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GEOLOGY OF THE HIGHLAND ROCKS 1:250 000 SHEET AREA, NORTHERN TERRITORY

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SUMMARY

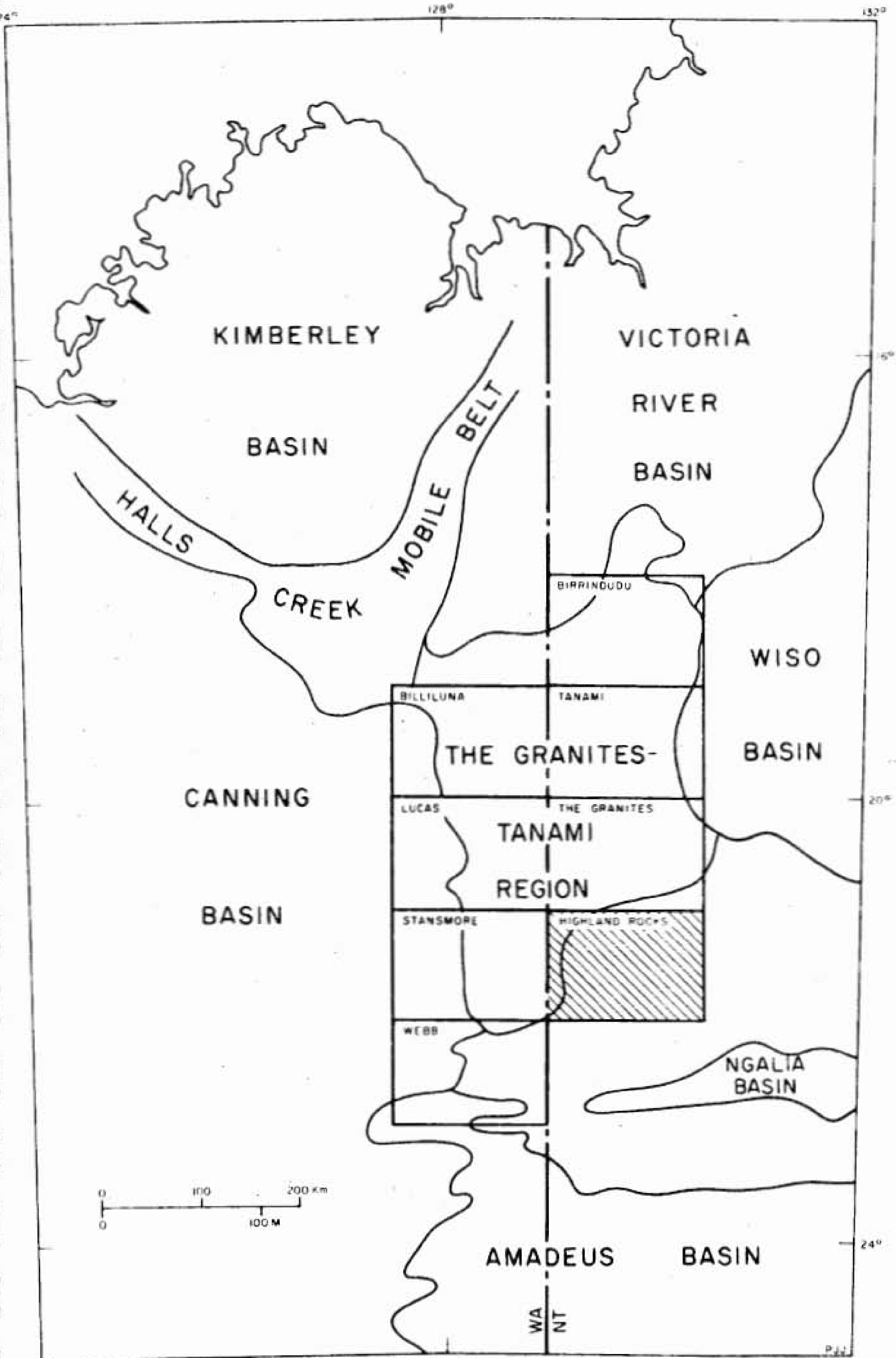
The Highland Rocks 1:250 000 Sheet area comprises parts of two major tectonic units, the Arunta Block and the Birrindudu Basin. It is largely covered by superficial Cainozoic deposits, and pre-Cainozoic rocks crop out as scattered low hills, ridges, and mounds.

The Arunta Block is made up of unnamed Archaean? sedimentary rocks which are regionally metamorphosed to quartzite, gneiss and schist, and probable Lower Proterozoic granite.

Sedimentary rocks of the Birrindudu Basin crop out along the western side of the sheet area. The basal unit, the Munyu Sandstone, is strongly unconformable on the Arunta Block, and is overlain by the Adelaidean Redcliff Pound Group.

Terrestrial sediments that are probably Palaeozoic crop out near the northern and southern margins of the area, and there are some scattered small outcrops of Mesozoic? sediments. Tertiary laterite is widespread.

No mineral deposits of present economic value have been found.



Record 1974/120 Fig. 1 Regional setting AUS 2/332

INTRODUCTION

The Highland Rocks 1:250 000 Sheet area, which forms part of the Lake Mackay Aboriginal Reserve, is bounded by latitudes 21° and 22° south and longitudes 129° and 130°30' east; its western boundary is the Northern Territory/Western Australia border. The area was mapped in 1972 and 1973 by D.H. Blake and I.M. Hodgson - the western and northern margins in 1972, and the remainder in 11 days of helicopter traverses in 1973. The mapping of this Sheet area completed a reconnaissance survey of The Granites-Tanami region (Fig. 1). The geology of the other Sheet areas in the survey is described by Blake & Towner (1974) and Blake et al. (1972, 1973, and in prep.).

The Sheet area lies southwest of the road connecting Alice Springs and Halls Creek. It is uninhabited, and the only track known in the area is in the southeast; from a few kilometres west of Mount Farewell (22°00'S, 130°16'E) it leads to Vaughan Springs homestead in the Mount Doreen Sheet area.

The area consists mainly of gneiss, schist, quartzite, and granite of the Archaean? to Lower Proterozoic Arunta Block. However, these rocks are mostly concealed by superficial Cainozoic deposits, and where they are exposed they are almost invariably intensely weathered. Sandstone of the Proterozoic Birrindudu Basin crops out in the west.

Climate and vegetation

The area is semi-desert, and has an average annual rainfall of about 200 mm. The rain falls mostly in the summer, but the amount and distribution, both annual and seasonal, are very variable. Maximum summer temperatures are about 40°C, and winter minima are low enough to cause frosts.

Vegetation is sparse, and consists mainly of spinifex, small shrubs, and scattered trees.

Survey methods

The Sheet area is virtually inaccessible on the ground, and travel within it is slow and difficult because of the lack of tracks, the innumerable sand dunes, and navigation problems caused by the general low relief and lack of prominent landmarks. For these reasons the Sheet area was mapped wholly by helicopter traverses. In 1973, when the main part of the area was mapped, about 50 hours were flown in 11 days with up to 40 landings a day.

Vertical aerial photographs at a nominal scale of 1:80 000 were used for flight planning, recording observation points, and, together with the Highland Rocks 1:250 000 topographical map, for navigation. Run 1 of the photographs was flown in 1971, and the remainder in 1972. The photographs can be obtained from the Division of National Mapping in Canberra.

Geological data were plotted on photographic overlays and later transferred to planimetric sheets compiled by the Division of National Mapping. The compilations were photographically reduced to 1:250 000 scale and redrawn for the preliminary edition map accompanying this report.

Previous investigations

The first recorded crossing of the Highland Rocks Sheet area was by Warburton, who crossed the area from southeast to northwest in 1873 (Warburton, 1875; Feeken, Feeken, & Spate, 1970). He named Mount Farewell on about 13 June 1873, and reached Lake White, which he named after his cook, on about 6 August. He described the area as - 'a most hopeless country indeed'.

