DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1974/53

GEOLOGY OF THE WEBB 1:250 000 SHEET AREA, WESTERN AUSTRALIA

by

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CONTENTS

SUMMARY

The semi-desert Webb Sheet area is largely covered by Cainozoic aeolian sand and evaporitic and lacustrine sediments. Outcrops of pre-Cainozoic rocks are restricted to scattered low hills, ridges, cuestas, mounds, and undulating terrain.

The Sheet area forms part of four major tectonic units, the most extensive of which is the Archaean? to Lower Proterozoic Arunta Block. This unit separates the Birrindudu Basin of The Granites-Tanami region in the northeast from the Amadeus Basin in the southwest: both these units here consist of Adelaidean sedimentary rocks. The fourth unit is the Phanerozoic Canning Basin in the northwest.

The Arunta Block is made up of unnamed Archaean? sedimentary rocks, which have been regionally metamorphosed to schist and quartzite of the greenschist facies, and Lower Proterozoic volcanics and associated sediments of the Pollock Hills Formation (new name), Mount Webb Adamellite (new name), unnamed granite, and basic dykes which cut the Mount Webb Adamellite. The granitic rocks intrude the schist, quartzite, and Pollock Hills Formation.

The basal units of the Birrindudu and Amadeus Basins, respectively the Munyu Sandstone and Heavitree Quartzite, are strongly unconformable on the Arunta Block, and may be stratigraphic equivalents. The Munyu Sandstone is overlain by the Redcliff Pound Group (not exposed in the Sheet area) which is succeeded by sandstone of the Hidden Basin Beds. The Heavitree Quartzite is overlain by limestone and dolomite of the Bitter Springs Formation.

Permian sandstone and siltstone, mainly the marine Balgo Member of the Liveringa Formation, crop out in the Canning Basin. Elsewhere there are scattered outcrops of terrestrial Palaeozoic Angas Hills Beds (new name) and Pedestal Beds and unnamed Mesozoic sediments.

No metallic deposits of economic value have been found, and except possibly for a small part of the Canning Basin in the northwest, the area is non-prospective for petroleum.

INTRODUCTION

The Webb Sheet area lies in Western Australia adjacent to the Northern Territory border, and is bounded by latitudes 22° and 23° south and longitudes 127°30' and 129°00' east. It consists of mainly Precambrian rocks which are largely covered by Cainozoic superficial sediments, and it forms part of four major tectonic units (Fig. 1). These are the Birrindudu Basin of The Granites/Tanami region in the northeast and the Amadeus Basin in the southwest, both of which here consist of Adelaidean sedimentary rocks; the most extensive unit in the Sheet area, the Arunta Block, which is formed of Archaean? metamorphic rocks and Lower Proterozoic volcanic, sedimentary and granitic rocks; and the Phanerozoic Canning Basin in the northwest.

In 1973 two geological parties mapped the Sheet area at a reconnaissance level. One party, consisting of D.H. Blake and I.M. Hodgson from the Bureau of Mineral Resources (BMR), spend 2½ weeks mapping all but the northwest part, continuing the reconnaissance survey of The Granites/Tanami region begun in 1971 (Fig. 1; Blake et al., 1972, 1973). The other party, R.R. Towner, BMR, and R.W.A. Crowe, Geological Survey of Western Australia (GSWA), mapped the northwest of the Sheet area in two days as part of the survey of the Canning Basin that was started in 1972.

The Sheet area is uninhabited. Access is by a dirt road in the south, the only vehicle track in the area. This road, which was constructed in 1960, is not regularly maintained; it runs eastwards 400 km to Papunya Native Settlement, where it joins a maintained road to Alice Springs, the nearest town, and westwards to the Canning Stock Route and eventually to the west coast near Port Headland.

Climate and vegetation

The area is semi-desert, and has an average annual rainfall of probably less than 225 mm. Most of the rain falls during the summer, but both the amount and seasonal distribution are highly variable. The average maximum daily temperature during the summer months is between 35° and 40° C. In winter it is between 20° and 25° C, and the average daily minimum temperature is between 7° and 10° C. Frosts can be expected in June. (This climatic information is extrapolated from the meteorological data of Giles Weather Station, 225 km south of the Webb Sheet area.)

As a result of the semi-desert climate and predominantly sandy soils, the vegetation is sparse and consists mainly of spinifex and associated small shrubs, herbaceous plants, and scattered small trees (Figs. 3 to 13).

Survey methods

Field work was planned from vertical aerial photographs at a nominal scale of 1:80 000 taken in 1972, supplemented by aerial photographs at a nominal scale of 1:50 000 taken in 1953. (Copies of the aerial photographs can be obtained from the Division of National Mapping, Canberra.)

Landrover traverses were carried out in the south, working from the only road in the area. Away from the road access on the ground is slow and difficult, because of the numerous longitudinal sand dunes, and most of the Sheet area was mapped using a helicopter. The 1:250 000 topographical map of the Webb Sheet area (SF/52-10, Edition 1, Series R502), which shows all the sand dunes and most other topographic features, was used for general navigation.

Observation sites were recorded on the aerial photographs. Geological data were plotted on overlays and later transferred to planimetric sheets compiled by the Division of National Mapping. These were at a scale of 1:46 500, and had to be photographically reduced to 1:80 000 to be compatible with the overlays. For the preliminary map accompanying this Record (Plate 1) the compilation sheets were photographically reduced to 1:250 000 scale and redrawn.

Previous investigations

Little geological work had been carried out in the area before the present survey. The first recorded crossing of the Sheet area was from north to south in 1897 by Carnegie (1898), who named Mount Webb. Previously, in 1889, the Angas Hills had been named, but apparently not visited, by Tietkins (1891). Lake Mackay was discovered by the Mackay Aerial Survey Expedition in 1930 (Mackay, 1934). In 1933 Terry (1934, 1937) named and explored the Alec Ross Range.

Geologists from the Bureau of Mineral Resources have made several observations recently in marginal parts of the Sheet area. During a survey of the Canning Basin (Veevers & Wells, 1961), Wells and Stinear visited the Waterlander Breakaway in the northwest in 1956, and Veevers examined several outcrops in the south and southwest in 1957. Mount Webb and its environs were investigated in 1960 by Wells, Forman, & Ranford (1964) during the survey of the Macdonald Sheet area. In 1968 Wells and Nicholas visited the Alec Ross Range while surveying the Lake Mackay Sheet area (Nicholas, 1972). The Stansmore Sheet area to the north was mapped in 1972 by joint parties from the Bureau of Mineral Resources and the Geological Survey of Western Australia (Blake et al., 1973; Blake & Yeates, in prep.).

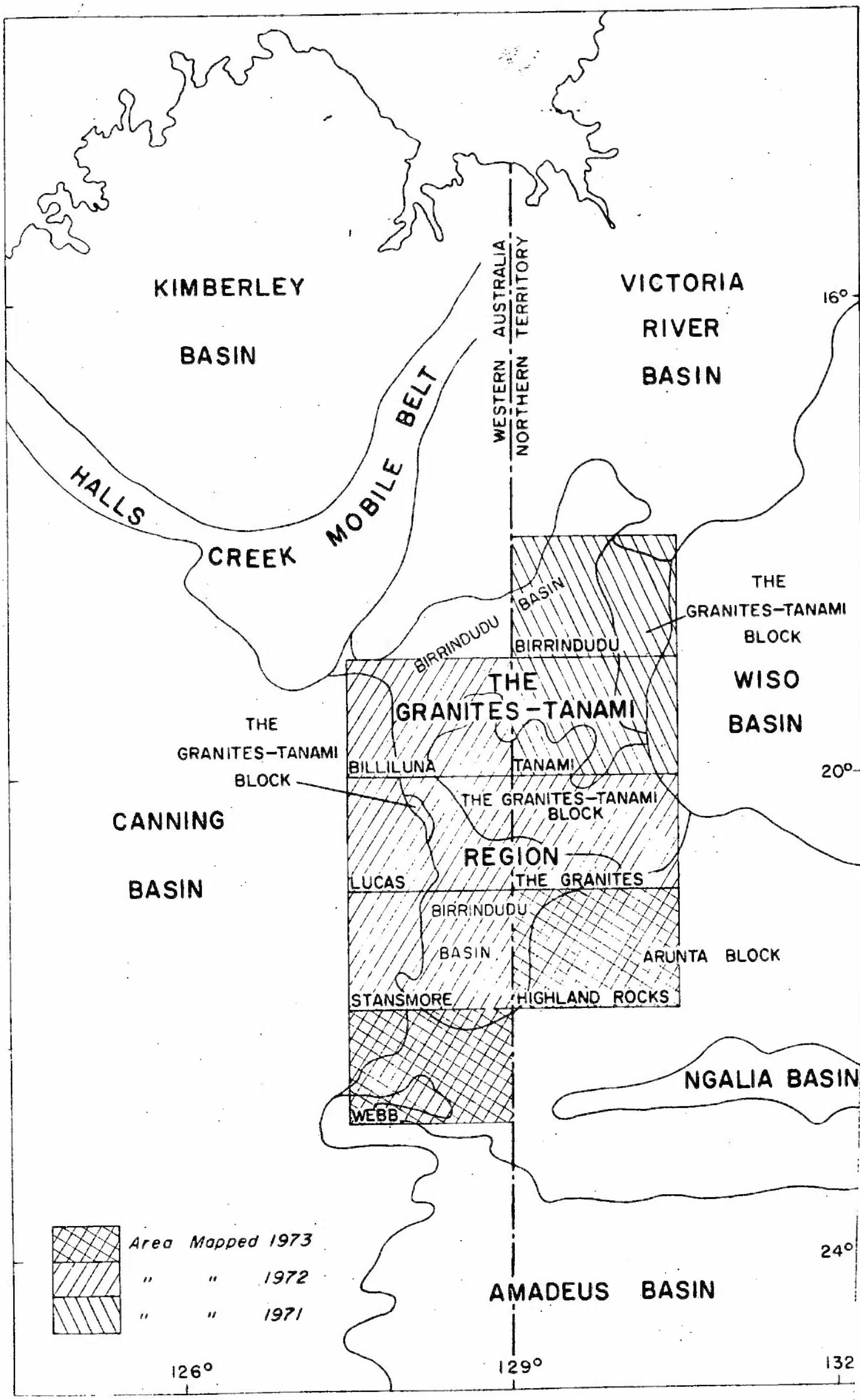

Fig. 1 Tectonic Setting

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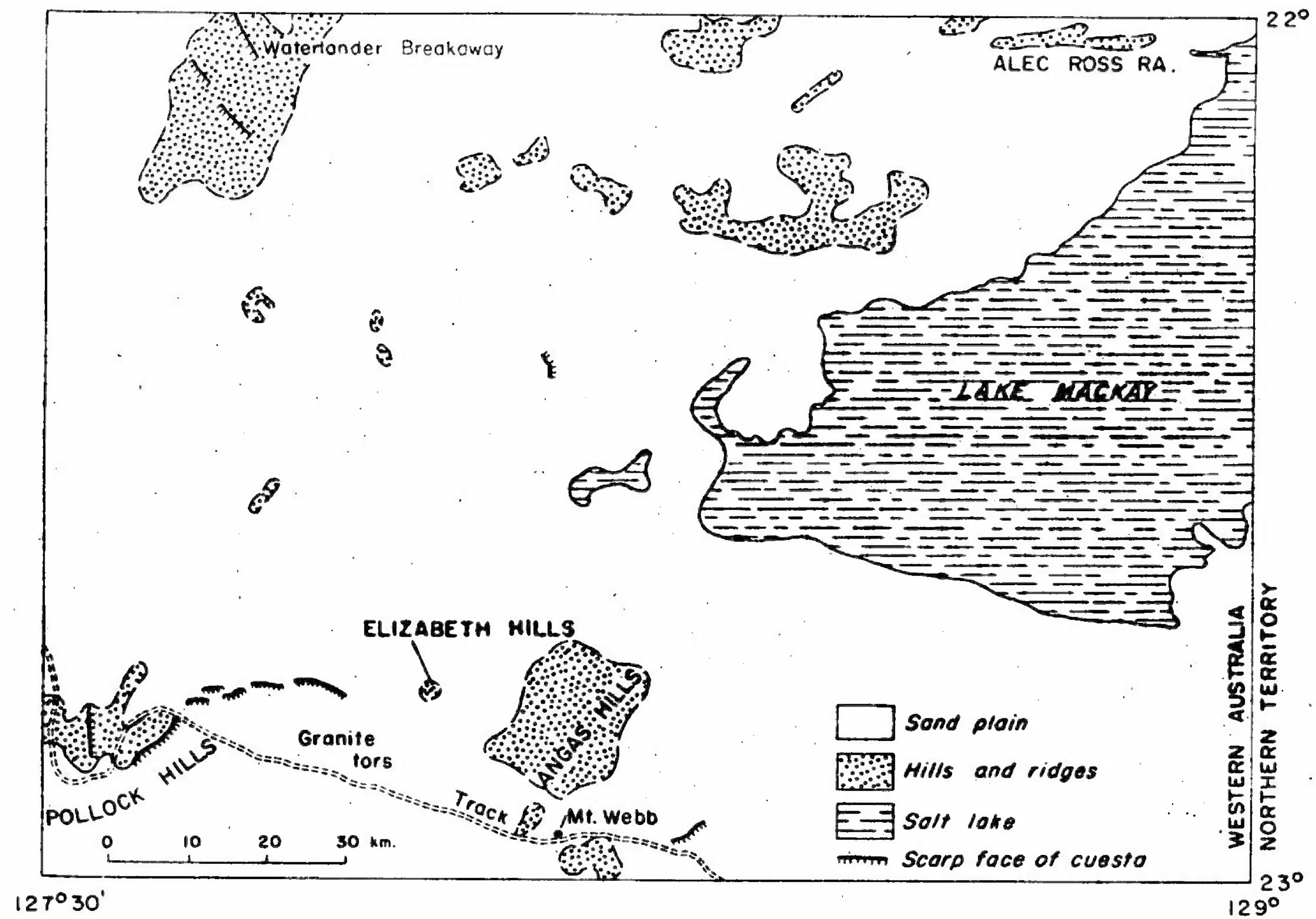

Fig.2 Topographic features

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Fig. 3. View west along the Alec Ross Range. Steeply dipping Munyu Sandstone in the foreground overlies Archaean? metamorphic rocks which are concealed by superficial deposits to the left. The highest part of the range, rising nearly 100 m above the sand plain, is shown on the sky-line. (Neg. GA/8929)

