COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

REPORT No. 113

Geology of the North-Eastern Part of the Amadeus Basin, Northern Territory

BY

A. T. WELLS, L. C. RANFORD, A. J. STEWART, P. J. COOK,
and R. D. SHAW

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CONTENTS

TABLES

PLATES

FIGURES

SUMMARY

Over 18,000 feet of sediments ranging from Upper Proterozoic to Tertiary in age are preserved in the north-eastern part of the Amadeus Basin. The Upper Proterozoic rocks are up to 10,000 feet thick; they include a basal sandstone overlain by marine carbonate rocks and shale with some evaporites and volcanics, which are succeeded unconformably by a lenticular glacial formation (Areyonga Formation). The youngest Precambrian formation (Pertatataka Formation) comprises shale, dolomite, and limestone, and changes considerably in lithology from west to east. It is thickest in the east, and includes one member which is probably glacial in origin. This is the first record of a younger period of Precambrian glaciation in the Amadeus Basin.

The Cambrian Pertaoorrta Group is up to 5000 feet thick and in the Ross River area consists of a basal red-bed sandy facies overlain by about 2500 feet of dolomite and limestone, and a silty glauconitic sandstone at the top. To the west, the carbonate content decreases and the proportion of shale increases, but the upper and lower sandy formations show little change.

The overlying Larapinta Group was deposited during marine transgressive and regressive cycles in the Upper Cambrian and Ordovician. In the north-east, the sediments may have been up to 7000 feet thick, but the Pacoota Sandstone is the only formation preserved. In the south, less than 1000 feet of Larapinta Group sediments (with the Stairway Sandstone at the base) were deposited disconformably on the Pertaoorrta Group.

The Mereenie Sandstone (Ordovician - Devonian) unconformably overlies the Larapinta or Pertaoorrta Groups and is in turn unconformably overlain by the Pertnjara Formation, a continental deposit of Devonian to Carboniferous age.

The Upper Proterozoic and Palaeozoic sediments were folded and faulted during the Alice Springs Orogeny, which started in the late Ordovician and reached a climax in the Upper Devonian. The nappes which were formed along the present northern margin of the basin consist of basement and the older Upper Proterozoic sediments. The overlying Upper Proterozoic and Palaeozoic sediments were pushed in front of the nappes and formed a décollement with Jura-type folds and faults. The style of folding and the position of the thrust planes suggest that evaporites within the Bitter Springs Formation and the Pertaoorrta Group (and possibly in the Pertatataka Formation in some areas) played an important role in the deformation of the sediments.

The Pertnjara Formation was deposited in the synclines and folded during the last pulses of the orogeny.

In the north-west the younger sediments include only lacustrine and fluviatile sediments of Cainozoic age, but in the south-east, sediments of Permian, Mesozoic, and Cainozoic age are preserved in the relatively undisturbed Great Artesian Basin. Geophysical data indicate that the Amadeus and Great Artesian Basins are separated by a platform, but in some areas it has been shown by drilling that the Amadeus Basin formations are present unconformably below the Great Artesian Basin sediments.

Several exploratory wells have been drilled, and shows of oil and gas have been recorded. Some of the anticlines are closed in Cambrian sediments and could provide traps

for petroleum, and in the Brewer and Camel Flat synclines, the Pertnjara Formation may conceal diapirs and anticlines with petroleum potential. In the Great Artesian Basin, the petroleum prospects depend largely on the age, thickness, and lithology of the pre-Permian rocks. In one exploratory well, McDills No. 1, drilled recently in the Great Artesian Basin, a large part of the prospective Palaeozoic section was missing.

INTRODUCTION

From June to October 1964, two field parties from the Bureau of Mineral Resources mapped the Rodinga and Hale River Sheet areas and the southern third of the Alice Springs Sheet area and southern quarter of the Illogwa Creek Sheet area. L.C. Ranford and P.J. Cook were responsible for the mapping of the Rodinga Sheet area. The remaining sheets were mapped by A.T. Wells, A.J. Stewart, and R.D. Shaw. D.J. Forman and E.N. Milligan made a complementary study of the Arunta Complex and marginal structures of the north-eastern Amadeus Basin (Forman, Milligan, & McCarthy, 1966). Palaeontologists Joyce Gilbert-Tomlinson and C.G. Gatehouse worked with the field parties for about six weeks. M. Fetherston and L. Kruger were draftsmen with the parties.

The mapping of the Amadeus Basin at a scale of 1:250,000 was completed in 1964.

Location and Access

The area lies between latitudes 23°30'S. and 26°S. and longitudes 113°30'E. and 136°30'E. (Fig. 1). It includes the eastern MacDonnell and Fergusson Ranges, parts of the Waterhouse and James Ranges, the Phillipson Pound, and the western margin of the Simpson Desert.

Alice Springs, in the north-western corner of the area, is linked with Adelaide by rail and road, and to Darwin by the Stuart Highway. Graded roads radiate from Alice Springs by Jay Creek Aboriginal Settlement, Atnarpa, Numery, Deep Well, and Rodinga homesteads, and Santa Teresa Mission. Andado homestead, in the McDills Sheet area, is connected by a gravel road to the Alice Springs/Adelaide road. The more important station tracks are shown on the maps.

Climate

The region lies in the 4 to 10-inch rainfall belt and the rainfall, which is extremely irregular, but generally greater in summer, increases progressively northwards. There are marked diurnal and seasonal fluctuations in temperature. The mean daily maximum may exceed 100°F for many weeks. In the winter months, mean average temperatures range from 65°F to 85°F, and the nights are cold, with frosts common in late June and early July. The prevailing wind is from the south-east. Numerous dust storms were experienced during the winter of 1964.

Development

Most of the population is engaged in the cattle industry. Permanent settlements include Temple Bar, Maryvale, Allambi, Idracowra, Todd River, Ringwood, Limbla, Numery, Deep Well, Rodinga, and Andado homesteads. Aboriginal missions have been established at Santa Teresa and Jay Creek. With the exception of Andado, the main grazing areas are in the better watered and less sandy north-western corner of the area.

A flourishing tourist industry has been developed at Alice Springs and Ross River. Alice Springs, which has a population of about 3500, is the only large town in the southern part of the Northern Territory.

