COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1963/117

NORTHERN NEW GUINEA BASIN RECONNAISSANCE AEROMAGNETIC SURVEY 1961

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SUMMARY

A reconnaissance aeromagnetic survey of the Northern New Guinea Basin was flown during October and November 1961. The survey is described and an analysis of the magnetic records is discussed.

The magnetic profiles indicate pronounced regional geological structures within the Basin which are parallel to known structural trends. A high degree of correlation is established between magnetic and geological data associated with major structural elements such as the Bewani Geosyncline, the northern and coastal geanticlinal ranges, and general basement character in areas of Tertiary to Recent sedimentation.

1. INTRODUCTION

The reconnaissance aeromagnetic survey of the Northern New Guinea Basin was flown by Adastra Hunting Geophysics Pty Ltd under contract to the Bureau of Mineral Resources during October and November 1961. The survey was the first to be flown over the basin and was made in order to investigate, as an aid to oil exploration, the regional geological structure of the Basin between the metamorphics of the central ranges and the north coast. The aeromagnetic coverage comprised three groups of traverses, each group containing three parallel traverses spaced four miles apart. Group A was situated about 10 miles east of the West Irian/New Guinea border, Group B near Wewak, and Group C about 50 miles south-east of Madang. Groups A and B were oriented approximately north-south, and Group C was oriented north-east. Plate1 shows the location of the traverses.

2. GEOLOGY

The following description of the geology of the Northern New Guinea Basin is taken from B.M.R. (1960).

'Tertiary

The Northern New Guinea Basin extends from the Huon Peninsula to the West Irian/New Guinea border, and beyond, and from the Sepik River valley to north of the coast. Shelf-type limestone along the coast and sedimentary structures in the geosynclinal sediments farther inland indicate that the sediments are derived from the north and that the hinge between the shelf and the trough in the Tertiary is close to the present coast.

Miocene marine shale, greywacke, and thick limestone, of an aggregate thickness of 12,000 feet, rest unconformably on Eocene limestone and chert, on Mesozoic sediments, or on the schist and granite of the basement. More or less unconformably overlying the Miocene are Pliocene marine and freshwater shale, sandstone, and conglomerate, with some minor lignites, ranging in total thickness from 7000 to 15,000 feet. The thickness is variable because folding started in late Miocene time, the Miocene strata were terminated by erosion, and more or less detached basins of Pliocene deposition were formed. The coastal ranges were probably rising during Pliocene time, but the main movements occurred at the end of the Pliocene, and gave rise to three main structural units - the narrow coastal belt, the geanticlinal coastal ranges, and the Sepik - Markham fault trough or synclinal trough. The coastal lowlands are essentially only the flank of the geanticline except in the western part, where they widen out in the Bewani Geosyncline.

The geanticlinal coastal ranges comprise the Finisterre and Saruwaged Ranges north-west of Lae, the Adelbert Range west of Madang, and the Torricelli and Bewani Mountains west of the mouths of the Sepik and Ramu Rivers. Miocene strata form the central parts of the eastern geanticline, with Pliocene strata, folded and faulted, on the flanks. The Torricelli-Bewani uplift exposed the pre-Tertiary metamorphic and igneous rock in the core of the ranges, with Miocene and Pliocene strata on the flanks.

The great Sepik-Ramu -Markham Trough which extends into Netherlands/New Guinea as the valleys of the Idenberg and Rouffaer Rivers, is either a fault trough or a synclinal trough. Tertiary sediments on the south side are very much thinner and folding is more gentle than on the northern side.

The geology in the three areas surveyed is illustrated in Plates 2, 3, and 4 and is based on the Geological Map of Australian New Guinea (Western Sheet) by Australian Petroleum Company Pty Ltd and Island Exploration Company Pty Ltd (unpublished). Plate 4 includes additional information in the region of the Bismarck Range obtained from McMillan and Malone (1960).

