

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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GUNANYA 1:250 000 GEOLO-
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31.
EXPLANATORY NOTES ON THE GUNANYA

1:250 000 GEOLOGICAL SHEET

WESTERN AUSTRALIA

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I.R. Williams and S.J. Williams

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EXPLANATORY NOTES
ON THE
GUNANYA 1:250 000 GEOLOGICAL SHEET
WESTERN AUSTRALIA

by

I.R. Williams and S.J. Williams

INTRODUCTION

The Gunanya 1:250 000 Sheet, SF51-4 of the International Series, is bordered by latitudes $23^{\circ}00'S$ and $24^{\circ}00'S$, and longitudes $121^{\circ}30'E$ and $123^{\circ}00'E$. It straddles the Tropic of Capricorn (approximate latitude $23^{\circ}26'$) and lies in the Eastern Land Division of Western Australia. It is named from Gunanya Spring (approximate location $23^{\circ}05'S$, $122^{\circ}43'E$) which occurs near the southeastern end of the McKay Ranges. The spring was first noted by Hann in 1897, and a description was given in Talbot (1910) who refers to it as Gunanyu Spring. An unsuccessful attempt was made in the present survey to re-locate the spring.

The region is uninhabited although many cave paintings and stone arrangements point to earlier, aboriginal habitation. Cattle grazing has extended as far east as the junction of Savory and Boondawari Creeks.

Vehicle access is restricted to four-wheel drive units. The old, graded track from Talawana Homestead to Windy Corner via Karara Well (Well 24 of the Canning Stock Route) crosses the northeast corner of the area. A tortuous but well-defined four-wheel-drive track roughly follows the old Canning Stock Route past Well 16 to the Durba Hills. From Killagurra

Spring in the Durba Hills, a faint, sandy track can be followed with difficulty northwards around the western margin of Lake Disappointment, thence northeast to join the Talawana to Windy Corner track near Well 23. Another track extends eastwards from Robertson Range homestead on the adjoining Robertson 1:250 000 Sheet, to the junction of Savory and Boondawari Creeks. During the present survey a vehicle traverse was made from the Durba Hills west-northwestwards to the Boondawari-Savory Creek junction.

The Gunanya mapping was part of a helicopter-mapping project in August-September 1975 which covered the Proterozoic terranes of seven 1:250 000 scale sheets. The Gunanya Sheet was mapped mainly from a helicopter (11 days, 28 hours flying, 70 stops). Vehicle traverses were carried out along all tracks, and a ground traverse was made over the metamorphic rocks in the McKay Ranges.

Geological data was plotted on air photographs, at an approximate scale of 1:80 000, flown in 1974 by the Commonwealth Department of Interior.

PREVIOUS INVESTIGATIONS

The initial investigations on the Gunanya Sheet were carried out by exploration parties endeavouring to cross the desert regions of Western Australia. In 1876, Ernest Giles, on his return journey to South Australia, passed along the southern boundary of the sheet. Lawrence A. Wells (1902), leader of the Calvert Scientific Exploring Expedition, crossed the southeast corner in 1896. He located and named a number of prominent topographic features such as Sir Fowell Headland, Russel Head and Calvert Range, but failed to observe Lake Disappointment. However, shortly after, in April 1897, F.H. Hann, searching for pastoral land, discovered the northwest

corner of Lake Disappointment. A proposed stock-route from Wiluna to Halls Creek was surveyed through the region by Canning in 1906-1907.

The first geological observations were made by Talbot (1910, 1920) who accompanied Canning's well-sinking party along the stock route in 1908-1909. He noted the isolated, sandstone hills of the Durba and Diebil areas, and commented on the metamorphic rocks and structure of the McKay Range.

Kidson (1921) carried out a magnetic survey along the Canning Stock Route in 1914, as part of an Australia-wide survey for the Carnegie Institute of Washington.

Because the rock succession was acknowledged to be Precambrian, the sheet was not included in the surveys of the adjoining Phanerozoic Canning Basin by oil companies and the Bureau of Mineral Resources during the 1950's and early 1960's (Traves and others 1957; Veevers and Welis 1961). Hence the 1975 field mapping represents the first systematic geological investigation of the sheet.

CLIMATE, VEGETATION, PHYSIOGRAPHY

There are no meteorological stations on the sheet; however, the area would be classified as desert having a summer rainfall (Beard and Webb, 1974). The average rainfall is about 200 mm, most of which falls in the summer and is the product of tropical cyclonic activity. Winter rains are generally light.

Three main groups of vegetation have been distinguished (Beard and Webb, 1974). The most characteristic group, a mixed-shrub steppe of *Acacia*, *Hakea* and *Grevillea* spp. with spinifex (*Triodia pungens* and *Plectrachne schinzii*), grows on the extensive sand-dune country. The gently sloping, largely

dune-free sandplain areas, which occur on the western sides of prominent hills bear a shrub steppe of *Acacia* and *Hakea* spp. with a different spinifex (*Triodia basedowii*). The third and most restricted group is a grass steppe of spinifex (*Triodia* spp.) on the rocky hills and ranges.

Eucalyptus spp., particularly Desert Bloodwood, are widely scattered over the sand-dune country. River gums (*Eucalyptus camaldulensis*) occur along the Savory Creek west of the McFadden Ranges and around permanent springs. Desert oaks (*Casuarina decaissneara*) are common in interdunal flats west of Lake Disappointment and also along calcreted, drainage lines. The margins of Lake Disappointment, the lower reaches of Savory Creek, and the salt lake country west of the McFadden and Diebil Hills support samphire communities.

The sheet lies in the Sandridge or Sandland Division as defined by Jutson (1950). However it is uncertain which desert region the area belongs. Historically it is regarded as part of the Gibson Desert. However, its superficial deposits are not typical of the main Gibson Desert further east (which is a stony desert with a laterite surface), but similar to those of the Great Sandy Desert to the north. This anomaly has been pointed out by Beard (1969), who argues in favour of a new name, Little Sandy Desert, for the Gunanya area and adjacent sand-dune country to the south and west.

Desert sand-dune and plain country, rocky island-hills, and salt-lake country are the three main physiographic types (Fig.1).

Lake Disappointment is a salt lake or playa, which covers an area of about 1 500 km² and lies about 324 m above sea level. All calcreted drainage lines, as well as the present day Savory Creek and other ephemeral creeks flow towards Lake Disappointment, which, in the early Tertiary, emptied eastwards around the northern end of the Runton Ranges.

