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# CANNING BASIN AEROMAGNETIC RECONNAISSANCE SURVEY, W.A. 1954



by

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## ABSTRACT

The results of the aeromagnetic reconnaissance survey in the Canning Basin indicate that the thickness of sediments may be 20,000 ft in the Fitzroy Trough, with localised shallowings where the basement rock is 10,000 ft below the surface. A basement shelf is indicated along the northern margin of the Trough, where the thickness of sediments is about 5000 ft. The southern boundary of the Trough between Broome and the Fenton Fault, is marked by indications of a basement ridge where the thickness of sediments is about 6000 ft.

The boundaries of the Trough are well defined from Dampier Peninsula to Christmas Creek, but east of Christmas Creek the southern boundary is not definite and the aeromagnetic results show that a branch of the Trough may swing southward to the west of Mt. Ernest.

On the eastern margin of the Canning Basin estimates of depth to basement based on the aeromagnetic results, are 10,000 to 15,000 ft. On the coastal strip of the Canning Basin, the results indicate that the thickness of sediments is less than 10,000 ft in the central portion of the strip and that the Basin shallows towards both ends of the strip.

In the central part of the Canning Basin, the indications from a single aeromagnetic traverse are that the depth to basement is less than 10,000 ft in the central portion of the traverse, and decreases towards the boundary of the Basin both in the south-west and towards the Fenton Fault in the north-east.

## 1. INTRODUCTION

Between 13th July and 1st September 1954, the Bureau of Mineral Resources made an aeromagnetic reconnaissance survey of the Canning Basin, Western Australia, as part of the oil search programme in that Basin.

The Canning Basin is in the north of Western Australia; it intersects the coast between Port Hedland and King Sound, and extends eastward almost to the Northern Territory border. The aeromagnetic survey consisted mainly of widely spaced flight lines (Plate 2); in addition, two separate areas were surveyed in greater detail (Plate 3) and six closely spaced parallel lines were surveyed along the coastal strip of the Basin (Plate 2).

The Bureau of Mineral Resources personnel engaged in the survey were P.E. Goodeve (Party Leader), A.G. Spence, L.E. Howard, F. Mulvaney, and M. Ciszek. The aircraft was piloted by Captain K. Duffield and First Officer M. Nicholls of Trans-Australia Airlines.

## 2. GEOLOGY

A geological sketch map of the Canning Basin is shown on Plate 1. This map is based on the Bureau of Mineral Resources geological map of the Canning Basin at a scale of 1 inch to 20 miles. The Basin covers a large area on land extending south-east from the coastline, and it includes an elongated area of deep sedimentation, the Fitzroy Trough, parallel to its north-eastern boundary. No information is available on the offshore extent of the Basin north-westwards.

### Fitzroy Trough

The following notes on the geology of the Fitzroy Trough are drawn in part from the work of Wade (1936), Guppy, Cuthbert, and Lindner (1950), Schneeberger (1952), and Guppy, Lindner, Rattigan, and Casey (1958).

The Fitzroy Trough is bounded in the north-east by Precambrian rocks, and in the south-west by the Fenton Fault. The Trough extends as a well-defined depression from Derby to Christmas Creek, but south-east of Christmas Creek its trend is not definite. The existence of a basement rock shelf along the north-eastern margin is indicated by bore hole data and geophysical investigations, and near Christmas Creek the edge of the shelf is marked by the Pinnacle Fault. The down-throw of this fault has been measured by seismic methods to be about 18,000 ft (Smith, 1955).

The Fenton Fault, on the south-western boundary of the Trough, has been described as a hinged fault with a well defined down-throw to the north-east in some places and a down-throw to the south-west in other places. The Fault is not continuous along the boundary, and possibly forms part of a basement ridge bordering the Trough.

A large part of the surface of the Fitzroy Trough is covered by Permian sediments, with outcrops of Triassic and Cretaceous sediments in the north-west. Carboniferous sediments have been penetrated in several deep bores within the Trough, and also crop out in small areas along the north-eastern margin. Devonian sediments crop out extensively on the shelf which abuts the north-eastern boundary of the Trough, and have been penetrated in the Meda Bore and Sisters Bore; they may also underlie the Permian and Carboniferous sediments in the deeper parts of the Trough. Outcrops of Ordovician sediments are limited to the Prices Creek area; the distribution of these sediments within the Trough is unknown. The basement rocks are Precambrian and include igneous and metamorphic rocks. The cycle of erosion in the Trough is at an advanced stage, and Quaternary erosion products cover much of the surface.

Several dome structures have been mapped in Permian sediments on the surface of the Trough, and seismic measurements have been made to determine the depths to which these structures persist. Bore holes have been drilled on some favorable structures.

## Canning Basin

Cretaceous, Jurassic, and Permian sediments crop out in the Canning Basin south of the Fenton Fault; large areas of this Basin are covered by Quaternary sand dunes.

A basement ridge east of Broome is believed to form the southern boundary of the Fitzroy Trough. In this area, shallow sedimentation has been indicated by geophysical investigation (Vale and Williams, 1955), and several bore holes have been drilled. In each bore, Jurassic and Permian sediments were underlain by Ordovician sediments, although there may also be Devonian sediments in the Roebuck Bay Bore.

In the Wallal and Samphire Marsh Bores farther south-west, gneissic granite was penetrated below Permian sediments. No Carboniferous sediments have been recognised in these bores.

In all bores south of the Fitzroy Trough, basement rocks or early Palaeozoic sediments were penetrated at considerably lesser depths than in bores in the centre of the Fitzroy Trough.

# 3. AEROMAGNETIC METHOD

This method of geophysical surveying is based on the difference in magnetic susceptibilities of different minerals; i.e. the degree to which they become magnetised in a magnetic field. If the earth's crust were composed of uniformly magnetised material or layers of material, the magnetic field measured on the surface of the earth would have a regular and predictable pattern. The observed variations (anomalies) from such a pattern are due to non-uniform magnetisation of sub-surface materials. Boundaries of strongly magnetised ore bodies and rock enclosed by weakly magnetised rocks may be delineated by analysis of these anomalies.

