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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1966/65

GOULBURN AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY,

NEW SOUTH WALES 1965

by

E.P. SHELLEY

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SUMMARY

During the period November 1965 to January 1966, an airborne magnetic and radiometric survey was flown over the Goulburn 1:250,000 map area of New South Wales. This Record deals with the analyses of the magnetic and radiometric results.

The interpretation of the magnetic data is only qualitative. The area has been subdivided into zones based on magnetic character, the different magnetic characters being ascribed to different rock types. Magnetic trends have been resolved and several fold axes delineated.

The results showed no anomalies that could be related to economic mineralisation in the survey area, but several intense anomalies near the margins of granite bodies suggest the presence of mineralisation along the granite/sediments contacts.

Intense negative anomalies over areas mapped as Tertiary basalt indicate that some of these basalt flow remnants are reversely polarised.

The contour presentation of the radiometric data reveals some correlation between radioactive "highs" and regions of granite and porphyry outcrop. The survey revealed twenty-eight radiometric anomalies of restricted source, of which seventeen are recommended for ground investigation.

1. INTRODUCTION

At the request of the New South Wales Department of Mines, a programme of airborne magnetic and radiometric surveys was commenced by the Bureau of Mineral Resources in 1957. The areas selected for survey are known to contain metalliferous deposits; some have considerable areal extent of soil cover obscuring the rock surface. The Bureau has so far completed airborne surveys of the following 1:250,000 standard map areas:

Cobar, Nymagee, and Cargelligo (Spence, 1961);

Bourke and Forbes (Carter, 1960);

Narromine and Bathurst (Young, 1963).

During the period November 1965 to January 1966 a further stage of the programme was completed with the flying of the Goulburn 1:250,000 map area. The area is enclosed by latitudes 34°00'S and 35°00'S and longitudes 148°30'E and 150°00'E (Plate 1).

Previous geophysical work in the Goulburn area was confined to a ground magnetic survey of the Rye Park scheelite deposit (Horvath and Davidson, 1958).

The Goulburn area consists of a folded sequence of Lower to Middle Palaeozoic sediments and volcanics. The fold axes trend north to north-north-west as do the granite bodies which intrude these rocks.

Tertiary basalts which occur as flow remnants are mainly confined to the eastern half of the area.

Mineralisation is wide-spread and is thought to be related to the granites and associated intrusions.

The purpose of the survey was to assist in the interpretation of the regional geological structure and to provide basic data for detailed metalliferous prospecting.

2. GEOLOGY

The rocks of the Goulburn area lie within the Tasman Geosynclinal Zone, a composite structural belt with pronounced north-north-west trends. The detailed tectonic history is known in only a few places but the broad pattern of the zone is one of transient troughs, ridges, and basins which were formed and deformed by earth movements differing in intensity and timing from place to place. In general, the zone became increasingly stable from the late Silurian onwards, and igneous intrusion and vulcanism migrated markedly to the east and north (BMR, 1962).

In the Goulburn area there are folded sequences of Ordovician, Silurian, and Devonian rocks which have been intruded by granites of the Tabberabberan (Middle Devonian) and Kanimblan (Lower Carboniferous) orogenies. These granites outcrop as bodies trending north-north-west and are responsible for mineralisation in the area. In the east of the area there is an outcrop of Upper Permian marine sediments and in the north-west there is a small area of continental Tertiary sedimentation. Some small basic intrusive bodies are associated with the granites. Patches of Tertiary basalt cover some parts of the area. A stratigraphic table appears in Appendix 1.

Stratigraphy

Ordovician. Rocks of Upper Ordovician age occur predominantly in the central part of the area. They consist of graptolitic slate, shale, sandstone and siltstone. Porphyry has been recorded in some parts. In places where contact and low grade regional metamorphism has taken place, these rocks can be recognised as quartzite, phyllite, and schist.

In the north-west of the area some Lower Ordovician rocks are thought to occur. These consist of andesitic volcanics, tuff, and thin limestone.

Silurian. The Silurian rocks lie unconformably on the Ordovician rocks. Detailed mapping of this sequence has generally been confined to rather small areas. In the Yass district, Browne (1954) has mapped a series of shale, conglomerate, sandstone, tuff, and limestone with porphyry and coarse tuff, Some dacite flows have been recorded in the Frogmore district (Gibbons, 1960). The porphyry is confined to the western half of the survey area while in the eastern half the Silurian rocks are predominantly slate and limestone with minor tuff and quartzite.

The Silurian strata are preserved, for the most part, in north-trending synclines, and in places they unconformably overlie the tightly folded Ordovician slate (Voisey, 1953).

Devonian. The base of the Devonian was marked by wide-spread volcanic activity. In the Goulburn area, Lower Devonian rocks are confined to the western half, and consist of agglomerate and conglomerate, rhyolite, dacite, andesite, and tuff. They are followed by a sequence of limestone and fine-grained clastic sediments which are regarded as Middle Devonian.

Lower and Middle Devonian rocks have not been recorded in the east of the area, where Upper Devonian formations rest unconformably on the Silurian sequence. These Upper Devonian rocks consist of a basal coarse conglomerate followed by beds of quartzite, shale, mudstone, and sandstone.

Upper Permian. A small area of Upper Permian rocks occurs on the central-eastern boundary of the Goulburn area. They are flat-lying and consist of coarse conglomerates, breccias, and sandstones.

Cainozoic. A small area of Tertiary sedimentation has been mapped in the north-western corner of the Goulburn area..

Igneous rocks

Granites and associated intrusions. Two phases of granite intrusion have affected the Goulburn area. These were associated with the Tabberabberan and Kanimblan orogenies. The former is thought to have given rise to the Marulan, Goulburn, and Wyangala batholiths (Browne, 1949; Stevens, 1955) and the latter to the Kanimbla batholith.

Associated with the granites are areas of granodiorite, felsite, quartz-feldspar porphyry, and some dioritic and basic intrusives. These latter occur noticeably in the Frogmore and Bigga districts.

Basalts. Olivine basalts of Tertiary age occur in the centre and north-eastern parts of the area as flow remnants.

Mineralisation

Three periods of mineralisation have occurred in the Goulburn Area (Browne, 1949), these being associated with the Bowning, Tabberabberan, and Kanimblan orogenies. Most of the mineralisation is thought to be of Tabberabberan age although the gold at Tuena is regarded as having a Bowning age. Most of the deposits are magmatic concentration or contact metamorphic or replacement-type deposits.

Appendix 2 contains a list of the principal minerals in the Goulburn area and the localities in which they occur. Of economic importance in the past were the tungsten of Rye Park and the numerous iron ore deposits.

Tungsten. The main deposit of tungsten is the Rye Park scheelite deposit. The minerals of the orebody are wolframite, scheelite, magnetite, and cassiterite; these occur in flat-lying Silurian tuff and porphyry intruded by granite, the latter being regarded as the source of the ore (Horvath and Davidson 1952; Burton & Smith, 1953).

Iron ore. In the Goulburn area there are numerous small iron ore deposits (Barrie, 1961) which may be classified as either superficial deposits, lateritic bauxite, or lodes. No ore is being mined at present.

