COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1969 / 148

Geology of the Gearys Gap - Sutton - Gundaroo Area, New South Wales

by

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GEOLOGY OF THE GEARY'S GAP - SUTTON - GUNDAROO AREA, NEW SOUTH WALES.

by

Roland M. Hill

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SUMMARY

The Geary's Gap - Sutton - Gundaroo area consists of complexly folded quartz greywackes, shales and argillites interbedded with acid tuffs and volcanics, and intruded by bosses of adamellite (Sutton Granite) and dykes of porphyritic microgranodiorite. Faulting has taken place at different times during the evolution of the area and has produced not only the Cullarin Horst of which the area forms a section but many smaller horsts and grabens within the Cullarin Horst. In one of the smaller grabens cross-cutting the Cullarin Horst orthoquartzite gravels have been deposited and later lateritized.

Although once the site of a gold rush, the present economic potential of the area is confined to the building stone it may provide and the water it can conserve to support its agricultural industries.

INTRODUCTION

Location

The Geary's Gap - Sutton - Gundaroo area extends westwards from the western shore of Lake George to the Sutton-Gundaroo Road and northwards from the Federal Highway (linking Canberra and Goulbourn) to the Gundaroo - Collector Road. The south-western corner of the area lies thirteen miles north-east of Canberra (Fig. 1.).

The area is confined between latitudes 35°00'S and 35°10'S and longitudes 149°15'E and 149°23'E. It comprises a major portion of the Lake George 1:50,000 Map Sheet 8727-1, and is on the northern edge of the Canberra 1:250,000 Sheet SI55-16.

Object

This report covers part of a proposed programme of integrated scientific studies into Lake George and its drainage basin. The studies include the geology, geomorphology, sedimentation, and hydrology of the basin.

The object of the Geary's Gap - Sutton - Gundaroo Mapping was to provide a detailed reconnaissance survey of the geology of portion of the western environs of the lake. The information obtained is meant to form part of the basis of more detailed work in the area. A bibliography has been compiled with this object in mind, and petrographic descriptions of thin sections from the area are presented in the Appendix.

Access

Major roads border all sides of the area. Formed earth roads and minor tracks connecting properties form a close network giving good access to all parts of the area.

Method of survey

Outcrops of bedrock are very poor throughout the area; soil and deep weathering conceal most of the geological detail of the bedrock. Relatively good exposures are found, however, in many of the creek beds; most of the larger creeks were traversed on foot during the survey. Locations at which geological detail was noted were marked directly onto aerial photographs of a nominal scale of 1:50,000 (the same scale as the final map). Foot traverses in the creeks were supplemented by cross-country vehicle traverses.

Details of the aerial photography relevant to the area are as follows:

Photos by Adastraphoto, 1959, approximately 1:50,000:

Lake George Run 1 (5006-5011), Run 2 (5010-5014), Run 3 (5055-5060) and Run 4 (5071-5075).

Little mapping was done along the Lake George fault-scarp(?) and this feature will not be discussed. The extension of the Sutton Granite south of the Federal Highway has been plotted onto the final map from Moore's (1957) work.

The field party consisted of a field hand, Peter Davis, and the author, helped for part of the project by two student geologists, Richard Coles and Ross Horsley.

Previous work

The most recent geological mapping in this region is that of Coventry (1968), who mapped an area immediately south of the present mapping and briefly reviewed previous works. Coventry is now engaged on a Ph.D study into the geomorphology and soils at the northern end of the lake. The more significant geological studies include those of Garretty (1936), Carter (1949), Moore (1957), Öpik (1958), Wilson (1964), Stauffer (1964), Oldershaw (1965), Smith (1965), and Stauffer and Rickard (1966) (Fig.1). Some of this work has been incorporated into the Canberra 1:250,000 Geological Map compiled by Best et al (1963).

Griffith-Taylor (1907), Craft (1928), Woolnough (1929), Garretty (1937), Noakes and Jennings (1954), van Dijk (1959, 1961), Jennings et al. (1964), Galloway (1965, 1967), and Coventry (1968) have discussed various aspects of the physiography and geomorphology of the region. Relevant geophysical studies have been reported by Kevi (1964), Polak and Kevi (1964), and Cleary (1967).

PHYSIOGRAPHY

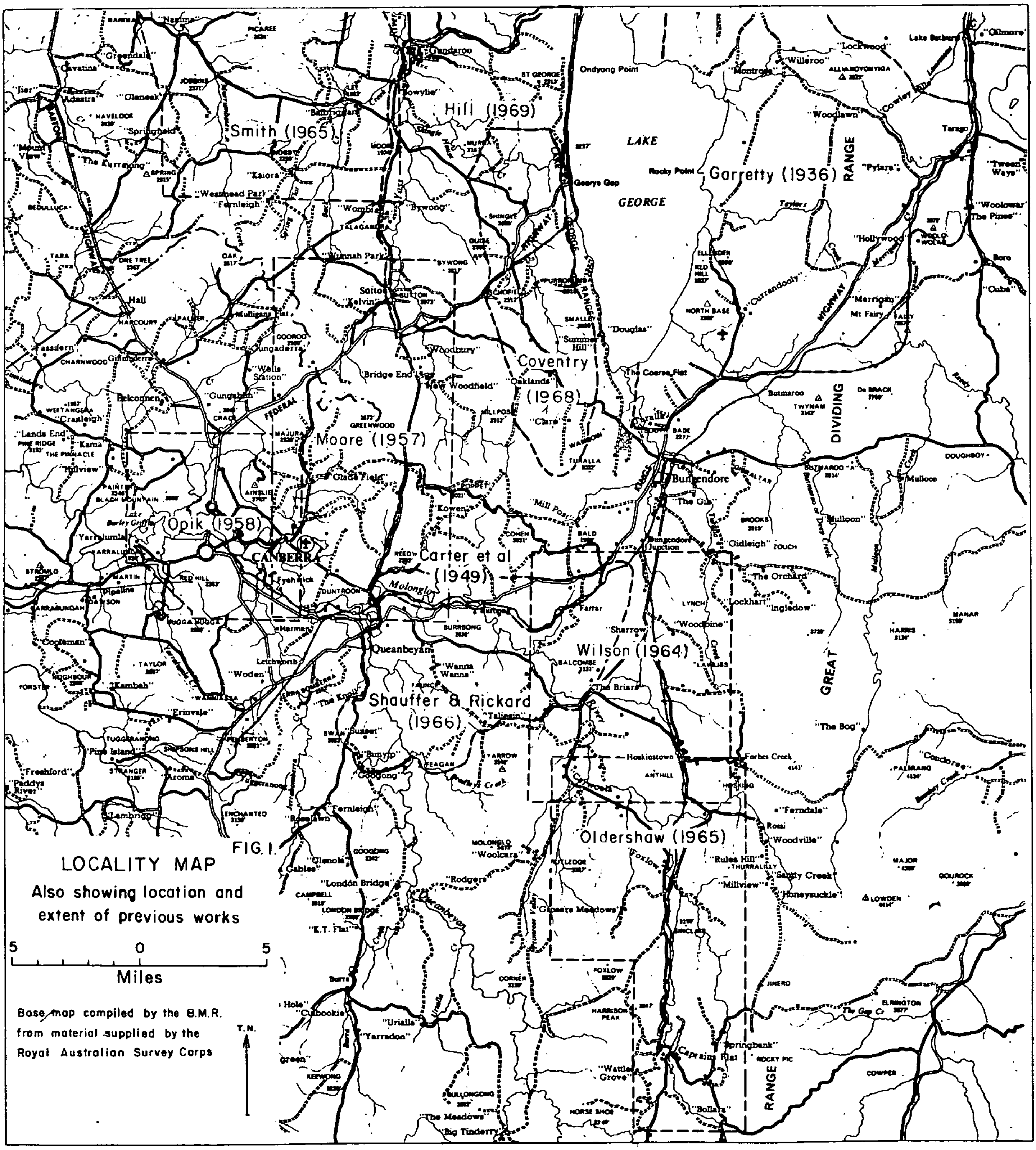
The area mapped forms a section of the Cullarin Horst (Stauffer and Rickard, 1966): it falls naturally into two physiographic subdivisions which are differentiated in Fig.2.

