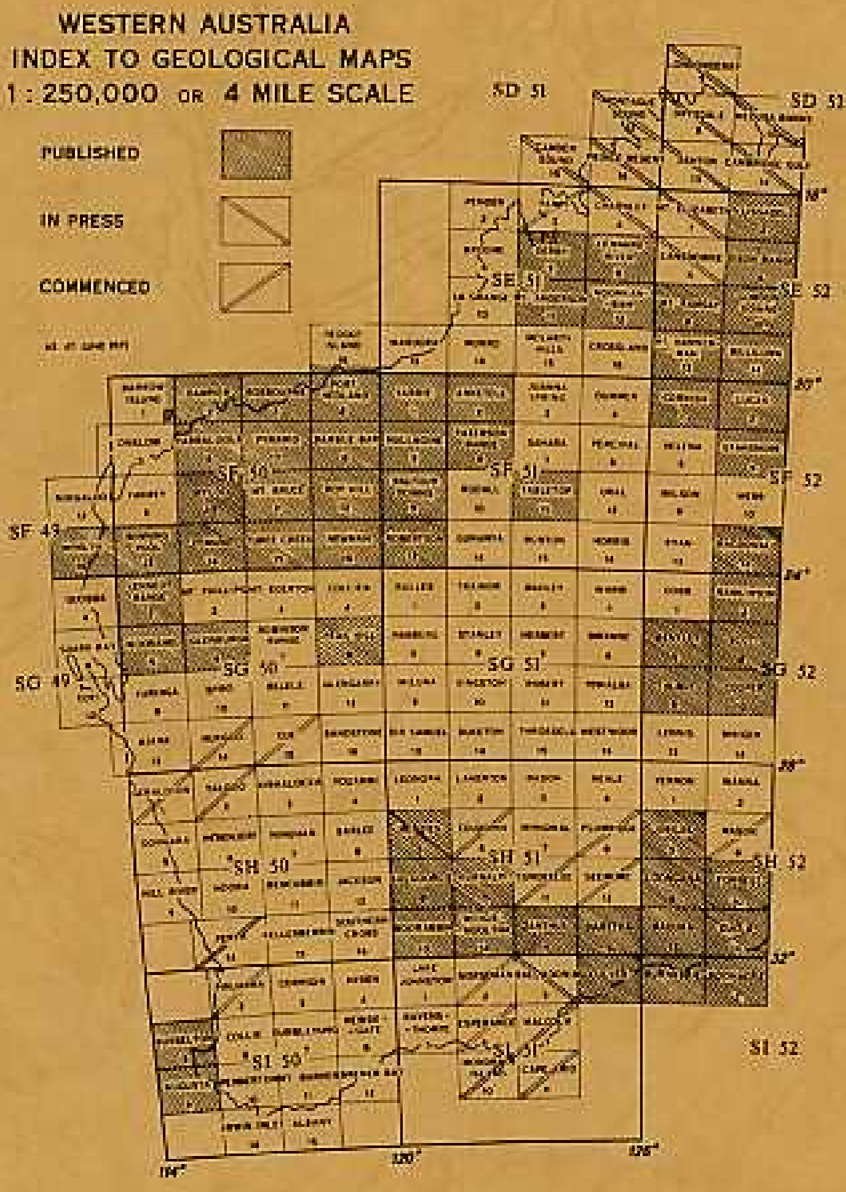
1:250,000 GEOLOGICAL SERIES—EXPLANATORY NOTES

ZANTHUS
WESTERN AUSTRALIA

SHEET SH/51-15 INTERNATIONAL INDEX


WESTERN AUSTRALIA
INDEX TO GEOLOGICAL MAPS
1 : 250,000 OR 4 MILE SCALE
PUBLISHED
IN PRESS
COMMENCED
SD 51
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

COMMONWEALTH OF AUSTRALIA

STATE OF WESTERN AUSTRALIA

1:250,000 GEOLOGICAL SERIES—EXPLANATORY NOTES

ZANTHUS

SHEET SH/51-15 INTERNATIONAL INDEX

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

Geological Survey of Western Australia

Published by the Bureau of Mineral Resources, Geology and Geophysics, and issued under the authority of the Hon. R. W. C. Swartz, M.B.E., E.D., M.P., Minister for National Development
1970

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT
MINISTER: THE HON. R. W. C. SWARTZ, M.B.E., E.D., M.P.
SECRETARY: L. F. BOTT, D.S.C.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
DIRECTOR: N. H. FISHER
GEOLOGICAL BRANCH: ASSISTANT DIRECTOR, J. N. CASEY

STATE OF WESTERN AUSTRALIA

DEPARTMENT OF MINES
MINISTER: THE HON. D. G. MAY, M.L.A.
UNDER SECRETARY: G. H. COOPER

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
DIRECTOR: J. H. LORD

Printed in Australia by Graphic Services Pty Ltd, 60 Wyatt Street, Adelaide

Explanatory Notes on the Zanthus Geological Sheet

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

INTRODUCTION

The Zanthus 1:250,000 Sheet, SH/51-15 on the International Grid, is bounded by latitudes 31°S and 32°S and longitudes 123°E and 124°30′E. It is located within the Eucla Land Division of Western Australia, and the portion of the Sheet area north of 31°53′ is within the North East Coolgardie Goldfield.

The only settlements within the Sheet area are Coonana, Zanthus and Kitchener on the Trans-Australian Railway which crosses the northern part of the sheet. The Sheet area contains portions of the pastoral properties of Coonana, Kanandah and Fraser Range Stations.

The main access is by way of a road from Kalgoorlie, the nearest town, 96 miles to the west of the sheet. The road lies on the southern side of the Trans-Australian Railway. There are only a few tracks over the greater portion of the Sheet area and although travel away from the tracks is possible by four-wheel drive vehicle, it is hampered by dense scrub, especially in the western portion of the sheet.

Precambrian high-grade metamorphic and granitic rocks crop out in the western portion of the Sheet area. They are overlain to the east by Phanerozoic sediments of the Eucla Basin.

PHYSIOGRAPHY

The sedimentary rocks in the eastern half of the Zanthus Sheet area form part of the western margin of the Bunda Plateau. This limestone plateau slopes gently seaward from an altitude of 650 feet in the northwest to 400 feet in the southeast of the Sheet area. The flatness of the plateau is inherited from the flatness of the Tertiary sea floor and has been perpetuated by uniform erosion. The surface of the plateau has been modified by deflation of clay soils and by the formation of rock holes, shallow caves and blow-holes (Jennings, 1963, 1967; Lowry, 1968a).

* Geological Survey of Western Australia.