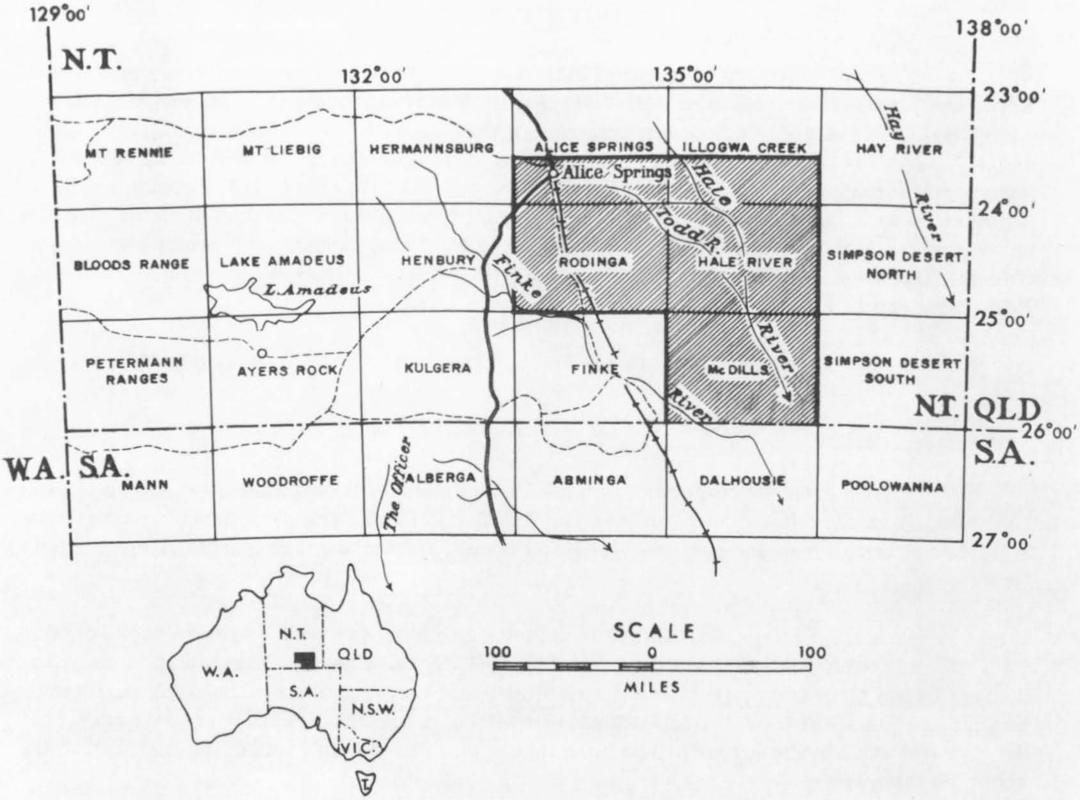

Fig. 1. 1:250,000 Sheet index and locality map.

Survey Method

The area was mapped by reconnaissance traverses using four-wheel-drive vehicles. A helicopter was used for about two weeks to map the more inaccessible parts and for comparison of widely separated sections. The geology was plotted on air-photographs (scale 1:46,500) taken by the Royal Australian Air Force in 1950, and was later transferred to controlled photo-scale overlays. The photo-scale maps were reduced photographically to the 1:250,000 scale and redrafted for the Preliminary Edition. Sections were measured with tape, compass, and abney level.

PHYSIOGRAPHY

The physiographic divisions are shown in Figure 2.

Mountain ranges and hills are present mainly in the northern and western parts of the area. In the north, the ranges are formed mainly of steeply dipping Upper Proterozoic sediments and some Lower Palaeozoic formations. The Waterhouse Range; the areas near Mount Polhill, in the vicinity of Deep Well, around Santa Teresa Mission, and near Mount

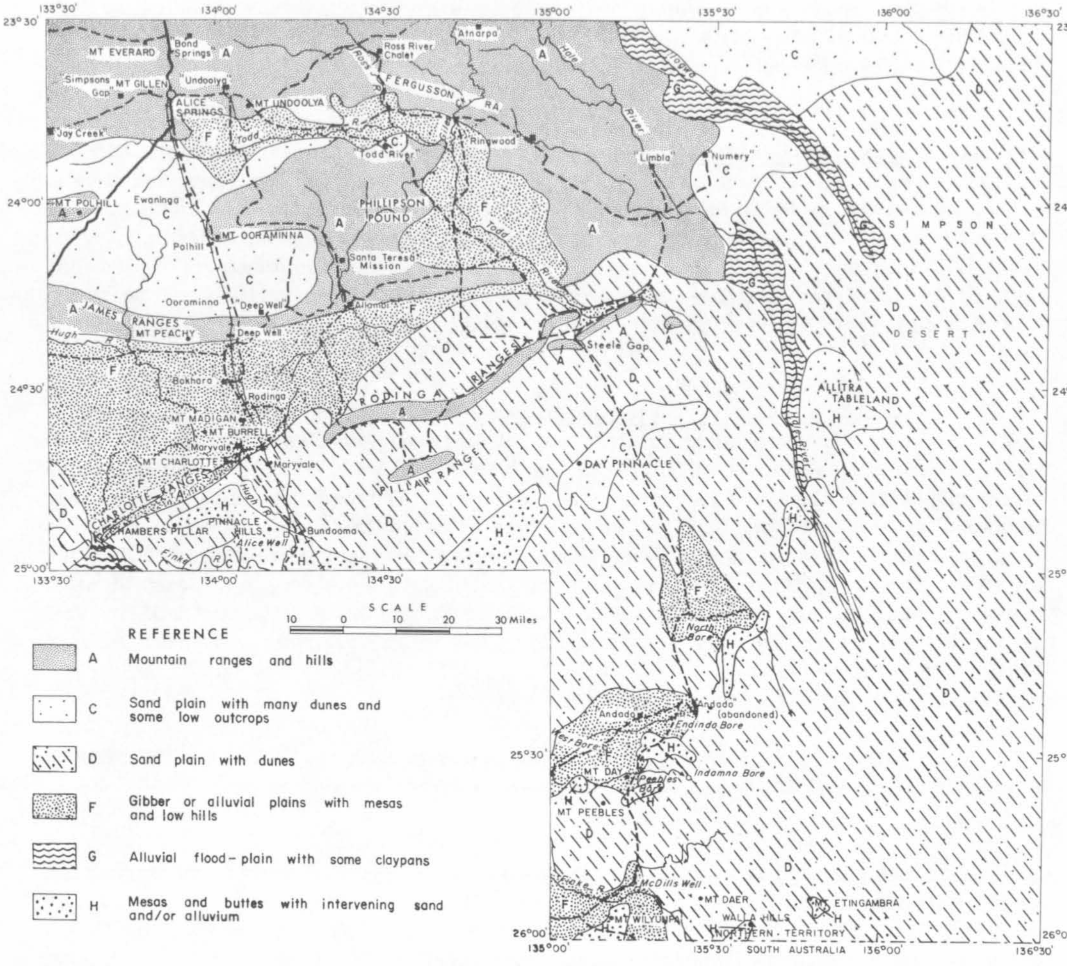

Fig. 2. Physiographic divisions.