A. Area of undulating relatively low relief, deeply weathered with a thick soil cover. Lateritized orthoquartzite gravels are common in this area.

B. Area of relatively high relief, deeply incised by the drainage system. Its weathering is much less pronounced, and the soil mantle is much thinner than in area A.

The northern boundary of Area A is quite pronounced and corresponds to the course of Shingle House Creek. The southern boundary of Area A is poorly defined, but appears to be controlled to some extent by the Sutton Granite.

The drainage is controlled partly by the north-south "grain" of the country which is defined by both bedding and cleavage. In some localities jointing and faulting control the drainage system.



To accompany Record 1969/148 155/A16/596

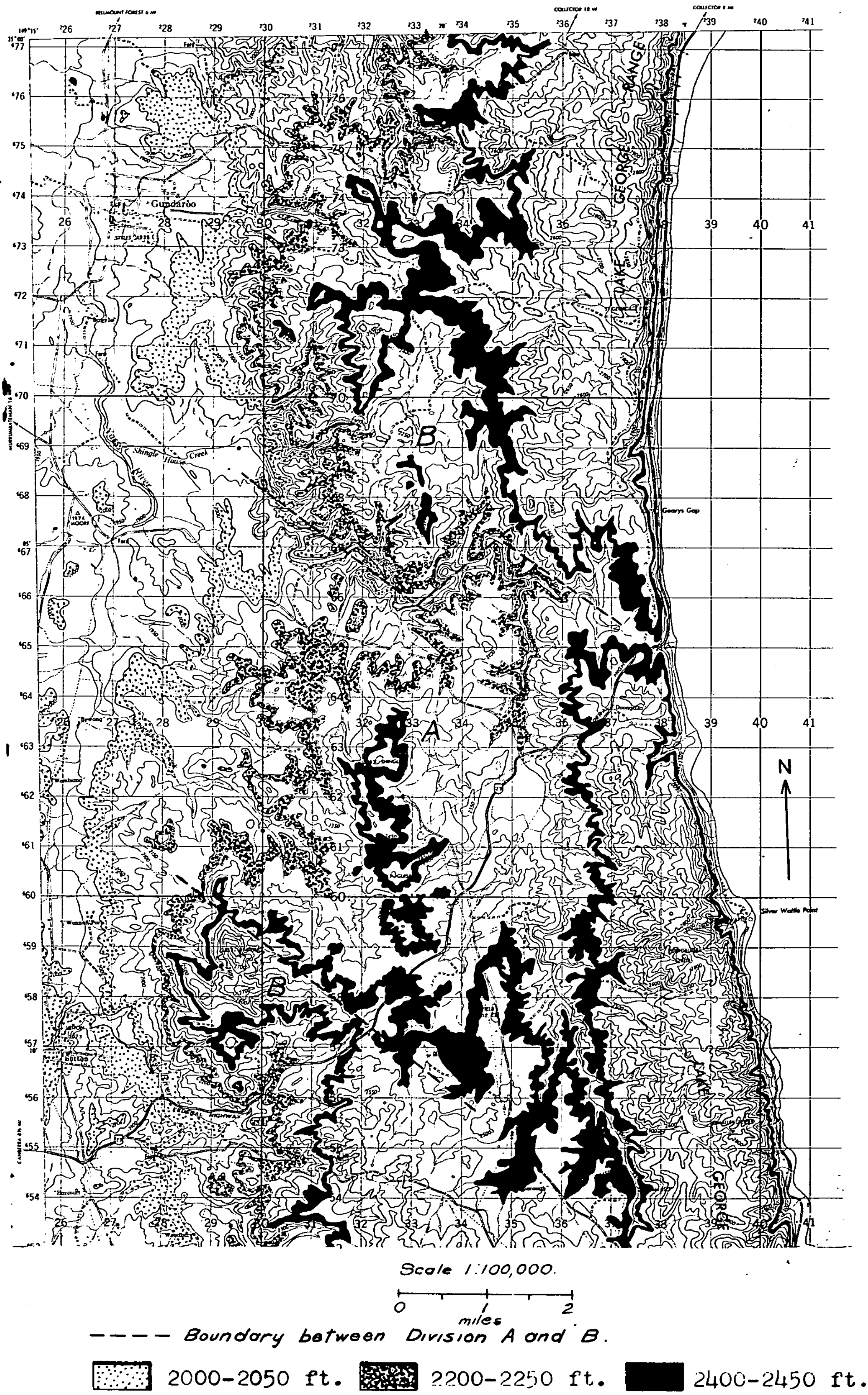


Fig. 2. Physiographic Divisions of the Geary's Gap-Sutton-Gundaroo Area. A. Mature, deeply weathered, gently undulating area. B. Relatively young, unweathered, deeply incised area. Contour interval = 50 ft..

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STRATIGRAPHY

The area consists of a sequence of fine to medium-grained sediments, interbedded in the eastern part with minor acid volcanics, and intruded by minor porphyritic micro-granodiorite dykes and small bosses of adamellite. No separate formations or members could be differentiated within the area. No fossils of any type were located though exhaustive searches were made of likely locations. The facing of bedding could be determined at only a few of the places where bedding dips were measured.

There is no structural or petrographic difference between the sediments of the area and those adjoining it to the west of the Yass River, which were mapped by Smith (1965). Smith considers that these sediments belong to the Pittman Formation mapped in the Canberra District by Öpik (1958). On palaeontological evidence Öpik considers that the Pittman Formation was formed during the Middle and lower Upper Ordovocian.

As the structure is complex and not completely understood, the thickness of the sediments within the area cannot be estimated with any degree of confidence. Coventry (1968) considers that the sediments of the Cullarin Horst form part of a sequence that is more than 12,500 feet (3,800 metres) thick.

PETROGRAPHY

Representative samples of the major rock types are described in detail in Appendix 1. Only brief generalized descriptions are presented here.

Sediments

The sediments fall into three distinct classes:

(i) Quartz greywacke

(ii) Shale

(iii) Argillite

(i) The Quartz greywacke is typically brownish-grey to grey, weathering to browns and yellows, and consist of medium to fine-grained quartz in a matrix of fine-grained micas. The rock is generally massive, but sedimentary banding and cleavage is delineated by tonal variations in some of the larger exposures. Small scale cross-bedding is commonly present.