Sixty years later, in 1933, Terry (1937) traversed the area, naming False Mount Russell and Wickhams Well.

No systematic geological work was done in the Sheet area until the 1973 survey, although Mount Farewell and the McEwin Hills were visited by geologists of the Bureau of Mineral Resources (BMR) in 1969, during the mapping of the Lake Mackay Sheet area (Nicholas, 1972). Of the other adjacent Sheet areas, Stansmore and The Granites were mapped in 1972 (Blake, Hodgson & Muhling, 1973) and Mount Theo to the east was mapped in 1971 (Stewart, in prep.).

In 1967 the Highland Rocks Sheet area was covered by a reconnaissance gravity survey of parts of the Northern Territory and Western Australia (Whitworth, 1970). The Bouguer anomaly contours will be shown on the 1st Edition of the Highland Rocks 1:250 000 Geological Sheet.

Topography and drainage

The Sheet area consists largely of undulating sand plains and dune fields from which rise residual hills, ridges, cuestas, and mounds. In general the land slopes very gently, from an elevation of 550 m in the southeast to

Fig. 2. Undulating sand plain with low rises of laterite developed on metamorphics and granite; central part of Sheet area. (Neg. GA/8671).

Fig. 3. Sand plain and laterite rises with low breakaways; central part of Sheet area (Neg. GA/8920).

about 320 m in the northwest where Lake White forms part of a local centre of inland drainage. From the central part of the area the land slopes also toward the southwest and Lake Mackay, a large salt lake in the Webb and Lake Mackay Sheet areas.

An area of laterite rises in the eastern central part of the area is named Highland Rocks.

The dunes are longitudinal, and their trends range from west-northwest to west-southwest. They differ greatly in length, in spacing, and complexity.

There are no major surface drainage channels.

The most prominent hill in the area is False Mount Russell, in the northwest. Other prominent features are a series of northwest-trending cuestas in the west, and the McEwin Hills and Mount Farewell in the south.

Rock nomenclature

In this report, Precambrian sandstones are classified according to Pettijohn, Potter & Siever (1972). They comprise quartz arenite in which over 95 percent of the detrital grains are quartz, and sublithic and lithic arenite, in which, respectively, 5 to 25 percent and over 25 percent of the grains are rock fragments and feldspar. Phanerozoic sandstones are termed quartzose if at least 75 percent of the detrital grains are quartz; otherwise they are termed lithic.

Grainsize terms for sandstones are fine, 0.125-0.25 mm; medium, 0.25-0.5 mm; coarse, 0.5-1 mm; and very coarse, 1-2 mm.

Bedding thicknesses used for sedimentary rocks are 1 cm, laminated; 1-50 cm, thin-bedded; 50 cm - 2 m, medium-bedded; 2 m, thick-bedded.

Because of the intense alteration of many granitic outcrops the term granite is used generally in its widest sense. The classification of Hatch, Wells & Wells (1961) is used where practicable. Granitic rocks having an average grainsize of less than 1 mm are described as fine; those of 1-5 mm, medium; those of 5 mm-3 cm, coarse; those over 3 cm, pegmatitic.

Terms describing metamorphic facies are as defined by Turner & Verhoogen (1960).

ARCHAEAN? (At, Atg, Atq, Ats)

A summary of the stratigraphy is given in Table 1. The oldest rocks in the area are metamorphic rocks of possible Archaean age. They are intruded and metamorphosed by granite which is probably late Lower Proterozoic, and together with the granite they form part of the Arunta Block, the basement throughout the Sheet area. They crop out in a belt roughtly 25 km wide trending east-west across the centre of the Sheet area and form scattered outcrops elsewhere in the area.

Three rock types have been mapped: gneiss, quartzite, and schist. However, these are commonly interbedded, and cannot always be mapped separately. Over the greater part of the area the schist and gneiss and the granite which intrudes them are intensely weathered, and cannot readily be distinguished from one another. Quartzite crops out as east-trending strike ridges up to 20 m high. Gneiss and schist are mostly exposed in breakaways bounding irregular laterite-capped rises (Figs 2, 3). The breakaways are generally only a few metres high, but in places they are up to 12 m high.

The gneiss is generally very weathered, and is difficult to distinguish from weathered granite. Generally, however, compared with the granite, the gneiss is more quartzose and micaceous and less feldspathic, and has a better developed foliation. Some unweathered gneiss is exposed on the eastern side of the area (at about lat. 21°22'S, long. 130°12'E), where it forms low mounds and spheroidal boulders. The gneiss here is fine to coarse-grained and consists essentially of quartz, microcline, biotite, and sillimanite; some contains cordierite, and some is also garnetiferous. In the southeast corner of the Sheet area, gneiss which is only slightly weathered contains tourmaline porphyroblasts. In the highly weathered gneiss only quartz and, rarely, biotite are preserved, the other minerals being pseudomorphed by clay and iron oxide.

Quartzite, flanked by gneiss, forms a prominent east-southeast trending ridge about 20 km east of False Mount Russell. It is white, fine-grained, thin-bedded, and steeply dipping (Fig. 4). One kilometre south of this ridge a parallel band of quartzite is coarse-grained and glassy, and shows small-scale cross-bedding; it has a cleavage parallel to steeply dipping bedding. Mica is commonly developed along this cleavage, and with increasing mica content the quartzite grades into gneiss. North of

TABLE 1. Summary of stratigraphy

	Unit & Symbol	Estimated thickness (m)	Lithology	Stratigraphic relations	Remarks
CAINOZOIC QUATERNARY	Qa	?	Sand, silt, clay; minor halite, gypsum	Superficial veneer on older units	Alluvial, lacustrine, and evaporitic
	Qe	?	Halite, gypsum, sand, silt, clay	"	Evaporitic, alluvial, and lacustrine; occupies salt lakes
	Qs	?	Sand, silt	"	Alluvial and aeolian; occupies barely perceptible drainage depressions
	Qz	?	Sand, minor gravel	"	Aeolian and piedmont; gravel restricted to piedmont slopes flanking residual hills
	Qm	?	Sand, halite, gypsum, calcrete	"	Aeolian and evaporitic
	Qr	?	Red silt and clay	"	Red soil; in southeast corner of Sheet area
	Czq	?	Vein quartz rubble	Superficial veneer on Archaean?	Residual rubble from weathering of Archaean?
TERTIARY	Tt	?	Calcrete, partly silicified	Superficial veneer on older units	Forms low rises in broad depressions; probably a subsurface deposit formed in Tertiary drainage channels
	Ts	<1	Silcrete	Superficial veneer on Cretaceous?, Palaeozoic, and Proterozoic rocks	Commonly developed on quartz-rich rocks but most outcrops not large enough to show on map.
	(Stipple)	7	Laterite	Veneer on pre-Tertiary units	Caps most metamorphics and granite in Sheet area
CRETACEOUS?	Unnamed K?	3	Quartzose sandstone, conglomerate	Unconformable on unnamed granite and Archaean? metamorphics	

U N C O N F O R M I T Y

PALAEOZOIC		Pedestal Beds Pzs	500	Quartzose sandstone; minor conglomerate, siltstone, shale	Unconformable on Archaean? metamorphics and Lower Proterozoic granite	Northern and southern edges of Sheet area
				U N C O N F O R M I T Y		
		Lucas Formation Pzl	1000	Calcareous and non-calcareous sandstone, siltstone, mudstone; minor limestone	Unconformable on Erica Sandstone	In northwest corner of Sheet area only
				M A J O R U N C O N F O R M I T Y		
P R O T E R O Z O I C	CARPENTARIAN OR ADELAIDEAN	REDCLIFF POUND GROUP				
		Erica Sandstone Bre	800	Sublithic arenite; minor quartz arenite	Overlain unconformably by Lucas Formation; conformable on Murraba Formation	Western edge of Sheet area only
		Murraba Formation Brb	800	Chert granule conglomerate, sublithic arenite, quartz arenite	Probably conformable on Munyu Sandstone	"
		Munyu Sandstone Buu	300	Quartz arenite, sublithic arenite, conglomerate	Unconformably overlies unnamed granite and Archaean? metamorphics	"
				M A J O R U N C O N F O R M I T Y		
ARCHAEAN?	ARCHAEAN OR LOWER PROTEROZOIC	Unnamed granite Bg		Biotite granite, muscovite-biotite adamellite, biotite granodiorite	Intrudes Archaean? metamorphics; overlain by Munyu Sandstone, Pedestal Beds, and unnamed Cretaceous?	Most outcrops strongly lateritized
		Unnamed At, Atg, Ats, Atq	?	Gneiss, schist, quartzite	Intruded by unnamed granite; overlain unconformably by Munyu Sandstone, Pedestal Beds, and unnamed Cretaceous?	Strongly lateritized

False Mount Russell vertically dipping quartzite, brecciated and cut by many quartz veins, forms low narrow ridges trending east-northeast. The ridges of Mount Farewell are composed of quartzite; here it is intruded by granite, and within a few metres of the contact it contains tourmaline porphyroblasts. The quartzite consists of a mosaic of strained quartz with flakes of muscovite and commonly biotite. Tourmaline and zircon are present as accessories.

