 60 counts per second. No other anomalous radioactivity could be found. The anomalous area is not a topographic high and nothing else could be found to explain the airborne anomaly so it can only be classified as due to uranium and thorium mineralisation along minor fault shears.

4.2.8 Anomaly C1 (B) - Priority 2

This anomaly occurs about ½ mile south of C1 (A) in pink to purple felspathic siltstones and sandstones of the Grindall Metamorphics. These rocks strike east-west and dip steeply south. Radioactive background was again about 40 counts per second with occasional increase to about 60 counts per second. The anomaly area was thoroughly prospected, without finding any satisfactory explanation for the airborne anomaly.
4.2.9 Anomaly H1 - Priority 1

This anomaly is situated on the southern tip of Bustard Island where a spectacular sequence of acid volcanics of the Bickerton Volcanics can be observed. The acid volcanics gave a consistent reading of 60 - 70 counts per second against a background of 15 - 25 for the overlying Groote Eylandt Beds which form the remainder of the island.

4.2.10 Anomaly J1 - Priority 1

This anomaly is situated on the western side of South Bay on Bickerton Island. The anomaly corresponds with several large areas of outcrop of Bickerton Volcanics. These volcanics give 60 - 70 counts per second whilst the overlying sandstones and conglomerates of the Groote Eylandt Beds give a background of 15 - 25 counts per second.

4.2.11 Anomaly J2 - Priority 2

This anomaly is situated on the central edge of South Bay on Bickerton Island. The anomaly corresponds with a large outcrop of Bickerton Volcanics which give 60 - 70 counts per second while the overlying sandstones and conglomerates of the Groote Eylandt Beds give 15 - 25 counts per second background upon testing with the spectrometer thorium provided to be the dominant source of radiation.

4.2.12 Gooninah Island

Though Gooninah Island is outside Prospecting Authority 1966 a series of helicopter traverses were flown across the island at a height of 300 feet using a GIS - 2 spectrometer because the geology is similar to the other islands tested in Blue Mud Bay. A weakly anomalous area was detected on the eastern edge of Gooninah Island. Further investigation on the ground indicated a background of 15 - 25 counts per second for the
sandstones of the Groote Eylandt Beds, though a narrow ferruginous quartz pebble band (less than 2 feet thick) gave a consistent 130 - 160 counts per second. Testing with the spectrometer indicated thorium as the source of radiation. Thus this occurrence is of no importance.

4.3 Outline of Anomaly Types

After all the anomalies in Prospecting Authority 1966 had been investigated it became apparent that they could mainly be grouped into four broad genetic classifications. These classifications also prove applicable in Prospecting Authority 1964 and Prospecting Authority 1967.

(a) Granitic types
(b) Acid Volcanic types
(c) Lateritic types
(d) Minor Fault types

4.3.1 Granitic Types

Some radioactive concentrations in Prospecting Authority 1966 occur in Lower (?) Proterozoic granitic complexes (the Caldon Granite). These rocks contain accessory minerals which may be the source of the uranium and thorium e.g. zircon, apatite and allanite (Gardina 1957). Anomaly BB1 may represent a weak alluvial concentration of resistant minerals adjacent to a granite outcrop.

These accessory minerals give granite outcrops a high background radioactivity in relation to other rock types and thus give rise to weak anomalies such as anomaly C1.

4.3.2 Acid Volcanic Types

Anomalies RH1, H1, J1 and J2 can be related to outcrops of rhyolites and porphyries of the Bickerton Volcanics. These volcanics have a high background radiation probably due to accessory minerals. Thus areas of outcrop of Bickerton Volcanics give rise to broad anomalies which may be enhanced by very low background radiation in adjacent rocks.
4.3.3 Laterite Types

Anomaly D2 can be related to outcrops of laterite. These anomalies probably represent a weak concentration of thorium bearing resistant minerals from the underlying parent rock as indicated by studies by Adams and Richardson 1960.

4.3.4 Minor Fault Types

Anomaly C2 (A) is related to chloritic material occurring along small faults and joints - possibly a weak hydrothermal emanation.
5. **CONCLUSION**

A programme of exploration was carried out in the Blue Mud Bay area in October 1969. Nine anomalies previously outlined by an airborne spectrometer survey were followed up. Location of the anomalies on the ground was particularly successful due to the method of presentation of the survey results by Geophysical Resources Development.

A helicopter programme proved a quick and efficient method of reaching the anomalies which were in relatively inaccessible areas. The ground follow up work involves radiometric traverses of each anomaly using Scintrex BGS - 1 scintillometers with occasional tests for uranium and thorium content using GIS - 2 spectrometers. The use of the GIS - 2 spectrometers has proved a good qualitative approach although their use as quantitative instruments has not been successful.

All nine anomalies proved to be very weak and none represented concentrations of uranium mineralisation worthy of any further investigation. No uranium mineralisation of the Westmoreland type was discovered. (Subsequent to the granting of Prospecting Authority 1966 further work on the Westmoreland type has indicated a different source of uranium mineralisation. This new idea suggests that the mineralisation is related to feeder dykes leading to overlying volcanics. In this respect the Westmoreland and Blue Mud Bay areas differ as there are no volcanics above the Groote Eylandt Beds).

As the thorium and uranium occurrences are not of economic interest no further work is warranted: It is recommended that Prospecting Authority 1966 be relinquished.
APPENDIX 1

STATEMENT OF EXPENDITURE

Expenditure for the year ending May 31, 1970. $12,428
Expenditure previously reported to May 31, 1969. 7,981

Total Expenditure to May 31, 1970. $20,409