DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

1976/2

AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY

BENDIGO, WANGARATTA AND TALLANGATTA, VICTORIA, 1972

by

D.N. DOWNIE, S.S. LAMBOURN and J.E. OLSEN

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SUMMARY

During the period February to October 1972 the Bureau of Mineral Resources made an airborne magnetic and radiometric survey of the BENDIGO, WANGARATTA, and TALLANGATTA 1:250 000 map areas at the request of the Victorian Department of Mines to assist geological mapping.

The survey area was divided into two blocks; the part east of 146° 30' was flown at 1800 metres above sea level and the part west of 146° 30' was flown at a nominal 150 metres above ground level.

The interpretation of the magnetic results given is largely qualitative. The area has been subdivided into zones on the basis of the interpreted cause of various magnetic anomalies. The sources of the major magnetic anomalies are the Cambrian basic volcanics in the west and the Lower Devonian granitic rocks in TALLANGATTA.

Radiometric data was collected only in the western part of the survey area. Recorded count rates were generally low, with the highest counts associated with acid igneous rocks. No anomalies of significant amplitude from restricted area sources were located.

1. INTRODUCTION

An airborne magnetic and radiometric survey of the BENDIGO*, WANGARATTA, and TALLANGATTA 1:250 000 map areas were made by the Bureau of Mineral Resources (BMR) during the period February to October 1972.

The survey was made at the request of the Victorian Department of Mines. It was expected that the survey would help to elucidate certain aspects of the regional geological structure of this part of northeast Victoria and also provide basic geophysical data of possible assistance in the search for economic mineral deposits.

The survey covered an area of 44,000 km^2 between 36°00' and 37°00'S latitude and between 144°00' and 148°30'E longitude as shown on the locality map (Pl. 1). It is situated mostly in northeast Victoria but does include small sections of New South Wales. The topography in the east of the survey area is extremely rugged, in considerable contrast to the low-lying plains to the northwest. The survey was divided into two parts at the 146°30'E meridian because of the impossibility of flying the mountainous area at a constant ground clearance. The east block was flown at a constant height of 1800 metres above sea level, with minor excursions above that level to clear the higher mountain peaks. As a result of this operational decision, gamma-ray spectrometer data were not recorded in the east block. The west block was flown maintaining, where possible, a constant 150 metres ground clearance.

Survey flight lines were oriented east-west and separated by 1.5 km in both areas.

This survey was the first flown by the BMR's Twin Otter aircraft, VH-BMG. Most of the geophysical, data acquisition, and navigation equipment installed in the aircraft was also being used for the first time.

Total magnetic intensity was measured using a fluxgate magnetometer, with field values being recorded on magnetic tape every second. A four-channel gamma-ray spectrometer was used to record gamma-ray intensity in the potassium, uranium, and thorium energy windows. The fourth channel, total count, registered all emissions with an energy above 1.0 MeV. The spectrometer data were recorded on magnetic tape in the form of counts accumulated over one-second intervals. The aircraft ground clearance, as

*Throughout this Record capital letters are used to denote 1:250 000 Sheet areas.

indicated by a radar altimeter, was also recorded but this instrument performed unsatisfactorily and little reliance can be placed on the data. The doppler navigation system was brought into operation as the survey proceeded. When this system became operational doppler along-track and across-track co-ordinates were recorded at 10-second intervals.

Previous Geophysics

The northern half of BENDIGO and the northern quarter of WANGARATTA had been covered previously by part of a subsidized aeromagnetic survey (Prior & Howe, 1962). This coverage was flown at a height of 600 metres above sea level with a variable flight line spacing of between 3 and 6 km.

The Cobberas 1:50 000 map area, in the southeast corner of TALLANGATTA, was flown by BMR in 1956. The survey results are available in contour map form.

Some early experimental airborne scintillometer work was done in 1956 by BMR over the Strathbogie Ranges and over an area south of Albury (Mulder, 1956). No significant radiometric anomaly was detected.

The eastern half of the survey area has been covered by a widely spaced network of gravity stations (Van Son & Langron, 1967). The main feature of the gravity results is a -60 mGal trough which extends east from Mt Buller to Benambra thence changes strike direction to northeast across eastern TALLANGATTA.

Since 1971, BMR, in conjunction with the Mines Department of Victoria and the States Rivers and Water Supply Commission of Victoria, has been engaged in a groundwater investigation in the lower Goulburn River valley. Two detailed gravity and seismic refraction traverses were made in the vicinity of Numurkah and Nathalia in conjunction with regional gravity coverage of a strip approximately 80 km wide from Shepparton to the Murray River (Taylor, Hill, & Pettifer, in prep.).

2. GEOLOGY

The following discussion of the geology of the survey area has been divided into two parts, corresponding to the division of the survey into two blocks by the 146°30'E meridian. The west and east blocks are described under the headings BENDIGO-WANGARATTA and TALLANGATTA-WANGARATTA, respectively. Although the survey area falls within the southeastern section of the Tasman Geosyncline, the east and west parts of the survey area have had a markedly different sedimentary and tectonic history.

Short accounts of the geology and structure of this part of Victoria have been given by Talent (1965) and Singleton (1965).

BENDIGO-WANGARATTA

This west block of the survey area has been subjected to lesser igneous activity and tectonism than the TALLANGATTA-WANGARATTA block. It underwent a long period of uninterrupted sedimentation that took place in the central Victorian trough between the Upper Cambrian and the Lower Devonian. The deformations and igneous activity associated with the Benambran and Bowning orogenies had limited influence. Marine sedimentation was terminated in BENDIGO-WANGARATTA in the Middle-Upper Devonian by the Tabberabberan Orogeny. Folds, faults, and the surface distribution of geological formations exhibit a dominant northerly trend (Pl. 2).

Cambrian

Altered volcanic rocks (greenstones) of Cambrian age occur along several widely spaced, generally north-trending belts in Victoria (Thomas & Singleton, 1965). The northern section of two of these belts enter the survey area, the most prominent crossing the southern boundary south of Heathcote and extending northward along the line of the Heathcote and Mt Ida Faults for approximately 70 km. It is composed of about 2000 metres of basic submarine lavas, predominantly dolerite, which in places have been altered to chloritic and serpentinous schist.

In WANGARATTA, about 110 km to the east, a discontinuous belt of similar rocks has surface expression at Tatong and Dookie, where a succession of dolerite sills are interbedded with tuff, ash, and chert.

Ordovician, Silurian, and Lower Devonian

The onset of normal geosynclinal sedimentation marks the base of the Ordovician in this region. Thick sequences of greywacke, sandstone, and shale follow the Cambrian, apparently conformably. Ordovician sediments occupy the area west of the Heathcote belt and east of the Tatong-Dookie belt. In the central trough sedimentation continued without apparent break until the Middle Devonian.

At Bendigo the Ordovician is estimated to be 3000 metres thick, and at Heathcote the thickness of the Lower Silurian to the Lower Devonian is about 7000 metres.

In the east of the zone the Chesney Vale and Warby Range Granites were emplaced during the intrusive phase of the Lower Silurian Benambran Orogeny.

Middle-Upper Devonian

The Lower Palaeozoic sediments were strongly folded in the Tabberabberan Orogeny. The deformation was followed in this region by the intrusion of at least three major granitic bodies, viz:

(i) Southern WANGARATTA, where a large semi-circular mass of intrusive and extrusive rocks is known as the Strathbogie Igneous Complex (White, 1957).

(ii) Southwest of Bendigo where Ordovician sediments have been intruded by the Ravenswood Granodiorite. The sediments are metamorphosed along the granite contact.

(iii) In northwest BENDIGO where the Pyramid Hill granite protrudes from the surrounding Murray Valley alluvium.

Post-Devonian

Glaciation during the Permian produced extensive tillite and fluvioglacial deposits. Subsequent faulting has preserved some of this material from erosion, particularly northwest of Heathcote.

Numerous erosional remnants of Tertiary basalt occur scattered through south WANGARATTA, and Quaternary basalt flows fill some of the topographic lows in southwest BENDIGO.

Recent fluvial and lacustrine alluvium covers most of the north of BENDIGO and WANGARATTA.

TALLANGATTA-WANGARATTA

This block (Pls 4 and 5) is more complex geologically than BENDIGO-WANGARATTA, having been subjected to at least three phases of deformation and intrusion since the Ordovician period. This history is reflected by the large number and variety of igneous intrusions found in the area, particularly in east TALLANGATTA.

Ordovician

The oldest rocks in the area are marine sediments of Ordovician age, forming an eastward continuation of the Ordovician of the BENDIGO-WANGARATTA block. These rocks consist of greywacke, sandstone, shale, and mudstone, which exhibit a general northwest structural trend. They have been tightly folded by subsequent deformations.

Silurian

The Mitta Mitta Volcanics, which cropout around Mt Cobberas, overlie the Ordovician and form the base of the Silurian rocks. They consist of a great thickness of rhyolite, rhyodacite, fragmental ignimbrite, and minor tuff.

To the south the Mitta Mitta Volcanics are overlain by the marine sediments of the Wombat Creek Group, which exceed 1000 metres in thickness and consist of conglomerate, minor limestone, and fine-grained terrigenous sediments. Another body of Silurian sediments, the Cowombat Group, occurs about the headwaters of the Indi River in southeast TALLANGATTA.

A major period of deformation and intrusion, the Benambran Orogeny, preceded the extrusion of the Mitta Mitta Volcanics. Ordovician sediments were tightly folded and the Mt Wills, Yackandandah, and other Silurian granites were emplaced.

A belt of Ordovician sediments, stretching from Albury south-southeast into BAIRNSDALE, was metamorphosed to a variety of schist, gneiss, and migmatite, with the concurrent intrusion of granite (Tattam, 1929; Beavis, 1962). The intensity of metamorphism is greatest at the core of the belt and is gradational eastwards into unaltered Ordovician. The western boundary is more abrupt, commonly a massive shear zone.

Lower Devonian

Great intrusions of granitic rocks accompanied the Epi-Bowning orogeny, some time between the Middle Devonian (Edwards & Easton, 1937). These intrusives are reported only in TALLANGATTA and include the Kosciusko Complex and the Koetong, Tallangatta, and Corryong Granites. Widespread quartz porphyry dykes represent a later stage of Lower Devonian igenous activity.

A number of bodies of basic and ultrabasic rock occur in a zone a few miles wide in the northern part of Snowy Mountains. This belt extends north-northeast from Geehi Dam and is made up of a number of roughly parallel, elongated masses. Rock types include pyroxenite, hornblendite, gabbro, diorite, monzonite, and lamprophyre.