The schist is highly micaceous, grey to reddish-brown, and ironstained. It consists of muscovite and quartz, and in some places biotite. It is commonly contorted, and, like the gneiss, is intruded by granite. At Mount Farewell schist is poorly exposed in depressions between quartzite ridges. At the McEwin Hills it is cut by granite, pegmatite, and quartz-tourmaline veins. Some of the schist here is graphitic, and some in the southeast of the area is spotted with iron oxide pseudomorphs, possibly after andalusite.

Stratigraphic relations and age

The unnamed metamorphics are intruded by probably late Lower Proterozoic granite (Fig. 5). In the west they are overlain with strong angular unconformity by the Munyu Sandstone of the Birrindudu Basin. This unconformity is well exposed at the eastern end of False Mount Russell. The metamorphics are also unconformably overlain by the Palaeozoic Pedestal Beds at the eastern end of the McEwin Hills, and by unnamed Cretaceous? sediments 40 km northeast of the Munyu Hills.

The unnamed metamorphic rocks are lithologically similar to and may be correlated with the metamorphics of the Arunta Complex to the south and the Tanami complex to the north. The Tanami complex is correlated with the Halls Creek Group, which may be Archaean (Dow & Gemuts, 1969; Gellatly, 1971), and hence the unnamed metamorphics of the Highland Rocks Sheet area are considered to be possibly Archaean.

LOWER PROTEROZOIC

Unnamed granite (Bg)

East of the Birrindudu Basin, outcrops of unnamed granite are scattered throughout the Sheet area, but are most prominent in the southwest. The granite forms mounds and low hills up to 6m high, and is exposed in breakaways beneath a laterite capping. It is generally highly altered (Fig. 6), being lateritized and locally silicified, and it is often difficult to distinguish from schist and gneiss. The granite is fine to coarse-grained, and locally porphyritic or pegmatitic. It characteristically has a steeply dipping foliation and is intersected by quartz and aplite veins. Unweathered granite forms a bare pavement (Fig. 7) at two rockholes in depressions between sand dunes in the north (at 21°08'10"S, 129°48'30"E, and at 21°11'00"S, 130°15'30"E), and crops out as groups of spheroidal boulders in the northeast (at 21°02'S, 139°29'E). At the first rockhole, biotite granite contains feldspar phenocrysts up to 10 cm long; at the second, the granite is a medium to fine-grained muscovite-biotite adamellite. The boulders in the northeast consist of biotite granodiorite containing feldspars up to 3 cm long.

The granite intrudes the Archaean? metamorphics. It commonly occurs as veins, generally less than 1 m thick, which may have thin quartz and quartz-tourmaline veins associated with them. At Mount Farewell granite intruding quartzite is surrounded by a thermal metamorphic aureole, a few metres wide, containing porphyroblasts of tourmaline. On the north side of False Mount Russell the granite is overlain by Munyu Sandstone, and east of False Mount Russell it is overlain by Palaeozoic Pedestal Beds.

The granite is probably similar in age to the other dated granites in The Granites-Tanami region, and is therefore probably uppermost Lower Proterozoic (Blake, Hodgson & Muhling, 1973).

CARPENTARIAN OR ADELAIDEAN

Munyu Sandstone (Buu)

The Munyu Sandstone, named after the Munyu Hills (21°47'S, 129°08'E) in the southwest, crops out as northeast-trending strike ridges up to about 40 m high on the western edge of the Sheet area, and also forms False Mount Russell, an east-trending syncline in the northwest. The formation extends into the Stansmore Sheet area to the west, where the type section is located (Blake, Hodgson & Muhling, 1973), and also into the Webb Sheet area to the southwest (Blake & Towner, 1974). The maximum exposed thickness in the Highland Rocks Sheet area is about 300 m.

The formation comprises quartz arenite and conglomerate and subordinate sublithic arenite. The quartz arenite is generally poorly sorted and medium to coarse-grained and contains abundant lenses and bands of

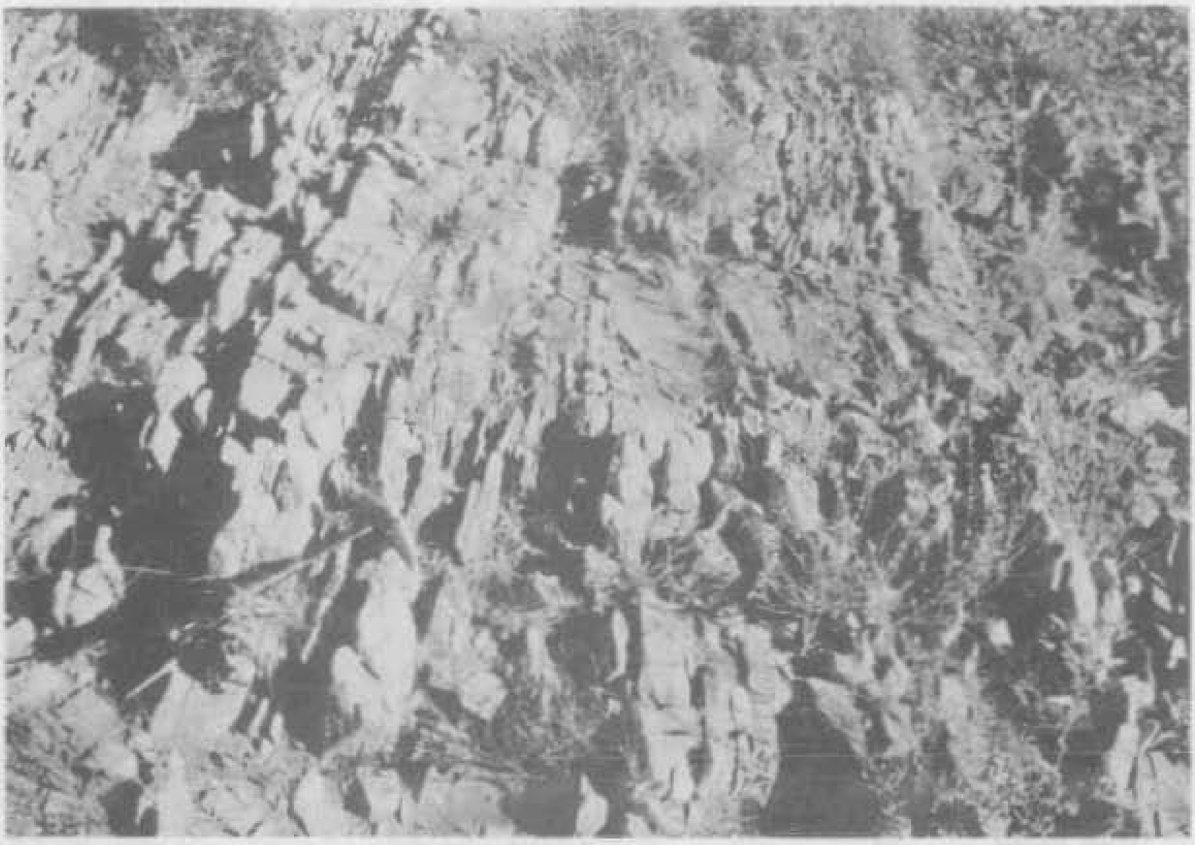


Fig. 4. Steeply dipping, thin-bedded quartzite of unnamed Archaean? metamorphics. 20 km east-southeast of False Mount Russell (GA/8922).