Most of the western portion of the Sheet area is gently undulating and soil covered. Drainage is internal towards broad valleys which contain salt lakes. The land surface rises from about 600 feet above sea level at the edge of the Bunda Plateau to over 1,200 feet in the western portion of the sheet.

The south end of Ponton Creek (also known as Goddard Creek and Ponton River) is in the north of the Sheet area. It is the lower part of an ancient major river system, the upper reaches of which are now marked by Lakes Raeside and Rebecca (Morgan, 1966). After rare periods of heavy rain these lakes discharge into Ponton Creek. The creek extends a short distance onto the Tertiary limestones. Its intermittent flows end in a claypan. In the past however, it discharged into a saline playa, now filled with alluvium, farther to the south.

Lake Harris lies in another ancient river valley, the western portion of which is now marked by Lake Lefroy.

CLIMATE

The average annual rainfall in the Zanthus Sheet area ranges from 11 inches in the southwest to 7 inches in the northeast. The hottest month is January with an average maximum temperature of about 85°F and an average minimum temperature of about 60°F. The coldest month is July with an average maximum of about 60°F and an average minimum of about 40°F. Humidity is low in summer and the annual evaporation ranges from 70 inches in the southeast to 90 inches in the northwest.

VEGETATION

The vegetation on the Bunda Plateau consists mainly of open myall scrub (*Acacia* spp). Over the Precambrian portion of the sheet the vegetation ranges from open eucalypt woodland, to dense scrub dominated by mallee-type eucalypt. Areas of grassy plain with blue-bush (*Kochia sedifolia*) and salt bush (*Atriplex* spp.) are present in the southeast of the sheet in the vicinity of Emu Point Tank, to the southeast of Coonana Siding, and over the Fraser Complex.

GEOLOGICAL INVESTIGATIONS

Streich (1893), Gibson (1909), and Talbot (1920) traversed parts of the Sheet area. General descriptions of the geology of the Eucla Basin are given by Maitland (1919), Fairbridge (1953), Singleton (1954), Ludbrook (1958), and Lowry (1968b and in prep.). Wilson has written numerous papers about the Fraser Range area, the most comprehensive of which (Wilson, 1969) contains a summary of his previous work. Doepel (1969) discussed the regional structure and relationships of the Precambrian rocks between Zanthus, the Fraser Range, and Israelite Bay.

Explanatory notes are available for the adjoining Sheet areas of Widgiemooltha (Sofoulis, 1966), Kurnalpi (Williams, 1970), Naretha (Lowry, 1969), Culver (Lowry, in press), Balladonia (Doepel and Lowry, 1970), and Norseman (Doepel, in prep.).

In 1965, D. C. Lowry mapped the sedimentary rocks on the east of the Sheet area and the Precambrian rocks were mapped by J. J. G. Doepel and P. R. Koehn in 1968.

GEOLOGICAL SUCCESSION

Archaean granite crops out in the northwest corner of the Sheet area; Proterozoic gneisses, granites and granulites of the Albany-Fraser Province (as defined by Daniels and Horwitz, 1969) are present to the south and west; nearly horizontal Tertiary and Cretaceous sediments of the Eucla Basin overlie the Proterozoic rocks in the eastern portion of the Sheet area; and a superficial Cainozoic cover is present over most of the Sheet area. The stratigraphy is summarized in Table 1.

ARCHAEAN

Granite

A medium-grained biotite granite*, in part porphyritic, crops out in the northwestern corner of the Sheet area. It is intruded by numerous aplite and pegmatite dykes. It is presumed to be of Archaean age.

ARCHAEAN AND ?PROTEROZOIC

Mixed granites

An area of mixed granites is present to the south of Coonana Siding. There are four facies of granite. Equigranular leucocratic granite intrudes porphyritic granite, medium-grained biotite granite, and fine to medium-grained gneissic biotite granite. Numerous pegmatites and quartz veins, both of which characteristically contain accessory tourmaline, intrude all the granites. The older granites are presumably of Archaean age. The granitic rocks and intruding veins have been sheared and rodded in the eastern portion of their area of outcrop. It is suggested that the equigranular leucocratic granite may be Proterozoic.

PROTEROZOIC

Porphyritic granite

Porphyritic biotite granite crops out adjacent to the Fraser Complex on both its eastern and western sides, at Wadabuna Rock and about 15 miles north

* In these Notes the term granite is used to include all granitoid rocks.

TABLE 1. STRATIGRAPHIC SUMMARY ZANTHUS 1:250,000 SHEET AREA

Age	*Symbol on map or diagram*	*Name or short description*	*Max. known thickness (feet)*	*Lithology*	*Stratigraphic relation with underlying unit*	*Remarks*
RECENT	Qro	Colluvium	10 +	Calcareous clay with fragments of limestone and kankar	Overlies Tertiary formations with a very slight unconformity	Forms clay flats on limestone plateau
	Qrk	Lake deposits, non-saline	20 ±	Clay, silt and sand	Overlie older units unconformably	In claypans and swamps
	Qre	Lake deposits, saline	?200	Silt and clay with halite and gypsum		Saline playas fed by internal drainage
RECENT-PLEISTOCENE	Qo	Eolian deposits	50 ±	Quartz sand, silt, clay in part gypsiferous	Overlie older units unconformably	In dunes and sheets; derived from lakes
	Qe	Eolian deposits	50 ±	Quartz sand		In sheets and dunes
PLEISTOCENE	Qpv	Alluvium	?50	Clay, silt, sand, pebbles	Overlie older units unconformably	Valley fill; may contain water; surface of unit approximates position of present drainage
	Qpc	Colluvium	25 ±	Sand, silt, clay, rock fragments	Unconformably overlies dissected unit Qpe and Precambrian rocks	May contain small supplies of water; small rock outcrops may be present
	Qpe	Residual and eolian loam	20	Calcareous clay, silt and sand, containing sheet and nodular kankar	Formed residually over Tertiary limestones; unconformably overlies Pleistocene-Pliocene and Precambrian rocks	Residual over limestone; loess deposit over Precambrian
	Qpr	Residual clay and kankar	5	Clay containing sheet and nodular kankar	Formed over Nullarbor Limestone	