Middle-Upper Devonian

The Snowy River Volcanics, occurring in southeast TALLANGATTA, are of Middle Devonian age. They consist of up to 3000 metres of rhyodacite, tuff, and other lavas.

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Widespread plutonic intrusions, associated with the intrusive phase of the Tabberabberan Orogeny, were emplaced in the Middle Devonian. These include the Mt Pilot, Mt Stanley, and Buffalo granites in WANGARATTA and the Pine Mountain, Mittamatite, and Swampy Plains granites in TALLANGATTA.

Numerous smaller bodies of intermediate, basic, and hybrid igneous rocks were intruded throughout the older formations during a late-intrusive phase of this Orogeny.

Triassic

The region entered a milder tectonic regime during the Mesozoic that has persisted to the present.

Igneous activity was briefly renewed, north of Benambra, during the Triassic with the intrusion of a granite porphyry-syenite-trachyte complex.

Tertiary

Tertiary basalt erruptions represent the last stage of igneous activity in the region. Remnants of the basalt remain in the region southwest of Mt Bogong, along the Gibbo River north of Benambra, and in the northern Snowy Mountains.

Economic mineralization

Gold has been by far the most important mineral mined in this area. Production reached its peak around 1860 but has declined steadily since then and is now negligible. Gold was widely distributed throughout central and northeast Victoria. Gold mineralization mainly took the form of auriferous quartz reefs introduced into faults and folds in the Lower Palaeozoic strata. Gold also occurred as an accessory mineral in some of the granites in the east.

Tin is scattered throughout the eastern part of the area, in placers, and in dykes and veins associated with the older granites.

Small sub-economic occurrences of copper, lead, tungsten, molybdenum, antimony, bismuth, chromium, and fluorite have been recorded, mostly associated with the granites of the eastern block.

3. MAGNETIC RESULTS AND INTERPRETATION

A contour map of the total magnetic intensity data recorded over the BENDIGO-WANGARATTA area is displayed, together with the geology of the area, in Plate 2. An interpretation of the magnetic data superimposed on geology is displayed in Plate 3. The magnetic contour map shows a small number of areas of intense magnetic disturbances, but over most of the area the magnetic field is flat or only weakly disturbed. The largest magnetic anomalies coincide with the Cambrian basic volcanics in the Heathcote, Dookie, and Tatong districts.

Total magnetic intensity contours covering the eastern survey block are displayed, together with the geology, in Plate 4. An interpretation of the magnetic data with the geology is displayed in Plate 5. Overall the magnetic contours for this survey block are much more disturbed. Magnetic anomalies are associated with most of the Devonian granitic bodies that form a large part of the TALLANGATTA area.

The interpretation of the magnetic results that follows is largely qualitative. For this purpose, the survey area has been sub-divided into zones of which there are 6 types. The basis of this classification is the interpreted cause of the various magnetic anomalies, determined in the light of the available geophysical and geological data. The geological significance of these magnetic zones is summarized below and discussed in greater detail, for both survey blocks.

Zone	Magnetic Characteristics	Interpreted Geological Significance
1	Extensive regions of low magnetic disturbance. Anomalies seldom exceed 20 nT	Rocks in this zone are of uniformly low magnetic susceptibility. They comprise thick sequences of Lower Palaeozoic sediments or acid igneous rocks of very low magnetic susceptibility
2	Broad magnetic anomalies, varying considerably in intensity but usually less than 200 nT in amplitude	Rock types of low to moderate magnetic susceptibility, interpreted as granitic intrusions, commonly of batholithic proprotions

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Zone	Magnetic Characteristics	Interpreted Geological Significance
3	Relatively intense magnetic anomalies, commonly associated with zone 2 anomalies	Igneous rocks of high magnetic susceptibility. These are generally smaller in size and tend to occur in association with larger masses of granitic rock. They are interpreted as bodies of intermediate to basic rock, commonly basic differentiates of the granitic intrusives. They occur mainly in the east
4	Weak magnetic anomalies less than 50 nT in amplitude and usually elongated in form	Metamorphic rocks of low to moderate magnetic susceptibility. In BENDIGO-WANGARATTA these take the form of metamorphic aureoles surrounding some of the granitic intrusives. In TALLANGATTA this zone is represented by the northeast Victorian metamorphic belt
5	Areas of intense magnetic disturbance	The strongly magnetic rocks of the Cambrian greenstone belts. These are restricted to BENDIGO-WANGARATTA
6	Areas of sharp magnetic disturbances from near-surface sources	Minor flows of basalt of Tertiary and Quaternary age. Magnetic anomalies over the young basalts in southwest BENDIGO are invariably negative

BENDIGO-WANGARATTA

Areas of BENDIGO-WANGARATTA classified as zone 1 form the largest part of this block. The magnetic field recorded over the thick Lower-Middle Palaeozoic sediments of BENDIGO is very flat, particularly in the south where gradients associated with deep-seated regional anomalies are absent. In several localities in southern BENDIGO clusters of small anomalies, usually less than 60 nT in amplitude, were recorded. These anomalies are too small in both amplitude and areal extent to be adequately represented on the 1:250 000 contour map. Nevertheless they are very evident on profiles of the magnetic data. The small amplitude, regular spacing, and shallow depth of these anomalies suggest that they are caused by very small susceptibility differences between steeply dipping strata. They show a definite north trend but continuity from line to line is poor.

No magnetic anomalies are associated with the near-surface rocks of the Strathbogie Igneous Complex and only a small number of very localized anomalies were recorded over the Silurian granites of WANGARATTA.

Several magnetic anomalies, ranging in amplitude up to 100 nT, are interpreted as indicating large bodies of weakly magnetic crystalline rocks (zone 2). One such extensive region of high magnetic intensity occurs in northwest BENDIGO. The Echuca aeromagnetic survey (Prior & Howe, 1962) does not define the northern extent of this anomalous region but it would appear to form an elongated zone, orientated east-west, straddling the northern boundary of BENDIGO. Within this zone granitic rock crops out at Pyramid Hill in northwest BENDIGO. The presence of granite also is indicated at shallow depth, some 15 km north of Numurkah by a detailed seismic refraction traverse (Taylor et al., in prep.). Whether these bodies of granite are isolated intrusives into a large region of older and deeper magnetic basement or whether the entire region is formed of a uniform body of granite of varying depth is uncertain. In the area of flat magnetic field between Pyramid Hill and Echuca the thickness of the overlying sediment could be very great. East of Echuca the slightly more disturbed magnetic contours indicate a much lesser depth to crystalline rock. Several faults, most having a general north trend, have been interpreted as the cause of the linear magnetic gradients in this area. The most definite of these faults forms a northern extension of the faults bounding the Heathcote greenstone axis.

Other magnetic anomalies associated with granitic rocks occur over the western part of the Ravenswood granodiorite in southwest BENDIGO and in the northeast and southeast corners of this survey block. The magnetic high in the southeast is partly obscured by the magnetic anomalies produced by small areas of basalt. This anomaly is the western extension of the regional magnetic high in the southwest corner of TALLANGATTA-WANGARATTA that includes several areas of granite outcrop.

Four magnetic anomalies, the most intense having an amplitude of 450 nT, indicate igneous intrusives of rather higher magnetic susceptibility (zone 3). Three of these are of restricted horizontal extent and occur on the outer margin of larger, less intense magnetic highs (zone 2). They also are quite shallow, the deepest body some 10 km north of Wangaratta being at an estimated 850 metres below the surface. These three anomalies are interpreted as basic differentiates of the larger, less magnetic masses of acid rock.

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The fourth magnetic anomaly included in this zone is a much larger feature. This anomaly, some 150 nT in amplitude, covers a very large area centred south of Euroa. The body causing the anomaly is estimated to be some 35 to 40 km in diameter at an estimated depth of burial of 9.5 km. The calculated magnetic susceptibility is 0.002 cgs units. These estimates assume that the source body has vertical sides. A domed structure would reduce both the depth and susceptibility contrast. The Bouguer gravity contours from the eastern Victorian gravity survey (Van Son & Langron, 1967) show a weaker Bouguer high coinciding with this magnetic anomaly, indicating only a low density contrast between the magnetic body and the surrounding rock. The relation of this magnetic body with the Strathbogie Igneous Complex, which it partly underlies, is unknown. The near-surface rocks of the Strathbogie Complex have negligible magnetic effect.

Bands of magnetic anomalies occur around the periphery of some of the granitic intrusions (zone 4). These anomalies range in amplitude up to 50 nT and usually arise in the metamorphosed sediment along the granite contract. In a few cases some small anomalies were recorded over the outer margin of the granite. These weakly magnetic metamorphic aureoles are particularly well developed around the Pyramid Hill Granite and the Ravenswood Granodiorite in west BENDIGO.

The most intense magnetic anomalies in the BENDIGO-WANGARATTA area are related to the Cambrian basic volcanic rocks (zone 5). Magnetic anomalies of up to 1500 nT were recorded over the three areas where these rocks crop out. The complex and intense magnetic disturbance in the northwest corner of BENDIGO has been tentatively interpreted as another occurrence of Cambrian greenstone, solely on the magnetic character of the disturbance.

A zone of intense magnetic anomalies coincides with the surface occurrence of the Cambrian along the Heathcote greenstone axis. In the southern section of the belt where pyroclastics are predominant the amplitudes of the magnetic disturbances are very much reduced. In the north the greenstones continue beneath the Murray Valley alluvium for only a short distance before undergoing a major structural change. Here the main part of the belt comes to an abrupt end 3 km northeast of Rochester. The area of relatively shallow granitic basement in north BENDIGO is probably a controlling factor in this change. A minor discontinuous arc of anomalies continues northwards, finally assuming a northwest trend near Echuca. These anomalies are assumed to indicate the presence of small bodies of Cambrian at about 200-300 metres below the surface. This arc follows the interpreted fault forming the western boundary of an area of shallow magnetic basement in the east. Alternatively this line of anomalies could be due to younger basic material intruded along the interpreted fault.

In the Dookie district the magnetic contours show that the Cambrian is more extensive than the area of surface occurrence indicates. Here basic rocks continue west, beneath a thin cover, as far as Shepparton. Narrow linear belts of basic material also extend northwest towards Nathalia and southeast towards Tatong. The southeast extension ends abruptly 14 km northwest of Benalla and there is no magnetic evidence to indicate the presence of shallow Cambrian between this locality and that at Tatong.