In thin section the rock is seen to consist of very poorly sorted, sub-rounded to angular quartz grains in a matrix of fine-grained biotite or muscovite (or both) and detrital plagioclase, zircon, and tourmaline. Some of the quartz grains are compound, strongly stained and appear to be of metamorphic origin - probably from a quartzite.

Metamorphism has produced a lepidoblastic texture.

The classification of the rock is based on an extension of Pettijohn's (1957) classification of sandstones. It is used in a purely descriptive sense and has no genetic connotations.

(ii) The Shale is generally brown to grey, except when weathered to pale colours, including yellow. The rocks are very fine-grained with sedimentary laminae defined by changes in the proportions of constituent minerals. Small slump structures and indefinite cross-bedding is present in places.

Thin sections show that the rock is generally lepidoblastic, consisting predominantly of biotite and muscovite, with 30-40 percent fine-grained xenoblastic quartz. Opaque minerals and traces of detrital tourmaline and zircon are also present.

(iii) The Argillite is an extremely fine-grained massive rock, brown and weathering to yellows. The rocks are weakly lepidoblastic and those within the wide contact aureole of the adamellite bosses contain relic porphyroblasts of cordierite or andalusite, now altered to fine-grained muscovite. The rock consists essentially of muscovite with lesser amounts of biotite and quartz. Very small grains of opaque minerals, including streaks of graphite, are also present.

In some specimens (e.g. 69390002) the foliation is strongly crenulated (forming the F_3 or F_4 folds described by Stauffer and Rickard (1966)). The porphyroblasts themselves are not affected by this folding and thus appear to belong to a later stage of development.

Igneous Rocks

The main igneous rocks within the area include:

(i) Adamellite,

(ii) Porphyritic microgranodiorite, and

(iii) Acid tuffs and volcanics.

(i) Adamellite occurs in three separate bodies which are very similar in all respects except that the smaller bosses are finer grained than the large boss, known as the Sutton Granite, in the west of the area.

The adamellite is a coarse to medium-grained white rock, flecked with grains of black biotite. Glassy quartz grains can be differentiated from the white plagioclase and alkali feldspar grains. Small amounts of pyrite are also present, which along with the biotite cause iron staining of the rock on weathering.

The thin section reveals that the rock is hypidiomorphic granular and poikilitic consisting of strongly zoned subidiomorphic andesine enclosed by larger grains of orthoclase and quartz. Chloritized biotite is interstitial and idiomorphic apatite and zircon are present in minor amounts.

(ii) Porphyritic micro-granodiorite occurs in a broken line of small irregular dyke-like intrusions running north-south through the centre of the area. The rock typically forms rounded tors.

The rock is dark grey and porphyritic, mottled with large white phenocrysts of plagioclase, bluish glassy phenocrysts of quartz, black mafic clots, and black flakes of biotite. The groundmass is dark grey and aphanitic.

In thin section the plagioclase phenocrysts are found to be subidiomorphic. zone andesine crystals, while the quartz phenocrysts are allotriomorphic and extensively fractured. The mafic clots are a matted aggregate of biotite, chlorite, tremolite and ilmenite; the groundmass is an allotriomorphic granular mass of quartz and untwinned plagioclase. Idiomorphic zircon and apatite are present as accessory minerals.

(iii) Acid tuffs and volcanics are present predominantly in the eastern portion of the area. They occur as thin bodies, generally less than ten feet thick, interbedded with the sediments. Poor exposures prevent determination of the exact contact relations with the sediments. Although fragments of the sediments are included within these bodies, at no place have discordant relationships been found. It is thought that they represent acid tuffs and/or volcanics extruded and deposited during the deposition of the sediments.

The rocks are grey to brown and porphyritic with white phenocrysts of plagioclase and glassy phenocrysts of quartz in an aphanitic groundmass. Some of the rocks are strongly flow banded.

Thin section reveals that the groundmass consists of quartz, untwinned plagioclase, biotite, and chlorite. The strong flow banding is defined by the mafic and accessory minerals of the rock. In some of the rocks lenticular masses parallel the flow layering and are more coarsely crystalline than the rest of the groundmass. They are interpreted as being pumice fragments that have crystallized. The overall texture of the rocks is tuffaceous.

STRUCTURE

The structure of the area is extremely complex and requires considerably more study. The styles of folding and structural relationships observed by Stauffer and Rickard (1966) to the south are observable, but nothing short of a detailed structural synthesis, such as they have done, could produce really meaningful results.

Bedding and Cleavage.

A common problem encountered in the field was the differentiation between cleavage and bedding. In good exposures evidence of transposition structures and the resultant pseudo-bedding was often found. In poor exposures, which were much more common, it was impossible to differentiate between the two possibilities unless sedimentary structures such as micro-crossbedding or slumping were present. The pseudo-bedding is everywhere parallel to the cleavage, and thus has been simply called a cleavage.

Folding

Folding of the styles described by Stauffer and Rickard (1966) are common within the area. They consider these folds, F_2, F_3, and F_4, represent two or possibly three periods of folding. On the combined evidence of the F_2 folds and facing structures they have postulated large recumbent F_1 folds with a north-south axis.

The measured axes of all folds observed within the area have been plotted on a Schmidt Net (equal area net). (Fig.3) and it is found that they cluster around an axis trending at 160° and plunging at about 25° south. The pole to each bedding surface of which an accurate dip and strike was obtained has also been plotted. These points form a rough great circle around the fold axes as may be expected.

Faulting

The faulting within the area is generally of the vertical horst and graben type.

Within and bordering the Sutton Granite faults are expressed as vertical quartz bands many of which stand up as much as ten feet above the surrounding countryside. The western edge of the Sutton Granite is defined by such a fault which extends northwards beyond the granite and the map area. A second fault cuts east-west across the granite mass. Moore (1957) suggested this fault represents a hinge fault along which the south-eastern portion of the granite has been lowered.

