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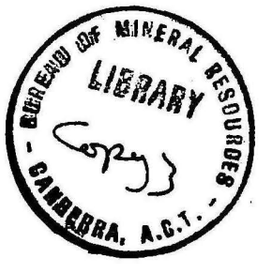

REPORT ON SEARCH FOR PHOSPHATE DEPOSITS IN THE NORTHERN TERRITORY

by

W.F. McQueen.

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Island:- 1 inch = 400 feet

SUMMARY

A reconnaissance survey for phosphate deposits was made in the Northern Territory of the islands between Cape Don and Groote Eylandt and of Cartier Island and the islands in Ashmore Reef. The islands close to the Northern Territory coast show no limestone or coral deposits and can be disregarded as a source of phosphate. The islands in Ashmore Reef show quantities of calcareous material with a very low phosphate content. This may be of some use for agricultural or metallurgical purposes.

INTRODUCTION

As part of a survey for phosphate deposits arranged by the Governments of Australia and New Zealand, a reconnaissance survey was carried out in July and August, 1957 of the islands along the north coast of Arnhem Land and in the Gulf of Carpentaria as far south as Groote Island. In August, 1958 a reconnaissance survey was made of Cartier Island and islands in the Ashmore Reef.

LOCALITY AND ACCESS

1. Islands along the north coast of Arnhem Land and in the Gulf of Carpentaria

All islands visited in the Gulf of Carpentaria and north of Arnhem Land (see Plate 2) are accessible by sea, but in many cases surrounding reefs and shallow shelving offshore mud flats require a shallow draught vessel to get close inshore. As these islands are not far from the mainland, it was possible to visit them by motor launch.

2. Ashmore Reef and Cartier Island

Cartier Island lies 430 miles due west of Darwin and the Ashmore Reef, surrounding West, Middle, and East Islands, lies 450 miles bearing 272° from Darwin (see Plate 1). Access to these islands is possible by seagoing craft.

TOPOGRAPHY

1. Islands between Cape Don and Groote Eylandt

The islands between Cape Don and Groote Eylandt fall into three groups.

(a) Croker Island and nearby islands, (b) the Crocodile Islands, and (c) the Wessel Islands and islands in the Gulf.

(a) Croker Island and adjacent islands

These islands represent remnants of the former Cretaceous peneplain and show a much eroded surface with a few residual higher areas remaining. Low areas of coast alternate with laterite cliffs with a maximum height of about 70 feet.

(b) The Crocodile Islands

This group comprises low lying, almost flat islands with the outer rim slightly higher than the centre. They represent the slightly raised portions of a deltaic region.

(c) The Wessel Islands and islands in the Gulf

Most of these islands show a dip slope topography and have steep cliffs on one side, gently sloping to white sand beaches on the other side.

2. Ashmore Reef and islands

These are flat, low lying islands of unconsolidated shelly material with a slightly raised rim. The maximum height above sea level is about nine feet.

(a) Ashmore Reef

Ashmore Reef is a large oval coral reef about 13 miles by 7 miles surrounding three small islands, East, Middle and West. The islands are entirely composed of unconsolidated calcareous material, mainly shell and shell fragments. There are a few safe anchorages within the reef (see Plate 3).

At low tide (Springs) the islands form a continuous chain about 9 miles long. Within the reef the bottom is almost entirely shelly material with some coral "nigger heads", and the water is 3 to 6 fathoms deep.

(b) East Island

East Island is flat and low lying with an area, above high water mark, of 178,000 square yards. There is a slightly raised rim around the island. The average height of the island above high tide level is about four feet.

The island is composed of finely broken calcareous material which has been cemented into a very thin layer on the western edge of the island and into a slightly thicker mass at the northwestern corner of the island.

A well containing fresh water with well worn tracks leading to it and a group of young palms indicates that East Island is used as a watering place by fishermen. There are three graves near the well.

(c) Middle Island

This is the smallest island in the group with an area of 136,000 square yards. Fresh water exists at a depth of 7 feet 6 inches but the well has caved in. None of the surface material on this island was cemented but there was a small amount of cemented calcareous material between the high and low tide marks.

(d) West Island

With an area of 370,000 square yards, West Island is the largest in the group. There are a few clumps of low shrubs along the northeastern edge. A well containing fresh water has been fitted with two 44-gallon drums. There are three graves on this island.