Fig. 4. The Pollock Hills from the southeast, showing short low hogback ridges in the foreground and long cuestas and hogback ridges in the distance, all formed of sublithic arenite, lithic arenite and tuffaceous sandstone of the Pollock Hills Formation. (Neg. M/1536/6)

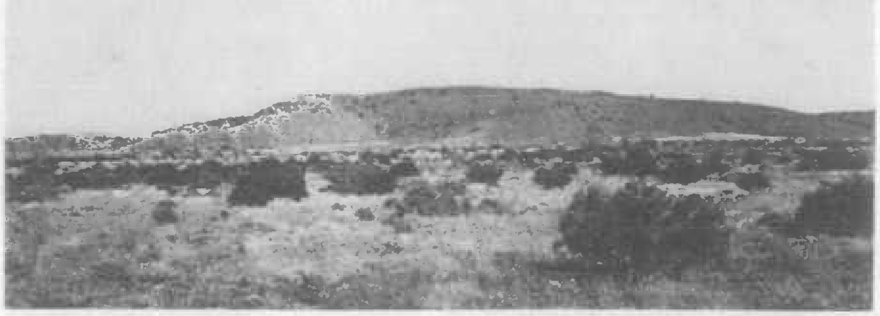

Fig. 5. Scarp face of cuesta on northeast side of the Pollock Hills. Cliff-forming sublithic arenite overlies largely scree-covered acid lava. Pollock Hills Formation. (Neg. M/1536/12)

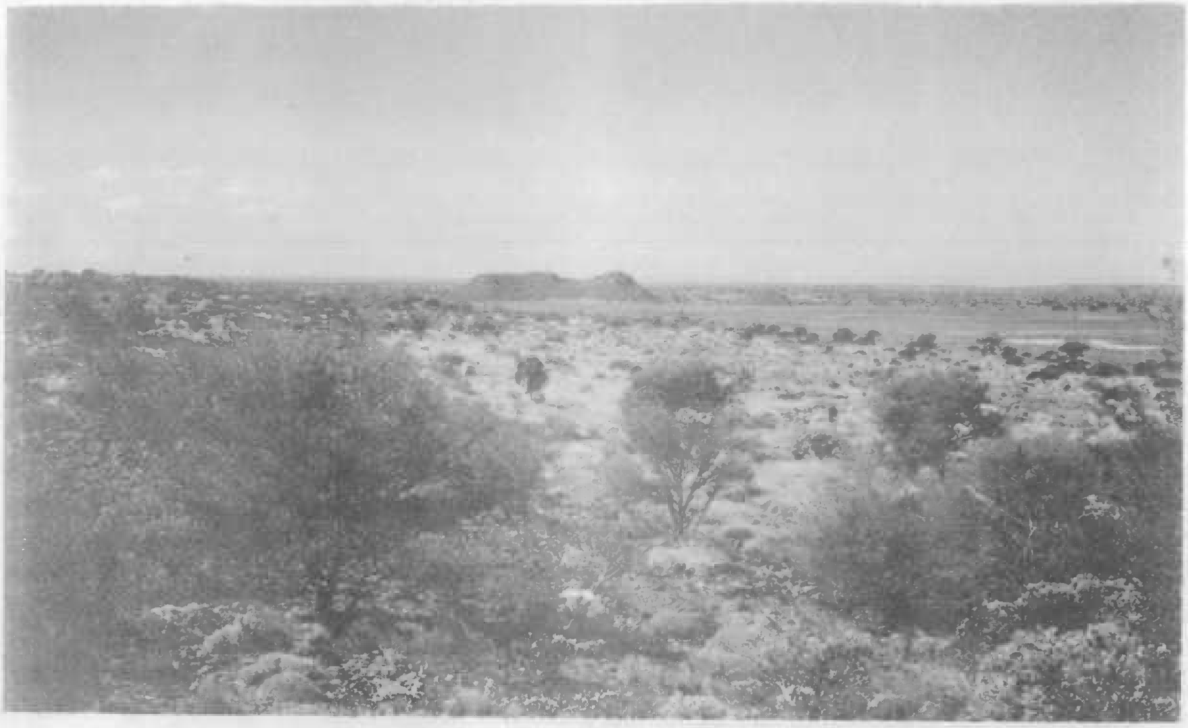

Fig. 6. The Elizabeth Hills from the northwest, showing a claypan to the right. The hills are formed of Angas Hills Beds. (Neg. GA/8931)

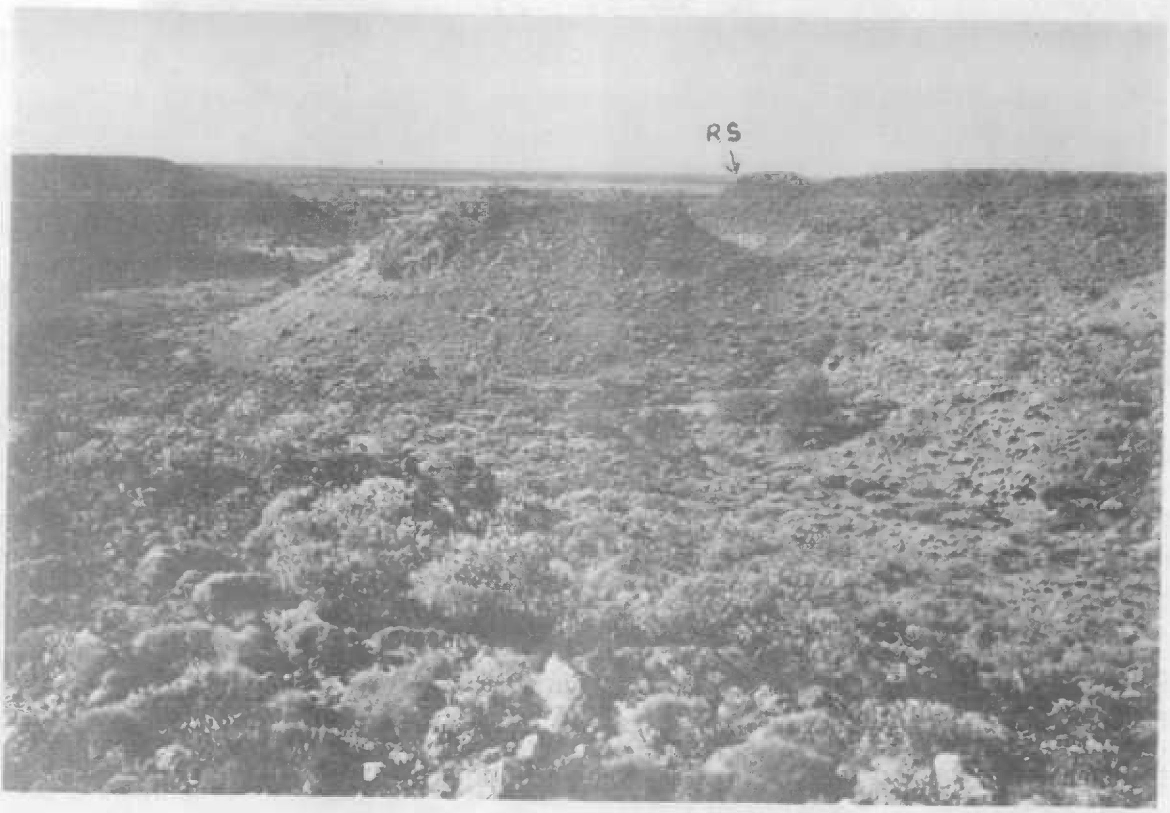

Fig. 7. East side of the Angas Hills, looking east to the reference section (RS) for the Angas Hills Beds. (Neg. GA/8952)

Fig. 8. Low rounded ridges of the northern Angas Hills, from the north. The ridges are formed of conglomerate and sandstone of the Angas Hills Beds. (Neg. GA/8953)

Fig. 9. Mount Webb from the south, showing the only road in the Sheet area in the foreground. Scarp-forming quartz arenite belonging to the Heavitree Quartzite overlies foliated Mount Webb Adamellite which is largely concealed by scree. (Neg. GA/8958)

Fig. 10. Sand dunes in the northern part of the Sheet area, looking west, showing small salt pans in depressions between the dunes. Many of the salt pans are surrounded by dense dark-toned low shrubs. (Neg. GA/8930)

Fig. 11. Lake Mackay covered by a white salt crust, from the west. The shore in the foreground and the small island in the centre are formed of aeolian and evaporitic sediments (Qm). (Neg. GA/8954)

A Bouguer anomaly map of the Webb Sheet area, based on gravity and microbarometer surveys carried out in 1962 and 1968 by the Bureau of Mineral Resources, was issued in 1970 (BMR, 1970).

Topography and drainage

The Sheet area consists mainly of isolated residual low ridges, hills, and cuestas separated by sand plain and salt lakes (Fig. 2). There are few drainage channels and none of any consequence, the drainage being mainly subsurface. The range in altitude is from 538 m, the highest point of the Pollock Hills in the southwest, to 361 m, the level of Lake Mackay in the east.

The main ridges and hills rise up to 100 m above the surrounding plain in the north and south of the Sheet area. Those in the north are the Alec Ross Range (Fig. 3), a group of east-trending steep-sided narrow strike ridges; the Waterlander Breakaway, a prominent cuesta; and an unnamed group of strike and hogback ridges west of the Alec Ross Range. In the south are the Pollock Hills, consisting mainly of hogback ridges and cuestas (Figs. 4, 5); low sandstone cuestas and granite tors (Fig. 18) to the east; a small group of low mesas and mounds named the Elizabeth Hills (Fig. 6); the Angas Hills, which consist of low rounded ridges, cuestas, and mounds (Figs. 7, 8); Mount Webb, a prominent sandstone mesa (Fig. 9); and a group of narrow steep-sided strike ridges east and south of Mount Webb. Elsewhere low mounds, ridges, and breakaways generally less than 30 m high are scattered within the sand plain; several of these are capped by laterite. The hills and ridges are incised by small streams (Fig. 8) which flow out onto the surrounding sand plain and then disappear. Small alluvial fans and piedmont plains are commonly developed where the streams leave the hills. Larger streams are present in some of the depressions between ridges.

The sand plain which covers most of the Sheet area is crossed by longitudinal sand dunes trending east-west (Fig. 10). These show a wide range in length, distance apart, and individual complexity (see Pl. 1). They are mainly 5 to 15 m high but are locally higher, and they form a major obstacle to cross-country travel. The dunes end abruptly against the eastern margins of hills and ridges, but continue unbroken over most low rises, including some capped by laterite.

The main salt lake is Lake Mackay (Fig. 11), which occupies about one sixth of the Sheet area. It covers about 3500 km^2, about one fifth of which is the adjoining Lake Mackay Sheet area to the east, and is a local centre of inland drainage. Several unnamed smaller salt lakes and many saltpans (Fig. 10) are present, and there are also a few claypans, as for instance near the Elizabeth Hills (Fig. 6). After heavy rain the salt lakes and pans become covered by water, but a salt crust soon develops as the water evaporates. At other times the water table probably lies only a few centimetres below the surfaces of the lakes.

Rock nomenclature

Precambrian sandstones are here classified according to Pettijohn et al. (1972) as follows: sandstone having less than 15 percent matrix is termed quartz arenite, sublithic arenite, and lithic arenite respectively where over 95 percent, 75 to 95 percent, and less than 75 percent of the detrital grains are quartz; sandstone having over 15 percent matrix is termed greywacke; tuffaceous sandstone contains abundant volcanic rock fragments. The arenites characteristically have a cement of quartz that is in optical continuity with detrital quartz grains. Many of the so-called lithic grains in the arenites may be altered feldspar: they are commonly white in hand specimen and consist of kaolinitic clay.

Phanerozoic sandstones are termed quartzose if over 75 percent of the detrital grains are quartz, otherwise they are described as lithic. These sandstones commonly have over 15 percent clay matrix.

Grainsizes of sandstones are: 0.125-0.25 mm, fine; 0.25-0.5 mm, medium; 0.5-1 mm, coarse; 1-2 mm, very coarse.

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

The classification of Hatch, Wells, & Wells (1961) is used for igneous rocks.

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

Introduction to stratigraphy

The stratigraphy is summarized in Table 1. The oldest rocks exposed are unnamed metamorphics which may be Archaean*. They are inferred to be overlain in the southwest by the Lower Proterozoic Pollock Hills Formation,

* As used in this Record, the Archaean is older than 2300 m.y., the Lower Proterozoic ranges from 2300 m.y. to about 1800 m.y., the Carpentarian from about 1800 m.y. to 1400 m.y., and the Adelaidean from 1400 m.y. to 600 m.y.