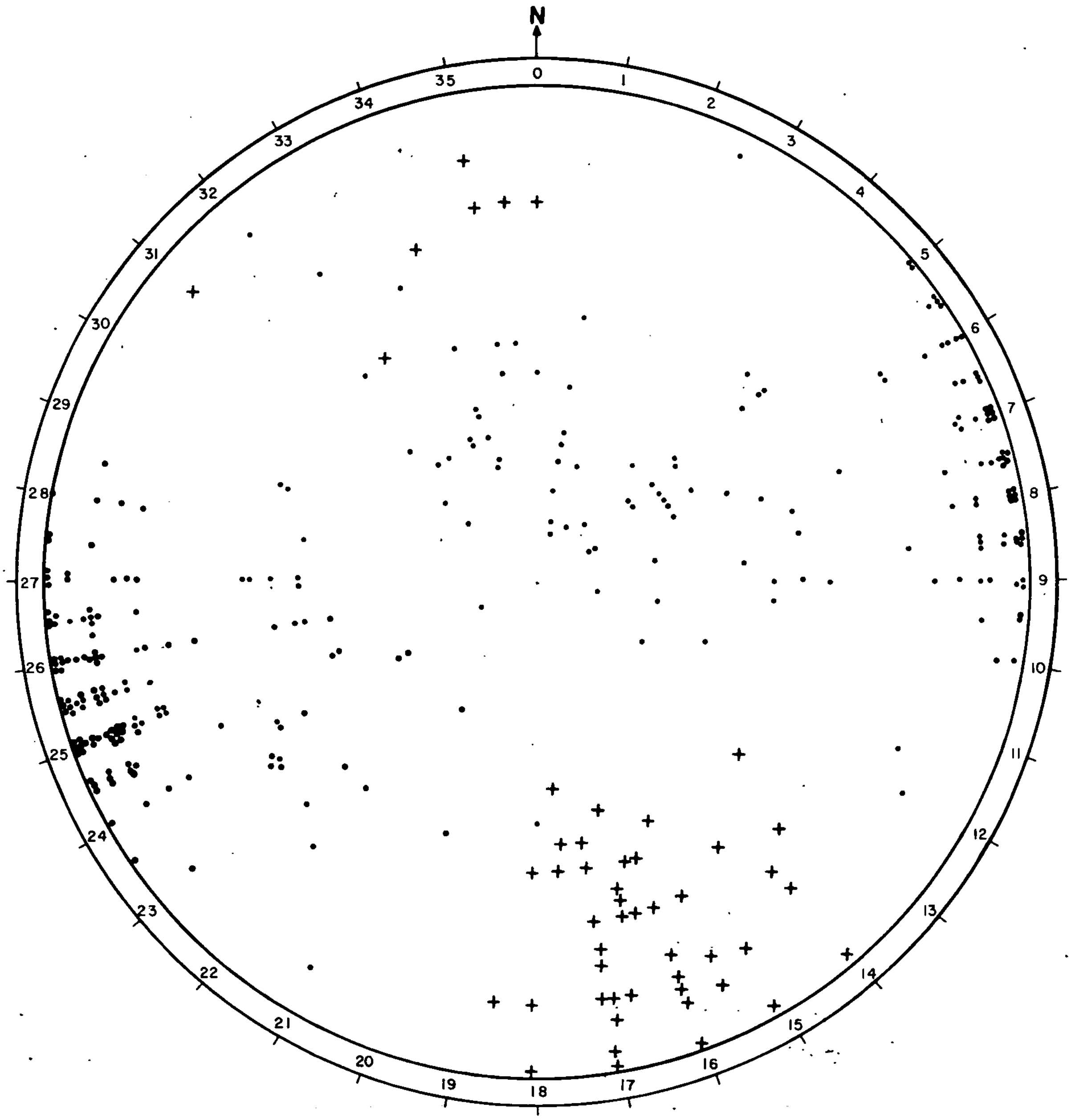
In the rest of the area the evidence for faulting is much more meagre. At Grid Reference 303679 a small tributary of Shingle House Creek has followed a weakness produced by severe disruption of the sediments. The main evidence for faulting is the silicification that has taken place in these sediments. In several places south-east of this point intense jointing has been observed along Shingle House Creek. Fold axes in the same locations diverge considerably from the mean of fold axes observed in the area. The line of the creek also marks the boundary between the high, deeply-incised unweathered area to the north and the low mature country to the south, as illustrated in Fig.2. The lineament represented by the creek is interpreted as a fault, or fault zone. Although it has been represented on the map as a single line it is considered to be a zone of disruption and diverse differential movements, the net result of which has been a vertical movement.

Similar evidence has been used to identify the other faults shown on the map. The faults have been established with varying degrees of certainty as shown.

A close examination of the air photographs revealed many lineaments not observable on the ground. These lineaments also have been recorded on the final map. They may help to delineate zones and directions of weakness within the area.

FIG. 3

EQUAL AREA PROJECTION OF STRUCTURAL DATA



• Pole of Bedding

+ Axis of Folding

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ECONOMIC GEOLOGY

In spite of the rushes caused by the discovery of alluvial gold in the orthoquartzite gravels in past decades, the area has no economic importance at present as a source of gold or base metals. Its main economic potential lies in the water it can supply for agricultural purposes and the building stone and road fill that it can supply to the nearby rapidly growing city of Canberra.

Gold and copper:

Old shafts, costeans, and pits are the only evidence of past mining in the district. They are located in two distinct areas, the orthoquartzite gravels, and in the areas of most intense quartz veining within the sediments.

Within the orthoquartzite gravels alluvial gold was sought. Generally shafts were sunk, some to over sixty feet, and the gold was extracted by sluicing the excavated material.

The quartz veins were also mined from shafts and large open pits. The veins were traced along strike for up to a mile by a series of shafts and pits. Local residents report that a large battery operated within the area when the mining activity was at its peak. Carne (1895), reported on the workings in the area, and his map has been reproduced (Fig.4.) to show more accurately the extent of the diggings.

Although traces of copper have been recorded within the area, none was seen during this survey.

Building stone

The sediments are generally discoloured, weathered, intensely fractured and broken, and are of little use as a building stone, but some of them may provide brick shale and others suitable road base material. The adamellite, quartz filling within faults, and orthoquartzite gravels, however, offer distinct possibilities as building stones.

The adamellite is an attractive white rock with black flecks. The rock would take a good polish but has the disadvantage of becoming iron stained due to the breakdown of biotite and pyrite on exposure to the weather. Although modern preservation techniques can readily overcome this, the stone may find its greatest use in interior decoration. Decomposed adamellite from a quarry just south of the Federal Highway (location 292556) has been used to surface some of the local formed gravel roads.

The quartz filling the east-west fault within the Sutton Granite is a delicate pale pink to pure white and very clean without any metallic impurities. It does not stain on weathering. The material is in a large vein generally at least ten feet wide and is fractured enough to make mining feasible. This material may have a potential use, after crushing and grading, for exposed aggregate facing on concrete buildings.

The orthoquartzite gravels consist predominantly of smooth rounded white quartz pebbled ranging from $\frac{1}{4}$ to 3 inches in diameter. The deposits are poorly cemented and are readily rippable with ordinary earth-moving equipment. Much of the material is quite clean with very little matrix and after washing and grading could be used very effectively as a decorative material for facing concrete buildings, and in gardens and pavements. The poorer quality material has a potential use in road building.

Underlying the orthoquartzite gravels is a white kaolinitic clay which may be useful as a source of kaolin. Within the deeply weathered, gently undulating portion of the area mapped (Fig.2), the shale and argillite are possibly suitable for brick making provided that unsuitable sandy beds are not present in the sequence.

