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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1967/52

AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY OF THE WESTERN PART OF THE SYDNEY 1:250,000 MAP AREA,

NEW SOUTH WALES 1966

by

R. GERDES

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1967/52

SUMMARY

During September 1966, an airborne magnetic and radiometric survey was flown over the western part of the Sydney 1:250,000 map area in New South Wales. The area has been subdivided into zones based on magnetic character, and where possible the geological significance of these zones is discussed. Magnetic basement depth determinations indicate a deepening of the Sydney Basin to the east but do not show any structures suitable for oil accumulation. Magnetic anomalies at or near the granite margins indicate the presence of mineralisation in the metamorphic aureoles of the granites.

The radiometric data are not presented or analysed as the extreme topographic relief in this region primarily controls the level of gamma radiation recorded.

1. INTRODUCTION

At the request of the New South Wales Department of ·nes, an airborne magnetic and radiometric survey was flown over the western part of the Sydney 1:250,000 map area during the period 1st to 12th September 1966.

The object of the survey was primarily to complete the aeromagnetic coverage of SYDNEY to assist oil search. In addition it was expected that the geophysical data would assist the search for mineral deposits and provide information regarding regional geological structure.

The survey area (Plate 1) occupies approximately 1500 square miles of the Blue Mountains Plateau and the country to the west. Ground elevation in this area ranges from 1000 to 4470 ft above sea level, the region being highly dissected by rivers. This area forms the western part of the Sydney Basin, with Permian-Triassic sediments resting unconformably on Palaeozoic granitic and sedimentary rocks.

No previous geophysical work has been done in the survey area.

An aeromagnetic survey of the remainder of SYDNEY was flown in 1955 by Adastra Hunting Geophysics Pty Ltd for Australian Oil and Gas Corporation Ltd as part of the Sydney Basin survey. The Corporation did the reduction and plotting of the data. Airborne magnetic and radiometric surveys have been flown by the Bureau of Mineral Resources in the adjacent areas of BATHURST (Young, 1963) and GOULBURN (Shelley, 1965).

2. GEOLOGY

The geology of the survey area (Plates 1 and 3) is tectonically divided into two parts. In the west Palaeozoic rocks (Ordovician to Devonian) crop out and form part of the Tasman Geosynclinal Zone. They are unconformably overlain to the east by flat-lying Permian and Triassic sediments of the Sydney Basin.

The rocks of the Tasman Geosynclinal Zone have been subjected to three orogenies: the Bowning Orogeny (Silurian), the Tabberabberan Orogeny (Devonian), and the Kanimblan Orogeny (Lower Carboniferous). In general, major structures are aligned north-north-west. Some synchronous (Silurian and Devonian) granites parallel this trend, whereas younger granite batholiths (Lower Carboniferous) are oriented east-west.

The Tasman Geosynclinal Zone is overlain unconformably by Permian and Triassic sediments of the Sydney Basin. During the Triassic the facies of these basin sediments changed from marine to continental. Coal measure facies were developed in the Upper Permian.

The detailed stratigraphy of the area is outlined in Appendix 2.

Lower Carboniferous granite of the Kanimbla Batholith intrudes Silurian and Devonian rocks in the southern part of the area, resulting in some contact metamorphism. This batholith consists predominantly of biotite granite with some granodiorite. Large quartz porphyry intrusions, elongated in a north-west direction, occur to the north of Ben Bullen.

At Ben Bullen, Hartley, and the south-west corner of the area small stocks of gabbro and diorite crop out. Some quartz-porphyry and basaltic dykes intrude the granite and the older Palaeozoic rocks in the same area.

Deposits of lead-zinc in the Hartley district and lead-copper at Little River, north of the Black Range, occur on the margins of the Kanimbla Batholith. The results of prospecting these deposits did not justify their economic development.

Coal from the Lithgow Coal Measures is of economic importance in this area and is mined from three seams at Lithgow, Blackmans Flat, and several other centres. Oil-shale was once very important in the area but production has now ceased.

3. MAGNETIC RESULTS AND INTERPRETATION

The magnetic data are displayed in Plates 2 and 3. Plate 2 shows all profiles of total magnetic intensity reduced to an east-west scale of 1:250,000 and related to a series of east-west lines which approximate the flight paths. A north-south scale of 1:125,000 has been used to improve data presentation. The reduction of the original profiles was by pantography; three or more control points were established for each flight line and the aircraft's ground speed was considered constant between adjacent control points. Variations in the aircraft's ground speed between the adjacent control points introduces positional errors in the presentation of the magnetic data, which in general does not exceed $\pm \frac{1}{2}$ mile. A systematic deviation in flight path orientation of W20°N along lines 34 to 37 has resulted in a maximum error of $\pm$ 2 miles in the presentation of the magnetic data.