The magnetic properties of a rock are those of its mineral constituents. The iron mineral magnetite, is highly magnetic; ilmentite, pyrrhotite, and hermatite are less so, and other minerals are virtually non-magnetic. Igneous and metamorphic rocks, because of their magnetite content, are generally more highly magnetised than sedimentary rocks, and this fact is the basis of the applicability of the magnetic method of prospecting over sedimentary basins. In many basins the basement consists of magnetic igneous and metamorphic rocks, and the sedimentary rocks within the basins are virtually non-magnetic. Magnetic anomalies recorded over a basin normally arise from the basement rocks only, and analysis of the anomalies enables conclusions to be drawn concerning the depth, and possibly the configuration, of the surface of the basement. This yields information on the thickness and distribution of sediments in the basin.

The magnetism of minerals may be either that induced by the earth's present magnetic field, or a remanent magnetism from a previous magnetisation. Both types of magnetism may exist in the same rock.

With the development of the airborne magnetometer, large areas such as sedimentary basins can be surveyed in a relatively short time. Compared with the ground method of magnetic surveying, the airborne method has the advantages that large areas can be surveyed rapidly regardless of the type of terrain, and the results are less affected by minor local magnetic disturbances at the surface. The airborne magnetometer is designed to give a continuous record of the variations in the intensity of the earth's total magnetic field.

## 4. EQUIPMENT

### Airborne Magnetometer

The total magnetic field intensity was measured with an airborne magnetometer, type AN/ASQ-1, mounted in the rear of the main compartment of a DC.3 aircraft.

The airborne magnetometer consists of a detector element self-oriented with respect to the earth's magnetic field, electronic oscillators and amplifiers, and recording equipment. The operation of airborne magnetometers has been described by Dobrin (1952) and Landsberg (1952).

### Ancillary Equipment

The aircraft was equipped with Sperry CL2 gyrosyn compass, a radio altimeter, a 35-mm vertical camera, and a drift-sight. Normal radio communication and navigation equipment was also carried.

Shoran radio equipment was used for navigation in areas in which detailed surveying was required, and in which the lack of prominent surface features prevented satisfactory navigation by aerial photographs.

## 5. SURVEY OPERATIONS

The flight line diagram of the Canning Basin aeromagnetic survey is shown on Plate 2. All lines were flown at an altitude of 1500 ft above ground level.

In the Fitzroy Trough, fourteen approximately parallel north-east lines were surveyed between Broome in the west and Halls Creek in the east. Navigation along these lines was by dead reckoning.

In the centre of the Canning Basin, lines were surveyed by dead reckoning between Lake Auld and Marble Bar and between Marble Bar and Christmas Creek; in the eastern part of the Basin lines were surveyed connecting Tobin Lake, Wilson Cliffs, Halls Creek, and Sturt Creek. Aircraft positioning along these flight lines was by a series of check points at which the aircraft's position was recognised from land features. Between check points, the most probable path of the aircraft was determined from aircraft speed, compass bearing, and wind speed and direction. In the western part of the Basin, the departure of the true course of the aircraft from the plotted course between check points was less than five miles; in the eastern part, the departure was less than 10 miles.

An Esterline-Angus chart recorder was used to make a continuous record, at a chart speed of three inches per minute, of the intensity of the total magnetic field along flight lines. The chart record and the plotted course of the aircraft were correlated by annotating the chart record with the same check points as those on the flight diagram.

Six closely spaced lines were surveyed parallel to the coast where it intersects the Canning Basin. Navigation of the aircraft and subsequent plotting of its course were made with aerial photographs.

Two areas, shown as Maps 1 and 2 on Plate 3, were surveyed in greater detail using the Shoran radio system for navigation. In this method the distance of the aircraft from two ground beacons is measured and recorded at regular intervals. This enables the aircraft's flight path to be plotted accurately. Flight line spacing in these areas was approximately two miles. Visual navigation was used on flight lines A to D (Maps 3 and 4, Plate 3). Line A was surveyed over the Bureau's seismic traverse at Nerrima. Line B is east of Broome, C near Jurgurra Creek, and D north-east of Grant Range.

## 6. RESULTS

The profiles of total magnetic intensity recorded on the reconnaissance flight lines are shown on Plate 2. Where the profiles could not be reduced to a common datum, an arbitrary datum level was adopted. All profiles have been corrected for the regional variation in the earth's total magnetic field.

On Plate 3 the magnetic data recorded in the two areas surveyed with Shoran control are presented in the form of contours of equal magnetic intensity (Maps 1 and 2). This plate shows also the magnetic profiles recorded on flight lines A to D (Maps 3 and 4).

## 7. METHODS OF INTERPRETATION

The interpretation of the results of the aeromagnetic survey involves the study of the magnetic data in relation to all available geological and bore hole data and the results of surveys by other geophysical methods. By this means a description of the sources of the magnetic anomalies can be given, and estimates made of their depths.

In sedimentary basins magnetic anomalies are usually assumed to have their origin in structures of the igneous or metamorphic rocks which form the basement of the Basin. The anomalies may be due either to lithological differences in the basement rocks or to topographic differences in the basement surface.

The chief difficulty in interpreting magnetic anomalies is that there is no unique solution to the problem; i.e., sources of different forms at different depths can produce anomalies of similar intensity and extent. However, by using some external control, such as geological and bore hole data or the results of some geophysical method which does not involve measurement of potential fields, an estimate can be made of the depth and form of the source of an anomaly.

A common method of interpreting an anomaly is to compare its dimensions with those of an idealised source whose magnetic effect has been computed, and to estimate its depth within the limits set by the control data. Full use of this method would require more detailed data than that recorded in the Canning Basin survey, because the flight lines there were widely spaced and individual anomalies not clearly defined. However, some use was made of this method in interpreting the magnetic data.

Another method of interpretation involves a useful qualitative relationship which can be established between sharpness of individual anomalies and depth to basement rock. Assuming that all anomalies have their origin in basement rock structures, the sharpness of the anomalies will decrease as distance of the source from the level of observation increases; i.e., with increase in depth to basement. In any survey area a study of the profiles recorded over outcrops of basement rock will show whether this method can be used. The qualitative relationship can be extended to a quantitative one if sufficient information is available to allow direct correlation to be made between magnetic profile characteristics and known depths to basement. This method was the main one used in interpreting the magnetic data of the present survey. To illustrate how the method was applied, some estimates of depth to basement on Plate 2 were made by comparing such features as the roughness or smoothness of the profile, and degree of sharpness of the more clearly defined anomalies, with similar features on profiles recorded over areas where depth control was available from outcrops, records of bore holes, or seismic measurements.