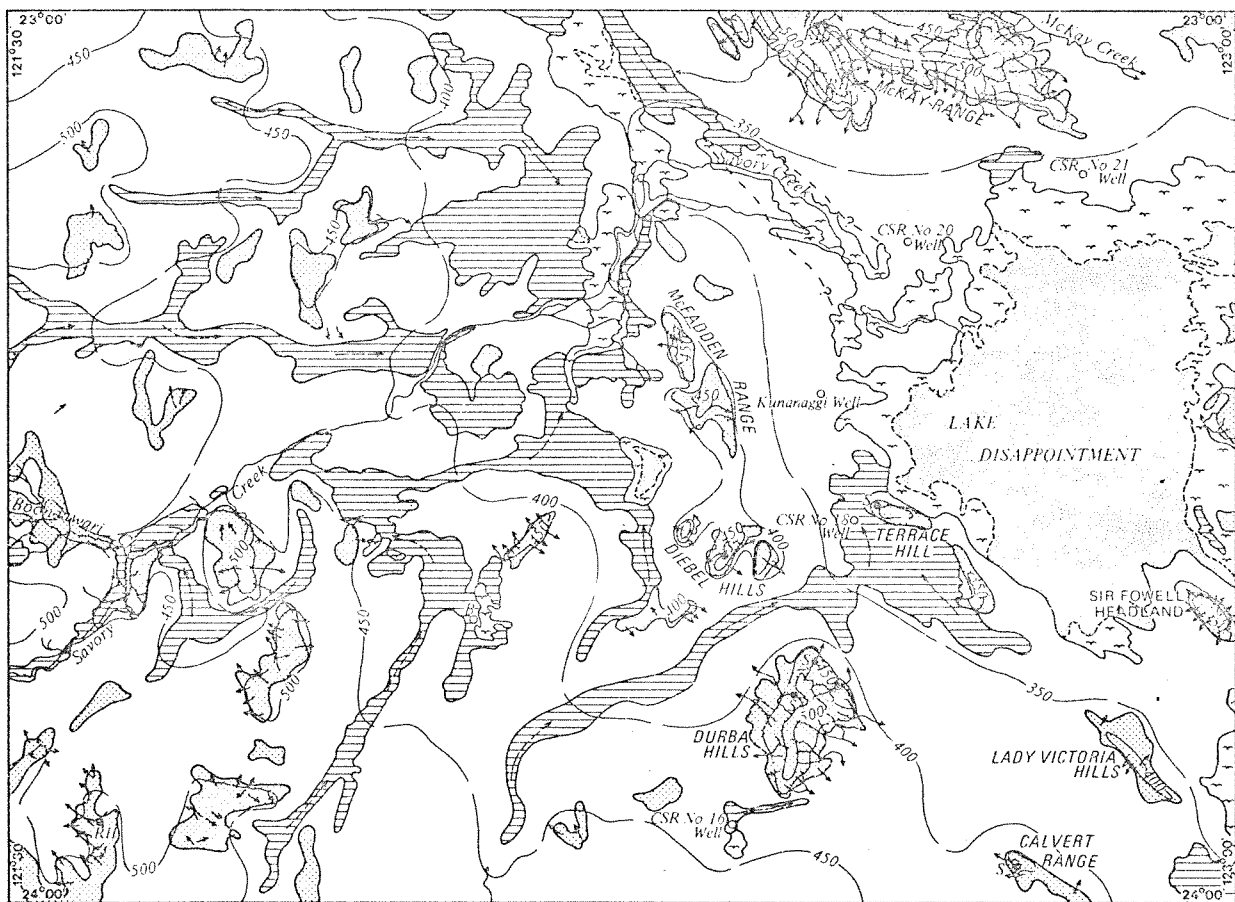













FIGURE 1
PHYSIOGRAPHY AND DRAINAGE
 GUNANYA SHEET SF 51-14

10 0 10 20 30 40km

REFERENCE

- | | | | |
|---|----------------------------------|---|-------------------------------|
|  | Saline lake, playa |  | Ephemeral drainage |
|  | Lake country |  | Inferred flow palaeodrainage |
|  | Calcrete in palaeodrainage lines |  | Topographic contour in metres |
|  | Island hills, major outcrop |  | Spring |
|  | Desert sand |  | Rockhole |
| | |  | Canning Stock Route Well |

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Savory Creek can be divided into two domains. Before entering salt-lake country west of the McFadden Ranges, it has a well-defined, braided channel incised to a depth 20 m in places, and containing thick vegetation and pools of relatively fresh water. Between the McFadden Ranges and Lake Disappointment, the creek divides into several widely separated saline channels up to 10 metres deep, which support little vegetation apart from samphire communities.

A north-trending zone of salt and clay pans, lunette dunes, and kopi deposits, occurs west of the Diebil Hills and the McFadden and McKay Ranges.

Profiles suggest that the salt lakes are migrating to the east. Fresh bedrock occurs on the eastern side of Lake Disappointment whereas extensive kopi and sand-buried lake deposits fringe the western margin. Low breakaways also occur on the western side of the McFadden Ranges. The easterly migration of the salt lakes is contrary to that in the Eastern Goldfields region and the Salinaland Division in general, where it has been suggested that the salt lakes migrate west-northwestward (Jutson, 1950).

The island-hills and most outcrop areas are rocky and dissected. Maximum relief of 200 m is attained in the McKay Ranges and Durba Hills. Scarps are common on the western sides of prominent hills, for example the Durba Hills and the unnamed hills east of the Boondawari-Savory Creek junction. In contrast, the eastern sides are buried in wind-blown sand.

The bulk of the area is covered with wind-blown sand. The dunes are predominantly seif or longitudinal dunes which trend between 270° and 300° . They range from 3 m to 35 m in height and are spaced as many as 4 per kilometre. Individual dunes may be up to 20 km long. Simple, and chain, longitudinal dunes occur, and both types commonly link up along strike. Extensive net-dune complexes generally occupy

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drainage depressions. The origin of the dunes has been discussed by Veevers and Wells (1961) and Crow (1975).

REGIONAL SETTING

The Gunanya Sheet includes parts of two tectonic units of the Western Australian Shield, the Paterson Province and the Bangemall Basin (Fig.2). These terms were introduced by Daniels and Horwitz (1969), but their boundaries have been considerably modified following the recognition of the Yeneena Group (Williams and others, 1976).

The Paterson Province now includes both the Rudall Metamorphic Complex and the Yeneena Group. The Yeneena Group is a thick, strongly folded, Middle or Lower Proterozoic sedimentary sequence which unconformably overlies the metamorphic basement.

Rocks of the Bangemall Group occupy the western two-thirds of the sheet, and an inferred unconformity between these rocks and the Yeneena Group is taken as the north-eastern boundary of the Bangemall Basin (Williams and others, 1976).

The stratigraphy of the sheet is summarized in Table 1.