Plate 3 shows a selection of the magnetic profiles superimposed on the geological map.

Interpretation

The interpretation of the magnetic data involves the delineation of magnetic trends and magnetic zones within the Palaeozoic rocks and the determination of depths to this basement. The procedures are described in detail in Appendix 1.

Magnetic trends

Plate 4 shows a large number of magnetic trends, the longest of which is situated in the northern part of the area. Elsewhere the trends do not extend across more than three lines. Most magnetic trends are orientated approximately NNW, parallel to the regional structure of this area.

Magnetic zones and their significance

Tabulated below are the zone-types with a brief description of their magnetic character. The anomaly-range quoted for each zone-type include most, but not necessarily all, of the anomalies in any zone of that type. Where possible these zone types are correlated subsequently with geology.

Zone type	Magnetic character and values in gammas
1	Random magnetic anomalies, mainly less than 50 gammas
2	Random magnetic anomalies, mainly in the range 50 to 150 gammas
3	Random magnetic anomalies, mainly in the range 150 to 250 gammas
4	Random magnetic anomalies, greater than 250 gammas
5	Magnetic lineaments with amplitudes mainly less than 150 gammas
6	Magnetic lineaments with amplitudes mainly in the range 150 to 250 gammas
7	Magnetic lineaments with amplitudes mainly in the range 250 to 500 gammas
8	Magnetic lineaments with amplitudes greater than 500 gammas

Type-1 zones. In general, these zones correlate with areas of low magnetic intensity indicative of acid igneous or non-magnetic sedimentary rocks. Silurian and Lower-Middle Devonian sediments and Carboniferous 'quartz porphyry' are included within the zones of this type.

Type-2 zones. These are interpreted as areas of slightly more basic composition than type-1 zones. The Kanimbla granitic batholith in the area south of Lithgow correlates with a type-2 zone. The continuity of the zone suggests that the batholith underlies the Permian unconformity.

Type-3 zones. These are interpreted as either basic rocks assimilated in the granite or metamorphic aureoles about the granite stocks. The type-3 zone that occurs south of Jenolan River is possibly due to Devonian basic rocks assimilated in granite.

Type-4 zones. These are interpreted as either basic intrusions in the form of plugs on basic rocks assimilated by the granite.

An example of the former are the basic Carboniferous plugs, west of Mount Victoria. It is probable that the type-4 zones near Ben Bullen and in the upper reaches of the Wolgan River represent similar plugs situated beneath the Permian unconformity.

Zones of types 5 and 6. These are characterised by moderate magnetic anomalies that show some elongation. The boundary between these zones is based on amplitude alone.

The type-5 zone situated in the area of the Rydal Syncline is attributed to this synclinal structure. The type-6 zone located about the Capertee and Wolgan Rivers is attributed to Palaeozoic sediments and granite that occur beneath the Permian unconformity. The well defined magnetic trends occurring in this zone are possibly related to volcanic horizons within the sedimentary sequence. The type-6 zones about Wallerawang and Lithgow occurs on the edge of the Kanimbla Batholith and probably represents a basic margin of this igneous mass or a metamorphic aureole.

Zones of types 7 and 8. These zones are characterised by intense magnetic anomalies that have a pronounced elongation. These zone types are either related to basic intrusions or associated with granite boundaries.

The type- 7 zones situated to the north and south of Jenolan Caves are related to basic intrusions of gabbroic and dioritic composition. The type-7 zone situated 14 miles west of Katoomba is associated with a granite margin. The magnetic anomalies included in the latter zone are probably produced either by assimilation of the country rocks or by a metamorphic aureole and/or metasomatism, which has localised some magnetic minerals at the margin of the granite mass.

Basement depth contours

Magnetic basement depth estimates range from 900 to 3400 ft above sea level (a.s.l.) about a mean level of 2000 ft a.s.l. These depth estimates have been contoured at an interval of 500 ft, as shown in Plate 4. These contours show a general deepening of the basement towards the east, which is in agreement with known geology. The magnetic anomalies within the type-8 zone situated north of Jenolan Caves, on lines 28 and 29, indicate source depths of 1200 ft a.s.l. These depth determinations could indicate a minor basement trough, but it is more likely that an intra-basement feature is involved as basic material crops out at the surface. Interpretation of magnetic anomalies over the granitebatholith shows that susceptibility contrast increases towards its margins. This indicates that the basic composition of this mass increases towards the margin.