## 8. INTERPRETATION OF RESULTS

### (1) Magnetic Profiles in the Fitzroy Trough (Plate 2)

Depths to basement rock are known approximately from seismic measurements in several areas of the Fitzroy Trough. The locations of these seismic surveys are shown on Plate 2. A bore hole at Grant Range, drilled to 13,000 ft, and one at Nerrima, drilled to 9000 ft, provide data of the minimum thickness of sediments in these places.

The degree of smoothness of the magnetic profiles recorded near those bore holes provides a basis for estimating depths in other areas covered by the aeromagnetic survey. The estimated depths are marked along the flight lines (Plate 2.)

The flight lines numbered 1R to 14R are discussed below.

Lines 1R and 4R: The smoothness of the magnetic profiles recorded over Dampier Peninsula on these two lines indicates that a considerable thickness of sediments overlies the basement rocks in this area. The outcropping sediments are mainly Mesozoic. A seismic survey along a traverse eastward from Broome recorded reflections from depths calculated to be up to 12,500 ft, and a few reflections were recorded from a depth calculated to be 20,000 ft (Vale and Williams, 1955). The magnetic profiles indicate that similar depths to basement persist along the parts of the flight lines over Dampier Peninsula and King Sound.

By contrast, the roughness of the magnetic profiles recorded on the parts of the lines over the peninsula between King Sound and Collier Bay indicates shallow basement. For the most part the outcropping rocks here are Upper Archaeozic metamorphics and Proterozoic volcanics.

Line 2R: Smoothness of the profile near point 4A matches that of the profiles of lines 1R and 4R over Dampier Peninsula, and depth to basement is estimated to be 20,000 ft. Anomalies of amplitude near points 3A and 5A indicate a decrease in depth to basement rock. North of point 3 the profile is smooth to the northern end of the flight line. The smoothness of the profile over the outcropping basement between points 3 and 1 can only be explained by assuming that the basement here consists of acidic rocks of low magnetic susceptibility.

Lines 3R and 5R: The smoothness of the magnetic profiles in the central sections of these two lines is similar to that recorded on lines 1R and 4R. Seismic measurements near Langey Crossing on the Fitzroy River have shown that the thickness of sediments probably exceeds 16,000 ft and may exceed 20,000 ft. (Vale and Smith, 1956). The magnetic profiles indicate depths to basement of this magnitude between points 3 and 6 on line 5R and between points 3 and 5 on line 3R. The anomaly centred 10 miles north-east of point 6 on line 3R, and that centred 26 miles north-east of point 7 on line 5R, are probably due to a structure trending north-west at an estimated maximum depth of 6000 ft. These anomalies provide evidence of decreasing depth to basement rock in this area.

The anomaly at point 2 on line 5R is interpreted as due to a vertical tabular structure in the basement complex at an estimated maximum depth of 6000 ft. The anomaly at point 2.7 on line 3R is probably due to a similar structure, also at a maximum depth of 6000 ft. Sharp anomalies were recorded at the northern end of line 3R over basement outcrops.

Line 6R: Between points 3 and 8 the magnetic profile is smooth, indicating a considerable thickness of sediments overlying basement rock. In this vicinity, the Grant Range Bore penetrated nearly 13,000 ft of Permian and Upper Carboniferous sediments, but did not reach basement rock. Between points 3 and 8 depth to basement rock probably exceeds 13,000 ft. Between points 8 and 9 the profile is slightly disturbed, indicating a decrease in depth to basement. On the northern portion of the line, the anomaly at point 2.5 is estimated to be due to a source at a depth of 5000 ft or less. A sharp anomaly near the northern end of the line is over basement outcrops.

Lines 7R and 8R: The central portions of these lines, over the Fitzroy Trough, have smooth profiles. Seismic measurements at Myroodah (Williams, 1955) and the stratigraphic sequence encountered in a bore hole drilled to 9070 ft at Nerrima, confirm the magnetic indications of great depth to basement rock. Furthermore, seismic measurements show that on the northern (down-throw) side of the Fenton Fault, near Barnes Flow, the depth to basement is at least 16,000 ft (Vale and Smith, 1959). The smoothness of the magnetic profile suggests a depth of about 20,000 ft between points 3 and 6.7 on line 7R and between points 4 and 6.5 on line 8R. Northward, anomalies in the profile indicate that the sediments are thinner as far as the mapped boundary of the Basin. On line 7R there is evidence that, south of the Fenton Fault, the depth to basement becomes less; the source of the anomaly at point 2.7 is estimated to be less than 15,000 ft deep. The seismic survey near Barnes Flow indicated basement at about 5000 ft on the southern side of the Fenton Fault (ibid.). No magnetic anomaly was recorded directly over the Fenton Fault on these two flight lines.

Line 9R: South of the Fenton Fault the magnetic profile indicates shallow basement. Between the Fenton Fault and point 6 to the north, the profile becomes smoother and depth to basement is estimated to be about 15,000 ft. North-east of point 6 basement is probably deeper. The profiles show that the depth to basement becomes less between points 4 and 3 as the basement outcrop is approached.

Line 10R: The conspicuous anomaly near the southern end of this flight line is south of the Fenton Fault. The anomaly is such as would be caused by a basement fault with down-throw to the north-east. Assuming that the anomaly is due to a fault, the maximum depth to basement on the up-throw side is estimated to be 5000 ft. The sharpness of individual anomalies on the profile north of the Fenton Fault suggests a depth to basement of less than 10,000 ft.

Line 11R: The magnetic profile is smooth over the Fitzroy Trough. Seismic measruements at Poole Range, east of point G on this flight line, have shown that basement depth is about 20,000 ft (Smith, 1955), and a similar depth probably persists along this line up to the Fenton Fault. South of the Fenton Fault the magnetic profile is rough, indicating possible lessening of depth to basement. The northern end of the profile near the Pinnacle Fault has a steep gradient and, assuming that this is due to a structure within the basement, the estimated depth to basement at this point is not greater than 3500 ft.