Small remants of basalt flows are common in the south of the BENDIGO-WANGARATTA block. These stand out on the magnetic contours as characteristically sharp, shallow anomalies (zone 6). In WANGARATTA, only the more extensive basalt anomalies have been delineated on the interpretation map. The Quaternary basalt in southwest BENDIGO gives distinctive negative anomalies. The correspondence between these negative anomalies and the areas of exposure of the young basalt is nearly exact, the only exception occurring in the Campaspe River valley where the basalt continues north beneath alluvial cover for a further 20 km.

TALLANGATTA-WANGARATTA

Areas of flat magnetic field are restricted to the west and north of this survey block (zone 1) and are associated with outcropping Ordovician sediments (Pl. 5). A number of Silurian granite intrusives occur here but they produce no measurable magnetic effect. Several regions of undisturbed magnetic field in northern TALLANGATTA are associated with granitic intrusions, the main ones being the large Koetong Granite mass and a variety of acid intrusive bodies northeast of Corryong.

Broad areas of moderate magnetic anomaly amplitude frequently coincide with Devonian granite bodies (zone 2). In the west magnetic anomalies of widely varying amplitude were recorded over the exposed Middle-Upper Devonian granites at Mount Pilot, The Horn, Mount Emu, and Sugarloaf Hill.

This corner of the survey area, southwest of Mount Buffalo, is an area of relatively high magnetic intensity which suggests that Mount Buffalo and the other nearby granites are the protruding parts of a large, shallow granitic mass occupying this region.

Three large complex magnetic anomalies dominate the eastern half of TALLANGATTA. These outline the areas of higher magnetic susceptibility within the extensive composite Lower Devonian granite complex. In places the sharp magnetic gradients along the boundaries of these zones may be indicative of faulting.

Within and around the periphery of some of the granite batholiths a number of more intense magnetic disturbances were recorded (zone 3). In the west, some 10 km southwest of Beechworth, a 300 nT anomaly coincides with an eroded intrusive stock outlined by the resistant metamorphosed sediments surrounding the stock. Quantitative interpretation of this anomaly indicates that the magnetic source, which has a susceptibility of 0.0018 cgs units, is less than 500 metres below the surface. This intrusion is possibly a basic differentiate of the Mount Pilot Granite to the north. In TALLANGATTA some very intense magnetic anomalies, the greatest having an amplitude of over 1000 nT, are interpreted as unusually basic centres within the granitic batholiths. The ultrabasic rocks of the Snowy Mountains give rise to a band of magnetic anomalies in northeast TALLANGATTA. Numerous anomalies, of smaller areal extent, also included in zone 3 are interpreted as diorite plugs and other intermediate-basic intrusives.

A broad, low-amplitude magnetic trend occurs over the northern half of the Ordovician metamorphic rocks (zone 4). This weak anomaly is interpreted as arising from the slight magnetite contect of the strongly altered metamorphic rocks at the core of this complex. A number of intense anomalies within the north and south sections of this band (zone 3) are interpreted as igneous material intruded into the core of the complex. The only one of these anomalies that can be correlated with the surface outcrop of intrusive rock is the 300 nT anomaly over the Big Hill Quartz Diorite 5 km south of Mount Beauty township.

Tertiary basalt flows (zone 6) are associated with magnetic anomalies northeast of Hotham Heights and in the northeast corner of TALLANGATTA.

4. RADIOMETRIC RESULTS AND INTERPRETATION

Stacked profiles of the gamma-ray spectrometer total count channel are displayed in Plate 6. Background radiation has been removed from these data by the subtraction of a constant 50 counts/second. Actual background count rates varied, both with time and with position, between limits of 45 to 55 counts/second.

The recorded levels of gamma-ray activity reveal very little of interest. No point source anomalies of sufficient intensity to warrant further investigation were located. One important factor relating to radioactive sources of limited area is that a spectrometer carried in an aircraft flying at 150 metres above the ground, with a survey line spacing of 1.5 km, effectively samples about 30% of the ground covered. In this survey area changing ground clearance was by far the most important factor contributing to the variation in count rates. Wide extremes in ground clearance in the southeast corner of the west block severely limit the value of the radiometric data in this sector. Although a digital record of ground clearance was available an altitude correction could not be applied to the data for reasons explained in Appendix 2.

The natural gamma-ray intensity recorded over the alluvial plains, that cover most of the northern half of this area, was low and very uniform. A number of small variations in count rate were noted but apart from a weak correlation with old river channels and stream deposits their distribution appears to be random.

The radiometric response of the acid igneous rocks is substantially higher, as expected. Most of the additional radiation is in the potassium channel, but smaller and rather variable responses were recorded in the uranium and thorium channels. The Silurian granite in WANGARATTA, particularly that of the Warby Range, and the Ravenswood Granodiorite in southwest BENDIGO produced the highest counts. The Ravenswood Granodiorite gave a particularly high thorium count. The Pyramid Hill Granite in northwest BENDIGO gave a definite potassium anomaly but produced negligible counts in the uranium and thorium channels.

Count rates over the exposed sedimentary rocks of south BENDIGO were, after allowing for the greater variation due to terrain clearance changes, not significantly higher than over the alluvium.

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Radiometric lows coincide in places with the exposed Cambrian basic volcanics. This correlations is most evident over the central part of the Heathcote axis and in the Dookie district.

5. CONCLUSIONS

The magnetic data clearly outline the extent of the shallow Cambrian basic rocks in BENDIGO and WANGARATTA, these rocks being generally related to the areas of surface occurrence. One possible exception is an area interpreted as Cambrian basics in the northwest corner of BENDIGO.

The large, deep-seated anomaly centred near Euroa is related to a body of regional significance. Most detailed gravity data might provide more information on the nature of its source and as such should be considered.

The complex nature of the magnetic field over the granitic batholiths of east TALLANGATTA is partly due to lithological variations within the heterogeneous granite masses and partly due to numerous interspersed intermediate and basic intrusives.

The radiometric data contain little or interest, with the largest total count anomalies of only 100 cps. As expected, the acid igneous rocks are the most radioactive in the survey area. The prospects for the presence of uranium mineralization in this area appear to be low.

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APPENDIX 1

RADIOMETRIC INTERPRETATION PROCEDURE

The gamma-ray spectrometer data recorded are the number of counts registered in each channel over one-second counting intervals. These data have the rapid time response needed to define radiometric anomalies due to point sources but, because of the low count rates, show a considerable statistical variation. The standard deviation of these data is given by the relation:

$$S.D. = \sqrt{n} \qquad (1)$$

where n = average count/time interval

The first stage of processing the data was to examine the one-second Total Count analogue records for point source anomalies. These were defined as those anomalies where the half-width at half maximum amplitude was less than 10 seconds. This definition is appropriate to the speed and average ground clearance of the aircraft on this survey. After anomalies that could be explained by rapid changes in the ground clearance profile were eliminated, no point sources of significant amplitude remained.

The spectrometer data were then subjected to an averaging process to reduce the relative amplitude of the random statistical count variation. This was done by accumulating counts over 20-second time intervals, the result being positioned at the centre of the interval.

Overlapping 20-second count rate data, spaced at one-second separation, were used to produce the Total Count profiles shown in Plate 6. The highly dependent nature of adjacent 20-second counts gives a deceptively smooth profile. The standard deviation applicable is still as given in (1). This smoothing process reduces the standard deviation relative to the count rate by a factor of $\sqrt{20}$.

Ground clearance, as indicated by the Bonzer radar altimeter was recorded and used to attempt altitude correction of the Total Count data. This correction was based on a model that assumed flight over an infinite, uniformly radioactive plain. Unfortunately the poor performance of the radar altimeter severely reduced the usefulness of the altitude correction. Over flat terrain, variations in ground clearance were compensated accurately. Over rugged terrain or thickly timbered ground the altimeter tended to lose return signal. This behaviour was common over the southern half of the survey and made general application of the altitude correction impossible.

APPENDIX 2

OPERATIONAL DETAILS

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	R. Curtis-Nuthall	Technical Officer
	K.A. Mort	Technical Assistant
	B.I. Ludewig	Technical Assistant (part time)
T.A.A.	First Officer	I.G. Haigh, Pilot
	First Officer	R.P. Mansfield, Pilot

Equipment

Aircraft: DHC Twin Otter VH-BMG

Magnetometer: Airborne - Prototype MFS7 Fluxgate magnetometer, tail boom installation

Ground - MFD4 fluxgate magnetometer and MNS2 proton precession magnetometer

Gamma-ray Spectrometer : Hamner-Harshaw 4-channel system, stabilization by CS137 source, detector crystal volume 220 in^3.

Gamma-ray Spectrometer energy windows used:

Channel 1	Total	Integral above 1.0 MeV
Channel 2	Potassium	1.37 - 1.57 MeV
Channel 3	Uranium	1.66 - 1.86 MeV
Channel 4	Thorium	2.40 - 2.80 MeV

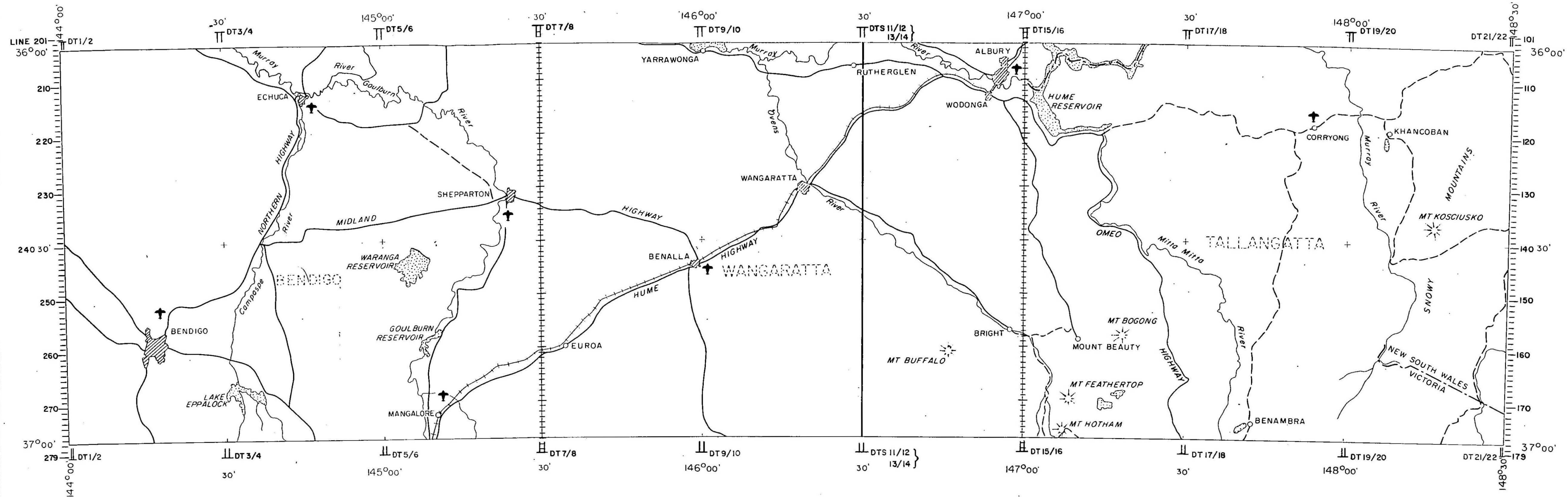
Doppler Navigation system: Marconi AD560