PLEISTOCENE-PLIOCENE	TQr	Residual clay and kankar	20	Clay containing sheet and nodular kankar with oolitic texture	Formed over Nullarbor Limestone	
	TQb	Silcrete and ferricrete	50 ±	Clay to boulder deposits with siliceous ferruginous cements	Formed over weathered granitic rocks	Residual and reworked
	TQf	Sandstone	50 ±	Ferruginous sandstone, minor conglomerate	Unconformable on Precambrian rocks	In major valleys
	TQc	Recrystallized limestone	10	Microcrystalline limestone	Formed from Nullarbor Limestone	Occurs near surface of plateau
LOWER MIOCENE	Tmn	Nullarbor Limestone	50	Foraminiferal calcarenite	Disconformable on Toolinna Limestone	
UPPER EOCENE	Tet	Toolinna Limestone	350 ±	Porous bryozoan limestone	Unconformable on Precambrian rocks	May grade laterally into Wilson Bluff Limestone
UPPER AND ?MIDDLE EOCENE	Tew	Wilson Bluff Limestone	?350	Chalky bryozoan limestone	Conformable on Hampton Sandstone or disconformable on Madura Formation	?Present in Sheet area
	Teh	Hampton Sandstone	?	Sandstone; commonly incoherent and ironstained	Disconformable on Madura Formation	Lenticular; presence inferred
UPPER AND LOWER CRETACEOUS	Km	Madura Formation	?200	Sandstone and mudstone; commonly glauconitic and carbonaceous	Conformable on Loongana sandstone, or unconformable on Precambrian rocks	Presence inferred
LOWER CRETACEOUS	Kll	Loongana Sandstone	?	Sandstone, probably conglomeratic in places	Unconformable on Precambrian rocks	Lenticular; presence inferred

		INTRUSIVE AND HIGH GRADE METAMORPHIC ROCKS		RELATIONS WITH OLDER UNITS	
PROTEROZOIC	Ꝑu	Serpentinite	Magnetite-serpentine schist	?Intrusive into Ꝑm	Probable dyke
	Ꝑx	Fraser Complex	Acid and basic granulites, acid gneiss, amphibolite, gabbroic rocks, micro-granite, acid pegmatite		Dates of 1,210, 1,280 and 1,328 ± 12 m.y. obtained from Fraser Complex
	Ꝑy	Equigranular leucocratic granite	Equigranular leucocratic granite; accessory biotite	Intrusive into Ag. Ꝑb	Not all occurrences necessarily comagmatic
	Ꝑb	Augen gneiss	Garnet-biotite-quartz-feldspar gneiss containing feldspar augen	?Intrusive into basic rocks of Fraser Complex	?Metamorphosed porphyritic granite; date of 1,660 ± 40 m.y. obtained from gneiss
	Ꝑl	Porphyritic granite	Porphyritic biotite granite	?Intrusive into basic rocks of Fraser Complex	Date of 1,660 ± 40 m.y. obtained from western outcrop
ARCHAEAN AND ?PROTEROZOIC	ꝐƐm	Mixed granites	Equigranular leucocratic granite intrusive into biotite granites		Possibly Ꝑy intrusive into Ag
ARCHAEAN	Ag	Granite	Biotite granite; in places porphyritic		

of Symons Hill respectively. Specimens from the western outcrop were pooled with specimens of garnet-biotite-quartz-feldspar augen gneiss collected 40 miles to the southwest, and with a specimen of rapakivi granite intruding partly metamorphosed gabbro at the margin of the Fraser Complex 35 miles to the northeast. An isochron of 1,660 ± 40 m.y. with initial Sr^{87}/Sr^{86} of 0.708 ± 0.002 was obtained from this suite of specimens (Arriens and Lambert, 1969).

Augen gneiss

Garnet-biotite-quartz-feldspar gneiss containing feldspar augen crops out to the northwest and southeast of Uraryie Rock, in the northwest segment of the Sheet area. It appears to be a metamorphosed porphyritic granite which could be comagmatic with rapakivi granite intruding the partly metamorphosed gabbro at the margin of the Fraser Complex. It is intruded by dykes of equigranular biotite granite, which have also been metamorphosed.

Similar augen gneiss is present to the northwest of the Fraser Complex on the Widgiemooltha Sheet area (Sofoulis, 1966), and on the Norseman Sheet area (Doepel, in prep.) where it was included in the Mount Andrew Migmatites. Specimens of the augen gneiss from the Norseman Sheet area were included in the suite from which the 1,660 ± 40 m.y. isochron was obtained (Arriens and Lambert, 1969).

Equigranular leucocratic granite

Equigranular leucocratic granite is present in numerous outcrops between Coonana Siding and the rocks of the Fraser Complex. It is intrusive into other granites and into the augen gneiss. It is sheared in the vicinity of the Fraser Complex and in an area south of Coonana Siding. Not all of its occurrences are necessarily comagmatic.

Fraser Complex

Rocks of the Fraser Complex (Doepel, in prep.) crop out in the Zanthus Sheet area as a 20-mile wide northeast-trending belt which extends from the southwestern corner to the northern border of the sheet. The southwestern end of the Fraser Complex is about 30 miles to the southwest of the Zanthus Sheet. The complex is covered by Phanerozoic rocks to the northeast of the Sheet area.

The Fraser Complex consists of basic pyroxene granulites which contain veins and bands of acid granulite, acid gneiss and microgranite. Remnants of gabbro are present in the granulites. One pod of porphyritic granite is present within the complex. Pegmatites intrude the gabbros and the granulites. Muscovite from these pegmatites has been dated at 1,280 m.y. and 1,210 m.y., using Rb-Sr and K-Ar methods respectively (Compston and Arriens, 1968).

The basic granulites are augite-hypersthene-plagioclase rocks with or without hornblende or biotite. Chemical analyses (Wilson, in press) show that they have a tholeiitic composition. In places they contain stringers and scattered ellipsoids of quartz, perthite and plagioclase. The acid granulites contain hypersthene and range in composition from granite to granodiorite. Arriens and Lambert (1969) report that the granulites give an isochron of 1,328 ± 12 m.y. with initial Sr^{87}/Sr^{86} of 0.705 ± 0.001.

The complex is bounded on the west by a zone of shearing called the Fraser Fault Zone (Wilson, 1969). Epidote and green hornblende-bearing migmatites have developed in this zone. The eastern boundary of the complex has no outcrop, but it is likewise thought to be a zone of faulting.

On the western margin of the complex, about 4 miles southwest of Harris Lake, there is a partly metamorphosed gabbro intruded by rapakivi granite. A specimen of this granite was included in the suite from which the 1,660 ± 40 m.y. isochron was obtained (Arriens and Lambert, 1969). Both the gabbro and the granite have been sheared in the Fraser Fault Zone.

Wilson (1969) considers that the majority of the granulites are metamorphosed volcanic rocks which contained some sedimentary bands. He has interpreted the quartz and plagioclase ellipsoids in the pyroxene granulites as metamorphosed amygdales of the original basalts, and he has interpreted structures in the basic granulites as relict pillows.

One of the authors (J. Doepel) however, disagrees with Wilson's interpretations. He has found no evidence of sedimentary or volcanic structures within the complex and except for some graphite-bearing bands reported by Wilson (1969), he considers that there is no evidence to suggest that the complex is composed of supracrustal rocks. He suggests, however, that the complex is an upfaulted wedge of a lower crustal layer, and believes that the injection of granitic material into a uniform rock mass of basaltic composition, and subsequent metamorphism and folding, can account for the majority of the features of the granulite (Doepel, in prep.).