3. MAGNETIC RESULTS AND INTERPRETATION

Magnetic profiles for all flight-lines, reduced to an east-west scale of 1:250,000 are shown in Plate 2. A north-south scale of 1:62,500 has been used to improve data presentation. For the purpose of this presentation, accurate plotting of the flight-line positions has not been attempted. The flight-lines shown are idealised and serve as baselines for the magnetic profiles, the maximum probable error in the positioning of the magnetic data being one mile. Plate 3 shows a selection of magnetic profiles together with the geology.

The interpretation of the magnetic data is mainly qualitative and somewhat restricted, owing to the unreliability of the geological information available. Magnetic trends have been resolved, some fold structures have been delineated, and the survey area has been zoned on the basis of magnetic character. This interpretation is shown in Plate 4 superimposed on the geological map of the area. The "herringbone" pattern in both the magnetic lineations and the zone boundaries is indicative of the positioning errors of the magnetic data.

Listed below are the zone types with a brief description of their magnetic character.

Zone Type	Magnetic Character, values in gammas
A	Random magnetic anomalies mainly less than 50
B	" " " mainly in the range 50-150
C	" " " mainly greater than 150
D	Magnetic lineations with amplitudes mainly less than 150
E	" " " " mainly in the range 150-250
F	" " " " mainly in the range 250-500
G	" " " " mainly greater than 500

Geological significance of zones

Zone A is resolved by the smoothness of the magnetic profiles and the lack of linearity between adjacent flight-lines. Generally there is a lower magnetic intensity in this zone as compared with neighbouring zones.

Zones of type A occupy approximately 60 percent of the Goulburn area and are interpreted as non-magnetic sedimentary sequences or relatively homogeneous acid igneous rocks. Most Ordovician and Upper Devonian rocks and the granite bodies in the west and centre of the survey area are included in Zone A. Most of the other sedimentary units have zones of type A corresponding to them.

Zones of type B are interpreted as slightly more basic variations of zone A rock types. A large zone of type B corresponds to the area of Silurian porphyries in the west and south-west of the survey area. Although these zones are irregularly shaped they exhibit some north to north-north-west elongation.

Zones of type C are characterised by moderate to intense magnetic anomalies and are interpreted as an indication of near-surface basic igneous bodies. Only two such zones have been delineated. One is located five miles east-south-east of Boorowa and the other just south-east of Crookwell. The latter corresponds to an area of basalt.

Zones of type D and E are interpreted as sedimentary sequences containing interbedded lavas. The boundary between these two zones is determined only by the average amplitudes of the anomalies. As these zones often adjoin each other it is suggested that there is a gradation in the magnetic character of the lavas rather than two distinct geological environments.

Zones of type F and G are characterised by intense magnetic anomalies which have a pronounced linearity. Where these zones occur in areas of sedimentary rocks apart from those in areas of Tertiary basalt, the anomalies are interpreted as caused by basic lavas included with the sequence, e.g. in the Ordovician rocks north of Frogmore. In most cases, however, these zones occur near or within granitic areas and it is thought that metamorphic or metasomatic effects have produced concentrations of magnetic minerals along the margins of the granite bodies as well as within them. This is particularly noticeable along the eastern boundary of the survey area from south of Bungonia to Wombeyan Caves. It is also possible that the anomalies are caused by large basic and ultrabasic igneous bodies.

Magnetic response to specific geological features

Many anomalies of moderate to intense amplitude were recorded over areas mapped as Tertiary basalt. In the north-east and centre-east of the survey area, some intense negative anomalies corresponding to a number of the basalt outcrops indicate that a number of these flows are reversely magnetised.

Three small basic intrusions have been mapped in the survey area, namely east of Frogmore, 16 miles north of Frogmore, and east of Lake George (Plate 3). Magnetic anomalies were recorded over the latter two only. The anomaly over the intrusion east of Lake George has an amplitude of 250 gammas and indicates a much smaller body than that shown on the geological map. The basic intrusion 16 miles north of Frogmore produces an anomaly of 500 gammas. The present survey and also that of Young (1963) shows that this body is about four miles long and two miles wide and has a north-south elongation.

No outstanding magnetic anomalies were recorded over the numerous iron ore deposits in the survey area.

Magnetic trends

The magnetic trend lines are shown in Plate 4 together with the geophysical interpretation and geology. The resolution of these trends bears a direct relation to anomaly amplitude. Strong continuous lineations occur in zones of type D, E, F, and G whereas the isolated trends delineated in zones of type A, B, and C are relatively short and are caused by local geological features such as dykes.

It is quite common for a trend line to pass from one zone to another. This is particularly evident between zones of type D and E, illustrating the minor difference of geological significance between these two zones.

The magnetic trends are oriented north to north-north-west, paralleling the regional geological strike of the survey area. An examination of the magnetic profiles of the tie-line system did not reveal any major east-west magnetic trends.

Fold structures

Five anticlinal and synclinal structures were interpreted from the magnetic data. They were recognised in a study of the zonal configuration and magnetic anomaly repetition. Three of these occur in the Silurian porphyries, one in Lower Devonian rocks, and one in Silurian and Upper Devonian rocks (Plate 4). The last is a clearly resolved synclinal structure located immediately east of Goulburn; it trends approximately north-south and extends for at least 13 miles. This syncline corresponds to a similar feature mapped by Naylor (1935). Some of the magnetic anomalies associated with this structure had relatively simple form, making them suitable for the "curve-fitting" analysis of Gay (1963). Application of Gay's method of interpretation shows that the eastern limb of the the syncline has a dip approximately 50°W and the western limb a dip of 80°E. Four magnetic horizons are apparent, the lowest being 300-500 ft thick.

4. RADIOMETRIC RESULTS AND INTERPRETATION

Two scintillometers were used to record the radiometric data. The inboard scintillometer recorded the change in level of radiometric intensity, as an aid to geological mapping. The outboard scintillometer was used to detect localised sources of radioactivity.

Inboard scintillometer results

The radiometric profiles recorded by the inboard scintillometer have been reduced to a scale of 1:250,000 but are not presented in this Record. A contour presentation of the radiometric data is shown superimposed on the known geology in Plate 5. The contours have been smoothed in an attempt to reduce contour distortions produced by variations in aircraft-to-ground clearance and by instrumental drift.

The average level of radioactivity in the Goulburn area is approximately 50 counts per second with a general increase in level apparent from east to west. There are no pronounced trends in the radiometric contours although there is some east-west elongation of the anomalous areas below 50 counts per second. This probably results from variations in the detector height above ground and the east-west orientation of the flight-lines.

A high level of radioactivity (above 75 counts per second) is found to be associated with granite bodies. In general, the Ordovician, Silurian, and Devonian sedimentary rocks are characterised by low radioactivity. Exceptions to this are to the north-west of Gunning where a level of 75 counts per second is associated with Ordovician rocks and in the north-east of the survey area where a similar level occurs over a region of Silurian sediments. The high radioactivity in both of these areas is probably caused by sediments derived from a granitic source.

Outboard scintillometer results

The radiometric anomalies from restricted sources are shown in Plate 5 and listed in Appendix 3. The criteria used for the acceptance of these anomalies are also discussed in Appendix 3.