Fig. 5. Archaean? gneiss intruded by granite; 38 km east-southeast of False Mount Russell (Neg. GA/8921).

Fig. 6. Highly altered granite intruding Archaean? metamorphics; 55 km southeast of False Mount Russell. (Neg. GA/8918).

Fig. 7. Pavement of fresh granite with small rock hole; 32 km southwest of northeast corner of Sheet area. (Neg. GA/8670).

quartz pebble conglomerate (Figs 8 & 9). It forms thin to medium beds and commonly shows small-scale cross-bedding. Some of the arenite has minor amounts of clayey matrix and some contains mica. It is generally silicified, but locally it weathers to become friable and ironstained.

The Munyu Sandstone may be folded into a series of anticlines and synclines as shown in Figure 13, or the outcrops may represent a series of fault slices. Dips of the Munyu Sandstone range up to 45°, but most are about 20°. Minor folding is present southwest of the Munyu Hills.

Stratigraphic relations, correlation, and age

The Munyu Sandstone is seen to be unconformable on metamorphics of the Arunta Complex at the eastern end of False Mount Russell and 8 km southwest of the Munyu Hills, and is inferred to be unconformable on the granite that intrudes the metamorphics.

The Munyu Sandstone is overlain by the Murraba Formation of the Redcliff Pound Group. However, the contact between the two units is not exposed, and its nature is uncertain. If the units are conformable, the Munyu Sandstone can be correlated with the Lewis Range and Muriel Range Sandstones, the basal formations of the Redcliff Pound Group to the north and west (Blake, Hodgson & Muhling, 1973; Blake & Yeates, in prep.; Crowe & Muhling, in prep.; Muhling, Passmore & Blake, in prep.). It may also be correlated with the Vaughan Springs Quartzite of the Ngalia Basin to the east, which has been dated at about 1300 m.y. (Cooper, Wells & Nicholas, 1971; Wells, Moss & Sabitay, 1972), and hence may be the stratigraphic equivalent of the Heavitree Quartzite. Alternatively, the Munyu Sandstone may be the equivalent of the Gardiner Sandstone, the basal unit in the Carpentarian Birrindudu Basin (Blake, Hodgson & Smith, 1972).

At one locality, 8 km east of Jangga Bluff, moderately dipping Munyu Sandstone is overlain unconformably by flat-lying Palaeozoic Pedestal Beds.

REDCLIFF POUND GROUP

The Redcliff Pound Group, named after Redcliff Pound (21°35'S, 128°45'E) in the Stansmore Sheet area to the west, is defined by Blake, Hodgson & Muhling, (1973). It is made up of four formations consisting predominantly of sublithic and quartz arenites: the Muriel Range and Lewis Range Sandstones, which are not present in the Highland Rocks Sheet area, the Murraba Formation, and the Erica Sandstone.

The Group may be Adelaidean or Carpentarian. If, as seems most likely, the underlying Munyu Sandstone is the equivalent of the Vaughan Springs Quartzite, glauconite from which has been dated at 1280 m.y. (Cooper et al., 1971), the Redcliff Pound Group is Adelaidean or younger. However, if the Munyu Sandstone is the equivalent of the Gardiner Sandstone of the Carpentarian Birrindudu Group, the Redcliff Pound Group could be Carpentarian.

Murraba Formation (Brb)

The Murraba Formation crops out in a syncline northeast of the Sydney Margaret Range in the northwest. It consists mainly of white and maroon fine-grained, generally thin-bedded, sublithic to lithic arenite with micaceous partings, but also includes some beds, up to 2 m thick, of chert granule conglomerate. Undulating bedding planes, cross-bedding, and ripple marks are common. The maximum thickness of the formation in the Highland Rocks Sheet area is probably about 500 m. The main outcrops and the type section are in the Stansmore Sheet area (Blake et al., 1973) where the maximum thickness exposed is about 800 m.

The Murraba Formation is known to be overlain conformably by the Erica Sandstone, although the contact is not exposed in the Highland Rocks Sheet area, and it overlies, probably conformably or possibly unconformably, the Munyu Sandstone.

Erica Sandstone (Bre)

The Erica Sandstone crops out in the northwest, where it forms the Sydney Margaret Range. Its main outcrops and type section are in the Stansmore Sheet area to the west (Blake et al., 1973). The formation consists of maroon and white, well sorted, mainly medium-bedded and medium to fine-grained, sublithic and quartz arenites that have a clayey matrix. Cross-bedding and ripple marks are common, beds containing flattened clay pellets are present locally, and some arenite contains fragments of chert granule conglomerate.

The Erica Sandstone is the youngest unit of the Redcliff Pound Group. It is known to overlie the Murraba Formation conformably and to be unconformably overlain by the Palaeozoic Lucas Formation, although neither of these relations can be seen in the Sheet area.

Fig. 8. Cross-bedded Munyu Sandstone containing conglomerate bands; Nardudi Hill. (Neg. GA/8924).

Fig. 9. Conglomerate in Munyu Sandstone; 18 km southwest of False Mount Russell. (Neg. GA/8925).

PALAEOZOIC

Lucas Formation (Pzl)

The Lucas Formation was named and defined as Lucas Beds by Casey & Wells (1964), and was upgraded to formation status by Blake et al. (1973). Its main outcrops are in the Lucas and The Granites Sheet areas to the north, and in the Highland Rocks Sheet area it crops out at only two localities, on the north side of Lake White. Here it is exposed in cliffs up to 5 m high, and consists of very gently dipping, thick to thinly interbedded, calcareous and non-calcareous sandstone, limestone, and mudstone. The calcareous sandstone is greenish to purple, medium-grained, and highly lithic; it has a calcite cement. Locally it contains abundant soft mudstone pellets and also concretions up to 1 m across. The sandstone is cut by calcite veins. Bedding ranges from thick to thin, cross-bedding is common, and ripple marks are present locally. The non-calcareous sandstone is maroon, thin-bedded and flaggy, fine-grained, lithic, and micaceous. At the top of the cliffs the formation is overlain by calcrete, about 2 m thick, and aeolian sand. In this area, a thickness of 1000 m has been calculated for the Lucas Formation on the assumptions that the average dip of the beds is 2-3^{o} and that there is no repetition of beds because of folding or faulting.

The Lucas Formation is mapped as Palaeozoic. It is inferred to be unconformably overlain by the Pedestal Beds as in The Granites Sheet area (Blake et al., 1973), and it unconformably overlies the probable Adelaidean Redcliff Pound Group.

Pedestal Beds (Pzs)

The Pedestal Beds crop out in the McEwin Hills in the south (Fig. 10), northeast of False Mount Russell in the north, and 8 km east of Jangga Bluff in the west. The reference area is in The Granites Sheet area to the north (Blake et al., 1973).

At the McEwin Hills, in the south, the unit consists of mainly medium-grained quartzose sandstone that has a clayey matrix. Some coarse gritty bands comprising grains of quartz, chert, quartzite, muscovite, and tourmaline are also present. The sandstone is thin to thick bedded, generally has well marked flaggy partings, and shows some low-angle cross-bedding. Some bedding planes are covered with flattened mudstone pellets. At the McEwin Hills the beds form a tight east-trending syncline, and dips range from gentle to steep and possibly overturned.