PATERSON PROVINCE

RUDALL METAMORPHIC COMPLEX

Metamorphic rocks, which form part of the Rudall Metamorphic Complex (Chin and others, in prep.), are exposed

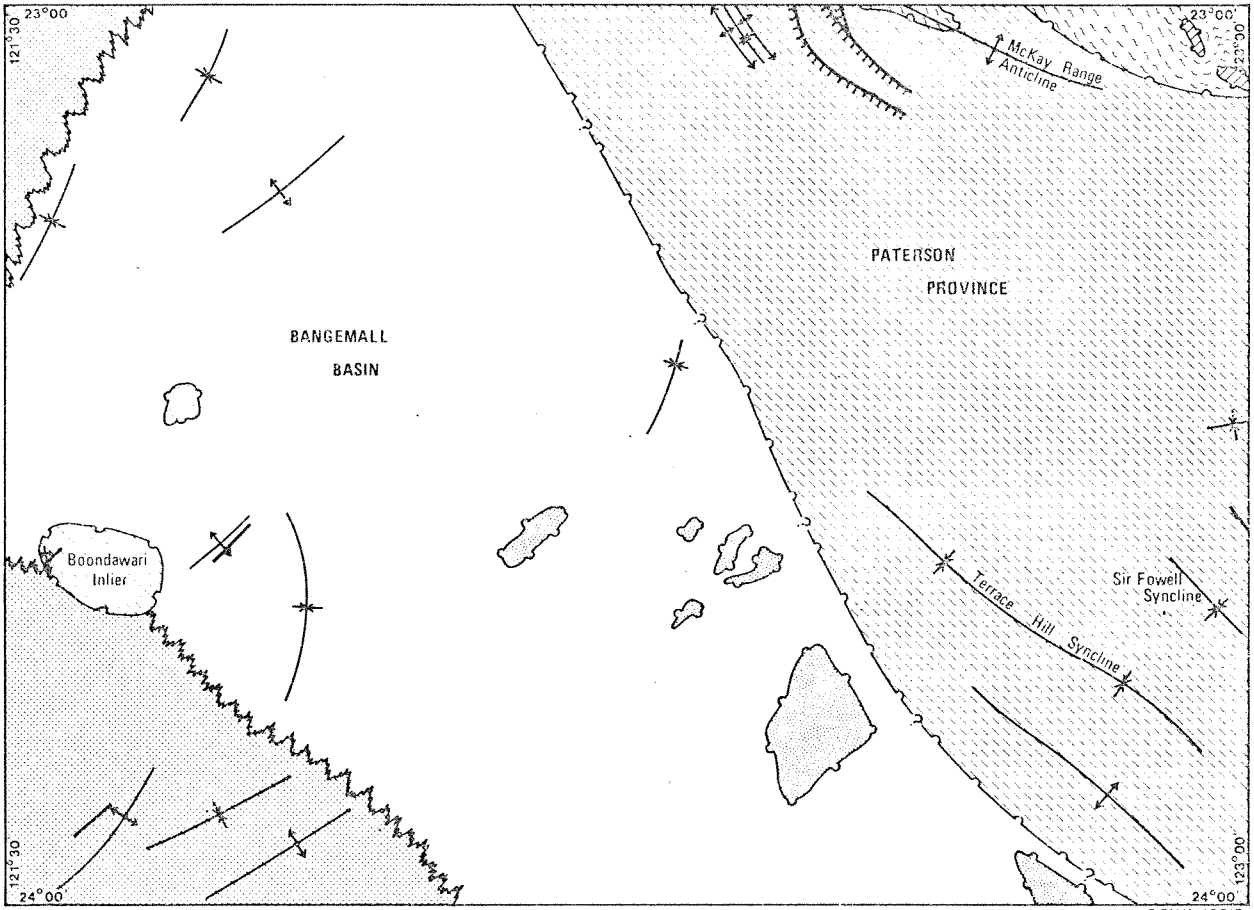















FIGURE 2
STRUCTURAL SKETCH
 GUNANYA SHEET SF 51-14

10 0 10 20 30 40km

REFERENCE

- | | | | |
|---|----------------------------|--|--|
|  | Durba Sandstone |  | Fault |
|  | McFadden Sandstone |  | Reverse fault, (hachures show downthrow) |
|  | Calyie Sandstone |  | Syncline |
|  | Karara Beds |  | Anticline |
|  | Yeneena Group |  | Concealed boundary |
|  | Rudall Metamorphic Complex |  | Unconformity |
| | |  | Facies change |

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TABLE 1. STRATIGRAPHY OF THE GUNANYA 1:250 000 SHEET AREA

Age	Rock unit and symbol	Lithology	Thick- ness (m)	Remarks	
CENOZOIC	Quaternary	Ql	Clay, silt, sand, gypsum	?20	Poorly consolidated, lacustrine, saline
		Qg	Silt, sand, kopi	?20	Poorly consolidated, mixed eolian and lacustrine
		Qa	Clay, silt, sand, gravel	?20	Poorly consolidated; alluvium confined to larger creek systems
		Qc	Silt, sand, gravel	?25	Poorly consolidated and poorly sorted colluvium includes talus, low slope deposits
		Qp	Sand, pebbles	?10	Poorly consolidated, eolian sand, mixed with interdunal occurrence of ironstone pebbles derived from underlying soil profile. A lag deposit
		Qs	Red quartz sand	?30	Poorly consolidated eolian sand
		Czk	Calcrete	?20	Moderately to well-consolidated limestone in old drainage lines
		Czc	Hardpan, clay, silt, sand and pebbles	?15	Moderately consolidated, exposed in incised banks of Savory Creek, crude bedding
		Czl	Pisolitic ironstone, nodular, cavernous laterite	?3	Overlies deep weathered bedrock; well cemented duricrust, includes some silcrete

TABLE 1 CONT'D

Age	Rock unit and symbol	Lithology	Thick- ness (m)	Remarks	
PROTEROZOIC	--- Middle Proterozoic ---				
	Bangemall Group	Durba Sandstone Bs	Quartz sandstone, thin basal conglomerate	100	Marine; unconformable on McFadden Sandstone of the Bangemall Group
		McFadden Sandstone BMm	Quartz arenite, quartzose wacke and feldspathic wacke, common granule-bearing and pebble conglomerate	1 000	Shallow marine facies equivalent to Calyie Sandstone; unconformable on Yeneena Group; calcareous siltstone in lowest exposure; very large cross-bed sets, up to 16 m thick
		Calyie Sandstone BMy	Quartz arenite, minor conglomerate, shale and siltstone	1 000	Deep-water marine; facies equivalent of McFadden Sandstone
	?	Karara Beds BK	Siltstone, sandstone, conglomerate	-	Marine, unconformable on Yeneena Group and Rudall Metamorphic Complex Deformed by D4 only
	?	Yeneena Group BY	Quartz sandstone, shale, siltstone, conglomerate, minor dolomite	3 000	Marine; unconformable on Rudall Metamorphic Complex. Lower units show low-grade regional dynamic metamorphism in the McKay Range. Deformed by D3 and D4
	--- Lower Proterozoic ---	Rudall Metamorphic Complex E _q , E _i , E _n	a. Quartzite-schist	?	Unconformable on older gneiss unit. Greenschist metamorphism deformed by D2, overprinted by D3 and D4
		b. Gneiss	?	Subjected to high grade metamorphism during D1 followed by greenschist retrograde metamorphism and cataclastic deformation during D2; later folding and crenulation by D3 and D4	

in the core of the McKay Range Anticline and in the north-eastern corner of the sheet. The metamorphic rocks comprise a gneissic unit and a younger group of quartzite and schist. Both units are Lower, or possibly, Middle Proterozoic; and some of the original rock sequences may have been Archaean.