Twenty-eight anomalies were detected and grouped into the three classes, A, B, and C, examples of which are shown in Plate 6, (Tipper and Finney, 1965). Ten of the anomalies are located in the region mapped as Silurian porphyries in the western part of the Goulburn map area. Most of the remainder occur in regions of sedimentary rocks, and no definite conclusions can be made as to their sources. Further investigation of these anomalies would require detailed ground work. However, only those in classes A and B would warrant investigation, as those of class C have low significance and might be very difficult to detect by ground survey.

5. CONCLUSIONS AND RECOMMENDATIONS

The qualitative interpretation presented in this Record is based on the examination of the original and reduced magnetic profiles. Further information may be revealed when the magnetic contour maps are available. It would be appropriate, therefore, to review the interpretation using both contours and profiles when detailed geological mapping of the Goulburn area has been carried out.

The intense magnetic anomalies recorded near the margins of granite batholiths warrant some detailed ground investigation to determine whether economic mineralisation exists in these favourable locations.

It is also recommended that samples of the Tertiary basalts and the volcanic members of the sedimentary sequences be collected. These should be tested to ascertain their palaeomagnetic properties.

Twenty-eight radiometric anomalies of restricted source were detected by the outboard scintillometer. Seventeen of these anomalies, as indicated in Appendix 3, warrant ground investigation to determine the nature of their source.

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APPENDIX 1

STRATIGRAPHY OF THE GOULBURN AREA

Age	Series	Lithology	Remarks
QUATERNARY		Sand, gravel, alluvium, etc.	
TERTIARY		Olivine basalt	Flow remnants
		Sand, silt, clay	Undifferentiated continental sediments
PERMIAN	Shoalhaven Group	Conglomerate, sandstone, breccia	Formerly "Upper Marine Series"
LOWER CARBONIFEROUS		Granite, porphyry	Kanimbla batholith
UPPER DEVONIAN		Conglomerate, quartzite, shale, mudstone, sandstone	
MIDDLE DEVONIAN		Granite	Tabberabberan orogeny
	Murrumbidgee	Limestone, tuff	8000' in the Yass district
LOWER DEVONIAN	Black Range	Agglomerate, conglomerate, acid & intermediate lavas, tuff	3500' in the Yass district
UPPER SILURIAN		Granite, etc.	Bowning orogeny
SILURIAN	Hume	Shale, conglomerate, tuff, sandstone, limestone	800'
	Laidlaw	Tuff, porphyry	900'
	Yass	Sandstone, shale, mudstone, limestone	800'
	Douro	Coarse tuff and some porphyry	3000'

Age	Series	Lithology	Remarks
SILURIAN	Bango	Marmorised limestone, shale, in part tuffaceous	800'
	Hawkins	Coarse tuff, in part fossiliferous & in part intrusive into the Bango shales	2000'
UPPER ORDOVICIAN		Granite, porphyry, etc.	Benambran orogeny
		Graptolitic slate, shale, sandstone, siltstone, and some porphyry	In parts metamorphosed to quartzite, phyllite, and schist
LOWER ORDOVICIAN		Andesitic volcanics, tuff and thin limestones	Recorded in north-west of area

<u>Note</u>: Thickness of Silurian rocks from Browne (1954).

APPENDIX 2

PRINCIPAL MINERAL LOCALITIES IN THE GOULBURN 1:250,000 MAP AREA

District	Gold	Silver	Lead/ Zinc	Copper	Tin	Iron	Bismuth	Tungsten
Binda	*							
Boorowa	*	*	*	*				
Breadalbane						*		
Crookwell	*					*		
Frogmore								*
Goulburn	*			*				
Gunning	*							
Koorawatha				*				
Marulan		*		*	*			
Murrumbateman	*						*	
Peelwood		*	*	*				
Rye Park		*	*	*	*			*
Tuena	*							
Yass	*	*	*	*				

APPENDIX 3

OUTBOARD RADIOMETRIC ANOMALIES - INTERPRETATION CRITERIA

Amplitude

For an anomaly to be resolved from the normal gamma-ray background noise, its amplitude must be statistically significant. To be acceptable, the anomaly amplitude must be greater than or equal to three times the standard deviation of the background noise.

Gamma-ray background noise

Two distinct types of gamma-ray background noise are recognised, which are produced by:

1. Statistical variation of the recorded gamma-ray intensity from a homogeneous source. The standard deviation of the count rate is given by

   $$S.D. = (N/2T)^{\frac{1}{2}}$$ where N = count rate, T = time constant of the counter.

2. Variation of the gamma-ray intensity from a heterogeneous source; similar variation can be caused by variation in overburden above a homogeneous source.

Examples of anomalies in different categories are shown in Plate 6.

Form

Anomaly shape depends on the configuration of the source and its location relative to the detector. The width of an anomaly at half-peak amplitude is related to these factors. For an anomaly to be acceptable, the half-peak width must be greater than 3 seconds and less than 4 seconds.

A continuous series of source types would satisfy this width criterion. The limiting cases are a source with a maximum radius of 300 ft centred on the line of flight, and a point source located within 300 ft of the line of flight.

TABLE 1

OUTBOARD RADIOMETRIC ANOMALIES

Anomaly No.	Line No.	Fiducial No.	Half-Peak Width (sec)	Amplitude x S.D.	Classification
1	11E (a)	1776.0	3.0	4	C
2	17E (a)	192.6	3.0	6	B *
3	17E (a)	193.6	4.0	7	B *
4	18W (a)	337.8	3.0	5	A *
5	22W	118.5	4.0	10	B *
6	26W	2279.0	3.0	6	C
7	31W	471.1	3.0	4	C
8	31W	479.3	4.0	8	A *
9	36E	1241.3	3.0	5	A *
10	38E	541.5	4.0	8	A *
11	38E	544.8	4.0	9	A *
12	39W	292.6	4.0	6	C
13	40E	75.8	4.0	7	A *
14	41E	1777.0	3.0	3	C
15	44W	1122.1	4.0	6	A *
16	48W (a)	1401.2	3.5	4	C
17	50W (b)	156.4	3.0	4	B *
18	51E (b)	24.0	3.5	8	A *
19	51E (b)	48.0	4.0	7	C
20	53E	599.7	4.0	7	A *
21	54W (a)	422.4	4;0	7	C
22	57W	1481.2	4.0	6	A *
23	58E	1061.9	3.5	5	C
24	62E	185.8	3.5	7	B *
25	62E	236.1	4.0	6	C
26	63E	1179.8	3.0	4	B *
27	66W	370.2	3.0	5	C
28	67E	108.2	3.5	5	A *

Note: (a) denotes western half of survey area
(b) denotes eastern half of survey area
* denotes anomalies that warrant ground investigation