Serpentinite

Serpentinite crops out south of Coonana over a distance of 3 miles in a north-northwest-trending band about 500 feet wide. The serpentinite is schistose and it contains abundant magnetite, both disseminated and in veins up to an inch in thickness. The serpentinite's sheet form, its presence in an area of granite, which may be in part Proterozoic, and the absence of any other rocks likely to be present in a remnant of Archaean layered succession, indicate that it is probably intrusive into the granites.

Mesozoic

Cretaceous beds do not crop out, but are believed to underlie the eastern part of the Sheet area. Two formations are likely to be present; the Loongana Sandstone and the Madura Formation.

Loongana Sandstone

The Loongana Sandstone ("Loongana Conglomerate" of Fairbridge, 1953; amended Lowry, in press), is typically a lenticular formation composed of feldspathic sandstone and conglomeratic sandstone. It is Lower Cretaceous (probably Neocomian-Aptian) in age and appears to be a fluvial deposit which accumulated in hollows in the surface of the Precambrian rocks.

Madura Formation

The Madura Formation ("Madura Shale" of Fairbridge, 1953, and McWhae and others, 1958; amended Lowry, in press), which may range in age from Lower to Upper Cretaceous, contains greensand, glauconitic sandstone, carbonaceous sandstone and carbonaceous mudstone. The formation is likely to be about 200 feet thick along the eastern edge of the Sheet area and it either unconformably overlies Precambrian rocks or conformably overlies the Loongana Sandstone.

Cainozoic

EOCENE

Hampton Sandstone

The Hampton Sandstone ("Hampton Conglomerate" of Fairbridge, 1953; amended Lowry, 1968b), is a carbonate-cemented or incoherent limonite-stained medium to coarse-grained sandstone. It occurs as lenses in many parts of the Eucla Basin and probably occurs beneath the Tertiary limestones on parts of the Zanthus Sheet. The formation contains Middle Eocene foraminifers in the central part of the basin (Ludbrook, 1960), but it may be as young as Upper Eocene in the Zanthus Sheet area.

Toolinna and Wilson Bluff Limestones

The Toolinna Limestone (Lowry, 1968b) is a porous bryozoan limestone that crops out in a small area on the western edge of the Bunda Plateau. It is present in spoil from New Pioneer Tank, and may crop out in the bed of Ponton Creek. In the southeastern corner of the Sheet area the formation is probably about 350 feet thick and may grade laterally into the Wilson Bluff Limestone—a bryozoan limestone that is chalky and more poorly sorted than the Toolinna Limestone (Singleton, 1954; Lowry, 1968b). Elsewhere in the basin the Toolinna Limestone contains echinoids, molluscs and foraminifers, all of which indicate an Upper Eocene age.

MIOCENE

Nullarbor Limestone

The Nullarbor Limestone (Singleton, 1954; Lowry, 1968b), is exposed on several parts of the plateau, and underlies the soil on much of the remainder. The limestone is typically a hard, indurated, micritic foraminiferal calcarenite with numerous moulds of pelecypods and gastropods. The formation probably does not exceed 50 feet in thickness. It overlies the Toolinna Limestone disconformably and elsewhere in the basin contains foraminifers which indicate a Lower Miocene (Burdigalian) age (Ludbrook, 1963 and 1967).

PLEISTOCENE-PLIOCENE

Recrystallized limestone

The Nullarbor Limestone has been recrystallized near the surface of the Bunda Plateau in some areas, to form a microcrystalline limestone with little or no trace of the original texture. In places it is pale, porous, and friable, but in others it is hard and compact with lithologies that include brown, featureless limestone, limestone with irregular light and dark brown patches, and limestone with a texture resembling well rounded calcarenite. The recrystallization is probably due to prolonged weathering of limestone in an arid to semi-arid climate.

Sandstone and conglomerate

Thin-bedded sandstone, with a ferruginous cement, crops out in the shores of the lake to the south of Coonana. It shows medium scale current-bedding and rare thin pebbly bands.

Silcrete and ferricrete

Residual and reworked clay to boulder deposits, with siliceous and ferruginous cements, crop out as a cap to deeply weathered granitic rocks to the south of Coonana and in the vicinity of Zanthus. Reworking has been by wind and water action. The deposits were probably formed during the general period of time of deposition of the ferruginous sandstones in the valley to the south.

Residual clay and kankar

Much of the Nullarbor Limestone in the northern part of the Sheet area is overlain by a layer of residual calcareous clay 15 to 20 feet thick, containing a layer of grey kankar about 6 feet thick. The kankar forms slabs and cobbles with a complex internal oolitic or pisolitic structure. In places the kankar is exposed on the surface and in others it is buried to depths of up to 5 feet. Where the soil is deeply dissected, the kankar crops out as a resistant layer on the face of low scarps. The clay is believed to be mainly residual. The land snail *Bothriembyron* sp. occurs within the clay and cemented in the kankar, indicating that the kankar was formed by lithification of the clay.

The clay and kankar form the oldest land surface in the Eucla Basin and result from the prolonged weathering of the Nullarbor Limestone. The unit is tentatively regarded as Pliocene-Pleistocene in age. It has been removed from the plateau in some places by deflation during the Pleistocene (Lowry, in press), and it has been dissected by an ancient river in the southeast of the Sheet area. The river has probably not flowed since the Pleistocene. It caused only slight erosion and was therefore probably not active for long.

PLEISTOCENE

Residual clay and kankar

Part of the Nullarbor Limestone is covered by a sheet up to 5 feet thick of residual clay containing kankar. The kankar is not as massive as the older kankar described above, but forms plates and concentrically laminated nodules up to 3 inches across. It is commonly reddish, silty, and lacking in oolitic texture. The clay which encloses the kankar is thought to be dominantly residual, with minor reworking in some areas.

Residual and eolian loam

Sandy loam containing kankar in the form of sandy, finely laminated nodules occurs over the Precambrian rocks and parts of the Bunda Plateau within the Zanthus Sheet area. Over the Tertiary limestones the loam is thought to be mainly a residual weathering product. The sand is thought to derive in part from sandy limestones and possibly in part from adjacent Precambrian areas.

Over the Precambrian rocks the unit's widespread distribution, 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.

Colluvium and alluvium

Dissection of the eolian loam over the Precambrian rocks has produced depressions which contain colluvial deposits of sand, silt, clay and rock fragments. Small rock outcrops are present in some of the depressions.

Alluvium floors many of the valleys in the western portion of the Sheet area and sheets of alluvium lead north and south from the breakaway near Coonana.