TABLE 1. SUMMARY OF STRATIGRAPHY

Age		Rock unit & map symbol	Max. thickness (m)	Lithology	Stratigraphic relationships	Remarks
CAINOZOIC	QUATERNARY	Qa	?	Sand, silt, clay; minor halite, gypsum	Superficial veneer	Lacustrine and minor evaporitic deposits in clay pans
		Qe	?	Halite, gypsum, sand, silt, clay	Superficial veneer	Evaporites and alluvium in salt lakes and salt pans
		Qm	?	Sand, halite, gypsum, calcrete	Superficial veneer	Aeolian and evaporitic deposits on windward shores of salt lakes
		Qe	?	Sand, silt	Superficial veneer	Alluvial and aeolian deposits in depressions
		Qs	?	Sand; minor gravel	Superficial veneer	Mainly aeolian, but includes sand and gravel on piedmont slopes flanking residual hills
		Czq	2?	Vein quartz rubble	Superficial veneer on metamorphic rocks and granite	Residual deposit resulting from prolonged weathering of quartz-veined rocks
		Czk	?	Calcrete, chalcedony	Superficial veneer	Chemical precipitate formed by evaporation of groundwater
		Czs	2	Silcrete	Superficial veneer	Developed on pre-Tertiary quartz-rich rocks
		Czl	3	Laterite	Superficial veneer	Ferruginous upper part of lateritic weathering profile
				MAJOR UNCONFORMITY		
MESOZOIC		M	10?	Quartzose sandstone, conglomerate, siltstone, claystone; medium to very thin-bedded	Unconformable on Archaean? metamorphics, Pollock Hills Formation, Munyu Sandstone, and probably Heavitree Quartzite and Bitter Springs Formation	Probably fluvial and lacustrine; unfossiliferous
PALAEOZOIC		Angas Hills Beds Pza	300	Conglomerate, quartzose to lithic sandstone, mudstone	Unconformable on Archaean? metamorphics, Heavitree Quartzite and probably Bitter Springs Formation	Probably fluvial; unfossiliferous
		Pedestal Beds Pze	5+	Coarse polymictic conglomerate, micaceous and quartzose sandstone	Unconformable on Hidden Basin Beds and probably also on Redcliff Pound Group and Munyu Sandstone	Probably fluvial; unfossiliferous
	PERMIAN	P	?	Sandstone, siltstone	Probably unconformable on Archaean? metamorphics	Strongly weathered
		Liveringa Formation Balgo Member Po	200	Interbedded ferruginous and micaceous fine sandstone and siltstone with medium to coarse sandstone lenses	Inferred to be unconformable on Archaean? metamorphics and conformable on concealed older Permian sediments	Shallow marine
				MAJOR UNCONFORMITY		

Age		Rock unit & map symbol	Max. thickness (m)	Lithology	Stratigraphic relationships	Remarks
PROTEROZOIC	ADELAIDEAN	Hidden Basin Beds Bui	600	Quartz arenite, sublithic arenite; mainly medium to thin-bedded	Overlies, possibly unconformably, Erica Sandstone; unconformably overlain by Pedestal Beds	Basal contact not exposed
		Redcliff Pound Group Erica Sandstone Bre	?	Sublithic arenite, quartz arenite	Conformable on Murraba Formation; overlain, possibly unconformably, by Hidden Basin Beds, and probably unconformably by Pedestal Beds	Concealed by superficial deposits
		Murraba Formation Brb	?	Chert granule conglomerate, sublithic arenite, quartz arenite	Overlies, possibly unconformably, Munyu Sandstone; overlain conformably by Erica Sandstone and probably unconformably by Pedestal Beds	Concealed by superficial deposits
		Bitter Springs Formation Bub	300	Limestone, dolomite, chert lenses and laminae, thin-bedded quartz arenite	Conformable on Heavitree Quartzite; probably unconformably overlain by Angas Hills Beds and unnamed Mesozoic	Shallow marine; possibly stromatolitic
		Heavitree Quartzite Buh	500	Quartz arenite, sublithic arenite; minor siltstone, greywacke; mainly thin to very thin-bedded, cross-bedded	Unconformable on Archaean? metamorphics, Pollock Hills Formation, Mount Webb Adamellite; overlain conformably by Bitter Springs Formation and unconformably by Angas Hills Beds and probably unnamed Mesozoic	May be correlated with Munyu Sandstone. Shallow marine
		Munyu Sandstone Buu	400	Quartz arenite; minor limestone, chert, conglomerate	Unconformable on Archaean? metamorphics and unnamed granite; overlain unconformably by unnamed Mesozoic, possibly, Murraba Formation, and probably by Pedestal Beds	May be correlated with Heavitree Quartzite
				MAJOR UNCONFORMITY		
	LOWER PROTEROZOIC	Bg	-	Granite, generally richly micaceous and strongly foliated	Intrudes Archaean? metamorphics; overlain by Munyu Sandstone	May be correlated with Mount Webb Adamellite
		Mount Webb Adamellite Bgm	-	Biotite and hornblende-biotite adamellite; minor aplite	Intrudes Archaean? metamorphics and Pollock Hills Formation; cut by basic dykes; overlain unconformably by Heavitree Quartzite	May be comagmatic with acid volcanics of Pollock Hills Formation
		Pollock Hills Formation Bus, Bus_a	1000+	Lithic and sublithic arenite; tuffaceous sandstone, siltstone and conglomerate; lapilli tuff; agglomerate (Bus). Porphyritic acid lava and non-porphyritic andesitic lava (Bus_a)	Intruded by Mount Webb Adamellite; probably unconformable on Archaean? metamorphics; unconformably overlain by Heavitree Quartzite and unnamed Mesozoic	Acid volcanics may be comagmatic with Mount Webb Adamellite
				MAJOR UNCONFORMITY		
ARCHAEAN?		As, Aq, A	-	Schist, quartzite, undivided schist and quartzite	Intruded by Mount Webb Adamellite and unnamed granite; overlain unconformably probably by Pollock Hills Formation and by Munyu Sandstone, Heavitree Quartzite, Balgo Member, Angas Hills Beds, and unnamed Mesozoic	Predominantly sediments regionally metamorphosed to greenschist facies

a sequence of acid lava and tuffaceous and non-tuffaceous sandstone. Both the metamorphic rocks and the Pollock Hills Formation are intruded by probably late Lower Proterozoic granitic rocks which are themselves intruded by basic dykes. These rocks together form the basement Arunta Block and are correlated with The Granites-Tanami Block to the north. Adelaidean sedimentary rocks of the Amadeus and Birrindudu Basins are strongly unconformable on the basement. The Precambrian units are overlain by marine Permian sediments of the Canning Basin succession in the northwest and by terrestrial Palaeozoic sediments elsewhere. Thin terrestrial Mesozoic and Cainozoic sediments complete the stratigraphy.

The problems encountered previously in the reconnaissance mapping of The Granites-Tanami area (Blake et al., 1972, 1973) are also present in the Webb Sheet area. Most of the area is covered by superficial Cainozoic sediments, and outcrops of pre-Tertiary rocks tend to be widely separated. The pre-Tertiary rocks exposed are mainly resistant quartz-rich sandstones, and rocks more susceptible to weathering and erosion are generally concealed. Granitic and metamorphic rocks are commonly deeply and intensely weathered, hindering identification both in the field and in the laboratory.

ARCHAEAN? (A, Aq, As)

Metamorphic rocks mapped as possibly Archaean crop out north and northwest of Lake Mackay, north of the Pollock Hills, and east of Mount Webb. They form mainly low ridges, many of which are capped by laterite, and also undulating terrain, and they underlie flat areas partly or wholly covered by a thin veneer of vein quartz rubble. On air photographs the trends of the metamorphic rocks commonly show through the quartz rubble, which has very pale grey to white tones. Three units are mapped: quartzite (Aq), schist (As), and undivided quartzite and schist (A).

Quartzite forms low strike ridges northwest of Lake Mackay and east of Mount Webb. It is medium to very coarse, glassy, and white to pale grey or maroon. Some mica is generally present and locally the quartzite is schistose. The original bedding is discernible at most localities and shows that the quartzite has steep to vertical dips and is medium to very thin-bedded. Cross-cutting quartz and quartz-tourmaline veins abound, and locally the quartzite is sheared and brecciated. Thin sections show that the quartzite is a mosaic of strained quartz with scattered flakes of muscovite and biotite and small amounts of tourmaline, zircon, and in some cases opaque minerals.

Schist has been mapped separately only in the south, 20 km east of Mount Webb, where a prominent ridge is formed of grey quartz-biotite schist, quartz-muscovite-biotite schist, schistose quartzite, and dark greyish green amphibole schist containing chlorite and epidote.

Scattered outcrops of undivided schist and quartzite are present in the northern part of the Sheet area. Except for two small outcrops on the south side of the Alec Ross Range, most outcrops are in breakaways beneath cappings of laterite. At the various outcrops the two rock types are commonly interbedded, although schist generally predominates. The schist is highly micaceous and generally much iron-stained, due to weathering. It is probably metamorphosed greywacke and siltstone. Cross-cutting quartz, quartz-tourmaline and granitic veins are common.

Except for the amphibole schist east of Mount Webb, which may be metamorphosed basic volcanics, and possible highly altered basalt associated with schist at one locality (lat. 22°21'30"S, long. 128°03' 30"E), the metamorphic rocks are altered sediments. The presence of muscovite, biotite, green amphibole, chlorite, epidote, and tourmaline indicates that the rocks probably belong to the greenschist facies of regional metamorphism, modified locally by thermal metamorphism associated with granitic intrusions.

Relationships, correlations and age

The metamorphic rocks are intruded by Mount Webb Adamellite and unnamed granite, and they are overlain by Munyu Sandstone on the south side of the Alec Ross Range, by Heavitree Quartzite east of Mount Webb, by probable Angas Hills Beds north of the Pollock Hills, and by Mesozoic conglomeratic sandstone northwest of Lake Mackay (at lat. 22°11'S, long 128°02'E). They are also inferred to be overlain by Pollock Hills Formation in the southwest and by both the Balgo Member of the Liveringa Formation and undivided Permian in the northwest.

The metamorphic rocks are similar lithologically to metamorphic rocks in the Highland Rocks and The Granites Sheet areas (Hodgson, 1974; Blake et al., 1973), and they may be correlated with metamorphic rocks of the Arunta complex to the east and the Tanami complex to the north and northeast. The Tanami complex is correlated with the Halls Creek Group of the East Kimberleys, which is possibly Archaean (Dow & Gemuts, 1969; Gellatly, 1971); hence the metamorphic rocks of the Webb Sheet area are also considered to be possibly Archaean.

liff-forming sublithic arenite to the right overlies acid lava which forms the gentle slope below the cliff and the low hills to the left. art of the type section of the Pollock Hills Formation in the Pollock ills. (Negs. M1536/13-14) FIG. 12

Bluff of sublithic arenite overlying the largely scree covered altered top of an acid lava flow, southeast Pollock Hills. Pollock Hills Formation. (Negs. M/1536/3-4) FIG. 13

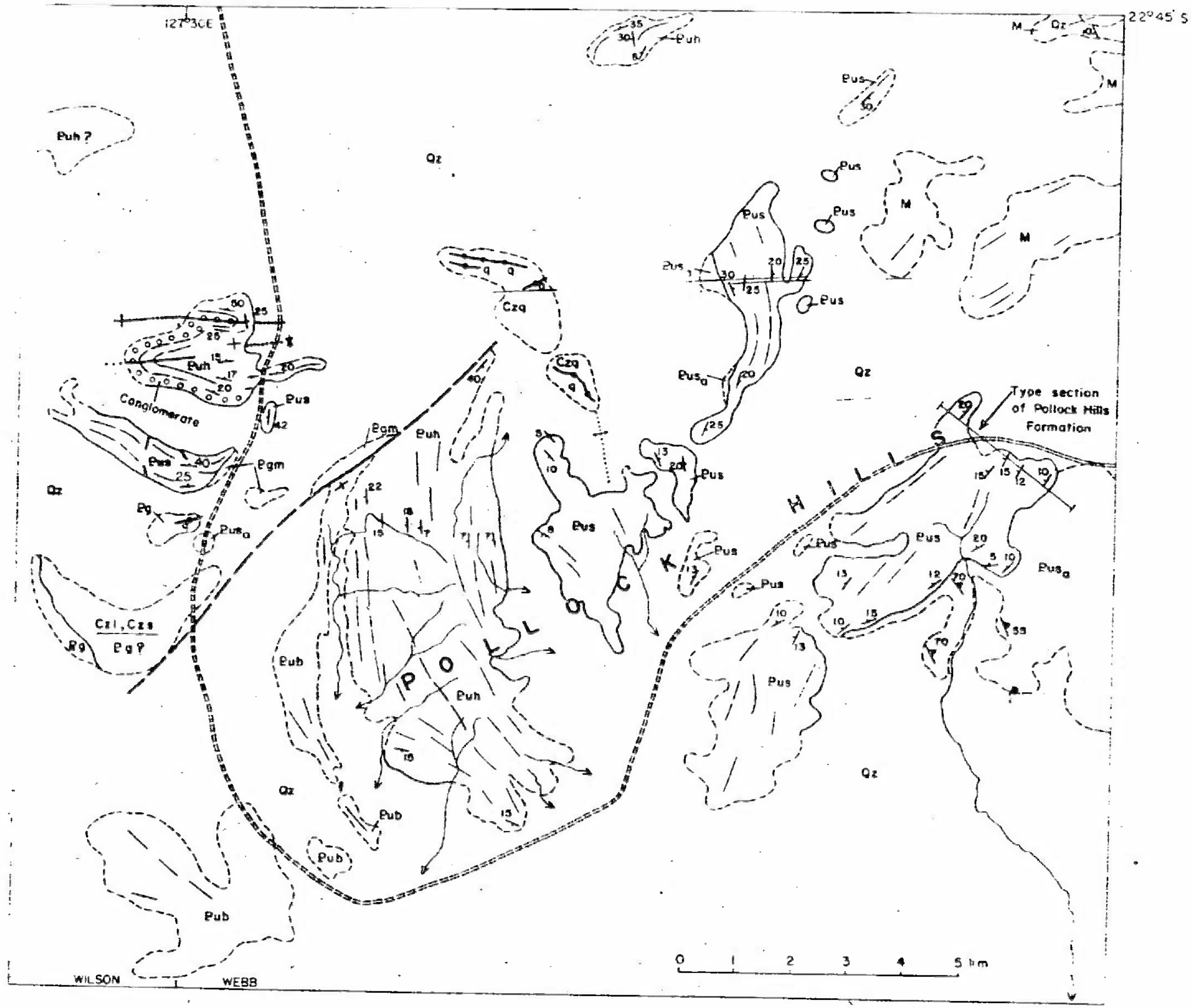

Fig.14 Geological map of the Pollock Hills area.
(Reference as for Plate I)

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Fig. 15. Much altered upper part of an acid lava flow exposed in a creek on the southeast side of the Pollock Hills, Pollock Hills Formation. (Neg. M/1536/10)

Fig. 16. Agglomerate consisting of subangular blocks of acid lava in a tuffaceous matrix. It overlies the acid lava shown in Fig. 15, the exposure being in the same creek. Pollock Hills Formation. (Neg. M/1536/11)

LOWER PROTEROZOIC

Pollock Hills Formation (Bus, Bus_a)

(new name)

The Pollock Hills Formation comprises acid and andesitic lava (Bus_a) and associated tuffaceous and non-tuffaceous sediments (Bus) which crop out in the southwest corner of the Webb Sheet area and extend westwards into the adjoining Wilson Sheet area. It is named after the Pollock Hills (lat. 22°50'S, long. 127°40'E). Outcrops consist of strike ridges and hills, cuestas, and undulating terrain (Figs. 4, 5, 12, 13).