APPENDIX 4

OPERATIONAL DETAILS

Staff

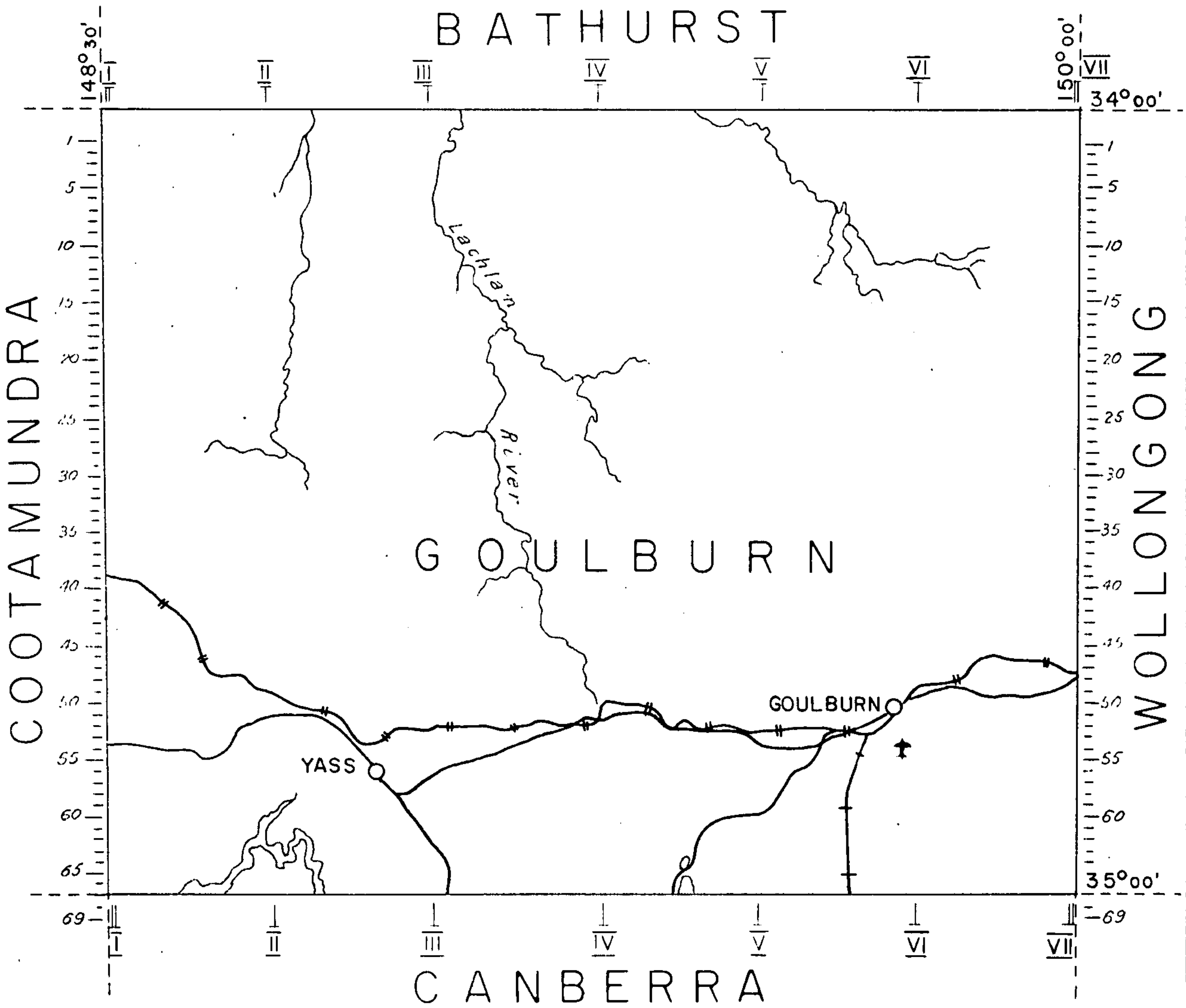
Party leader	: E.P. Shelley
Senior radio technician	: P.B. Turner
Drafting assistant	: D.P. Lankester
Geophysical assistants	: K.A. Mort D. Park C.I. Parkinson
Pilots (T.A.A.)	: Capt. M. Stewart First Officer D.A. Spiers
Aircraft maintenance engineers (T.A.A.)	: J. Maskiell K. Phillips

Equipment

Aircraft	: DC.3, VH-MIN
Magnetometers	: MFS-5 saturable core fluxgate, tail boom installation coupled to "Speedomax" and digital recorders.
Scintillometers	: Twin crystal MEL scintillation detector heads inboard and single crystal detector head outboard (the latter suspended from a cable 200 feet below aircraft), outputs coupled to DeVar recorder.
Radio altimeter	: STR30B, frequency modulated type, output coupled to DeVar recorder.
Air position indicator	: Track recorded by DeVar recorder.
Camera	: BMR 35-mm strip

Survey specifications

Altitude	: 500 feet above ground level
Line spacing	: 1 mile
Line orientation	: East-west
Tie system	: Single lines spaced 15 miles apart; double lines at the eastern and western boundaries of the area and through centre of area.
Navigation control	: Aerial photographs
Record sensitivities	
MFS-5	: 50 gammas per inch
Inboard scintillometer	: 50 counts per second per cm
Outboard scintillometer	: 50 counts per second per cm
Scintillometer time constants	
Inboard	: 10 seconds
Outboard	: 1 second



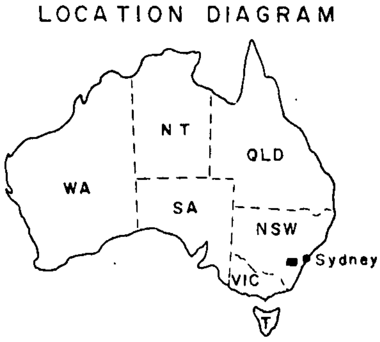
AIRBORNE MAGNETOMETER AND SCINTILLOGRAPH SURVEY, 1965
GOULBURN, NSW

FLIGHT-LINE AND TIE-LINE SYSTEM

10 0 10 20 30 40 MILES

10 0 10 20 30 40 50 60 KILOMETRES

LOCATION DIAGRAM



GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS I55/BI-41

To Accompany Record No 1966/65

GOULBURN
NEW SOUTH WALES

AIRBORNE SURVEY, GOULBURN NSW, 1965

TOTAL MAGNETIC INTENSITY PROFILES

EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC.3 AIRCRAFT AT AN ALTITUDE OF 500FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART. THE FLIGHT-LINES ARE IDEALISED, AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ±½ MILE