The Pedestal Beds reach their maximum thickness, about 500 m, northeast of False Mount Russell, where some shale is locally interbedded with sandstone and conglomerate. The sandstone is quartzose to lithic, white to maroon, and medium to fine-grained. It contains scattered, well rounded pebbles and cobbles, and has a clay matrix and a micaceous, flaggy parting. Bedding is medium to thick. The conglomerate forms medium to thick beds containing well rounded cobbles and pebbles of sublithic and quartz arenites and also vein quartz, quartzite, and banded chert. It has a sparse matrix of clayey quartzose sandstone. The Pedestal Beds here generally dip gently northward, but steep dips occur adjacent to faults.

At the locality east of Jangga Bluff, flat-lying conglomerate containing blocks of Munyu Sandstone is overlain by clayey quartzose sandstone.

Thirty kilometres east-northeast of False Mount Russell, a prominent steep-sided hill about 15 m high is formed of Pedestal Beds impregnated with iron oxide and dipping northwest at 65°.

The Pedestal Beds are seen to be unconformable on Archaean? metamorphics in the McEwin Hills, on unnamed granite 3 km east of False Mount Russell, and on Munyu Sandstone 8 km east of Jangga Bluff. In The Granites Sheet area to the north, drilling has shown that they overlie Lower Cambrian Antrim Plateau Volcanics. The unit appears to be unfossiliferous and is probably non-marine. Lithologically the sandstone of the Pedestal Beds is similar to the Devonian Knobby Sandstone of the Billiluna Sheet area. It is unlike the sandstone of the Cretaceous Hazlett Beds (Blake et al., 1973) and the possible Cretaceous sandstone in the Highland Rocks Sheet area. The Pedestal Beds are therefore regarded as probable Palaeozoic.

MESOZOIC?

CRETACEOUS?

Five small outcrops mapped as possible Cretaceous occur in the western half of the Sheet area - three are north and east of False Mount Russell, and two are north and east of Jangga Bluff. They consist predominantly of quartzose sandstone similar to that of the Larranganni Beds

Fig. 10. McEwin Hills - an escarpment of Palaeozoic Pedestal Beds overlying Archaean? schist. (Neg. GA/8669).

Fig. 11. Wickhams Well (Neg. GA/8927).

in Sheet areas to the north, and to that of the Cretaceous Hazlett Beds in the Stansmore Sheet area to the west (Blake et al., 1973). The sandstone is flat-lying, and forms low knolls only a few metres high. It is medium to coarse-grained and poorly sorted, and is made up of generally angular quartz grains set in an abundant clay matrix. Conglomerate with mostly angular pebbles in a clayey sandstone matrix is present at one locality (21°35'S, 129°27'30"E). At the localities near Jangga Bluff the unit unconformably overlies highly weathered granite and mica schist. Two of the outcrops north of False Mount Russell have thin cappings of silcrete.

CAINOZOIC

Over most of the Highland Rocks Sheet area the pre-Tertiary rocks are concealed beneath a veneer of Cainozoic sediments. Quaternary aeolian sand covers extensive areas, and the irregular outcrops of granite and Archaean? metamorphics are largely covered by laterite. Lake White, in the northwest corner of the Sheet area, is part of an extensive inland drainage system which contains aeolian, alluvial, lacustrine, and evaporitic Quaternary sediments.

Laterite (stipple)

Laterite, the iron-rich upper part of lateritic weathering profiles, is widespread as a capping on granite and Archaean? metamorphics. In places it caps breakaways up to 7 m high, but over the greater part of the area it forms topographic highs with flat or gently undulating tops and gently sloping sides, and the underlying bedrock is concealed. On aerial photographs the laterite has a smooth dark tone.

In the breakaways the lateritic weathering profile is seen to consist of an upper pisolitic layer about 2 m thick overlying mottled and pallid clayey zones. The cleavage of the metamorphics and the foliation of the granite are commonly discernible in the profile beneath the pisolitic capping, and quartz veins are preserved throughout the weathered zone.

The laterite cappings seem to be the remnants of a flat to gently undulating surface much of which has been removed by erosion. The amount of erosion that has taken place suggests that the laterite was probably formed during the Tertiary, and the surface on which it developed may be correlated with the early or mid-Tertiary Tennant Creek erosion surface of Hays (1967).

Silcrete (Ts)

Patches of silcrete occur locally, but are generally too small to be mapped at 1:250 000 scale. However, several small patches have been mapped north and east of False Mount Russell on granite and Cretaceous? quartzose sandstone. The silcrete is pale grey to cream, and consists of angular unsorted quartz grains in a very fine siliceous matrix.

Silcrete does not appear to be forming at present, and is regarded as probably Tertiary.

Calcrete (Tt)

Calcrete crops out as low rises in broad topographic depressions that represent old drainage lines. Two of these radiate from the centre of the Sheet area, one trending northwest towards the depression around Lake White, and the other trending southwest towards Lake Mackay. Large calcrete outcrops in the northeast occupy a broad east-trending depression which extends into The Granites Sheet area to the north.

On aerial photographs the calcrete shows up as very pale to white areas, many of which have a cerebriform texture.

The calcrete consists of white, pink, and grey inorganic limestone. It commonly contains sand grains, and some is finely banded. In places it is partly silicified and contains nodular blocks of chalcedony.

The calcrete is a chemically precipitated terrestrial deposit associated with former drainage channels, and possibly also lakes, and was deposited by groundwater. It now forms low mounds, and is considered to be mainly Tertiary.

Vein quartz rubble (Czq)

Patches of vein quartz rubble are sparsely scattered in the area. The rubble is the residue of the prolonged weathering of underlying Archaean? metamorphic rocks. It occurs as a thin veneer, and commonly shows wavy patterns on aerial photographs, reflecting trends in the underlying rocks.

QUATERNARY

The unconsolidated superficial deposits that cover most of the Sheet area are grouped into six units, all of which are considered to be Quaternary. Aeolian sand and minor associated piedmont deposits are mapped together as Qz, the main unit. The other five units are restricted to the corners of the Sheet area: in the northwest a complex of claypans and saltpans marks the depression centred on Lake White; the southwest corner of the Sheet area is occupied by part of a claypan and saltpan complex on the northern tip of Lake Mackay; in the northeast, a broad depression, mainly in The Granites Sheet area to the north, contains alluvial, lacustrine, aeolian and evaporitic deposits; and in the southeast, patches of red silt and clay soil are present.

Alluvial, lacustrine, and evaporitic sediments (Qa)

This unit comprises water-laid sand, silt, and clay, and minor halite and gypsum. It occupies claypans and ephemeral lakes in the neighbourhood of Lake White.

Evaporitic, alluvial, and lacustrine sediments (Qe)

Evaporitic halite and gypsum are associated with alluvial and lacustrine sand, silt, and clay in the vicinity of Lake White and in the southwest, on the northern tip of Lake Mackay. The unit has been mapped on the presence of a salt crust, generally only a few millimetres thick, which shows up white on aerial photographs.

Alluvial and aeolian sand and silt (Qs)

This unit consists of sand and silt washed into broad and shallow drainage depressions and mixed with aeolian deposits. Some patches of the unit are crossed by sand dunes, and some contain saltpans and claypans too small to be mapped individually.

Aeolian sand and minor piedmont gravel (Qz)

The most widespread of the Quaternary deposits in the Sheet area is aeolian sand which forms plains and dune fields.

Minor gravel is present on piedmont slopes flanking residual hills and ridges.

Aeolian sand, evaporitic halite and gypsum, and calcrete (Qm)

Low rises of aeolian sand, evaporitic halite and gypsum, and powdery calcrete have been built up into 'islands' in the Lake White complex, and have also been banked up against the western margins of saltpans.

Red silt and clay soil (Qr)

Patches of red silt and clay soil have been mapped in the southeast corner of the Sheet area; they extend westwards from the adjoining Mount Theo Sheet area. The red soil probably represents colluvial and alluvial outwash from lateritic rocks (Stewart, in prep.).

STRUCTURE

The Highland Rocks Sheet area forms part of two major tectonic units, the Arunta Block and the Birrindudu Basin (Fig. 12).