Near the well a few square yards of surface material has been cemented to a depth of 2 or 3 inches and the island is almost completely surrounded by ledges of recently cemented calcareous material which lie between high and low tide marks.

GEOLOGY

1. Islands between Cape Don and Groote Eylandt

The geology of these islands falls into two broad divisions with the Wessel Islands marking a natural boundary.

(a) Croker Island and adjacent islands, Crocodile Islands

Most of the islands show a flat lying basement of quartzite disconformably overlain by Cretaceous sediments which show in places a complete lateritic profile. On Sims Island where the basement is exposed the massive quartzites dip at 1^{o} to 2^{o} with a strong joint pattern striking 305^{o} and 35^{o}. The quartzite contains thin lenses of quartz-pebbles. Graded bedding and cross bedding are seen. The probable age of these quartzites is Upper Proterozoic.

The thickness of the laterite ranges from a thin cover of about one foot to cliffs of 60 or 70 feet. Practically all laterite is tubular, the pisolitic zone having been removed by erosion, but Reynolds Pacific Mines Pty. Ltd. have reported the presence of pisolitic and bauxitic laterite from the northern portion of Croker Island.

The Crocodile Islands are a group of very low lying islands not more than nine or ten feet above sea level. Laterite is exposed at the surface. A bore hole on Millingimbi has shown that the quartzite basement is present at depth.

(b) Wessel Islands and islands in the Gulf of Carpentaria

Here a basement of interbedded felspathic sandstone, quartzite and boulder conglomerate is exposed and dipping at about 15°. The rocks here have also been lateritized but most of the laterite has been eroded. Many examples of cross and current bedding, ripple, wave and rain marked sandstone and quartzite are visible, particularly in the area around Groote Eylandt.

Raised beaches and wave cut platforms show that sea level has fallen about 8 to 10 feet in recent times. On some beaches deposits of dead coral, washed up from offshore reefs were seen.

2. Islands in the Ashmore Reef

These islands are of recent origin and are comprised entirely of shells and shell fragments. A minute amount of coral was seen. The enclosing coral reef was charted by the Navy. There are three vegetated islands and a fourth non vegetated bank which is only a few inches above normal high tide level.

At low tide the bank of shelly material on which the three islands lie is exposed for a length of 9 miles. Most the area enclosed by the reef is becoming a vast shoal.

A very small part of this shelly material is cemented into a friable rock. This cementation occurs between the high tide level and the edge of the flats exposed at low tide (see Plate 3).

Over some very small areas the top two or three inches of the upper surface of the islands has been cemented together. The total area is very small.

Altogether the amount of cemented material from the surface of the islands, and between high and low tide level, would be approximately 750 tons, a very small proportion of the total material.

3. Cartier Island

Aerial inspection and the closest possible approach by launch showed that Cartier Island is similar to those in the Ashmore Reef, being composed of shelly material with a small area of consolidated material. A party from H.M.A.S. Warrego was able to land on Cartier Island at high tide and collect samples which were tested for phosphate.

PHOSPHATE DEPOSITS

1. Islands between Cape Don and Groote Eylandt

On some of the islands masses of dead coral have been piled up by tidal action. Pieces of coral from these areas were tested for phosphate but in only one case, coral washed up on Croker Island, was a positive result obtained and this

showed only a trace of P_2O_5. The uniformity of the basement of the majority of the islands visited and the fact that none of them are "coral" islands indicate the complete lack of phosphate deposits in these islands.

2. Islands in the Ashmore Reef

As detailed a survey as possible in the time available was made of the three islands, East, Middle and West.

(a) East Island

The bird life on this island is prolific and reaction between the bird droppings and the shell fragments has resulted in the formation of some calcium phosphate. However it is evident that most of the phosphate is concentrated in the organic matter which is mixed with the top 18 inches of the shelly material.

As it was impossible to use the auger in the loose material tests pits were dug and samples taken at various levels. These samples were tested qualitatively for P_2O_5. and showed that it was present down to ground water level, i.e., about eight feet below the highest point. However the tests indicated that the grade would be very low. Quantitative tests carried out in Darwin have verified this and show that the average of the top layer (about 2 feet) is 5% while the shelly material shows a range from 2% down to a trace. Tests were made of the material exposed at low tide. Detailed assay results are given in the next section.

