1:250,000 GEOLOGICAL SERIES—EXPLANATORY NOTES

MURGOO
WESTERN AUSTRALIA

SHEET SG/50-14 INTERNATIONAL INDEX

WESTERN AUSTRALIA
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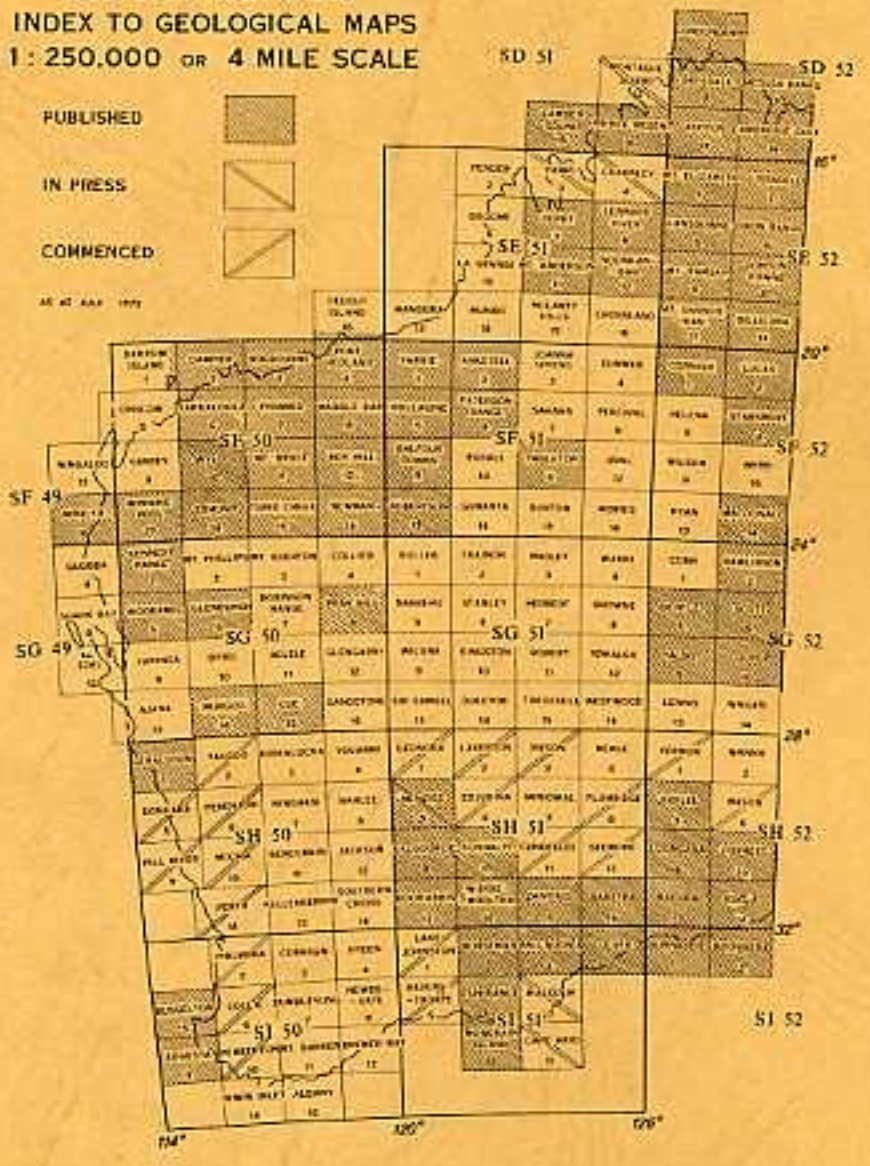
1 : 250,000 OR 4 MILE SCALE



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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MURGOO
WESTERN AUSTRALIA

SHEET SG/50-14 INTERNATIONAL INDEX

COMPILED BY J. L. BAXTER

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Explanatory Notes on the Murgoo Geological Sheet

*Compiled by J. L. Baxter**

INTRODUCTION

The Murgoo Sheet area lies in the Yalgoo Goldfield of Western Australia and is delimited by parallels of latitude 27°00′S and 28°00′S and meridians of longitude 115°30′E and 117°00′E. The area is served from the townsites of Mullewa and Yalgoo, south of the Sheet area. There is a network of graded roads and telephone links between pastoral stations. Murgoo station, after which the sheet is named, is located in the centre of the area, and is about 150 miles (240 km) northeast of Geraldton.

Twenty-one pastoral leases have been taken up in the area. These are Yallalong, New Forest, Billabalong, Wooleen, Twin Peaks, Meeberrie, Murgoo, Boolardy, Mount Wittenoom, Meka, Woolgorong, Pinegrove, Bullardoo, Wandina, Yuin, Tardie, Narloo, Jingemarra, Gabyon, Melangata, and Dalgaranga. Most stations have authorized landing areas in the vicinity of the homesteads, and there are numerous landing grounds used in mustering which may be suitable for light aircraft. The abandoned gold mining centre of Yuin lies in the southern part of the Sheet area.

The area is arid to semi-arid; the mean average rainfall is 9 inches (228 mm) in the southwest of the area, lessening to the north and east to 8 inches (203 mm). The climate is described as "intermediate" by Gentilli (1959). The weather is normally controlled by frontal depressions from the south, although between October and March tropical depressions may dominate the weather pattern. The sparse natural vegetation comprises thin scrub on most of the plains, thick *Acacia* on sandy rises and river gums along the major drainages.

* *Geological Survey of Western Australia*

Air-photographs of the Sheet area at a scale of 1 inch to 50 chains (1:39,600), flown in 1964, are available from the West Australian Lands and Surveys Department. Photo-mosaics, topographic maps, and compilation sheets based on aerial photography flown in 1953 are also available.

The area is divided into the Wael, Murchison, Roderick, Sanford, Greenough and Pindathuna drainage sub-basins. The divides are mainly hills of granitic rocks, and plateaux of sandplain. The runoff is intermittent, the creeks flowing only after heavy rain. The Pindathuna basin drains internally to a saline calcrete south of the Sheet area. The remaining basins are external, draining into the Indian Ocean.

PREVIOUS INVESTIGATIONS

Most of the prominent physiographic features of the area were named by such early explorers as R. Austin (1855), H. Y. L. Brown (1871) and J. Forrest (1875). Brown (1871) and Maitland (1898) were the first to describe the geology of the area. Johnson (1950) described the regional geology of the Sheet area as part of a reconnaissance mapping of the Murchison and Yalgoo Goldfields. The mining centre at Yuin has been described by Jutson (1913, 1914) and a small copper deposit at Illimbirrie by Maitland (1918, 1919), Low (1963) and Sofoulis and Williams (1970). Perry and Dickens (1960) described the geology of the Woodrarrung Range.

The present compilation is based on geological mapping by J. Baxter, L. de la Hunty, and P. Muhling in 1968. Hydrogeological investigations were carried out during this survey by J. Baxter and K. Leeder.

GEOLOGY

The oldest rocks exposed in the Murgoo Sheet area are of Archaean age, and include metamorphosed fine-grained basic and acid extrusive and intrusive rocks with varying amounts of fine-grained metasediments. The succession is intruded by granitic rocks. The Archaean is overlain by Proterozoic sandstone, siltstone and shale and the entire succession is intruded by Proterozoic dolerite. There are no exposures of Palaeozoic or Mesozoic strata in the Sheet area. Cainozoic colluvial, eluvial and alluvial sediments have thicknesses of up to 100 feet (30 m).

The general stratigraphy is summarized in Table 1.

