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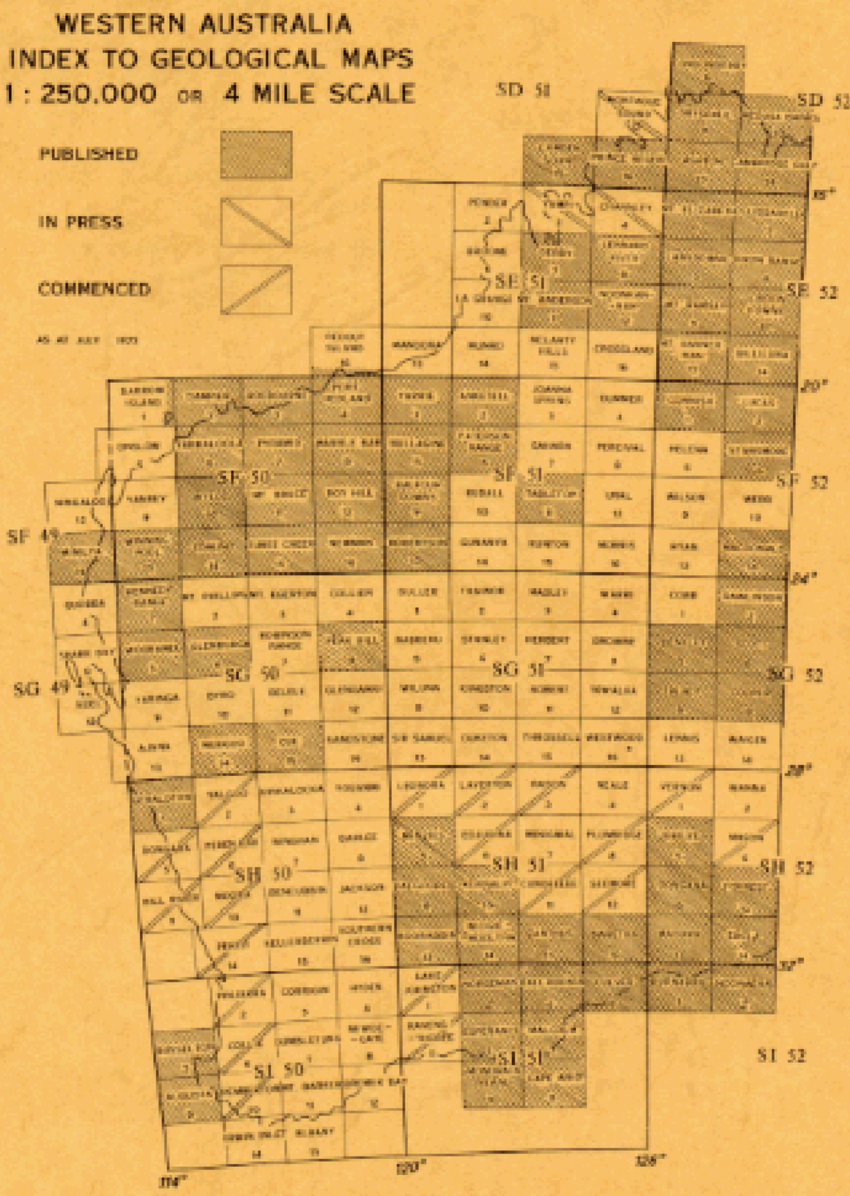
MALCOLM—CAPE ARID

WESTERN AUSTRALIA

SHEET SI/51-7, 11 INTERNATIONAL INDEX



WESTERN AUSTRALIA
INDEX TO GEOLOGICAL MAPS
1 : 250.000 OR 4 MILE SCALE
PUBLISHED
IN PRESS
COMMENCED
SD 51
SD 52
SE 51
SE 52
SF 49
SF 50
SF 51
SF 52
SG 49
SG 50
SG 51
SG 52
SH 50
SH 51
SH 52
SI 50
SI 51
SI 52
114°
120°
126°

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

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MALCOLM—CAPE ARID

WESTERN AUSTRALIA

SHEET SI/51-7, 11 INTERNATIONAL INDEX

COMPILED BY D. C. LOWRY AND J. J. G. DOEPEL

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE, CANBERRA 1974

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Explanatory Notes on the Malcolm—Cape Arid Geological Sheet

Compiled by D. C. Lowry and J. J. G. Doepel**

INTRODUCTION

The Malcolm-Cape Arid Geological Sheet is bounded by latitudes 33°S and 34°15′S, and longitudes 123°E and 124°30′E. It includes the Malcolm Sheet and the northern part of the Cape Arid Sheet, being SI/51-7 and SI/51-11 respectively on the International Grid. The Sheet is located in the Eucla Land Division of Western Australia, and covers part of the Eucla Basin and part of the Albany-Fraser Province.