The Arunta Block is made up of Archaean? metamorphics and Lower Proterozoic? granite, and occupies about three-quarters of the Sheet area (Fig. 13). The bedding of the quartzite, the cleavage of the schist, and the foliation of the gneiss and granite are steep to vertical, and trend generally east-west. Owing to lack of continuity of outcrop, no major folds have been mapped within the block.

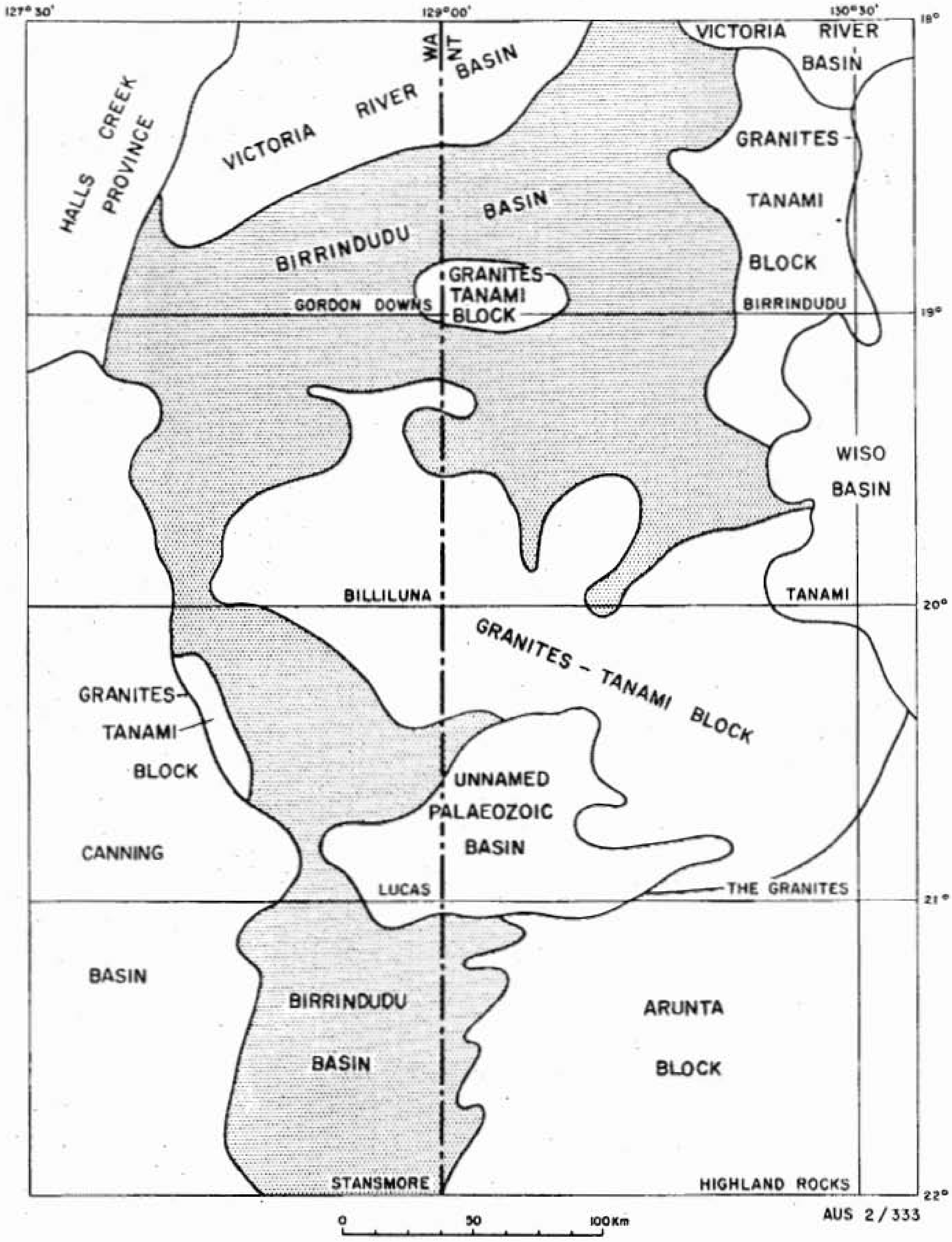


Fig. 12 Tectonic setting

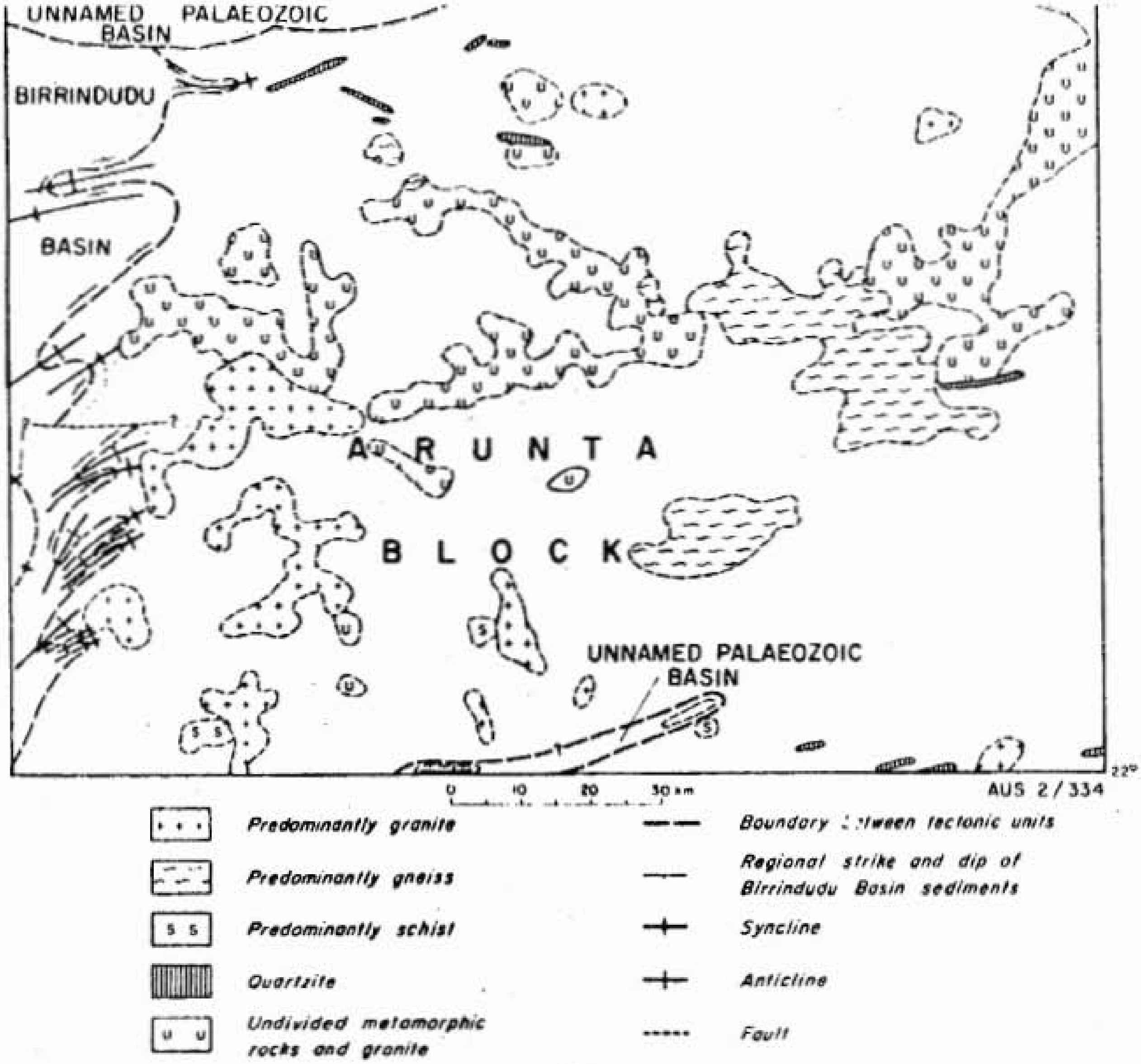
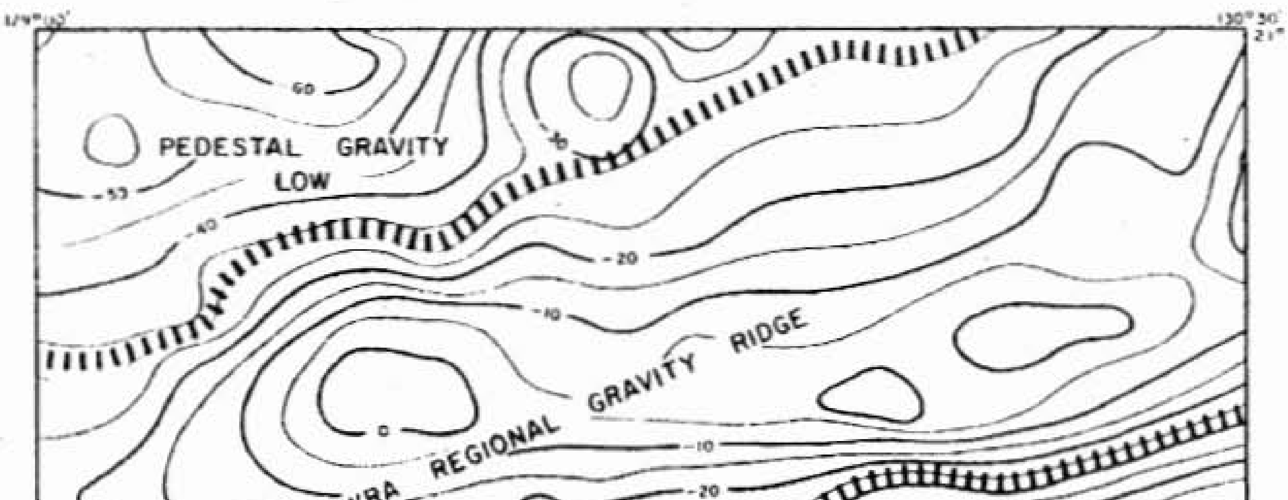