Group A traverses (Plate 2)

The most important structure in this locality is the west-north-west-trending Bewani Geosyncline which is divided into two distinct geological provinces by the east-west striking Torricelli - Bewani fault system (Osborne, 1942). There is an area of regional depression to the north, the geosynclinal valley being mainly occupied by Pliocene sediments and covered largely by Pleistocene terrace material and Recent alluvium. A zone of east-west folding along the north front of the Bewani Mountains tends to die out rapidly northwards. To the south is the mountain zone, an area of regional uplift, where erosion has exposed an igneous basement composed primarily of diorite and granodiorite in the Bewani Mountains.

Stratigraphic evidence indicates that 35,000 to 40,000 ft of Miocene and Pliocene sediments were laid down in a conformable sequence in the Bewani Geosyncline, commencing with intense volcanic activity in the lower Miocene (Bliri Group).

The Oenake coastal range at the northern end of the traverse constitutes a region of uplift on the northern edge of the geosyncline. Igneous basement crops out in Mount Bougainville to form the core of an east-south-east plunging anticline.

The major fault at the northern front of the Bewani Mountains has a throw of about 15,000 feet and probably occurred during the upper Pliocene.

South of the Bewani Mountains basement outcrops have been noted in the Border Mountains and along the Sepik river (Stanley, 1938). Transition from igneous to metamorphic basement character was observed in the Border Mountains.

In the region between the Bewani and Border Mountains Pliocene sediments indicate that the geosyncline extended southwards during upper Miocene time to form a shallow basin south of the Bewani Mountains.

Group B traverses (Plate 3)

Igneous basement is exposed in two localities, viz. near the coast in the Prince Alexander Mountains and just north of the Sepik River near Chuingai. The basement outcrop in the Prince Alexander Mountains trends west-north-west and forms a continuation of the Bewani-Torricelli mountain system. The exposure near Chuingai, however, is of the form of an isolated outcrop associated with Miocene limestone in which a south-east trending structure is evident (Stanley, 1939).

The greater part of the area south of the Prince Alexander Mountains has a Pliocene to Recent sedimentary cover, Pliocene sediments being exposed on the southern flanks of these mountains. South of Chuingai the sediments are mainly Recent up to the southern extremity of the traverses where Mesozoic sediments are presumed to be exposed.

North of the Prince Alexander Mountains, Miocene and Recent sediments are exposed in a narrow coastal belt. The northern extremities of the traverses are located just offshore over the extinct volcano of Kairiru Island.

Group C traverses(Plate 4)

The major structures in the area have a predominant north-west trend. This trend is reflected in the long axis of depositional basins that existed in Mesozoic and Tertiary times, in the axes of the geanticlinal Finisterre Range and the geanticlinal Palaeozoic block of the Bismark Range, and in the linear Ramu-Markham valley (Van Bemmelen, 1949; Rickwood, 1955; Corbett, 1962).

In the Finisterre Range undetermined thicknesses of lower and upper Miocene sediments are exposed. The lower Miocene (Finisterre and Mebu Series) contain basic and intermediate igneous intrusives together with pillow lavas and olivine basalt (Ongley, 1939). No evidence of igneous activity has been determined in this locality in the upper Miocene (Mena) series. Shallow water sediments are exposed on the southern slopes of the Finisterre Range and limestone to the north. A narrow coastal strip containing outcrops of Pliocene sediments results from a normal fault bordering the northern flank of the range with a downthrow of at least 1200 ft to the north (Mott, 1939).

A broad arch of Palaeozoic metamorphic rocks, composed mainly of schists and gneisses, forms the Bismarck Range in this region. Several groups of igneous intrusive and extrusive rocks are associated with this metamorphic block and include the Bismarck granodiorite, intermediate to basic intrusives of unknown age, acid to basic late-Tertiary intrusives, basic to intermediate Pliocene volcanics, and acid Quaternary volcanics. Some metamorphosed granite of probable Palaeozoic age is also included in this complex. On the southern flank of the arched Palaeozoic rocks, Mesozoic and Tertiary sediments are exposed (Mackay, 1955; McMillan and Malone, 1960).

Between the Finisterre Range and the Bismarck Range is the trough of the Ramu-Markham valley which contains an undetermined thickness of sediments, the outcrops being Pliocene to Recent.