CLIMATE

The average annual rainfall in the Sheet area varies from about 26 inches (660 mm) in the southwest to 11 inches (279 mm) in the northeast. The hottest month is February, with an average maximum temperature of about 78°F (25.5°C) and an average minimum temperature of about 60°F (15.6°C). The coldest month is July with an average maximum of 60°F (15.6°C) and an average minimum of about 45°F (7.2°C). The annual evaporation is about 50 inches (1,270 mm).

PHYSIOGRAPHY

In the eastern and southern parts of the Sheet, Eocene beds form a plateau (the "Bunda Plateau") 300 to 500 feet (90 to 150 m) above sea level. The flatness is largely inherited from the flatness of the Tertiary sea floor. Projecting above the plains are inliers of Proterozoic rocks, some of which, for example Mount Ragged, have prominent benches at about 1,000 feet (300 m) above sea level. The benches are believed to have been cut by waves during the Upper Eocene. The plateau is bounded on the seaward side by a scarp which was eroded by waves in the Pleistocene. Between the scarp and the coast is a coastal plain with sand dunes and chains of elongated lagoons.

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* Geological Survey of Western Australia

The northern and western parts of the Sheet stand about 500 to 1,000 feet (150 to 300 m) above sea level and have low relief and internal drainage.

GEOLOGICAL INVESTIGATIONS

The Precambrian rocks of the Sheet area were described by Woodward (1909), who visited Dow Island; Maitland (1925), who journeyed east along the coast to Israelite Bay and then north along the track to Balladonia; Clarke and others (1954); and Fairbridge and Serventy (1954). Regional structure and rock relationships of the Precambrian rocks of the region were discussed by Morgan and others (1968) and Doepel (1969).

General descriptions of the geology of the Eucla Basin were given by Maitland (1919), Fairbridge (1953), Singleton (1954), Ludbrook (1958), and Lowry (1968 and 1970a).

Explanatory notes are available for the adjoining Sheet areas of Esperance-Mondrain Island (Morgan, 1969), Norseman (Doepel, 1970), Balladonia (Doepel and Lowry, 1970), and Culver (Lowry, 1970b).

In 1965, D. C. Lowry mapped the sedimentary rocks of the eastern part of the Sheet area; and the portion of the Sheet on the mainland containing Precambrian rocks was mapped by J. J. G. Doepel, P. R. Koehn and M. Kriewaldt during 1968. In 1967, K. H. Morgan, R. C. Horwitz and C. C. Sanders examined the rocks on some of the islands of the Recherche Archipelago.

GEOLOGICAL SUCCESSION

Proterozoic granites, gneisses and migmatites of the Albany-Fraser Province (as defined by Daniels and Horwitz, 1969) crop out on the mainland and on the islands of the Archipelago of the Recherche. They are overlain by the Proterozoic Mount Ragged Beds. In the northeastern portion of the Malcolm Sheet area the Proterozoic rocks are overlain by the nearly horizontal Tertiary and Cretaceous sediments of the Eucla Basin. A superficial Cainozoic cover is present over most of the mainland. The stratigraphy is summarized in Table 1.

PROTEROZOIC

Migmatite

A belt of migmatite crops out on the mainland between Cape Pasley and Point Malcolm and is also exposed on most of the islands of the Cape Arid Sheet area.

The migmatite is composed of granitic rocks, metamorphosed basic rocks and minor schists and quartzites.

TABLE 1. STRATIGRAPHIC SUMMARY

Age	Symbol on Map or Diagram	Name or Short Description	Known Maximum Thickness Feet	Lithology	Stratigraphic Relation with Underlying Unit	Remarks
	Qrn	Eolian sand	200-300	Unconsolidated sand; weakly calcareous		Forms coastal dunes
	Qrp	Altered eolian deposits	200?	Calcareous and siliceous; phosphatic in part		Contains minor phosphate deposits
	Qre	Lake deposits	200?	Silt and clay with halite and gypsum		Playas fed by internal drainage; those along coast are old lagoons
RECENT	Qro	Colluvium	10±	Calcareous clay with fragments of limestone and kankar		Forms clay flats on limestone plateau
	Qru	Colluvium	100±	Rock fragments, sand, clay		Slope deposits
	Qrv	Alluvium	50?	Clay, silt, sand, pebbles, boulders		Valley fill, inter-dune fill
RECENT-PLEISTOCENE	Qo	Eolian deposits	50±	Quartz sand, silt, clay; sometimes gypsiferous		In dunes and sheets; derived from lakes
	Qpo	Eolian sand	100±	Siliceous sand with sheet or nodular kankar at or near the surface		Forms coastal dunes
PLEISTOCENE	Qpl	Residual and eolian loam	20	Calcareous clay, silt and sand, containing sheet and nodular kankar		Residual over limestone; loess deposit over Precambrian
	Qpp	White and yellow sand	20?	Siliceous sand with limonite pisoliths and clay		