TABLE 1. GENERAL STRATIGRAPHY OF MURGOO 1:250,000 SHEET

Age		Map Symbol	Name or Short Description	Lithology	Distribution and Relationship	Remarks
CAINOZOIC	QUATERNARY	Qa	Alluvium	Fine to coarse-grained quartz sand with patches of clay, silt and conglomerate	Restricted to creek beds and major drainage lines	
		Qb	Sand	Quartz sand of eolian, alluvial, and eluvial origin	Forms flats along major drainages	Usually underlain at a shallow depth by a consolidated alluvium which is the main aquifer in the area
		Qc	Colluvium	Rock fragments and quartz sand	Outwash slopes, adjacent to hilly areas	Good quality groundwater is contained in unit.
		Ql	Saline Alluvium	Clay with silt and minor sand	Wooleen Lake	
		Czk	Kankar and calcrete	Limestone with siliceous caps in places	Lower reaches of drainage tracts	Shallow aquifer, good supplies, stock water
		Czg	Grit	Kaolinitic quartz grit	Unconformably overlies the weathered profile in granitic areas	Contains fossil larval cases
		Czs	Sandplain	Fine-grained quartz sand with variable clay content	On upland plateaux	Usually overlies weathered granite profile
		Czl	Laterite	Massive or pisolitic iron-rich material	Above weathered rock profiles, usually granitic	
PROTEROZOIC	BADGERADDA GROUP	Pbc	Coomberarie Formation	Shale siltstone and fine-grained sandstone	Mount Vinden — conformably overlies Woodrarung Sandstone	
		Pbw	Woodrarrung Sandstone	Thick-bedded medium to coarse-grained quartz sandstone and fine to medium-grained white to light brown kaolinitic sandstone	Woodrarrung Ranges, conformably overlying Bililly Formation	
		Pbb	Bililly Formation	Kaolinitic sandstone, conglomerate shale, and grit	Woodrarrung Ranges, probably unconformably over Nilling Beds	
		Pn	Nilling Beds	Thin beds quartz-greywacke, coarse sandstones and shale	Unconformably overlies Archaean migmatite	Contains manganese nodules in shale bands

TABLE 1. GENERAL STRATIGRAPHY OF MURGOO 1:250,000 SHEET.—(*cont.*)

ARCHAEAN		At	Tallering Formation	Metamorphosed acid volcanics, sandstone, siltstone, and polymictic conglomerate intruded by metagabbro sills	Disconformable to conformable overlying Eerada Formation		Includes map symbols Atg, Ats, Ata, Atc
			Eerada Formation	Fine-grained actinolite-quartz rocks with minor actinolite-tremolite schist	Base of formation has been removed by emplacement of migmatite and granite	Contains gold mineralization in a quartz vein	Includes map symbols Aeg, Aeb, Aes and Aet
			Illimbirrie Formation	Metamorphosed basic volcanic rocks with banded iron formation, phyllite, and acid volcanics	Isolated remnant of metamorphosed rock between granitic units	Contains minor copper mineralization	Includes map symbols Aid, Ais, Aia, Aic, Aif, Aij, Aib, Aie, Ait
			Barloweerie Formation	Metamorposed basic volcanic rocks and banded iron formation	Surrounded by porphyritic granite	Contains minor beryl in pegmatites	Includes map symbols Abg, Abm, Abr, Abc, Abj, Aba, Abt
			Moyagee Formation	Amphibole-plagioclase and biotite-plagioclase rocks	Surrounded by granite and small areas of migmatite		Includes map symbols Ama, Amj
				INTRUSIVE ROCKS			
PROTEROZOIC	AGE UNCERTAIN	Pd	Dolerite dyke	Fine to medium-grained	Mainly from northeast to southwest corner of sheet area		
		Pdi	Diorite dyke	Fine to medium-grained rock occasionally with phenocrysts of hornblende	Distributed across the sheet—not common		
		Ad	Uralitized dolerite dyke	Fine to medium-grained	Restricted to west and southwest of Sheet area		
ARCHAEAN		Apg	Porphyritic granite	Leucocratic, quartz, feldspar, biotite granitic rocks with tabular phenocrysts	Exposed in dissected areas sometimes weathered		
		Age	Even-grained granite	Leucocratic quartz, feldspar, biotite granitic rock	As for porphyritic granite		
		Agm	Even-grained foliated granite	Quartz, microcline, plagioclase granitic rock	Low exposures in south of sheet usually weathered	Similar to nebulitic migmatite (after Mehnert, 1968)	
		Agn	Migmatite	Even-grained granitic rocks with foliation parallel to remnants of metamorphosed country rock	Low relief exposures mainly in northwest of Sheet area	Similar to stromatic migmatite (after Mehnert, 1968)	

NOT CORRELATED BETWEEN AREAS

ARCHAEAN

The Archaean layered successions consist of metamorphosed acid and basic pyroclastics and lavas, with some fine-grained amphibolite of unknown origin, intercalated with fine-grained metamorphosed sedimentary rocks. In different areas the thicknesses of individual units vary, some areas being predominantly of one rock type. Most of this succession has been metamorphosed to the greenschist facies (Turner and Verhoogen, 1960), however in some areas the rocks have been metamorphosed to a higher grade due to the proximity of intrusive rocks. The succession has been intruded by granitic rocks and dolerite. The dolerite and some of the granitic rocks are folded, though usually to a lesser degree than the layered rocks. There are discrete bodies of granite which intruded the succession prior to folding and others which are not folded. A small area of metamorphic rock on the western margin of the sheet has granulite texture. This has been correlated with 2,900 to 3,000 million year-old rocks described from north of Mullewa by Arriens (1970).

METAMORPHOSED LAYERED ROCKS

Correlation between exposures of Archaean layered rocks is impossible in the Sheet area as they are separated by granitic rocks, and in general their geographic distribution is such that no reliable stratigraphic control can be obtained. With the exception of the Eerada and Tallering Formations, which have known stratigraphic relationships, the division into formations has been made on geographic distribution. In the following descriptions, lithological units mapped within the various formations are in italics, together with their appropriate map symbols.

Eerada Formation

The Eerada Formation has been defined by Baxter (1971a). Where this formation is exposed in the southwest of the Sheet area, the base has been removed by emplacement of granitic rock. The formation is generally green in colour and consists essentially of fine-grained actinolite-quartz rocks with varying amounts of epidote, tourmaline and minor feldspar.

The main exposure of the Eerada Formation is on the north limb of a west-plunging syncline. The main rock type of the formation is *actinolite-quartz schist* (Aeb) within which there are thin bands of ultramafic actinolite schist.

Although there is a layering reflected in proportions of quartz and actinolite throughout the unit, no evidence was seen for either a volcanic or sedimentary origin. Two and a half miles (4 km) east of Wandina Homestead is an exposure of *actinolite-tremolite schist* (Aet) which is the only area of ultramafic rock mapped in the formation. This rock may be associated with the adjacent sills of *metagabbro* (Aeg) which have intruded the metamorphic rocks.

Tallering Formation

The Tallering Formation was defined by Baxter (1971a) on the Yalgoo 1:250,000 Sheet area, and it can be traced north into the Murgoo Sheet area where it is present in isolated exposures. It consists of a succession of metamorphosed acid volcanics, sandstone, siltstone and polymictic conglomerate intruded by metagabbro sills.

Quartz-muscovite schist (Ats) of probable meta-sedimentary origin, is exposed south of the Greenough River, southwest of Snake Well. The unit here is riddled with small quartz veins, some of which contain gold deposits. Although correlation in the area is made difficult by the Quaternary cover and the intrusion of granitic rocks, it is considered that this unit overlies an acid volcanic rock which is also represented by *quartz-muscovite schists* (Ata). One mile (1.6 km) northeast of Tinderlong Well is an exposure of metamorphosed rhyolite and acid volcanic breccia of this unit. *Polymictic conglomerate* (Atc) is exposed east of Yuin in a small outcrop. The conglomerate has clasts of chert and granitic rock, and is considered to be within the acid volcanic unit. The clasts are between 7 and 20 cm in diameter.

Illimbirrie Formation

The formation consists mainly of basic volcanic rocks and has been named after a prominent hill north-northeast of Twin Peaks Homestead. The exposure of the formation extends about 21 miles (34 km) north-northeast from Twin Peaks and is surrounded by granitic rocks.

The layering of the metamorphic succession dips west at angles ranging from 25 degrees (on the south side) to 80 degrees, though most of the dips are from 65 to 75 degrees. Pillow lavas at Mount Hope, 5 miles (8 km) north of Twin Peaks Homestead indicate a west-facing succession. Although no direct evidence has been seen at Illimbirrie it is considered the west-dipping succession all faces to the west.

Allowing for a possible increase in thickness due to a drag fold at Illimbirrie (Sofoulis and Williams, 1970), about 19,500 (5,950 m) of the formation is exposed in the Mount Hope Illimbirrie area. The succession here comprises two bands of basic rocks separated by banded iron formation, phyllite and minor acid volcanic rocks. The rock sequence has been intruded in the southeast by an even-grained granite which has a finely banded, partly migmatitic granodiorite at its edge and a lit-par-lit zone at the contact. The top of the formation is obscured at Mount Hope by Quaternary colluvium, and further north it has been intruded by a porphyritic granite. Regional metamorphism to the greenschist facies of Turner and Verhoogen (1960) has affected the rocks, though some fresh relict pyroxene is present in the basic pyroclastic rocks. Near Illimbirrie several small shafts were sunk for copper (Low, 1963).