Fig. 13 Structural and tectonic sketch map



Record 1974/120

Fig 14 Bouguer anomalies and gravity features (after Whitworth, 1970)

The Birrindudu Basin forms the western part of the Sheet area. The oldest formation deposited in the basin here, the Munyu Sandstone, is strongly unconformable on the Arunta Block and is overlain by the Murraba Formation and Erica Sandstone of the Redcliff Pound Group. These formations have been folded into a number of anticlines and synclines whose axes dip steeply and trend northeast to east. Minor folds were observed southwest of the Munyu Hills. Faults mapped and postulated in the Munyu Sandstone trend roughly eastward.

The Redcliff Pound Group forms the core of an east-trending syncline in the north, and a north-trending syncline in the south.

Terrestrial Palaeozoic, Mesozoic, and Cainozoic sediments overlie the main tectonic units. The Palaeozoic Beds are folded on an east-trending axis at the McEwin Hills, and are displaced by faults in the north. Elsewhere, the dips of Palaeozoic and younger rocks are very gentle, and are probably depositional.

Whitworth (1970) divides the area into three regional gravity features (Fig. 14). The large area of Archaean? metamorphic rocks corresponds to the Willowra Regional Gravity Ridge. The southeast part of the area lies in the Yuendumu Regional Gravity Low, and the northwest is part of the Pedestal Gravity Low, whose position coincides with a Palaeozoic Basin.

GEOLOGICAL HISTORY

The oldest rocks in the area are the metamorphics of the Arunta Block. These were originally sediments that may have been deposited during the Archaean. After being folded and regionally metamorphosed they were intruded by granite at the end of the Early Proterozoic.

Probably for most of the Carpentarian the area was part of a landmass subject to erosion; certainly, any sediment deposited during this period was eroded before the deposition of the Munyu Sandstone, the oldest unit of the Birrindudu Basin. The Munyu Sandstone was succeeded by the probable Adelaidean Redcliff Pound Group, and towards the end of the Adelaidean, perhaps during the Petermann Ranges orogeny, the sediments of the Birrindudu Basin were folded, faulted, and uplifted, forming a landmass which has persisted throughout the Phanerozoic.

During the Palaeozoic, the terrestrial Lucas Formation and Pedestal Beds were deposited in shallow basins. Local terrestrial sedimentation during the Mesozoic is indicated by small patches of quartzose sandstone and conglomerate.

Continued subaerial erosion throughout the Cainozoic has formed the present general plain with scattered residual hills. The lateritic weathering profiles, Tertiary calcrete, and dune fields show that there have been climatic changes during the Cainozoic.

ECONOMIC POTENTIAL

No mineralization of any kind is known in the Sheet area, but very little prospecting has been done. The Archaean? metamorphics which are the most likely host rocks for metals are poorly exposed, being generally capped by laterite or concealed by sand; where they do crop out they are deeply weathered. Access to the area and travel within it are difficult owing to a lack of tracks and abundant sand dunes. The area lies entirely within the Lake Mackay Aboriginal Reserve.

Water

There are no watercourses in the area. Rainwater may last a few days in the claypan and saltpan complexes around Lake White in the northwest, and the northern tip of Lake Mackay in the southwest. Other occurrences of surface water are a soak, Wickhams Well (Fig. 11, lat. 21°16'10"S, long. 129°36'10"E), and to a few small rock holes that are quite exposed and therefore probably short-lived.

Information is lacking on subsurface water as there are no bores in the Sheet area. However, judging by information obtained from bores in The Granites Sheet area to the north and the Mount Theo Sheet area to the east, water of variable quality and quantity is probably present at shallow depth beneath calcrete.

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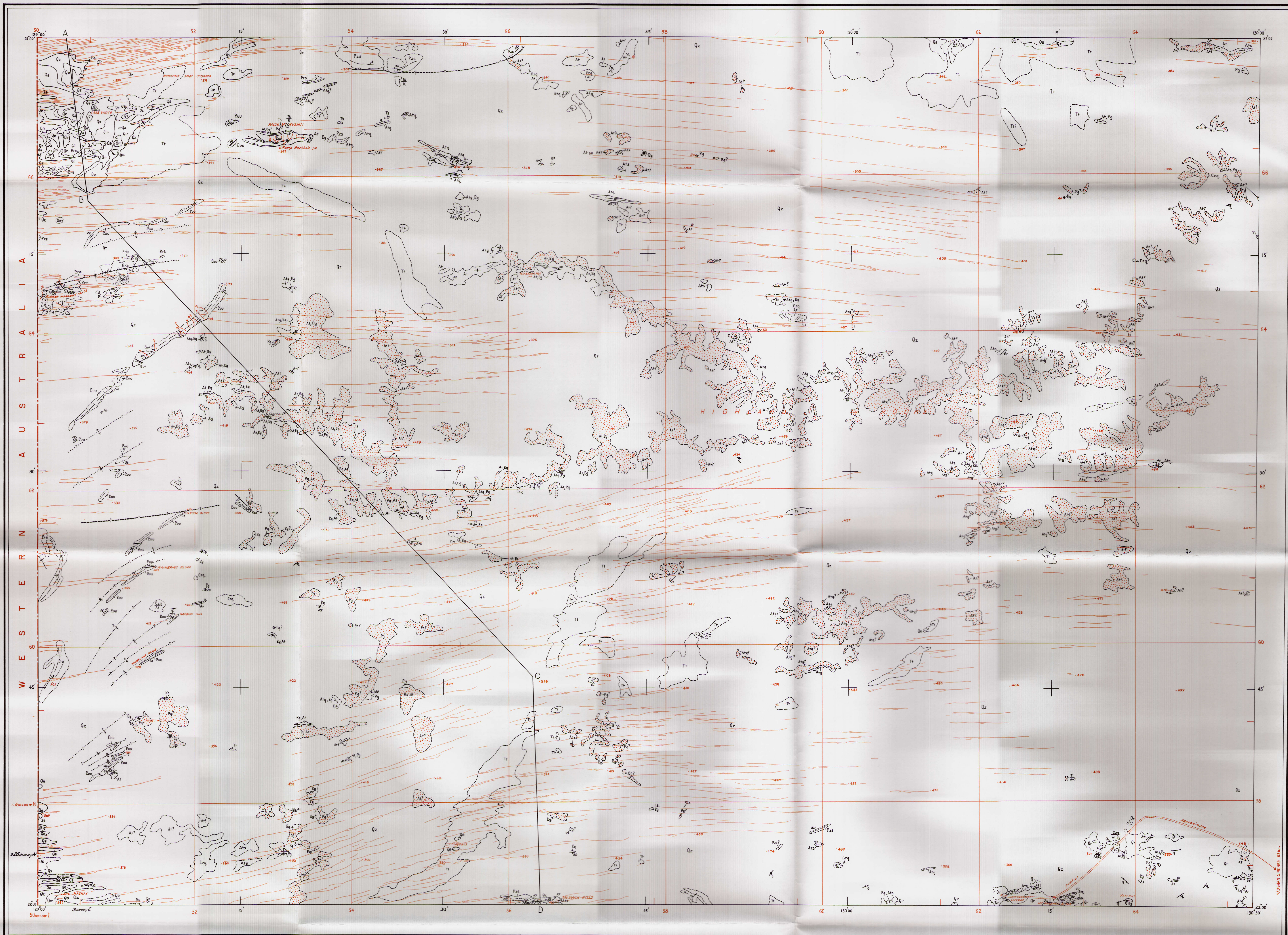
AUSTRALIA 1:250 000 GEOLOGICAL SERIES