Charlotte; and the ranges east of Maryvale homestead all consist of steeply dipping Mereenie Sandstone. The ranges are commonly east-west strike ridges with peaks rising 200 to 1300 feet above the level of the plain. The highest mountains occur in the MacDonnell and Fergusson Ranges. The Heavitree Quartzite forms the most prominent ridge, which rises 1300 feet above the plain at Mount Gillen (3123 feet). There is a well-defined drainage pattern, which generally follows the strike valleys.

Sand plain with many dunes and some low outcrops occupies areas around Ewaninga Siding, east and north-east of Numery homestead, and east of Day Pinnacle on the Hale River Sheet area. The sand plain has no well-defined drainage pattern. At the eastern end of Missionary Plain, around Ewaninga Siding, the undulating sandy country with rises composed of conglomerate has a relief of only 30 feet. The large area of sandy flats and undulating plain north-east of Numery homestead has some low hills, but in the smaller area near the homestead the hills have a relief of up to 200 feet. The sand plain around Day Pinnacle includes a few outcrops up to 50 feet high.

Sand plain with dunes covers a large portion of the area, and includes the Simpson Desert in the east and south-east. Outcrops are very rare. The sand plain is probably underlain by flat-lying or gently dipping Upper Palaeozoic and Mesozoic sediments. The dunes are of the longitudinal type, trend north-west, and may be many miles long. Some reach a height of 50 feet. The dunes are more closely spaced than those in the preceding division and the narrow interdune areas are unable to support much vegetation. A few creeks flow through the area to the south-east, but the drainage is generally poorly defined.

Gibber or alluvial plain with mesas and low hills is present east and west of Bokhara homestead, east of Alice Springs, south of Ringwood homestead, and also near North Bore, Andado homestead, and McDills Well. In the Rodinga Anticlinorium the discontinuous strike ridges rise about 100 feet above the gibber plain. The calcareous alluvial plain near Ringwood is relatively stable. The small areas of active floodplain adjacent to the Todd River and the small area of sand dunes on the margin of the plain have been included in this division. The floodplains of the Todd River and its tributaries coalesce to the east of Alice Springs. The gibber and alluvial plain near Andado and North Bore contains areas of buckshot gravel and some sand, but there are few mesas or low hills. Near McDills Well some sandy flood plains are present.

Alluvial flood plain with some claypans occurs along the Illogwa and Hale Rivers in the east and around the Finke River in the west. Outcrops are very rare.

Mesas and buttes with intervening sand and/or alluvium occur in the south-east, where flat-lying Mesozoic sandstone crops out. The mesas are up to 200 feet high and in many areas they appear to be the remnants of an old peneplain. The upper slopes of the mesas are prominent steep scarps. Some fairly large creeks occur on their flanks, but the intervening areas have a poorly defined drainage pattern.

STRATIGRAPHY

The relationships of the rock units in the north-eastern part of the Amadeus Basin are shown diagrammatically in Figure 4 and the stratigraphy is summarized in Table 1. The locations of the measured sections are shown in Figure 3 and the thicknesses of the formations from measured surface exposures are given in Table 2 and thicknesses from well completion reports in Table 3.