TABLE 1. STRATIGRAPHIC SUMMARY.—(*cont.*)

Age	*Symbol on Map or Diagram*	*Name or Short Description*	*Known Maximum Thickness Feet*	*Lithology*	*Stratigraphic Relation with Underlying Unit*	*Remarks*
PLEISTOCENE-PLIOCENE	TQo	Leached and silicified granitic rocks	?	Siliceous rock		? in shear zones
LOWER MIOCENE	Tmn	Nullarbor Limestone	?50	Foraminifera calcarenite	Disconformable on Toolinna Limestone	
UPPER EOCENE	Tep	Pallinup Siltstone	20	Spicular siltstone and sandstone, conglomeratic sandstone	Unconformable on Precambrian rocks	Probably grades laterally into Toolinna Limestone
	Tet	Toolinna Limestone	220±	Porous bryozoan limestone	Unconformably on Precambrian rocks; grades down into Wilson Bluff Limestone	Laterally equivalent to upper part of Wilson Bluff Limestone
	Tew	Wilson Bluff Limestone	?200	Chalky bryozoan limestone	Conformable on Hampton Sandstone or disconformable on Precambrian rocks	Does not crop out
EOCENE	Teh	Hampton Sandstone	?	Sandstone; commonly incoherent and ironstained	Disconformable on Precambrian rocks	Lenticular; does not crop out
PROTEROZOIC	Psa	Mount Ragged Beds	800+	Quartz feldspar porphyry		Unknown whether flow or sill
	Ps		6,000+	Quartzite, micaceous schist, quartz-pebble conglomerate	Unconformable over granitic complex	

		INTRUSIVE AND HIGH GRADE METAMORPHIC ROCKS		RELATIONS WITH OLDER UNITS	
	d	Dolerite	Porphyritic olivine dolerite	Intrusive into Py	Unmetamorphosed
	Py	Equigranular leucocratic granite	Fine to very coarse-grained equigranular granite; accessory biotite, magnetite	Intrusive into Pl, Pb	Not all occurrences necessarily co-magmatic
MIDDLE PROTEROZOIC	Pl	Biotite granite	Biotite granite; in part containing potassium feldspar phenocrysts	Intrusive into Pm, Pb	
	Pm	Mixed granitic rocks	Granite, gneiss, migmatite		
	Pb	Augen gneiss	Garnet - biotite - quartz feldspar gneiss containing feldspar augen		Metamorphosed porphyritic granite; in places may be component of Pm and Pn
	Pn	Migmatite	Granitic rocks, amphibolite, basic granulite, quartzite, schist		

NOTE: 1 foot = 0.3048 metres

At Point Malcolm biotitic granitic rock is veined by leucocratic granitic material and both are intruded by a 100-foot (30 m) thick dolerite dyke. These rocks are tightly folded and metamorphosed, the dolerite being altered to an amphibolite. Pegmatite veining occurred during folding. Dykes of fine-grained biotitic granitic rock were later intruded, followed by an even later emplacement of unfolded pegmatites.

At Cape Pasley there are remnants of staurolite-garnet-biotite schist and garnet-biotite muscovite-quartzite in the metamorphosed granitic rocks.

Basic granulites occur in the migmatites on Pasley Island and a cordierite-bearing garnetiferous gneiss is known from Salisbury Island.

Augen gneiss

An 8-mile (12.8 km) wide strip of garnet-biotite-quartz-feldspar gneiss containing feldspar augen extends in a northeasterly direction across the Sheet area from Cape Arid through Israelite Bay. The gneiss is tightly folded. It contains lenses of basic material which probably represent former xenoliths. It also contains folded dykes of equigranular granitic rock and folded and unfolded pegmatites. It appears to be a metamorphosed porphyritic granite.

Augen gneiss also crops out on Dome Island, 16 miles (25.7 km) southeast of Cape Arid.

Mixed granitic rocks

To the northwest of the augen gneiss there is a belt of mixed granitic rocks. Some outcrops within this belt are of a single rock type and others are of a migmatite of more than one granitic rock. For instance, at and to the south of Point Jedacorrudup unfolded pegmatites and fine to medium-grained leucocratic granite intrude strongly foliated medium-grained granite and augen gneiss. Strongly foliated dykes of intermediate rock also appear to intrude the gneiss.