HIGHLAND ROCKS

NORTHERN TERRITORY

SHEET SF 52-7



Reference

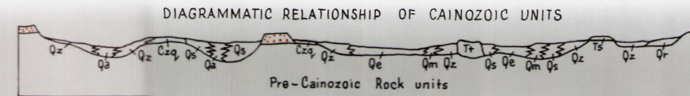
CAINOZOIC	QUATERNARY		Qa	Sand, silt, clay; minor halite, gypsum : alluvial, lacustrine and evaporitic
			Qe	Halite, gypsum, sand, silt, clay : evaporitic, alluvial and lacustrine
			Qs	Sand, silt : alluvial and aeolian
			Qz	Sand; minor gravel : aeolian and piedmont
			Qm	Sand, halite, gypsum, calcrete : aeolian and evaporitic
			Qr	Red silt and clay : soil
			Czq	Vein quartz rubble
	TERTIARY		Tt	Calcrete, partly silicified
			Ts	Silcrete
			(stippled)	Laterite capping
MESOZOIC?	CRETACEOUS?		K	Quartzose sandstone, conglomerate
PALAEOZOIC		Pedestal Beds	Pzs	Quartzose sandstone, lithic sandstone, conglomerate, minor shale
		Lucas Formation	Pzl	Calcareous sandstone, micaceous sandstone; minor limestone and mudstone
PROTEROZOIC	CARPENTARIAN OR ADELAIDEAN	Redcliff Pound Group: Erica Sandstone	Ere	Sublithic arenite; minor quartz arenite
		Redcliff Pound Group: Murraba Formation	Erb	Chert granule conglomerate, sublithic arenite, quartz arenite
		Redcliff Pound Group: Munyu Sandstone	Euu	Quartz arenite, sublithic arenite, conglomerate
	LOWER PROTEROZOIC?		Eg	Granite
ARCHAEAN?			At	Schist, gneiss, quartzite
			Atg	Gneiss
			Atq	Quartzite
			Ats	Schist

- Geological boundary
- Anticline
- Syncline
- Fault

Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes

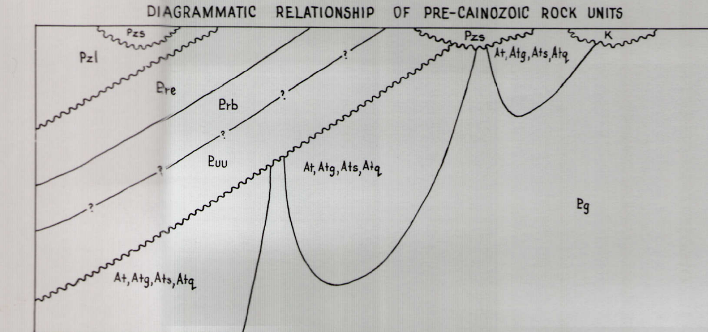
- Strike and dip of strata
- Strike and dip of strata facing not known
- Vertical strata
- Horizontal strata
- Trend line (airphoto interpretation)
- Strike and dip of foliation
- Vertical foliation
- Strike and dip of cleavage
- Vertical cleavage
- Strike and dip of cleavage and bedding facing not known
- Vertical strike and dip of cleavage and bedding
- Dyke, q – quartz
- RH Rock hole
- Sand dunes
- Vehicle track
- Trigonometrical station
- Astronomical station
- ·473 Elevation in metres – approximate
- pa Position approximate

DIAGRAMMATIC RELATIONSHIP OF CAINOZOIC UNITS



Facies change

DIAGRAMMATIC RELATIONSHIP OF PRE-CAINOZOIC ROCK UNITS



Unconformity

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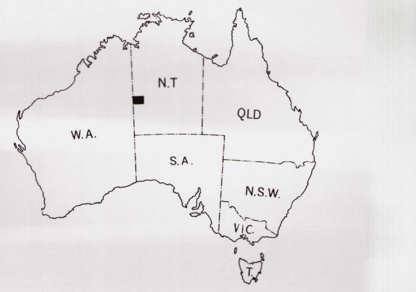
Transverse Mercator Projection



NOTE ON GRID COORDINATES

Brown ticks with black italic numbers (numbers shown only at SW corner of map and change of zone), indicate the 20 000 yard intervals of the Australian National Grid, Zone 4 (Australian Series), CLARKE 1858 SPHEROID, Transverse Mercator Projection

Brown numbered lines (with larger upright numbers), indicate the 20,000 metre intervals of the superimposed Australian Map Grid Zone 52 , AUSTRALIAN NATIONAL SPHEROID. Transverse Mercator Projection

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Scale 1:250 000

5 0 5 10 15 20 25 KILOMETRES

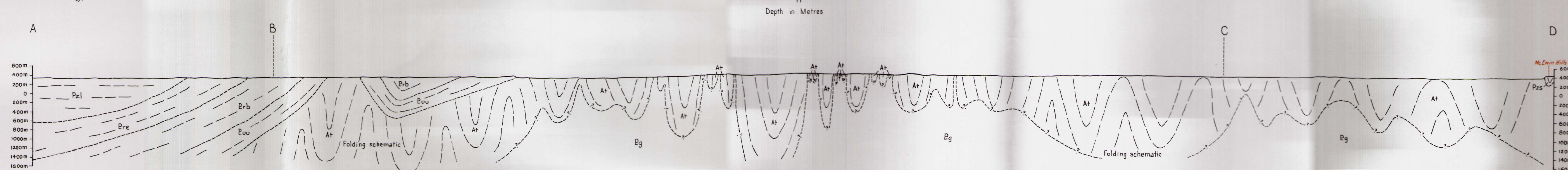
5 0 5 10 MILES

Section

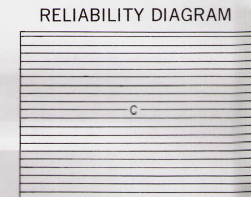
Cainozoic sediments omitted

Scale: $\frac{V}{H} = 4$

Depth in Metres



RELIABILITY DIAGRAM



Geology C General reconnaissance helicopter traverses and airphoto interpretation

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SUBJECT TO AMENDMENT

HIGHLAND ROCKS

SHEET SF 52-7