Line12R: Roughness of the magnetic profile through points D, E, and F indicates that depth to basement rock is less in these areas than near Grant Range, Nerrima , and Myroodah. Similar rough profiles were recorded also on the profile between points H and I. Sharper anomalies recorded midway between points B and C coincide with the probable position of the Pinnacle Fault. Northward, the profile continues to be fairly smooth until the Precambrian boundary is approached; the profile then becomes rough.

Line 13R: North of point 1 the flight line passed over basement rock and the magnetic profile is rough. Between points F and H the profile is not as smooth as those over deep basement in the central portions of lines 7R and 8R, and the depth estimates are correspondingly less. South of point F, the profile is rougher. The shape of the anomaly between B and C suggests that it is due to a vertical tabular structure striking east. The maximum depth of the structure is 15,000 ft, but the actual depth is probably much less.

Line 14R: This profile is rough and suggests a depth to basement of about 15,000 ft. In the central portion between points G and K the depth may be somewhat greater than this.

(2) Magnetic Profiles in the Central and Eastern Canning Basin (Plate 2)

Lake Auld - Marbel Bar flight line: South-east of Marbel Bar the flight line crossed outcrops of Precambrian basement rocks between points 10 and 16.

The oldest of these rocks, the Archaeozoic, are divided geologically into three groups :- acid rocks (granite etc.); the Whitestone Series (mainly metamorphosed sedimentary rocks); and the Greenstone Series (mainly metamorphosed igneous rocks). The younger Proterozoic rocks are represented by the Nullagine Series (sediments and lavas with basic intrusives).

Correlation between the magnetic profile and the mapped boundaries of these rocks indicates that the Nullagine outcrops cause anomalies such as those near points 10, 11, and 12 on the profile, whereas the adjacent acid rocks produce very few noticeable anomalies.

The rough profile between points 14 and 16 corresponds mainly with outcrops of the Greenstone and Whitestone Series which evidently contain rocks of high magnetic susceptibility.

The anomaly five miles south-east of point 14 corresponds with a contact between the Whitestone Series and the acid group, and its form suggests a near-vertical contact between two formations with different magnetic susceptibilities. Between 9.5 and Lake Auld the profile is smooth over outcrops of Permian and Jurassic sedimentary rocks, but the relative sharpness of individual anomalies near Lake Auld indicates that basement rock there is not at a great depth.

Marble Bar - Christmas Creek flight line: This flight line crossed outcrops of basement rock between points 1 and 6. Two conspicuous anomalies were recorded, one at a point 12 miles north-east of point 3, and the other at point 5. The first is an anomaly of 1200 gammas and can be correlated with a mapped outcrop of a broad band of Upper Proterozoic volcanics of the Nullagine Series. The second anomaly, of 3000 gammas, lies close to the mapped boundary of the Precambrian outcrop on the southern edge of the Basin, and is also correlated with a band of Nullagine rocks which strike north-west. This anomaly is probably a continuation of the one recorded on each of the coastal flight lines to the north-west. It is similar in form to anomalies computed for vertical tabular structures. Basic dykes which could cause such anomalies, are characteristic of the Nullagine Series.

Between points 5 and 7 the profile is marked by anomalies of small amplitude which are less sharp than those recorded over basement outcrops and which indicate a gradual deepening of the Basin. The structure which causes the anomaly at point 6.7 is estimated to be no deeper than 5000 ft. Between points 7 and 9 individual sections of the profile are smooth, but the existence of small, relatively sharp anomalies leads to the conclusion that the thickness of sediments below this section of the traverse is much less than that measured or estimated in the central part of the Fitzroy Trough. Comparison with the magnetic profiles near La Grange, where a depth to basement of 8000 to 10,000 ft has been indicated by a seismic survey (Smith, 1960) indicates that between points 7 and 9 the basement is less than 10,000 ft below the surface. Between points 9 and 10, sharp anomalies occur near the Fenton Fault, and the depth to basement twenty miles north-east of point 9 is estimated to be less than 3000 ft.

Between points 10 and 11 the profile is smooth and an estimate of a large depth to basement agrees with seismic measurements of up to 20,000 ft of sediments at Poole Range (Smith, 1955).

Sturt Creek - Halls Creek flight line: This line crossed outcrops of Precambrian rocks. The profile shows sharp individual features characteristic of profiles over near-surface basement.

Wilson Cliffs - Sturt Creek flight line: The magnetic profile indicates that basement is not at great depth on the northern and southern parts of the line. In the central part, individual anomalies are less sharp, and depth to basement is estimated to be up to 10,000 ft between points F and M.

Tobin Lake - Wilson Cliffs flight line: Greater depth to basement is indicated by the greater smoothness of this profile west of Wilson Cliffs. The thickness of sediments is estimated to be up to 10,000 ft along most of the line, but is less near Tobin Lake.

Halls Creek - Tobin Lake flight line: Sharp anomalies were recorded over outcrops of Precambrian rocks near Halls Creek and point C. The profile is smooth between points D and L. The broad anomaly south of point H probably arises from a source at a depth not greater than 15,000 ft. Similar depths probably persist between points D and L. South of point L the roughness of the profile indicates shallowing of the Basin to depths of about 10,000 ft.

(3) Magnetic Profiles along the Coast (Plate 2)

The southern ends of all six profiles are rough. The sharpness of the anomalies indicates that depth to basement rock is small in this area. The source of the group of anomalies marked X on the profiles is an elongated structure striking north-west, whose extension produces a similar but sharper anomaly at point 5 on the Marble Bar-Christmas Creek flight line. A depth to basement of about 1000 ft is estimated from the dimensions of the anomalies. The anomalies are possibly due to a basic dyke.

Another group of anomalies, marked Y, twenty miles east of X, is possibly due to a dyke. Depth to basement here is estimated to be less than 3900 ft. Progressive smoothing of the profiles to the north-east along the coastline, indicates gradual deepening of the Basin. Basement depths up to 10,000 ft are estimated for the central sections of the profiles. The line of broad anomalies marked Z is interpreted as a contact between two rock types, the more magnetic rock being to the north of the contact. The contact strikes east and has been crossed obliquely by the flight lines.

Basement depths of 8000 to 10,000 ft have been measured by seismic methods at La Grange (Smith, 1960). Comparison between these measurements and profile features has been used as the basis for estimating depths to basement of up to 10,000 ft in the central sections of these coastal flight lines.