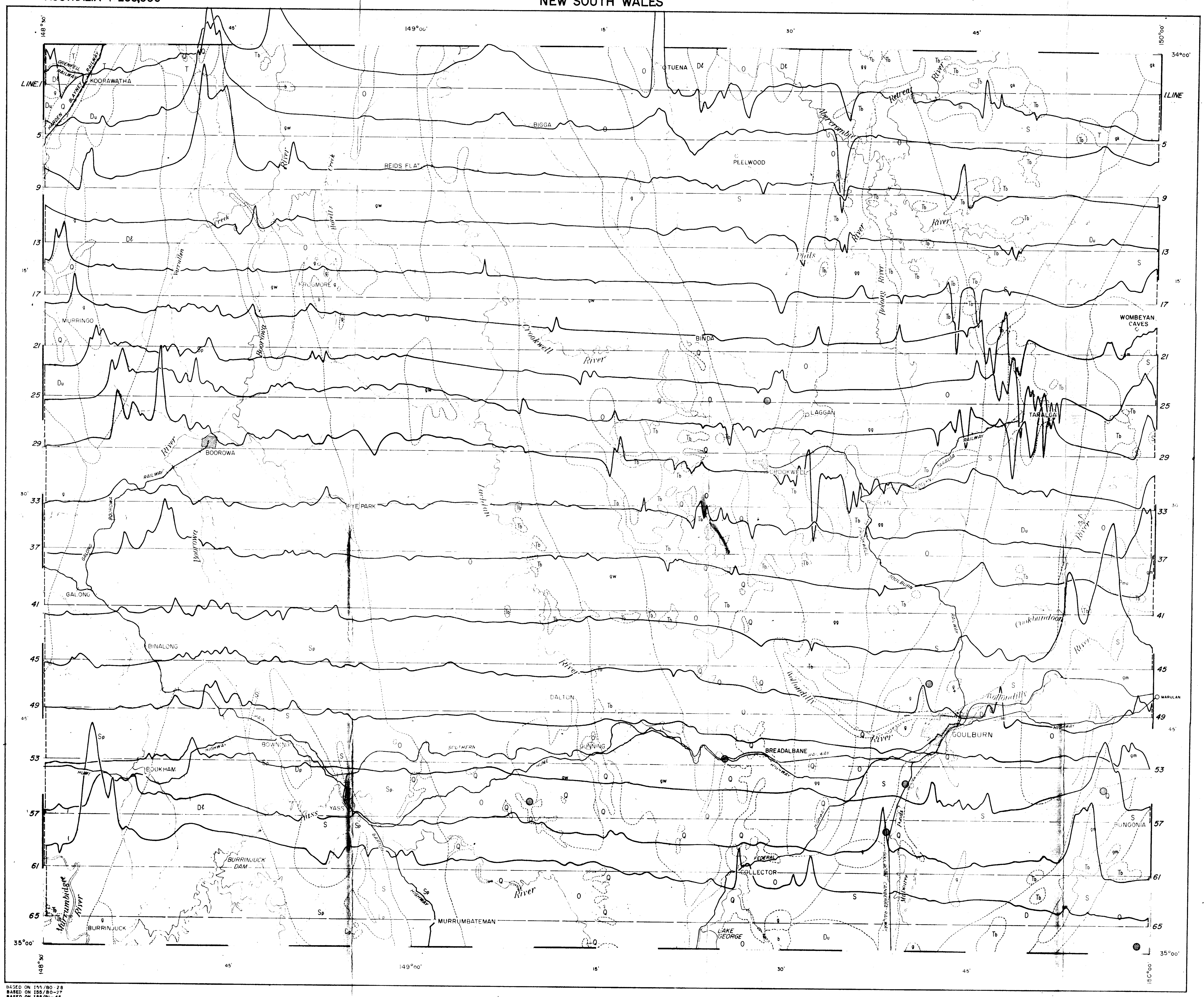
THE PROFILES HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL MAGNETIC INTENSITY. THIS COMPONENT AMOUNTS TO 7·5 GAMMAS PER MILE.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics 155/B1-42
To Accompany Record No 1966/65

PLATE 3

AUSTRALIA 1:250,000

GOULBURN
NEW SOUTH WALES



BASED ON 155/B0-28
BASED ON 155/B0-27
BASED ON 155/B1-45

GEOLOGICAL LEGEND

CAINOZOIC	QUATERNARY	Q	Alluvial gravel, sand, silt, clay.
	TERTIARY	Tb	Volcanics, mainly basalt.
		T	Undifferentiated sediments, mainly continental
PALAEOZOIC	PERMIAN	Pmu	Conglomerate, sandstone. Shoalhaven Group
	DEVONIAN	Du	Upper Devonian. Conglomerate, quartzite, sandstone, clayshale, mudstone.
		Dℓ	Middle to Lower Devonian. Lavas, tuff, conglomerate, limestone, andesite. Murrumbidgee and Black Range "Series"
		Dp	Quartz felspar porphyry, rhyolite, agglomerate
		D	Undifferentiated strata mainly marine
	SILURIAN	S	Slate, quartzite, shale, sandstone, limestone tuff, conglomerate and lavas.
		Sp	Quartz felspar porphyry, lavas.
	ORDOVICIAN	O	Slate, shale, sandstone, quartzite, siltstone tuff, andesite and limestone.

IGNEOUS

g	Mainly granite, granodiorite and granite porphyry
gw / gg	Goulburn batholith, Wyangala batholith — Granite, granodiorite and granite porphyry
gm / gk	Kanimbla batholith, Marulan batholith — Granite, granodiorite and granite porphyry
b	Basic intrusives

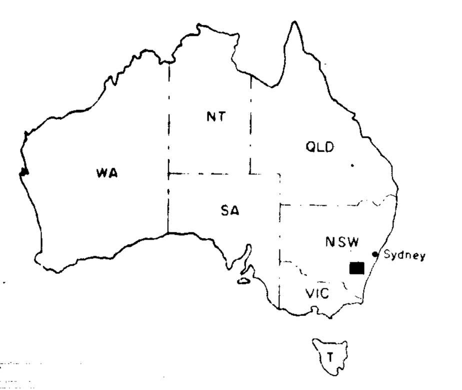
Geological boundary

Approximate position of iron ore deposits

TOPOGRAPHICAL LEGEND

- River or creek
- Highway
- Secondary road
- Road or track
- Railway
- Built-up area
- Named place
- Railway station

LOCATION DIAGRAM



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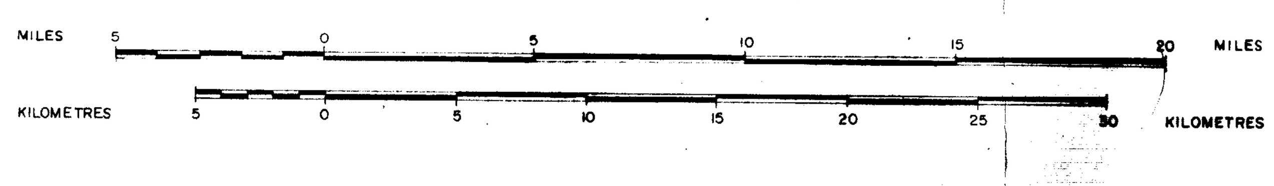
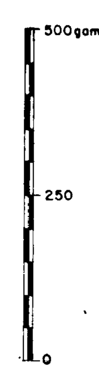
AIRBORNE SURVEY, GOULBURN NSW, 1965

TOTAL MAGNETIC INTENSITY PROFILES AND GEOLOGY



APPROX. PROFILE SCALE



EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC.3 AIRCRAFT AT AN ALTITUDE OF 500 FEET ABOVE GROUND LEVEL ALONG LINES SPACED ONE MILE APART. THE FLIGHT-LINES ARE IDEALISED, AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ± ½ MILE. PROFILES AT INTERVALS OF FOUR MILES ARE SHOWN ON THIS MAP.

THE PROFILES HAVE BEEN CORRECTED FOR THE SOUTH COMPONENT OF A REGIONAL GRADIENT IN TOTAL MAGNETIC INTENSITY. THIS COMPONENT AMOUNTS TO 7·5 GAMMAS PER MILE.