The type section is across part of the Pollock Hills, from lat. 22°50'S, long. 127°40'E to lat. 22°49'S, long. 127°38'E (Fig. 14). Here porphyritic acid lava is overlain by 600 m of westerly dipping medium to thin-bedded lithic and sublithic arenite and tuffaceous sandstone. The maximum thickness of the formation is uncertain, as the base is not exposed, but it is probably in excess of 1000 m and may be over 1500 m.

Lithology

The main rock types exposed are acid lava, lithic and sublithic arenite, and tuffaceous sandstone. Also present are andesitic lava, tuffaceous siltstone and conglomerate, lapilli tuff, and agglomerate.

Acid lava is exposed in the northern and eastern parts of the Pollock Hills, where it is overlain by arenite (Figs. 5, 12, 13). It is porphyritic, and variations in phenocryst content indicate that several lava flows may be present, although no contacts between flows have been recognized. Wherever acid lava crops out, it is the oldest rock exposed. The lava top is well exposed in scarps, where much altered, flow-banded and brecciated lava (Fig. 15), yellowish to greenish to maroon, is overlain directly by arenite or less commonly by agglomerate and tuff. The highly altered lava, once glassy, is now felsitic. It ranges in thickness from a few to over 10 m and passes down into massive relatively unaltered lava which is dark grey to greyish maroon or purple. The dark lava is hard and dense, and commonly has a prominent steeply dipping to vertical parting or foliation that trends north to west-northwest.

Microscopic examination shows that the relatively unaltered lava generally contains 10 to 20 percent of phenocrysts, less than 5 mm long, of feldspar and in most samples quartz. Altered ferromagnesian phenocrysts and unaltered microphenocrysts of opaques and apatite are also commonly present. The groundmass is fine to very fine, and is felsitic, micrographitic, or less commonly micrographic; it consists of quartz, turbid alkali feldspar, opaque granules, and in some specimens flecks of chlorite, greenish biotite, and amphibole. One specimen contains small xenolithic clots of quartz, biotite, and opaques. The feldspar phenocrysts are mainly weakly zoned euhedral sodic plagioclase which shows variable amounts of alteration to clay, epidote, sericite, chlorite, and calcite. Alkali feldspar phenocrysts have been identified in some samples; they are distinguished by lack of zoning, absence of lamellar twinning, and in one specimen by cross-hatch twinning. Quartz phenocrysts are of the -quartz type; they are commonly partly resorbed and show strained extinction. The ferromagnesian phenocrysts are pseudomorphed by aggregates of one or more of the following minerals: chlorite, iron oxide, greenish biotite, pale green amphibole, sphene.

Andesitic lava crops out 7 km southeast of the Pollock Hills. The only sample collected is dark greenish-grey, fine-grained, and non-porphyritic. It consists of plagioclase laths, green amphibole, opaques, and minor epidote, calcite, and veinlets of quartz.

The upper part of the Pollock Hills Formation, overlying the acid lava, consists mainly of lithic and sublithic arenite and tuffaceous sandstone. Clasts of acid lava are present in all three types of sandstone and form over 50 percent of tuffaceous sandstone. The arenites and tuffaceous sandstone are mainly medium to thin bedded and medium to coarse-grained; cross-bedding, lenses of coarse gritty arenite, and lenses of conglomerate made up of quartz pebbles and volcanic rock fragments are common locally, and ripple marks are present in places. The sublithic arenite is generally pale buff, moderately well sorted, and silicified. The lithic arenite and tuffaceous sandstone arenite are deep maroon owing to hematite staining, and are more poorly sorted than the sublithic arenite. They are also generally unsilicified and friable, and hence are less resistant to erosion, tending to underlie depressions between ridges of sublithic arenite.

The arenites and tuffaceous sandstone contain clasts of quartz, quartzite, acid volcanics, feldspar, and minor tourmaline, muscovite, and zircon. The volcanic clasts are generally subangular to angular and some have shard-like forms. Clasts of feldspar, both sodic plagioclase and alkali feldspar, make up to 10 percent of some samples. Variable amounts of sericitic matrix, which is commonly iron-stained, and some quartz overgrowth cement are present.

In places the arenites and tuffaceous sandstone rest directly on acid lava, as in the type section (Fig. 12), but elsewhere they are separated from underlying lava by volcanic agglomerate (Fig. 16), laminated tuffaceous siltstone, agglomeratic tuff (Fig. 17), and lapilli tuff, as at the base of the scarp 2 km southwest of the type section.

Stratigraphic relationships and age

The Pollock Hills Formation is intruded by Mount Webb Adamellite and is overlain by Heavitree Quartzite and Mesozoic rocks. It is inferred to overlie Archaean? metamorphic rocks.

Tuffaceous sandstone of the Pollock Hills Formation is intruded by Mount Webb Adamellite on the west side of the Pollock Hills, near the western edge of the Sheet area (Fig. 14). Here dense hornfelsic mottled tuffaceous sandstone is exposed within 1 m of adamellite. An intrusive contact between acid lava and adamellite is apparent north of the track 7 km east of the Pollock Hills, where dense hornfelsic mottled lava lies adjacent to fresh adamellite. Similar hornfelsic lava 3 km to the northwest, which contains feldspar phenocrysts with ragged outlines attributed to partial melting, is cut by granitic veins. Apart from slight recrystallization and minor partial melting immediately adjacent to intrusive contacts, the adamellite has little associated thermal metamorphism. This indicates that it is probably a high-level intrusion, and it may have been comagmatic with the acid lava of the Pollock Hills Formation.

An unconformable relationship between Pollock Hills Formation and Heavitree Quartzite is inferred in the western part of the Pollock Hills, where hilly outcrops of the two formations are separated by depressions covered by superficial deposits. Northeast of the Pollock Hills gently dipping sublithic arenite mapped as Heavitree Quartzite? overlies the flow-banded and highly altered uppermost part of an acid lava. A few metres south of this contact the lava is cut by granitic veins. Less than 2 km north from this locality identical sublithic arenite overlies weathered Mount Webb Adamellite.

Mesozoic rocks are not seen in contact with the Pollock Hills Formation, but are inferred to be unconformable on it north of the Pollock Hills (Fig. 14).

The age of the Pollock Hills Formation is uncertain, but may be resolved when samples of acid lava and of Mount Webb Adamellite are isotopically dated. At present the Pollock Hills Formation is tentatively regarded as Lower Proterozoic, similar to the Mount Winnecke Formation in the Birrindudu Sheet area (Blake et al., 1972; Blake, in press).

Mount Webb Adamellite (Bgm)

(new name)

Mount Webb Adamellite crops out in the southwestern part of the Sheet area. It is named after Mount Webb (22°56' 30"S, 128°08'30"E) where adamellite is exposed beneath Heavitree Quartzite (Figs. 9, 19). Between the Pollock Hills in the west and Angas Hills in the east unweathered Mount Webb Adamellite forms scattered groups of spherical boulders and tors up to 30 m high surrounded by sand (Fig. 18), and one of these groups, at locality 22°50'00"S, 127°50'30"E, 32 km west-northwest of Mount Webb, is selected as the type locality. Similar but smaller outcrops are also present near Mount Webb. On air photographs unweathered adamellite shows up as small dark-toned patches surrounded by pale-toned sand. Weathered adamellite is exposed on slopes beneath scarp-forming Heavitree Quartzite and also as irregular rocky knolls up to 10 m high both west of the Pollock Hills and near Mount Webb; it is very pale-toned on air photographs.

The adamellite is mainly pinkish to greyish, medium to coarse, and contains biotite, locally accompanied by hornblende. There is also some augite-bearing adamellite, mainly near Mount Webb. The adamellite commonly has a moderately to steeply dipping foliation trending west to north-northwest. Such adamellite, as northwest of Mount Webb, has a gneissose appearance. Locally the adamellite is cut by sparse aplite veins less than 1 m thick and also by thin quartz veins. These are generally parallel to the foliation, as also are post-foliation basic dykes. Thicker quartz veins cut highly altered and brecciated adamellite west of the Pollock Hills.

Petrography

The Mount Webb Adamellite is generally non-porphyritic, and consists essentially of quartz, about equal proportions of sodic plagioclase and alkali feldspar, biotite, and locally hornblende; accessory and secondary minerals commonly present are apatite, calcite, chlorite, epidote, sphene, white mica, zircon, and metamict and clay minerals; allanite and tourmaline are rare accessories, and augite is present locally. Quartz shows strained extinction and is commonly granulated, especially in gneissose adamellite. Sodic plagioclase (which has refractive indices less than those of quartz) shows weak zoning, and is partly altered to epidote, white mica, clay minerals, and chlorite; in contrast, alkali feldspar, most of which is slightly perthitic microcline, is generally unaltered. Biotite is mainly greenish-brown and shows alteration to chlorite and epidote. Bluish-green strongly pleochroic hornblende is associated with biotite in some of the adamellite east of longitude 127°47'E, and pale green uralitic amphibole is associated with colourless augite in gneissose adamellite mainly near Mount Webb.

Fig. 17. Agglomeratic tuff of the Pollock Hills Formation showing crude bedding, Pollock Hills. (Neg. M/1536/1)

Fig. 18. Mount Webb Adamellite exposures 8 km east of the Pollock Hills. (Neg. GA/8668)

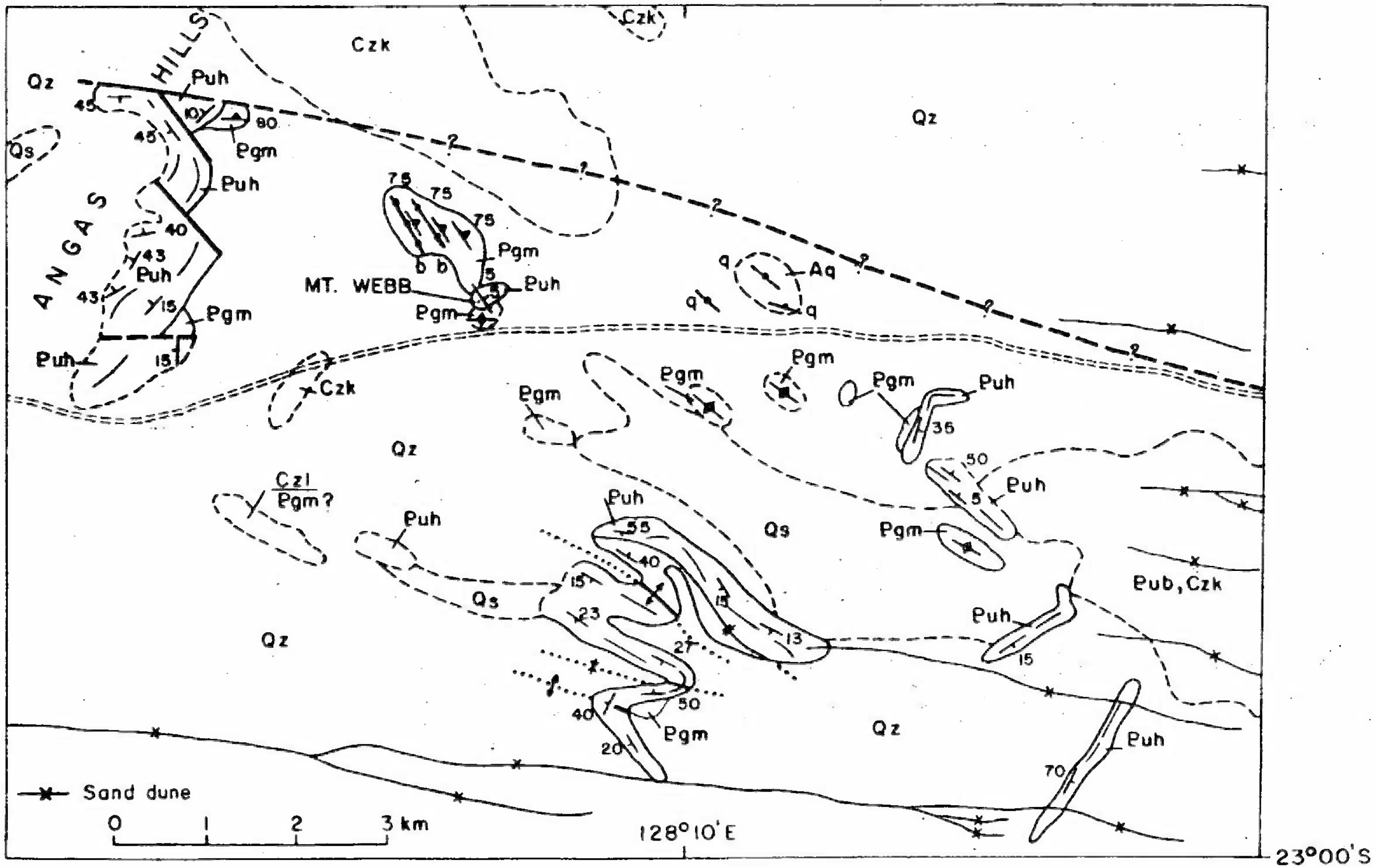

Fig.19 Geological map of Mount Webb area.

(Reference as for Plate I)

To accompany Record 1974/53

F52/A/14

At one locality, 12 km east of the Pollock Hills, partly melted and recrystallized adamellite is exposed alongside a cross-cutting basic dyke. Within 1 m of the chilled margin of the dyke the adamellite is altered to quartz-feldspar 'porphyry' containing anhedral megacrysts of plagioclase, partly resorbed quartz and microcline, and chloritized biotite set in a fine-grained partly granophyric groundmass. Narrow zones of clay alteration have developed along cleavage planes in many of the microcline megacrysts in the adamellite close to the dyke, giving the crystals a striped appearance.

Relationships, correlations, and age

The Mount Webb Adamellite intrudes metamorphic rocks and Pollock Hills Formation, and is cut by later basic dykes. It is also overlain unconformably by Heavitree Quartzite. Contacts with the Pollock Hills Formation are exposed 7 km east of the Pollock Hills, where hornfelsed acid lava is intruded by adamellite, and west of the Pollock Hills, near the western edge of the Sheet area, where adamellite intrudes overlying tuffaceous sandstone (Fig. 14). The emplacement of the adamellite was accompanied by little thermal metamorphism, indicating that the adamellite may have been intruded at a high structural level. If this was the case, the adamellite may have been comagmatic with the acid volcanics of the Pollock Hills Formation (cf., the Winnecke Granophyre and acid volcanics of the Mount Winnecke Formation, 350 km to the north-northeast, described by Blake et al., 1972). Basic dykes are seen to cut the adamellite at numerous exposures between the Pollock Hills and Mount Webb. The dykes are younger than the foliation of the adamellite. Heavitree Quartzite overlies weathered adamellite on Mount Webb and 15 km to the east, in the southern part of the Angas Hills, and 27 km north-northeast of the Pollock Hills, and arenite mapped as Heavitree Quartzite? overlies weathered adamellite a few kilometres northeast of the Pollock Hills.