Roughness of the profiles south of Roebuck Bay indicates shallowing of the basement in this area. The anomalies marked W strike east and are probably due to a magnetic change in the basement rock.

### (4) Areas of More Detailed Aeromagnetic Survey (Plate 3)

Map 1: Contours of total magnetic field intensity in this area indicate an elongated structure striking east in the centre of the area. The line of intensity maxima lies south of the Fenton Fault. The form of the magnetic anomaly is similar to that computed for a simple fault with its down-throw side to the north-east. The estimated maximum depth to basement on the up-throw side is 5000 ft.

Map 2: The northern part of this area is magnetically undisturbed and, as indicated by the reconnaissance profiles across the area, the lack of anomalies in the magnetic field suggests that basement rock is either at a considerable depth or that it is almost non-magnetic.

There is a magnetically anomalous area south of latitude 18 degrees. The major anomaly is near the southern boundary of the Map 2 area and has an easterly trend. This anomaly is also present on the profiles of reconnaissance flight lines 3R, at 10 miles north of point 6, and 5R, at point 6.5. The source of the anomaly is an elongated structure striking east at an estimated depth of 6000 ft or less.

Map 3: The profile along line C is similar to that along the adjacent portion of line 6R (Plate 2). When comparing these two profiles, allowance must be made for the difference in the vertical scale of plotting. The anomalies of small amplitude on line C and the smooth profile on the central portion of line 6R indicate that the depth to basement becomes less southward from the Grant Range Bore where at least 13,000 ft of sediments have been proved. There is no magnetic indication of a fault where line C crosses the possible extension of the Fenton Fault.

Along line D, north-east of the Grant Range Bore, the profile is smooth with only minor disturbances, and indicates a thickness of sediments similar to that at the Grant Range Bore.

The aeromagnetic profile of line A over the Nerrima seismic traverse is more disturbed than the profile of line D, and indicates a possible decrease in depth to basement. The drilling results at Nerrima, however, showed a sedimentary thickness of at least 9000 ft. The magnetic disturbance may be due in part to magnetic material within reported basic plugs which penetrate the sediments in this area.

Map 4: The aeromagnetic profile B eastward from Broome is smooth and undisturbed, indicating large depth to basement. Seismic measurements on the western end of this line indicated basement depths of at least 12,500 ft (Vale and Williams, 1955) and the magnetic results suggest that these depths persist along the line.

## 9. CONCLUSIONS

The interpretation of the aeromagnetic profiles over the Fitzroy Trough, in conjunction with the results of gravity and seismic surveys, leads to the conclusion that the Trough extends as a well-defined structure from Dampier Peninsula in the west to the vicinity of Christmas Creek in the east (Plate 2). Within the Trough it is estimated that the thickness of sedimentary rocks ranges from 10,000 to 20,000 ft.

South-east of Christmas Creek the southern boundary of the Trough is not definite and, in addition to the indications that the main Trough continues east or slightly north of east, some evidence exists that a branch of the Trough swings south to the west of Mt. Ernest. Near Lake Tobin, Wilson Cliffs, and the eastern margin of the basin, moderate depths to basement rock (up to 10,000 ft) are indicated.

In the northern part of the Fitzroy Trough, the aeromagnetic results indicate a basement shelf where the thickness of sediments is 5000 to 6000 ft. South of the Fitzroy Trough, at its western end, there is evidence from the aeromagnetic profiles (and from drilling results near Dampier Downs, see Appendix) of a basement "high" trending north-west towards Broome.

In the coastal strip of the Canning Basin the aeromagnetic results indicate depths to basement rock of less than 10,000 ft beneath the whole area traversed. Depth estimates of 1000 ft and 3000 ft at points X and Y are confirmed by drilling results at Wallal Bore. Drilling results at Samphire Marsh and Roebuck Bay Bores also agree with aeromagnetic indications (see Appendix).

In the central part of the Canning Basin the indications from a single aeromagnetic traverse are that the depth to basement is less than 10,000 ft in the central part of the traverse, with a decrease in depth toward the boundary of the Basin in the south-west and towards the Fenton Fault in the north-east.

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## APPENDIX

### Results of Drilling and Ground Geophysical Exploration

The results of drilling and seismic exploration which are now available (B.M.R.G.G., 1960) give information on depths or likely depths to basement, and provide a check on the aeromagnetic interpretation. Gravity survey results are also available for comparison with the aeromagnetic reconnaissance profiles.

#### Fitzroy Trough

Fraser River No. 1 Bore, near point 3 on line 4R over Dampier Peninsula, penetrated Precambrian igneous rock at about 10,100 ft; this information confirmed the aeromagnetic indications on traverse 2R.

Roebuck Bay No. 1 Bore, located midway between the southern ends of line 2R and 4R, was drilled to 4000 ft and penetrated Ordovician sediments, which suggests that the Basin there is fairly shallow. Goldwyer No. 1 Bore, 15 miles south of Roebuck Bay No. 1 Bore, penetrated granite at 4720 ft.

Dampier Downs No. 1 Bore, located near point 6 on line 3R, was drilled to 3030 ft and penetrated Ordovician sediments. A maximum depth to basement rock of 6000 ft was estimated from the aeromagnetic anomaly nearby on lines 3R and 5R and it appears that the actual depth is probably within the estimated maximum.

Meda No. 1 Bore, north of point 3 on line 3R, penetrated basement schist at 8660 ft. Slightly north of this point, maximum depth to basement was estimated at 6000 ft.

Myroodah No. 1 Bore, between points 4 and 5 on line 7R, reached 6000 ft without penetrating basement rock. North of point 6 on line 7R, Sisters No. 1 Bore reached 9830 ft in sediments; this is consistent with the aeromagnetic indications of a large depth to basement.

#### Canning Basin (Coastal Area)

At Wallal, on the coastline near the southern ends of the coastal aeromagnetic flight lines, a bore drilled by the Bureau of Mineral Resources penetrated basement at about 2220 ft. A basement depth of 2000 ft was estimated from examination of anomalies recorded on the coastal flight lines.

Samphire Marsh No. 1 Bore, on the coastline north-east of Wallal, penetrated granite at approximately 6660 ft. The aeromagnetic profiles indicated that depth to basement rock in this area is less than 10,000 ft.