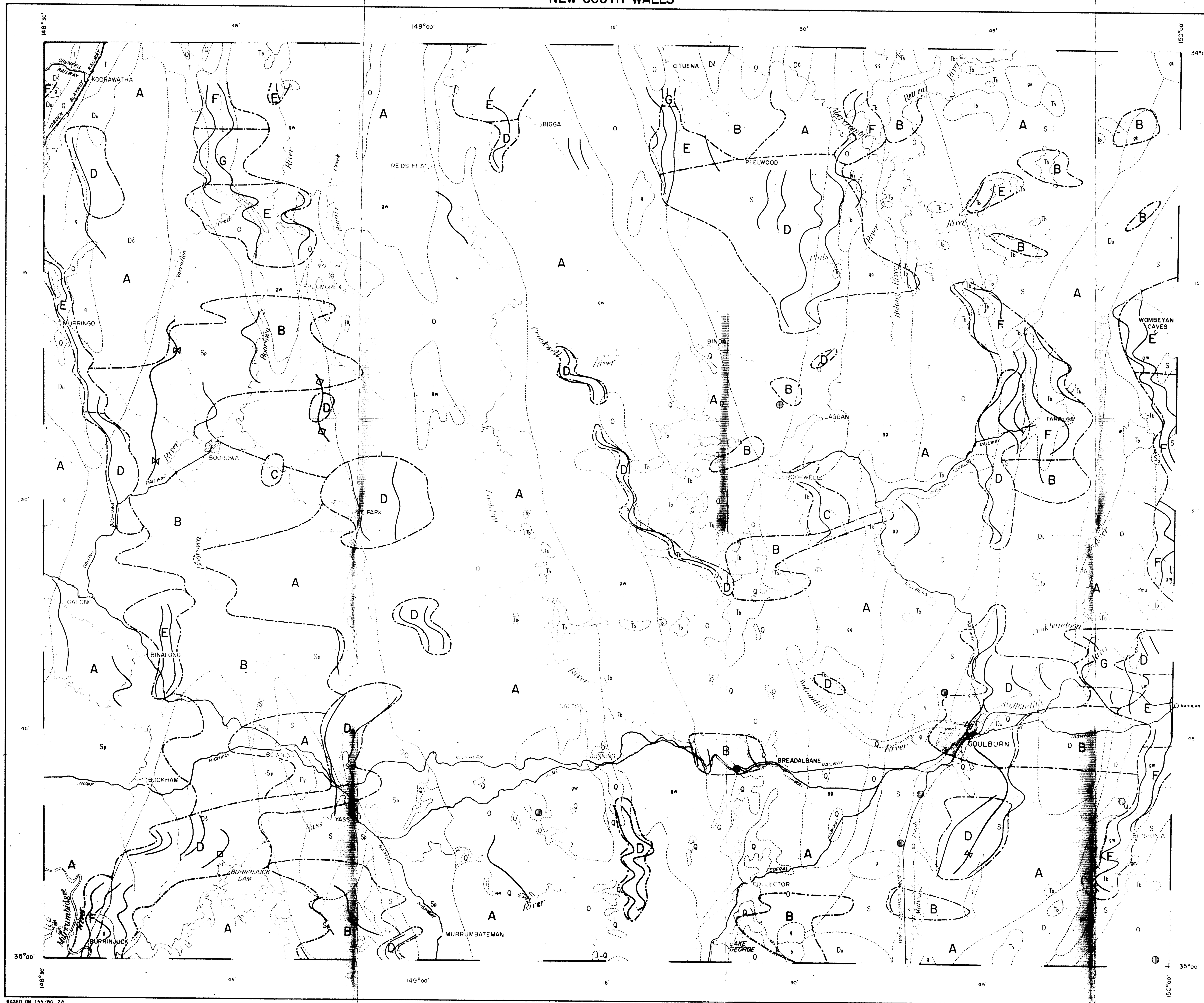
Topography after 1:250,000 scale map Royal Australian Survey Corps. Geology after Geological Map of New South Wales, Geological Survey of New South Wales. Division of Regional Geology, 1962. Transverse Mercator Projection.

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics I55/B1-47
To Accompany Record No 1966/65

PLATE 4

AUSTRALIA 1:250,000

GOULBURN
NEW SOUTH WALES



BASED ON 155/B0-28
BASED ON 156/B0-77
BASED ON 155/B1-48

GEOLOGICAL LEGEND

CAINOZOIC
- QUATERNARY — Q — Alluvial gravel, sand, silt, clay.
- TERTIARY — Tb — Volcanics, mainly basalt.
- TERTIARY — T — Undifferentiated sediments, mainly continental

PALAEOZOIC
- PERMIAN — Pmu — Conglomerate, sandstone. Shoalhaven Group
- DEVONIAN — Du — Upper Devonian. Conglomerate, quartzite, sandstone, clayshale, mudstone.
- DEVONIAN — Dl — Middle to Lower Devonian. Lavas, tuff, conglomerate, limestone, andesite. Murrumbidgee and Black Range "Series"
- DEVONIAN — Dp — Quartz felspar porphyry, rhyolite, agglomerate
- DEVONIAN — D — Undifferentiated strata mainly marine
- SILURIAN — S — Slate, quartzite, shale, sandstone, limestone tuff, conglomerate and lavas.
- SILURIAN — Sp — Quartz felspar porphyry, lavas.
- ORDOVICIAN — O — Slate, shale, sandstone, quartzite, siltstone tuff, andesite and limestone.

IGNEOUS
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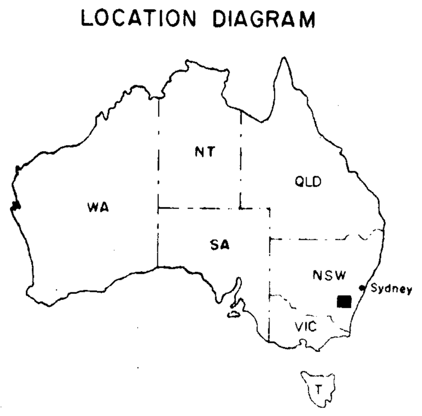
- b — Basic intrusives
- Geological boundary
- Approximate position of iron ore deposits

TOPOGRAPHICAL LEGEND
- River or creek
- Highway
- Secondary road
- Road or track
- Railway
- Built-up area
- Named place
- Railway station

GEOPHYSICAL LEGEND
- Magnetic trend
- Zone boundary
- Syncline
- Anticline

LOCATION DIAGRAM



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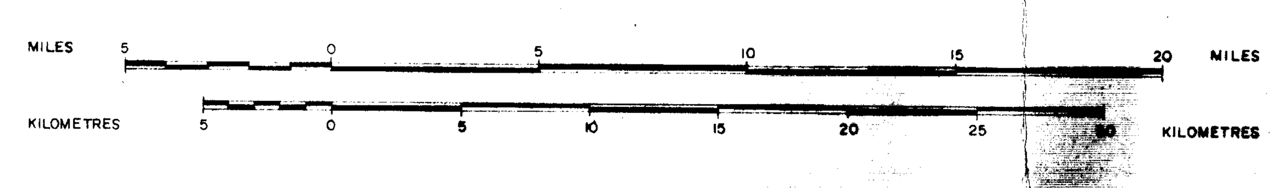
AIRBORNE SURVEY, GOULBURN, NSW, 1965

GEOPHYSICAL INTERPRETATION AND GEOLOGY



Topography after 1:250,000 scale map Royal Australian Survey Corps.
Geology after Geological Map of New South Wales, Geological Survey of New South Wales, Division of Regional Geology, 1962.
Transverse Mercator Projection.