3. INTERPRETATION

The magnetic profiles produced by reduction of the original magnetometer records are shown in Plates 2, 3, and 4. The reduction involved a decrease in profile sensitivity by a factor of approximately seventeen, and a decrease in horizontal scale by a factor of approximately five. It is likely that some error is present in the indicated positions of these traverses owing to the nature of the terrain. The regional magnetic gradient has not been removed from the profiles.

Plates 2, 3, and 4 also show the interpretation of the magnetic data. The interpretation is based on examination of the original magnetometer records and not on the profiles as presented here, as the reduced scale does not allow accurate reproduction of all the detailed features of the profiles. The depth contours are drawn using rock depth estimates made on individual magnetic anomalies. The parameter used was the horizontal extent of the anomaly's maximum gradient which was equated to the depth of the body causing the anomaly. It is important to note that at the latitude of the areas surveyed, the inclination of the Earth's magnetic field is only about 25° and magnetic anomalies are characterised by relatively small maxima and large minima, the minima being located south of the maxima. Magnetic trends derived from the profiles are marked on the plans.

Group A traverses

In general the magnetic profiles show distinct local and regional magnetic anomalies trending east to east-north-east.

At the northern end of the traverses, between the Puive and Usipi Creeks and the coast, the profiles indicate a near-surface magnetic basement which correlates with the pre-Tertiary igneous core of the Oenake Mountains and deepens to the south-east.

Following a progressive reduction in amplitude and general broadening of magnetic anomalies indicative of deepening basement southward, an abrupt change in the character of the magnetic profiles occurs at approximately latitude 3°04'S and is interpreted as a sudden uplift of the magnetic basement by at least 10,000 ft to bring it near surface level. This feature corresponds to the geological evidence of a major fault on the north front of the Bewani Mountains.

A region of well-defined magnetic trends striking east-north-east with intensities as high as 750 gammas extends from latitude 3°04'S to 3°35'S and includes the igneous basement outcrops of the Bewani and Border Mountains. At no place in this region is magnetic basement seen to be at a depth greater than 2000 ft below ground, which confirms that there is only a thin veneer of Pliocene and Miocene sediments.

At approximately latitude 3°35'S the character of the profiles again abruptly changes following a distinct magnetic 'low'. Immediately south of this feature little magnetic disturbance is evident except in the Green River locality where it is of a very minor nature. Anomaly amplitudes here are less that 40 gammas, but indicate shallow magnetic basement. These data, coupled with geological evidence of an igneous-metamorphic basement contact occurring in the Border Mountains near this magnetic 'low', are interpreted as a change in the nature of a near-surface magnetic basement with a susceptibility decrease to the south.

Group B traverses

This group of traverses also shows local and regional magnetic trends. The correlation between the profiles is more difficult than in Group A, because of the low angle of intersection between the traverses and the magnetic trends.

The most outstanding magnetic feature on these profiles is the negative anomaly associated with Kairiru Island; however, the traverses do not extend far enough northwards to completely delineate this anomaly. Magnetic basement is at, or near, surface level over this volcanic island, whereas immediately south, magnetic basement is at least 2000 ft below sea level.

Magnetic basement, of pre-Tertiary igneous origin, is at near-surface level in the Prince Alexander Mountains and extends in an arc to the south-east to underlie Pliocene sediments at a shallow depth as far south as latitude 3°48' on the most easterly traverse.

The north-west trending zone of minor anomalies that lies north of the Sepik River about latitude 4°00'S is indicative of another area of shallow magnetic basement confirming the isolated basement outcrop of diorite in the Chuingai locality.

Between these two areas of shallow magnetic basement the profiles indicate a deepening basement plunging to the north-west, the greatest depth determined on the western traverse being roughly 8000 ft below ground level.

In the Sepik River area, numbers of minor flexures in the magnetic profiles have been interpreted to indicate a magnetic basement at a depth not greater than 4000 ft below ground level.