Known basic intrusions (gabbro and diorite) in the area have an associated susceptibility contrast in the range 4.2 to 10.0x 10^{-3} c.g.s. units. The basic intrusion situated on line 9, near Ben Bullen, falls within the range.

The interpreted magnetic anomaly trending NNW in the Glen Davis area is geologically related to either a granitic mass or volcanics in the Palaeozoic (Devonian) below the Permian unconformity. An estimate of its susceptibility contrast lies between that calculated for the granite and basic intrusions, but is closer to the contrast estimated for the granite margin in the survey area.

4. RADIOMETRIC RESULTS

Radiometric data were recorded along all flight lines. These data are not presented or analysed in this report as the extreme topographic relief in this region primarily controls the level of gamma radiation recorded.

5. CONCLUSIONS AND RECOMMENDATIONS

Magnetic basement contours indicate a deepening of the Sydney Basin to the east, with the maximum thickness of the Permian and Triassic sediments in the survey area limited to approximately 1500 ft. This thin succession of sedimentary rocks does not warrant any further investigations for oil.

Intense magnetic anomalies recorded near the margins of the granite batholiths warrant some detailed ground investigation to determine their economic significance.

6. REFERENCES

MOO, J. K. C.	1965	Analytical aeromagnetic interpretation. The inclined prism. Geophysical Prospecting. 13 (2).
PETERS, L. J.	1949	The direct approach to magnetic interpretation and its practical application. Geophysics 14 (3).
REFORD, M. S., and SUMNER, J.S.	1964	Aeromagnetics. Geophysics. 29 (4).
SHELLEY, E. P.	1965	Goulburn airborne magnetic and radiometric survey. N.S.W. 1965. Bur. Min. Resour. Aust. Rec. 1966/65.
YOUNG, G. A.	1963	Narromine and Bathurst airborne magnetic and radiometric survey N.S.W. 1961. Bur. Min. Resour. Aust. Rec. 1963/114.
VACQUIER, V., STEENLAND, C., HENDERSON, R. G., and ZIETZ, I.	1951	Interpretation of aeromagnetic maps. Geol. Soc. Amer. Mem. 47.

APPENDIX 1

Interpretation Procedure

Qualitative magnetic interpretation

The magnetic data have been qualitatively analysed by delineating magnetic trends and zones. A magnetic trend, by definition, joins the peak positions of the anomalies that are attributed to one continuous magnetic body. The resolution of these anomalies depends on their amplitude and magnetic character.

Magnetic zones are based on the degree of magnetic linearity and the dominant anomaly amplitude range. These criteria are generally satisfactory for distinguishing between contrasting rock types but geological control must also be considered when stating the geological significance of the particular zone type.

Quantitative magnetic interpretation

Quantitative interpretation involves the determination of the depth, width, and apparent susceptibility contrast of selected anomaly sources based on the assumption that the magnetisation is wholly induced.

Basement depth estimates were obtained from the interpretation of magnetic anomalies of simple form which showed no mutual interference. Methods used for depth calculations included the half-maximum-slope technique advocated by Peters (1949) and extended by Moo (1965) and the straight-slope method advocated by Vacquier et al (1951).

Depth factors applied in these determinations were 1.6 for Peters' method and 1.1 for straight-slope determinations. The basement depths were corrected for magnetic strike with respect to the flight orientation. Susceptibility contrasts were calculated from a standard formula given by Reford and Sumner (1964).

APPENDIX 2

Stratigraphic column of the western part of the Sydney area

Age	Group	Lithology	Remarks
Quaternary		Sands, gravels, alluminum, etc.	
Tertiary		Olivine basalt	Flow remnants, present on mountains to the east
		Gentle folding and faulting	Hunter-Bowen Orogeny
	Wianamatta Group	Sandstone and shales	Not present in survey area
Triassic	Hawksbury Sandstone	Massive coarse to medium-grained sandstone with shale lenses	
	Narrabeen Group	Quartz and lithic sandstone and shales	
	Former 'Upper Coal Measures'	Lithic sandstone, shale claystone, conglomerate, and several areas of coal and oil shale. Includes Lithgow Coal Measures	
Permian	Former 'Marine Series'	Massive conglomerate, breccias, grit, sandstone and shale. Includes Capertee Group	
Lower Carboniferous		Kanimbla Batholith. Biotite granite and granodiorite; also quartz-porphyry and basic intrusion	Kanimbla Orogeny Pb, Zn, Cu mineralisations along the margins of batholith