To the north and east of Mount Baring are outcrops of foliated fine-grained biotitic granitic rock and gneiss. These are intruded by numerous aplites, pegmatites and quartz veins.

Biotite granite

A large area of biotite granite, in part porphyritic, is present to the northwest of the belt of mixed granitic rocks.

Three other bodies of biotite granite, for the most part porphyritic, are present within the belt of mixed granitic rocks. Six miles (9.6 km) north-east of Mount Baring, unstressed porphyritic granite from one of these bodies intrudes fine-grained gneissic granitic rock. Although no contact of the porphyritic granite with the augen gneiss was observed, the lack of strong metamorphic foliation within the granite indicates that it is probably younger than the gneiss.

Equigranular leucocratic granite

The presence of two northeasterly trending bodies of equigranular leucocratic granite is inferred in the northwest portion of the Sheet area. These rocks are present just to the north in the Balladonia Sheet area (Doepel and Lowry, 1970), and their extension to the south appears likely.

To the west of one of the inferred bodies, on Mount Coobaninya, dykes of leucocratic equigranular granite do intrude the biotite granite; and at Deralinya, at the inferred eastern margin of the body, a mixture of granites is also present.

Another body of equigranular leucocratic granite crops out on the coastal plain north of Israelite Bay. It is intrusive into the augen gneiss.

Mount Ragged Beds

The name Mount Ragged Beds is here proposed for a sequence of quartzites, micaceous schists, quartz-pebble conglomerates and acid volcanic rocks exposed in the vicinity of Mount Ragged. The rocks crop out in two separate synclinal structures. Mount Ragged and Russell Range form part of the western limb of the northern syncline, and Mount Esmond, Mount Dean and Brook Peak, part of the eastern limb. Mica Hill is at the northern end of the southern structure.

Clarke and others (1954) reported quartzite, biotite-muscovite quartzite, andalusite-quartz-muscovite schist, and garnetiferous biotite-quartz-muscovite schist from the beds. Quartz-granule and quartz-pebble conglomerates are also present. Prider (1969) reported viridine from Mount Ragged; sillimanite is present on the east flank of Diamond Hill.

The base of the beds is nowhere exposed, although on Hill Sixty Two sediments crop out to within a few hundred feet of the underlying migmatite. About 6,000 feet (1,830 m) of sediments are exposed in Mount Ragged and the Russell Range.

About 6 miles (10 km) northeast of Mount Ragged and about 10,000 feet (3,000 m) above the lowest exposed sediment there is a single outcrop, about 1,000 feet (300 m) square, of quartz-feldspar porphyry. It contains flakes of biotite aligned parallel to the strike of the underlying sediments. It is not known whether this is a metamorphic or flow alignment, or whether the rock is a flow or a sill.

The rocks occupying the core of the syncline above this possible acid volcanic are not exposed and their nature is unknown.

Quartz reefs intrude the beds, and Clarke and others (1954) report by hearsay that there are pegmatites at Mica Hill.

Gneissic granite, migmatite and porphyritic granite are all exposed in the neighbourhood of the beds, but no granitic rocks are seen to intrude the beds which appear to lie unconformably upon the granitic complex.

Possible Proterozoic

Dolerite

A single 9-inch (22.8cm) thick dyke of unmetamorphosed olivine dolerite intrudes the equigranular leucocratic granite, 30 miles (48.2 km) to the north-northeast of Israelite Bay. The dyke has a strike of 56° and a dip of 72° to the northwest.

Cainozoic

EOCENE

Hampton Sandstone

The Hampton Sandstone ("Hampton Conglomerate" of Fairbridge, 1953; amended Lowry, 1968), occurs in parts of the Eucla Basin and is a carbonate-cemented or incoherent limonite-stained medium to coarse-grained sandstone. It is a lenticular marine deposit of Eocene age and may be present in places near the eastern edge of the sheet.

Wilson Bluff Limestone

The Wilson Bluff Limestone (Singleton, 1954; Lowry, 1968) is present in the subsurface in the northeast of the Sheet area. It is a chalky bryozoan limestone and contains Upper Eocene foraminifers. The formation conformably overlies the Hampton Sandstone.

Toolinna Limestone

The Toolinna Limestone (Lowry, 1968) is a porous to indurated bryozoan limestone that crops out on the coastal scarp and on the edges of salt lakes near Pine Hill. The formation underlies the soil of the eastern part of the Malcolm Sheet area. The Toolinna Limestone overlies and intertongues with the Wilson Bluff Limestone, and unconformably overlies Proterozoic rocks at the western margin of the basin. The formation is 220 feet (67 m) thick in the coastal cliffs near Point Culver, 12 miles (19.3 km) northeast of the Malcolm Sheet. It contains abundant echinoids and molluscs of Upper Eocene age.