Immediately south of the Sepik River, little magnetic disturbance is apparent. A magnetic 'low' trending north-west between the Sepik and Karawari Rivers probably reflects a change in magnetic basement character with lower susceptibility to the south. South of the magnetic 'low' the profiles indicate a very shallow basement.

<u>Group C traverse</u>

Magnetic disturbances of amplitude 50 to 500 gammas persist along each traverse and are characteristic of outcropping or near-surface magnetic rocks.

In the Bismark Range, the magnetic basement is near surface level and, although well-defined geological structure is associated with this area, it is not possible to trace a definite pattern of local magnetic trends across the three profiles. This is probably due to the igneous-metamorphic basement complex of the Bismarck Range being non-homogeneous, coupled with too great a separation of traverses.

The anomalies observed in the Finisterre Range are due to bodies at, or near, the surface and are attributed to the igneous rocks associated with the lower Miocene Finisterre and Mebu Series. However, there is a well-defined north-west trending regional magnetic 'low' associated with the Finisterre Range and this may be interpreted as a considerable thickness of uplifted sediments overlying a downwarped basement.

In the area of the Ramu-Markham valley, the profiles are noticeably smoother, which is partly due to an increase in aircraft terrain clearance. An anomaly on the southern traverse, near fiducial point 1403, appears to be caused by magnetic rocks at ground level and probably corresponds to a nearby igneous outcrop of late Tertiary age. On the northern traverse however, the magnetic profile indicates that the magnetic basement is at least 3000 ft below ground level, which is consistent with the generally accepted trough structure of the valley.

A change in magnetic character occurs across the coastal area north of the Finisterre Range where the depth to magnetic rocks increase from near-surface to about 2000 ft in the vicinity of an established fault.

South of the Bismarck Range, some doubt exists as to the accuracy of the data collected. The profile of the centre traverse south-west of fiducial point 524 indicates that magnetic rocks are near surface level, whereas profiles of adjacent traverses suggest that the magnetic basement deepens fairly rapidly to the south-west. It is possible that either the centre traverse is incorrectly located or that it goes over magnetic rocks that are not encountered on the adjacent traverses. The magnetic 'low' located south of the Garfutina River may indicate downfaulting of the Bismarck basement complex to the south-west.

4. CONCLUSIONS

The magnetic profiles indicate pronounced regional geological structures within the Northern New Guinea Basin which are parallel to known structural trends. A high degree of correlation is established between magnetic and geological data associated with the major structural elements such as the Bewani Geosyncline, the northern and coastal geanticlinal ranges, and general basement character in areas of Tertiary to Recent sedimentation.

The survey has proved the suitability of the airborne magnetic method to yield fairly-detailed structural information within the basin between longitudes 141°00'E and 144°00'E. It is recommended that a routine airborne magnetic survey be flown in this area before engaging upon any extensive ground geophysical programme.

The application of the airborne magnetic method in the Finisterre Range about longitude 146°00'E, with respect to the collation of data required to determine the depth to crystalline basement, does not appear promising. This is due to the presence of magnetic rocks of igneous origih included within the sediments.

