COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1965/1

INTERPRETATION OF THE CONTRACT AEROMAGNETIC SURVEY, KOPPERAMANNA - FROME AREA, SOUTH AUSTRALIA 1963

by

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SUMMARY

In 1963, an aeromagnetic survey was made in the south-western part of the Great Artesian Basin by Adastra Hunting Geophysics Pty Ltd, under contract to the Bureau of Mineral Resources, Geology and Geophysics. The area comprised the southern halves of the Kopperamanna and Strzelecki 1:250,000 map areas and the whole of the Frome, Marree, and Callabonna 1:250,000 map areas.

The results of the survey are to be plotted, reduced, and contoured by the Department of Mines, South Australia. This record describes a brief preliminary interpretation made on the magnetic profiles prior to their despatch to the Department of Mines, South Australia.

The depth estimates indicate a basement ridge extending north-east from the Flinders Ranges and separating two possible sedimentary basins, one north-west of Lake Blanche and one beneath Lake Frome.

1. INTRODUCTION

In 1963, an aeromagnetic survey of the Kopperamanna- Frome area in the south-west of the Great Artesian Basin was programmed by the Bureau of Mineral Resources. The purpose of the survey was to assist in the search for oil by determining the thickness of sediments and the principal features of basin structure in a region in which almost no subsurface information was available. The area comprised the southern halves of the Kopperamanna and Strzelecki 1:250,000 map areas and the whole of the Marree, Callabonna, and Frome 1:250,000 map areas (Plate 1). The survey, originally requested by the Department of Mines, South Australia, was flown under contract by Adastra Hunting Geophysics Pty Ltd at a flight-line spacing of two miles and a constant barometric altitude of 1500 ft above mean sea level, with the exception of a small area of the Flinders Ranges, which was flown at 2500 ft above mean sea level. Most of the sedimentary areas are less than 100 ft above sea level, but the Flinders Ranges reach heights of over 2000 ft within the survey area.

Plotting, reduction, and contouring of the results will be carried out by the Department of Mines, South Australia. This Record describes a brief preliminary interpretation made on the original profiles prior to their despatch to the Department of Mines, South Australia.

Aeromagnetic surveys were made in 1961 to the north of the Kopperamanna-Frome area by Aero Service Corporation, under contract to Delhi Australian Petroleum Ltd (Delhi-Santos, 1961).

No deep drilling has yet been carried out in the Kopperamanna-Frome area, but a number of deep stratigraphic holes have been drilled to the north (Delhi-Santos, 1964) and large gas flows have been obtained from holes drilled on the Gidgealpa structure, only thirty miles from the northern boundary of the survey area, and exploration activity in this area may be expected to increase.

Because of the very limited time available for interpretation, it was possible to examine only every fourth east-west profile. Tie-line profiles were referred to where additional information on magnetic field trends was required. Depth estimates were made on all suitable anomalies, using Peters' half-maximum-slope method (Peters, 1949) with a factor of 1.6. Because of the lack of positional information, no correction could be made for oblique intersection of flight lines and magnetic contours; calculated depths are therefore maximum estimates only, even if the sources are ideal. Similarly, no allowance could be made for variations in groundspeed. Because of these limitations, the basement contours presented in Plate 2 are likely to be unreliable in detail, although they should show the broad general features of the magnetic basement. The contours are based on the depth estimates shown and also on a qualitative assessment of the profiles.

In the Frome 1:250,000 map area, this qualitative assessment has resulted in some of the deeper estimates being ignored in drawing the basement contours. Thus, four estimates (7300 ft, 5900 ft, 6400 ft, and 7100 ft), along a line trending a little east of north near the centre of the Frome area, are not contoured. It seems likely that these estimates were made on profiles taken across the anomaly from a single elongated source, which is almost certainly at a horizon deeper than that contoured, since the northernmost estimate of 7100 ft is adjacent to one of only 800 ft. This explanation seems preferable to postulating a graben structure, which the form of the profiles does not suggest, but the depth estimates remain as an indication of this possibility. A few other depth

estimates have been similarly disregarded. Contours drawn in the west of the survey area, where very few depth estimates could be made, are necessarily less reliable than those in the east.