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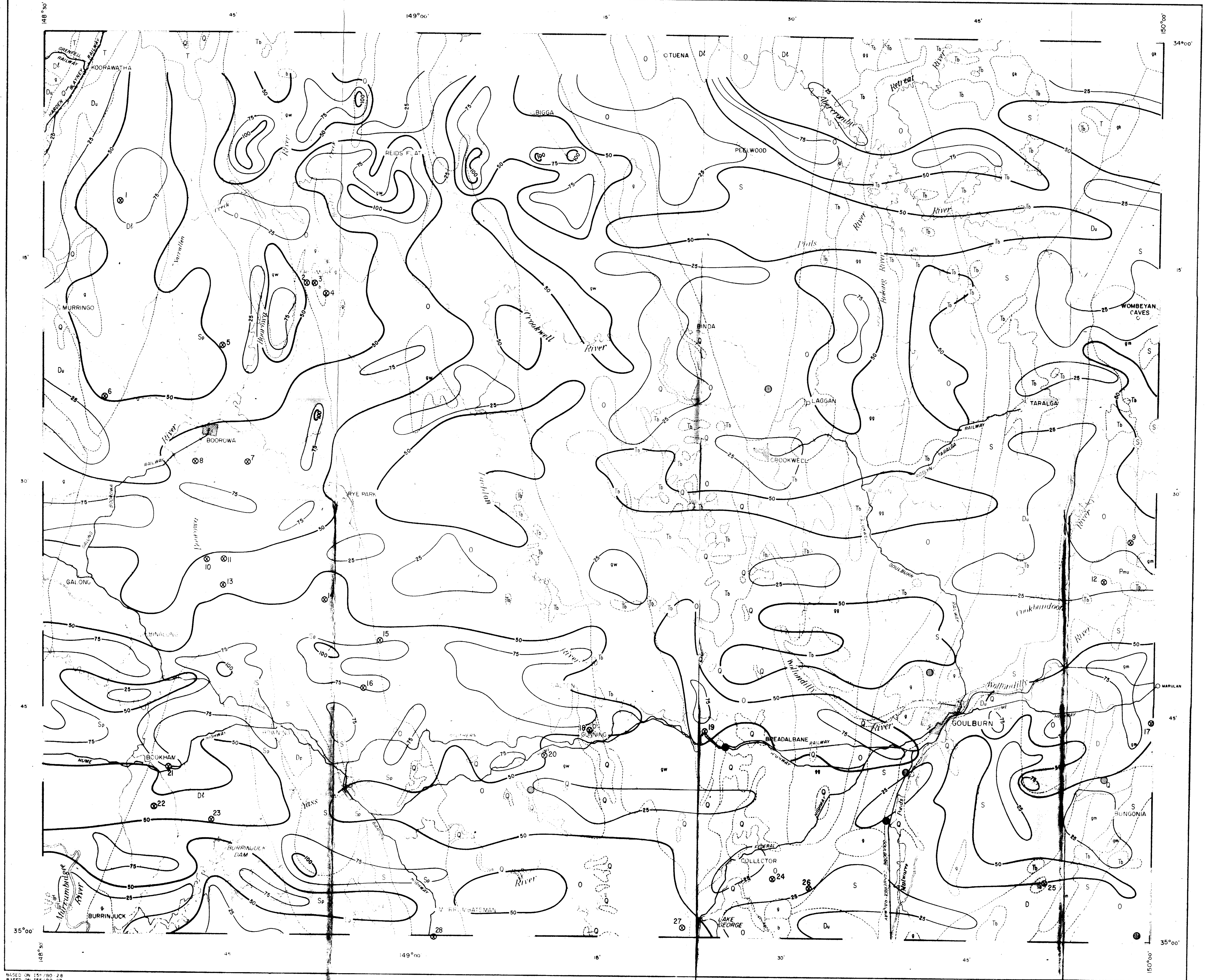
AUSTRALIA 1:250,000

GOULBURN
NEW SOUTH WALES



BASED ON I55/BO-28
BASED ON I55/BO-27
BASED ON I55/BI-50

GEOLOGICAL LEGEND

CAINOZOIC	QUATERNARY	Q	Alluvial gravel, sand, silt, clay.
	TERTIARY	Tb	Volcanics, mainly basalt.
		T	Undifferentiated sediments, mainly continental
PALAEOZOIC	PERMIAN	Pmu	Conglomerate, sandstone. Shoalhaven Group
	DEVONIAN	Du	Upper Devonian. Conglomerate, quartzite, sandstone, clayshale, mudstone.
		Dl	Middle to Lower Devonian. Lavas, tuff, conglomerate, limestone, andesite. Murrumbidgee and Black Range "Series"
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IGNEOUS

g	Mainly granite, granodiorite and granite porphyry	
gg / gw	Goulburn batholith; Wyangala batholith	Granite, granodiorite and granite porphyry
gk / gm	Kanimbla batholith; Marulan batholith	
b	Basic intrusives	

Geological boundary

Approximate position of iron ore deposits

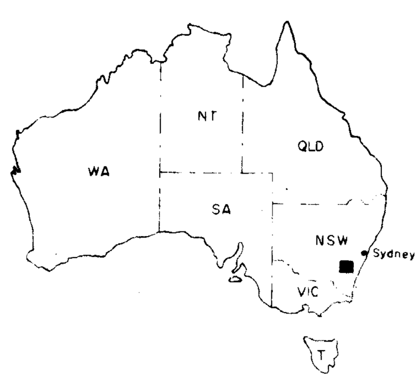
TOPOGRAPHICAL LEGEND

- River or creek
- Highway
- Secondary road
- Road or track
- Railway
- Built-up area
- Named place
- Railway station

GEOPHYSICAL LEGEND

- 50 — Radiometric contours, counts per second
- 24 ⊗ Radiometric anomaly, restricted source (Anomalies are numbered for reference only)

LOCATION DIAGRAM



True North
Mag. North
11°5'

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AIRBORNE SURVEY, GOULBURN, NSW, 1965

RADIOMETRIC RESULTS
AND
GEOLOGY

MILES 5 0 5 10 20 MILES

KILOMETRES 5 0 5 10 15 20 30 KILOMETRES

Topography after 1:250,000 scale map Royal Australian Survey Corps.
Geology after Geological Map of New South Wales, Geological Survey of New South Wales, Division of Regional Geology, 1962.
Transverse Mercator Projection.