RECENT-PLEISTOCENE

Eolian deposits

Eolian sheets and dunes of quartz sand extend in a northeast-trending strip across the Sheet area, and eolian dunes and sheets are present around the eastern side of many of the salt lakes. The latter dunes and sheets are composed of quartz sand, silt, clay and gypsum, blown from the salt lakes.

RECENT

Lake deposits

Recent lacustrine deposits of clay, silt and sand, with halite and gypsum, occur on salt lakes or playas. Non-saline clay, silt and sand occur in a few claypans and swamps.

Colluvium

The clay flats on the Bunda Plateau are underlain by clay washed from the surrounding 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 thick.

STRUCTURE

Figure 1 is a structural sketch map of the Sheet area.

PROTEROZOIC ROCKS

The granitic rocks that make up the northwest portion of the Sheet area are strongly sheared to the south and southwest of Coonana Siding. It is suggested that this zone of shearing reflects an east-dipping reverse fault between Proterozoic rocks to the east and dominantly Archaean rocks to the west. The slopes of gravity profiles (drawn from the regional gravity map, of the southern part of the Western Australian Precambrian Shield, released by the Australian Bureau of Mineral Resources in 1970), indicate that a major crustal fault may be present in this position. It is suggested that the serpentinite southwest of Coonana Siding was intruded along this zone of fracture.

The trend lines on Figure 1 in the area of Proterozoic granite, gneiss and migmatite to the west of the Fraser Complex are drawn from aeromagnetic trends. In general they parallel the direction of metamorphic foliation in the gneisses.

The Fraser Complex is thought to be an upthrust block. Everingham (1965) suggested that both its western and eastern boundaries may dip to the east. A number of shear zones are present in the vicinity of the western margin of the Fraser Complex near the Uraryie Rock-Buningaria Spring track. All of the rock types cropping out in the area are sheared.

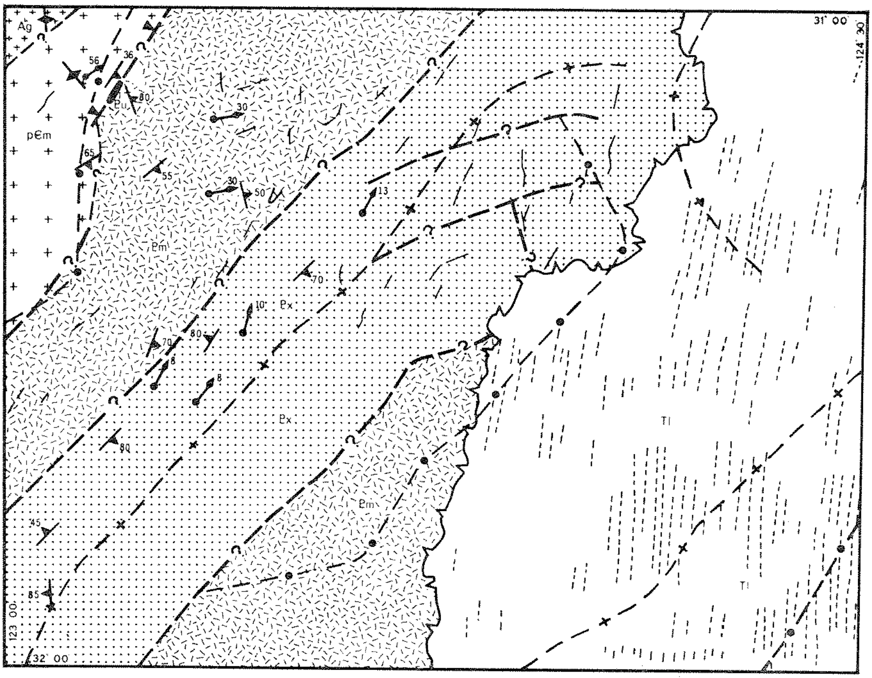
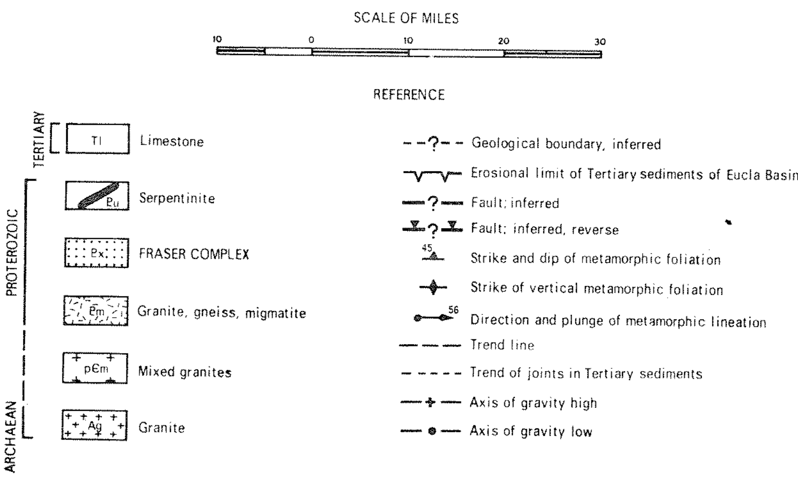


FIGURE 1
STRUCTURAL SKETCH MAP
ZANTHUS SHEET SI 51-15



The trend lines in the Fraser Complex on Figure 1 are drawn from photo-lineaments. They reflect bands of acid granulite and gneiss within basic granulites.

The network of faults on Figure 1 at the northern end of the complex is inferred from aeromagnetic discontinuities.

The axes of gravity highs and lows are drawn from the regional gravity map. The southern continuations of the high and low axes in the eastern portion of the Sheet area coincided in the Balladonia Sheet area with areas of Proterozoic migmatite and porphyritic granite respectively (Doepel and Lowry, 1970).

Phanerozoic rocks

The sedimentary rocks of the Eucla Basin dip gently eastwards at about 2 to 10 feet per mile, as a result of gentle downwarping in the Cretaceous and Tertiary. In the southeast of the Sheet area they reach a probable thickness of 550 feet.

Air-photographs show a regular pattern of north-trending joints in both the Toolinna and Nullarbor Limestones. They appear as abundant parallel lines approximately 800 feet apart.

ECONOMIC GEOLOGY

Barite is the only mineral for which production has been recorded from the Zanthus Sheet area.

Barite

In 1953, 42.22 long tons of barite worth $760.20 were won from a barite vein in granite, 5 miles southwest of Coonana Siding. Quartz and accessory galena, chalcopyrite and covellite were present in the vein.

Barite is also reported from 10 miles east of Buningonia Rock (Simpson, 1948).