(b) Middle Island

Bird life is slightly less plentiful here but conditions are very similar to those on East Island. All qualitative tests were positive but again the grade was very low.

(c) West Island

This is the largest island but there is less bird life than on the other islands. Test pits were dug and samples taken. The results were very similar to those for the other two islands.

3. Cartier Island

The samples from Cartier Island showed that the P_2O_5 content of the consolidated material was less than 1%.

ASSAY RESULTS

All assays were done in Darwin using the method outlined in Appendix 1. Three samples were reassayed in Canberra as a check on the method. Results showed that the assay figures given below should be divided by two to give true results.

(a) East Island in the Ashmore Reef

Sample No.	Description and Remarks	Vol. of Precipitate (in Ml)		%P_2O_5		Average
		1st	2nd	1st	2nd	
2601	From beach, shelly material unconsolidated, Test Hole 1 0'-3'	0.1	0.1	3%	3%	3%
2602	0'-2' Test Hole 2	0.3	0.4	9%	11%	10%

Sample No.	Description and Remarks	Vol. of Precipitate (in Ml)		$\%P_2O_5$		Average
		1st	2nd	1st	2nd	
2603	Unconsolidated Material, Test Hole 3. 0'-3'	0.1	0.1	3%	3%	3%
2604	Test Hole 4. No organic matter. 0'-3'	0.1	0.1	3%	3%	3%
2605	Test Hole 5. 2'-6'	0.1	0.1	2%	2%	2%
2606	Test Hole 5. 0'-2'	0.3 0.35	0.5 0.4	9% 10%	14.5% 11%	11%
2607	Test Hole 6. Above H.T. level. 0'-3'	Trace	Trace	Trace	Trace	Trace
2608	Test Hole 7. 0'-2'	0.2	0.2	6%	6%	6%
2640	Test Hole 8 (2' deep) 0'-1' (in cemented material)	Trace	Trace	Trace	Trace	Trace
2641	Test Hole 8. 1'-2' (below cemented material)	Trace	Trace	Trace	Trace	Trace
2642	Test Hole 9. Low tide level (1' deep) Below cemented material	Trace	Trace	Trace	Trace	Trace
2643	Guano rich sample from bird rookery	0.9	0.9	26%	26%	26%

(b) Middle Island in Ashmore Reef

Sample No.	Description and Remarks	Vol of Precipitate (in Ml)		$\%P_2O_5$		Average
		1st	2nd	1st	2nd	
2609	Test Hole 1. 0'-2'	0.1	0.1	3%	3%	3%
2610	Test Hole 1. 2'-7'	0.1	0.1	3%	3%	3%
2611	Test Hole 2. 2'-6'	Trace	Trace	Trace	Trace	Trace
2612	Test Hole 2. 0'-2'	0.3	0.3	9%	9%	9%
2613	Test Hole 3. 0'-2'	0.075	0.075	2%	2%	2%
2614	Test Hole 3. 2'-5'	0.075	0.075	2%	2%	2%

Sample No.	Description and Remarks	Vol. of Precipitate (in Ml)		$\%P_2O_5$		Average
		1st	2nd	1st	2nd	
2615	Test Hole 4. 0'-2'	0.1	0.1	3%	3%	3%
2616	Test Hole 4. 2'-5'	0.1	0.1	3%	3%	3%
2617	Test Hole 6.	Trace	Trace	Trace	Trace	Trace
2644	Test Hole 5. 0'-2'	0.3	0.3	9%	9%	9%
2618	Test Hole 5. 2'-4'	0.1	0.1	3%	3%	3%
2619	Test Hole 7.	Trace	Trace	Trace	Trace	Trace
2620	Test Hole 8. 0'-2'	Trace	Trace	Trace	Trace	Trace
2621	Test Hole 8. 2'-4'	Trace	Trace	Trace	Trace	Trace
2622	Test Hole 9.	Trace	Trace	Trace	Trace	Trace