Radar Altimeter: Bonzer TRN-70

Tracking Camera: 35 mm strip camera

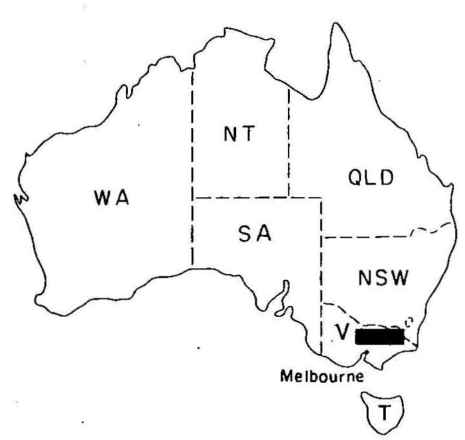
Survey Parameters

Altitude:	1800 metres above sea level (east block) 150 metres above ground level (west block)
Line orientation:	east-west
Tie system:	North-south double ties, spaced at 30' intervals
Navigation:	Aerial photographs and doppler



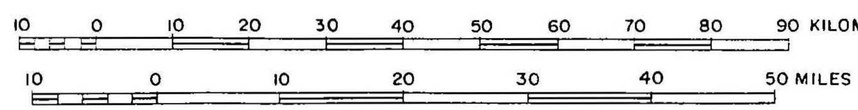
AIRBORNE SURVEY, BENDIGO, WANGARATTA, TALLANGATTA, VICTORIA-NSW 1972

LOCATION DIAGRAM



LOCALITY MAP

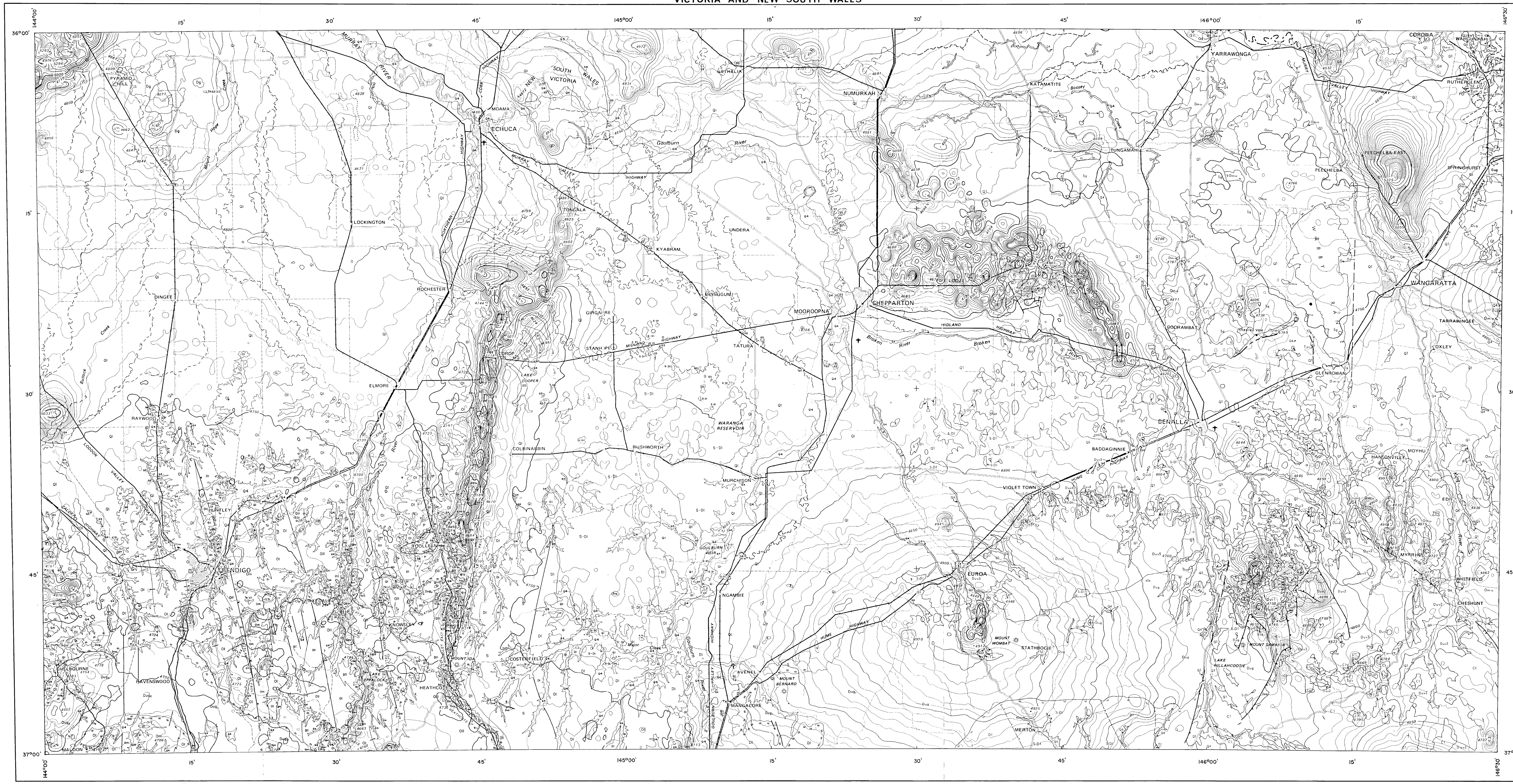
FLIGHT-LINE AND TIE-LINE SYSTEM



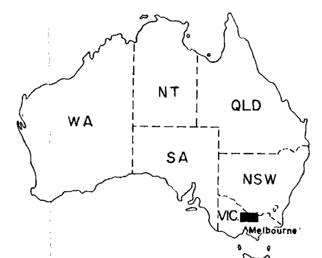
REFERENCE TO 1:250,000 MAP SERIES

SWAN HILL	DENILIQUIN	JERILDERIE	WAGGA WAGGA	CANBERRA
SAINT ARNAUD	BENDIGO	WANGARATTA	TALLANGATTA	BEGA
BALLARAT	MELBOURNE	WARBURTON	BAIRNSDALE	MALLACOOTA

BENDIGO-WANGARATTA
VICTORIA AND NEW SOUTH WALES



LOCATION DIAGRAM



INDEX TO STANDARD
1:250000 MAP SERIES

SWAN HILL	DENILIQUIN	JERILDERIE
ST ARNAUD	BENDIGO	WANGARATTA
BALLARAT	MELBOURNE	WARBURTON

AIRBORNE SURVEY, BENDIGO, WANGARATTA, TALLANGATTA, VICTORIA–NSW 1972

TOTAL MAGNETIC INTENSITY
AND
GEOLOGY

5 0 5 10 15 20 KILOMETRES

5 0 5 10 MILES

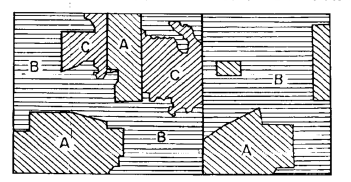
GEOPHYSICAL LEGEND

5000 / 4980 Magnetic contours

× 5002 Magnetic value

MAGNETIC CONTOUR INTERVAL 10nT

GEOLOGICAL RELIABILITY DIAGRAM



A.....Detailed ground survey and aerial photo interpretations

B.....Reconnaissance ground survey and aerial photo interpretation.

C.....Detailed soil survey.

Geology after Bendigo and Wangaratta 1:250 000 map sheets, Provisional Editions 1968 by Mines Department of Victoria.

TOPOGRAPHIC LEGEND

- Highway or main road
- Secondary road
- Road or track
- Railway with station
- Built-up area
- Named place
- Homestead
- Aerodrome or landing
- Mine
- River or creek
- Lake
- Swamp
- Hill feature

BENDIGO GEOLOGICAL LEGEND

Cainozoic	Quaternary	Recent / Pleistocene	Q4	Stream alluvial flats, lacustrine, levee and swamp deposits of clay, silt and gravel.
			Q3	Lunette deposits of fine sand, silt and minor clay and gravel
			Q2	Hill wash of soil and decomposed rock debris.
			Q1	Plain and outwash alluvial deposits, lacustrine deposits, prior stream deposits, high river terraces of clay, silt, sand and minor gravel
		Pleistocene	Qpv	Basalt, olivine basalt.
	Tertiary	Pliocene	Tp	Gravel, sand and clay. (includes MANGALORE GRAVELS)
Palaeozoic	Permian		P	Glacial deposits of tillite, conglomerate and sandstone.
	Devonian	Upper	Dug1	Granodiorite
			Dug2	Granite
			Dud	Acid dykes
		Lower	Dl	Mudstone, shale and conglomerate. (includes Encrinurus-Chonetes BEDS, Mc.IVOR and MT. IDA BEDS)
			Dg	Granite
	Silurian–Devonian	(Undifferentiated)	S-Dl	Sandstone, mudstone, shale and conglomerate.
	Silurian	Upper	S	Sandstone, mudstone and conglomerate. (includes COSTERFIELD, WAPENTAKE and DARGILE BEDS)
	Ordovician	Middle	Om	Quartzite, sandstone, greywacke and slate.
		Lower	Ol	Sandstone, greywacke, shale and quartzite. (includes BENDIGONIAN, CHEWTONIAN, CASTLEMAINIAN, YAPEENIAN and undifferentiated stages.)
			Oll	Sandstone, greywacke, shale and quartzite. (LANCEFIELDIAN stage)
	Cambrian	Middle-Upper	Єm-u	Shale, siltstone, chert and jasper.
		Lower	Єlv	Diabase, dolerite, agglomerate, ash and tuff.