The gneissic rocks consist mainly of medium-grained, compositionally banded, quartz-microcline-biotite gneiss (Bnb), which is commonly pinkish grey. In the extreme northeast corner of the sheet there is a small amount of mafic gneiss, (Bna) composed of hornblende, plagioclase and, in places, garnet. Banded quartz-magnetite rock or metamorphosed, banded iron-formation (Bim) occurs in the same area. These rocks have a well-defined gneissic foliation. The gneissic group has subsequently undergone retrograde metamorphism which, in the Bnb rocks, has commonly resulted in the formation of muscovite and sericite.

The younger group of metamorphic rocks consists of white, medium-grained, flaggy, laminated quartzite (Egq), micaceous quartzite and quartz-muscovite schist (Egm), and quartz-biotite-muscovite schist (Egb) which contains 10-20 per cent biotite. Tourmaline is a common accessory and some schists have andalusite. All these rocks have a well-defined schistosity in hand specimen, and this is frequently crenulated. The quartzite-schist group has been metamorphosed under conditions of middle greenschist to lower amphibolite facies. This prograde metamorphism occurred at the same time as the retrograde metamorphism of the older gneissic group.

YENEENA GROUP

On the adjacent Rudall 1:250 000 Sheet, the Yeneena group has been divided into four formations; the basal Coolbro Sandstone, and the overlying Broadhurst, Choorun and Isdell

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Formations (Chin and others, in prep.). Equivalent rocks on the Gunanya Sheet outcrop discontinuously; which prevents the use of formational names on the Gunanya Sheet.

The Yeneena Group occupies the eastern third of the sheet. It outcrops prominently in the McKay Ranges where the folded unconformity with the underlying Rudall metamorphic complex is well exposed. The best section of the Yeneena Group occurs in the McKay Ranges where a basal conglomerate and sandstone unit up to 250 m thick, lies unconformably with a southerly dip of 30° on quartzites and quartz-mica schists of the Rudall Metamorphic Complex. The conglomerate is poorly sorted and contains clasts, ranging from pebbles to large cobbles, set in a micaceous sandy matrix. The clasts are locally derived from the quartz-mica schist and quartzite. The unit is possibly equivalent to the basal Coolbro Sandstone of the Rudall Sheet.

The conglomerate is overlain conformably by a sequence, not more than 250 m thick, of purple, blocky, micaceous siltstone, sandy siltstone and shale. Thin interbeds of fine-grained micaceous sandstone are also present. This siltstone-shale unit possibly correlates with the Broadhurst Formation.

It is overlain conformably by a sequence in excess of 2 500 m, of interbedded medium- to coarse-grained, flaggy or thick-bedded quartz sandstone, and quartz-pebble conglomerate. Cross-bedding is a common feature of the sandstone units. Random, siliceous veining and small micro-faults have been found in the sandstone units of the McKay Range and in scattered exposures northeast of the McFadden Range.

Well-bedded, fine to medium-grained, massive or flaggy sandstone occurs at Terrace Hill and in the Lady Victoria Hills. Ripple marks, both directional and non-directional are more common than cross-bedding. The coarse sandstone units contain bands of clay and siltstone pellets.

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The Sir Fowell Headland consists of purple, micaceous siltstone and shale, interbedded with white, flaggy or thick-bedded, fine to medium-grained sandstone. A rhythmic sequence was observed in a cliff in the eastern side of the headland. Purple shale passes upwards to siltstone, then, to white, fine- to coarse-grained sandstone, and then again to purple shale. This sequence is repeated. Ripple marks are common in the siltstone, and cross-bedding occurs in the sandstone. Similar sequences are found in the outliers of the Runton Range east of Lake Disappointment. Dolomite has been recorded from this sequence on the adjacent Runton Sheet (Crowe and Chin, in prep.).

PRE-BANGEMALL ROCKS OF THE BOONDAWARI INLIER

A small window of pre-Bangemall rocks outcrops around, and upstream from, the junction of Boondawari and Savory Creeks. At the western edge of this exposure, on Boondawari Creek, the rocks consist of purple, or chocolate-brown, micaceous siltstone and shale, interbedded with white, fine- to medium-grained sandstone. A hard, medium-grained, silicified orthoquartzite outcrops along the eastern bank of Savory Creek downstream from the junction with Boondawari Creek. This is interbedded with fine-grained, ripple-marked, silty sandstone.

These rocks differ from the surrounding flat-lying Bangemall Group in that they are folded, have dips up to 20° , and have a coarse fracture-cleavage. Correlation with the Yeneena Group is tentative because the nearest exposure lies 75 km to the east. Nevertheless they show lithological and structural similarities to the Yeneena Group.

KARARA BEDS

Small exposures of Karara Beds (Crowe and Chin, in prep.) occur on the northeastern margins of the sheet. The Karara Beds are a mixed sequence of coarse-grained quartz wacke and greenish greywacke at the base, passing up into a pebble conglomerate, medium-grained sandstone, and orthoquartzite. Thin, carbonate beds, chloritic phyllite, and sandy feldspar-rich argillite occur within the greywacke sequence. The pebbles in the conglomerate are quartzite and granitoids. Cross-bedding and load casts have been found.

The sequence sits unconformably on granitoid rocks of the Rudall Metamorphic Complex. The Karara Beds have been subjected to very low-grade, dynamic metamorphism. They show a distinct fracture-cleavage, and contain zones of strong penetrative foliation which possibly represent shear zones or tight folding. The relationship of the Karara Beds to the Bangemall Group is unknown.

MAFIC IGNEOUS ROCKS

Two, small, irregular-shaped dolerite bodies (Bd) intrude the younger quartzite and schist group of the Rudall Metamorphic Complex. These bodies are folded and slightly metamorphosed. They are correlated with sills that intrude the Yeneena Group on the Rudall sheet (Chin and others, in prep.). The sills are folded with the Yeneena Group rocks.

BANGEMALL BASIN

BANGEMALL GROUP

Nowhere on the sheet have the Bangemall and Yeneena Groups been seen in actual contact; however, the difference

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in structural style between the gently dipping Bangemall Group and the moderately folded, northwest-trending Yeneena Group suggests an unconformity between the two. The outcrop distribution points to a remarkably straight north-northwestward trending contact, which could possibly represent a fault, but corroborating evidence for an unconformity has been found on the Rudall Sheet in the Hanging Rock district (Chin and others, in prep.).

The Bangemall Group is divided into the McFadden Sandstone and the Calyie Sandstone. The two formations are thought to be coeval facies-variants that reflect different sedimentary environments. However, the exact form of the contact between the two cannot be established. The boundary as shown on the map, reflects only the approximate position of a change in the sandstone characteristics.