The Mount Webb Adamellite may be correlated with the Winnecke Granophyre (Blake et al., 1972), Lewis Granite, and other granitic intrusions of The Granites-Tanami Block (Blake et al., 1973), which have been dated isotopically at about 1800 m.y. (R.W. Page, pers. comm. 1973). This may be confirmed when the ages of specimens of Mount Webb Adamellite collected in 1973 are determined.

Unnamed granite (Ɓg)

Scattered outcrops of unnamed granite are present in the northern part of the Sheet area. The granite is much weathered, and is locally capped by laterite. It is generally richly micaceous and strongly foliated. In places the granite intrudes Archaean? metamorphic rocks as pegmatitic veins, which are locally associated with quartz-tourmaline veins. The veins are commonly parallel to the schistosity of the country rocks, as seen on the south side of the Alec Ross Range (Fig. 20). At this locality the granite and metamorphic rocks are overlain by Munyu Sandstone.

The unnamed granite can probably be correlated with the Mount Webb Adamellite and may be late Lower Proterozoic.

Basic dykes

Between Mount Webb and the Pollock Hills, numerous basic dykes intrude Mount Webb Adamellite. These dykes are generally less than 10 m wide, but range up to more than 100 m. They have general north-northwesterly trends, although at most exposures they are seen to be irregular and anastomosing. Outcrops commonly consist of spheroidal boulders which tend to be somewhat smaller than spheroidal boulders of adjacent adamellite. Prominent lineaments visible on air photographs between the Angas Hills and Pollock Hills are probably the trends of dykes concealed by superficial deposits.

Although the dykes are locally parallel to the foliation of the Mount Webb Adamellite, they are not themselves foliated, indicating that they were intruded after the folidation had taken place, probably late in the Lower Proterozoic.

At one locality, near the track 11 km east of the Pollock Hills, a large basic dyke has caused local recrystallization in the adamellite.

Petrography

The dykes have chilled fine-grained basaltic margins and doleritic to gabbroic centres. They are non-porphyritic, and consist essentially of subhedral plagioclase (bytownite-labradorite showing normal zoning), ophitic pale brownish augite and pale pinkish to greenish-grey pleochroic orthopyroxene, olivine, and opaque minerals. Most samples examined also contain primary yellow-brown biotite, greenish-brown hornblende, and apatite. The olivine generally shows alteration to 'serpentine' and opaque minerals, and some has vermiform opaque inclusions. Other secondary minerals commonly present are actinolite, calcite, chlorite, epidote, and sericite. Some specimens have small amounts of interstitial quartz and alkali feldspar.

ADELAIDEAN

Munyu Sandstone (Buu)

The Munyu Sandstone crops out in the northeast part of the Sheet area, where it forms the steep-sided discontinuous strike ridges of the Alec Ross Range (Figs 3, 20), parts of which rise nearly 100 m above the surrounding sand plain. It is probably also present beneath Cainozoic superficial deposits to the west, as indicated on the section line A-D (See Map). Further outcrops occur in the Stansmore Sheet area to the north, where the type section of the formation is located (Blake et al., 1973), and in the Highland Rocks Sheet area to the northeast, where the Munyu Hills, after which the formation is named, are situated (Hodgson, in prep.).

The maximum thickness of the Munyu Sandstone in the Webb Sheet area is about 400 m, in the western part of the Alec Ross Range. Along this range the formation generally dips steeply northwards (Fig. 3), but is locally involved in tight almost isoclinal folding and associated faulting (Fig. 20).

Lithology

The main rock type exposed is quartz arenite, but some limestone, chert, and conglomerate also crop out. The quartz arenite is medium to thin-bedded and commonly shows cross-bedding (Fig. 21), some of which is of the festoon type. It is generally poorly sorted, medium to coarse, and commonly contains gritty layers and lenses and scattered quartz pebbles. Near the base of the formation some beds are conglomeratic and some are richly micaceous.

Grey limestone and associated thin lenses and laminae of dark grey chert crop out in the western part of the Alec Ross Range (at lat. 22°02'S, long. 128°42'E), probably near or at the top of the Munyu Sandstone (Fig. 20). Both the limestone and chert are recrystallized and appear to be unfossiliferous, although local vague banding indicates that they may be stromatolitic. Several specimens of chert and limestone have been examined for microfossils by Dr M.R. Walter, but were found to be barren, possibly because of post-depositional recrystallization.

Stratigraphic relationships, correlations, and age

The Munyu Sandstone is seen to be strongly unconformable on unnamed granite and Archaean? metamorphics on the south side of the Alec Ross Range, and is overlain by unnamed Mesozoic sandstone in the western part of this range. West of the range (see Map) it is inferred to be overlain, possibly unconformably (as in the Stansmore Sheet area to the north), by Murraba Formation although here both these formations are concealed by superficial deposits, and also by Pedestal Beds.

The Munyu Sandstone is the oldest unit in the southwest part of the Birrindudu Basin. It may be correlated with the Lewis Range and Muriel Range Sandstones, the basal formations of the probably Adelaidean Redcliff Pound Group (Blake et al., 1973) north of the Webb Sheet area, and also with the Vaughan Springs Quartzite of the Ngalia Basin to the east (Wells et al., 1972), which has been dated at about 1300 m.y. (Cooper et al., 1971). If the latter correlation is correct, the Munyu Sandstone is probably stratigraphically equivalent to the Heavitree Quartzite.

Heavitree Quartzite (Buh)

The Heavitree Quartzite was named and defined by Joklik (1955), Heavitree Gap at Alice Springs being the inferred type locality (Wells et al., 1970). The formation has been traced westwards from Alice Springs to the Dovers Hills in the Macdonald Sheet area (Wells et al., 1964, 1970), and it persists northwestwards into the Webb Sheet area, where the main outcrops are in the vicinity of Mount Webb and in the Pollock Hills (Figs 9, 14, 19). Mount Webb, which rises 100 m above the surrounding plain, is formed of strongly foliated granite capped by about 20 m of Heavitree Quartzite dipping 5° to 060°. In the Pollock Hills the formation forms a series of cuestas less than 50 m high. Elsewhere in the Sheet area the Heavitree Quartzite crops out as isolated low cuestas and strike ridges.

The maximum thickness exposed in the Sheet area is in the Pollock Hills, where the Heavitree Quartzite is about 500 m thick and dips westwards at 7-22°. Here it overlies the Pollock Hills Formation and is overlain by the Bitter Springs Formation.

Lithology

In the Webb Sheet area the Heavitree Quartzite consists of quartz arenite, sublithic arenite, and subordinate siltstone and greywacke. Bedding is generally thin to very thin, especially in the upper part of the formation, where a platy parting is commonly developed. Small scale and mainly low angle cross-bedding is common. Most of the Heavitree Quartzite is white to pale pink or maroon, but some is strongly iron-stained and much darker. The arenites are mainly medium to coarse, although thin gritty and fine conglomeratic lenses and laminae, formed largely of angular to subangular grains, granules, and

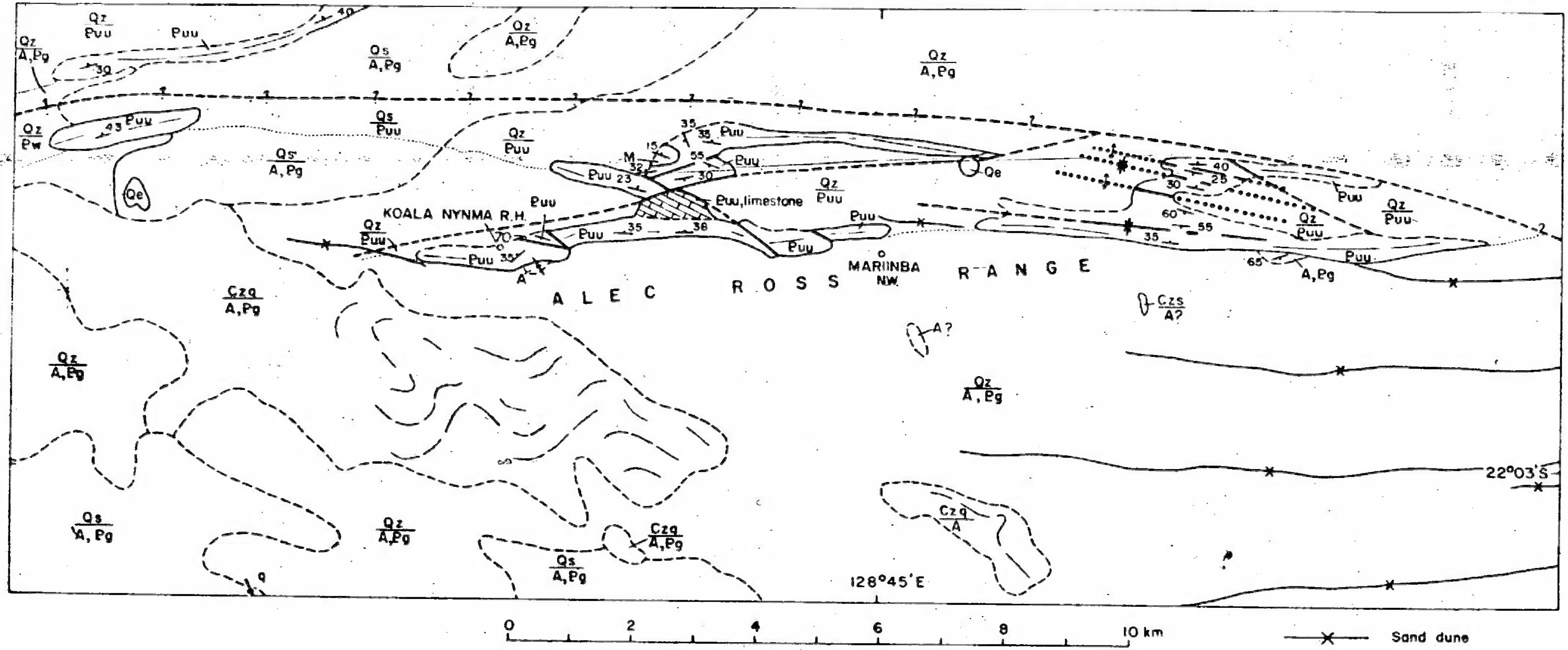

Fig. 20 Geological map of the Alec Ross Range area.

To accompany Record 1974/53

F 52/A/16

Reference as for Plate 1

Fig. 21. Small scale cross-bedding in poorly sorted basal quartz arenite of the Munyu Sandstone, Alec Ross Range. (Neg. M/1536/19)

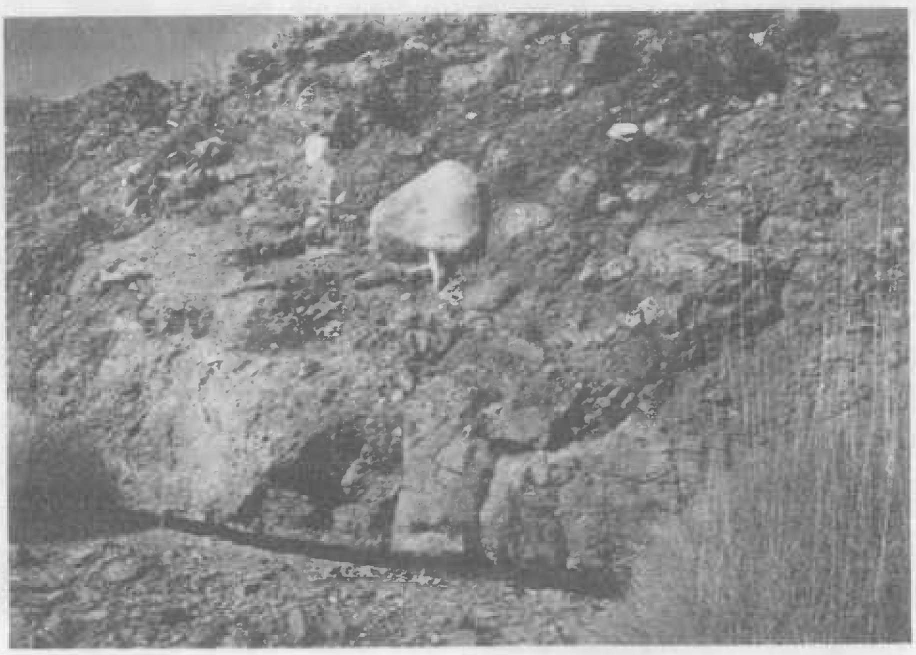

Fig. 22. Large boulder in chaotic polymictic conglomerate overlying micaceous sandstone. Pedestal Beds east of the Waterlander Breakaway. (Neg. GA/8949)

pebbles of quartz, are present locally, generally near the base of the formation. Micaceous sublithic arenite and greywacke are commonly present immediately overlying weathered granite, as on Mount Webb. Conglomerate consisting of rounded pebbles and cobbles of vein quartz, quartzite, chert, quartz arenite, clayey arenite, and mudstone is present at basal exposures of the formation west of the Pollock Hills, interbedded with medium to thick beds of pebbly arenite: both the conglomerate and arenite show some cross-bedding, and overlying arenite contains scattered well rounded quartz pebbles.

The beds generally have gentle to moderate dips, but steep dips occur locally, as near Mount Webb (Fig. 19), where the beds have been affected by irregular folding and associated faulting, and show shearing, brecciation, slickensided surfaces, and quartz and chalcedonic veining.

Surface silicification is common, and most of the arenites exposed have a siliceous cement. However, some beds appear to have little or no cement; these beds are friable and tend to form depressions between cuestas of silicified arenite.

Wells et al. (1970, p. 21) consider that ... 'The widespread distribution of the .... Heavitree Quartzite suggests deposition in a shallow-marine epicontinental sea under relatively stable conditions', and that the coarse basal beds may indicate a littoral environment.