In the Illimbirrie-Mount Hope area pyroclastic rocks are the main feature, however they are rare to the northeast in this formation. The basal pyroclastic rocks are mainly *acid to intermediate banded tuffs* (Air) with some coarse-

grained volcanic breccia near the mine. On the northwest side of Mount Hope, *banded basic tuffs* (Aif) mixed with minor sediments are the youngest rocks exposed in the formation. A band of coarse acid pyroclastic rocks is exposed immediately southeast of Mount Hope.

Tremolite-chlorite and tremolite schists (Ait) are exposed in the lower basic succession. These ultramafics are thought to be differentiates of *metadolerite* (Aid), with which they are associated, and were probably pyroxenite. At the base of the *amygdaloidal basic lavas* (Aib) exposed southeast of Mount Hope, there is a narrow band of chlorite schist which is the only ultramafic rock seen in the upper basic succession.

Sills of *metadolerite and metagabbro* (Aid) have been grouped on the map. They intrude both the acid and basic volcanic rocks. Thirteen miles (21 km) northeast from Twin Peaks Homestead a body of metagabbro with a thickness of 3,000 feet (900 m) is exposed. No evidence of differentiation was recorded. At Mount Hope a thin metagabbro associated with metadolerite is exposed.

Banded iron formation (Aij), exposed 12 miles (19 km) along strike to the north from Illimbirrie, is correlated with that which crops out with phyllite south of Mount Hope. The exposure of these rocks south of Mount Hope is poor and very weathered. Sandstone, phyllite, banded iron formation, and acid tuffs have been recognized, but the relative proportions of each are unknown.

Acid lava flows with intercalated tuffs and minor sediments are exposed near Illimbirrie and short narrow bands of rhyolitic lava in basic tuffs crop out north of Mount Hope.

The *metabasalt* (Aib) is amygdaloidal and three horizons of pillow lavas were recognized near Mount Hope.

The type area for the Illimbirrie Formation includes Mount Hope and Illimbirrie and is enclosed by longitude 115°59′E to 115°57′E and latitudes 27°16′S to 27°23′S.

Barloweerie Formation

The name Barloweerie Formation is proposed for a sequence of basic volcanic rocks with banded iron formation about 12 miles (19 km) southeast of Wooleen Homestead. The thickness exposed is approximately 17,000 feet (5,200 m). The type area lies between longitude 116°16′E and 116°20′E and latitudes 27°09′S and 27°16′S.

The Barloweerie Formation is exposed in a narrow fold. Both north and south-plunging lineations have been observed, however a truncated slump structure near the north end of the exposure indicates that the bed faces east. The structure is believed to be a syncline. The lineation discrepancy is explained if we assume that the steep north-plunging fold has been disturbed by the intrusion of porphyritic granite which completely surrounds the formation.

West of the Murgoo-Wooleen Road, narrow bands of phyllite are exposed below fine-grained *actinolite-plagioclase rocks* (Aba). The western margin of the succession is a mixture of metamorphosed acid volcanic rocks and phyllite, intruded by a fine-grained granite.

The section exposed between the Murgoo-Wooleen Road and Mount Barloweerie is covered with colluvium and weathered rocks which are thought to be basic volcanic rocks. Immediately west of the *quartz-hematite banded iron formation* (Abj) are small areas of dark green phyllite (quartz-biotite) and weathered fine-grained ?acid tuffs (included in map unit weathered Aba). Overlying the banded iron formation are fine-grained actinolite-plagioclase rocks and metabasalts (containing quartz amygdules) with narrow bands of medium to coarse-grained sheared basic rocks containing streaks of quartz, actinolite, feldspar and fine-grained basic material, which are interpreted as sheared pyroclastic rocks.

Conformably overlying the fine-grained basic rock is a *polymictic conglomerate* (Abc) containing clasts of banded iron formation, trondhjemite, and porphyry, and quartz, set in a quartz-biolite matrix. The trondhjemite and porphyry boulders are up to 9 inches (20 cm) in diameter and are rounded, while the clasts of banded iron formation are angular.

Overlying the conglomerate and underlying the youngest *metabasalt* (Abm) is a series of acid rocks with streaks and crystals of biotite. Some beds contain quartz lenses, thought to be amygdules, and are probably acid flows with minor tuffaceous beds.

Intrusive basic rocks are not common in the Barloweerie Formation. *Metagabbro* (Abg) is exposed in lenses on the western edge of the metamorphic rocks. Along strike from the metagabbro are lenses of *tremolite and tremolite-chlorite schist* (Abt). In a gully about 10 chains (160 m) west-southwest from Mount Barloweerie some weathered talcose rocks crop out.

Moyagee Formation

The Moyagee Formation was defined on the Cue 1:250,000 Sheet area by de la Hunty (1970). Rocks correlated with this formation are exposed in the southeast corner of the Murgoo Sheet area. The exposure is bounded on the north by laterite and colluvium, probably overlying even-grained granitic rocks. To the south and west, even-grained granitic rocks intrude the formation and contain xenoliths of country rock.

The formation is made up of mainly fissile, finegrained, metamorphosed basic rocks which are either amphibole-plagioclase rocks or biotite-plagioclase rocks. The amphibole is probably hornblende and is of the dark green to black variety, typical of contact metamorphism zones. A few of the rocks are amygdaloidal, but many have banded textures and are probably basic tuffs.

The southwest margin is marked by a decrease in basic rocks with development of fine-grained metasediments, porphyries, and banded iron formation

intercalated with biotite-plagioclase rocks which may have formed by metasomatism related to the granitic rocks.

The succession has been intruded by numerous aplites and pegmatites. The grade of metamorphism is probably the hornblende-hornfels facies of Turner and Verhoogen (1960).

HIGH GRADE METAMORPHIC ROCKS

On the western margin of the Sheet area, immediately south of the Murchison River, are exposures of granulite textured rocks and recrystallized granite. There is no mineralogical data available from these rocks, and no correlation with the granulite facies of metamorphism can be made. The area appears to be bounded to the northeast and southeast by faults. The age of the granulite is not known; it may be related to the metamorphic provinces of the Northampton area or the Mullewa area (Arriens, 1970).

An *even-grained granite with some recrystallization* (A^g) and numerous stringers of metamorphosed country rock occupy most of the area. There are two bands of *coarse-grained banded granulite* (A^a) exposed in the area. These bands contain minor garnetiferous granulite. A band of *medium-grained granulite* (A^b) contains remnants of rock which have been metamorphosed to amphibolite grade and retain some characteristics of basic volcanic rocks.

INTRUSIVE ROCKS

Four groups of granitic rocks and one group of basic rocks are distinguished in the area. The granitic rocks are divided partly on texture and partly on the relationship of the rock unit to folding. It is considered that the youngest granite intrusions are not affected by folding.

North and west of the Murchison River is a large area of *migmatite* (Agn) composed of remnants of metamorphosed country rock in a matrix of granitic rock. The granitic rock varies from granite to adamellite and is mainly concordant with the country rock, although there are discordant lenses. Xenoliths of *metamorphosed banded iron formation with quartz-muscovite schist* (Asj), *metamorphosed banded iron formation with actinolite-plagioclase-quartz schist* (Aaj), *metamorphosed fine-grained acid volcanics* (Ava), and *actinolite-tremolite schist* (Aab) have been separated from the unit for mapping purposes, however, small areas of these rock types occur throughout the unit. One characteristic feature of this area is that the granitic and metamorphic rocks are both folded.

Even-grained foliated granite (Agm) with xenoliths of country rock and schlieren is exposed over a large tract of country in the southwest of the Sheet area. Smaller areas of this rock type have been mapped north of Narloo Homestead, southwest of Boolardy Well, and at Yarra Yarra Well. Xenoliths of *acid volcanics* (Aav), *actinolite-tremolite schist* (Aab) and *metagabbro* (Afg) have been mapped within the unit. There are also xenoliths within the unit which have not been separated in the mapping. This granite has been

folded and is commonly sheared. It is even grained and composed of quartz, microcline, and sericitized plagioclase with accessory apatite, epidote, zircon, sphene, and an unidentified opaque mineral.

Three different granites which intruded the migmatite have been mapped. These form discrete intrusive bodies within the migmatite and may have resulted from anatexis of the migmatite. A *fine-grained foliated granite* (Agf), forming an elongate body extending parallel to the general foliation of the migmatite north of Yallalong Homestead, has been intruded by an *even-grained foliated granite* (Aga). The latter even-grained foliated granite is medium grained and has the form of a stock. An *even-grained foliated biotite granite* (Agb) has intruded the eastern margin of the migmatite and is exposed south of Billabalong Homestead. The foliation in this granite appears to be conformable with that of the adjacent migmatite.