- Geological boundary
- Prior stream course
- Fault
- Reverse fault
- Dip and strike
- Anticline
- Syncline
- Swamp
- Zone of metamorphism

WANGARATTA GEOLOGICAL LEGEND

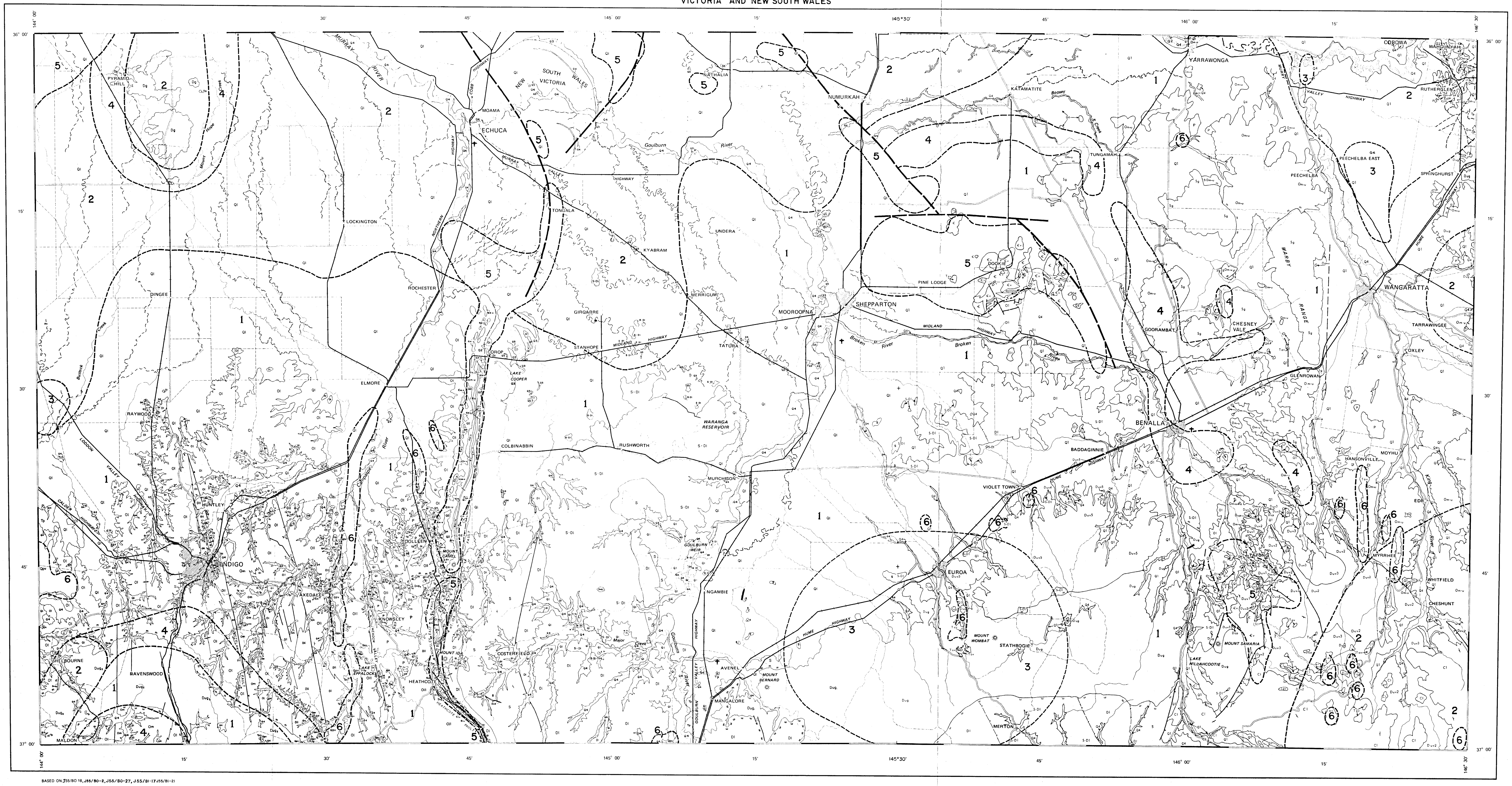
NON–MARINE MARINE IGNEOUS METAMORPHIC

Quaternary	Recent / Pleistocene	Q4	Alluvial terraces, lacustrine and swamp deposits: clay, silt, sand and gravel.
		Q3	Lunette deposits: clay, silt and fine grained sand
		Q2	Aeolian deposits: silt, sand.
		Q1	Plain, alluvial, lacustrine and stream levee deposits: high river terraces and alluvial fans; clay, silt, sand, minor gravels and conglomerates.
Tertiary	Pliocene	Tp	Fluvial deposits: gravels, often ferruginous.
	Eocene	Tov	OLDER VOLCANICS: basalt, melabasalt and phonolite.
Permian		P	Glacial and fluvio–glacial deposits: tillite, sandstone, conglomerate and arkosic clay.
Carboniferous	Lower	Cl	Terrestrial deposits: conglomerate, red sandstone, siltstone and shale.
Devonian	Upper	Dug	Granite, adamellite, aplite and minor granodiorite. Includes PILOT RANGE, MT. BUFFALO, STANLEY, STRATHBOGIES and BARJARG GRANITES.
		Dup	Granodiorite porphyrite.
		Duv5	Quartz-biotite-hypersthene rhyodacite (VIOLET TOWN VOLCANICS)
		Duv4	Rhyolite (VIOLET TOWN VOLCANICS)
		Duv3	Rhyodacite (TOOMBULLUP RHYODACITE)
		Duv2	Rhyolite (RYANS CK. RHYOLITE) and undifferentiated acid volcanics of the upper King and upper Rose Rivers.
		Duv1	Rhyodacite, ignimbrite, conglomerate and minor pebbly sandstone and mudstone (HOLLANDS CREEK RHYODACITE sequence)
	Lower	Dlg	Granite, includes JINDERA GRANITE
		Dl	Mudstone, siltstone and sandstone.
		Dlv	Quartz-felspar-porphyry, rhyolite and tuff.
Silurian–Devonian	(undifferentiated)	S-Dl	Mudstone, siltstone and sandstone.
Silurian		S	Mudstone, siltstone and sandstone.
		mg	Gneiss, biotite gneiss, gneissic granite.
		ms	Meta sediments, high grade phillite and mica schist.
		Sg	Granite, gneissic granodiorite. Includes CHESNEY VALE, WARBY RANGE and YACKANDANDAH BASIN GRANITES and BARNAWARTHA GNEISSIC GRANODIORITE.
Ordovician	Upper	Og	Two-mica granite, includes RUN BOUNDARY GRANITE.
	Middle	Om-u	Greywacke, sandstone, siltstone, shale and mudstone.
	Lower	Ol	Greywacke, shale and chert.
Cambrian	Middle & Upper	Є	Tuff, chert, cherty shale.
	Lower	Єv	Greenstone, diabase

- Geological boundary
- Prior stream course
- Fault
- Fault, showing direction of dip
- Dip and strike of bedding
- Synclinal axis
- Zone of contact metamorphism

Record No. 1976/2

BENDIGO-WANGARATTA
VICTORIA AND NEW SOUTH WALES



BASED ON J55/B0-18, J55/B0-2, J55/B0-27, J55/B1-17, J55/B1-21

BENDIGO GEOLOGICAL LEGEND

Cainozoic	Quaternary	Recent	Q4	Stream alluvial flats, lacustrine, levee and swamp deposits of clay, silt and gravel.
			Q3	Lunette deposits of fine sand, silt and minor clay and gravel
		Pleistocene	Q2	Hill wash of soil and decomposed rock debris.
			Q1	Plain and outwash alluvial deposits, lacustrine deposits, prior stream deposits, high river terraces of clay, silt, sand and minor gravel
			Qpv	Basalt, olivine basalt.
	Tertiary	Pliocene	Tp	Gravel, sand and clay. (includes MANGALORE GRAVELS)
Palaeozoic	Permian		P	Glacial deposits of tillite, conglomerate and sandstone.
	Devonian	Upper	Dug_1	Granodiorite
			Dug_2	Granite
			Dud	Acid dykes
		Lower	Dl	Mudstone, shale and conglomerate. (includes *Encrinurus Chonetes* BEDS Mc.IVOR and MT. IDA BEDS)
			Dg	Granite
		(Undifferentiated)	S-Dl	Sandstone, mudstone, shale and conglomerate.
	Silurian	Upper	S	Sandstone, mudstone and conglomerate. (includes COSTERFIELD, WAPENTAKE and DARGILE BEDS)
	Ordovician	Middle	Om	Quartzite, sandstone, greywacke and slate.
		Lower	Ol	Sandstone, greywacke, shale and quartzite. (includes BENDIGONIAN, CHEWTONIAN, CASTLEMAINIAN, YAPEENIAN and undifferentiated stages.)
			Oll	Sandstone, greywacke, shale and quartzite. (LANCEFIELDIAN stage)
	Cambrian	Middle-Upper	€m-u	Shale, siltstone, chert and jasper.
		Lower	€lv	Diabase, dolerite, agglomerate, ash and tuff.

Geological boundary
Prior stream course
Fault
Reverse fault
Dip and strike
Anticline
Syncline
Swamp
Zone of metamorphism

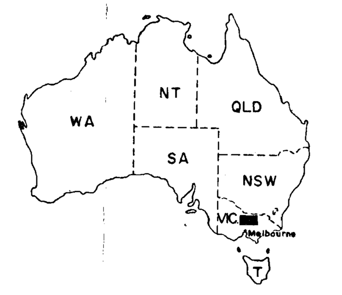
WANGARATTA GEOLOGICAL LEGEND

NON-MARINE MARINE IGNEOUS METAMORPHIC

Quaternary	Recent	Q4	Alluvial terraces, lacustrine and swamp deposits: clay, silt, sand and gravel.
		Q3	Lunette deposits: clay, silt and fine grained sand
	Pleistocene	Q2	Aeolian deposits: silt, sand.
		Q1	Plain, alluvial, lacustrine and stream levee deposits: high river terraces and alluvial fans, clay, silt, sand, minor gravels and conglomerates.
Tertiary	Pliocene	Tp	Fluvial deposits: gravels, often ferruginous.
	Eocene	Tov	OLDER VOLCANICS: basalt, melabasalt and phonolite.
Permian		P	Glacial and fluvio-glacial deposits: tillite, sandstone, conglomerate and arkosic clay.
Carboniferous	Lower	Cl	Terrestrial deposits: conglomerate, red sandstone, siltstone and shale.
Devonian	Upper	Dug	Granite, adamellite, aplite and minor granodiorite. Includes PILOT RANGE, MT. BUFFALO, STANLEY, STRATHBOGIES and BARJARG GRANITES.
		Dup	Granodiorite porphyrite.
		Duv5	Quartz-biotite-hypersthene rhyodacite (VIOLET TOWN VOLCANICS)
		Duv4	Rhyolite (VIOLET TOWN VOLCANICS)
		Duv3	Rhyodacite (TOOMBULLUP RHYODACITE)
		Duv2	Rhyolite (RYANS CK. RHYOLITE) and undifferentiated acid volcanics of the upper King and upper Rose Rivers.
		Duv1	Rhyodacite, ignimbrite, conglomerate and minor pebbly sandstone and mudstone (HOLLANDS CREEK RHYODACITE sequence)
	Lower	Dlg	Granite, includes JINDERA GRANITE
		Dl	Mudstone, siltstone and sandstone.
		Dlv	Quartz-felspar-porphyry, rhyolite and tuff.
	(undifferentiated)	S-Dl	Mudstone, siltstone and sandstone.
Silurian		S	Mudstone, siltstone and sandstone.
		mg	Gneiss, biotite gneiss, gneissic granite.
		ms	Meta sediments, high grade phillite and mica schist.
		Sg	Granite, gneissic granodiorite. Includes CHESNEY VALE WARBY RANGE and YACKANDANDAH BASIN GRANITES and BARNAWARTHA GNEISSIC GRANODIORITE.
Ordovician	Upper	Og	Two-mica granite, includes RUN BOUNDARY GRANITE
	Middle	Om-u	Greywacke, sandstone, siltstone, shale and mudstone.
	Lower	Ol	Greywacke, shale and chert.
Cambrian	Middle & Upper	€	Tuff, chert, cherty shale.
	Lower	€v	Greenstone, diabase