McFadden Sandstone

The type area of the newly defined McFadden Sandstone is the McFadden Range ($23^{\circ}21'30''S$, $122^{\circ}18'30''E$), 25 km west of Lake Disappointment, where the unit is exposed in mesas up to 100 m high. West and northwest of this area the formation outcrops in many isolated, low, rock hills. The largest outcrops lie in rounded hills 15 km east of the Boondawari-Savory Creek junction. The McFadden Sandstone also forms an extensive breakaway at the headwaters of Boondawari Creek; it occupies most of the western half of the sheet, and extends southeasterly across the adjoining Trainor Sheet (Brakel and Leech, in prep.) and marginally onto the Rudall Sheet (Chin and others, in prep.).

The McFadden Sandstone is predominantly a purple, purple-brown, or grey-brown, friable quartzo-feldspathic sandstone. Many sandstones contain more than 10 per cent matrix, and could be termed wackes. Where the case-hardened outer surface has been stripped off, as for example in overhangs along cliffs, a purplish-white, speckled, or banded appearance is revealed.

In the McFadden Range, Diebil Hills, and Durba Hills, the formation contains thin beds of pebble and granule conglomerate. The clasts are quartz, chert, and quartzite. The formation is characterized large heterogenous cross-bed sets up to 10 m thick. Flaggy bedding within the cross-bedding units show graded bedding, ranging from pebbles and granules upwards to coarse- and fine-grained sandstone. The very large cross-bed sets make it difficult to ascertain the regional bedding dip in small outcrops. 14

West and northwest of the McFadden Ranges, the formation consists of flaggy to thick-bedded, medium- to coarse-grained feldspathic and quartz sandstone, generally with small amounts of wacke. Siltstone and claystone intraclasts are recorded. The sandstones contain scattered lenses of poorly sorted, polymictic, pebble and cobble conglomerate, which were deposited in troughs within the sandstone unit. A type locality for these conglomerates is $23^{\circ}14'30''\text{S}$, $121^{\circ}36'00''\text{E}$, where clasts up to 250 mm are recorded. The clasts are quartzite, vein quartz, various granitoids, and small pebbles of distinctive red and grey-blue, banded chert. These conglomerates seem to be confined to the area north of $23^{\circ}40'\text{S}$ and west of 122°E . Large-scale cross-beds also occur in this region.

The hills east of the Boondawari-Savory Creek junction consist of purple-brown, medium- to coarse-grained, granule-bearing arenite. The rocks contain scattered cobbles and pebbles of chert and vein quartz. Lenses of siltstone and thin conglomerate beds are also present. Large-scale cross-beds are present, particularly in the more flaggy sandstones. The more massive sandstone beds contain symmetrical ripple-marks and siltstone intraclasts. These rocks are probably transitional to the Calyie Sandstone which occupies the southwestern corner of the sheet.

West of the McFadden Range on the shores of a salt lake marginal to Savory Creek ($23^{\circ}21'00''\text{S}$, $122^{\circ}15'00''\text{E}$), is a small exposure of smoke-grey, laminated, fissile- to thin-bedded, calcareous siltstone and shale. The bed dips 5° eastwards beneath the McFadden Sandstone. This unit may be the Skates Hills Formation which occurs conformably beneath the McFadden Sandstone on the Trainor Sheet (Brakel and Leech,

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in prep.), where it is a sequence of conglomerate, sandstone, siltstone, shale, and stromatolitic dolomite.

The thickness of the McFadden Sandstone is unknown because neither the top nor the bottom have been identified. It is at least 1 000 m thick.

The coarseness of the detrital material and the extremely large cross-beds and conglomerate-filled scours and channels suggests it was deposited in a near-shore, marine environment.

Calyie Sandstone

The Calyie Sandstone (Brakel and Muhling, 1976) is widespread on Collier, Trainor (Brakel and Leech, in prep.) and Bullen Sheets (Leech and Brakel, in prep.). It is restricted to the southwestern corner and northwestern margin of the Gunanya Sheet.

The Calyie Formation consists mainly of white to red-brown, thick-bedded, massive, fine to coarse-grained quartz arenite. Granule-bearing lenses, scattered pebbles and cobbles, and intraclasts of siltstone and claystone occur within the sandstone. The clay content of the more friable sandstone is up to 15 per cent. Cross-bedding and ripple marks are present. Thick beds of hard, laminated, grey to purplish-grey siltstone having a conchoidal fracture occur interbedded with the sandstone in several localities.

The Calyie Formation appears to grade into the McFadden Sandstone Sandstone. The formation is at least 1 000 m thick, and is considered to be marine and a deeper water facies of the McFadden Sandstone.

DURBA SANDSTONE

The Durba Sandstone unconformably overlies the McFadden Sandstone. The formation forms bold cliffs in the Calvert Ranges, Durba Hills, Diebil Hills, an unnamed hill 26 km west of Diebil Hills, and a ridge 20 km north of the Boondawari-Savory Creek junction. Small, scattered outcrops extend southeasterly onto the adjoining Trainor Sheet (Brakel and Leech, in prep.). The type area for the formation is the northern end of the Durba Hills (23°43'S, 122°29'30"E). The thickness is unknown although about 100 m is present in the Durba and Diebil Hills.

The Durba Sandstone is a massive, medium to coarse-grained quartz arenite containing scattered pebbles and cobbles. It contains ripple marks, slumped bedding, and numerous small-scale cross-beds. At the base is an irregularly developed, poorly sorted, pebble and cobble conglomerate which ranges up to 2 m thick, but which is generally less than 0.5 m thick. The clasts are of vein quartz, fine-grained quartzite, and chert. The conglomerate was deposited in erosional channels in the underlying McFadden Sandstone.

The unconformity between the McFadden and Durba Sandstones may be either sharply angular, or almost conformable. Some of the discordance is due to the large-scale cross-bedding in the McFadden Sandstone; however, there has been undoubted erosion of the McFadden Sandstone before the Durba Sandstone was laid down. In the Diebil Hills there is suggestion of minor warping and small-scale faulting which is not detected in the overlying Durba Sandstone. The interval of time between the deposition of the two sandstone units is not known.

The formation appears to have been deposited in a very shallow basin that was elongated parallel to structural trends in the older rocks of the Paterson Province to the northeast (Williams and others, 1976).

MAFIC IGNEOUS ROCKS

Unfolded, dolerite dykes (d) and sills (b) intrude the McFadden and Calyie Sandstones and also the Yeneena Group. Most dykes trend 025° - 030° but a single dyke was found trending 315° . A small, dolerite sill which contains traces of copper, intrudes the McFadden Sandstone at the headwaters of Boondawari Creek. A large sill occurs in the Calyie Sandstone on the southern margin of the sheet. The sills contain some fresh dolerite, but all the dykes are weathered to clay.

STRUCTURAL EVOLUTION

The Rudall Metamorphic Complex has undergone several periods of deformation and metamorphism. The first recognizable deformation (D1) and metamorphic event was the development of gneissic foliation and metamorphic banding in the older gneiss. A second deformation (D2) produced near isoclinal folds of all scales; this deformation produced the first metamorphic surface in the younger quartzite-schist group, and an overprinted foliation in the older gneiss. D2 took place prior to deposition of the Yeneena Group, and accounts for the angular unconformity between the Yeneena Group and the Rudall Metamorphic Complex as observed in the McKay Range anticline.