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APPENDIX

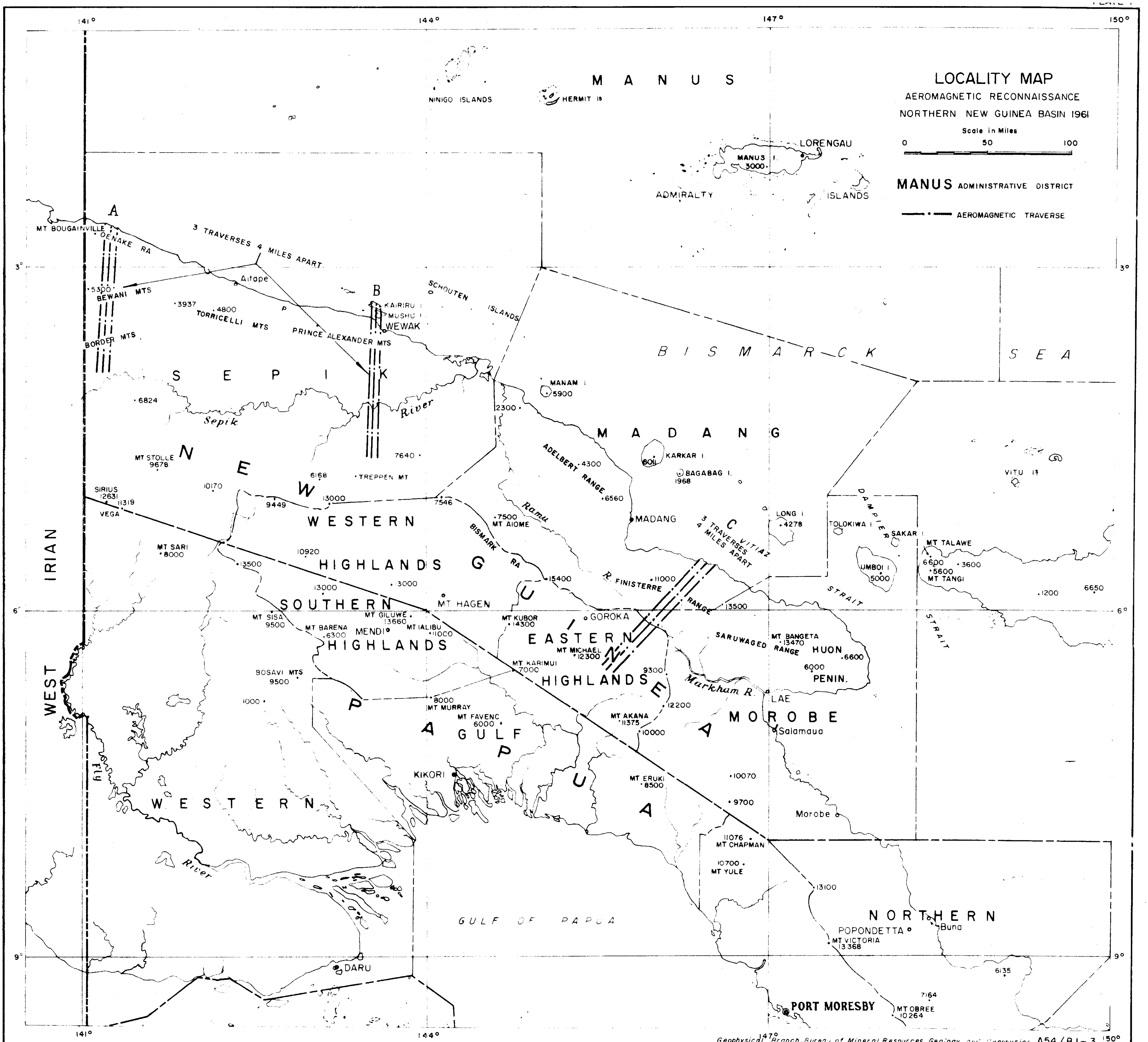
Operational details

Survey specifications:

Altitude	1500 feet above general ground level where practicable.
Line spacing	Three widely separated groups of traverses, each group consisting of three traverses spaced four miles apart.
Tie system	Single ties at the ends of each group of traverses.
Sensitivity	Approximately 60 gamma/in.

Equipment:

Gulf Research and Development Corporation ML3 magnetometer, APN-1 radio-altimeter, barometric altimeter, Vinten 35-mm camera, single fluxgate magnetometer recording total force at base station.



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GROUP 'A' TRAVERSES VANIMO-AITAPE

GEOLOGY AND TRAVERSES

BASEMENT-DEPTH CONTOURS AND MAGNETIC TRENDS

LEGEND

- Qr — Recent
- Qp — Pleistocene
- Tp — Pliocene
- Tmu — upper Miocene
- Tmo — middle Miocene / upper Oligocene
- K — Mesozoic
- Pz — Pre-Mesozoic metamorphic rocks mainly schist, gneiss, etc.
- Intrusive and hypabyssal igneous rocks
- Limestone
- Volcanics

Geology after Geological Map of Australian New Guinea by Australasian Petroleum Co. and Island Exploration Co.