Age	Group	Lithology	Remarks
Upper Devonian	Lambie Group	Red shale, sandstone, conglomerate, and massive white quartzite	5000 ft
Middle Devonian		Granite plus mineralisation	Tabberabberan Orogeny
		Chert and limestone	
Silurian		Sills of acid and intermediate porphyries	Bowning Orogeny
		Limestone, shales, and interbedded dacitic tuff and rhyolitic keratophyric, and spilitic lavas	

APPENDIX 3

Operational details

Staff

Party leader	: R. A. Gerdes
Senior radio technician	: P. T. Ryan
Geophysical assistants	: K. A. Mort C. I. Parkinson
Pilots (T.A.A.)	: Capt. G. Litchfield Capt. M. Stewart First Officer D. A. Spiers
Aircraft maintenance engineer (T.A.A.)	: E. Murphy

Equipment

Aircraft	: D.C.3 VH-MIN
Magnetometers	: MFS-5 saturable cure fluxgate, tail boom installation coupled to speedomax and digital recorders
Storm warning device	: MNZ-1 experimental observatory proton magnetometer, output coupled to an Esterline-Angus recorder
Scintillometers	: Twin crystal MEL scintillation detector heads inboard output coupled to De Var recorder.
Radio altimeter	: STR 30B, frequency modulated type, output coupled to De Var recorder
Air position indicator	: Track recorded by De Var recorder
Camera	: BMR 35-mm strip

Survey specifications

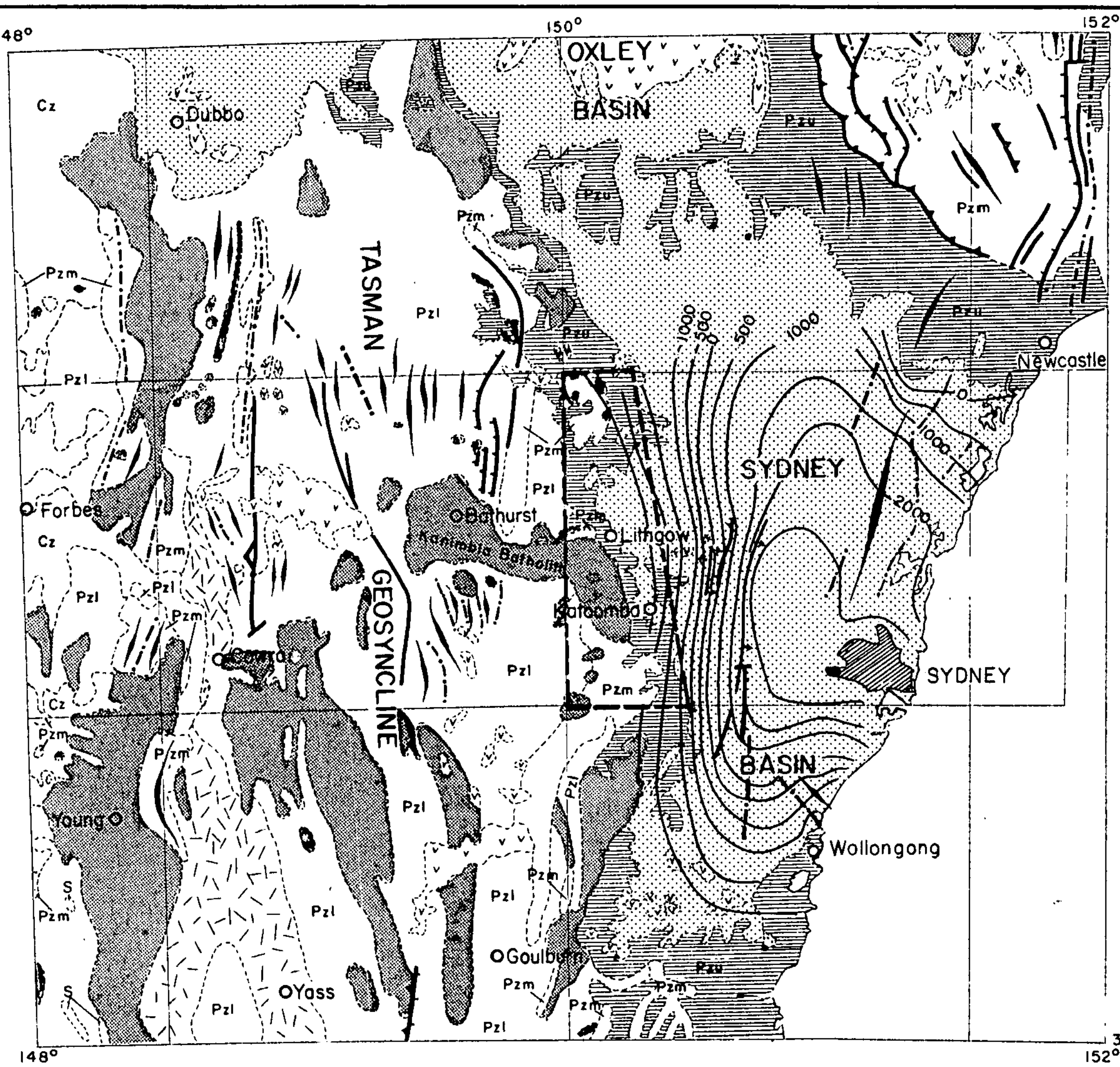
Altitude	: 4000 ft above sea level or 750 ft a.g.l.
Line spacing	: 2 miles
Line orientation	: East-west
Tie system	: Three single ties located at western and eastern boundaries and at centre of survey area
Navigation control	: Aerial photographs and topographic maps