Stratigraphic relationships, correlations and age

The Heavitree Quartzite overlies Archaean? metamorphics, Pollock Hills Formation, and Mount Webb Adamellite, and is overlain by Bitter Springs Formation and Angas Hills Beds. A major unconformity between steeply dipping cleaved metamorphics and gently dipping Heavitree Quartzite is exposed in low scarps 18 km east of Mount Webb. The contact between Heavitree Quartzite and underlying Pollock Hills Formation in the Pollock Hills is concealed by superficial deposits. A few kilometres northeast and east of the Pollock Hills the flow-banded and highly altered top of an acid lava flow, part of the Pollock Hills Formation, is overlain by thin-bedded sublithic arenite and quartz arenite mapped as Heavitree Quartzite?; these arenites also overlie weathered Mount Webb Adamellite, which intrudes the lava. This indicates that the arenites are unconformable on the lava, and that by chance they here overlie the upper highly altered part, rather than the less easily eroded massive central part, of the acid lava.

At and near Mount Webb the Heavitree Quartzite is unconformable on strongly foliated Mount Webb Adamellite (Figs 9, 19). The adamellite immediately beneath the unconformity is much weathered and easily eroded, and the contact is generally concealed by sandstone scree. In an isolated exposure 27 km north-northeast of the Pollock Hills, the Heavitree Quartzite is seen to overlie weathered biotite adamellite.

A conformable contact with the overlying Bitter Springs Formation is exposed on the west side of the Pollock Hills. The contact is taken to be the base of the lowest carbonate bed. Near the contact, arenites within both units are thin to very thin bedded.

An inferred unconformity between Heavitree Quartzite and overlying Angas Hills Beds is poorly exposed 28 km northeast of Mount Webb. Mesozoic sediments probably overlie the Heavitree Quartzite north of the Pollock Hills.

The Heavitree Quartzite can probably be correlated with the Munyu Sandstone and also the Vaughan Springs Quartzite of the Ngalia Basin (Cooper et al., 1971; Wells et al., 1972), and hence is probably Adelaidean. Rb-Sr and K-Ar measurements on glauconite indicate that the likely age of Vaughan Springs Quartzite is about 1300 m.y.

Bitter Springs Formation (Bub)

The Bitter Springs Formation was originally named the Bitter Springs Limestone by Joklik (1955) after the type locality, Bitter Springs, east of Alice Springs. The name was revised to Bitter Springs Formation by Wells et al. (1967). Like the underlying Heavitree Quartzite, outcrops of the formation extend westwards from the Amadeus Basin into the southern part of the Webb Sheet area. Here it crops out as low mounds and, on the west side of the Pollock Hills, as low hogback ridges.

The formation is generally steeply dipping, and east of the Pollock Hills it is probably tightly folded and locally contorted. This may be attributed to its acting as an incompetent layer which deformed plastically during folding. On the west side of the Pollock Hills the formation is at least 300 m thick.

Lithology

The rock types exposed are pale greyish finely crystalline limestone and dolomite, associated thin lenses and laminae of dark grey chert, and thin-bedded quartz arenite: no indications of evaporitic minerals, known to be present in the formation in the Amadeus Basin to the east (Wells et al., 1970), were found. The limestone and dolomite, which generally have some calcrete developed on them, are mainly thin-bedded and locally show undulating to contorted banding which may indicate the presence of stromatolites. Under the microscope they and the associated chert are seen to be recrystallized; this has destroyed any microfossils that may have been present (Dr M.R. Walter, pers. comm., 1974). Quartz arenite is present near the base of the Bitter Springs Formation on the west side of the Pollock Hills, interbedded with carbonates.

The formation was probably deposited in a relatively stable shallow marine environment (Wells et al., 1970).

Stratigraphic relationships, correlations and age

The Bitter Springs Formation is seen to be conformable on Heavitree Quartzite on the west side of the Pollock Hills, where the contact is taken at the base of the lowest carbonate bed. Elsewhere the contacts of the Bitter Springs Formation are concealed by superficial deposits. The formation is inferred to be overlain unconformably by the probably Palaeozoic Angas Hills Beds north of Mount Webb and near the Elizabeth Hills, and by Mesozoic sediments north of the Pollock Hills.

Carbonate beds with associated chert lenses and laminae similar to those of the Bitter Springs Formation also occur in the Munyu Sandstone in the northeast of the Sheet area, indicating a possible correlation between these two units.

Like the Heavitree Quartzite which it overlies, the Bitter Springs Formation is probably Adelaidean.

Redcliff Pound Group

Two formations of the Redcliff Pound Group, the Murraba Formation (Brb) and Erica Sandstone (Bre), are inferred beneath superficial deposits in the northern part of the Sheet area, overlying Munyu Sandstone and overlain, possibly unconformably, by Hidden Basin Beds. The two formations of the group crop out in the Stansmore Sheet area to the north, where their type sections are situated (Blake et al., 1973): the Murraba Formation consists mainly of thin to very thin-bedded chert granule conglomerate, sublithic arenite, and quartz arenite, and the overlying Erica Sandstone consists predominantly of sublithic arenite and subordinate quartz arenite. In the Webb Sheet area both formations are probably overlain unconformably by the Pedestal Beds.

Hidden Basin Beds (Bui)

The Hidden Basin Beds extend south from the Stansmore Sheet area, where their reference area is located (Blake et al., 1973), into the northern part of the Webb Sheet area. Here the beds form plunging anticlines and synclines, and crop out as low cuestas and strike ridges. The maximum thickness exposed is about 600 m.

The rock types cropping out are quartz arenite and sublithic arenite. These are mainly medium to thin-bedded, but the youngest beds exposed, in the centre of the syncline 38 km west of the Alec Ross Range, are very thin-bedded to laminated, and have a flaggy micaceous parting. Cross-bedding is common throughout. The sublithic arenite in composition. Both the quartz arenite and sublithic arenite are mostly medium-grained, but coarse-grained to gritty layers and lenses and also pellety layers are present in places, especially near the basal exposures of the unit. Most of the arenites have some clay matrix, which is locally iron-stained, and although generally silicified, some arenites are friable.

The Hidden Basin Beds are inferred to overlie Erica Sandstone, possibly unconformably, and are overlain unconformably to the west by flat-lying Pedestal Beds. They were folded at the same time as the Redcliff Pound Group, and are probably Adelaidean.

PALAEOZOIC

PERMIAN

Permian rocks belonging to the Canning Basin succession crop out in northwestern part of the Sheet area, where they form low rounded ridges, mesas and buttes, and cuestas. They are generally much weathered, and most outcrops have laterite cappings. The best exposures are along the Waterlander Breakaway. The Permian rocks are less compact and more friable than the Proterozoic sediments. Most of those exposed belong to the Balgo Member of the Liveringa Formation, but some are mapped as undivided Permian. Older Permian and also pre-Permian sediments are probably present in the subsurface, as in the southwest part of the adjoining Stansmore Sheet area (Blake & Yeates, in prep.) - this is evident from seismic, gravity, and well data.

Liveringa Formation - Balgo Member (Po)

In the northeast Canning Basin the Liveringa Formation (Guppy et al., 1958; Veevers & Wells, 1961) is subdivided into the basal Lightjack Member and its lateral equivalent the Balgo Member, the middle Condren Sandstone Member, and the upper Hardman Member. Of these only the Balgo Member* crops out in the Webb Sheet area. Here it consists of flat-lying interbedded ferruginous and micaceous fine ripple-marked sandstone and siltstone and lenses of cross-bedded medium to coarse sandstone containing sparse quartz pebbles. The beds are shallow marine sediments laid down near the eastern margin of the Canning Basin.

The Balgo Member is not seen in contact with other pre-Cainozoic units. It is inferred to be unconformable on Archaean? metamorphic rocks southeast of the Waterlander Breakaway, and conformable on concealed older Permian sediments to the northwest.

Undivided Permian (P)

Several small outcrops south-southeast of the Waterlander Breakaway are mapped as undivided Permian. They consist of weathered sandstone and siltstone which cannot be confidently assigned to formally named Permian units.

UNDIVIDED PALAEOZOIC

Pedestal Beds (Pzs)

The reference area for the Pedestal Beds, and the Pedestal Hills after which they are named, is in The Granites Sheet area (Blake et al., 1973). In the Webb Sheet area the unit crops out in the north, east of the Waterlander Breakaway, where it forms low mounds, hills, and hummocky terrain. Most of the outcrops have cappings of laterite, and good exposures were found at one locality only (lat. 22°02'30"S, long. 128°15'50"E). Here the Pedestal Beds consist of coarse polymictic conglomerate (Fig. 22), about 4 m thick, overlying thin to very thin-bedded fine micaceous sandstone and overlain by cross-bedded pebbly quartzose sandstone which has a clay matrix. The conglomerate contains rounded to angular pebbles, cobbles and boulders, some over 1 m across, of quartzite, arenites, schist, chert, granite, and vein quartz in an abundant matrix of clayey quartzose sandstone. It generally appears quite chaotic, although in places there are some lenses of medium to coarse cross-bedded sandstone. The beds are probably fluvial, and the conglomerate may be a mud-flow deposit.

* In future the term Balgo Member will probably be changed to Lightjack Formation.

The sandstone associated with the conglomerate is similar to that of the Pedestal Beds cropping out in the adjoining Stansmore Sheet area, and also to the sandstone of the Angas Hills Beds to the south.

The Pedestal Beds are flat-lying, and lie unconformably on Hidden Basin Beds and probably also on the Redcliff Pound Group. In The Granites Sheet area they overlie basalt of the Lower Cambrian Antrim Plateau Volcanics. The induration of the Pedestal Beds is similar to that of Devonian sandstone and conglomerate cropping out in the Lucas and Billiluna Sheet area (Blake et al., 1973), and the Beds are therefore thought to be probably Palaeozoic rather than Mesozoic.

Angas Hills Beds (Pza)
(new name)

The Angas Hills Beds form the Angas Hills north of Mount Webb (Figs 7, 8), the Elizabeth Hills to the west (Fig. 6), and isolated outcrops north of the Pollock Hills. They are named after the Angas Hills (lat. 22°50'S, Long. 128°10'E), where the reference section has been selected. Outcrops consist of cuestas and mesas up to 36 m high and craggy to smoothly rounded knolls and ridges. They generally show up as smooth dark tones on aerial photographs. The beds are mainly gently dipping to flat-lying.

The maximum thickness of the Angas Hills Beds appears to be about 300 m, on the west side of the Angas Hills, where the beds dip 15 to 20 southeast. Elsewhere the beds are probably much thinner.

Lithology

The Angas Hills Beds comprise interbedded conglomerate and sandstone (Figs 23, 24) and minor mudstone. Abrupt lateral changes in lithology occur locally. The conglomerate forms beds ranging up to more than 10 m thick, within which there are commonly thin sandstone lenses. It is made up of generally well rounded pebbles, cobbles, and in some cases boulders up to 20 cm across, enclosed in an abundant matrix of poorly sorted clayey sandstone. Exposures commonly consist of pebble-strewn surfaces. Most of the pebbles are of quartzite, chert and Proterozoic quartz arenite and sublithic arenite, but pebbles of gneiss and rare vein quartz are present at some localities. All the pebbles are probably locally derived.

Fig. 23. Angas Hills Beds. Conglomerate overlying sandstone in the Angas Hills. (Neg. GA/8948)

Fig. 24. Angas Hills Beds. Interbedded conglomerate, pebbly sandstone and sandstone showing cross bedding, Angas Hills. (Neg. GA/8956)

The sandstone of the Angas Hills Beds commonly forms craggy exposures. It is medium to thin-bedded, mainly medium-grained, and ranges from quartzose to lithic. It has a commonly abundant and often iron-stained clayey matrix. Some of the sandstone has a micaceous flaggy parting, some has bedding planes covered with pellets, and some is pebbly. Although generally friable, exposed upper surfaces are commonly silicified and many have silcrete cappings. Most beds show low-angle cross-bedding, and ripple marks have been found at a few localities.

At the reference section, a cliff face 36 m high ($22^{o}51'00"S$, $128^{o}12'30"E$) on the east side of the Angas Hills (Fig. 7), 12 km northeast of Mount Webb, the basal 12 m consists of coarse pebble conglomerate with some thin lenses and layers of clayey sandstone. The conglomerate is overlain by 24 m of partly pebbly cross-bedded sandstone, in the middle of which there are some interbeds of maroon mudstone about 10 cm thick. The beds here dip 10^{o} west. Westwards the conglomerate gives way to mainly sandstone.

The Angas Hills Beds are unfossiliferous and are probably fluvial sediments.

Stratigraphic relationships, correlations and age

The contacts of the Angas Hills Beds with other pre-Cainozoic units are generally concealed. However, the Beds are seen to be unconformable on Archaean? metamorphic rocks north of the Pollock Hills and on Heavitree Quartzite east of the Angas Hills. They are probably also unconformable on Bitter Springs Formation.

The lithology, induration, and attitude of the Angas Hills Beds are strikingly similar to those of the Pedestal Beds, with which they are correlated. They are therefore probably Palaeozoic. The Angas Hills Beds may also be correlated with the lithologically similar Ligertwood Beds, also probably Palaeozoic, in the Amadeus Basin to the south and southeast (Wells et al., 1970).

MESOZOIC (M)

Scattered outcrops of undivided Mesozoic sediments have been mapped mainly in the western part of the Sheet area. The sediments are exposed as rocky mounds less than 5 m high and as gently undulating terrain. They are medium to very thin bedded and generally flat-lying; local gentle to steep dips may be depositional. Rock types represented are sandstone, conglomerate, siltstone, and claystone. They range from strongly iron-strained to bleached. Patchy cappings of silcrete are present on many exposures.

The sandstone is friable, porous, fine to coarse, and quartzose, and it has a clay matrix. Cross-bedding, grit and pebble lenses, and scattered pebbles are commonly present. Conglomerate beds contain well rounded pebbles and cobbles of quartz, various types of sandstone, volcanics and granite. The siltstone and claystone are generally white and soft.

The beds are interpreted as fluvial and lacustrine sediments. They are mapped as Mesozoic because they are more friable and softer than the Permian sediments, and they may be correlated with the Cretaceous? Hazlett Beds in the Stansmore Sheet area (Veevers & Wells, 1961; Blake et al., 1973).

CAINOZOIC

Over most of the Sheet area the pre-Tertiary rocks are covered by Cainozoic deposits. In many places the cover is less than 5 m thick, but locally it may be more than 30 m thick, as has been found in The Granites and Lucas Sheet areas to the north (Blake et al., 1973; Blake, in prep.).