Water

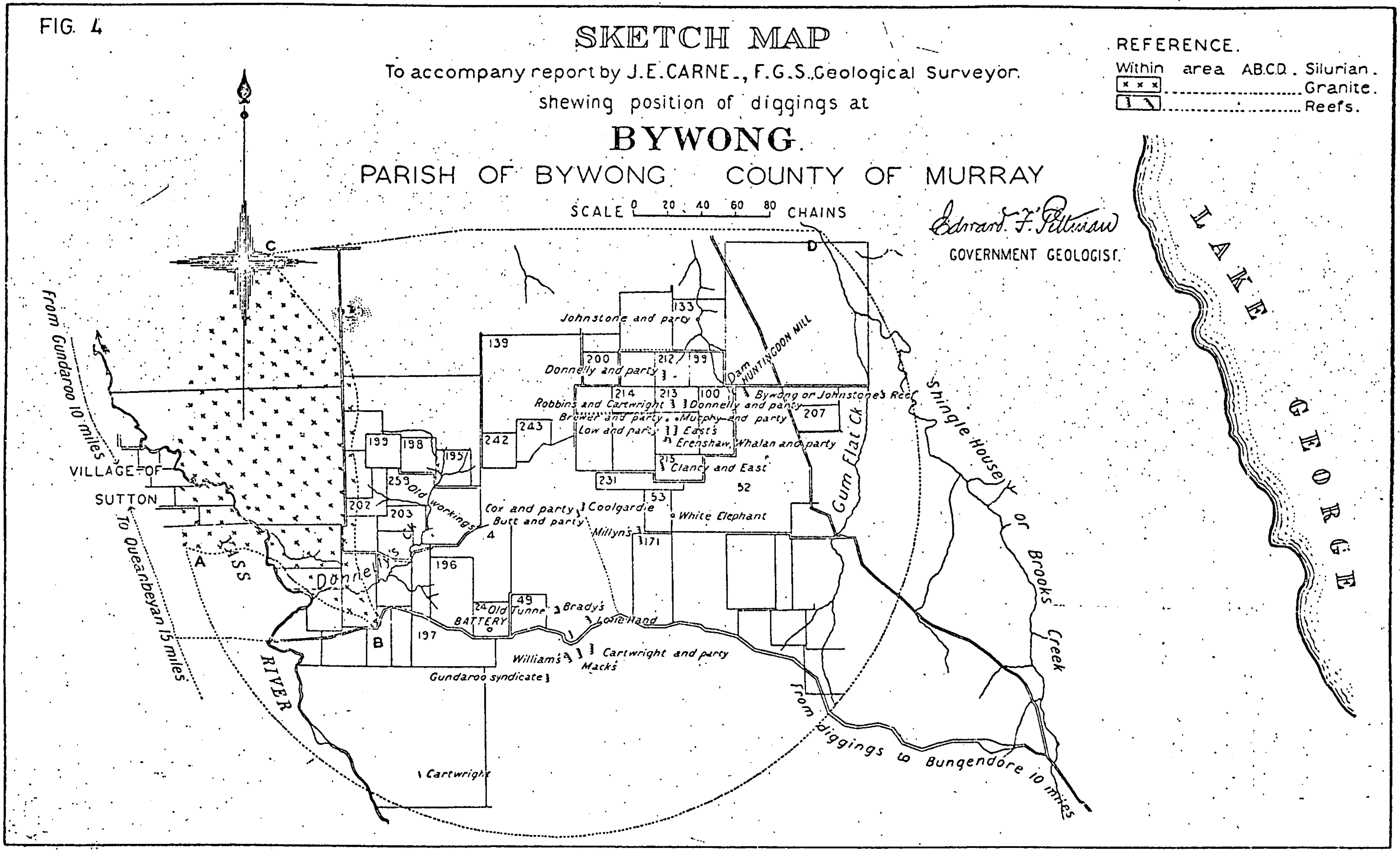
Water conservation within the area has received the serious attention of the property owners. Numerous earth dams have been constructed to catch surface run-off. Very few bores or wells have been sunk as the earth dams provide all the water necessary for the stock without the further trouble of having to pump it into tanks and troughs. Should the need arise however, there is little doubt that groundwater could be located. The yield from bores probably would be from 150 to 1200 gallons per hour and the content of total dissolved solids would be from about 500 to 2500 parts per million.

Geological History. CONCLUSIONS

Very fine-grained muds and silts accumulated possibly in a shallow water, low energy environment. This probably took place during the Middle and lower Upper Ordovician. Intermittent volcanic activity produced acid lavas, tuffs, and ash falls which became interbedded with the sediments. Some slumping of the sediments took place during sedimentation. East-west compression, probably accompanied by the intrusion of the adamellite caused intensive folding with a north-south axis. Faulting accompanied this orogeny and undoubtedly located the intrusions. A low grade regional metamorphism was also concurrent with this orogeny.

Further faulting, probably during the late Palaeozoic produced a horst and graben topography, some of the grabens becoming convenient stream coarses in which were deposited orthoquartzite gravels. The weathering cycle continued with denudation and finally (Tertiary?) laterization of the land surface.

It is likely that the horst and graben topography was rejuvenated by further movement along the old faults. The horsts then once more became deeply incised and lost their soil mantle while the old graben became even more filled with waste from the horsts to give the landscape, as seen today.



Reproduced with permission from Ann. Rep. 1895 Dept Mines N.S.W.

Recommendations

Although the area is relatively simple lithologically, its structure and geomorphology are complex: only a detailed structural analysis integrated with geomorphological studies will produce a full understanding of the geology.

Further work in the area needs to be detailed and comprehensive. Radiometric dating of the igneous rocks of the area would be useful. Some of the tuffs may be fresh enough to give a reasonable age for the sediments (although account must be taken of the fact that they have been affected by a low grade regional metamorphism). As the sediments have proved unfossiliferous to date structural and stratigraphic correlation with adjacent areas of known age is a necessity.

ACKNOWLEDGEMENTS

The project was supervised jointly by G.M. Burton and Dr. D.L. Strusz, who made many helpful suggestions. Several discussions with R.J. Coventry have led to a better understanding of the area, particularly some of its geomorphological aspects, and thanks are extended for his co-operation throughout the project.

Sincere thanks are also extended to A.W. Schuett for his help in preparing for the field operations.

Property owners in the area showed a keen interest in the project and their kindness and hospitality are gratefully recorded.

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APPENDIX

Detailed Petrography

Within this appendix detailed descriptions of representative rocks and thin sections collected within the mapped area are presented. Brief descriptions have already been presented within the main text of this report.

The rocks are described under the following headings

A. Sediments
   (i) Quartz greywackes
   (ii) Shales
   (iii) Argillites

B. Igneous Rocks
   (i) Adamellite
   (ii) Porphyritic micro-granodiorite
   (iii) Acid tuffs and volcanics

All textural terms used in the descriptions are used in the sense defined by Joplin (1968a, 1968b).

A. Sediments.

(i) Quartz greywacke

Specimen Nos.	69390004	Locations	295557
	69390012		276558

Hand Specimen

A brownish-grey rock weathering to browns and yellows consisting of medium to fine-grained quartz in a matrix of fine grained mica minerals. The rock is generally massive, though rare specimens have relic sedimentary banding or are strongly cleaved.

Thin Section

The rock is lepidoblastic and blastopsammitic, consisting of poorly sorted, subrounded to angular quartz grains, biotite, and a small amount of detrital plagioclase, zircon, and tourmaline.

Quartz, 70%; subrounded to angular, poorly sorted, 0.02-1.2 mm.; some grains are composite and have sutured mutual grain boundaries; smaller grains tend to be less rounded than larger grains.

Biotite, 20%; xenoblastic, 0.02 mm.; α = colourless to light straw-brown $\beta \simeq \gamma$ = yellowish brown to deep red brown.