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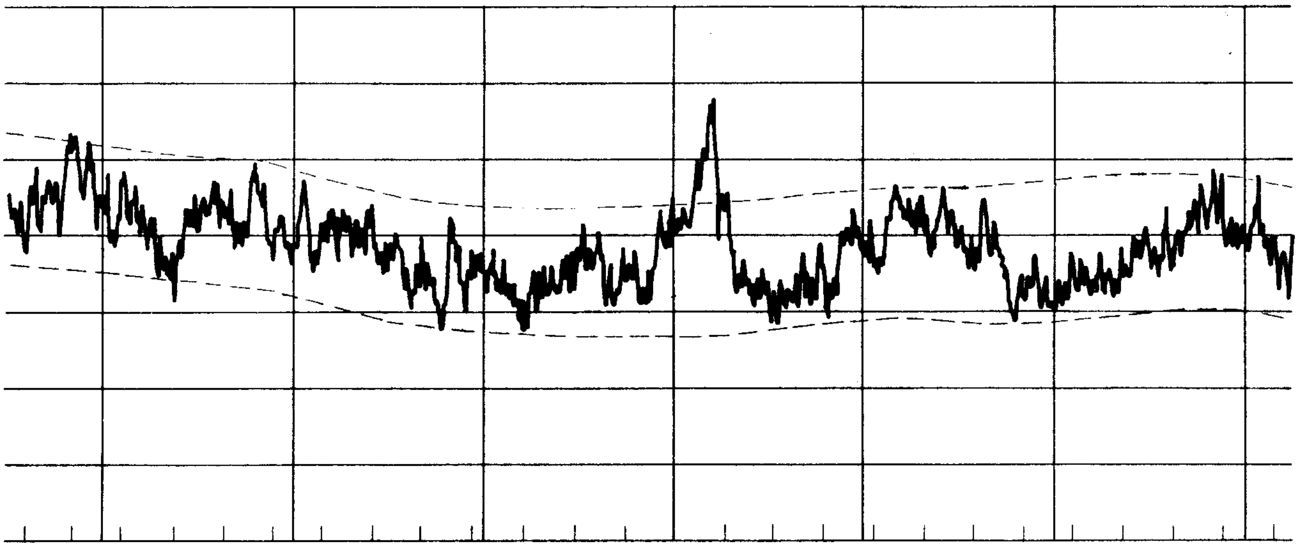
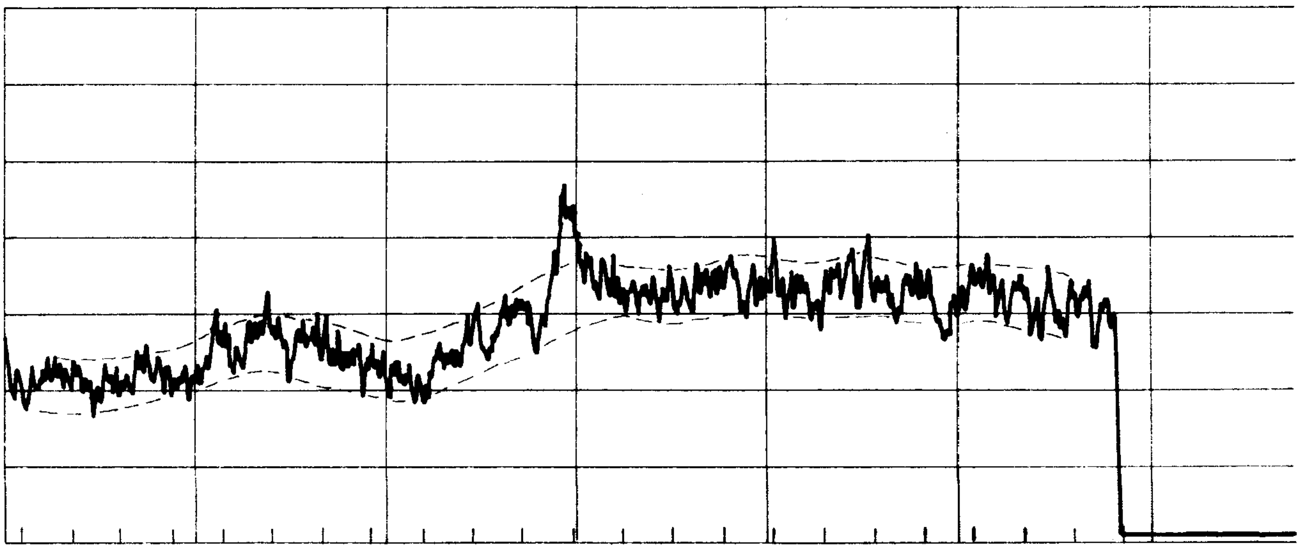
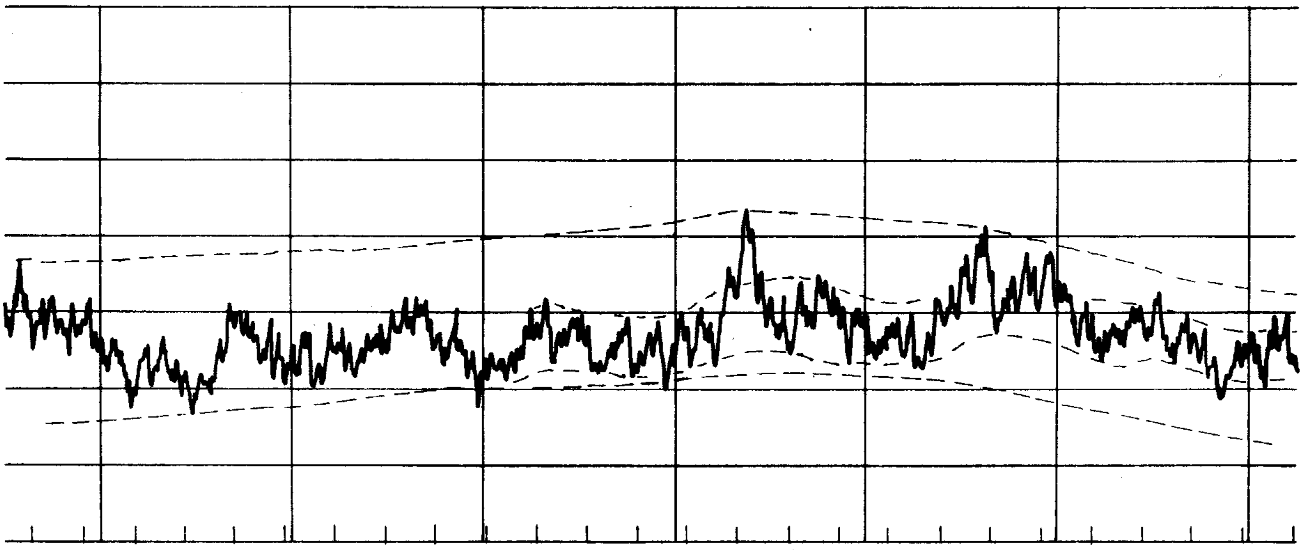


A. Anomaly significant with respect to associated geological noise envelope.



B. Anomaly significant with respect to statistical noise envelope.



C. Anomaly significant with respect to associated statistical noise envelope but insignificant with respect to neighbouring geological noise envelope.

TYPES OF RADIOMETRIC ANOMALIES

Geophysical Branch, Bureau of Mineral Resources, Geology and Geophysics.

H54/B1-30-1

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