TABLE 1: STRATIGRAPHY

Age	Formation (Map Symbol)	Maximum Thickness (ft)	Lithology	Topographic Expression	Hydrology	Remarks
QUATERNARY	Undifferentiated (Q)		Alluvium, conglomerate, travertine, and sand			Section only
	(Qa)		Alluvial gravel, sand, and silt	Stream deposits, alluvial flats, and scree slopes	Good potential for high-quality water in places	
	(Qs)		Aeolian sand	Dunes and sand plains)		
	(Ql)		Travertine	Low flat areas)	) Poor prospects	
	(Qg)		Gypsum	Low areas with mounds)	)	
	(Qc)		Conglomerate and scree	Gibber plains and scree scopes)	)	May cover Tc
TERTIARY	Undifferentiated (T)		Sandstone, calcareous sandstone, limestone, travertine, conglomerate, and chalcedony			
	(Tl)	100; E. of Todd R. homestead	Limestone, chalcedony, siltstone, and calcareous sandstone	Mesas, cappings on mesas, and low ridges	Deposits are above water table	Limestones are lacustrine in part
	(Tc)	50; near Hugh and Finke Rivers	Conglomerate	Low rubbly outcrops	Deposits are above water table	Old river deposits
	(Tb)	10; near Mt Blatherskite	Silcrete (grey billy)	Mesa cappings	Deposits are impermeable and above water table	
	(Ta)	5	Laterite and ferricrete	Mesa cappings	Deposits are above water table	
	(Ts)	930 (approx.); in water bores in Alice Springs Farm area	Siltstone, sandstone, conglomerate, clay, and lignite	Low outcrops and mesa cappings	Moderate prospects	Thicker deposits are mainly known from water-bores
	Etingambra Formation (Te)	40; in N. part of McDills Sheet	Conglomerate and sandstone	Mesa cappings	Deposits are above water level	Known only in the Hale R. and McDills Sheet areas
LOWER CRETACEOUS	Rumbalara Shale (Klr)	700; Anacoora Bore, S. margin of McDills Sheet, 1335 in McDills No. 1 Well	Siltstone, shale, porcellanite, and minor sandstone. Contains marine fossils	Mesa cappings		Flat-lying; usually has a thin capping of billy
JURASSIC	De Souza Sandstone (Md)	300 (approx.); Malcolms Bore, S. margin of Hale R. Sheet, 916? in McDills No. 1 Well	Conglomerate, sandstone and siltstone	Mesas		
PERMIAN	Crown Point Formation (Pc)	1200 (approx.); in Malcolms Bore, 1400? in McDills No. 1 Well	Sandstone, siltstone, boulder beds, tilloid	Mesas and low mounds		Probably fluvioglacial
DEVONIAN TO CARBONIFEROUS	Santo Sandstone (Pzt)	200) S. of Mt) Charlotte)	Kaolinitic sandstone with conglomerate bands	Mesas		Commonly has a capping of billy
	Finke Group (Pzf): Horseshoe Bend Shale (Pzh)	450))	Red-brown micaceous siltstone and shale	Plains		Very poorly exposed
	Finke Group (Pzf): Langra Formation (Pzn)	500 (est.); S. of Mt Charlotte, 1730 in McDills No. 1 Well	Coarsely conglomeratic sandstone			Known only subsurface south of Mt Charlotte
	Finke Group (Pzf): Polly Conglomerate (Pzo)	1290 in McDills No. 1 Well	Sandstone, pebbly sandstone, polymict pebble conglomerate			Present only in McDills No. 1 Well
DEVONIAN TO CARBONIFEROUS	Pertnjara Formation (Pzp(c))	5000 (est.); in Brewer Plain	Coarse, very thickly bedded conglomerate	Rounded hills		
	(Pzp(s))	1300; Williams Bore (ASA1), Alice Springs Sheet	Red-brown silty sandstone with pebbles	Prominent ridges and ranges	Some beds could supply quantities of moderate to good water	
	(Pzp(a))	150 (est.); near Mt Charlotte	Green and red-brown micaceous siltstone and shale	Strike valleys	Permeability low, prospects poor	Very poorly exposed
SILURIAN TO CARBONIFEROUS	(Pz)		Sandstone and pebbly sandstone		Good prospects	This unit consists of Pzp(s) + Pzm
SILURIAN TO DEVONIAN	Mereenie Sandstone (Pzm(2))	1700 (est.); near Desert Bore	Sandstone with large cross-beds	Prominent ridges and ranges	Yields large quantities of excellent water	Unconformably overlies successively older units to the east
ORDOVICIAN	Larapinta Group (Ꞓ-Ol): Stokes Formation (Ot)	455; near Nomra Bore (RdC7), Rodinga Sheet	Siltstone, shale, and limestone	Strike valleys	Impermeable sequence, prospects poor	Very poorly exposed
	Larapinta Group (Ꞓ-Ol): Stairway Sandstone (Os)	590; near Nomra Bore (RdC7), Rodinga Sheet	Sandstone and siltstone; some 'red-beds'	Strike ridges	Some porous beds, but water generally saline	Has thin phosphatic beds
	Larapinta Group (Ꞓ-Ol): Horn Valley Siltstone (Oh)	145; near Nomra Bore (RdC7), Rodinga Sheet	Siltstone, shale, and limestone	Strike valleys	Low permeability, prospects poor	Very poorly exposed
	Larapinta Group (Ꞓ-Ol): Pacoota Sandstone (Ꞓ-Op)	3100; near Ross R. Tourist Chalet	Sandstone and silty sandstone	Prominent strike ridges	Porosity and permeability highly variable. Could supply good water in some areas	Thins out markedly to south.
	Larapinta Group (Ꞓ-Ol): N'Dahla Member (Ou)	500 (approx.); N'Dahla Gorge	Silty sandstone			Found only on northern limb at Ross River Syncline
CAMBRIAN	Pertaoorrta Group (Ꞓp): Goyder Formation (Ꞓg)	1430; Williams Bore (ASA1)	Silty sandstone, siltstone, and limestone	Strike valleys and scarps	Upper part may provide small supply	Commonly poorly exposed
	Pertaoorrta Group (Ꞓp): Jay Creek Limestone (Ꞓj)	1400; W. margin of Rodinga Sheet (near Mt Peachy, RdR1) ?3500' in Waterhouse Range (Waterhouse No. 1 Well + surface exposure)	Interbedded siltstone and algal limestone	Strike valleys with low limestone ridges	Porosity and permeability probably low, and prospects poor	Present only in western part of the area
	Pertaoorrta Group (Ꞓp): Hugh River Shale (Ꞓh)	1600 (approx.); at Jay Creek	Shale and siltstone with dolomite at base	Strike valley	Poor prospects	
	Pertaoorrta Group (Ꞓp): Shannon Formation (Ꞓs)	2340; in Todd R. Anticline (ASR1)	Interbedded limestone, shale, siltstone, and some dolomite	Strike valleys with limestone ridges and low hills	Porosity and permeability probably low, and prospects poor	Present only in eastern part of the area
	Pertaoorrta Group (Ꞓp): Giles Creek Dolomite (Ꞓk)	1320; in Todd R. Anticline (ARS1)	Thick-bedded dolomite, limestone, shale, and siltstone	Strike ridges		Limestones are fossiliferous
	Pertaoorrta Group (Ꞓp): Chandler Limestone (Ꞓl)	300; Deep Well 740 in Mt Charlotte No. 1 Well	Limestone and dolomite with chert laminae	Low ridges and mounds	Very saline water	Generally highly contorted and incompetently folded. Interbedded evaporites penetrated in Mt Charlotte No. 1 and Alice No. 1 Wells, but nowhere seen in outcrop
	Pertaoorrta Group (Ꞓp): Todd R. Dolomite (Ꞓr)	510; at Ross R.. Tourist Chalet. 1491? in McDills No. 1 Well	Dolomite, sandstone, and siltstone	Strike ridges	Poor prospects	Contains archaeocyathans
	Pertaoorrta Group (Ꞓp): Arumbera Sandstone (Ꞓa)	2700 (est.); in Phillipson Pound	Red-brown sandstone, conglomeratic sandstone, and siltstone	Very prominent strike ridges	Porosity generally poor but prospects fair in some areas	Rapidly thins out to the south on Rodinga Sheet area
UPPER PROTEROZOIC	Pertatataka Formation (Ƀup)	6040; S.E. of Phillipson Pound (RdR7 & 8)	Mainly siltstone and shale; some dolomite, limestone, and sandstone	Wide strike valleys, with prominent strike ridges	Poor prospects	
	(Ƀup(c))		Conglomeratic sandstone			Possibly tillitic
	Julie Member (Ƀuj)	1770; S.E. of Phillipson Pound	Dolomite, limestone, sandstone, and minor siltstone	Prominent strike ridges	Porosity variable, prospects generally poor	Sandstone is lenticicular in places
	Waldo Pedlar Member (Ƀul)	200; near Olympic Bore	Interbedded sandstone, siltstone, and shale	Low strike ridges	Poor prospects	Incompetently folded in places
	Olympic Member (Ƀuf)	630; near Ringwood homestead (ASR4)	Dolomite, shale, conglomerate, and sandstone	Strike valley	Poor prospects	Conglomerate is possibly tillitie. Poor outcrop.
	Limbla Member (Ƀum)	470; near Ringwood homestead (ASR4)	Quartzose calcarenite, siltstone, and sandstone	Low strike ridges	Poor prospects	Upper sandstone unit exhibits fine cross-laminae and slumps
	Ringwood Member (Ƀur)	540; near Ringwood homestead (ASR4)	Calcarenite, dolomite, and siltstone	Low strike ridges	Poor prospects	Contains irregular stromatolites
	Cyclops Member (Ƀuy)	250; N. of Gaylad Dam	Fine-grained sandstone	Low strike ridges	Poor prospects	Very even, rhythmic, thin beds and laminae
	Areyonga Formation (Ƀua)	575; near Gaylad Dam (ASR3) est. 1200-1500 N. of Limbla homestead.	Siltstone, dolomite, conglomerate, and sandstone	Prominent ridge in places	Porous sandstone could give moderate supply	Fluvioglacial in part
	Bitter Springs Formation (Ƀub)	3500 (est.); in N. part of area	Algal dolomite, limestone, siltstone, sandstone, shale, and basic volcanics	Low ridges and hills	Good supply in some areas, but water generally very salty	Incompetent in places
	Loves Creek Member (Ƀue)	2500; in Williams Bore/Julie Dam area	Dolomite, limestone, red siltstone, basic volcanics, and chert	Low ridges and hills	As for Bitter Springs Formation	Contains algal stromatolites
	($Ƀue_1$)		Green basic volcanics, much weathered	Rubbly outcrops		Variable spilitic composition
	Gillen Member (Ƀug)	1350; south of Mt Gillen	Dolomite, siltstone, sandstone, and shale	Low ridges and hills	As for Bitter Springs Formation	Contains evaporites in subsurface
	Heavitree Quartzite (Ƀuh)	1000 (est.)	Sandstone, conglomeratic in places	Very prominent ridges	Very poor prospects	Up to 30 feet of shale at base in places
PRECAMBRIAN	Arunta Complex (pꞒa)		Gneiss, schistose gneiss, schist, and quartzite	Low hills	Prospects generally poor	