Base metals

There is a possibility of base metal deposits in the Fraser Complex. Wilson (1969) suggested that it may contain concentrations of copper, nickel and some other metals. Copper mineralization with associated nickel has been located near the western margin of the complex, on the Norseman Sheet area, by Newmont Pty Ltd.

Some specimens of chromite are reported to have come from 10 miles east of Buningonia Spring (Simpson, 1951).

Graphite

A kaolinized, ironstained rock found 8 miles east of Buningonia contained 22 percent flake graphite in veins and nests (Simpson, 1951).

TABLE 2. UNDERGROUND WATER SUPPLIES ZANTHUS SHEET SH/51-15

Locality of well	*Total depth Feet*	*Water level Feet*	*Salinity ppm*	*Use*	*Supply gpd*	*Aquifer*
Just west-southwest of Uraryie Rock	170	—	5,300	—	4,000	Weathered granite
Just east-southeast of Uraryie Rock	150	—	5,300	—	3,000+	Weathered granite
7 miles northeast of Symons Hill	—	67	2,800	Livestock	—	Fissured on Fraser Complex
Symons Hill	—	63	1,820	Livestock	1,820	Fissured Fraser Complex

Gypsum

A sample of kopi, collected from a dune to the east of the ancient salt lake into which Ponton Creek once flowed, assayed 92.6 percent $CaSO_4.2H_2O$ (Simpson, 1951).

Petroleum

Prospects of finding petroleum in the Eucla Basin appear to be poor, because of the absence of any traces of petroleum in wells already drilled, and because of the absence of any known closed structures. The prospects for the Zanthus Sheet area are particularly poor because of the thinness of the sedimentary section within it.

Water

Twenty bores were sunk in the Coonana-Uraryie Rock area. Of these only two, situated near Uraryie Rock, yielded good quantities of stock water. These two bores were in the upper reaches of drainages close to the catchment areas. The other bores were either dry or yielded saline water. A geological report on the siting of the bores was written by Sofoulis (1963).

Stock water is obtained from two wells in the vicinity of Symons Hill, in the southwest of the Sheet area. The wells are sunk in weathered and fractured basic granulites.

Details of the stock-water-containing bores and wells are given in Table 2.

Within the Zanthus Sheet area fresh water is available from the sand in the bed of Ponton Creek, the quality improving to the southeast (Gibson, 1909).

Within the Sheet area there are no bores in the sediments of the Eucla Basin, and there appears little prospect of obtaining stock water. Water with a salinity of 19,000 ppm was encountered in a bore on the Naretha Sheet area, about 25 miles northeast of Emu Point Tank, which is in the southeast of the Zanthus Sheet area (Lowry, 1969); and to the south in the Balladonia Sheet area, bores, beside the Eyre Highway to the east of Balladonia, also yielded highly saline water (Doepel and Lowry, 1970).

REFERENCES

Arriens, P. A., and Lambert, I. B., 1969, On the age and strontium isotopic geochemistry of granulite-facies rocks from the Fraser Range, Western Australia, and the Musgrave Ranges, Central Australia: Geol. Soc. Australia Spec. Pub. No. 2, p. 377-388.

Compston, W., and Arriens, P. A., 1968, The Precambrian geochronology of Australia Canadian Jour. of Earth Sci. v. 5, p. 561-583.

Daniels, J. L., and Horwitz, R. C., 1969, Precambrian tectonic units of Western Australia: West. Australia Geol. Survey Ann. Rept. 1968, p. 37-38.