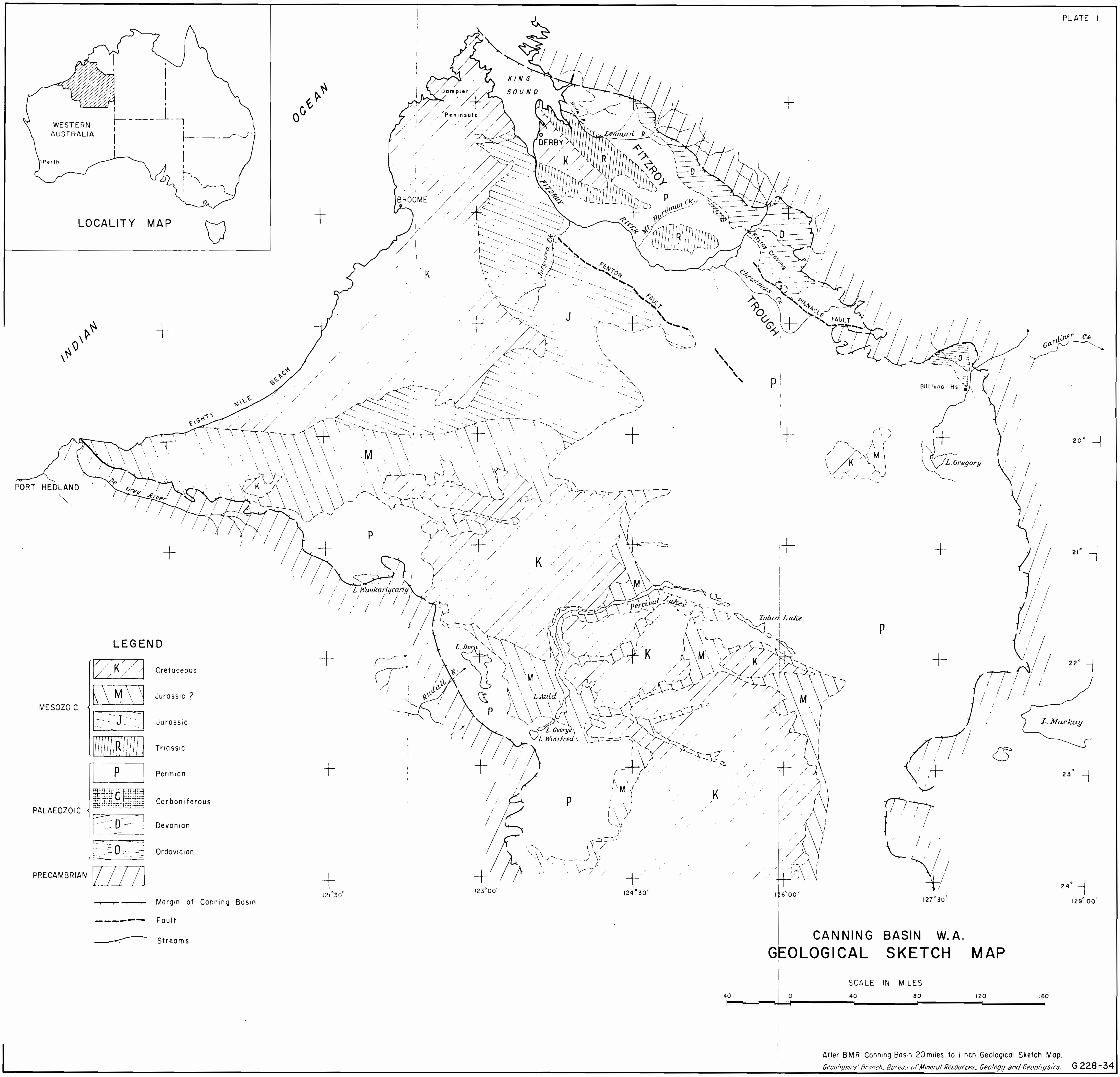
## Gravity Surveys

The available results of gravimetric surveys carried out in the Canning Basin provide more structural details than can be obtained from the aeromagnetic reconnaissance survey. Only those gravity results which affect the aeromagnetic interpretation are referred to here.

In the Meda River area in the northern part of the Fitzroy Trough, the gravity results suggest a shelf of basement rock. This is confirmed by the depths estimated from several aeromagnetic anomalies. Steep gravity gradients are recorded over the Fenton Fault on the Southern border of the Fitzroy Trough. The aeromagnetic profiles, however, show no features which can be definitely related to the Fenton Fault.

The northern and southern boundaries of the Fitzroy Trough are clearly defined by gravity results between Derby and Christmas Creek. Farther to the south-east the northern boundary continues to be well defined, but the southern boundary is not definite and there is some evidence that an arm of the Trough swings south. The prominent aeromagnetic anomalies at point C on line 13R and point H on line 14R appear to overlie gravity "highs" near Mt. Ernest.

PLATE I




CANNING BASIN W.A.

# GEOLOGICAL SKETCH MAP

After BMR Canning Basin 20 miles to 1 inch Geological Sketch Map.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 228-34

To accompany Records 1960, No.11

AUSTRALIA

1:1,000,000 EQUATORIAL SCALE
MERCATOR PROJECTION

PLATE 2


MERCATOR PROJECTION SCALE

STATUTE MILES 0 10 20 30 40 50 60 70 80 90 100

VERTICAL SCALE 0 500 1000 GAMMAS

ARBITRARY BASE 0 GAMMAS

# AEROMAGNETIC RECONNAISSANCE OF CANNING BASIN, 1954
## MAP SHOWING
## PROFILES OF TOTAL MAGNETIC INTENSITY

COMPILED & DRAWN IN THE GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES GEOLOGY & GEOPHYSICS.