The northwesterly trending folds in the Yeneena Group, such as the McKay anticline, Sir Fowell syncline, and Terrace Hill syncline, formed during a third period deformation (D3) which also involved the Rudall Metamorphic Complex. D3 generated an axial-surface cleavage, which is a fracture and slaty cleavage in the Yeneena Group, and a crenulation cleavage in the previously foliated rocks of the Rudall Metamorphic Complex. Cleavage in the Yeneena Group is confined

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to the tighter folds of the McKay Range area, and is not found in more open folds further south.

The D3 folds are asymmetrical; axial planes dip north-eastwards. Several fault-zones in the McKay Range are believed to be steep, northeasterly dipping thrust-faults. Similar faults are described from the Rudall Sheet (Chin and others, in prep.).

The Boondawari Inlier contains fold axes trending north-northwest, which are parallel to D3 in the Yeneena Group. A rough fracture-cleavage is also evident in some exposures.

Little information on the structural relationship of the Karara Beds can be obtained from the sheet. It has been established on the Runton Sheet that the Karara Beds unconformably overlies the Rudall Metamorphic Complex and Yeneena Group (Crowe and Chin, in prep.), and deposition of the beds may have been controlled by faulting associated with D3. The Karara Beds, in turn, are folded about east-northeasterly trending axes (D4). The style of folding is open, and a fracture cleavage is generally present.

The deformation of the Bangemall Group was gentle, with varied strikes and vague fold-axes. There is a general lack of cleavage. Fold axes are more clearly defined in the Calyie Sandstone, where they trend northeasterly. There is some suggestion of a swing to the north in the fold-axis-trend as the unconformity with the Yeneena Group is approached.

The Durba Sandstone has very gentle dips, which may reflect a primary depositional dip rather than folding. The distribution of the Durba Sandstone suggests a shallow, northwesterly trending basin that is roughly parallel to the fold trends in the Yeneena Group to the northeast. The gentle flexing which produced the shallow basin, may be related to waning tectonic activity related to that of the adjoining Paterson Province.

CAINOZOIC GEOLOGY

Cainozoic units cover 82 per cent of the sheet. The units can be separated into recent eolian, alluvial and colluvial deposits (Qs, Qa, Ql, Qg, Qc, Qp), and older remnants of duricrust (mainly laterite, some minor silcrete) hardpan and calcrete (Czl, Czc, Czk).

The characteristic cover is eolian sand (Qs) in sheets and dunes. The regional movement of the sand is east to west, and the source has been attributed to the breakdown of Phanerozoic sedimentary rocks (Beard, 1969; Kennewell, 1974).

A mixed, sand and ferruginous pebble unit (Qp) is closely associated with the Qs unit. The Qp unit occurs in interdunal areas, adjacent to outcrops, and alongside old calcreted drainage lines. The ferruginous pebbles are probably derived from an underlying pisolitic, ferruginous hardpan. The pebbles remain behind as a lag deposit whilst the finer material is removed by wind. The unit has a distinctive smooth, dark photo-pattern.

Lake deposits (Ql, Qg) occupy 10 per cent of the sheet. Lake Disappointment is the largest area of these units. Gypsum deposits in the form of old kopi-dunes are common around the margins of the salt lakes. Recent sand covers gypsum deposits on the western shores of Lake Disappointment.

Alluvial clay, silt, sand, and gravel deposits (Qa) occur in Savory Creek, McKay Creek, and small unnamed creeks flowing out of the McKay Ranges.

Colluvial silt, sand, gravel, and scree deposits (Qc) flank the western sides of rocky hills, away from the encroaching sand dunes.

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Extensive tracts of calcrete (Czk) reflect old drainage systems which can be traced towards Lake Disappointment. Although the calcrete is commonly covered by a veneer of sand, sufficient exposure is found in the interdunal areas to indicate that it is extensive. Also, the distribution of the net dunes, which favours depressions, reflects the calcreted drainages. The calcrete has been shown on the map in preference to the sand veneer.

The incised bed of Savory Creek near its junction with Boondawari Creek, reveals calcrete overlying at least 10 m of ferruginous hardpan (Czc). Crudely bedded pebble and grit bands were noted in this horizon. This unit is exposed elsewhere along the incised portions of Savory and Boondawari Creeks.

A few scattered remnants of laterite (Czl) occur in the Lady Victoria Hills and along the tops of drainage divides between the old, calcreted drainages in the southwest quarter of the sheet. Silcrete is not common and has been included in the symbol Czl.

ECONOMIC GEOLOGY

There is no recorded mineral production from, or any significant mineral occurrence on, the sheet. The only mineral occurrence found during the present survey was green copper staining (malachite or para-atacamite) in a goethite gossan found in a bouldery scree of weathered dolerite in the headwaters of Boondawari Creek ($23^{\circ}31'S$, $121^{\circ}31'E$).

Since the late 1960s prospecting for copper, nickel, gold, and platinum has been carried out within the Rudall Metamorphic Complex, which extends onto the northeast corner of the sheet.

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Gypsum deposits occur around the salt-lake systems, but are too remote to be of economic interest.

Overall, the economic potential is very low. Copper, uranium, and gold may be located in the Rudall Metamorphic Complex, and the Yeneena Group. However, prospecting results have not been encouraging.

WATER SUPPLIES

Good sources of water are scarce. The Savory Creek system, including Boondawari Creek, contains a number of semi-permanent, brackish pools. Scrub cattle were seen around the Savory-Boondawari Creek junction. During the helicopter survey, several new rock-holes were located; and Durba, Killagurra, and Diebil Springs were visited. A summary of these is given in Table 2.

The Canning Stock route passes to the west of the Durba Hills, and skirts the western and northern margins of Lake Disappointment. The Canning Stock route was surveyed in 1906-7, and the wells dug in 1908-1909. The wells were rehabilitated in 1933. The stock route was last used by drovers in 1959 (Chudleigh, 1969). Five wells occur on the sheet, and Table 3 shows the condition of these at the time of the survey. No.17 Well is either Killagurra Spring or Durba Spring.

TABLE 2. NATURAL WATER SUPPLY GUNANYA SHEET FOUND AUGUST 1975.