Porphyritic granite (Agp) and *even-grained granite* (Age) form complex batholiths throughout the eastern two-thirds of the Sheet area. There is a complex intrusive relationship between the granites. They are probably co-magmatic. The biotite content of the granite increases from the northeast to the southwest. Where there are discrete bodies of *biotite porphyritic granite* (Agpb) and *biotite even-grained granite* (Ageb) they have been separated on the map. East of Illimbirrie and south and west of Mount Barloweerie these granites intrude the country rocks in a lit-par-lit manner. East of Illimbirrie the area of lit-par-lit injection is large enough to be represented on the map as an *even-grained granite lit-par-lit association* (Agl).

Intruding the *migmatite* (Agn) and *even-grained foliated granite* (Agm) is a set of *uralitized dolerite dykes* (Ad) which have been folded.

PROTEROZOIC

Predominantly arenaceous sediments of Proterozoic age are exposed in the northwest of the Sheet area. These sediments unconformably overlie Archaean migmatite. Proterozoic dolerite intrudes both the Archaean succession and this sedimentary sequence.

SEDIMENTARY ROCKS

The Proterozoic sandstones and siltstones have been divided into two sequences: the Nilling Beds and the Badgeradda Group (Perry and Dickens, 1960). The sequences are separated by a probable unconformity. The Badgerradda Group has been divided into three formations: the Coomberarie, Woodrarrung and Bililly Formations. The lithologies of the formations are similar, being predominantly white to grey sandstone-siltstone associations. Glauconitic sandstone occurs within the Proterozoic strata. These sediments can probably be correlated with those of the Bangemall Group (Daniels, 1968).

Nilling Beds

The Nilling Beds (Perry and Dickens, 1960) are exposed south of the Woodrarrung Range and consist of thin beds of quartz greywacke and thin-bedded,

coarse-grained sandstones. The beds unconformably overlie the Archaean migmatite. At the base of the formation there are fragments of the Archaean rocks in the unit. South of Woodrarrung Range the unit is folded into small disconnected synclines along a major fault direction. Within the beds there is a salmon to chocolate-coloured shale in which were found nodules of manganese.

Bililly Formation

The Bililly Formation (Perry and Dickins, 1960) has a probable unconformable relationship with the underlying Nilling Beds. The sequence contains, from bottom to top of the formation, kaolinitic sandstone, quartz sandstone, conglomerate, salmon-coloured shale, and grits with mud casts. The sandstones are medium to coarse grained at the base of the formation and fine grained and micaceous at the top. The congomerate contains clasts of up to 4 cm diameter. Cross-bedding indicates that currents responsible for the deposition of the sandstone were from the east.

Woodrarrung Sandstone

Perry and Dickins (1960) have described the Woodrarrung Sandstone as containing two units; a lower thick-bedded medium to coarse-grained quartz sandstone and an upper fine to medium-grained white to light brown friable kaolinitic sandstone which in places is silty and micaceous. For the purposes of this compilation these units have been mapped as one unit. The formation is characterized by cross-bedding and by generally good sorting. The kaolinitic content of the upper part of the formation probably resulted from alteration of feldspar. The formation conformably overlies the Bililly Formation.

Coomberarie Formation

Coomberarie Formation (Perry and Dickins, 1960) is exposed in the vicinity of Mount Vinden and is composed of shaley siltstone and fine-grained sandstone. There are also bands of ferruginous shale within the unit. Although the contact of the formation with the underlying Woodrarrung Formation is obscured by Cainozoic deposits the contact is considered to be conformable.

INTRUSIVE ROCKS

Proterozoic dolerite and diorite dykes intrude the granitic rocks, the metamorphic rocks and the Proterozoic sediments on the Sheet area. De la Hunty (1970) correlates the dykes on the Cue 1:250,000 Sheet area, east of this area, with those of the Eastern Goldfields which have an age of 2,420 million years. It is considered that as this correlation is made primarily on direction and lithology, and as in the Gascoyne Province dolerite dykes are known to intrude Lower Proterozoic rocks (Daniels, pers. comm.), then the age of dolerite intrusion is uncertain and probably occurred at different times.

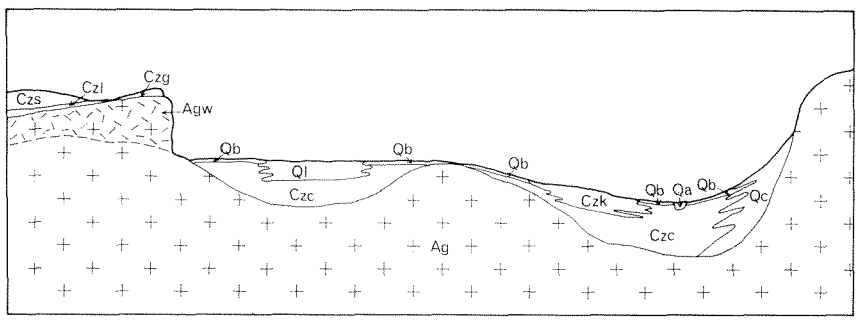
The dykes are usually straight and narrow and have metamorphosed the granitic rocks at their margins. They range in composition and grain size from fine-grained black dolerite to medium-grained grey quartz-dolerite, some of which has phenocrysts of hornblende.

CAINOZOIC

The Cainozoic rocks which cover most of the Sheet area are unconformable on all older units. Stratigraphic correlation between many of the units is impossible as exposures do not indicate their mutual relationships.

STRATIGRAPHY

There are three environments in which different types of deposits have formed. In the valleys, deposits of alluvium, saline alluvium and eluvial and eolian sands have formed, together with some calcrete and kankar in mature valleys. At the base of the hill slopes there are deposits of colluvium. Laterite, sandplain, and grit have formed on top of breakaways in the area. The stratigraphic relationship of the units is shown in Figure 1.



REFERENCE

Qa : Alluvium	Czk : Kankar and calcrete	Czc : Consolidated colluvium, not map unit
Qb : Sand	Czg : Grit	
Qc : Colluvium	Czs : Sandplain.	Agw: Weathered granitic rock
Ql : Saline alluvium	Czl : Laterite	Ag : Granitic rock

FIGURE 1
CAINOZOIC ROCK UNIT RELATIONSHIPS
MURGOO SHEET SG50-14

12426

Undifferentiated Cainozoic

Kankar and calcrete (Czk) are formed by deposition of calcium carbonate from solutions in low reaches of the drainage. The margins of the calcrete areas interfinger with consolidated alluvium and are often overlain by unconsolidated alluvium with kankar. The calcrete contains patches of opaline silica.

Grit (Czg); a kaolinitic quartz grit up to 20 feet (6 m) thick forms prominent escarpments at the edge of the sandplain. The unit stands out on air-photographs as it forms a second scarp above the normal scarp of weathered granitic rocks. The unit is considered to be formed by redistribution of weathered material. The relationship between the grit and laterite has not been seen, but it is thought that the grit lies unconformably on the profile of

laterite and weathered granitic rocks, and is consequently younger than the laterite. Fossils, considered to be traces of larvae cases of weevils, have been found in the unit.

Sandplain (Czs) consisting of varying amounts of fine-grained quartz sand and silt form a gently undulating surface which is generally above the level of the surrounding country, but may extend into the valleys in some places. The sand is yellow to red in colour due to iron staining of the grains. It usually overlies laterite or weathered rocks.

The origin of the sandplain is complex as it appears to be mainly restricted to areas where the underlying rocks contain relatively abundant quartz, which suggests an eluvial origin, however, some of the sandplain has characteristics of eolian deposits. It is suggested that the sandplain has been reworked to some degree after formation from the breakdown of quartz-rich rocks.

Laterite (Czl) is a massive or pisolitic iron-rich material, which overlies weathered older rocks. Frequently associated with the iron-rich sections are patches of siliceous capping, which presumably represent a variation in the composition of the underlying rock.

Quaternary

Alluvium (Qa) is developed in all the major drainages and is predominantly a fine to coarse-grained quartz sand. There are areas of silt, conglomerate and clay in the unit. The unit is restricted to the channels of the present rivers and the outwash plains of the major drainages.

Sand (Qb) derived from river alluvium, erosion of older rocks and consolidated alluvium, forms drifts in the older valleys. This sand unit overlies, in most places, consolidated alluvium. The consolidated alluvium is locally known as hardpan.

Colluvium (Qc) consisting of fragments of rock eroded from hills, particularly granitic rocks, forms flank deposits up to 40 feet (12 m) thick.