LEGEND

FLIGHT LINE & CHECK POINT
AERODROME
TOWN — DERBY
ESTIMATED BASEMENT DEPTH — 10,000 ft.
LOCATION OF SEISMIC SURVEY — LA GRANGE

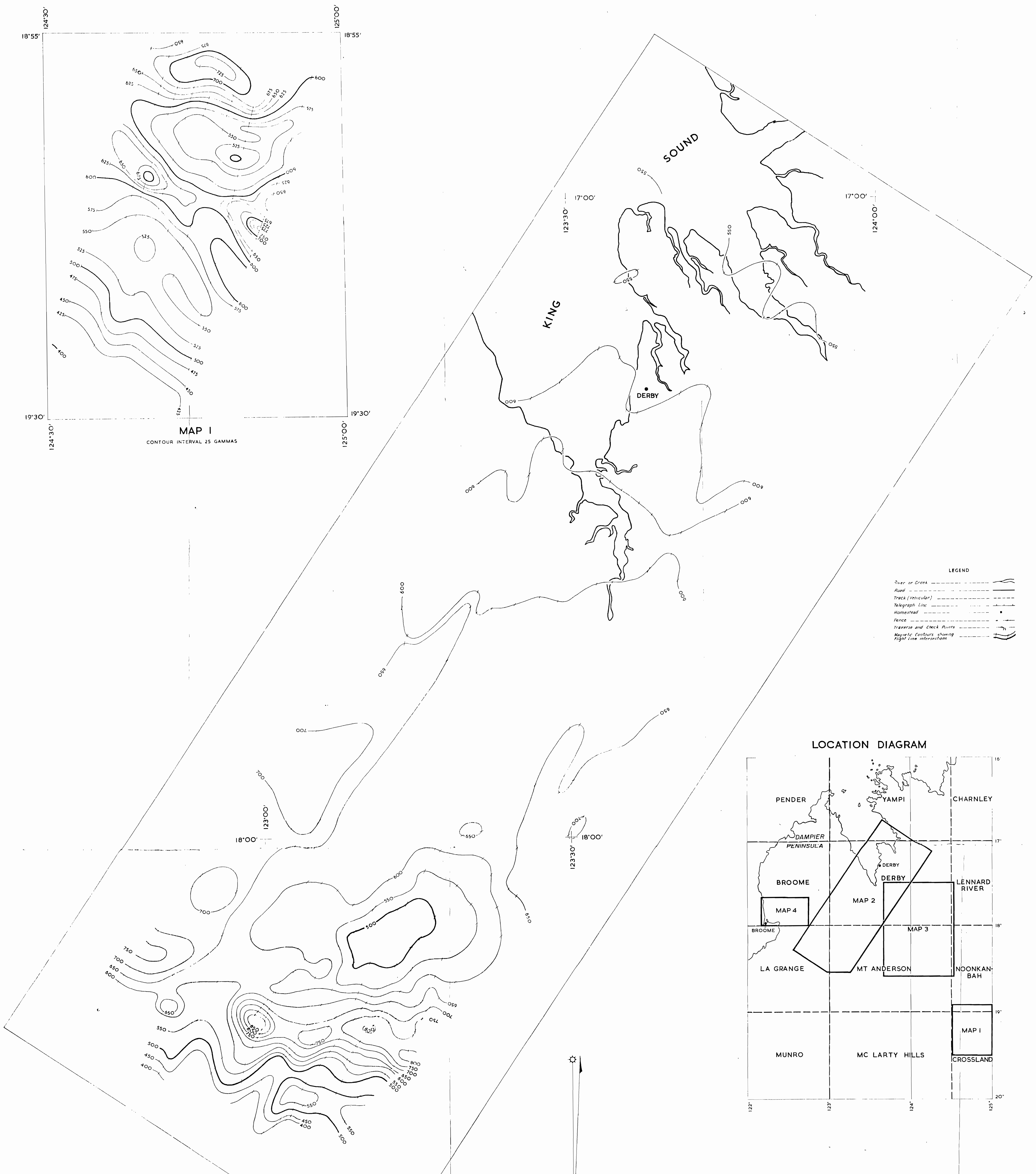
EXPLANATORY NOTE

*THE TOTAL MAGNETIC INTENSITY WAS CONTINUOUSLY RECORDED BY AN AN/ASQ-1 AIRBORNE MAGNETOMETER OPERATING AT AN ALTITUDE OF 1,500' ABOVE GROUND LEVEL.*

*THE AIRCRAFT WAS NAVIGATED BY VISUAL AND DEAD RECKONING SO THAT ERRORS IN POSITION MAY BE AS MUCH AS TEN MILES.*

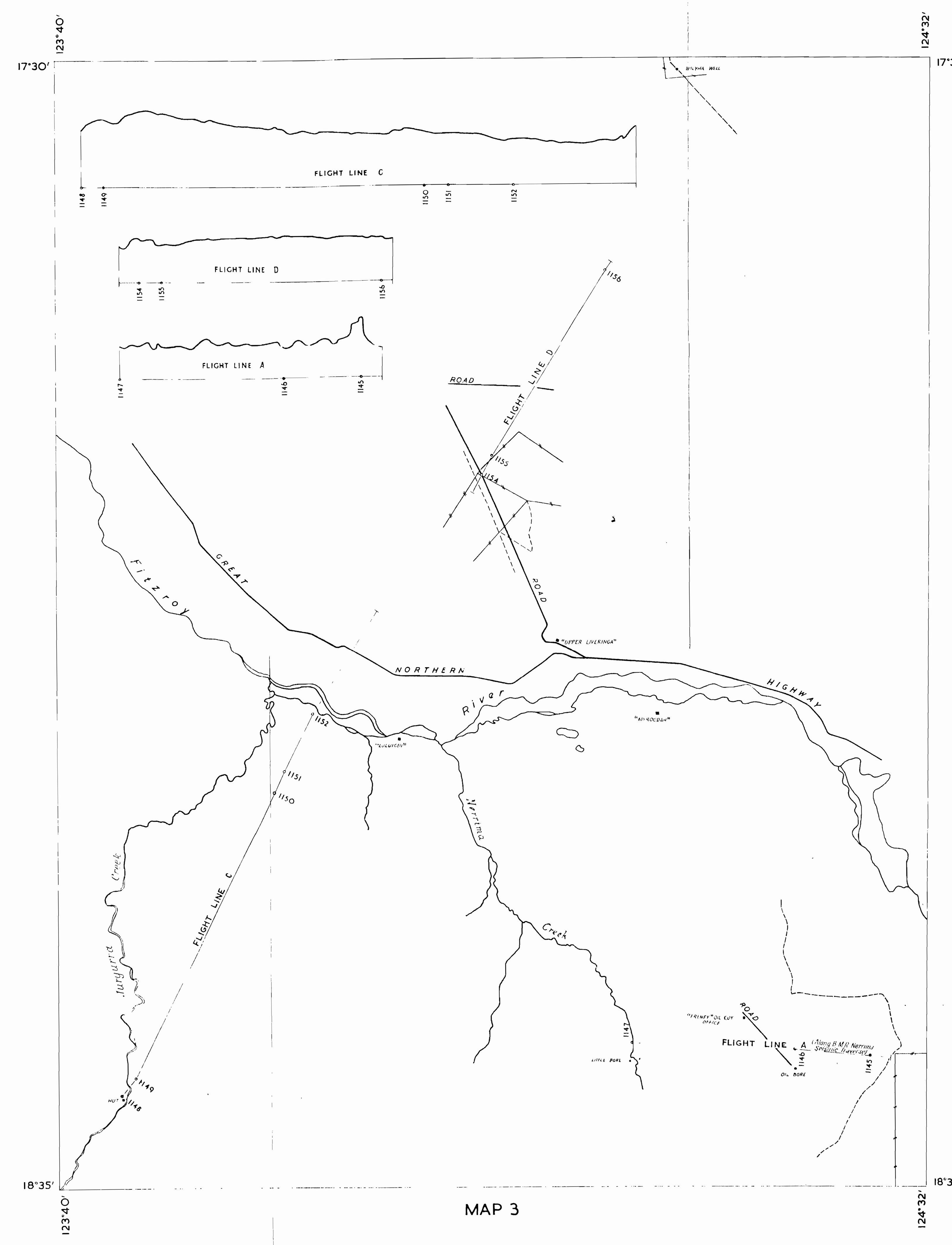
*THE DATA HAVE BEEN CORRECTED FOR THE REGIONAL VARIATION IN THE EARTH'S TOTAL MAGNETIC FIELD.*