Record sensitivites

MSF-5	: 50 gamma per inch or 500 gammas F.S.D.
Storm warning device	: 20 gammas per inch or 100 gammas F.S.D.
Inboard scintillometer	: 50 counts per second per cm
Inboard scintillometer time constants	: 10 seconds

Chart speeds

Speedomax	: 3 inches per minute
De Var: air position indicator and inboard Scintillograph recorder	: $1\frac{1}{2}$ inches per minute



AIRBORNE SURVEY, SYDNEY (WESTERN PART) NSW, 1966

LOCALITY MAP

50 0 50 100 150 MILES

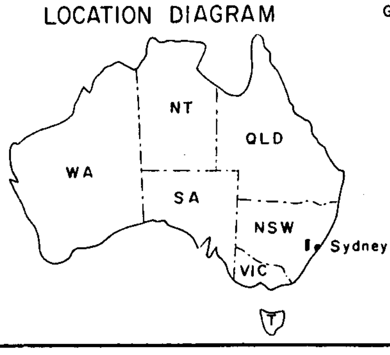
50 0 50 100 150 200 KILOMETRES

LEGEND

Cz	Alluvium
V	Tertiary volcanics
	Triassic
Pzu	Permian
Pzm	Devonian
Pzl	Silurian
	Granite
	Rhyolite pyroclastics etc
S	Palaeozoic serpentine

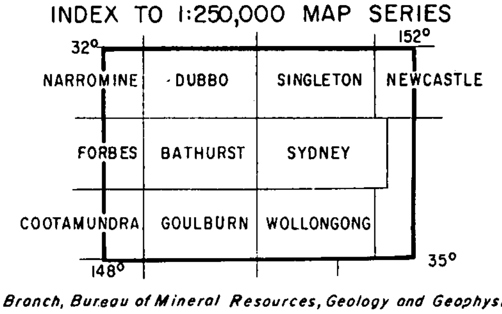
- Geological boundary
- —1000— Basement structure contours
- Anticline
- Syncline
- Monoclinal flexure
- Fault
- Low-angle reverse fault (triangles on upthrown side)
- High-angle reverse fault (hachures on downthrown side; triangle indicates dip)
- Limit of 1966 survey

LOCATION DIAGRAM



Geology after Tectonic map of Australia.

INDEX TO 1:250,000 MAP SERIES



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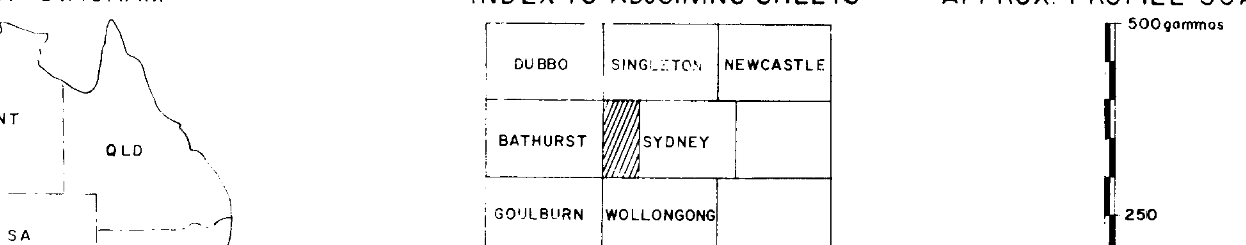
TO ACCOMPANY RECORD No. 1967/52