(c) West Island in Ashmore Reef

Sample No.	Description and Remarks	Vol. of Precipitate (in Ml)		$\%P_2O_5$		Average
		1st	2nd	1st	2nd	
2623	Test Hole 1. 2'-6'	Trace	Trace	Trace	Trace	Trace
2624	Test Hole 1. 0'-2'	0.4	0.4	11%	11%	11%
2625	Test Hole 2. 0'-2'	0.4	0.4	11%	11%	11%
2626	Test Hole 2. 2'-5'	Trace	Trace	Trace	Trace	Trace
2627	Test Hole 3. 0'-2'	0.8	0.65	23%	19%	21%
2628	Test Hole 3. 2'-5'	Trace	Trace	Trace	Trace	Trace
2629	Test Hole 4. 0'-2'	0.4	0.3	11%	9%	10%
2630	Test Hole 4. 2'-6'	Trace	Trace	Trace	Trace	Trace
2631	Test Hole 5. 0'-2'	0.2	0.2	6%	6%	6%

Sample No.	Description and Remarks	Vol. of Precipitate (in Ml)		%P_2O_5		Average
		1st	2nd	1st	2nd	
2632	Test Hole 5. 2'-5'	0.1	0.1	3%	3%	3%
2633	Test Hole 6. 2'-5'	0.4	0.5	11%	14.5%	13%
2634	Test Hole 6. 2'-5'	0.1	0.1	3%	3%	3%
2635	Test Hole 7. 0'-2'	0.2	0.2	6%	6%	6%
2636	Test Hole 7. 2'-6'	0.075	0.075	2%	2%	2%
2637	Test Hole 8. 0'-2'	0.075	0.075	2%	2%	2%
2638	Test Hole 8. 2'-5'	0.075	0.075	2%	2%	2%
2639	Test Hole 9. (Consolidated guano)	0.85	1.00	26%	29%	27%

Several important factors are illustrated by these results. It is apparent that the islands are of "recent" origin and that only some of the P_2O_5 in the bird droppings has combined with the calcareous material forming the islands to produce calcium phosphate.

There are thin layers of cemented material rich in organic matter on East and West Islands but the total quantity is less than 100 tons. This material (Samples 2627, 2639, 2643) showed an average of 24% P_2O_5.

The assays and other tests showed that the higher phosphate content of the upper two feet over most of the surfaco of the islands is due to the mixture of organic material with the mainly unaltered calcareous matter. A separation of one sample was made into dark material (organic) and the lighter shell fragments. This showed that nearly all the phosphate was confined to the dark organic material. The percolation of solutions through the shelly material forming the islands is gradually forming calcium phosphate but the process is a lengthy one and at present is incomplete. Hence, the corrected assay results show that, while the average P_2O_5 content of the upper two feet is about 5%, the average content of calcium phosphate would be about 2½% and the phosphate content of the organic material about 12%.

QUANTITIES OF PHOSPHATE-BEARING MATERIAL AVAILABLE AT ASHMORE REEF

The specific gravity of the calcareous material is 2.6. This was obtained by using a pycnometer and no allowance was made for voids. To offset this the figure of 1 ton per cubic yard loose measure has been adopted for these calculations.

(a) East Island

Area of 5%P_2O_5 = 150,000 sq. yds.
Depth of 5% P_2O_5 = 1'6"
Volume = 150,000 x ½ cub. yds.
= 75,000 tons

Area of less than 2% P_2O_5 = 175,000 sq. yds.
Depth of less than 2% P_2O_5 = 4'6"
Volume = 175,000 x $\frac{3}{2}$ cub. yds.
= 262,500 tons

(b) Middle Island

Area of Island = 136,000 sq. yds.
Area of 4% P_2O_5 = 40,000 sq. yds.
Depth = 1'6"
Volume = 40,000 x $\frac{1}{2}$ cub. yds
= 20,000 tons

Area of less than 2% P_2O_5 = 40,000 + 90,000 (40,000 from 1'6" to 6'. 90,000 from 0' to -6'0"

Depth = 4'6"
Volume = (40,000 x $\frac{3}{2}$) + (90,000 x $\frac{2}{I}$)
= 60,000 + 180,000
= 240,000 tons

(c) West Island

Area of 5% P_2O_5 = 350,000
Depth = 1'6"
Volume = 350,000 x $\frac{1}{2}$
= 175,000 tons

Area of less than 2% P_2O_5 = 350,000
Depth = 4'6"
Volume = 350,000 x $\frac{3}{2}$
= 525,000 tons

Total 4%-5% P_2O_5 = 270,000 tons
Less than 2% P_2O_5 = 1,027,000 tons

In round figures there are 250,000 tons of material in the 4% to 5% P_2O_5 range and 1,000,000 tons with less than 2% P_2O_5. The total quantity of available calcareous material containing phosphate would be about 1,500,000 tons and the quantity of calcareous material to low tide level would be 10,000,000 tons plus.