Geological boundary
Prior stream course
Fault
Fault, showing direction of dip
Dip and strike of bedding
Synclinal axis
Zone of contact metamorphism

LOCATION DIAGRAM



INDEX TO STANDARD 1:250000 MAP SERIES

SWAN HILL	DENILIQUIN	JERILDERIE
ST ARNAUD	BENDIGO	WANGARATTA
BALLARAT	MELBOURNE	WARBURTON

AIRBORNE SURVEY BENDIGO, WANGARATTA, TALLANGATTA, VIC.-NSW 1972

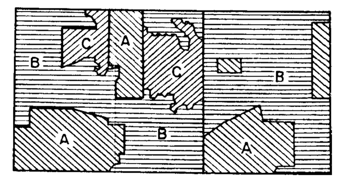
GEOPHYSICAL INTERPRETATION AND GEOLOGY

5 0 5 10 15 20 KILOMETRES
5 0 5 10 MILES

GEOPHYSICAL LEGEND

(2) Magnetic zone
Interpreted fault

GEOLOGICAL RELIABILITY DIAGRAM



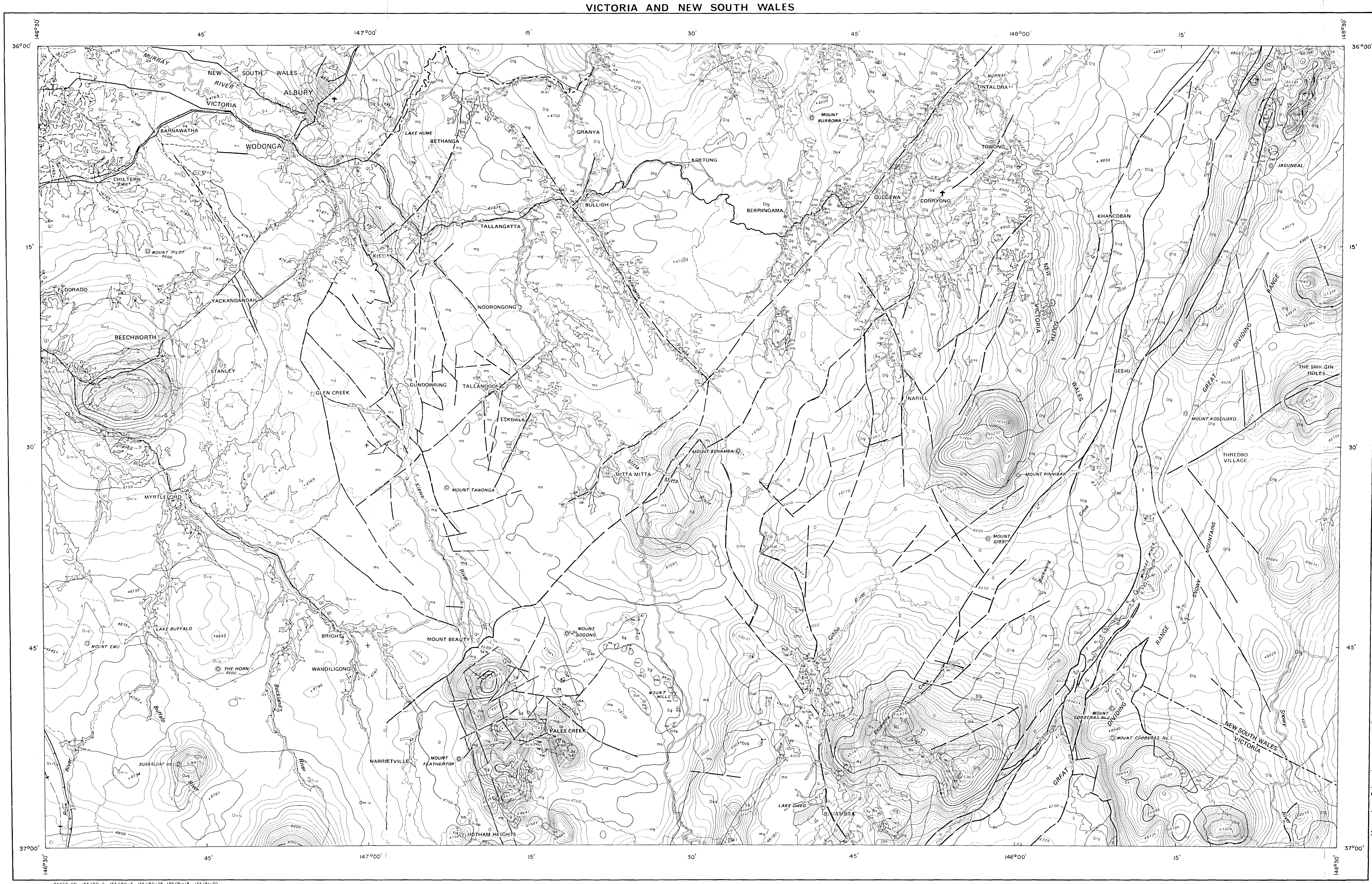
A.....Detailed ground survey and aerial photo interpretations
B.....Reconnaissance ground survey and aerial photo interpretation.
C.....Detailed soil survey.

Geology after Bendigo and Wangaratta 1:250 000 map sheets, Provisional Editions 1968 by Mines Department of Victoria.

TOPOGRAPHIC LEGEND

Highway or main road
Secondary road
Road or track
Railway with station
Built-up area
Named place
Homestead
Aerodrome or landing
Mine
River or creek
Lake
Swamp
Hill feature

WANGARATTA - TALLANGATTA
VICTORIA AND NEW SOUTH WALES



BASED ON J55/B0-2, J55/B0-3, J55/B0-28, J55/BI-18, J55/BI-20

WANGARATTA GEOLOGICAL LEGEND

NON-MARINE MARINE IGNEOUS METAMORPHIC

Quaternary	Recent / Pleistocene	Q4	Alluvial terraces, lacustrine and swamp deposits: clay, silt, sand and gravel.
		Q3	Lunette deposits: clay, silt and fine grained sand
		Q2	Aeolian deposits: silt, sand.
		Q1	Plain, alluvial, lacustrine and stream levee deposits: high river terraces and alluvial fans; clay, silt, sand, minor gravels and conglomerates.
Tertiary	Pliocene	Tp	Fluvial deposits: gravels, often ferruginous.
	Eocene	Tov	OLDER VOLCANICS: basalt, melabasalt and phonolite.
Permian		P	Glacial and fluvio-glacial deposits: tillite, sandstone, conglomerate and arkosic clay.
Carboniferous	Lower	Cl	Terrestrial deposits: conglomerate, red sandstone, siltstone and shale.
Devonian	Upper	Dug	Granite, adamellite, aplite and minor granodiorite. Includes PILOT RANGE, MT. BUFFALO, STANLEY, STRATHBOGIES and BARJARG GRANITES.
		Dup	Granodiorite porphyrite.
		Duv5	Quartz-biotite-hypersthene rhyodacite (VIOLET TOWN VOLCANICS)
		Duv4	Rhyolite (VIOLET TOWN VOLCANICS)
		Duv3	Rhyodacite (TOOMBULLUP RHYODACITE)
		Duv2	Rhyolite (RYANS CK. RHYOLITE) and undifferentiated acid volcanics of the upper King and upper Rose Rivers.
		Duv1	Rhyodacite, ignimbrite, conglomerate and minor pebbly sandstone and mudstone (HOLLANDS CREEK RHYODACITE sequence)
	Lower	Dlg	Granite, includes JINDERA GRANITE
		Dl	Mudstone, siltstone and sandstone.
		Dlv	Quartz-felspar-porphyry, rhyolite and tuff.
(undifferentiated)		S-Dl	Mudstone, siltstone and sandstone.
Silurian		S	Mudstone, siltstone and sandstone.
		mg	Gneiss, biotite gneiss, gneissic granite.
		ms	Meta sediments, high grade phillite and mica schist.
		Sg	Granite, gneissic granodiorite. Includes CHESNEY VALE WARBY RANGE and YACKANDANDAH BASIN GRANITES and BARNAWARTHA GNEISSIC GRANODIORITE.
Ordovician	Upper	Og	Two-mica granite, includes RUN BOUNDARY GRANITE.
	Middle	Om-u	Greywacke, sandstone, siltstone, shale and mudstone.
	Lower	Ol	Greywacke, shale and chert.
Cambrian	Middle & Upper	€	Tuff, chert, cherty shale.
	Lower	€v	Greenstone, diabase

Geological boundary
Prior stream course
Fault
Fault, showing direction of dip
Dip and strike of bedding
Synclinal axis
Zone of contact metamorphism