Pallinup Siltstone

Sandstone and siltstone with sponge spicules and bryozoan limestone are widespread beneath Quaternary cover in the southwest of the Sheet area. They are part of the Upper Eocene Pallinup Siltstone of the Plantagenet Group (Cockbain, 1968). Spongolite is characteristic of this formation, which is widely developed along the southern coast of Western Australia. The Pallinup Siltstone is the same age as the Toolinna Limestone and grades into it near Mount Ragged.

MIOCENE

Nullarbor Limestone

The Nullarbor Limestone (Singleton, 1954; Lowry, 1968) occurs as a single isolated outcrop near the abandoned Balbinya Homestead, where it is a hard, indurated, micritic foraminiferal calcarenite. It disconformably overlies the Toolinna Limestone and is of Lower Miocene age (Ludbrook, 1958).

PLIOCENE-PLEISTOCENE

Leached and silicified granitic rocks

A number of outcrops of foliated siliceous rock occur about 14 miles (22 km) to the northeast of Cape Arid. They appear to be the result of leaching and silicification of granitic rocks, possibly in shear zones.

PLEISTOCENE

White and yellow sand

The southwest part of the mainland of the Sheet area is largely covered by a predominantly white, but in places yellow sand. Over much of its area the sand contains a layer with limonite pisoliths. This sand unit overlies a yellow clay-rich layer. The sand covers a plateau which is dissected in the neighbourhood of the coast by recent drainage. West of Mount Ragged the sand forms long east-west ridges. Some of the valleys between the ridges are occupied by salt lakes.

Residual and eolian loam

Much of the northern portion of the Malcolm Sheet area is covered by a unit of clay or loam a few feet thick, containing sheet or nodular kankar. Where the unit overlies Tertiary Limestone the kankar is grey to orange-brown, and the clay is thought to be dominantly a residual weathering product. Near the edge of the Eucla Basin the clay has an increasing sand content.

Over the Precambrian rocks the unit is a partly reworked, buff, sandy, loam containing kankar in the form of sandy, finely laminated, orange-brown nodules. The widespread distribution of the unit, both in the Malcolm Sheet area and to the north and west, its presence on both high and low ground, and its consistent lithology over both acid and basic rocks, suggests an eolian origin for both the loam and the calcium present in the kankar. The calcium carbonate content of the unit increases and the kankar nodules become larger as the Eucla Basin is approached. It is suggested that where the unit overlies Precambrian rocks it is in part a loess derived from soils of the Eucla Basin. The unit appears to overlie the white and yellow sand unit.

Eolian sand

Coastal dunes are composed of fine-grained quartz sand and contain sheet or nodular, pale, sandy kankar 1 or 2 feet (30 to 60 cm) beneath the surface. The dunes probably contained a small proportion of bioclastic calcium carbonate which has been leached from the surface and deposited in the kankar horizon.

PLEISTOCENE-RECENT

Lake-derived eolian deposits

Eolian sheets and dunes are present around the eastern side of many of the salt lakes of the Sheet area. They are composed of quartz sand, silt, clay and gypsum blown from the salt lakes.

RECENT

Alluvium

Recent alluvial deposits floor the river valleys and the interdunal depressions on the coastal plain.

The clay flats on the Bunda Plateau are underlain by clay washed from the surrounding limestone slopes. The clay contains fragments of limestone and kankar and is believed to be accumulating today in most areas. The deposits are probably about 10 feet (3 m) thick. Colluvium also occurs as an apron at the front of the scarp in the east of the sheet and around the larger hills.

Lake deposits

Recent lacustrine deposits of clay, silt and sand, with halite and gypsum, occur on salt lakes (playas).

Some of the coastal lagoons near Israelite Bay also contain marine shell beds (Cotton, 1952) that formed in the Recent or late Pleistocene when the sea was a few feet higher than at present.

Altered eolian deposits

Calcareous and siliceous dunes occurring on some of the islands of the Sheet area have been altered in part by phosphatic solutions derived from bird droppings.

Eolian sand

A series of recent sand dunes cover parts of the coastal areas of the Sheet. Some of the dunes are mobile. The sand consists of quartz and bioclastic calcium carbonate.

STRUCTURE

A structural sketch map of the Malcolm-Cape Arid Sheet area is given in Figure 1.