TABLE 2: THICKNESS OF FORMATIONS

Sheet Area		Alice Springs						Rodinga									
	Formation	ASW1 ASR5	ASA1	ASR1 ASR2	ASR3	ASR4	Hale River HC11	RdC7 RdR2	RdC8 RdR1	RdC9	RdC1	RdC2	RdC3	RdC4	RdC5	RdC6	RdR7
	Pertnjara Formation (Ᵽzp)	P	1340+	1220+	NPS	NPS	NE	NM	NM	NE	P	440+	P	NE	215+	NM	172
	Mereenie Sandstone (Ᵽzm)	NM	720	1200	NPS	NPS	P	1310	NM	P	A	A	A	A	70	NE	100
Larapinta Group	Stokes Formation (Ot)	A	A	A	A	A	A	455	A	A	60+	P	P	105+	160	A	A
	Stairway Sandstone (Os)	A	A	A	A	A	A	590	355	410	355	NM	305	335	225	225	A
	Horn Valley Siltstone (Oh)	A	A	A	A	A	A	145	120	90	A	A	A	A	A	A	A
	Pacoota Sandstone (Є-Op)	205+	2530	405	NPS	A(?)	A	995	1015	345	A	A	A	A	A	A	A
Pertaoorrta Group	Goyder Formation (Єg)	1230	1430	610	NPS	A(?)	A	P	1180	P	A	A	A	A	A	A	A
	Shannon Formation (Єs)	1180	1700	2340	135+	NPS	830	A	A	A	A	A	A	A	A	A	NM
	Giles Creek Dolomite (Єk)	830	960	1320	1090	NPS	550	A	A	A	A	A	A	A	A	A	P
	Jay Creek Limestone (Єj)	A	A	A	A	A	A	A	P	1400	NM	P	P	P	NM	NM	A
	Chandler Limestone (Єl)	A	A	A	A	A	A	A	P	260	NM	P	P	P	NM	NM	NE
	Todd River Dolomite (Єr)	510	260	325	455	NPS	340	A	A	A	A	A	A	A	A	A	A
	Arumbera Sandstone (Єa)	1110	1800	2240	1530	NPS	1265	P	670	A	A	A	A	A	A	A	NPS
	Pertatataka Formation (Ᵽup)	2220	320+	480+	2215	4550+	430+	P	P	P	P	P	P	P	P	NE	
	Julie Member (Ᵽuj)	420	320	480	P	NPS	430+	A	A	A	A	A	A	A	A	A	
	Cyclops Member (Ᵽug)	160	NE	NE	NE	A	A	A	A	A	A	A	A	A	A	A	
	Olympic Member (Ᵽuf)	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	
	Limbla Member (Ᵽum)	A	A	A	A	A	470	NPS	A	A	A	A	A	A	A	A	
	Ringwood Member (Ᵽur)	A	A	A	A	A	540	NPS	A	A	A	A	A	A	A	A	
	Areyonga Formation (Ᵽua)	170	NPS	NPS	NE	575	NPS	NE	NE	NE	NE	NE	NE	NE	NE	NE	
	Bitter Springs Formation (Ᵽub)	365+	NM	NE	1265+	NM	P	NE	NE	NE	NE	NE	NE	NE	NE	NE	
	Loves Creek Member (Ᵽue)	365+	NM	NE	840	NM	P	NE	NE	NE	NE	NE	NE	NE	NE	NE	
	Gillen Member (Ᵽug)	NM	NM	NE	425+	NM	P	NE	NE	NE	NE	NE	NE	NE	NE	NE	

A: Absent
P: Poor or incomplete exposure
NE: Not exposed (may be present)