TALLANGATTA GEOLOGICAL LEGEND

SEDIMENTARY ROCKS

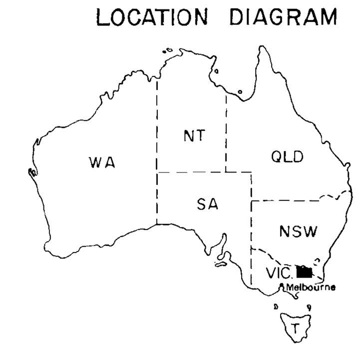
Cainozoic	Quaternary	Recent		Qr	Alluvium, sand, gravel, silt
		Pleistocene		Qp	High terraces and alluvial flats, sand, silt, clay, gravel
	Tertiary	Pliocene		Tp	Gravel, conglomerate, clay, clay shale, sand.
Palaeozoic	Middle Devonian		MT. TAMBO FORMATION	Dm	Sandstones and conglomerates.
	Silurian		COWAMBAT GROUP WOMBAT GROUP	S	Quartzite, conglomerate, sandstone, limestone.
	Ordovician			O	Sandstone, shale, slate, quartz

IGNEOUS AND METAMORPHIC ROCKS

Cainozoic	Tertiary	Eocene	OLDER VOLCANICS	Tob	Basalt
Mesozoic	Triassic			Rt	Trachyte
				Rs	Syenite, porphyritic syenite
				Rp	Granite porphyries.
Palaeozoic	Devonian	Upper	JEMBA RHYOLITE	Duv	Rhyolite, rhyolite breccia, tuff.
				Dud	Diorite, amphibolite, monzonite and hybrid intrusions.
				Dug	Granite, leuco granite – includes Grass Flat, Island Bend, Khancoban, Ogilvies, Scammels, Knocker, Pine Mountain, Mt Mittamatite granites
		Middle	SNOWY RIVER VOLCANICS	Dmp	Quartz porphyry, quartz felspar porphyry.
				Dmv	Rhyodacite (tuff flows), minor tuffs, agglomerate, rhyolite.
		Lower		Dlg	Granite, granodiorite, tonalite – includes Corryong, Happy Jacks, Hawkesview, Buckwong, Kosciusko, Townsend, Grey Mare, Tallangatta, Yabba, Koetong, Boebuck granites and Big Hill quartz diorite
	Silurian		MITTA MITTA RIVER VOLCANICS	Sv	Rhyodacite with minor rhyolite, tuff, agglomerate and sediments.
				Sg	Granite, granodiorite, granite gneiss – includes Banimboola Mt Wills and Kiewa granites.
	Ordovician			mg	Gneiss predominant } Metamorphic
				ms	Schist predominant } Metamorphic

Geological boundary
Fault
Probable fault
Aqueduct

LOCATION DIAGRAM



INDEX TO STANDARD
1:250 000 MAP SERIES

JERILDERIE	WAGGA WAGGA	CANBERRA
WANGARATTA	TALLANGATTA	BEGA
WARBURTON	BAIRNSDALE	MALLACOOTA

AIRBORNE SURVEY, BENDIGO, WANGARATTA, TALLANGATTA, VICTORIA - N S W 1972

TOTAL MAGNETIC INTENSITY
AND
GEOLOGY

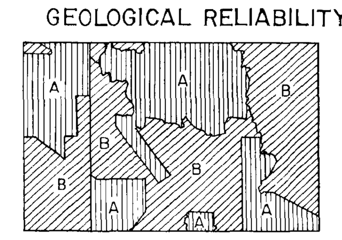
5 0 5 10 15 20 KILOMETRES
5 0 5 10 MILES

GEOPHYSICAL LEGEND

5000 4980 Magnetic contours
×5002 Magnetic value

MAGNETIC CONTOUR INTERVAL 10nT

GEOLOGICAL RELIABILITY DIAGRAM



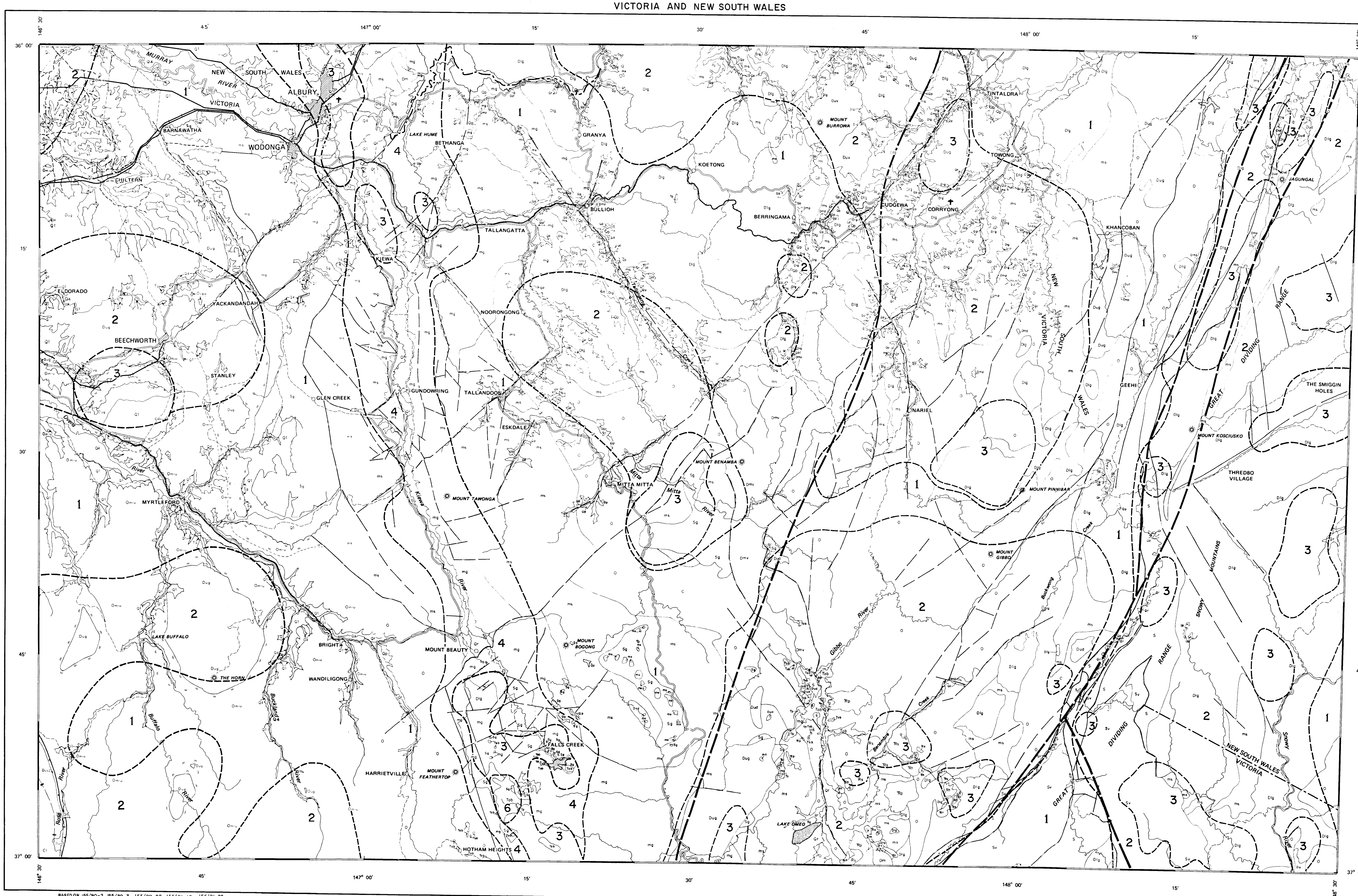
A. Detailed ground survey and aerial photo interpretation
B. Reconnaissance ground survey and aerial photo interpretation.

Geology after Wangaratta 1:250000 map sheet, Provisional Edition 1968 and Tallangatta 1:250000 map sheet, Provisional Edition 1966 by Mines Department of Victoria.

TOPOGRAPHIC LEGEND

Highway or main road
Secondary road
Road or track
Railway with station
Built-up area
Named place
Homestead
Aerodrome or landing ground
Mine
River or creek
Lake
Swamp
Hill feature

WANGARATTA-TALLANGATTA
VICTORIA AND NEW SOUTH WALES



BASED ON J55/B0-2, J55/B0-3, J55/B0-28, J55/B1-18, J55/B1-22

WANGARATTA GEOLOGICAL LEGEND

NON-MARINE MARINE IGNEOUS METAMORPHIC

Quaternary	Recent / Pleistocene	Q4	Alluvial terraces, lacustrine and swamp deposits: clay, silt, sand and gravel.
		Q3	Lunette deposits: clay, silt and fine grained sand
		Q2	Aeolian deposits: silt, sand.
		Q1	Plain, alluvial, lacustrine and stream levee deposits: high river terraces and alluvial fans, clay, silt, sand, minor gravels and conglomerates.
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Permian		P	Glacial and fluvio-glacial deposits: tillite, sandstone, conglomerate and arkosic clay.
Carboniferous	Lower	Cl	Terrestrial deposits: conglomerate, red sandstone, siltstone and shale.
Devonian	Upper	Dug	Granite, adamellite, aplite and minor granodiorite. Includes PILOT RANGE, MT. BUFFALO, STANLEY, STRATHBOGIES and BARJARG GRANITES.
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		Duv4	Rhyolite (VIOLET TOWN VOLCANICS)
		Duv3	Rhyodacite (TOOMBULLUP RHYODACITE)
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		Duv1	Rhyodacite, ignimbrite, conglomerate and minor pebbly sandstone and mudstone (HOLLANDS CREEK RHYODACITE sequence)
	Lower	Dlg	Granite, includes JINDERA GRANITE
		Dl	Mudstone, siltstone and sandstone.
		Dlv	Quartz-felspar-porphyry, rhyolite and tuff.
(undifferentiated)		S-Dl	Mudstone, siltstone and sandstone.
Silurian		S	Mudstone, siltstone and sandstone.
		mg	Gneiss, biotite gneiss, gneissic granite.
		ms	Meta sediments, high grade phillite and mica schist.
		Sg	Granite, gneissic granodiorite. Includes CHESNEY VALE WARBY RANGE and YACKANDANDAH BASIN GRANITES and BARNAWARTHA GNEISSIC GRANODIORITE.
Ordovician	Upper / Middle	Og	Two-mica granite, includes RUN BOUNDARY GRANITE.
		Om-u	Greywacke, sandstone, siltstone, shale and mudstone.
	Lower	Ol	Greywacke, shale and chert.
Cambrian	Middle & Upper	€	Tuff, chert, cherty shale.
	Lower	€v	Greenstone, diabase

Geological boundary
Prior stream course
Fault
Fault, showing direction of dip
Dip and strike of bedding
Synclinal axis
Zone of contact metamorphism

TALLANGATTA GEOLOGICAL LEGEND

SEDIMENTARY ROCKS

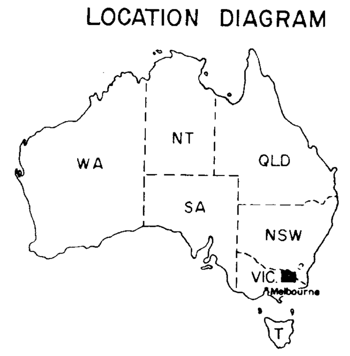
Cainozoic	Quaternary	Recent		Qr	Alluvium, sand, gravel, silt.
		Pleistocene		Qp	High terraces and alluvial flats, sand, silt, clay, gravel.
	Tertiary	Pliocene		Tp	Gravel, conglomerate, clay, clay shale, sand.
Palaeozoic	Middle Devonian		MT. TAMBO FORMATION	Dm	Sandstones and conglomerates.
	Silurian		COWAMBAT GROUP WOMBAT GROUP	S	Quartzite, conglomerate, sandstone, limestone.
	Ordovician			O	Sandstone, shale, slate, quartz.