- Geological boundary
- Anticline
- Fault
- Depth contours of magnetic rocks relative to ground surface
- Magnetic trend (low)
- Magnetic trend (high)

AEROMAGNETIC RECONNAISSANCE

NORTHERN NEW GUINEA BASIN 1961

APPROX SCALE

miles 4 0 4 8 12 16 miles

kilometres 5 0 5 10 15 20 kilometres

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics A54/B1-1

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GROUP 'B' TRAVERSES WEWAK-AMBUNTI

GEOLOGY AND TRAVERSES

BASEMENT-DEPTH CONTOURS AND MAGNETIC TRENDS

LEGEND

Qr	Recent
Qp	Pleistocene
Tp	Pliocene
Tmu	upper Miocene
Tmo	middle Miocene / upper Oligocene
K	Mesozoic
Pz	Pre-Mesozoic metamorphic rocks mainly schist, gneiss, etc.
+ +	Intrusive and hypabyssal igneous rocks
	Limestone
V V V	Volcanics

Geology after Geological Map of Australian New Guinea by Australasian Petroleum Co. and Island Exploration Co.

- Geological boundary
- Anticline
- Fault
- Depth contours of magnetic rocks relative to ground surface
- Magnetic trend (low)
- Magnetic trend (high)

M.N T.N

AEROMAGNETIC RECONNAISSANCE

NORTHERN NEW GUINEA BASIN 1961

APPROX. SCALE

miles 4 0 4 8 12 16 miles

kilometres 5 0 5 10 15 20 kilometres

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics A54/BI-2

TO ACCOMPANY RECORD No. 1963/117

GROUP 'C' TRAVERSES MADANG-MARKHAM

GEOLOGY AND TRAVERSES

BASEMENT-DEPTH CONTOURS AND MAGNETIC TRENDS

LEGEND

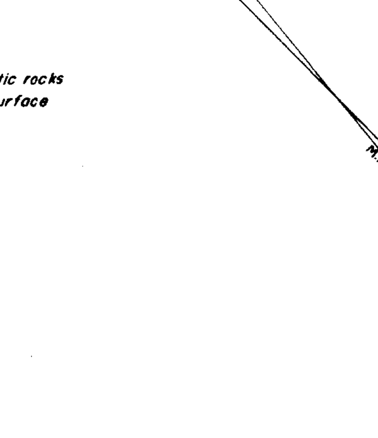
Qr	*Recent*
Qp	*Pleistocene*
Tp	*Pliocene*
Tmu	*upper Miocene*
Tmo	*middle Miocene / upper Oligocene*
K	*Mesozoic*
Pz	*Pre-Mesozoic metamorphic rocks mainly schist, gneiss etc.*
+ +	*Intrusive and hypabyssal igneous rocks*
(limestone symbol)	*Limestone*
V V	*Volcanics*

Geology after Geological Map of Australian New Guinea by Australasian Petroleum Co. and Island Exploration Co.

Qa	*Quaternary, undifferentiated*
Qv	*Quaternary, rhyolite, rhyolitic breccia*
QpK	*Pleistocene*
Tpa	*Pliocene*
Tme	*Miocene*
Pzg	*Palaeozoic, siltstone, phyllite, schist, quartz greywacke, some calcarenite*
Pzb	*Palaeozoic, arkose, granite gneiss, phyllite, schist, quartzite*
Td (Igneous Rocks)	*Late Tertiary, diorite, gabbro and hypabyssal equivalents*
gb (Igneous Rocks)	*Granodiorite, diorite, gabbro*
Pgm (Igneous Rocks)	*Palaeozoic, gneissic granite*

Geology after the Geology of the Eastern Central Highlands of New Guinea by N.J. McMillan and E.J. Malone

Geological boundary
Anticline
Fault
Depth contour of magnetic rocks relative to ground surface
magnetic trend (low)
magnetic trend (high)



AERIOMAGNETIC RECONNAISSANCE
NORTHERN NEW GUINEA BASIN 1961

APPROX. SCALE
miles 4 0 4 8 12 16 miles
kilometres 5 0 5 10 15 20 kilometres

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