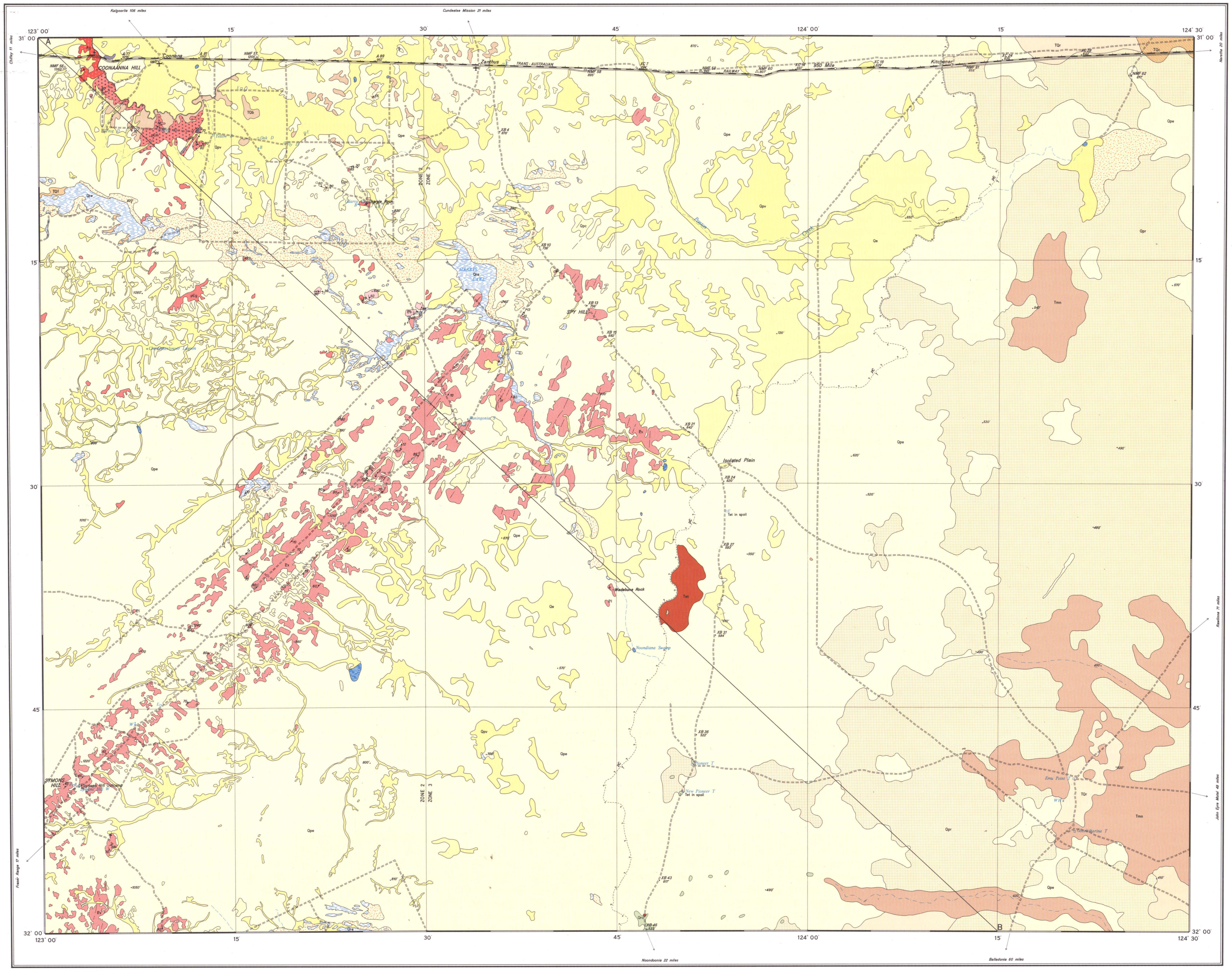
Doepel, J. J. G., 1969, The Precambrian geology between Zanthus and Israelite Bay, Western Australia: West. Australia Geol. Survey Ann. Rept. 1968, p. 41-42.
——— in prep., Norseman, W.A.: West. Australia Geol. Survey 1:250,000 Geol. Series Explan. Notes.
Doepel, J. J. G., and Lowry, D. C., 1970, Explanatory notes on the Balladonia 1:250,000 Geological Sheet, W.A.: West. Australia Geol. Survey Rec. 1970/11 (unpublished).
Everingham, I. B., 1965, Gravity anomalies on the Precambrian shield of south-western Australia: Univ. West. Australia Master's Thesis (unpublished).
Fairbridge, R. W., 1953, Australian stratigraphy: Univ. West. Australia Press (2nd ed.).
Gibson, C. G., 1909, Country lying along the route of the proposed transcontinental railway in Western Australia: West. Australia Geol. Survey Bull. 37.
Jennings, J. N., 1963, Some geomorphological problems of the Nullarbor Plain: Royal Soc. South Australia Trans. v. 87, p. 41-62.
——— 1967, The surface and underground geomorphology; p. 13-31, *in* Dunkley, J. R., and Wigley, T. M., eds., Caves of the Nullarbor: Sydney, Speleol. Research Council, 61 pp.
Lowry, D. C., 1968a, The origin of blow-holes and the development of domes by exsudation in caves of the Nullarbor Plain: West. Australia Geol. Survey Ann. Rept. 1967, p. 40-44.
——— 1968b, Tertiary stratigraphic units in the Eucla Basin in Western Australia: West. Australia Geol. Survey Ann. Rept. 1967, p. 36-40.
——— 1969, Explanatory notes on the Naretha 1:250,000 Geological Sheet, W.A.: West. Australia Geol. Survey Rec. 1969/6 (unpublished).
——— in prep., Geology of the Western Australian part of the Eucla Basin: West. Australia Geol. Survey Bull. 122.
——— in press, Culver, W.A.; West. Australia Geol. Survey 1:250,000 Geol. Series Explan. Notes.
Ludbrook, N. H., 1968, The stratigraphic sequence in the western portion of the Eucla Basin: Royal Soc. West. Australia Jour. v. 41, p. 108-114.
——— 1960, Exoil Pty. Ltd., Eyre No. 1 and Gambanga No. 1 Wells subsurface stratigraphy and micropalaeontological study: South Australia Dept. Mines Palaeont. Rept. 11/60 (unpublished).
——— 1963, Correlation of the Tertiary rocks of South Australia: Royal Soc. South Australia Trans. v. 87, p. 5-15.
——— 1967, Correlation of the Tertiary rocks of the Australasian region *in* Hatai, K., ed., Tertiary correlations and climatic changes in the Pacific: Sendai, Japan, Saski Ltd., 102 pp.
Maitland, A. G., 1919, Petroleum prospects in the Nullarbor Plains-Eucla Division: West. Australia Geol. Survey Ann. Rept. 1918, p. 7-11.
McWhae, J. R. H., Playford, P. E., Lindner, A. W., Glenister, B. F., and Balme, B. E., 1958, The stratigraphy of Western Australia: Geol. Soc. Australia Jour., v. 4, pt. 2.
Morgan, K. H., 1966, Hydrogeology of the East Murchison and North Coolgardie Goldfields: West. Australia Geol. Survey Ann. Rept. 1965, p. 14-19.
Singleton, O. P., 1954, The Tertiary stratigraphy of Western Australia, a review: Pan-Indian Ocean Sci. Cong., Proc. Sect. C, p. 59-65.
Simpson, E. S., 1948, Minerals of Western Australia, v. 1: Perth, Govt. Printer.
——— 1951, Minerals of Western Australia, v. 2: Perth, Govt. Printer.
Sofoulis, J., 1963, Report on groundwater prospects, Coonana area, south of Trans-Australian Railway, North East Coolgardie Goldfield: West. Australia Geol. Survey Hydrology Rept. No. 57 (unpublished).
——— 1966, Widgiemooltha, W.A.: West. Australia Geol. Survey 1:250,000 Geol. Series Explan. Notes.
Streich, V., 1893, Geology, *part of* Scientific results of the Elder Exploring Expedition: Royal Soc. South Australia Trans. v. 16, pt. 2, p. 74-115.
Talbot, H. W. B., 1920, Notes on the country to the north and south of the Transcontinental Railway, between Randall's and the 174½ miles peg: West. Australia Geol. Survey Ann. Rept. 1919, p. 4-5.
Williams, I. R., 1970, Explanatory notes on the Kurnalpi 1:250,000 Geological Sheet, W.A.: West. Australia Geol. Survey Rec. 1970/1 (unpublished).
Wilson, A. F., 1969, The pyroxene granulites and associated gabbros of the Fraser Range, Western Australia, and their economic significance: Australian Inst. Mining Metall. Proc. 231, p. 47-57.
——— in press, Some structural, geochemical and economic aspects of the metamorphosed East Fraser Gabbro and associated pyroxene granulites of the Fraser Range, Western Australia: Indian Mineralogist.

ZANTHUS

AUSTRALIA 1 : 250,000 GEOLOGICAL SERIES

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SH 51-15



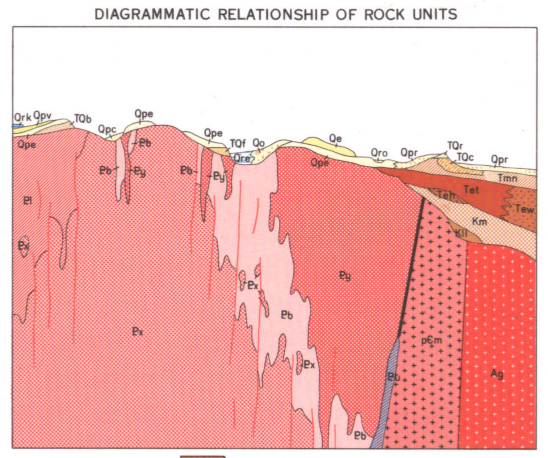
SYMBOLS

Geological boundaries	
Accurate	
Inferred and concealed boundary between Tertiary and Precambrian rocks	
Igneous foliation	
Inclined	15
Vertical	
Metamorphic foliation	
Inclined	20
Vertical	
Trend of foliation	
Direction and plunge of metamorphic lineation	25
Cleavage	
Inclined	30
Vertical	
Road	
Track	
Railway 4' 8½"	
Telegraph line	
Landing ground	
Siding	Zanthus
Horizontal control, major	NMF 58 895'
Bench mark, height accurate	XB 39 499'
Spot height, approximate	490'
Sand dune	
Low scarp, breakaway	
Watercourse	
Intermittent	
Ancient	
Bore	B
Tank or dam (earth)	T E
Well	W
Windpump	
Spring	S
Soak	Sk
Waterhole	WH
Mineral occurrence	
Barite prospect	Ba