SYDNEY WEST
NEW SOUTH WALES

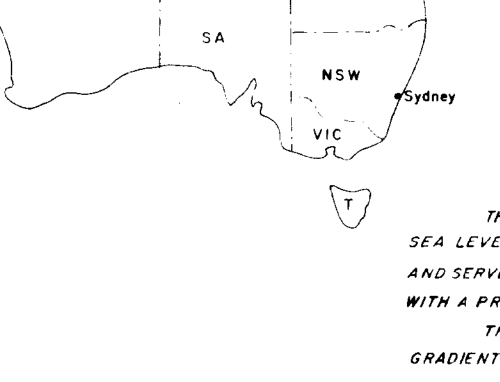
PLATE 2

AIRBORNE SURVEY, SYDNEY (WESTERN PART) NSW, 1966

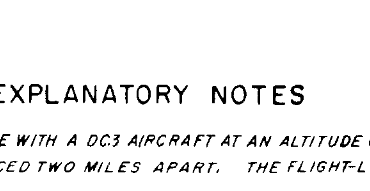
TOTAL MAGNETIC INTENSITY PROFILES



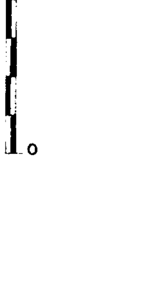
LOCATION DIAGRAM



INDEX TO ADJOINING SHEETS



APPROX. PROFILE SCALE



EXPLANATORY NOTES

THE SURVEY WAS MADE WITH A DC3 AIRCRAFT AT AN ALTITUDE OF 4000 FEET ABOVE SEA LEVEL ALONG LINES SPACED TWO MILES APART. THE FLIGHT-LINES ARE IDEALISED AND SERVE AS BASELINES TO THE PROFILES. THEY APPROXIMATE THE ACTUAL FLIGHT PATH WITH A PROBABLE ERROR OF ± 2 MILES

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

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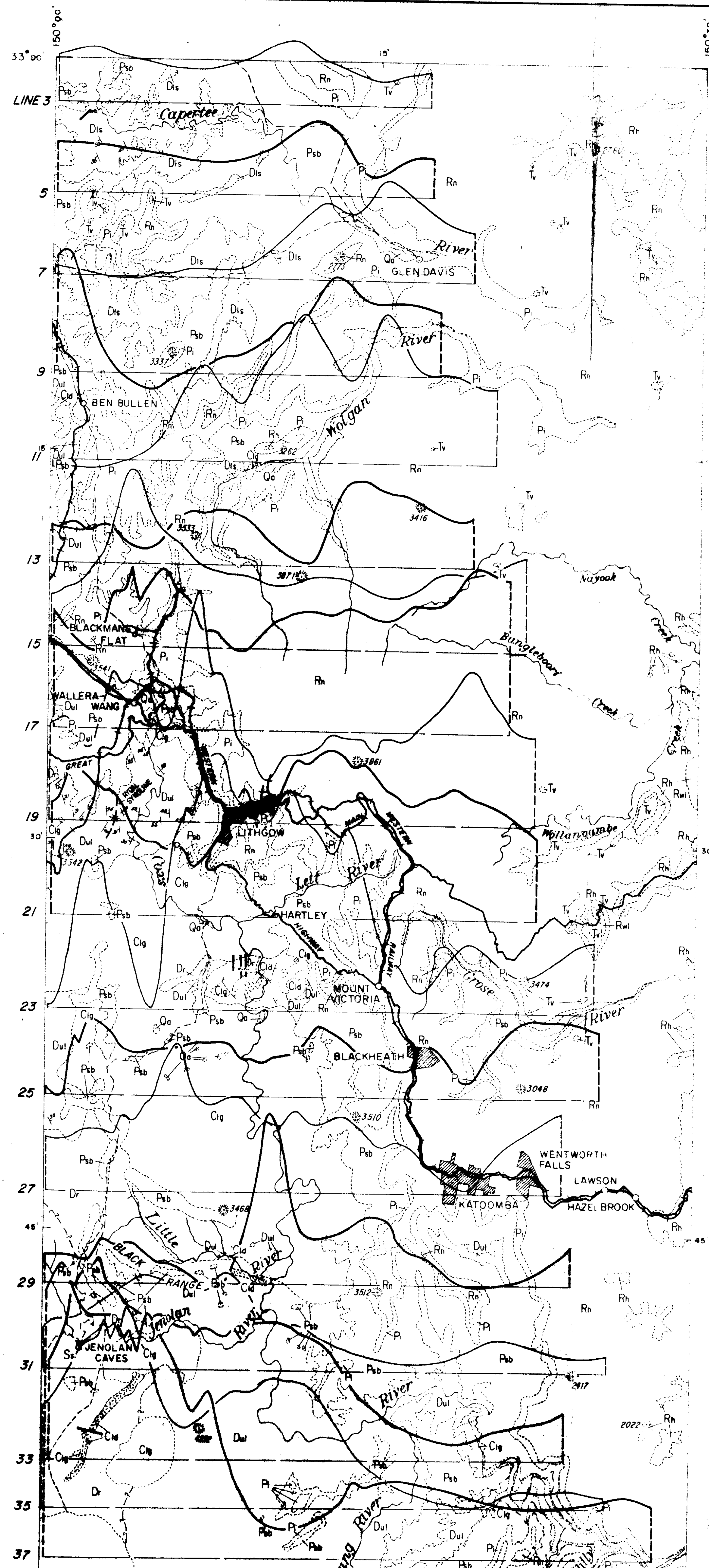
156/B1-4