Saline Alluvium (Ql) is developed in Wooleen Lake. It is a clay deposit with minor sand and silt. The lake is fed from the Roderick River and overflows into the Murchison River when in flood.

STRUCTURE

The distribution of the structural units on the Murgoo 1:250,000 Sheet area is shown on Figure 2. The dominant units in the Archaean are plutons of granitic rock which have displaced, infiltrated and absorbed Archaean sedimentary and volcanic deposits in different parts of the Sheet area. The granitic rocks have been divided into three lithological groups. The first group comprises four complex intrusive bodies on the eastern side of the Sheet area and individual bodies of intrusive granite are in the centre of the Sheet area. Nebulitic migmatite (Mehnert, 1968) exposed in the southwest of the sheet forms the second, and stromatic migmatite (Mehnert, 1968) with areas of metamorphic rocks, the third. The last is predominant in the northwest of the sheet, but is also found throughout the area. The Proterozoic structural unit in the northwest of the sheet is bounded by an unconformity

and has been folded into an asymmetrical syncline which plunges north. Dyke suites intersect all units on the Sheet area. The dykes have predominant northeast strikes and are usually vertical or close to vertical.

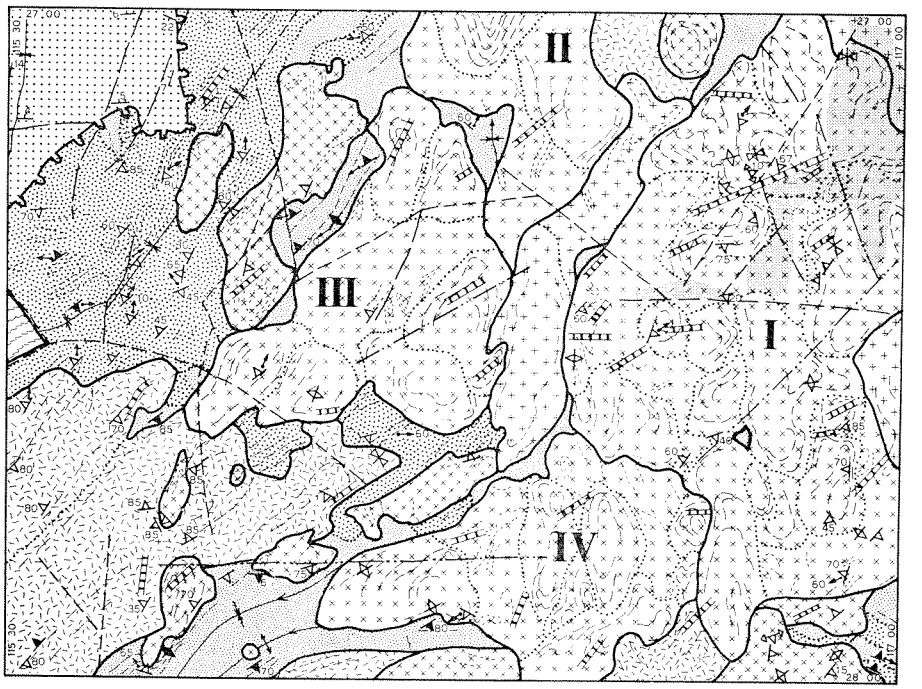


FIGURE 2

STRUCTURAL SKETCH MAP

MURGOO SHEET SG 50-14

SCALE

10 0 10 20 30

KILOMETRES

5 0 5 10 15

MILES

REFERENCE

- Dyke Suite
- Badgeradda Group and Nilling Beds
- Complex Pluton of internal facies granitic rocks
- Pluton of internal facies granitic rocks
- Border facies granite
- Migmatite – nebulitic
- Migmatite – stromatic with remnants of country rock
- Metamorphosed acid and basic igneous rocks and metasediments
- Granulite and granitic rocks with some recrystallization
- Aeromagnetic zone (moderate intensity)

- Structural unit boundary
- Unconformity
- Geological boundary
- Fault, position accurate
- Fault, position approximate
- Fault, or prominent lineament
- Aeromagnetic lineament
- Synclinal axis showing plunge direction
- Anticline axis
- Strike of vertical metamorphic foliation
- Inclined metamorphic foliation
- Undetermined dip of mineral foliation in igneous rocks
- Strike of vertical mineral foliation in igneous rocks
- Inclined mineral foliation in igneous rocks
- Inclined mineral foliation in igneous rocks, lineation horizontal
- Strike and dip of bedding
- Direction of plunge
- Photo lineaments, probably joints
- Photo lineaments, probably joints or compositional banding

12427

Archaean Metamorphic Areas

The Archaean metamorphic rocks are complexly folded. These structures have been disrupted by emplacement of granitic plutons and are probably the remains of more extensive folded sequences of Archaean acid and basic volcanic rocks and sediments. There is no consistent orientation of the fold axes preserved in the metamorphic rocks.

Granitic Plutons

Six divisions of granitic and migmatitic plutons have been distinguished in Figure 2.

The granulite and recrystallized granite unit on the western margin of the Sheet area is interpreted as a horsted block of a sequence of older rocks and is related to the older migmatite and granite south of the Sheet area.

Stromatic migmatite with remnants of country rock is commonly associated with areas of metamorphic rock. There is a large area of this rock in the northwest of the Sheet area where it contains stocks of homophanous (Mehnert, 1968) structured rock, which are interpreted as being anatectic products of the stromatic migmatite. This structural unit is folded, and has relict structures preserved in segments, particularly in the remnants of metamorphosed acid and basic rocks. The major direction of folding in the unit is north to northeast with minor northwest cross-folding. The position of the northwest axis is difficult to establish owing to disruption of the banding by emplacement of granitic rock.

Nebulitic migmatites are preserved in the southwest and in isolated patches throughout the Sheet area. The area in the southwest can be interpreted as two different plutons which are separated by a tongue of metamorphic country rock on the northeast margin of the unit. It is thought that these plutons of migmatite were formed at the time of folding of the metamorphic rocks, as along the southern margin of the pluton in the southwest of the Sheet area the platy flow foliation in the neosome (Mehnert, 1968) is parallel to the foliation in the metamorphosed country rock.

The remaining three types of granitic plutons have been emplaced after folding and all have displaced the preceding units. The four complex plutons (I, II, III, IV) are internal facies granite (after Muhling, 1969). They are each composed of several units or "cells" defined by compositional variation and structures within the plutons. The cells of granitic rock tend to be homogeneous in composition while the rocks between the cells tend to be heterogeneous. It is inferred that the cells have closures within 5 to 10 km of the surface, as some of them have platy flow foliations parallel to the margins of the cell and dipping toward the centre. The separate cells are interpreted as individual plutons of granitic rock which have intruded the migmatite succession with which they are surrounded. There are also simple plutons of border facies granitic rock (after Muhling, 1969) associated with the complex plutons, but containing more absorbed country rock. They are

probably only slightly older than the complex batholiths. Away from the complex plutons there are separate post-tectonic plutons of granitic rock intruding the succession. These small plutons were intruded during the same tectonic phase as the complex plutons.

Proterozoic

The Archaean sequence is overlain unconformably by beds of Proterozoic sandstone and siltstone which have been folded into an asymmetrical anticline, the axis of which plunges to the north.

Dyke Suites

There is a marked preferred orientation of the dykes of this Sheet area between 030 and 070 degrees. Minor trends occur at 085, 125 and 175 degrees.

Faults and Lineaments

No correlation can be established between the direction and length of drainages with those of the photolineaments and the dolerite dykes. The dolerite dykes have a predominant direction between 030 and 070 degrees. Photolineaments show a major trend at about 135 degrees with a secondary major trend at about 025 degrees and minor trends at about 065, 095 and 165 degrees. The drainage pattern has little preferred direction with the exception of a prominent orientation at about 005 degrees; there are minor groups at 045, 095, and 125 degrees.

A lineament direction at about 095 degrees parallels a prominent aeromagnetic trend, but there appears to be little evidence from mapping to support a major joint direction. The prominent 005 degree direction may reflect recent tectonic events.

ECONOMIC GEOLOGY

Gold, the principal metal produced from the Sheet area has been won from mines at Yuin. Minor copper has been obtained from two prospects at Twin Peaks. Small showings of manganese and pegmatite minerals have been noted, but not in sufficient quantities to warrant exploitation.