REFERENCE

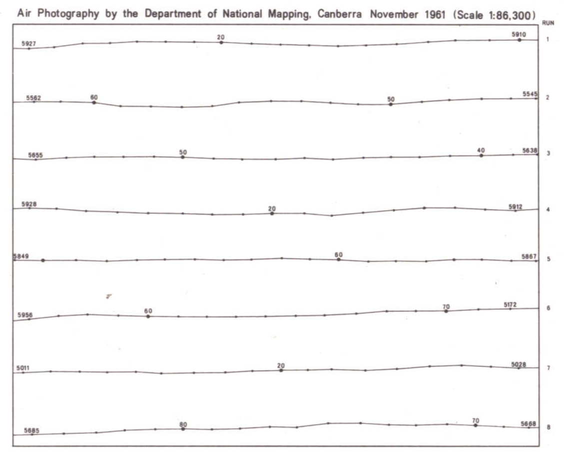
CAINOZOIC	QUATERNARY	RECENT	Qro	Colluvium—calcareous clay, in places containing sand; overlying Tertiary rocks
			Qrk	Lake deposits—clay, silt, sand; in claypans and swamps; non saline
			Qre	Lake deposits—silt, clay, and other lacustrine deposits; saline and gypsiferous
		RECENT – PLEISTOCENE	Qo	Eolian deposits—quartz sand, silt, clay; sometimes gypsiferous; in dunes and sheets; derived from lakes
			Qe	Eolian deposit—quartz sand; in dunes and sheets
		PLEISTOCENE	Qpv	Alluvium—clay to pebble deposits; surface of unit approximates position of present drainage
			Qpc	Colluvium—sand, silt, clay, rock fragments; small rock outcrops may be present
			Qpe	Residual and eolian loam—clay, silt and sand containing sheet and nodular kankar; overlying Precambrian and Tertiary rocks
			Qpr	Residual clay, and kankar—clay containing sheet and nodular kankar; overlying Tertiary rocks
		PLEISTOCENE – PLIOCENE	TQr	Residual clay and kankar—clay containing sheet and nodular kankar with oolitic texture; overlying Nullarbor Limestone
			TQb	Silcrete and ferricrete—residual and reworked clay to boulder deposits; siliceous and ferruginous cements
			TQf	Sandstone and congolomerate with ferruginous cement; bedded
			TQc	Recrystallized limestone—Nullarbor Limestone recrystallized to microcrystalline limestone
	TERTIARY	LOWER MIOCENE	Tmn	**NULLARBOR LIMESTONE:** foraminiferal calcarenite; containing sand near margin of Eucla Basin
		UPPER EOCENE	Tet	**TOOLINNA LIMESTONE:** porous, bryozoan calcarenite
PROTEROZOIC			Ꝑu	Serpentinite; schistose
			Ꝑx	**FRASER COMPLEX:** acid and basic granulites, acid gneiss, amphibolite, gabbroic rocks, microgranite, acid pegmatite
			Ꝑy	Equigranular leucocratic granite
			Ꝑb	Garnet—biotite—quartz—feldspar gneiss containing feldspar augen
			Ꝑf	Granite with potassium feldspar phenocrysts
			p€m	Mixed granites
ARCHAEAN			Ag	Granite with rare potassium feldspar phenocrysts
			p€g	Granite and gneiss—undifferentiated

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



FLIGHT DIAGRAM

Air Photography by the Department of National Mapping, Canberra November 1961 (Scale 1:86,300)

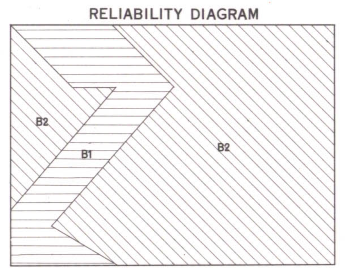


Compiled by Geological Survey of Western Australia. Cartography by Geological Drafting Section, Mines Department. Topographic base from compilations by Royal Australian Survey Corps, Department of Army.

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

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

RELIABILITY DIAGRAM



B1 Numerous traverses with air photo interpretation

B2 Air photo interpretation with a few traverses

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

SCALE 1 : 250,000

5 0 5 10 15 20 Miles

10,000 0 10,000 20,000 30,000 Yards

5 0 5 10 15 20 25 30 Kilometres

TRANSVERSE MERCATOR PROJECTION

ZONES 2 & 3 AUSTRALIA SERIES

Geology by D. C. Lowry 1965: J. J. G. Doepel and P. R. Koehn 1968
Printed by Mercury-Walch Pty Ltd, Hobart, Australia.

INDEX TO ADJOINING SHEETS

KURNALPI SH 51-10	CUNDEELEE SH 51-11	SEEMORE SH 51-12
WIDGIEMOOLTHA SH 51-14	ZANTHUS SH 51-15	NARETHA SH 51-16
NORSEMAN SI 51-2	BALLADONIA SI 51-3	CULVER SI 51-4

DECLINATION DIAGRAM

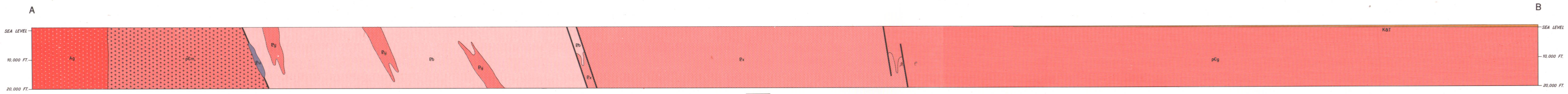
The lines indicate magnetic declination, 1965.
+ means declination is east and correction must be added to compass bearing to give true bearing.
− means declination is west and correction must be subtracted from compass bearing to give true bearing.

Annual change is +1' easterly

DIAGRAMMATIC SECTION

NATURAL SCALE

SECTION A - B



K&T Cretaceous and Tertiary

Fault

ZANTHUS

SHEET SH 51-15

FIRST EDITION 1971