Name	Co-ordinates	Remarks
Durba Spring		Water level low, possibly dries up in prolonged drought
Killagurra Spring		Water in pools below main spring-pool. Records suggest this source is permanent
Diebil Spring		Dry
Onegunyah Rock Hole		Dry
2 km south of Russel Head Calvert Range	23°57'30"S 122°43'30"E	Flowing spring and pool. Water flows out from unconformity between Durba and McFadden Sandstones
Unnamed rock hole 32.5 km south-southwest of junction of Savory and Boondawari Creeks	23°54'30"S 121°36'36"E	Semi-permanent rock hole in creek, on a fault zone
Unnamed rock-hole McKay Range	23°04'21"S 122°31'18"E	Rock hole in creek, semi-permanent
Unnamed rock-hole McKay Range	23°01'00"S 122°29'33"E	Rock hole in creek, semi-permanent

TABLE 3. DESCRIPTION OF WELLS ON CANNING STOCK ROUTE ON GUNANYA SHEET

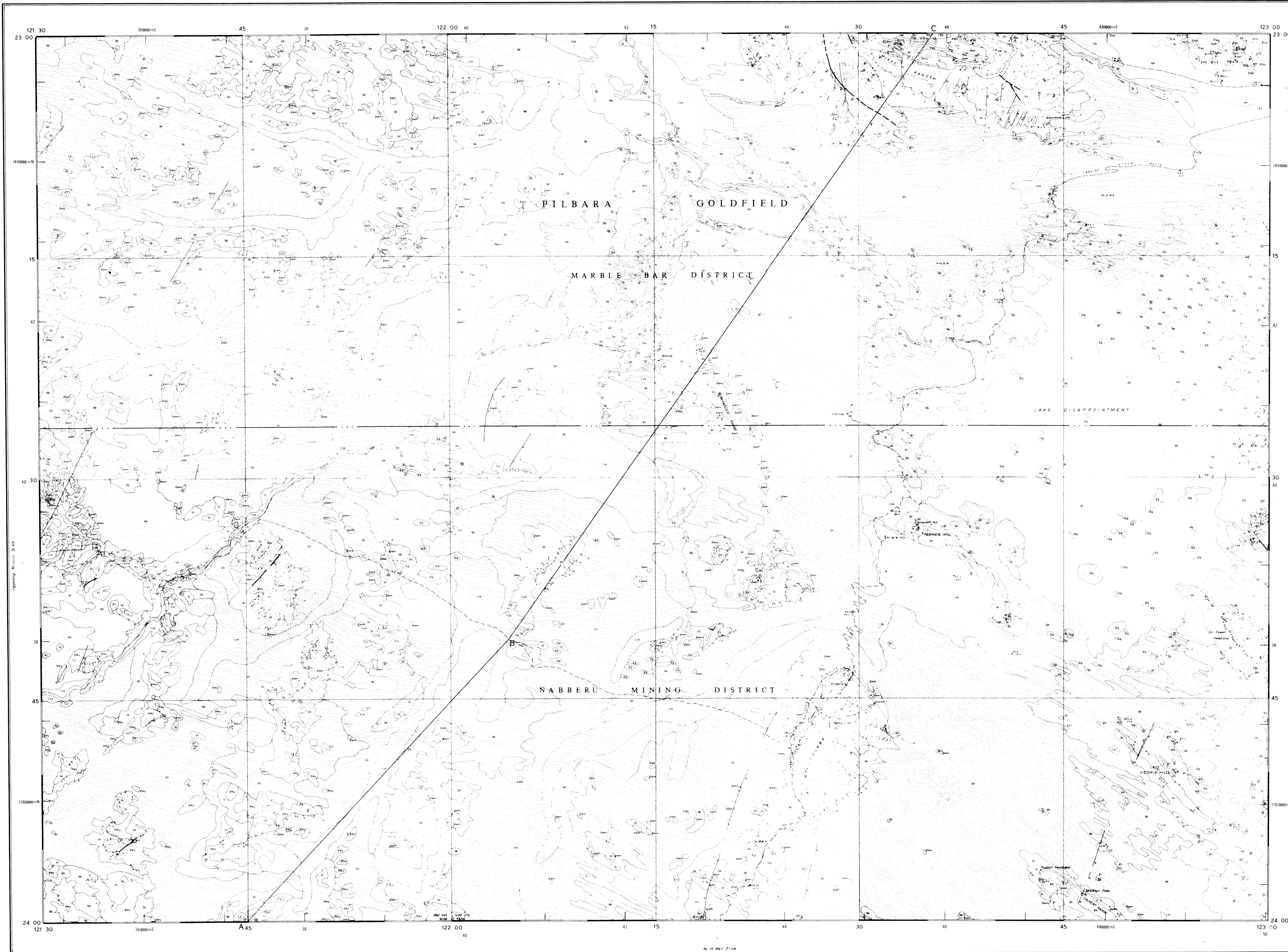
Well	Original Description Talbot 1910	Current State August 1975
No.16	Depth 55'6", made 240 gals/hour (16.9 m, 1091 l/hr)	Sunk in calcrete, water level 5.5 m, unfit to drink, reasonable condition
No.18	Depth 16', made 2000 gals/hour (4.9 m, 9092 l/hr)	Not located
No.19 (Kunanaggi) Well	Depth 13'6", made 200 gals/hour "good stock water" (4.1 m, 909 l/hr)	Edge of salt lake, has collapsed about 2.5 m down, filled with sand, dry
No.20	Depth 13'6", made 2000 gals/hour brackish. OK for stock (4.1 m, 9092 l/hr)	Completely collapsed, all wood supports have been burnt in recent grass fire. Will disappear soon under moving sand
No.21	Depth 51', made 150 gals/hour brackish. (15.5 m; 682 l/hr)	Water level 8 m, strong H ₂ S smell unfit for drinking, reasonable condition. (10 300 ppm total dissolved solids)

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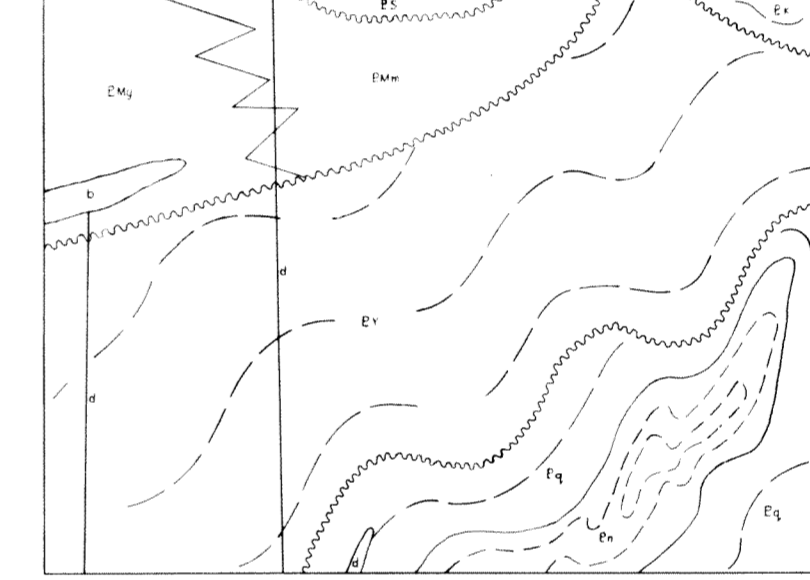
SYMBOLS

- Geological boundary
- Fault
- Accretion
- Concave
- Fold
- Range of minor anticlines
- Range of folds showing vergence
- Range of folds showing vergence
- Bedding
- Isocline
- Horizontal
- Dip-sloped
- Asymmetrical
- Trend line
- Top of bed
- Change
- Sinks and dip of consolidation and fracture cleavage
- Sinks and dip of later consolidation and fracture cleavage
- Foliation (metamorphic foliation overprinting previous and recent rocks)
- Isocline
- Vertical
- Secondary linear change foliation intersection
- Geological boundary
- Track
- Horizontal control, minor
- Bench mark, height accurate
- Sand dune
- Rivercourse, intermittent
- Pool
- Well
- Windmill
- Windmill
- Riparian
- Spring
- Flotation shaft
- Mineral occurrence
- Copper