Gold

Gold has been intermittently mined from the Yuin mining centre since 1897, the principal producers being Royal Standard Leases and Bullrush Gold Estates N.L. Most of the gold has been mined from quartz reefs intruding intermediate and basic volcanic rocks. Table 2 lists the ore produced from the various leases to December, 1968. The total production was 27,908.57 ounces (789.81 kg) of gold obtained from 68,639 long tons (69,737 tonnes) of ore treated. The principal periods of production were 1897 to 1899

(Royal Standard Leases), 1914 to 1917 (Bullrush Gold Estates N.L.)., and 1922 to 1923 (Royal Standard Leases and Bullrush Gold Estates N.L.). There has been little production from this centre since the depression years and all gold mining had ceased by 1937. The geology of the gold mining centre is described by Jutson (1913, 1914).

TABLE 2. GOLD PRODUCTION AT YUIN MINING CENTRE

No. of Lease	*Name*	*Production Period*	*Ore Treated long tons*	*Gold Produced fine ozs*
525, 409, 469, 470, 524, 654, 655, 656	Bullrush Gold Estates, N.L.	1912-13	6,904.00	2,144.03
712, 735	Bullrush Gold Estates, N.L.	1914-17	23,690.00	7,302.83
409, 410, 421, 427, 430, 469, 470, MA 8	Royal Standard Leases	1897-99	20,289.50	11,113.24
409, 469, 470, 524, 525	Royal Standard Leases	1911-12	4,049.00	1,679.01
976	Royal Standard Leases	1926-27	†	177.55
1082	Royal Standard Leases	1935-37	2,091.00	542.94
556	Standard Grade	1908	139.00	*20.76
712	Royal Standard, Bullrush Gold Estates, N.L.	1922-23	10,977.00	4,928.21
Sundry Claims			**335.50	617.53
Totals			68,475.00	27,976.10

Statistics from W.A. Dept. of Mines
NOTE: All leases mostly occupy same ground.
* Not included in 1908 figures: 127.12 oz. dollied or alluvial sources.
† Not recorded.
** 4.70 ozs dollied not included.
One long ton = 1.016 tonnes. One fine ounce = 31.103 grammes.

COPPER

Between 1906 and 1960, 84 tons (85 tonnes) of copper ore averaging about 16 per cent copper were won from small mines at Twin Peaks. The copper is concentrated in a contact zone between acid and basic volcanics. The deposits have been described by Maitland (1919), Johnson (1950), Low (1963) and Sofoulis and Williams (1970). The workings are now abandoned. Table 3 lists the total copper ore and concentrates produced from this deposit.

TABLE 3. COPPER ORE AND CONCENTRATES AT TWIN PEAKS

ORE

Production Period	*No. of Lease*	*Registered Names*	*Ore Produced long tons*	*Copper Content long tons*	*Value $A*
1906	PA 105H	Tibbits, W. H.	13.50	2.27	386.00
1907-08	PA 155*	Summers, S. D.	19.50	3.49	554.00
1909-68	Nil				
Total to end of 1968			33.00†	5.76	840.00

CONCENTRATE

Production Period	*No. of Lease*	*Registered Names*	*Concentrate Produced long tons*	*Average Assay % Cu*	*Copper Content Units*	*Value $A*
1949	MC 7	Dower, H. J. and Party	7.00	10.39	72.73	96.00
1951-55	MC 7	Twin Peaks Copper Industries Ltd	47.49	3.89	184.67	535.52
1956-58	Nil					
Total to end of 1968			54.49	14.28	257.40	681.52

Statistics from W.A. Dept. of Mines.
* Stated to be 1.5 miles south of Ringing Bell (Maitland, 1919).
† Maitland (1919) reports 8 tons of ore raised from Ringing Bell about 1917.
One long ton = 1.016 tonnes.

BERYL

Minor amounts of beryl are associated with narrow pegmatites intruding acid and basic volcanic rocks near Mount Barloweerie. Beryl was also noted in a very coarse-grained granite at a contact with a dolerite dyke northeast of Tardie Station.

MANGANESE

Manganese nodules associated with Proterozoic shale occur on the south side of the Woodrarrung Range.

AGGREGATES, DIMENSION STONE, ROAD METAL AND BALLAST

Road metal and ballast are readily available from even-grained and porphyritic granite, metabasalt, and dolerite areas. There are no sealed roads in the area, most of the roads being graded on natural colluvial surfaces.

CLAY

Clay in the pallid zone within the weathered granitic rocks is potentially interesting but has not so far been investigated.

QUARTZ SAND

Clean, medium to coarse, angular to well rounded quartz sand occurs in some of the larger river beds. The sand is usually saline.

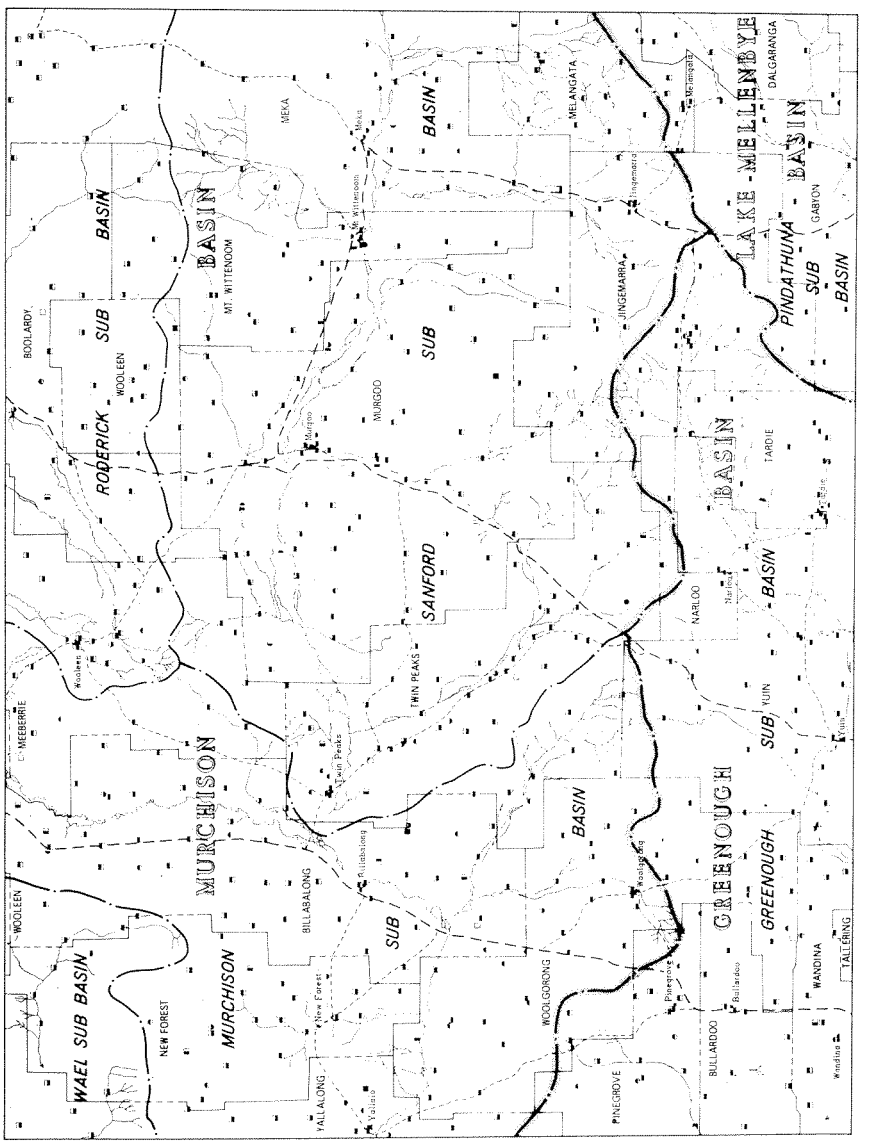
WATER RESOURCES

There are 627 wells and bores on the Sheet area. Supplies are sufficient for pastoral purposes in most areas. Most of the aquifers are shallow and located in the Cainozoic deposits. Aquifers found in the weathered granitic rocks generally yield only small supplies of water. The drainage province subdivision is shown in Figure 3.

generally yield only small supplies of water. The drainage province subdivision is shown in Figure 3.

FIGURE 3
DRAINAGE BASINS AND WATER SUPPLIES

MURGOO SHEET SG 50-14



Metamorphic and igneous terrains are mainly impermeable and in these areas the only aquifers available are in the Quaternary colluvium adjacent to hills. Calcrete supplies in the Sheet area are usually saline, and unsuitable for domestic requirements. Aquifers recharged from areas of granitic rock (Age and Agp on the map) have better quality water than those from other units.

Typical underground water supplies are listed in Table 4. A more comprehensive account of the hydrogeology of the Murgoo Sheet area is given by Baxter (1971b).