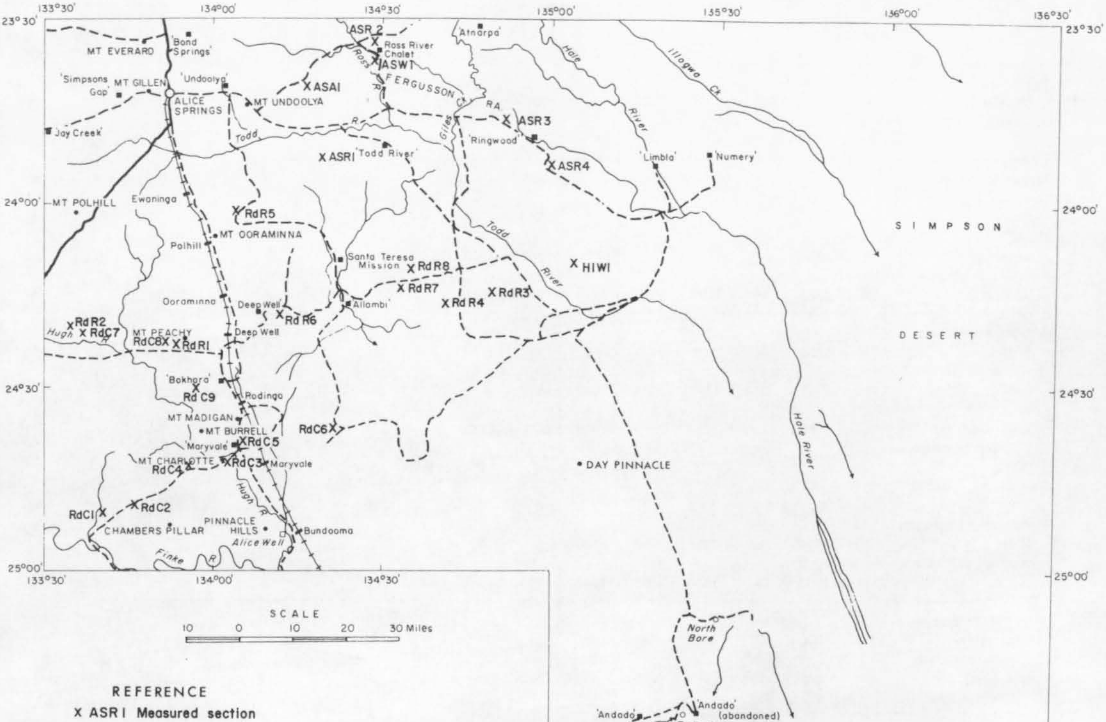

Fig. 3. Location of measured sections

TABLE 3: THICKNESS OF FORMATIONS FROM WELL COMPLETION REPORTS

AND ALTERNATIVE INTERPRETATIONS

		ALICE NO. 1		OORAMINNA NO. 1		McDILLS NO. 1			MOUNT CHARLOTTE NO. 1		WATERHOUSE NO. 1
	FORMATION	Completion Report	B.M.R. Interp.	Completion Report	B.M.R. Interp.	Completion Report	B.M.R. Interp.	Alice Springs Resident Geologists Interp.	Completion Report	B.M.R. Interp.	Completion Report
	Quaternary					85' (Surf.- 101')	85'	85'	42' (Surf.- 56')		
	Rumbalara Shale					1335' (101'-1436')	1335'+	1335'+			
	De Souza Sandstone					916' (1436'-2352')	916'(incl. transition beds at top)				
	Crown Point Form.					635' (2352'-2987')	1438'	2354'			
Finke Group	Idracowra Sandstone					803' (2987'-3790')	-			60'+	
Finke Group	Horseshoe Bend Shale					280' (3790'-4070')	)	)		460'	
Finke Group	Langra Form.					1730' (4070'-5800')	) 3300'	) 3300'		530'	
Finke Group	Polly Conglomerate					1290' (5800'-7090')	)	)		150' (Shale = Polly Conglom.)	
Finke Group	Pertnjara Form.	1154'+ (Surf.-1165')	1154'+						1144'+ (56'-1200')		
Larapinta Group	Mereenie Sandstone	950' (1165'-2115')	950'			1120' (7090'-8210')	1120'	1120'			
Larapinta Group	Undifferentiated					814' (8210'-9024') (Unnamed unit)	814'	814'			
Larapinta Group	Stairway Sandstone								345' (1200-1545)	345'	
Larapinta Group	Pacoota Sandstone	889' (2115'-3004')	890'								
Pertaoorrta Group	Goyder Form.	846' (3004'-3850')	850'								
Pertaoorrta Group	Jay Creek Limestone	3390' (3850'-7240')							785' (1545'-2330')	785'	2255' (Surf.-2255') (+abt. 1200' in outcrop)
Pertaoorrta Group	Shannon Form.		1630'								
Pertaoorrta Group	Giles Creek Dolomite		1170'								
Pertaoorrta Group	Chandler Limestone		520'						742' (2330'-3072')	742'	
Pertaoorrta Group	Todd River Dolomite		70'?			1491'+ (9024'-10515')	1491'+	1491'+			
Pertaoorrta Group	Arumbera Sandstone	278'+ (7240'-7518)	273+	1519'+ (Surf.-1530')	1519' (+abt. 400' in outcrop)						826'+ (2255'-3081')
	Pertatataka Form.			2204' (1530'-3734')	2500'				1601' (3072-4673')	1601'	
	Julie Member				400'						
	Areyonga Form.			672' (3734'-4406')	376'				593' (4673-5266') (Unnamed unit)		
	Bitter Springs Form.			1691' +(4406'-6097')	1691'+				1677'+ (5266'-6943')	2270'+ (true thickness 2130')	
	Loves Creek Member				874'					430'	
	Gillen Member				817'+					1840'+	
		T.D. 7518'		T.D. 6097'		T.D. 10,515'			T.D. 6943'		T.D. 3081'

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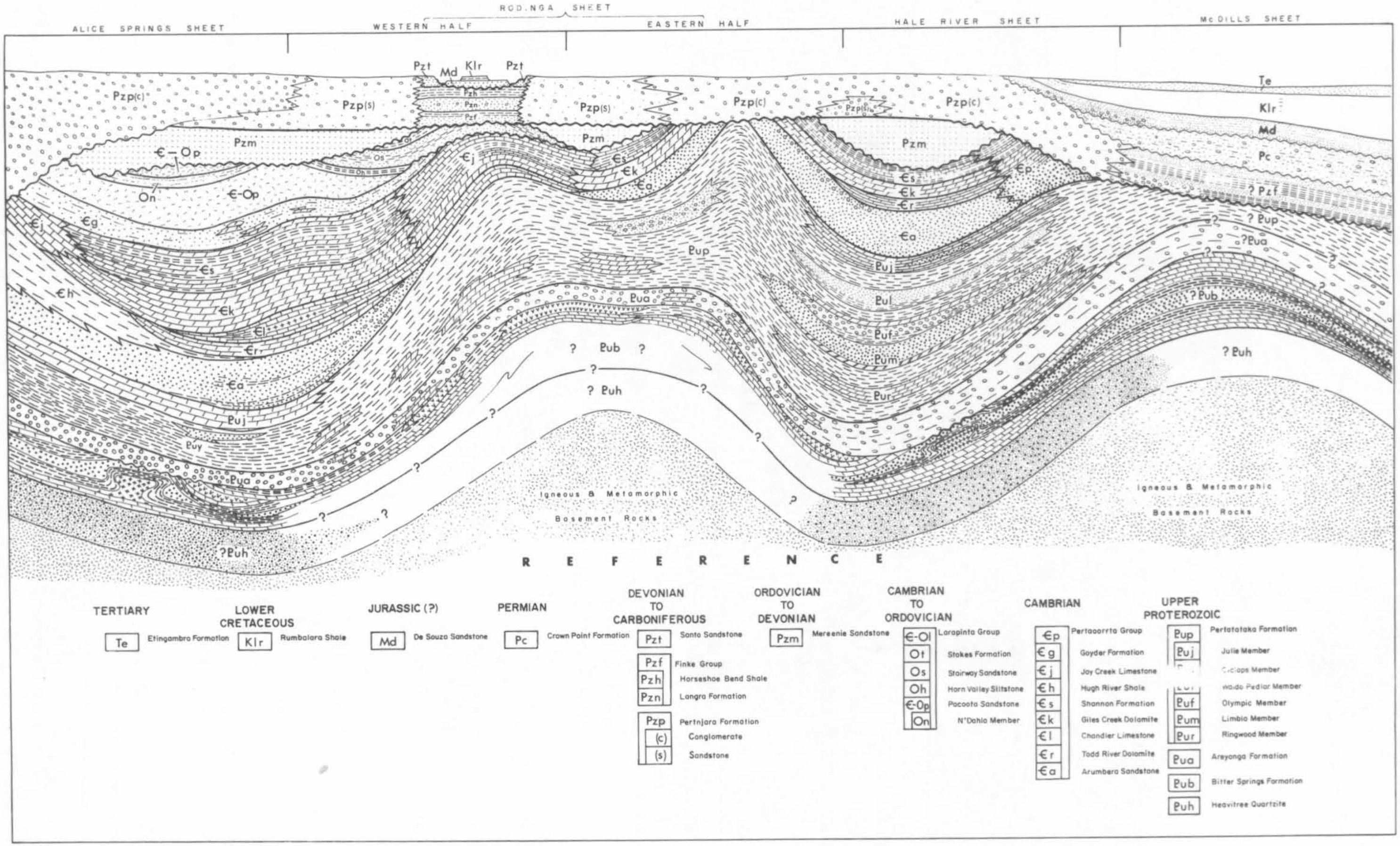