Laterite (Czl)

Laterite cappings, the ferruginous upper parts of lateritic weathering profiles, are commonly present on outcrops of schist, granite, and Palaeozoic sediments except those of the Angas Hills Beds. It shows up as smooth dark tones on aerial photographs. In general the rocks affected contain less quartz than the unaffected rocks.

The cappings are generally less than 2 m thick and consist of iron oxide which is commonly pisolitic and locally cemented, clay, and silica minerals. The nature of the underlying bedrock is not apparent in the lateritic capping but may be recognizable in the underlying mottled and pallid zones of the lateritic weathering profile.

As in the Sheet areas to the north (Blake et al., 1973), the laterite cappings appear to be remnants of a flat to gently undulating surface, most of which has been removed by erosion, although some is locally concealed by Quaternary sediments. The amount of erosion indicates that the laterite was probably formed during the Tertiary, and the surface on which it was developed may be correlated with the early or mid Tertiary Tennant Creek erosion surface of Hays (1967).

Silcrete (Czs)

Patches of silcrete are common locally, especially on Angas Hills Beds, but are generally too small to be mapped at 1:250 000 scale. A low mound of silcrete south of the Alec Ross Range is probably formed on Archaean? metamorphics. The silcrete consists of angular fragments, mainly of quartz, in an amorphous siliceous matrix. It does not appear to be forming at the present time, and may be Tertiary rather than Quaternary.

Calcrete (Czk)

Calcrete is developed on limestone and dolomite of the Bitter Springs Formation and apparently on lineaments within the metamorphic basement, but is most extensive as low rises in broad depressions. On the southern margin of the Sheet area west of Mount Webb the low rises are up to 10 m high and their sides are incised by steep-sided drainage channels. Nodular chalcedony is commonly associated with the calcrete, which is a white to pale grey inorganic limestone containing scattered sand grains. Most of the calcrete is hard and cellular, although some is soft and powdery, as on the edge of Lake Mackay. It has a very pale tone on aerial photographs. The calcrete is thought to be a chemical precipitate formed by evaporation of groundwater, and marks former drainage lines and possible lake sites.

Vein quartz rubble (Czq)

Vein quartz rubble is widespread as a thin veneer on metamorphic rocks and less commonly on granite. On aerial photographs it shows up white, and the rubble patches commonly have a wavy pattern caused by alternating bare and vegetated bands reflecting trends in the underlying bedrock. The vein quartz rubble is a residual product, the result of prolonged weathering of quartz-veined metamorphic rocks and granite.

QUATERNARY

The unconsolidated Quaternary sediments that cover most of the Sheet area are grouped into the following five mappable units:

Aeolian and minor piedmont sediments (Qz)

Aeolian sand, the most widespread of the Quaternary sediments, forms the extensive dune fields. These are topographically higher than adjacent Quaternary units, and consist of easterly trending longitudinal (seif) dunes, mainly 5 to 15 m high (Fig. 10). The dunes, which are stationary, show a considerable range in length, density, and complexity (see geological map). They have a sparse vegetation and some of their tops are locally bare.

The unit also includes gravel deposited on piedmont slopes flanking residual hills and ridges.

Alluvial, aeolian, and evaporitic sediments (Qs)

Detrital sand and silt deposited by sheet wash rather than by rivers and mixed with aeolian sand are mapped as Qs. This unit is restricted to broad barely perceptible depressions, many of which are crossed by sand dunes, and it includes salt and clay pans which are too small to be mapped individually (Fig. 10).

Aeolian and evaporitic sediments (Qm)

This unit comprises sand grains and halite and gypsum crystals that have been banked up by the prevailing easterly winds on the western shores of Lake Mackay (Fig. 11) and the large salt lake to the west, and also on the east sides of 'islands' within the lakes. Some soft calcrete (travertine) is commonly present with these sediments.

Evaporitic and lacustrine sediments (Qe)

Evaporitic halite and gypsum and alluvial sand, silt, and clay cover the floors of Lake Mackay (Fig. 11) and the other salt lakes in the Sheet area. The thickness of these sediments is not known. When dry the salt lakes have a thin white crust, generally less than 1 cm thick, of halite and gypsum overlying dark grey to reddish-brown gypsiferous clayey sediments that are waterlogged less than 1 m below the surface. Auger holes were drilled to 3.5 m in Lake Mackay in 1973. Chemical analyses of saline sediments from Lake Mackay within the Lake Mackay Sheet area are given by Terry (1934, 1937) and Nicholas (1969).

Lacustrine and minor evaporitic sediments (Qa)

Lacustrine sand, silt and clay, locally with some evaporitic halite and gypsum, are present in small claypans, such as those near Elizabeth Hills (Fig. 6).

STRUCTURE

Parts of four tectonic units are recognized in the Webb Sheet area: the Precambrian Arunta Block, Birrindudu Basin, and Amadeus Basin, and the Phanerozoic Canning Basin. They are shown in Figure 25, together with the main structural features of the area.

The Arunta Block probably occupies more than half the Sheet area. It is made up of Archaean? metamorphics and Lower Proterozoic Pollock Hills Formation, Mount Webb Adamellite, unnamed granite, and basic dykes. The metamorphic rocks have steep to vertical dips and appear to be tightly folded about steep axes that mainly have west to north-northwest trends. These trends are similar to the foliation trends of the Mount Webb Adamellite and unnamed granite, to the trends of the basic dykes that cut the Mount Webb Adamellite, and to the trends of most inferred major faults. In contrast, the Pollock Hills Formation is folded about north to northeast trending axes, more or less parallel to a major fault west of the Pollock Hills that has brought Mount Webb Adamellite to the north alongside Heavitree Quartzite to the south (Fig. 14). Major trends within the Arunta Block which may be faults are indicated by lineaments; some of these are marked by calcrete and others by quartz veins.

The Birrindudu Basin in the north comprises the Munyu Sandstone, which is strongly unconformable on the Arunta Block, the overlying Redcliff Pound Group, which is concealed, and the Hidden Basin Beds. In the Alec Ross Range the Munyu Sandstone is tightly folded about easterly trending axes and is displaced by several faults (Fig. 20). To the west the Hidden Basin Beds have been folded about axes trending west-northwest.

The outcrops of the Heavitree Quartzite and Bitter Springs Formation in the Sheet area are remnants of the western fringe of the Amadeus Basin, the Heavitree Quartzite being the oldest formation of the Amadeus Basin sequence (Wells et al., 1970). The Heavitree Quartzite has mainly gentle dips except near Mount Webb, where it has been folded into a series of tight elbow-like structures (Fig. 19). It forms more open folds north and west of the Pollock Hills (Fig. 14). The overlying Bitter Springs Formation is structurally incompetent and probably deformed plastically; southeast of the Pollock Hills it has steep to vertical dips and appears to be several kilometres thick, probably owing to isoclinal folding about easterly trending axes.

The fourth tectonic unit, the Canning Basin, occupies the northwest part of the Sheet area. Parts of two sub-units are present here, the southern end of the Gregory Sub-basin and the southeastern part of the Mid-basin Platform. Only flat-lying to very gently dipping Permian sediments are exposed, but older Palaeozoic sediments may be present at depth, especially in the northern part of the Gregory Sub-basin, where a northward increase in thickness of the Phanerozoic is indicated from gravity data within the Sheet area (BMR, 1970) and from well, gravity, and seismic data in the adjoining Stansmore Sheet area (Blake & Yeates, in prep.).

Terrestrial Palaeozoic, Mesozoic, and Cainozoic sediments overlie the main tectonic units. The Palaeozoic sediments may be slightly deformed on the west side of the Angas Hills, where they have relatively steep dips, but elsewhere the dips of the Palaeozoic and younger sediments are flat to gentle and are probably depositional.

Bouguer anomalies

A Bouguer anomaly map of the Sheet area was issued in 1970 (BMR, 1970). It is based on data obtained during and before 1968, and will be superimposed on the First Edition geological map of the Webb Sheet. The positions of the gravity relative 'highs' and 'lows' are shown in Figure 25. There are no steep gravity gradients or strong anomalies. The 'low' north of the Alec Ross Range may be related to granite of the Arunta Block, which crops out in the Stansmore Sheet area to the north. The 'high' on the south side of this range corresponds to metamorphic rocks of the Arunta Block. Anomalies in the south and southeast are also probably related to features of the basement. In the northwest the southern end of a gravity 'trough' corresponds to the termination of the Gregory Sub-basin and indicates a northward increase in thickness of the Canning Basin sediments. The gravity highs on the western edge of the Sheet area are probably related to features of the basement, which here is partly covered by thin Phanerozoic sediments.

GEOLOGICAL HISTORY

The oldest rocks in the Sheet area are the metamorphics of the Arunta Block. These represent sediments that may have been deposited during the Archaean, although the tight folding, regional metamorphism, and development of cleavage probably took place in the Lower Proterozoic. Near the end of the Lower Proterozoic, following a period of uplift and erosion, the acid and minor andesitic volcanics of the Pollock Hills Formation were laid down in the southwest, accompanied by clastic sediments. Some or all of the volcanism may have been submarine.

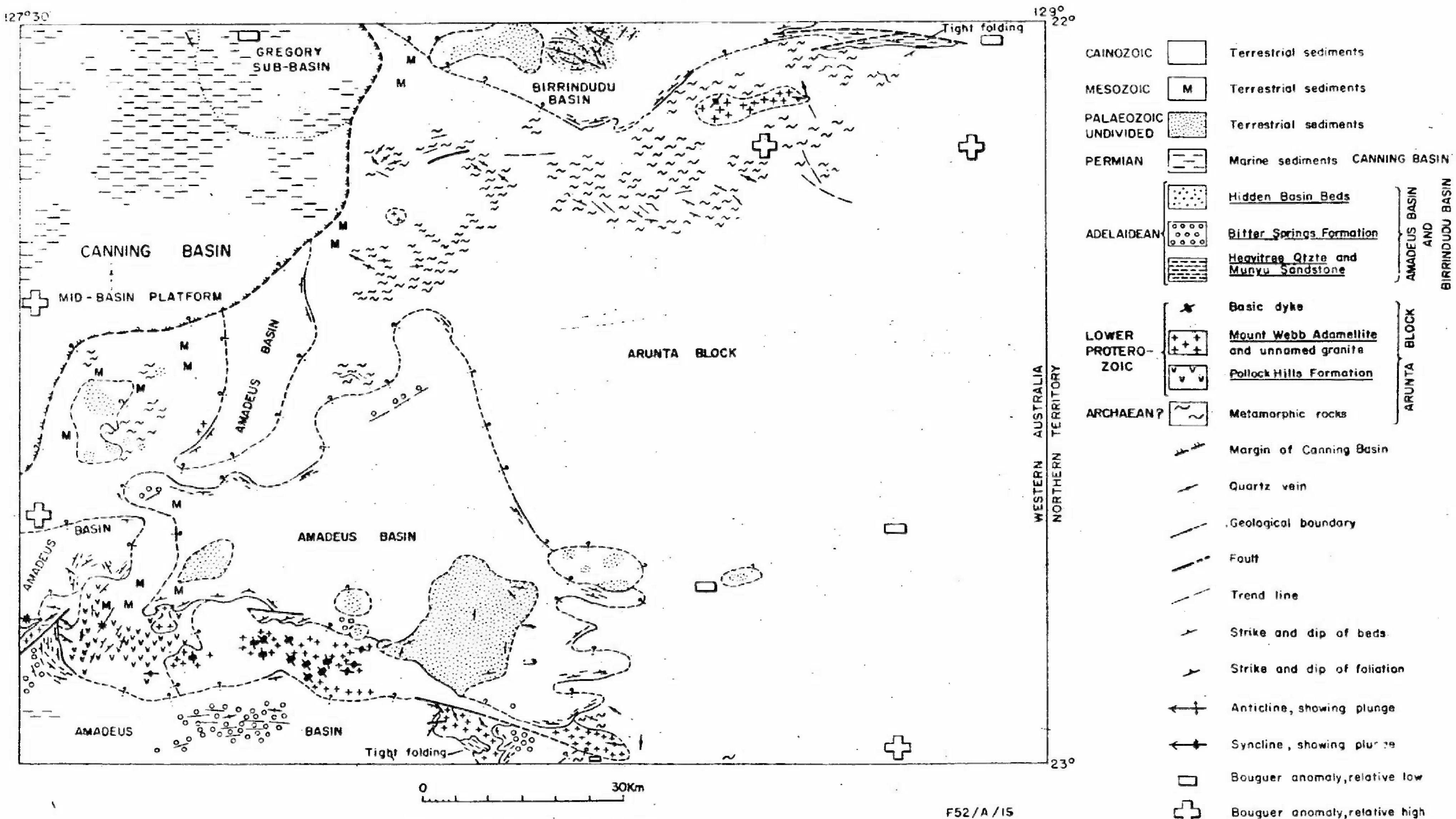

Fig 25 Structural sketch map

The Mount Webb Adamellite and the unnamed granite to the north were emplaced shortly after the deposition of the Pollock Hills Formation, probably in the late Lower Proterozoic. The Mount Webb Adamellite which may have been comagmatic with the acid volcanics of the Pollock Hills Formation, was foliated before being intruded by basic dykes; the foliation may have resulted from the forceful intrusion of the granitic magma as an almost solid crystal mush.

For most of the Carpentarian the area was probably part of a land mass which was gradually worn down by erosion to expose metamorphic rocks and granitic intrusions. A marine transgression occurred in the Adelaiden, and the Heavitree Quartzite and Bitter Springs Formation were deposited on an irregular surface on the western margin of the Amadeus Basin. The two formations probably represent shallow marine sedimentation. At about the same time in the north, and in a similar environment, the Munyu Sandstone was deposited on the southern margin of the Birrindudu Basin, and was succeeded by the Redcliff Pound Group and the Hidden Basin Beds.

Probably during the Petermann Ranges Orogeny, near the end of the Adelaidean or early in the Cambrian, the Adelaidean sediments were folded and faulted, and the area was uplifted to form a land mass.

Marine sedimentation began in the eastern part of the Canning Basin in the Ordovician (Veevers & Wells, 1961), but probably started later in the Webb Sheet area, where the only marine sediments exposed are those of the Balgo Member, part of the Permian Liveringa Formation, in the northwest. These sediments are the youngest marine sediments in the Sheet area, and were derived from the Precambrian landmass to the south and east. Terrestrial Palaeozoic sediments, represented by the Angas Hills and Pedestal Beds, were deposited locally on this land mass, probably in shallow erosional basins.