CONCLUSIONS

The qualitative tests carried out during the survey of the islands off the coast of Arnhem Land showed that there are no deposits of guano or phosphate rock. The only trace of phosphate found was so slight that I consider these islands, i.e., between Cape Don and Groote Eylandt, do not warrant any further investigation for phosphate.

The qualitative and quantitative results from the samples taken on the islands in the Ashmore Reef have shown the presence of phosphatic material of very low grade. This material is unconsolidated and consists entirely of shells and shell fragments, some of which have been altered to calcium phosphate, and some of which are mixed with guano.

The results of the tests plus detailed observations show that the actual amount of calcium phosphate varies from nothing to about 5%, the high content of P_2O_5 in some samples being due to the presence of organic matter which is mixed with the upper two feet of the shelly material. Where this organic matter is not present the P_2O_5 content is low.

It is apparent that the grade of P_2O_5 is too low to warrant development of these islands as a source of phosphate but they may be a valuable source of silica free lime or agricultural lime.

RECOMMENDATIONS

As nearly all of the islands between Cape Don and Groote Eylandt, with the exception of the Wessel Islands were visited and the other islands on the Northern Territory coast have been discussed with fishermen and others, it is recommended that no further search for phosphate deposits be made off the coast of Arnhem Land or the Northern Territory.

It is also recommended that the economics of using the calcareous material within Ashmore Reef, either for agricultural purposes (the upper layer) or as silica free lime for metallurgical purposes (the lower layer), be investigated.

ACKNOWLEDGMENTS

Thanks are due to the staffs of the Missions in the areas visited. They made available all local information and extended hospitality to the party.

Thanks are also due to J. Edwards who skippered the launch in which the party visited the islands around Arnhem Land and in the Gulf of Carpentaria.

The R.A.A.F. co-operation in flying some officers of H.M.A.S. Cootamundra and the writer to survey from the air the approaches to Ashmore Reef and prepare a programme for testing the potentialities of the islands was greatly appreciated.

Finally thanks are due to the Navy and officers and men of H.M.A.S. Cootamundra for their help in surveying the islands of the Ashmore group.

PLATE 1

TIMOR

Croker Is.

De Courcy Hd

Goulburn Is.

Melville Is.

Bathurst Is.

Crocodile Is.

Howard Is.

Elcho Is.

Wessel Is.

The English Company's Is.

Yirrkala Mission

DARWIN

Ashmore Reef

Cartier Is.

Isle Woodah

Bickerton Is.

Groote Eylandt

Railway Line

Stuart Highway

Wyndham

Broome

N O R T H E R N

T E R R I T O R Y

W E S T E R N

A U S T R A L I A

ALICE SPRINGS

SCALE

100 0 100 200 300 MILES

AUSTRALIA 1:6,000,000
94·70 Miles to 1 Inch

LOCALITY MAP
PHOSPHATE SURVEY
N.T.

Resident Geologists' Office,
Bureau of Mineral Resources,
Darwin, N.T. August, 1958.

PLATE 2

PHOSPHATE SURVEY, N.T.
GENERALISED GEOLOGICAL MAP

T I M O R O R A R A F U R A S E A

New Year I.
Oxley I.
Lawson I.
CROKER I.
Darch I.
Templer I.
Valencia I.
Mc.Cluer I.
Grant I.
Cape Croker
Palm Bay
Cape Dom
COBURG PENINSULA
Cape Cockburn
De Courcy Head
BATHURST ISLAND
MELVILLE ISLAND
North Goulbourn I.
South Goulbourn I.
Sims I.
Haul Round I.
Entrance I.
Mooroongga I.
Crocodile Islands
Millingimbi I.
Elcho I.
Stevens I.
Drysdale I.
Wessel Islands
Truant I.
The Companys Is.
English
Arnhem Bay
Bremer I.
Cape Arnhem
Blue Mud Bay
DARWIN
East Alligator River
South Alligator River
Mary River
Wilton River
North Australia Railway
Stuart Highway
ADELAIDE RIVER
Daly River
KATHERINE
Morgan I.
Nicol I.
Isle Woodah
Burney I.
Low Sandy Islet
Wedge Rock
Bustard I.
Winchelsea I.
Chasm I.
North Point I.
North East Isle
Hawk I.
Bickerton I.
Connexion I.
GROOTE
Mission
EYLANDT

16 8 0 16 32 48 64 MILES
SCALE

REFERENCE

- Route taken.
- Coral reef.
- Limestone formations.
- Granite
- ▲ Area sampled.