Plagioclase, 2%; rounded to subangular, 0.2-0.6 mm.; good albite twinning, often partially altered, commonly includes small opaque particles.

Muscovite, 3%; xenoblastic, 0.02-0.1 mm.

Opaques, 3%; xenoblastic, very small.

Accessory Minerals, 1-2%; Zircon, green tourmaline, ?rutile; rounded grains, 0.02 mm.;

Specimen No. 69390006 Location 352628

Hand Specimen

A fine-grained grey rock with alternate dark narrow bands between wider (about 1 cm.) light coloured bands. Quartz and mica appear to be the predominent minerals.

Thin Section

The rock has a blastopsammitic and weakly lepidoblastic texture, consisting of poorly sorted angular quartz and quartzite grains, muscovite, and small amounts of rounded detrital plagioclase and zircon.

Quartz, 80%; subrounded to angular, very poorly sorted ranging from 0.02-0.5 mm.; grain boundaries are sutured and extinctions are wavy due to strain; some grains are composite and probably originated from a quartzite.

Muscovite, 15%; xenoblastic, av. dia. 0.02 mm.

Plagioclase, 2%; subrounded to angular, 0.1-0.4 mm.

Opaques, 2%; irregular grains up to 0.2 mm.

Zircon, 1%; rounded, up to 0.2 mm.; often partially altered and clouded.

(ii) Shale

Specimen No. 69390007 Location 279628

Hand Specimen

A brownish-grey to grey rock weathering to paler colours or to yellow and consisting of very fine-grained quartz and mica. Sedimentary laminae with minor slump structures or micro-crossbedding are common features.

Thin Section

A very fine grained rock with relic sedimentary laminae defined by changes in the proportions of constituent minerals. The rock tends to be lepidoblastic.

Quartz, 35%; xenoblastic, 0.02 mm.; many grains show a strain extinction.

Biotite, 20%; xenoblastic, 0.02 mm.; α = buff to pale yellow brown, $\beta \approx \gamma$ = deep brown.

Muscovite, 40%; xenoblastic, 0.02 mm.

Opaques, 3%; irregular, ragged, 0.02 mm.

Zircon, trace; rounded.

Specimen Nos.	69390014	Locations	276558
	69390013		276558

Hand Specimen

A brownish-grey to grey rock with relic sedimentary banding and consisting predominantly of very-fine-grained quartz and mica.

Thin Section

A fine-grained blastopsammitic and weakly lepodoblastic rock consisting essentially of angular quartz grains and ragged grains of muscovite and biotite.

Quartz, 40%; angular, av. 0.1 mm.; occasionally grains up to 0.25 mm. present; extinctions are only slightly undulose.

Biotite, 25%; xenoblastic, av. 0.1 mm.; α = light yellowish green, slightly brown, $\beta \approx \gamma$ = reddish brown.

Chlorite, 5%; xenoblastic, av. 0.1 mm.; pleochroic from colourless to yellowish green; often closely associated with biotite.

Muscovite, 25%; xenoblastic, av. 0.1 mm.

Opaques, trace.

Zircon, tourmaline, trace; rounded grains.

(iii) Argillite

Specimen No. 69390001 Location 276558

Hand Specimen

The typical argillite is brown to grey and spotted with large porphyroblasts of a slightly different colour. The rocks weather to brownish red and yellow colours and the porphyroblasts are strongly delineated by differential weathering effects.

Thin Section

This rock is weakly lepodoblastic and contains relic porphyroblasts of ?cordierite, now altered to fine grained muscovite. It consists essentially of muscovite and lesser amounts of biotite and quartz. Very small opaque grains are also abundant especially within the porphyroblasts. (There is also a strong resemblance of the relic porphyroblasts to andalusite).

Muscovite, 75%; xenoblastic, very fine grained; abundant both as an alteration product of the prophyroblasts and as a mineral of the groundmass.

Biotite, 15%; xenoblastic, very fine grained; α = yellowish green, $\beta \approx \gamma$ = brown.

Quartz, 5%; xenoblastic, very fine grained; slightly strained.

Opaques, 5%; xenoblastic, very fine grained; tend to be concentrated in the relic prophyroblasts.

Specimen No. 69390002 Location 268559

Hand Specimen

A greenish grey to brown rock weathering to brownish yellow and spotted with large porphyroblasts. The strong foliation of the rock is corrugated. The rock is very fine grained.

Thin Section

The rock is porphyroblastic and the strong foliation produced by the orientation of mica grains is strongly corrugated. The porphyroblasts themselves are not folded and appear to belong to a later stage of development. They are surrounded by quartz-rich halos. The major minerals present are muscovite, biotite quartz and opaques. The porphyroblasts are completely altered to fine grained sericite.

Muscovite, 50%; xenoblastic; very fine grained.

Biotite, 30%; xenoblastic, very fine grained; α = yellowish brown, $\beta \approx \gamma$ = brown.

Quartz, 15%; xenoblastic, very fine grained; rare coarser grained pockets, also in rims about relic porphyroblasts.

Opaques, 5%; xenoblastic, very fine grained.

Zircon, Tourmaline, trace.

Specimen No. 69390005 Location 269564

Hand Specimen

The porphyroblasts of this rock have been preferentially iron stained during weathering and stand out against the lighter brown groundmass of the rock.

Thin Section

This rock is strongly lepidoblastic and contains relic ?porphyroblasts which have been preferentially iron stained and contain small amounts of graphite. The major minerals include muscovite, biotite and quartz.

Muscovite, 35%; xenoblastic, very fine grained.

Biotite, 40%; xenoblastic, very fine grained.

Quartz, 15%; xenoblastic, very fine grained.

Opaques, 7%; irregular, very fine grained; includes graphite and probably magnetite.

Zircon, trace.

B. Igneous Rocks.

(i) Adamellite

Specimen No. 69390003 Location 294557

Hand Specimen

The rock is an attractive coarse grained white rock flecked with black flakes of biotite. Plagioclase and alkali feldspar forms white grains while quartz forms clear glassy irregular masses. Minor pyrite and chalcopyrite are also present.

Thin Section

This rock is holocrystalline, medium grained, hypidiomorphic granular, and poikilitic consisting of strongly zoned subidiomorphic andesine grains enclosed by larger grains of orthoclase and quartz. Slightly chloritized biotite is interstial, and idiomorphic accessory minerals including apatite and zircon are present. A small amount of opaque minerals and allanite is also present.

Plagioclase, An_{35}, 50%; subidiomorphic, 1.5-3.0 mm.; all grains are zoned and generally the central zones show some degree of alteration to muscovite, av $\alpha' \wedge 010 = 18^{o}$; Albite, Carlsbad and Pericline twinning are common.

Alkali Feldspar, 15%; allotriomorphic, 5-10 mm.; gridiron twinning is poorly developed.

Quartz, 15%; allotriomorphic, 5-10 mm.; extensively fractured, undulose extinctions due to strain.

Biotite, 12%; allotriomorphic, 1-2 mm.; α = buff, $\beta \approx \gamma$ = deep red brown, pleochroic halos are present. Chlorite has grown along the cleavage traces.

Chlorite, 3%; allotriomorphic, 1-2 mm.; pleochroic in pale greens; intergrown with biotite parallel basal cleavages.