Fig. 4. Relationship of rock units.

PRECAMBRIAN

Arunta Complex

The only basement rocks within the area described in this Report are those which crop out between the two ridges of Heavitree Quartzite of the Blatherskite Nappe at Alice Springs (p. 65). The rocks are poorly exposed because most of the area is covered by alluvium, but on the northern side of the southern ridge, beneath the scarp of Heavitree Quartzite, the scree is underlain by weathered granite and gneiss. There are also a few hills of basement quartzite and schist 3 miles west of Temple Bar homestead, and a prominent hill of granite 1 1/2 miles north-east of the homestead.

Gneiss is present at locality AS139, 1 mile east of Temple Bar homestead. The rock is a sheared granite, and consists of drawn-out and granulated quartz grains, coated with thin films of feldspar and biotite. The foliation strikes west-north-west and dips at 55° to the south; there is a marked unconformity with the overlying Heavitree Quartzite.

Granite crops out at several localities. Two miles west of Mount Blatherskite, beneath the scarp of Heavitree Quartzite, the granite is leucocratic, and even-grained or porphyritic with phenocrysts of potash feldspar up to 3 inches long. The foliation dips to the south, and trends obliquely to the strike of the Heavitree Quartzite. Two miles west-north-west of Mount Blatherskite, the main medium-grained foliated muscovite granite is associated with some fine-grained biotite granite. Half a mile to the north-east, the granite adjacent to the main thrust plane of the nappe is a pegmatitic graphic granite, accompanied by some gneissic biotite granite. The large hill 1 1/2 miles north-east of Temple Bar homestead (locality AS116) is composed of weathered and kaolinized medium-grained granite, with some pegmatite and reef quartz. At locality AS119, graphic granite and reef quartz are exposed; the crystals of potash feldspar in the graphic granite range up to 6 inches long.

The schist north of the prominent hill north-east of Temple Bar homestead (locality AS117) is a friable green rock with layers of pink feldspar. The unsheared tough, dark green, fine-grained rock,, with indistinct phenocrysts, may represent an acid dyke. At locality AS137, 3 miles west of Temple Bar homestead, bands of fine-grained sericite-quartz schist are interbedded with the coarser-grained quartzite described below. The schist has been contorted into small isoclinal folds, whose axes form the b-lineation in the rock. The axial planes of the folds dip at 75° to the north-east and the axes have a rake of about 75° to the south-east.

The Precambrian quartzite is well exposed at locality AS137. It is a coarse-grained white to pale blue schistose rock composed of quartz and a little sericite. The schistosity dips at about 75° to the north-east. There is a weak lineation in the plane of the schistosity parallel to the b-lineation in the contorted schist interbeds. The attitude of the schistosity is strongly discordant with the strike and dip of the overlying Heavitree Quartzite which crops out to the south.

UPPER PROTEROZOIC

Heavitree Quartzite (Joklik, 1955)

The Heavitree Quartzite, which was originally referred to as the No. 1 Ridge quartzite (Ward, 1925), was named by Joklik (1955). It forms a prominent ridge rising about

1300 feet above the plain; it extends from Jay Creek in the west to north of the Ross River Tourist Chalet, and eastwards into the Illogwa Creek Sheet area. A high dissected plateau of flat-lying Heavitree Quartzite occurs in the Waldo Pedlar/Casey Bore area, at the junction of the Illogwa Creek and Hale River Sheet areas.

The Heavitree Quartzite rests unconformably on the Arunta Complex, and is overlain conformably by the Gillen Member of the Bitter Springs Formation. No section was measured; at Heavitree Gap, Prichard & Quinlan (1962) estimated the thickness to be 600 feet, and elsewhere the thickness estimated from the air-photographs is about 1000 feet or less.

The formation consists almost entirely of quartzite, but at a number of places, up to 30 feet of shale and siltstone is present at the base of the formation, immediately above the Precambrian basement. At Heavitree Gap and west of Mount Blatherskite, the lowermost 10 to 15 feet consists of red-brown laminated to thin-bedded micaceous sandy fissile shale and tough non-fissile siltstone. Sorting is generally good, but coarse sand grains are present in some beds. The upper part is bleached white, and consists mostly of siltstone.

Most of the formation consists predominantly of clean silicified quartz sandstone. In the Jay Creek/Alice Springs area, the basal few hundred feet consist of pinkish brown to white sandstone, which is mostly fine-grained, laminated to thin-bedded, cross-bedded, pebbly in places, poorly rounded and tough. The basal sandstone is overlain by a sequence of silicified sandstone, ranging from coarse-grained well rounded sandstone to fine-grained poorly rounded pinkish brown sandstone; a few conglomerate beds, some coarse-grained sandstone with small pebbles, and some fine-grained sandstone with a small amount of coarse sand are also present. The sandstone is laminated to thin-bedded, cross-bedded, and ripple-marked. The topmost few hundred feet of the formation is commonly bluish white and coarse-grained, or pinkish brown and fine-grained. Moulds of euhedral pyrite crystals were found in the uppermost quartzite half a mile south and 2 miles south-east of Jay Creek Aboriginal Settlement. Possible organic markings are common 1 mile west of Temple Bar homestead.

North of Ross River the lithology is similar to that in the Alice Springs area.

North of Numery homestead, in the Illogwa Creek Sheet area, and in the Waldo Pedlar/Casey Bore area in the Hale River Sheet area, the formation consists of brown silicified cross-bedded and coarse to very coarse-grained ferruginous sandstone; small pebbles are present in some beds, and also interbeds of ironstone.