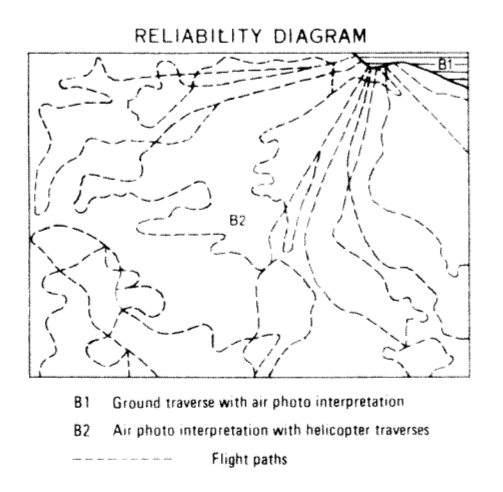
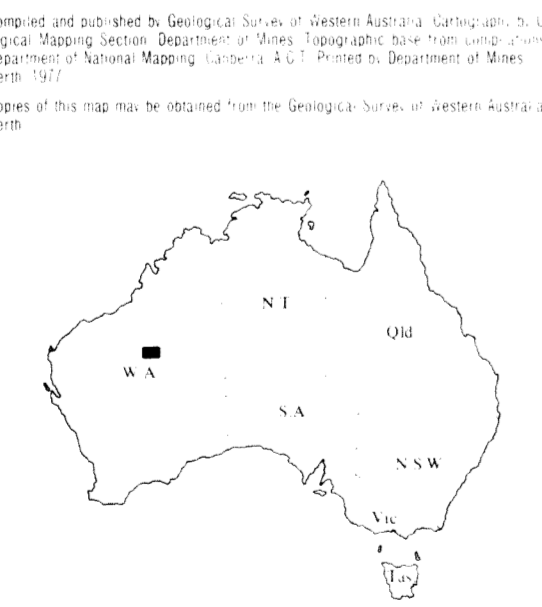
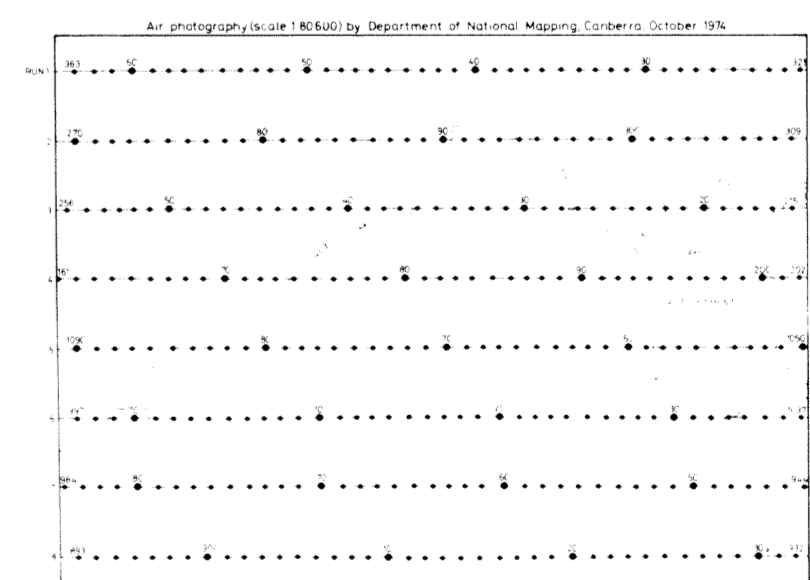
REFERENCE

- QUATERNARY
 - Q1 Late Pleistocene - clay, silt, sand, silt, siltstone
 - Q2 Deposits of recent to late Pleistocene - conglomerates, sands, silts, clays, shales, minor sandstone and claystone
 - Q3 Alluvium - clay, silt, sand, gravel, in drainage lines
 - Q4 Colluvium - alluvial sand, gravel, fine to coarse shales, with minor sandstone and claystone
 - Q5 Most recent Pleistocene and early Holocene
 - Q6 Colluvium - alluvial sand, gravel, fine to coarse shales, with minor sandstone and claystone
- PROTEROZOIC
 - Yanena Group
 - Fv Interbedded quartz sandstone, quartz pebble conglomerate, muscovite schistose and shaly, minor dolomite
 - Fvi Shale, micaceous schistose
 - Fvii Conglomerate
 - Ruggell Metamorphic Complex
 - Rm Quartz mudstone schist
 - Rvi Quartz schist, metamorphic schist
 - Rvii Foliated quartzite
 - Rviii Quartz magnetite rock, metamorphosed banded iron formation
 - Rvix Gneiss, amphibolite
 - Rviix Metagabbro, quartzite, gneiss, schist with strong overprinted foliation

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



FLIGHT DIAGRAM



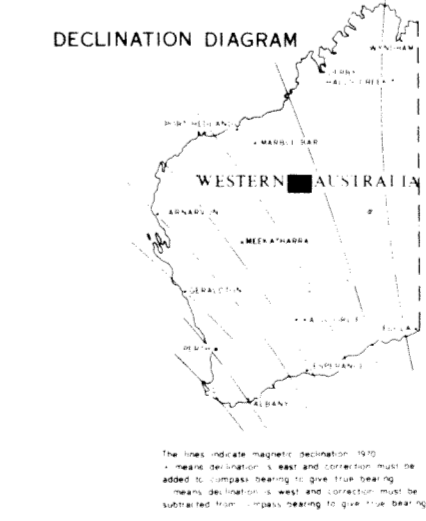
HON. A. MENZIES, M.L.A.
MINISTER FOR MINES
J. H. LORD, DIRECTOR, GEOLOGICAL SURVEY

SCALE 1:250 000

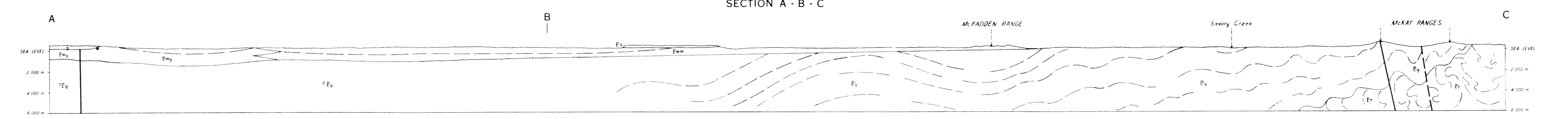
TRANSVERSE MERCATOR PROJECTION
ZONE 2, AUSTRALIA SERIES

INDEX TO ADJOINING SHEETS

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DIAGRAMMATIC SECTION



GUNANYA
SHEET SF 51-14
PRELIMINARY PRINTING, 1977
SUBJECT TO AMENDMENT