SYDNEY WEST
NEW SOUTH WALES

PLATE 3



GEOLOGICAL LEGEND

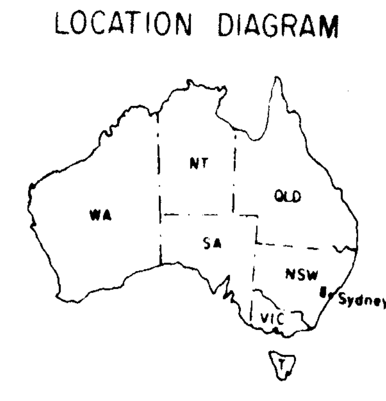
QUATERNARY		Qa	Alluvium, gravel, sand, silt and clay
POST-TRIASSIC		Tv	Basalt, dolerite, volcanic breccia etc
TRIASSIC	WIANAMATTA GROUP	Rwi	Shale with some sandstone beds.
	HAWKESBURY SANDSTONE	Rh	Sandstone, quartz with some shale
	NARRABEEN GROUP	Rn	Sandstone, shale and tuff
PERMIAN	ILLAWARRA COAL MEASURES	Pi	Shale, sandstone, conglomerate and chert with coal and torbanite seams
	SHOALHAVEN GROUP	Psb	Shale, conglomerate and sandstone including lenticular development of the Megalong Conglomerate.
LOWER CARBONIFEROUS		Clg	Adamellite, granite and granodiorite
		Cld	gabbro diorite
UPPER DEVONIAN		Dul	Quartzite, sandstone, siltstone and claystone
LOWER-MIDDLE DEVONIAN		[illegible]	Shale, siltstone, quartzite, tuff, and limestone
? LOWER-MIDDLE DEVONIAN		Dr	Rhyolite and rhyo-dacites
SILURIAN		Ss	Tuff, limestone, siltstone, phyllite and slate

- Geological boundary accurate
- Geological boundary approximate
- Geological boundary — probable or indefinite
- Geological boundary — concealed and accurate
- Established synclinal trough — position approximate
- Established fault — position accurate
- Probable fault
- Dip or strike

TOPOGRAPHICAL LEGEND

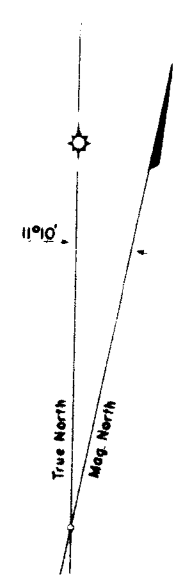
- River or creek
- Highway or main road
- Road or track
- Railway
- Built up area
- Named place
- Spot height in feet above sea level

LOCATION DIAGRAM



INDEX TO ADJOINING SHEETS

DUBBO	SINGLETON	NEWCASTLE
BATHURST	SYDNEY	
GOULBURN	WOLLONGONG	



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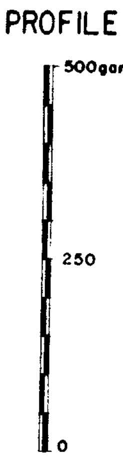

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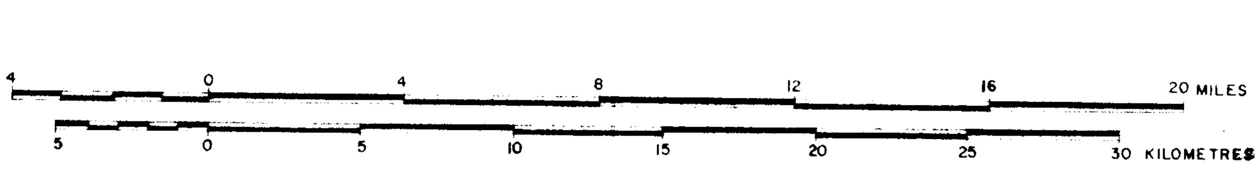
Topography after 1:250,000 scale map Royal Australian Survey Corps.
Geology after compilation sheet, Geological Survey of New South Wales, Division of Regional Geology, Third Edition 1966.
Transverse Mercator Projection.