TABLE 4. TYPICAL UNDERGROUND WATER SUPPLIES, MURGOO

Name	*Total Depth*	*Water Level*	*Quality ppm*	*Aquifer*
Balbadonga W	24'0"	10'6"	4,950	Alluvium
Soak W	20'0"	9'5"	1,170	Alluvium
Red Hill W	45'4"	30'8"	3,040	Alluvium
Uland W	15'0"	1'0"	469	Alluvium
Grassy Flat W	33'0"	24'4"	1,123	Consolidated colluvium
Nyeo W	21'7"	15'10"	3,140	Consolidated colluvium
Emu W	62'6"	31'0"	5,040	Consolidated colluvium
Jones W	10'8"	3'6"	3,760	Consolidated colluvium
Three Mile W (Jingemarra)	53'6"	26'6"	570	Weathered granite
Coffin W	61'0"	56'10"	758	Weathered granite
Taff W	64'9"	52'7"	5,470	Weathered gneiss
Blue Mountain W	72'0"	60'6"	3,140	Weathered gneiss
Wandarrie W	41'9"	26"3'	1,850	Sandplain
Killer Paddock W	18'3"	16'10"	1,140	Sandplain
Diamond W	41'3"	26'6"	6,380	Quartz sandstone
Chinerby W (Gabyon)	17'4"	12'7"	4,060	Calcrete
Limestone W	15'3"	14'0"	3,980	Calcrete
Pompey W	20'0"	15'10"	600	Unconsolidated colluvium
Two Mile W (Yallalong)	20'10"	16'6"	2,410	Unconsolidated colluvium

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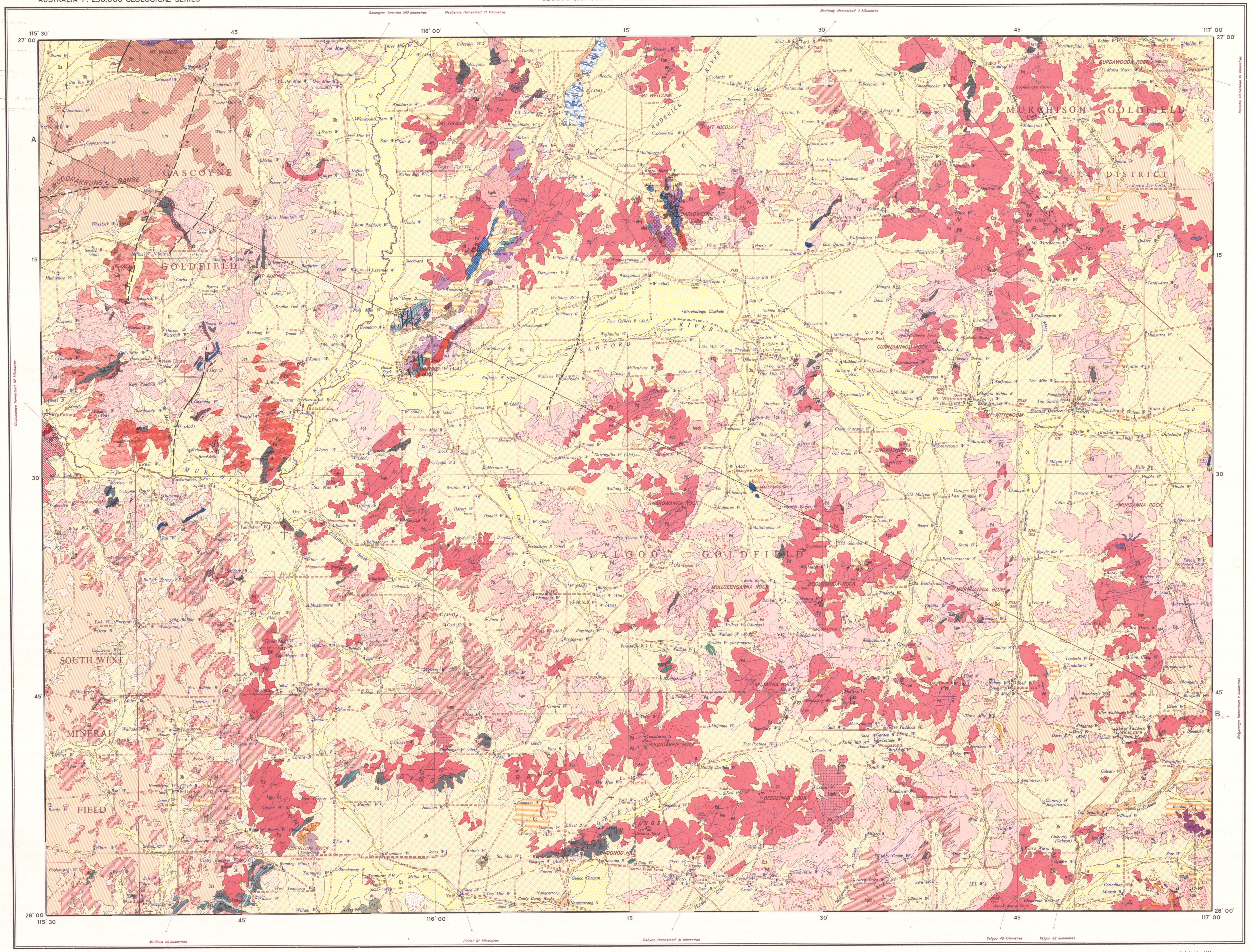
MURGOO

AUSTRALIA 1 : 250,000 GEOLOGICAL SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SG 50 - 14



Geology by J. L. Baxter, L. E. de la Hunty and P. C. Muhling 1968

SYMBOLS

Geological boundary
Fault
- Accurate
- Approximate
- Inferred
- Concealed and inferred
- Inclined
- Shear zone

Fold
- Anticline showing plunge
- Syncline showing plunge
- Syncline approximate
- Plunge of dragfold

Bedding
- Measured

Facing
- General
- Pillow lava

Lineation
- Direction and plunge

Foliation
- Measured
- Vertical

Mineral orientation in igneous rocks
- Foliation undetermined dip
- Foliation inclined
- Foliation vertical
- Foliation inclined, lineation horizontal
- Foliation vertical, lineation horizontal

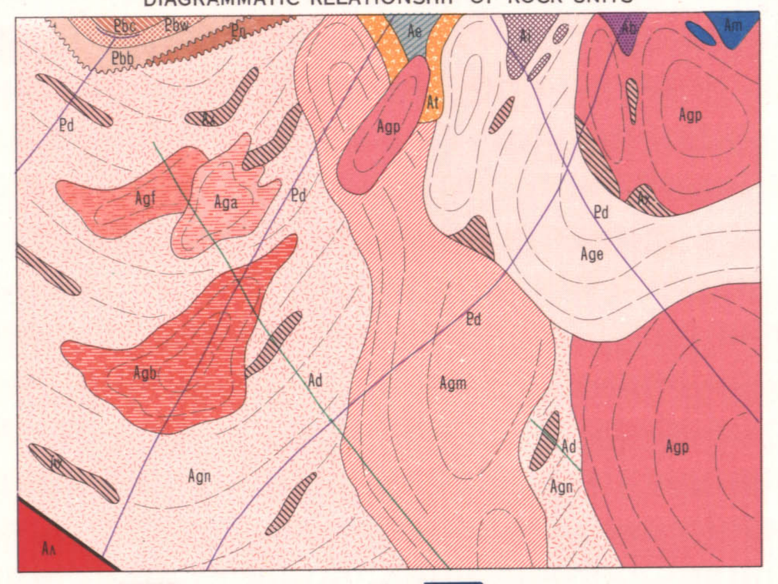
Trend line—air photo interpretation

Goldfield boundary
Road
Track
Telegraph line
Homestead — Murgoo
Yard
Landing ground
Horizontal control, minor
Bench mark, height accurate — ZM13 1054'
Sand dune

Watercourse, intermittent
Bore — B
Well — W
Windpump
Pool — P
Spring — S
Rockhole — RH
Abandoned — (Abd)