Opaques, trace; very small allotriomorphic grains, mainly pyrite.

Accessory Minerals, Zircon, Apatite, trace; idiomorphic, very small.

Epidote (?Allanite); trace; alteration product.

(ii) Porphyritic micro-granodiorite

Specimen No. 69390008 Location 323651

Hand Specimen

A dark grey porphyritic rock mottled with large (5-12mm) white phenocrysts of plagioclase, bluish glassy phenocrysts of quartz, black mafic clots and black flakes of biotite. The groundmass is dark grey and aphanitic.

Thin Section

The rock is holocrystalline and porphyritic, large subidiomorphic phenocrysts up to 12 mm. being in a groundmass of av. grain size less than 0.1 mm. The phenocrysts consist of quartz, plagioclase and biotite. Alteration producing tremolite and to a small extent chlorite has taken place.

Phenocrysts, 35%.

Quartz, 10%; allotriomorphic, 3-10 mm.; extensively fractured, very wavy extinctions due to strain.

Plagioclase, An_{45}, 15%; subidiomorphic, 1.5-12 mm.; zoned with a clear sodic rim, av. $\alpha' \wedge 010 = 24^{\circ}$. exsolution phenonema has taken place.

Biotite, 10%; subidiomorphic, 1-3 mm; α = yellowish brown, $\beta \sim \gamma$ = deep red brown, pleochroic halos; needles of ?rutile orientated at 60° to each other form a net in the basal planes.

Mafic clots, 12%.

Biotite, 7%; allotriomorphic, av. 0.5 mm., felted mass; α = yellowish brown, $\beta \sim \gamma$ = reddish brown.

Ilmenite, 1%; skeletal, av. 0.5 mm.

Tremolite, 2%; allotriomorphic forming aggregates, aggregate size 1-2 mm.; crystal size av. 0.2 mm.; $\gamma \wedge z = 15^{\circ}$; slightly pleochroic in pale greens.

Chlorite, 2%; subidiomorphic, 0.5 mm.; pleochroic in pale greens, anomalous blue interference colours.

Groundmass, 50%; allotriomorphic granular, av. grain size, approx. 0.05 mm., consists of quartz and untwinned plagioclase.

Accessory Minerals, 3%; Zircon, apatite; idiomorphic.

(iii) Acid tuffs and volcanics

Specimen No. 69390009 Location 373667

Hand Specimen

The rock is grey to brown, depending on the degree of weathering, and porphyritic. White phenocrysts of plagioclase and glassy phenocrysts of quartz are present. The groundmass is aphanitic.

Thin Section

The rock is porphyritic, consisting of phenocrcysts of plagioclase and quartz in a fine grained groundmass of quartz, untwinned plagioclase, and biotite. Accessory minerals include zircon, and small amounts of epidote, muscovite, and chlorite are present as alteration minerals.

Phenocrysts, 45%.

Quartz, 20%; allotriomorphic, 0.5-4 mm.; extensively fractured, very wavy strain extinction.

Plagioclase, 25%; subidiomorphic, 0.5-5 mm.; albite and carlsbad twinning common; incipient alteration to epidote; a large proportion of the grains are fractured.

Groundmass, 55%.

The groundmass consists predominantly of quartz and untwinned plagioclase forming an allotriomorphic granular texture. This makes up 40% of the rock.

Chlorite, 5%; allotriomorphic, less than 0.2 mm.; forming clusters; pleochroic in pale greens.

Biotite, 5%; allotriomorphic, less than 0.2 mm.; forming small aggregates; α= buff, $\beta \approx \gamma$= greenish brown; defines a rough lineation.

Epidote, 3%; allotriomorphic, forms small granular aggregates.

Zircon, trace; idiomorphic

Specimen No. 69390011 Location 373667

Hand Specimen

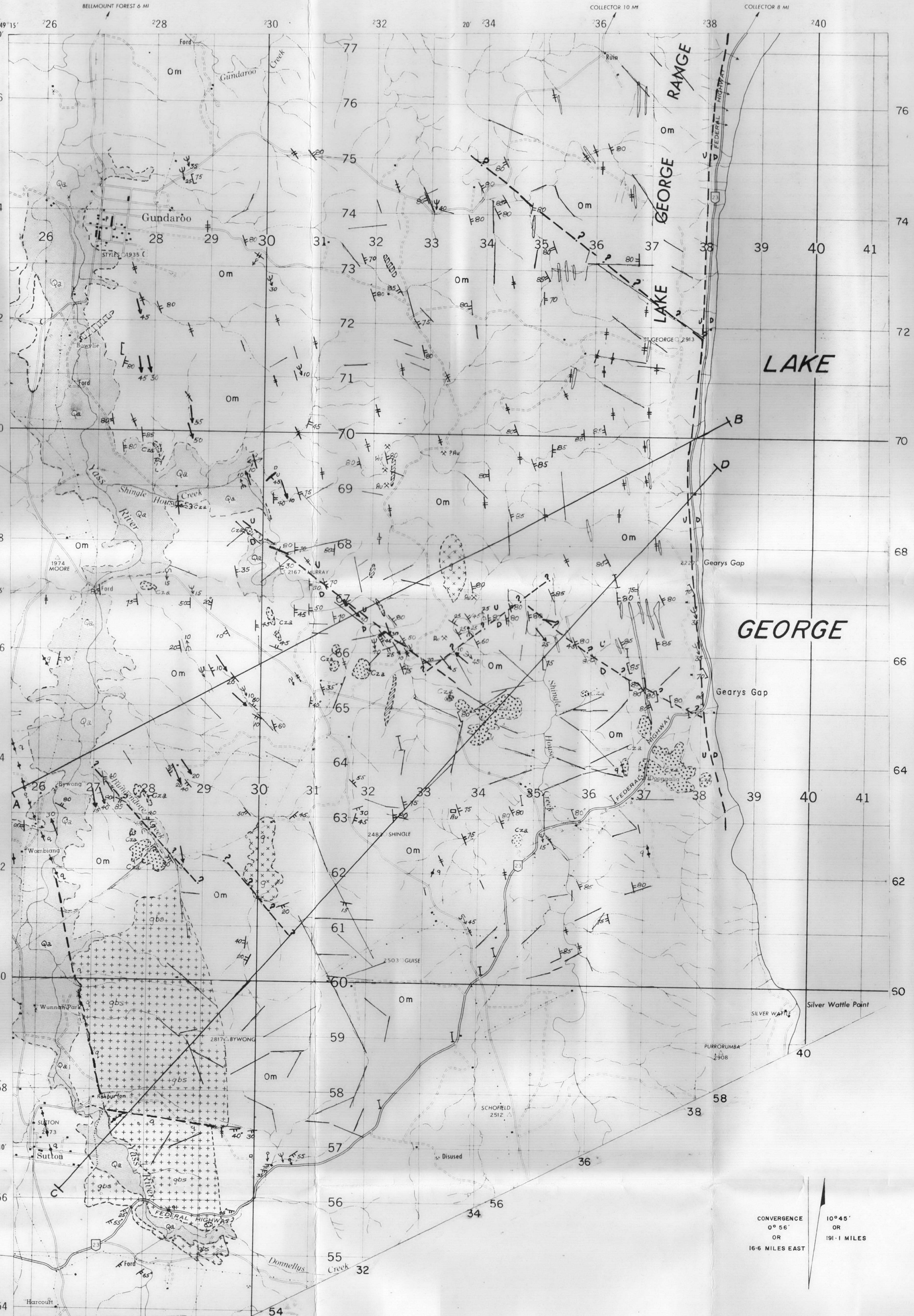
The rock is grey, prophyritic and strongly flow banded, the banding being defined by alternating shades of grey and trains of phenocrysts. The phenocrysts of plagioclase and quartz are small and the groundmass is aphanitic. Black flecks of biotite are also present.