Proterozoic granites, gneisses, and migmatites occur within the Malcolm-Cape Arid Sheet area as a series of northeasterly-trending belts. From east to west the belts consist of migmatite, augen gneiss, mixed granitic rocks, and biotite granite. Three other bodies of biotite granite occur in a northeast line across the Sheet area. Foliation directions within the bodies indicate that they are probably roughly circular in outline.

The Mount Ragged Beds are exposed in an echelon pair of northeast-trending synclines. The rocks dip steeply and in places are overturned.

The gravity-low axis shown on the structural sketch map is drawn from a regional gravity map of the southern part of the Western Australian Precambrian Shield, which was released by the Australian Bureau of Mineral Resources in 1970.

The sedimentary rocks of the Eucla Basin dip gently eastwards at about 2 to 5 feet per mile (38 to 93 cm per km) as a result of gentle downwarping in the Tertiary.

ECONOMIC GEOLOGY

The only recorded mineral production from the Sheet area is of salt from Middle Island.

SALT

Simpson (1952) reports the presence of excellent quality salt in a small salt lake on Middle Island. Some hundreds of tons were produced during the period 1899-1905. Salt on Bellringer Island is reported to be of poor quality (Simpson, 1952).

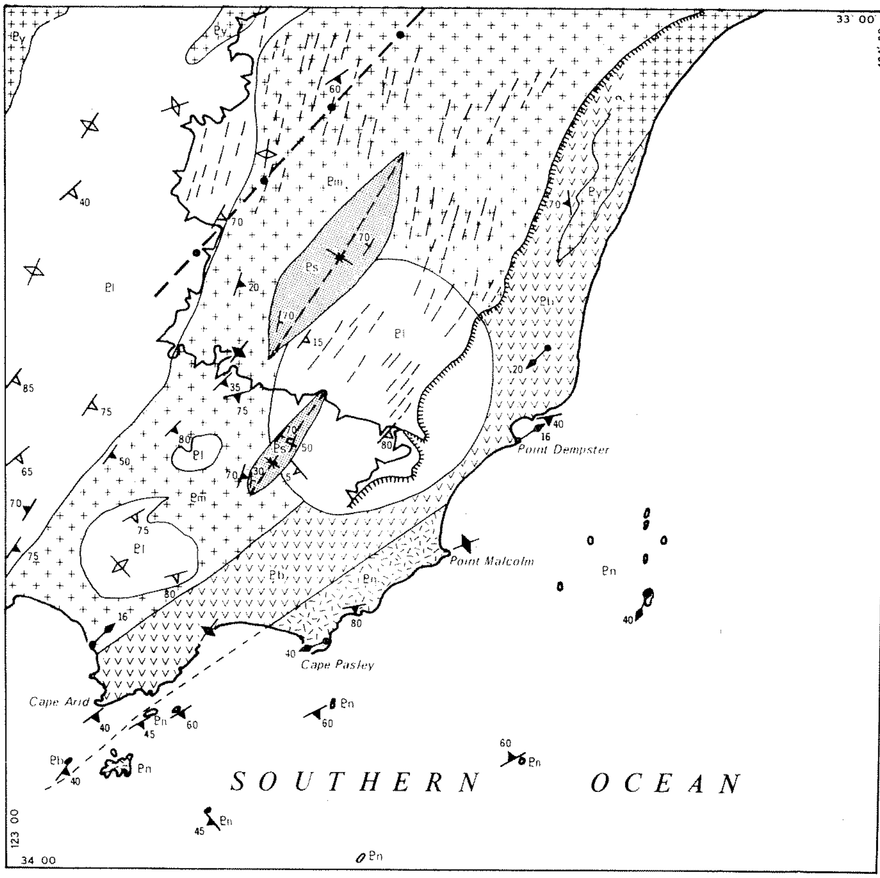

FIGURE 1

STRUCTURAL SKETCH MAP

MALCOLM-CAPE ARID SHEETS SI 51-7 AND SI 51-11

SCALE OF MILES

10 0 10 20 30

REFERENCE

PROTEROZOIC

- Ps — MOUNT RAGGED BEDS
- Py — Equigranular leucocratic granite
- Pl — Biotite granite
- Pm — Mixed granitic rocks
- Pbv — Augen gneiss
- Pn — Migmatite

- Geological boundary
- Erosional limit of Tertiary sediments of Eucla Basin
- 30 Strike and dip of bedding
- Strike and dip of overturned bedding
- 50 65 Strike and dip of igneous foliation
- Strike of vertical igneous foliation
- 45 Strike and dip of metamorphic foliation
- Strike of vertical metamorphic foliation
- 40 Direction and plunge of metamorphic lineation
- Trend of joints in Tertiary sediments
- Syncline
- Axis of gravity low
- Cliff – marks southeast boundary of Tertiary cover

21605

Phosphate

Phosphate occurs on Dow Island (formerly Christmas Island) as a phosphorized capping to eolianite and as a leach breccia with phosphatic cement. It is reported that only about 1,000 tons (1,016 tonnes) of ore are present.