2. GEOLOGY

The Frome 1:250,000 map area occupies part of a large embayment of Mesozoic sediments between the Precambrian outcrops of the Flinders and Barrier Ranges (Plate 1). The remainder of the Kopperamanna-Frome survey area lies north of this embayment in the south-west of the Great Artesian Basin. Archaean igneous and metamorphic rocks of the Flinders Ranges crop out round the junction of the Marree, Callabonna, and Frome 1:250,000 map areas, and Upper Proterozoic marine sediments and glacial tillites crop out in the south-west of the Marree 1:250,000 map area. Although Palaeozoic sediments are known in many parts of the Flinders Ranges, they have not been seen in the survey area. In some places the base of the Mesozoic sediments is seen to be directly in contact with the Precambrian rocks.

In recent years, there has been considerable oil search activity north of the Kopperamanna-Frome area and large flows of natural gas have been obtained from bores drilled on the Gidgealpa structure. The Oil Exploration Licence for the whole of the Great Artesian Basin within South Australia is held jointly by Delhi Australian Petroleum Ltd and Santos Ltd. Considerable subsurface information is available from the Gidgealpa and earlier bores drilled by these companies and this is summarised briefly in the well completion report on Gidgealpa No. 1 (Delhi-Santos, 1964). It has been shown that comparatively uniform, flat-lying Cretaceous and Jurassic sediments rest unconformably on widely differing older strata that range in age from Lower Triassic to possible Proterozoic. Permian and older Palaeozoic marine sediments are considered to be the most likely petroleum source rocks.

The following summary of the pre-Jurassic geology of the part of the Great Artesian Basin immediately north of the survey area, as inferred from deep drilling, is taken from the well completion report on Gidgealpa No.1 (Delhi-Santos, 1964).

"Quite obviously nothing can be set down firmly regarding the relationship of Lower Palaeozoic rocks in this region with the limited data available. However, it is quite probable that Cambrian seas extended down to the Gidgealpa area from the Georgina Basin with the possibility of a shoreline with active volcanoes to the south or west of Gidgealpa. At the end of Cambrian times tectonic movement thrust-faulted the Middle Cambrian over the Upper Cambrian in the immediate vicinity of Gidealpa, and subsequent erosion stripped the uppermost Cambrian strata. In Ordovician times marine quiet water deposition was very widespread. A severe Devonian to Carboniferous orogeny with subsequent erosion affected the whole region resulting in a complex outcrop pattern of these older Palaeozoic rocks. On this eroded surface Permian brackish or partly marine sediments were laid down. The Permian sedimentary basin evidently extended from east of Orientos No.1 to west of Gidgealpa No.1 but not as far as Pandieburra No.1. Its north-south extent has not been defined. With no appreciable break in deposition Lower Triassic sedimentation commenced in an area approximately the size of the Permian Basin. At the conclusion of Lower Triassic sedimentation an epeirogenic movement took place resulting in some erosion of the Triassic strata. On this surface Hutton Sandstone equivalents were laid initiating a long period of

sedimentation which was not terminated till the Winton Formation was deposited at the end of Mesozoic times. Renewed movements in Tertiary times along the old Palaeozoic structural trends resulted in gentle folding of the late Palaeozoic and Mesozoic strata."

It is also pointed out that the faunal zones in the Cambrian sediments intersected in Gidgealpa No. 1 are more closely related to those in the Cambrian sediments of the Georgina Basin, 320 miles to the north, than to those in the Flinders Ranges, only 210 miles to the south. The Kopperamanna-Frome area lies between Gidgealpa and the Flinders Ranges and the subsurface structure may be expected to be very complex.

3. INTERPRETATION

Discussion

The oldest outcrops in the area surveyed are of Archaean age. At the western end of the junction of the Frome and Callabonna 1:250,000 map areas, a ridge of Archaean metamorphic rocks, striking slightly north of east, dips under Mesozoic sediments. The magnetic profiles indicate that this ridge continues as a subsurface feature beyond the eastern limit of the survey area, dividing the area into two regions.