Resident Geologists Office,
Bureau of Mineral Resources,
Darwin, N.T. Sept. 1958.

PLATE 3

PHOSPHATE SURVEY, N.T.

ASHMORE REEF
SHOWING ENCLOSED ISLANDS.

Reef charted by H.M.A.S. Cootamundra. Positions checked by radar

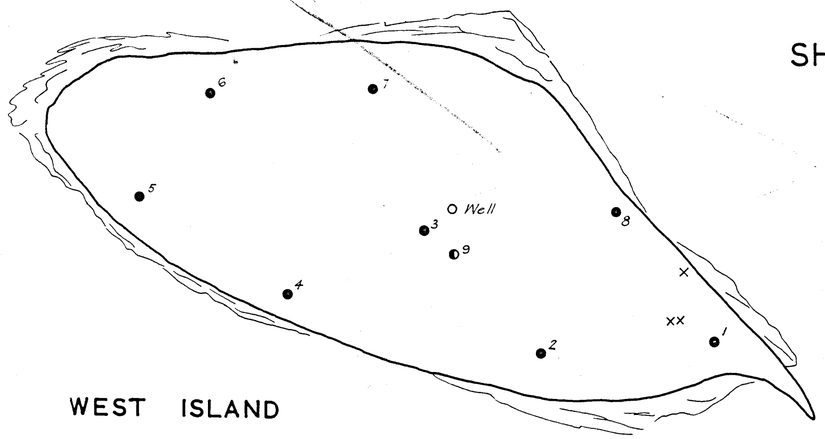
½ ½ 0 ½ 1 MILE

SCALE

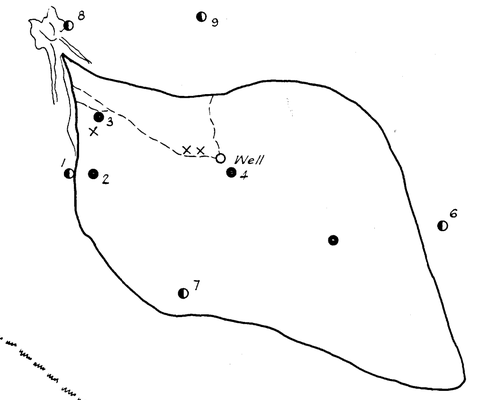
Inset islands surveyed by compass and chain.

400 200 0 400 800 YARDS

SCALE



WEST ISLAND



EAST ISLAND

‡ Safe anchorage for vessels up to 14 ft. draught.

Covered with niggerheads

Depth varies between 2 and 10 fathoms.

Barrier of niggerheads.

"Lagoon" very full of niggerheads Passage for vessels of shallow draught may be possible on western side.

WEST ISLAND

Passage is possible (for vessels of draught up to 8 ft.) to within a few hundred yards of East Island.

N

A S H M O R E R E E F

A fourth island appears in this position.

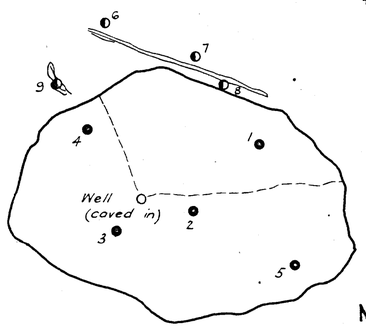
At low water (Springs) it appears possible to walk right along from East to West Island.

MIDDLE ISLAND

EAST ISLAND

REFERENCE

- Reef - position accurate.
- Reef - position doubtful.
- Vegetated shelly island.
- Non vegetated, low shelly bank.
- O Well
- X Grave
- Track
- ●² Test pit ●⁷ Surface sample.



MIDDLE ISLAND

Resident Geologists Office,
Bureau of Mineral Resources,
Darwin, N.T. September, 1958.