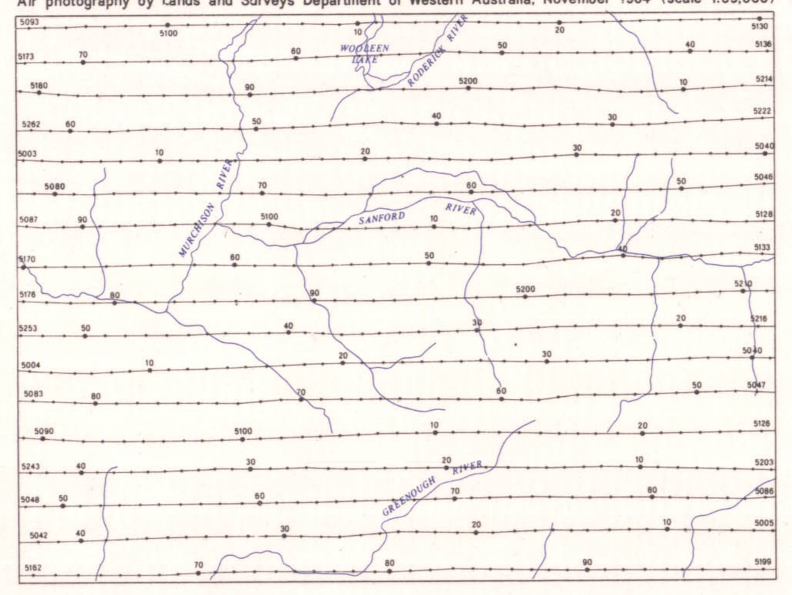
Mining centre — YUIN
Mine—not being worked — Royal Standard
Mineral occurrence
- Beryl — Be
- Copper — Cu
- Gold — Au
- Manganese — Mn

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



FLIGHT DIAGRAM

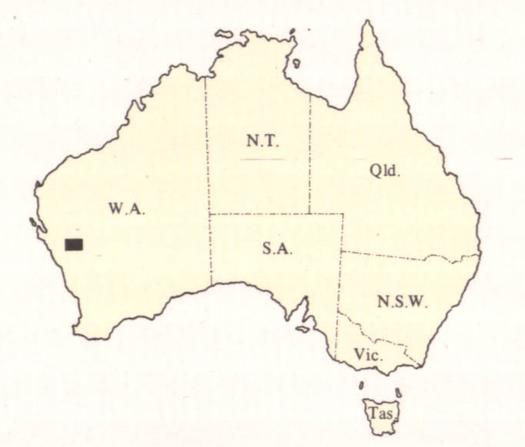
Air photography by Lands and Surveys Department of Western Australia, November 1964 (scale 1:39,600)



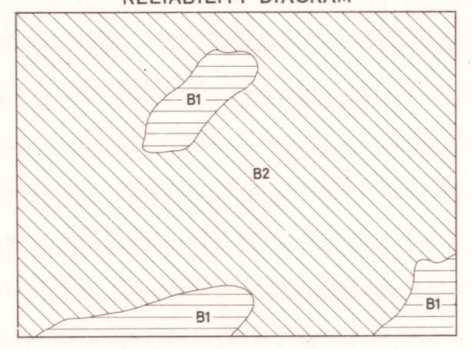
Compiled by Geological Survey of Western Australia. Cartography by Geological Drafting Section, Mines Department. Topographic base from compilations by Lands and Surveys Department.

Published by Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, Canberra, A.C.T.

Copies of this map may be obtained from the Geological Survey of Western Australia, in Perth; or the Bureau of Mineral Resources, Geology and Geophysics in Canberra, A.C.T.



RELIABILITY DIAGRAM



B1 Numerous traverses with air photo interpretation
B2 Air photo interpretation with a few traverses

HON. D.G. MAY, M.L.A.
MINISTER FOR MINES.
J. H. LORD, DIRECTOR, GEOLOGICAL SURVEY

SCALE 1 : 250,000

TRANSVERSE MERCATOR PROJECTION
ZONE 1 AUSTRALIA SERIES

INDEX TO ADJOINING SHEETS

YARINGA SG 50 - 9	BYRO SG 50 - 10	BELELE SG 50 - 11
AJANA SG 50 - 13	MURGOO SG 50 - 14	CUE SG 50 - 15
GERALDTON SH 50 - 1	YALGOO SH 50 - 2	KIRKALOCKA SH 50 - 3

DECLINATION DIAGRAM

The lines indicate magnetic declination, 1970.
+ means declination is east and correction must be added to compass bearing to give true bearing.
− means declination is west and correction must be subtracted from compass bearing to give true bearing.
Annual change is -1' westerly

REFERENCE

CAINOZOIC — QUATERNARY

- Qa Alluvium
- Qb Sand—alluvial, eluvial and eolian
- Qc Colluvium
- Ql Saline alluvium

- Czk Kankar and calcrete
- Czg Grit
- Czs Sandplain
- Czl Laterite

PROTEROZOIC — Badgeradda Group

- Pbc **COOMBERARIE FORMATION:** silty sandstone, siltstone
- Pbw **WOODARRUNG SANDSTONE:** thin-bedded kaolinitic sandstone and thick-bedded quartz sandstone
- Pbb **BILILLY FORMATION:** silty sandstone, siltstone, quartz sandstone
- Pn **NILLING BEDS:** sandstone, quartz greywacke

ARCHAEAN

TALLERING FORMATION
- Atg Metagabbro
- At Metamorphosed sandstone, siltstone and acid volcanics
- Ats Quartz-muscovite schist; originally siltstone and sandstone
- Ata Quartz-plagioclase-muscovite schist; originally acid volcanics
- Atc Metamorphosed polymictic conglomerate

EERADA FORMATION
- Aeg Metagabbro
- Aeb Actinolite-quartz schist
- Aes Quartz-plagioclase-muscovite schist
- Aet Actinolite-tremolite schist

ILLIMBIRRIE FORMATION
- Aid Metadolerite, metagabbro
- Ais Metamorphosed acid volcanics, minor sandstones and siltstones
- Aia Metamorphosed acid volcanics
- Air Metamorphosed rhyolite and dacite tuffs; banded
- Aif Metamorphosed basic pyroclastic rocks, tuffs and agglomerates
- Aij Metamorphosed banded iron formation with phyllites
- Aib Metabasalt
- Aie Amphibolite; fine-grained
- Ait Tremolite and tremolite-chlorite schist; medium-grained

BARLOWEERIE FORMATION
- Abg Metagabbro
- Abm Metabasalt; massive and amygdaloidal
- Abr Metamorphosed rhyolite
- Abc Metamorphosed polymictic conglomerate
- Abj Metamorphosed banded iron formation
- Aba Amphibolite; fine-grained, dark green
- Abt Tremolite and tremolite-chlorite schist; medium-grained

MOYAGEE FORMATION
- Ama Metamorphosed basic rocks; fine-grained. Includes minor tuffs. Contact metamorphosed by granitic rocks
- Amj Metamorphosed banded iron formation

- Afg Metagabbro, metadolerite

- Asj Metamorphosed banded iron formation and quartz-muscovite schist
- Aaj Metamorphosed banded iron formation and actinolite-plagioclase-quartz schist
- Aab Actinolite-tremolite schist
- Ava Metamorphosed acid volcanics; fine-grained

- Aʌg Granite; even-grained; some recrystallization
- Aʌa Granulite; coarse-grained, banded
- Aʌb Granulite; medium-grained. Carries amphibolite remnants

Occur as xenoliths in granitic rocks and as isolated exposures. Unknown formational status

Not correlated between areas

INTRUSIVE ROCKS

PROTEROZOIC
- Pd Dolerite dyke
- Pdi Diorite dyke

ARCHAEAN
- q Quartz vein
- Ad Dolerite dyke; uralitized

- Agp Granite; porphyritic
- Age Granite; even-grained
- Agpb Biotite granite; porphyritic
- Ageb Biotite granite; even-grained
- Agl Lit-par-lit association of Age with Illimbirrie and Barloweerie Formations

- Aga Granite; even-grained, foliated
- Agb Biotite granite; foliated
- Agf Granite; fine-grained, foliated

- Agm Granite; even-grained, foliated. Carries mobilized xenoliths

- Agn Migmatite of metamorphic and granitic rocks

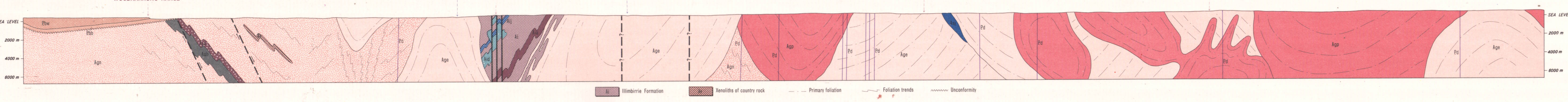
WEATHERED ROCKS

Overprint indicating deeply weathered rocks

DIAGRAMMATIC SECTION

NATURAL SCALE

SECTION A - B



MURGOO
SHEET SG 50 - 14

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