South of the ridge, along the eastern boundary of the Frome 1:250,000 map area, the magnetic field is disturbed for a short distance by narrow anomalies deriving from near-surface sources, possibly Archaean rocks similar to those that crop out near Broken Hill. A few miles west of the boundary the profiles become suddenly very flat, and for this reason a possible basement fault is shown on the contour map (Plate 2).

Disturbed profiles just east of Lake Frome indicate a basement 'high' striking a little west of south. West of this ridge the profiles are characterised by broad anomalies several hundred gammas in amplitude. Examination of the tie-line profiles shows that these anomalies are broad in the north-south plane also. Such broad anomalies suggest a region of highly magnetic basement rocks, as estimated depths are large, except in the extreme south. Profiles at the western ends of the traverses are disturbed by narrow anomalies, presumably due to basement rocks similar to those cropping out just west of the survey area.

Along the northern side of the main basement ridge the basement contours show a pronounced east-north-east trend. Magnetic sources are above sea level in the south-west corner of the Marree 1:250,000 map area, where Upper Proterozoic rocks crop out. Anomalies in this area are dispersed in an otherwise undisturbed field. Similar anomalies were seen in the north-east corner of the Andamooka 1:250,000 map area but were not considered to be due to basement rocks (Young, 1964). However, in this Record they are treated as basement anomalies.

Shallow basement is also indicated in the centre of the northern part of the survey area. Just to the north of this region the basement contours drawn by Aero Service Corporation, based on the Innamincka-Betoota aeromagnetic survey (Delhi-Santos, 1961), indicate a basement ridge with a pronounced east-west lineation. No attempt has been made to adjust the Kopperamanna-Frome contours to match the Aero Service Corporation interpretation (which is based on a much fuller analysis) but it should be noted that magnetic basement may be less than 6000 ft below sea level over much more of the Strzelecki 1:250,000 map area than is suggested in Plate 2.

The anomalies on which the shallow depth estimates are based in the north of the Marree 1:250,000 map area are of small amplitude and widely dispersed in an otherwise remarkably flat field. If these anomalies are considered to derive from basement rocks, then the basement in this region must be quite different in composition from that in other parts of the Kopperamanna-Frome area. Although they have been treated as basement anomalies in drawing the contours, it is possible that the sources are minor magnetic lenses within the sedimentary sequence.

Conclusions

The magnetic basement throughout the Kopperamanna-Frome area is likely to be of Archaean age, but it is possible that there are some magnetic sources in the older Palaeozoic and Upper Proterozoic strata. The greatest thickness of sediments is probably developed in the region north-west of Lake Blanche. Thicker sedimentary sections are likely north-west, west, and possibly north-east of the survey area, but there is a basement "high" in the north. There is possibly a thick sedimentary section under and to the south of Lake Frome, but it seems likely that magnetic basement will rise steeply south of the Frome 1:250,000 map area.