*To Accompany Records 1960, No 11* G169-4-1




MAP 1
CONTOUR INTERVAL 25 GAMMAS

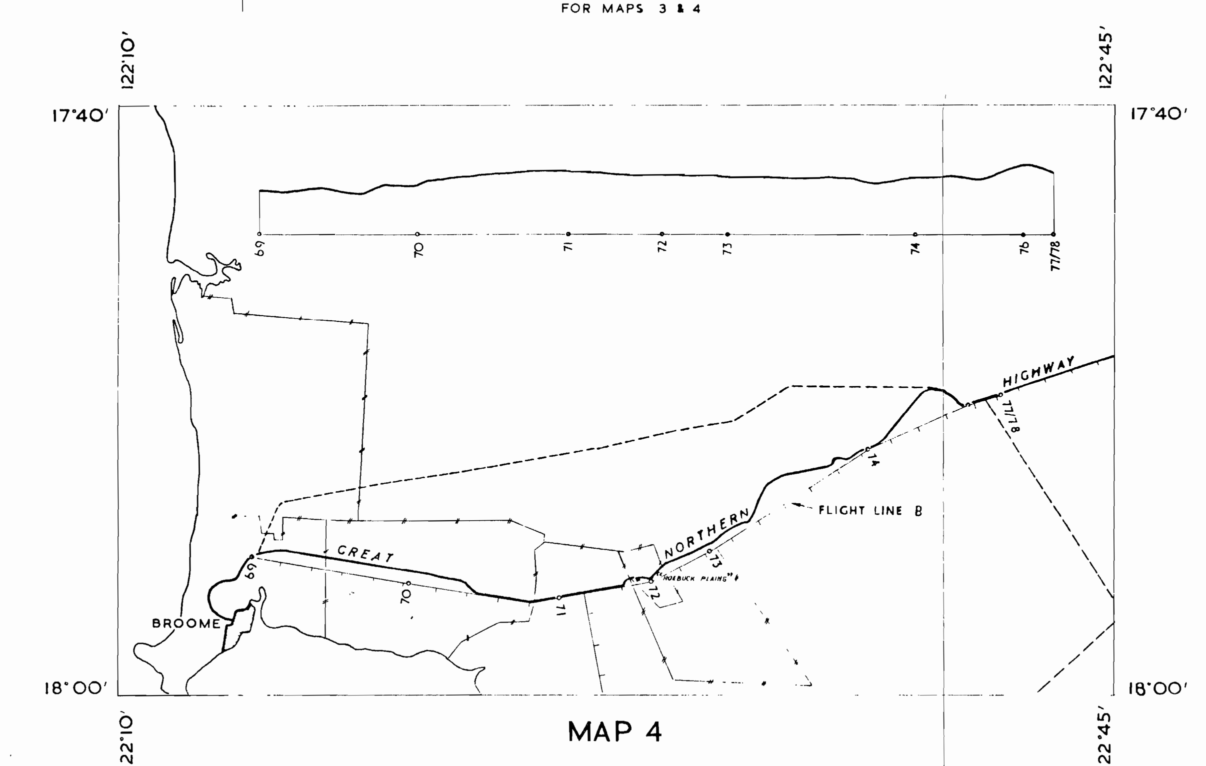
MAP 2
CONTOUR INTERVAL 50 GAMMAS




MAP 3

VERTICAL SCALE 400 300 200 100 0 GAMMAS

ARBITRARY BASE 300 GAMMAS FOR MAPS 3 & 4




MAP 4

# AEROMAGNETIC RECONNAISSANCE OF CANNING BASIN, 1954

## CONTOURS AND PROFILES OF TOTAL MAGNETIC INTENSITY IN SELECTED AREAS

MILES 4 2 0 4 8 12

*EXPLANATORY NOTE*

*THE TOTAL MAGNETIC INTENSITY WAS CONTINUOUSLY RECORDED BY AN AN/ASQ-1 AIRBORNE MAGNETOMETER OPERATING AT AN ALTITUDE OF 1500' ABOVE GROUND LEVEL.*

*THE AIRCRAFT WAS NAVIGATED VISUALLY IN THE AREAS COVERED BY MAPS 3 & 4, AND THE FLIGHTS PLOTTED FROM VERTICAL STRIP PHOTOGRAPHY TAKEN DURING FLIGHT.*

*IN THE AREAS COVERED BY MAPS 1 & 2 THE AIRCRAFT WAS NAVIGATED USING THE SHORAN METHOD.*

*THE DATA HAVE BEEN CORRECTED FOR THE REGIONAL VARIATIONS IN THE EARTH'S TOTAL MAGNETIC FIELD.*

COMPILED & DRAWN IN THE GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS.