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RECORDS 1960 No. 105

FORBES - WEST WYALONG AND BOURKE AREAS, AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY N.S.W. 1960

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ABSTRACT.

An airborne reconnaissance survey with magnetometer and scintillograph was made in the Forbes - West Wyalong, and Bourke areas of New South Wales.

Preliminary maps have been prepared showing the principal magnetic and radiometric results and the available geological information.

Although full evaluation of the aeromagnetic data must await completion of the final contour maps, the preliminary presentation shows that the aeromagnetic data will assist in the elucidation of the regional geology, particularly in the areas covered by alluvium, and in deciding whether or not any particular areas should be recommended for more detailed investigation by ground methods.

Thirty three radiometric anomalies were detected during the survey. They appear to be due to restricted areas of unusually high radioactivity. Examination of the anomalies on the ground would be required to determine the cause of the radioactivity.

1. INTRODUCTION

The survey described in this report forms part of a larger programme of regional airborne reconnaissance in New South Wales which was commenced by the Bureau of Mineral Resources in 1957. During 1957 and 1958, the Bureau completed airborne surveys of the Cobar, Nymagee, and Euabalong 4-mile military map areas.

The present survey covered the 4-mile map areas of Bourke and Forbes, the latter extended by 10 miles north and 5 miles east, and the 1-mile areas of Ardlethan, Barmedman, and Buddigower (Plate 1). The selection of these areas for inclusion in the Bureau's airborne programme was made in accordance with recommendations by the Mines Department of New South Wales. In addition, the Bureau's attention had been drawn to local reports of unexploited mineral deposits, including iron and manganese, in the Parkes district, and the survey was extended to the north and east of the Forbes 4-mile area in order to cover the areas referred to in those reports.

The flying operations were conducted in April and May 1960, with the Bureau's DC.3 aircraft VH-MIN. The field party was based first at Parkes and then at Bourke, and comprised the following officers of the Geophysical Branch - R.M. Carter (Party Leader), R. Wells, K.J. Seers, F.G. Walker, D.F. Upton, R. Jones, and E. Kram-Steins; and the following officers of Trans Australia Airlines - Capt. G. Close, First Officer G. Green, and Engineers J. Barrell and J. Maskell.

2. METHODS

The survey consisted of a systematic reconnaissance with airborne magnetometer and scintillographs.

Anomalies in the magnetic field, recorded by the magnetometer, are related to differences in magnetic properties of the underlying rocks. The results of an aeromagnetic survey, when presented as a contour map, are often an aid to regional geological mapping, particularly in areas of sparse rock outcrop. Aeromagnetic contour maps may also delineate areas suitable for more detailed investigation by ground magnetic methods.

The scintillographs were used to record the terrestrial gamma-radiation and hence to detect areas of high or above-average radioactivity. Such areas, depending on their geological environment, may warrant examination for occurrences of radioactive minerals. The gamma-radiation was recorded at two different heights by using two separate scintillographs, one within the aircraft and the other suspended some distance below. The additional information provided by the two-level recording technique assists in the analysis of any radiometric anomalies detected.

The survey areas were covered by flying along parallel east-west traverses spaced 1 mile apart. The height of the aircraft was maintained at a nominal 500 ft above ground level, but the actual height varied as much as $\pm$ 50 ft under normal flying conditions.

Tie-lines were flown in order to enable corrections to be made for differences in magnetic datums of individual flight-lines; such differences arise because of diurnal variations and instrumental drift. The tie-line system consisted of north-south lines spaced at a nominal 15 miles; each tie-line was flown in one direction only, and intersected all flight-lines.

The aircraft was navigated with aerial photographs upon which had been drawn the predetermined flight paths. The approximate position of the aircraft was determined by reference to recognisable ground features, and was marked on the photographs at intervals along each flight-line. A continuous photographic record of the track of the aircraft was produced by a vertical strip camera, to provide for the subsequent accurate plotting of the aircraft's track on photo-mosaics.

Correlation of the various records was achieved by means of fiducial marks on all the recorder charts and photographic records.

3. EQUIPMENT

A saturable-core fluxgate magnetometer, type AN/ASQ-8, was used with its detector head installed at the end of a cylindrical boom projecting from the tail of the aircraft. This arrangement ensured the least possible disturbance of the magnetic field at the detector head by the magnetism of the aircraft. The effects of the aircraft's magnetism were further reduced by the presence of compensating coils attached to the detector head. The output of the magnetometer, representing a continuous measurement of the intensity of the total magnetic field of the earth, was recorded by a "Speedomax" recorder. During the course of the survey, additional equipment was installed in the aircraft to provide a reduced-scale record of the magnetometer profile. The purpose of this record was to facilitate preliminary inspection of the results. The second recorder was in operation only for the latter part of the survey and reduced-scale profiles are therefore available only for the Bourke area.

The aircraft was fitted with two separate scintillograph systems. One, mounted in the aircraft, consisted of two M.E.L. scintillograph detection heads, the combined outputs of which were integrated by a B.M.R. rate meter and recorded by a single-channel Kelvin-Hughes recorder. The time constant of this system was approximately 2 seconds.

The second system, a "towed bird" scintillograph, used an aerodynamically-stable fibreglass shell, trailed 300 ft below the aircraft by means of a 500-ft cable controlled by a hydraulic winch. The shell contained a plastic phosphor detector head, a transistorised power unit, and a pre-amplifier, the output of which was fed via the towing cable to a second radiation monitor and Kelvin-Hughes recorder mounted within the aircraft. The second rate meter/recorder system was identical with the first, except that the time constant used was approximately 1 second.

Navigational equipment consisted of a radio-altimeter, for continuous and accurate altitude measurement, a radio-compass, and an air position indicator. An altitude profile was recorded on a Kelvin-Hugh recorder so that height corrections could later be applied to the radiometric data.

The air position indicator was used to provide an air plot of the progress of the aircraft along each flight-line. The air position was resolved into two components at right angles, and recorded in two ways:-

(a) By having the co-ordinates displayed on two milage counters which were photographed at regular intervals.

(b) By recording the air position graphically on a single-channel "Rectiriter" recorder, on which one co-ordinate was presented by chart movement and the other by pen displacement.

The track of the aircraft was recorded continuously by means of an "Aeropath" continuous-strip 35-mm vertical-axis camera.

4. FORBES - WEST WYALONG AREA

A. Geology

A regional geological map of the surveyed area is shown in Plate 2 and is based on information supplied by the New South Wales Department of Mines. The geology of much of the area is unknown because of the extensive alluvial cover.

The area is situated within a broad meridional belt of Ordovician and Silurian sedimentary rocks which extends with a width of about 100 miles from the Victorian border almost to the Darling River (Voisey, 1953).

The Silurian sediments in the area comprise shale, tuff, sandstone, and conglomerate. In the Forbes-Parkes district they are strongly folded and much altered. In places, the Silurian sediments are overlain unconformably by Devonian sediments.

The Ordovician and Silurian sediments have been extensively intruded by granite and porphyry. The mineralisation which produced the gold of Wyalong and of the Forbes-Parkes mineral field, the copper and gold of Condobolin, and the tin of Ardlethan is considered to be associated with these intrusions.

In the Forbes-Parkes mineral field, formerly an important gold producing district, the gold was one from alluvial deep leads and from fissure-type lodes localised in shear zones and stockworks. Manganese deposits near Parkes occur as lenses and veins in shear zones.

In the Condobolin district copper, silver, and lead have been mined in several localities. Near Condobolin, pitchblende and secondary uranium minerals have been found in association with zinc, lead, and copper in a fissure in granite. In the Ardlethan tin field, tin has been produced from lodes located along the eastern margin of the granite intrusion and from alluvial deep leads.

3. Magnetic Results

The results of the aeromagnetic survey will be published in a series of magnetic contour maps on a scale of 2 miles to one inch. These maps are in preparation and when completed will give a detailed and accurate presentation of the aeromagnetic data.

For the purpose of a preliminary inspection of the results, the anomalies with amplitudes greater than 500 gammas and width less than $2\frac{1}{2}$ miles have been selected and are shown in Plate 2. The points marked are the positions of the anomaly peaks. These have not been plotted with the same accuracy as used in the final contour maps, and probable errors of positioning are $\pm \frac{1}{2}$ mile north-south, and $\pm \frac{1}{2}$ mile east-west.

The magnetic results shown in Plate 2 are restricted to the more prominent anomalies and do not include many of the less intense features which will appear in the final contour maps. However, the anomalies marked are sufficient to show that large parts of the area are magnetically disturbed. None of these anomalies appear to coincide with the mining centres but it will be necessary to study the contour maps to determine if there is any correlation between the magnetic results and the known mineralisation.

Local reports concerning the occurrence of iron ore near Parkes have referred to two very large deposits, one centred about 14 miles east-north-east and the other about the same distance south-east of the town. Only three anomalies exceeding 500 gammas were recorded in the area north-east and east of Parkes. If the iron ore occurred mainly in the form of magnetite, deposits of the size described would produce anomalies many times stronger than those recorded. Although preliminary examination of the results does not support the existence of such deposits, it does not rule out the possibility of iron occurring in deposits mainly of haematite (like those in the Carcoar district); as haematite is non-magnetic, such deposits would not be detectable by the magnetic method.

The manganese deposits known in the Parkes district are referred to by Voisey (1953) as being similar to those in New England. The New England deposits occur as lenses, veins, and partial replacements in shear zones, and consist of jacobsite, pyrolusite, and psilomelane in association with quartz, rhodonite, and iron oxide. The jacobsite in New England is strongly magnetic (Stillwell and Edwards, 1951), but pyrolusite and psilomelane have low magnetic susceptibility. As there is very little specific information available concerning the manganese deposits in the Parkes district, there is no basis at present for supposing that they would be detected by a magnetic survey.

A group of intense anomalies was recorded over the Silurian sediments south-west of Forbes. These anomalies indicate a zone of magnetic disturbance which extends in the same direction as the general strike of the Silurian rocks, i.e. a few degrees east of north. The anomalies immediately to the north, north-west, and west of Parkes indicate that the same zone probably continues to the northern limit of the surveyed area.

The anomalies recorded over the alluvium-covered area south of Lake Cowal are also aligned in the general direction of strike of the Silurian rocks. It is clear that the complete aeromagnetic data will add to the knowledge of the geology by indicating the structural trends in areas of alluvium.

There are many anomalies in the area between West Wyalong and Barmedman. The location of these anomalies close to the contact of the intrusive granite with the sediments suggests the existence of further mineralisation associated with the intrusion, in addition to the known deposits at West Wyalong and Barmedman.

C. Radiometric Results

Twenty radiometric anomalies have been indicated on Plate 2. These are based on the interpretation of the two-level scintillograph data.

The interpretation consists of measurement of the widths (at half maximum amplitude) of the anomaly on each of the two scintillograph records and comparison of these widths with the theoretical values calculated for hypothetical radioactive sources. Widths have been calculated for sources of various areas and with various offset distances from the flight track. From the widths recorded at two different heights, it is theoretically possible to arrive at a single value for the radius of the source and for its offset distance. Thus small-area sources can be distinguished from broad exposures of only slightly radioactive rock such as granite.

The anomalies plotted on Plate 2 have been evaluated in this way, and each is attributed to a point or small-area source not exceeding 600 ft in radius. From examination of the radio-altimeter records, it is considered that none of these anomalies is due to topographic effects. This is certainly true of those recorded over flat expanses of alluvium. The four most intense anomalies were recorded over alluvium, and one of these (No. 9) is also the sharpest anomaly recorded.

A ground investigation will be necessary to establish the causes of the radiometric anomalies. Until this is done, there is no reason to suppose that any of the anomalies are associated with radioactive deposits of economic interest.

5. BOURKE AREA

A. Geology

The southern portion of this area is part of the Cobar Plateau, and the terrain slopes down gradually northward to the Darling River. The river basin is part of the southern margin of the Great Artesian Basin, and is covered by Mesozoic and Cainozoic sediments.

The belt of Ordovician and Silurian rocks which extends across the Southern Highlands from the south almost to the Darling River, occupies about one half of the Bourke area, in the south and east. Most of the remaining area is covered by Cainozoic alluvium, which covers the Palaeozoic rocks (Voisey, 1953) along the river in this vicinity. The other rocks and formations are : several small isolated patches of Cretaceous conglomerate and sandstone; several small isolated patches of Devonian quartzite and conglomerate; a few large expanses of Silurian granite within the slate and schist of the same period; and several very small patches of Tertiary basalt and sandstone. The Devonian strata in common with the older Palaeozoic rocks, were probably deformed by the Tabberabberan orogeny, which is evident over a large area of the state, including the Southern and Central Highlands (Browne, 1949).

The mineralisation associated with the orogenic granitic intrusions is considered to be the probable cause of the copper and gold of the Cobar area (ibid.) and perhaps the copper at Hermidale and Girilambone.

At Mt. Dijou there are quartz-magnetite-haematite lodes, and one variety, a siliceous vughy type, has been reported to be gold-bearing; several pits and shafts have been sunk on the lodes (Thomson, 1949). At Bald Hill, 4 miles south of Mt. Dijou, there has been extensive prospecting for gold.

The only other known mineral deposits apart from the gypsum near Bourke are the gold deposits near the Gunderbooka Range. These occur as narrow quartz veins in contorted claystone, sandstone, and sandy shale. The gold production has been almost negligible (Mulholland, 1940).

B. Magnetic Results

A preliminary presentation of the magnetic results from the Bourke area is given in Plate 3, in the form of profiles of total magnetic intensity. These are reproduced from the records made during the survey by the reduced-scale recorder, and have been superimposed on a regional geological map based on information provided by the New South Wales Department of Mines. The accuracy of positioning of the magnetic features is estimated to be $\pm \frac{1}{4}$ mile east-west and $\pm \frac{1}{2}$ mile north-south. The magnetic (vertical) scale of approximately 1200 gammas per inch used in drawing the profiles is such that anomalies of 50 gammas or less are not noticeable. The curvilinear type of chart record used has produced some distortion in the larger anomalies.

In the north-western part of the area the general smoothness of the profiles indicates a considerable thickness of sedimentary rocks, except at the western ends of flight-lines 57 and 58 and the central parts of lines 66 and 69, where depths to "magnetic basement" are estimated to be 1500 ft and 1000 ft respectively.

A previous aeromagnetic survey of part of the Bourke area was made in 1949 by Zinc Corporation Limited (Thomson, 1950). This survey, which was a very broad reconnaissance, detected a few of the magnetic features which have been recorded in more detail during the Bureau's 1960 survey. These include the isolated anomaly of about 1000 gammas near Mt. Dijou, the smaller and broader anomaly 30 miles west of Byrock, and a large intensely disturbed zone near the Bogan River in the eastern part of the area.

A geological reconnaissance carried out subsequently by Zinc Corporation Limited showed that, except at Mt. Dijou, these magnetic disturbances occur in areas covered by Recent alluvium, Tertiary sediments, or Devonian quartzite, with neither definite surface evidence of mineralisation nor topographical expression of rock alteration such as silification (Thomson, 1949).

The pronounced anomaly near Mt. Dijou is probably related in some way to the known mineralisation, but a detailed geological and ground magnetic investigation would be necessary to determine the exact nature of the association.

The present survey shows that there are strong magnetic disturbances to the west and south, as well as to the north, of the granite intrusion situated just west of Gongolgon. The disturbances are of interest in that they indicate the existence of important geological features not evident at the surface; the proximity to the granite intrusion suggests that the disturbances may be due to mineralisation. South of the granite mass, a line of prominent anomalies can be traced with a north to north-west strike for a distance of about 16 miles. This line of anomalies appears to be due to a narrow steeply-dipping magnetic body in the Silurian rocks, and may indicate a dyke or mineralised shear zone.

The sharp negative anomalies near the centres of lines 1 and 2 at the extreme south of the area, are continuous with a north-south line of similar negative anomalies detected during the Bureau's survey of the adjoining Cobar area. The line continues for about 12 miles to the south and is probably due to a basic dyke or flow with reversed polarisation.

C. Radiometric Results

The interpretation of the scintillograph results followed the procedure already described. Thirteen radiometric anomalies due to small-area sources were recorded and have been plotted on Plate 3. The average amplitude is much lower than that of the anomalies observed in the Forbes survey. The four most intense anomalies were recorded over alluvium. A ground investigation will be required to determine the cause of the anomalies.

6. CONCLUSIONS

As preparation of the final maps showing the complete results of the aeromagnetic survey is still in progress, it is possible at present to make only a preliminary assessment of the aeromagnetic results, based on consideration of the more prominent magnetic anomalies recorded.

Many such anomalies were recorded in both areas. Some of them indicate lines or zones of disturbance which follow the general strike of the regional geological structures. Others are grouped in areas adjacent to masses of granite, and may be related in some way to mineralisation. The known mineralisation in or near the survey areas is considered to be associated with the intrusion of granite into the sedimentary rocks. Except at Mt. Dijou in the Bourke area, there appears to be no close correlation between the more prominent magnetic anomalies and known mineral deposits.

Altogether, 33 radiometric anomalies were detected by the airborne scintillographs during the survey. In both areas some anomalies occur over Recent alluvium and others over outcropping Palaeozoic rocks. The more intense anomalies were detected over alluvium. It is considered that a ground investigation to establish the cause of these radiometric anomalies is warranted.

It is important to emphasise that an airborne reconnaissance survey of the type described here, should be regarded only as an initial phase in the exploration for mineral deposits. The advantage of airborne geophysical methods lies mainly in that they make possible the systematic reconnaissance of a large area in a relatively short time. The airborne survey should be followed by a careful study of the aeromagnetic contour maps in conjunction with the known geology. The aeromagnetic contours are expected to provide considerable information concerning the regional geology, particularly in places where geological surface mapping is not possible because of lack of outcrop.

All the available geological information as well as the aeromagnetic results will have to be taken into consideration before any detailed ground prospecting for mineral deposits could be recommended. If any particular localities are selected for further investigation, detailed geological mapping should first be carried out before a decision is made to apply ground geophysical methods.

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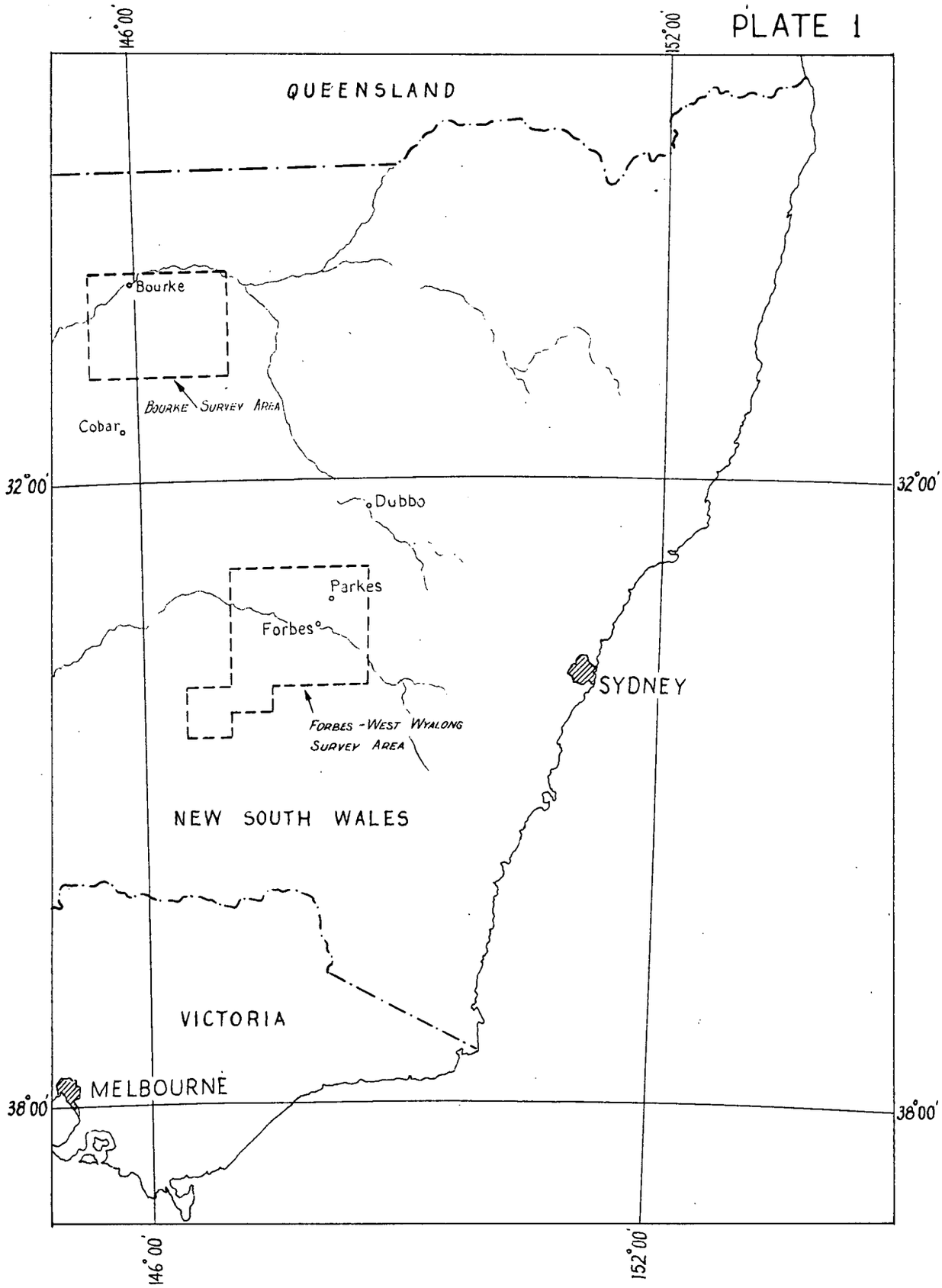
PLATE 1



LOCALITY MAP

AREAS COVERED BY 1960 AIRBORNE SURVEY, N. S. W.

SCALE 100 0 100 200 MILES.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics. G 358-3
To accompany Records 1960, No 105

PLATE 2

FORBES-WEST WYALONG
PRELIMINARY MAGNETIC AND RADIOMETRIC RESULTS

AIRBORNE SURVEY, 1960,
OF
FORBES 4 MILES TO 1 INCH MILITARY MAP AREA, N.S.W.
& ARDLETHAN, BUDDIGOWER, BARMEDMAN, 1 MILE MILITARY MAP AREAS, N. S. W.

SCALE
MILES 4 0 4 8 12

LEGEND

RECENT — Silt, Clay, Sand, Gravel

TERTIARY — Gravel, Sand

DEVONIAN (UPPER) — Sandstone, Quartzite, Conglomerate, Shale Cookpartra Group

DEVONIAN — Lavas Rhyolite Trachyte

SILURIAN — Sandstone, Conglomerate; Porphyry; Ungarie granite; Granite (not named); Granite & Porphyry; Norite; Diorite

ORDOVICIAN (UPPER & MIDDLE) — Sandstone, Quartzite, Phyllite, Shale, Slate, Fine Conglomerate, Grit Siltstone

Undifferentiated Igneous Material Granite, Rhyolite Porphyry

Geology not known

LEGEND

⊗600 MAGNETIC ANOMALY SHOWING AMPLITUDE IN GAMMAS

✦ RADIOMETRIC ANOMALY

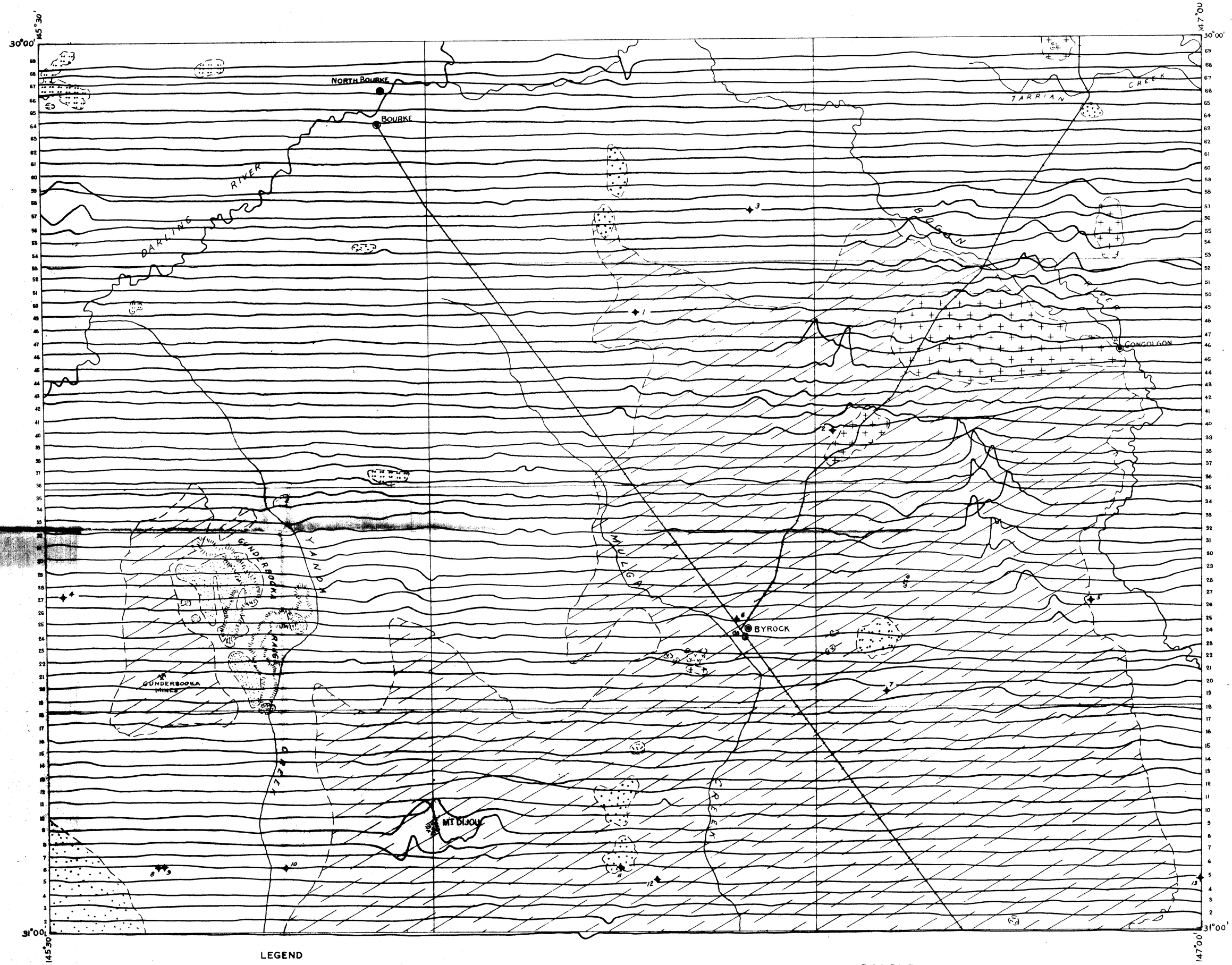
● TOWNSHIP

Geological Information Supplied by New South Wales Department of Mines

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics. G324-4

To accompany Records 1960, No 105

PLATE 3



LEGEND

CAINOZOIC — *Alluvium*

TERTIARY — *Coarse Sandstone*

TERTIARY — *Leucite Basalt*

CRETACEOUS — *Thinly Bedded White Sandstone and Fine Conglomerate.*

DEVONIAN — *Mulga Downs Formation Quartzite, Shale, Sandstone and Conglomerate.*

DEVONIAN — *Amphitheatre Group Quartzite, Sandstone, Shale and Conglomerate.*

DEVONIAN — *Undifferentiated Quartzite, Conglomerate, Shale, Sandstone.*

SILURIAN — *Slate, Schist, Crushed Sandstone and Phyllite.*

SILURIAN — *Granite*

BOURKE

GEOLOGY, PRELIMINARY MAGNETIC PROFILES AND RADIOMETRIC RESULTS

AIRBORNE SURVEY, 1960,

OF

BOURKE 4 MILES TO 1 INCH MILITARY MAP AREA, N. S. W.

SCALE

MILES 4 0 4 8 12 MILES

VERTICAL MAGNETIC SCALE APPROX. 1200 GAMMAS PER INCH

Traced from Geological Map of New South Wales in Course of Preparation by New South Wales Mines Department. Dated 29th Feb., 1960, and Reference No 2026.

LEGEND

RADIOMETRIC ANOMALY

RAILWAY

Geophysical Branch, Bureau of Mineral Resources Geology and Geophysics

G358-2

To accompany Records 1960, No 105