On Salisbury Island narrow beds of low-grade phosphate rock occur in a cliff face at the base of an eolianite (Dulfer, 1943).

Tantalite, Beryl

A small quality of tantalite was recorded in a micaceous pegmatite, half a mile (0.8 km) east of Bellringer Lake, about 12 miles (19 km) west of Point Malcolm (Simpson, 1952). A single beryl crystal was reported from a micaceous vein, possibly the same one, in this neighbourhood (Simpson, 1948). Simpson (1952) also records rolled pebbles of tantalite from Israelite Bay.

Heavy Mineral Sands

Recent dune and beach sands north of Israelite Bay contain low concentrations of ilmenite, garnet, and other heavy minerals.

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MALCOLM–CAPE ARID

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

REFERENCE

CAINOZOIC — QUATERNARY — RECENT

- Qrn Eolian sand—calcareous and siliceous; forms coastal dunes
- Qrp Altered eolian deposits—calcareous and siliceous; phosphatic in part
- Qre Lake deposits—silt and clay; saline and gypsiferous
- Qro Colluvium—calcareous clay; in clay flats overlying Tertiary rocks
- Qru Colluvium—clay, sand and rock fragments; slope deposits
- Qrv Alluvium—clay to pebble deposits

RECENT–PLEISTOCENE

- Qo Eolian deposits—quartz sand, silt, clay; gypsiferous in part; forms dunes and sheets: derived from saline lakes

PLEISTOCENE

- Qpo Eolian sand—siliceous sand in places containing sheet and nodular kankar at or near surface; forms coastal dunes
- Qpl Residual and eolian loam-clay, silt and sand containing sheet and nodular kankar
- Qpp White and yellow sand; in places containing limonite pisoliths; contains yellow clay beneath surface

PLEISTOCENE–PLIOCENE

- TQo Leached and silicified granitic rocks

TERTIARY — LOWER MIOCENE

- Tmn **NULLARBOR LIMESTONE:** foraminiferal calcarenite

UPPER EOCENE

- Tep **PALLINUP SILTSTONE:** yellow to grey claystone, siltstone, silty sandstone, contains fossil sponges and molluscs
- Tet **TOOLINNA LIMESTONE:** porous bryozoan calcarenite

MIDDLE PROTEROZOIC

- d Dolerite

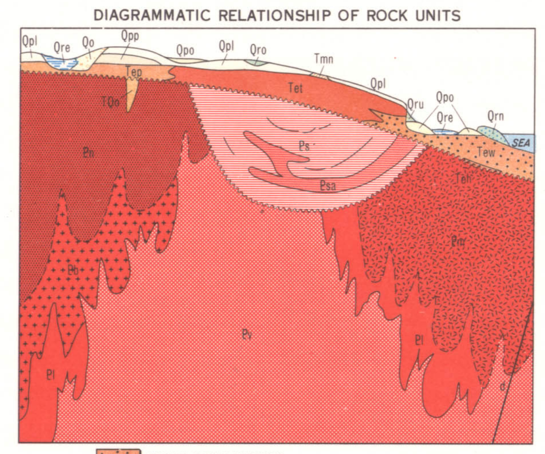
MOUNT RAGGED BEDS

- Psa Felsite with phenocrysts of quartz and feldspar: possibly a sill
- Ps Quartzite, quartz-muscovite schist, metamorphosed quartz pebble conglomerate—in places contains biotite, garnet, andalusite, viridine or sillimanite
- Py Equigranular leucocratic granite
- Pyi Inferred equigranular leucocratic granite
- Pl Biotite granite—in places has potassium feldspar phenocrysts
- Pli Inferred biotite granite
- Pm Mixed granitic rocks
- Pmi Inferred mixed granitic rocks
- Pb Garnet-biotite-quartz-feldspar gneiss containing feldspar augen
- Pbi Inferred augen gneiss
- Pn Migmatite of granitic rocks, amphibolite, basic granulite, quartzite
- Pni Inferred migmatite