IGNEOUS AND METAMORPHIC ROCKS

Cainozoic	Tertiary	Eocene	OLDER VOLCANICS	Tob	Basalt.
Mesozoic	Triassic			Rt	Trachyte
				Rs	Syenite, porphyritic syenite.
				Rp	Granite porphyries.
Palaeozoic	Devonian	Upper	JEMBA RHYOLITE	Duv	Rhyolite, rhyolite breccia, tuff.
				Dud	Diorite, amphibolite, monzonite and hybrid intrusions.
				Dug	Granite, leuco granite – includes Grass Flat, Island Bend, Khancoban, Ogilvies, Scammels, Knocker, Pine Mountain, Mt Mittamatite granites
		Middle		Dmp	Quartz porphyry, quartz felspar porphyry.
			SNOWY RIVER VOLCANICS	Dmv	Rhyodacite (tuff flows), minor tuffs, agglomerate, rhyolite.
		Lower		Dlg	Granite, granodiorite, tonalite – includes Corryong, Happy Jacks, Hawkesview, Buckwong, Kosciusko, Townsend, Grey Mare, Tallangatta, Yabba, Koetong, Boebuck granites and Big Hill quartz diorite
	Silurian		MITTA MITTA RIVER VOLCANICS	Sv	Rhyodacite with minor rhyolite, tuff, agglomerate and sediments.
	Ordovician			Sg	Granite, granodiorite, granite gneiss – includes Banimboola Mt Wills and Kiewa granites.
				mg	Gneiss predominant } Metamorphic
				ms	Schist predominant } Metamorphic

Geological boundary
Fault
Probable fault
Aqueduct

LOCATION DIAGRAM



INDEX TO STANDARD
1:250 000 MAP SERIES

JERILDERIE	WAGGA WAGGA	CANBERRA
WANGARATTA	TALLANGATTA	BEGA
WARBURTON	BAIRNSDALE	MALLACOOTA

AIRBORNE SURVEY BENDIGO, WANGARATTA, TALLANGATTA, VIC.-NSW 1972

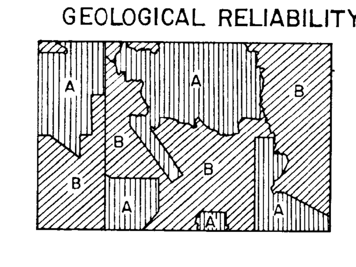
GEOPHYSICAL INTERPRETATION
AND
GEOLOGY

5 0 5 10 15 20 KILOMETRES
5 0 5 10 MILES

GEOPHYSICAL LEGEND

2 Magnetic zone
Interpreted fault

GEOLOGICAL RELIABILITY DIAGRAM



A .. Detailed ground survey and aerial photo interpretation
B .. Reconnaissance ground survey and aerial photo interpretation.

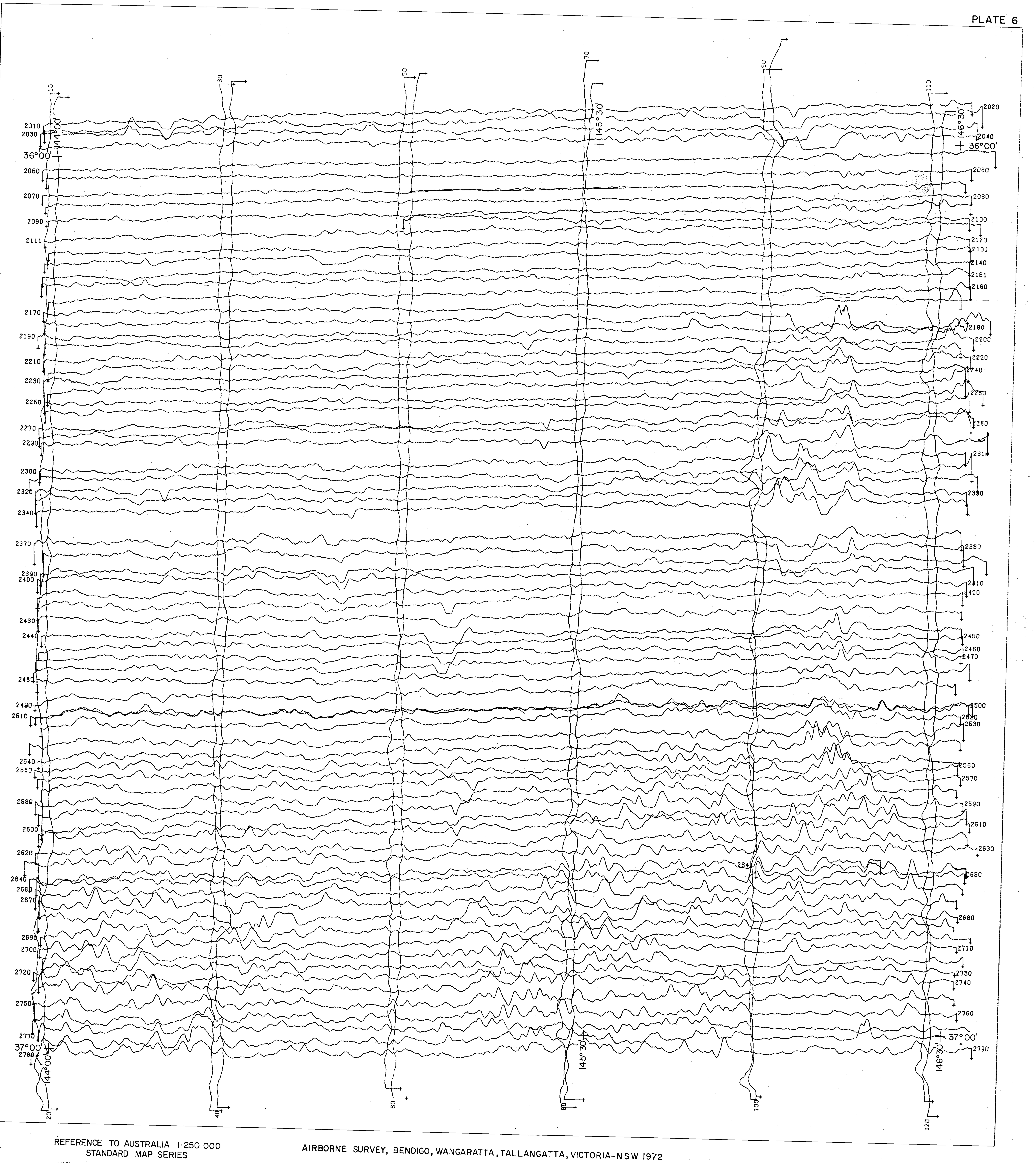
Geology after Wangaratta 1:250000 map sheet, Provisional Edition 1968 and Tallangatta 1:250000 map sheet, Provisional Edition 1966 by Mines Department of Victoria.

TOPOGRAPHIC LEGEND

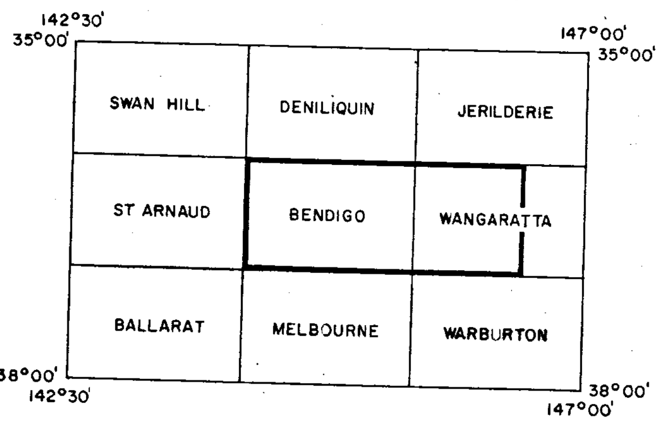
Highway or main road
Secondary road
Road or track
Railway with station
Built-up area
Named place
Homestead
Aerodrome or landing ground
Mine
River or creek
Lake
Swamp
Hill feature

BENDIGO - WANGARATTA (PART)

PLATE 6



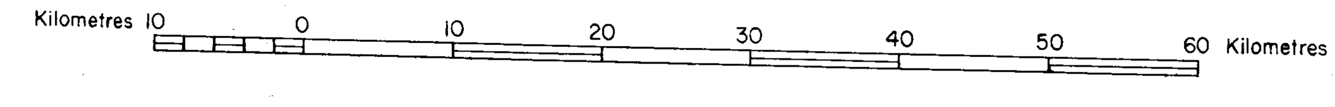
REFERENCE TO AUSTRALIA 1:250 000
STANDARD MAP SERIES



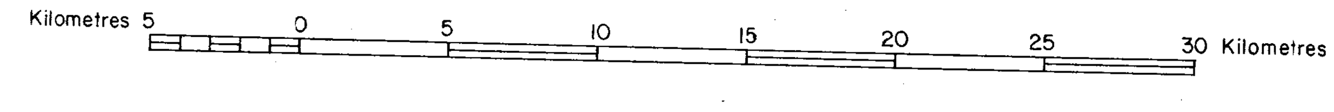
AIRBORNE SURVEY, BENDIGO, WANGARATTA, TALLANGATTA, VICTORIA-NSW 1972

GAMMA-RAY SPECTROMETER TOTAL COUNT PROFILES

EAST-WEST SCALE 1:500 000



NORTH-SOUTH SCALE 1:250 000



2070 — Gamma-Ray Spectrometer Profile
End of flight-line

Sensitivity: 100 counts/s/cm

Baseline value: 50 counts/s