Thin Section

The rock is porphyritic consisting of phenocrysts of plagioclase and quartz in a fine grained groundmass of quartz, untwinned plagioclase, biotite and chlorite. The groundmass shows a strong flow layering defined by the mafic and accessory minerals of the rock. The flow banding wraps around the phenocrysts of the rock. A lenticular mass parallel to the flow layering consists of elongate plagioclase and quartz grains and is more coarsely crystalline than the rest of the ground mass. This is interpreted as being a pumice fragment which has recrystallized. The overall texture of the rock is that of a tuff.

The mineralogy of the rock is similar to that of the previously described specimen and will not be described in detail here.

GEOLOGICAL MAP
of the
GEARY'S GAP — SUTTON — GUNDAROO AREA.
N·S·W



Scale 1 : 50,000

3 Miles; 4000 Metres

TRANSVERSE MERCATOR PROJECTION

Geology by R M Hill, R Coles, R Horsley.
Compiled by R M Hill.
Drawn by R M Hill, D.J. Callaghan.

Reference

CAINOZOIC
- QUATERNARY — Qa — *Alluvium*
- TERTIARY ? — Cza — *Orthoquartzite, white rounded quartz gravels partly lateritized*

PALAEOZOIC
- UPPER SILURIAN — MIDDLE DEVONIAN ? — Sutton Granite — gbs — *Medium-grained biotite adamellite*; g — *Fine to medium-grained biotite adamellite*
- *Porphyritic micro-granodiorite*
- MIDDLE ORDOVICIAN ? — Om — *Quartz greywacke, shale, argillite*; // — *Acid tuffs and volcanics*

Geological boundary, position approximate
Anticline
Syncline
Plunge of minor anticline
Plunge of drag fold
Plunge of fold axis
Fault attitude unknown, D, U, indicates relative movement down, up,
Where location of faults is approximate, line is broken, where inferred, queried, where concealed; faults are shown by short dashes, q – quartz filled.
Inclined fault (76)
Lineament, air-photo interpretation
Strike and dip of strata, facing not known (45)
Strike, dip indeterminable
Vertical strata, facing not known
Top of bed indicated by cross bedding
Vertical joints
Strike and dip of cleavage (60)
Vertical cleavage
Dyke or vein, q quartz

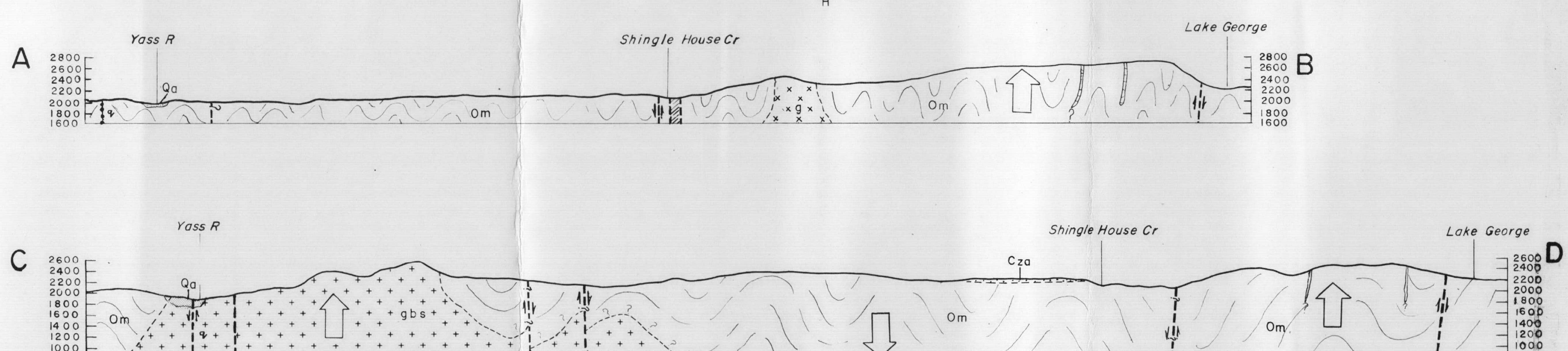
Mine, Au – gold
Quarry

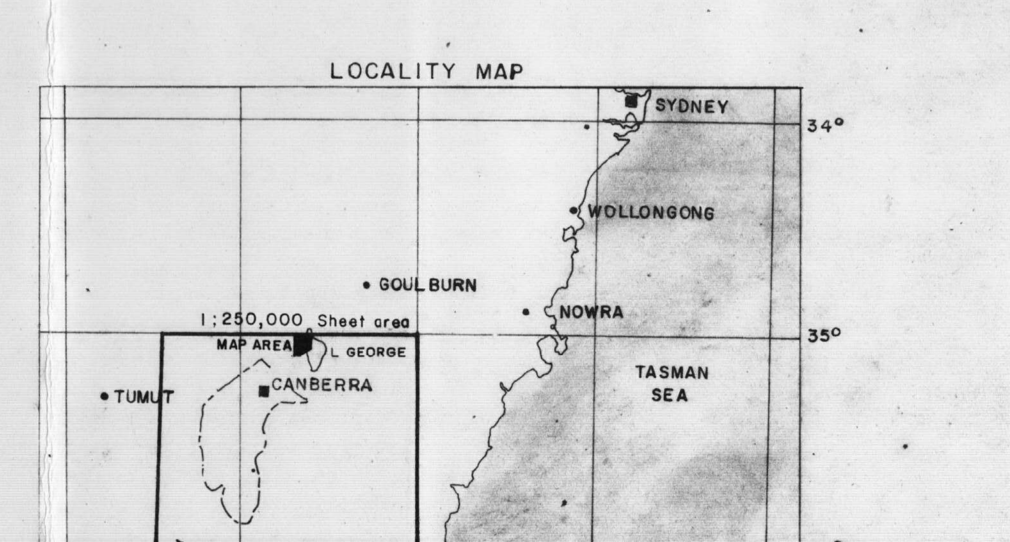
Road, sealed surface first class route marker (23)
Road, unimproved earth, gate, cattle grid
Telephone line, power transmission line
Building(s), church, school
P T W/T *Post office, telegraph office, wireless transceiver*
Yards, cemetery, racecourse
Control point, major, minor, astronomical
BM·750 750 *Bench mark, spot elevation in feet*
Lake, river, or stream, perennial
Lake, river, or stream, intermittent
Waterhole, dam
Windpump

Sections

Attitude of faults not known. Folding Schematic

Scale $\frac{V}{H} = 3$





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