Terrestrial sedimentation in the Mesozoic and Cainozoic is represented by thin cover deposits. During this time the topography in the Sheet area has become increasingly subdued as subaerial erosion has continued, and now it consists of a general plain with scattered low residual hills. Lateritic weathering profiles, extensive areas of calcrete, and the now stabilized sand dunes indicate that climatic changes have taken place during the Cainozoic.

ECONOMIC POTENTIAL

No mineral deposits of economic importance, nor any base metal occurrences, have been found in the area, either in Precambrian or Phanerozoic rocks. However, little prospecting for metals has been carried out, and the pre-Adelaidean rocks, which are the most likely to contain concentrations of base metals, are generally poorly exposed.

Petroleum

The Precambrian rocks are non-prospective for petroleum. The Permian sediments in the Canning Basin in the northwest are also probably unprospective, as in the Stansmore Sheet area to the north (Blake & Yeates, in prep.), but the possibility of finding petroleum or gas in the Gregory Sub-basin cannot be completely discounted, as there may be reservoir and source rocks in Carboniferous and older sediments possibly present in the deepest part of the sub-basin, on the northern edge of the Sheet area.

Water

Surface water is rare, because of the low rainfall and high evaporation rate, and is largely restricted to small temporary rock holes in the Alec Ross Range, Pollock Hills and Angas Hills. Accumulations of rain water may persist for a few days in salt lakes, salt pans and clay pans, but are unlikely to be fit for human or animal consumption.

There has been no need so far to test groundwater supplies, and there are no water bores in the area. Water of variable quality and quantity can be expected at shallow depth in calcrete, and other potential sources are the more porous of the Precambrian sandstones and perhaps some of the Permian sediments in the northwest. Water obtained from the Balgo Member is likely to be salty.

Evaporites

Except when covered by water, the salt lakes in the area have a thin surface crust, generally less than 1 cm thick, of the evaporite minerals gypsum and halite. Both minerals are also present in underlying lacustrine silt and clay, and occur with aeolian sand around the margins of the salt lakes.

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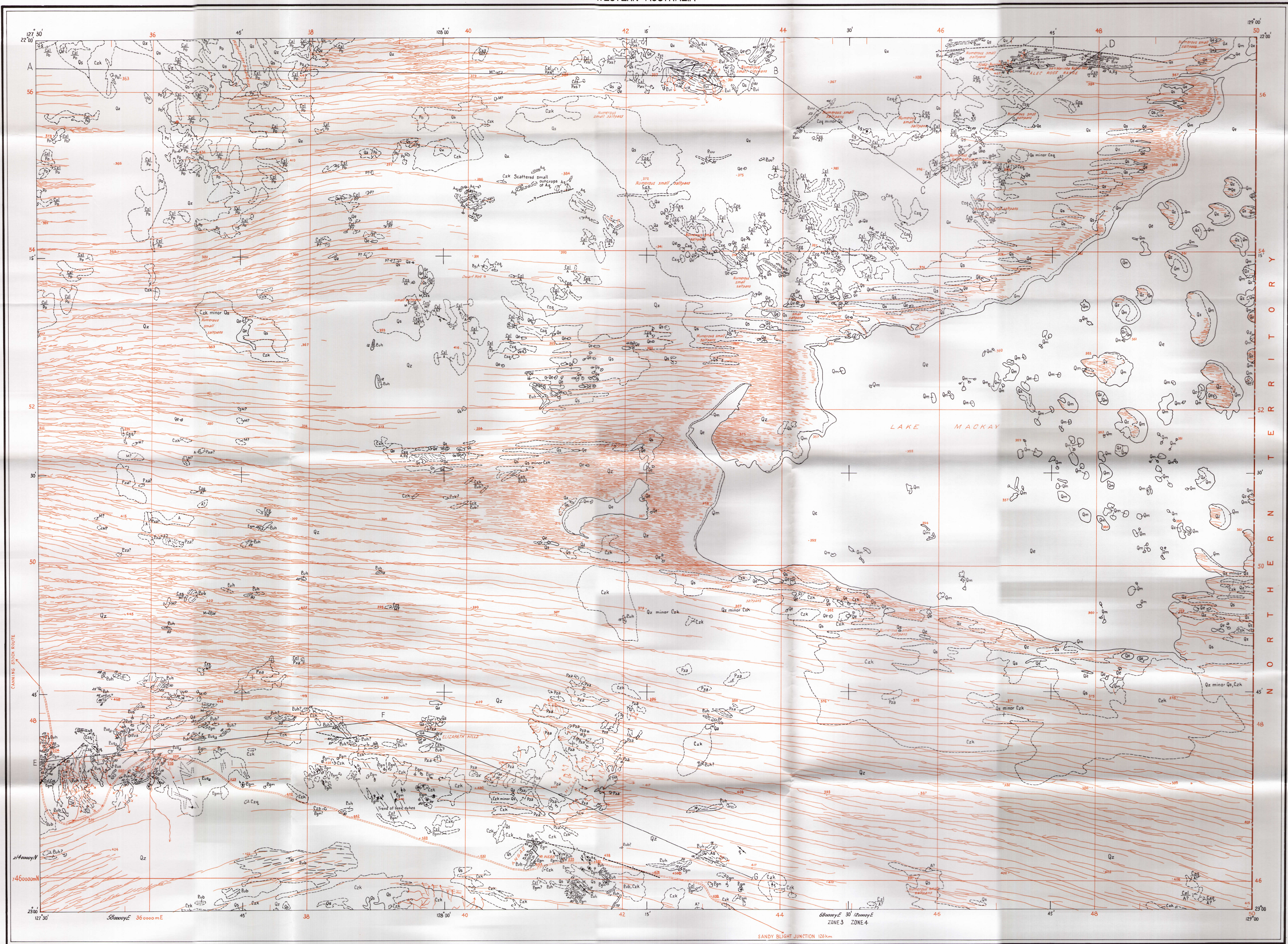
AUSTRALIA 1:250 000 GEOLOGICAL SERIES

WEBB

WESTERN AUSTRALIA

SHEET SF 52-10



Reference

CAINOZOIC	QUATERNARY		Qa	Sand, silt, clay; minor halite, gypsum: lacustrine and evaporitic
			Qe	Halite, gypsum, sand, silt, clay: evaporitic and lacustrine
			Qm	Sand, gypsum, halite, calcrete: aeolian and evaporitic
			Qs	Sand, silt; minor halite, gypsum: alluvial, aeolian and evaporitic
			Qz	Sand, minor gravel: aeolian and minor piedmont
			Czq	Vein quartz rubble
			Czk	Calcrete, chalcedony
			Czs	Silcrete
			Czl	Laterite capping
MESOZOIC ?			M	Clayey quartzose sandstone, conglomerate, siltstone, claystone
PALAEOZOIC		Angas Hills Beds	Pza	Conglomerate, clayey quartzose and lithic sandstone, locally micaceous; minor mudstone
		Pedestal Beds	Pzs	Conglomerate, quartzose and lithic sandstone, thin bedded siltstone and fine sandstone
	PERMIAN		P	Sandstone and siltstone
		Liveringa Formation Balgo Member	Po	Ferruginous fine sandstone and siltstone, coarse sandstone lenses
PROTEROZOIC	ADELAIDEAN	Redcliff Pound Group: Hidden Basin Beds	Ꝑui	Quartz arenite, sublithic arenite
		Redcliff Pound Group: Erica Sandstone	Ꝑre	Sublithic arenite, quartz arenite (Section only)
		Redcliff Pound Group: Murraba Formation	Ꝑrb	Chert granule conglomerate, sublithic arenite, quartz arenite (Section only)
		Bitter Springs Formation	Ꝑub	Limestone, dolomite, chert, thin bedded quartz arenite
		Heavitree Quartzite	Ꝑuh	Quartz arenite, sublithic arenite; minor siltstone and greywacke
		Munyu Sandstone	Ꝑuu	Quartz arenite; minor limestone, chert, conglomerate
	LOWER PROTEROZOIC		Ꝑg	Granite
		Mount Webb Adamellite*	Ꝑgm	Biotite and hornblende biotite adamellite; commonly foliated; minor aplite
		Pollock Hills Formation*	Ꝑus	Lithic and sublithic arenite, tuffaceous sandstone and siltstone, conglomerate, lapilli tuff, agglomerate
			Ꝑusa	Porphyritic acid lava and non-porphyritic andesitic lava
ARCHAEAN ?			A	Schist, quartzite
			Aq	Quartzite
			As	Schist

*Name not yet approved

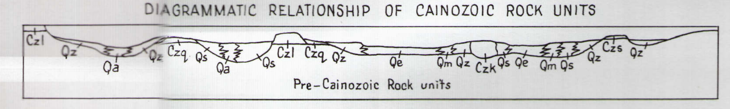
Geological boundary
Anticline showing plunge
Syncline showing plunge
Fault

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

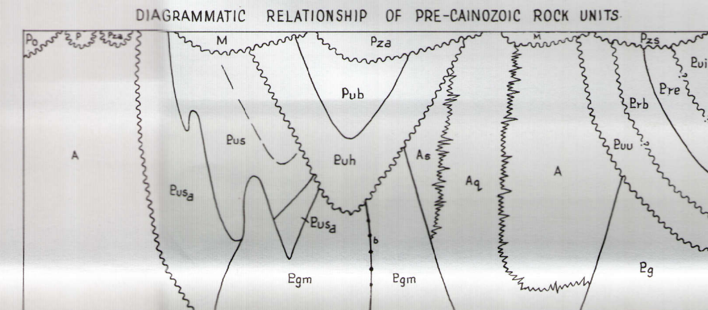
Strike and dip of strata
Strike and dip of strata, facing not known
Vertical strata, facing not known
Horizontal strata
Trend line } airphoto interpretation
Joint pattern } airphoto interpretation
Strike and dip of foliation
Vertical foliation
Strike and dip of cleavage
Vertical cleavage
Dyke or vein: Dyke b-basic, Vein q-quartz

Rockhole
Sand dunes
Vehicle track
State boundary
Trigonometrical station
Astronomical station
Elevation in metres, accurate
Elevation in metres, approximate
Position approximate

DIAGRAMMATIC RELATIONSHIP OF CAINOZOIC ROCK UNITS



DIAGRAMMATIC RELATIONSHIP OF PRE-CAINOZOIC ROCK UNITS



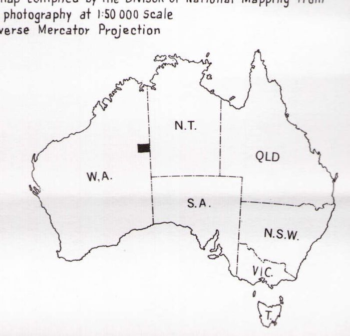
Uncomformity, Facies change

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, Zones 3,4 (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

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of Minerals and Energy. Issued under the authority of the Hon. R.F.X. Connor, M.P. Minister for Minerals and Energy.
Base map compiled by the Division of National Mapping from aerial photography at 1:50 000 Scale
Transverse Mercator Projection



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination 1970

DUMMER SF 51-4	CORNISH SF 52-1	LUCAS SF 52-2	THE GRANITES SF 52-3	MOUNT SOLITAIRE SF 52-4
PERCIVAL SF 51-8	HELENA SF 52-5	STANSMORE SF 52-6	HIGHLAND ROCKS SF 52-7	MOUNT THEO SF 52-8
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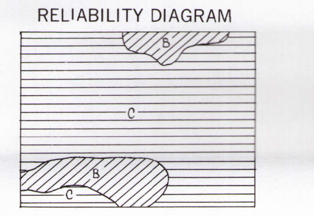
MORRIS SF 51-16	RYAN SF 52-13	MACDONALD SF 52-14	MOUNT RENNIE SF 52-15	MOUNT LIEBIG SF 52-16
WARRI SG 51-4	COBB SG 52-1	RAWLINSON SG 52-2	BLOODS RANGE SG 52-3	LAKE AMADEUS SG 52-4

Scale 1:250,000

5 0 5 10 15 20 25 KILOMETRES

5 0 5 10 MILES

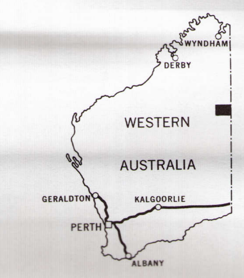
RELIABILITY DIAGRAM



B Detailed reconnaissance: numerous traverses, and airphoto interpretation

C General reconnaissance: few traverses, and airphoto interpretation

Geology 1973 by D.H.Blake, I.M.Hodgson, R.R.Towner (BMR); R.W.A. Crowe (GSWA)
Compiled 1973 by D.H.Blake
Drawn 1973 by D.Green
Printed by: Mercury-Walch Pty Ltd., Hobart, Australia

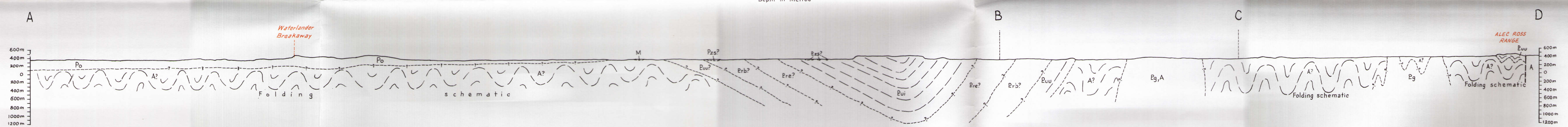


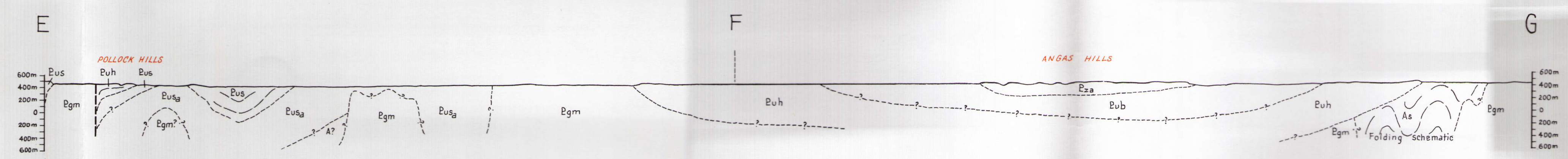
Sections

Cainozoic sediments omitted

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

Depth in Metres





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