4. REFERENCES

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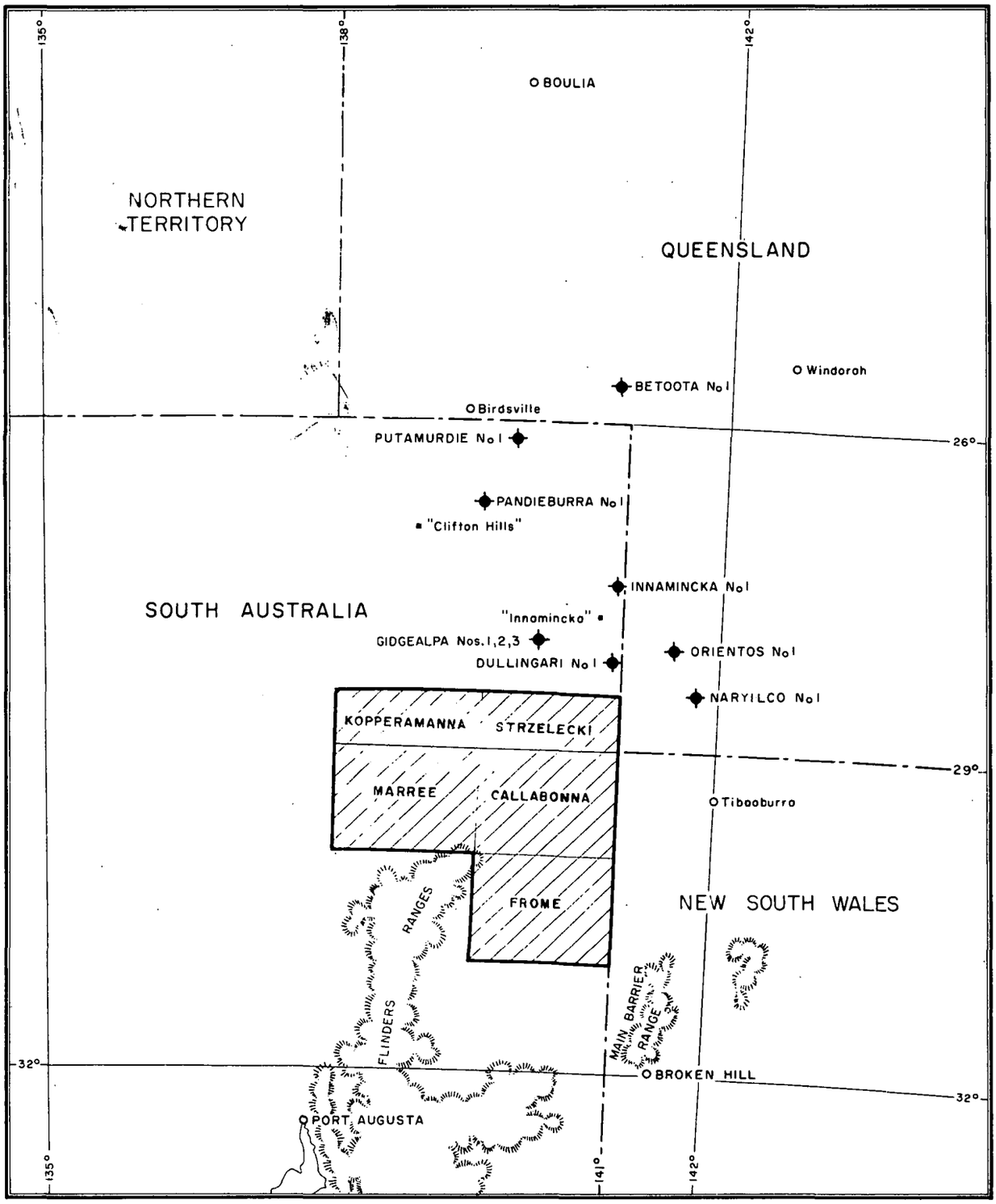