SYMBOLS

Geological boundary		Road	
Accurate		Track	
Inferred and concealed between Tertiary and Precambrian rocks	? T pЄ ?	Telegraph line	
		Building	
Fault, inferred	? ?		
Fold		Horizontal control, major, minor	
Syncline, concealed		Bench mark, height accurate	GJ32 314′
Plunge of minor syncline	50	Spot height, approximate	509′
Dragfold	66	Abandoned	(Abd)
Bedding			
Strike and dip	19	Watercourse	
Overturned	40	Intermittent	
Trend		Ancient	
Igneous foliation		Waterhole	WH
Inclined	20	Rockhole	RH
Vertical		Gnamma hole	GH
Trend		Spring	S
Metamorphic foliation		Dam	D
Indeterminable			
Inclined	67	Reef, submerged	
Vertical		Shoal	
Vertical cleavage		Sandbank	
Lineation with plunge	25	Fathomline	5
Specimen locality	24110		
Mineral occurrence		Sand dunes	
Tin	Sn	Cliff	
Phosphate rock	Ph		

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Tew **WILSON BLUFF LIMESTONE**

Teh **HAMPTON SANDSTONE**

Unconformity

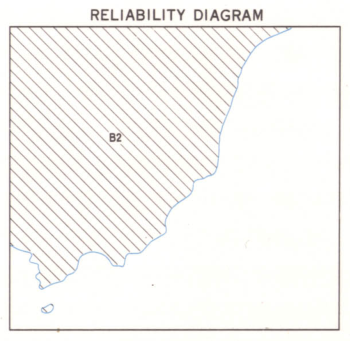
Py, Pl and Pb intrude older rocks of units Pn and Pm and form part of those units

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

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

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

RELIABILITY DIAGRAM



B2 Air photo interpretation with a few traverses

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

SCALE 1 : 250,000

5 0 5 10 15 20 25 30 Kilometres

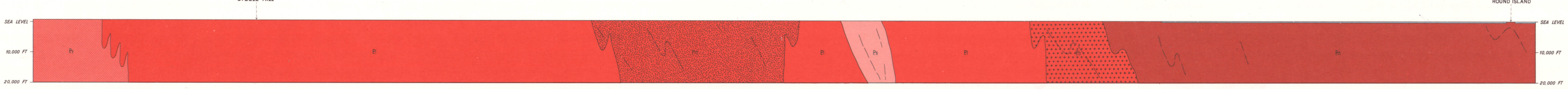
5 0 5 10 15 Miles

TRANSVERSE MERCATOR PROJECTION
ZONES 2 & 3 AUSTRALIA SERIES

DIAGRAMMATIC SECTION

NATURAL SCALE

SECTION A - B

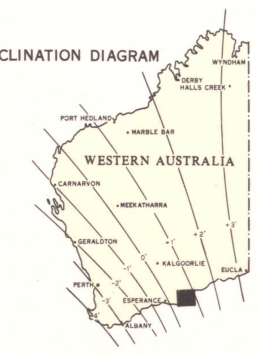


Geology by D. C. Lowry, 1965; J. J. G. Doepel, P. R. Koehn and M. Kriewaldt, 1968

INDEX TO ADJOINING SHEETS

NORSEMAN SI 51 - 2	BALLADONIA SI 51 - 3	CULVER SI 51 - 4
ESPERANCE SI 51 - 6	MALCOLM SI 51 - 7	
MONDRAIN ISLAND SI 51 - 10	CAPE ARID SI 51 - 11	

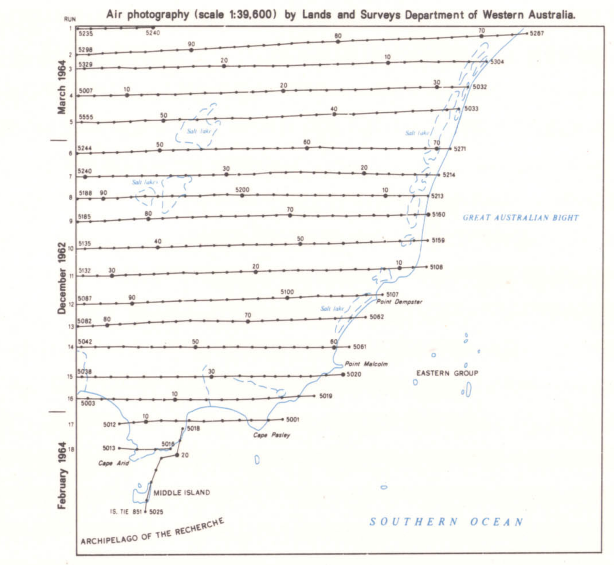
DECLINATION DIAGRAM



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

FLIGHT DIAGRAM

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



MALCOLM - CAPE ARID

SHEET SI 51-7 AND PART OF SI 51-11

FIRST EDITION 1972