BASED ON 156/B0-5
BASED ON 156/B1-5-1

AIRBORNE SURVEY, SYDNEY (WESTERN PART) NSW, 1966

TOTAL MAGNETIC INTENSITY PROFILES AND GEOLOGY



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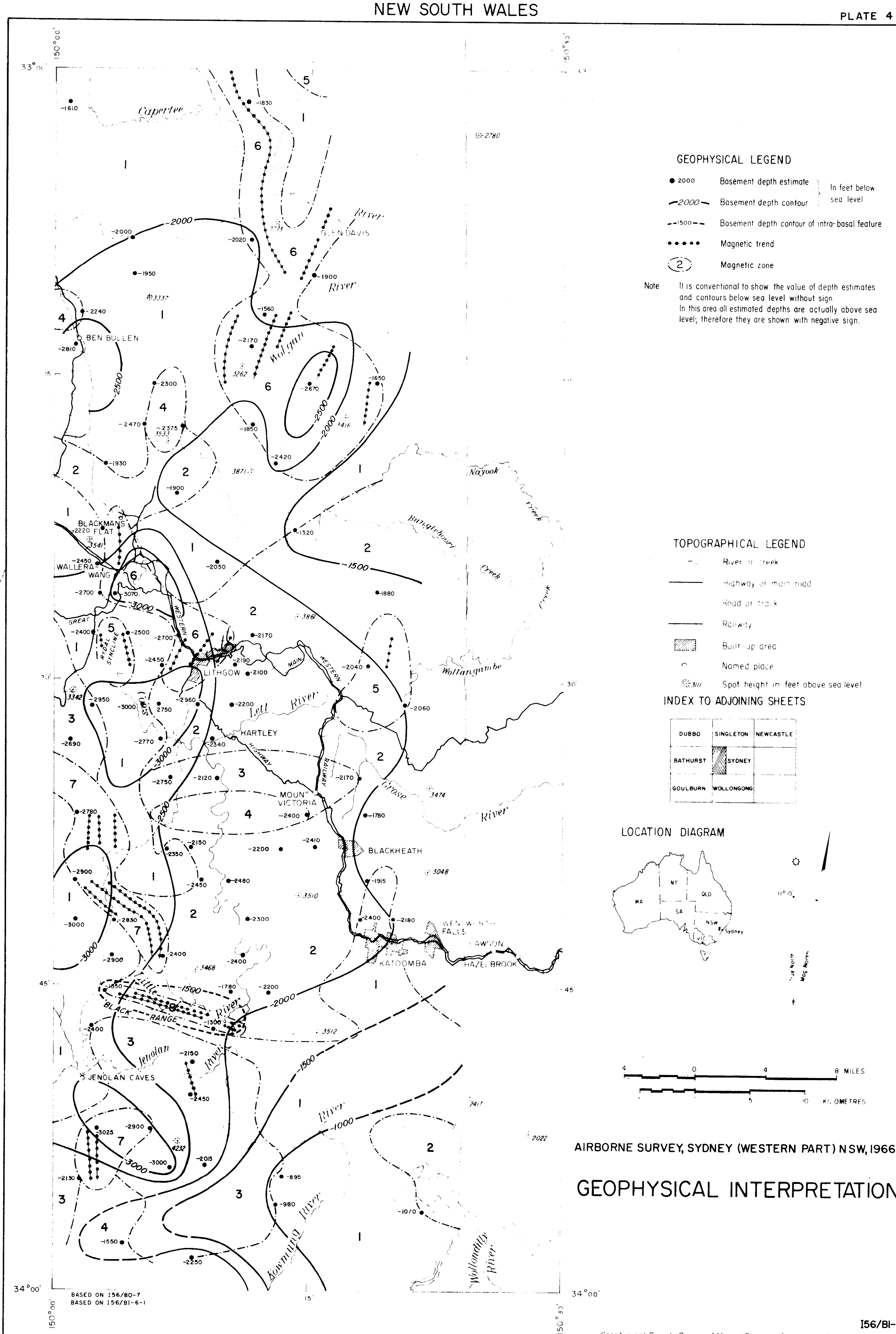
SYDNEY WEST
NEW SOUTH WALES

PLATE 4



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