LOCATION DIAGRAM

LOCALITY MAP

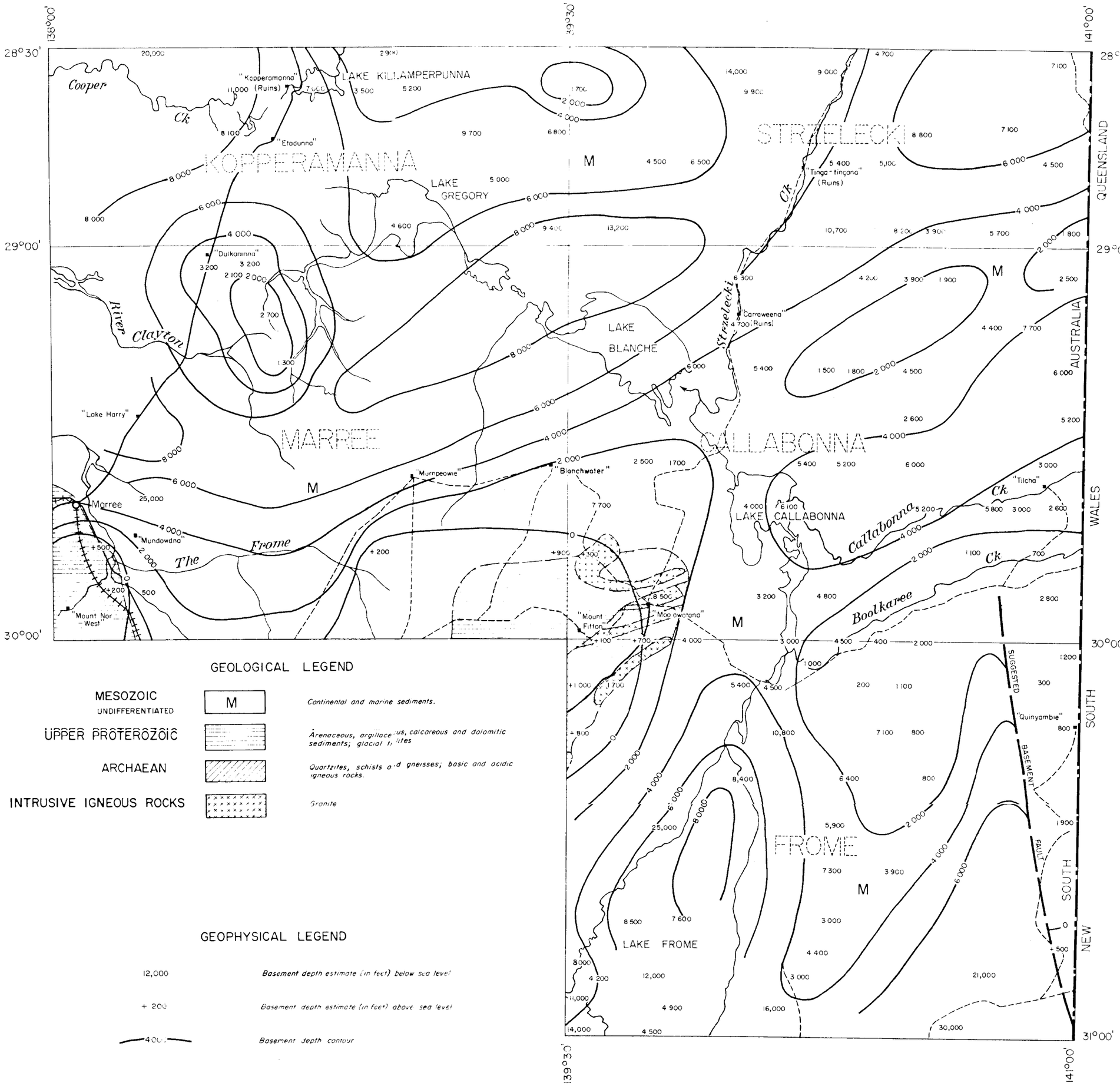
SCALE

100 50 0 100 200 MILES

Aeromagnetic Survey Area

Borehole

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. H54/B1-19
To accompany Record No. 1965/1



GEOLOGICAL LEGEND

MESOZOIC UNDIFFERENTIATED	M	*Continental and marine sediments.*
UPPER PROTEROZOIC		*Arenaceous, argillaceous, calcareous and dolomitic sediments; glacial tillites*
ARCHAEAN		*Quartzites, schists and gneisses; basic and acidic igneous rocks.*
INTRUSIVE IGNEOUS ROCKS		*Granite*

GEOPHYSICAL LEGEND

12,000	*Basement depth estimate (in feet) below sea level*
+ 200	*Basement depth estimate (in feet) above sea level*
4000	*Basement depth contour*

LOCATION DIAGRAM

SOUTH-WEST GREAT ARTESIAN BASIN, SOUTH AUSTRALIA

PRELIMINARY MAGNETIC BASEMENT CONTOURS AND GEOLOGY

(DEPTH ESTIMATES NOT CORRECTED FOR VARIATIONS IN STRIKE)

SCALE

10 0 10 20 30 40 50 60 70 MILES

10 0 10 20 30 40 50 60 70 80 90 100 KILOMETRES

GEOLOGY AFTER TECTONIC MAP OF AUSTRALIA

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics H54/B1-18

To accompany Record No. 1965/1