The Heavitree Quartzite appears to have been deposited in a shallow-water, probably marine, shelf environment. The formation contains no diagnostic fossils, and has been assigned to the Upper Proterozoic, as it lies beneath Collenia-bearing carbonate rocks in the Bitter Springs Formation hundreds of feet below the first Lower Cambrian fossils at Ross River.

Bitter Springs Formation (Joklik, 1955)

Madigan (1932a, b) included the Bitter Springs Formation in the Hermannsburg Sheet area in his Pertaknurra (B) Series. The formation was formally named the 'Bitter Springs Limestone' by Joklik (1955); the name has been amended by Ranford, Cook, & Wells (1966) to Bitter Springs Formation because the unit contains a variety of rock types. As it would be difficult to measure a section at the type locality at Bitter Springs Gorge, it is proposed to nominate the section measured by Prichard and Quinlan in 1956 as the reference section (Fig. 5). In this Report, the formation has been divided into a lower Gillen Member and an upper Loves Creek Member. Banks (1964) of Magellan Petroleum Corporation subdivided the Bitter Springs into three formations, but his middle formation is only known in the subsurface. We have included Banks' middle formation in the lower member.

The Bitter Springs Formation crops out to the south of the ridge of Heavitree Quartzite that extends from Jay Creek in the west to Numery homestead in the east. It covers large areas north of Allua Well and west and south-west of Ringwood homestead in the Alice Springs Sheet area, and east of Limbla homestead in the Illogwa Creek Sheet area. Only two outcrops are present in the Rodinga Sheet area, the first 12 miles east-north-east of Allambi homestead, the second 2 miles east of No. 5 Bore. The formation rests conformably on the Heavitree Quartzite, and is overlain disconformably by the Areyonga Formation in the west, but with a slight regional unconformity east of Ross River. There is an angular unconformity between the two formations 3 miles east-south-east of Shannon Bore. The Bitter Springs Formation is locally overlain by the Pertatataka Formation (see pp. 21 & 23).

A Rb/Sr determination on a single specimen of shale from the Bitter Springs Formation in Mount Charlotte No. 1 indicated an apparent maximum age of 1170 m.y. (Bofinger, pers. comm.).

There is no measured section through the Bitter Springs Formation, but the maximum thickness is estimated to be about 3000 feet (cf. Banks, 1964). The unit is considered to be Upper Proterozoic because Collenia-type stromatolites are common (Pl. 1, fig. 2; Pl. 2, fig. 1) and because of its stratigraphical position below the fossiliferous Lower Cambrian beds at Ross River.

Barghoorn & Schopf (1965) have described the micro-organisms from a sample of chert from the Bitter Springs Formation about 1 mile north-north-east of Ross River Tourist Chalet as follows: 'An assemblage of structurally and organically well preserved micro-organisms, interpreted as both green and blue-green algae, has been found in chert facies of the Bitter Springs limestone from the Upper Precambrian of Central Australia. This appears to be the earliest known occurrence of green algae in the fossil record. These organisms are among the oldest known multicellular and unicellular fossils exhibiting distinct histological preservation'.

Gillen Member (new name)

The 'Gillen Member' is the name here given to the lower member of the Bitter Springs Formation. The type locality is to the South of Mount Gillen, 4 miles west of Alice Springs. Mount Gillen is composed of Heavitree Quartzite resting on Arunta Complex, with Gillen Member cropping out immediately to the south.

The member is found throughout the MacDonnell Ranges to the south of the ridge of Heavitree Quartzite, but it does not crop out in the Rodinga Sheet area. It forms small hills and ridges of dolomite which are covered with spinifex. The slopes are short, and moderately to steeply inclined; the outcrop is dissected by a fine pattern of closely spaced streams.

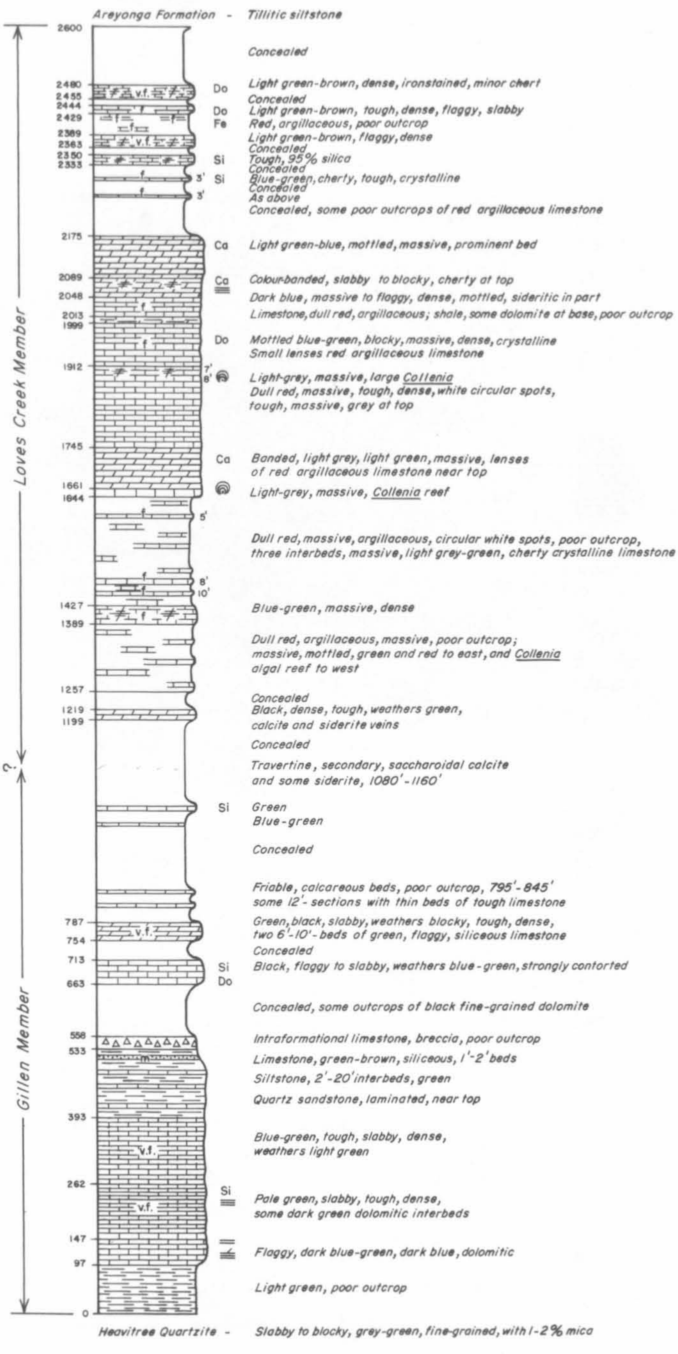

Fig. 5. Reference section of the Bitter Springs Formation, Ellery Creek. Measured by C.E. Prichard and T. Quinlan

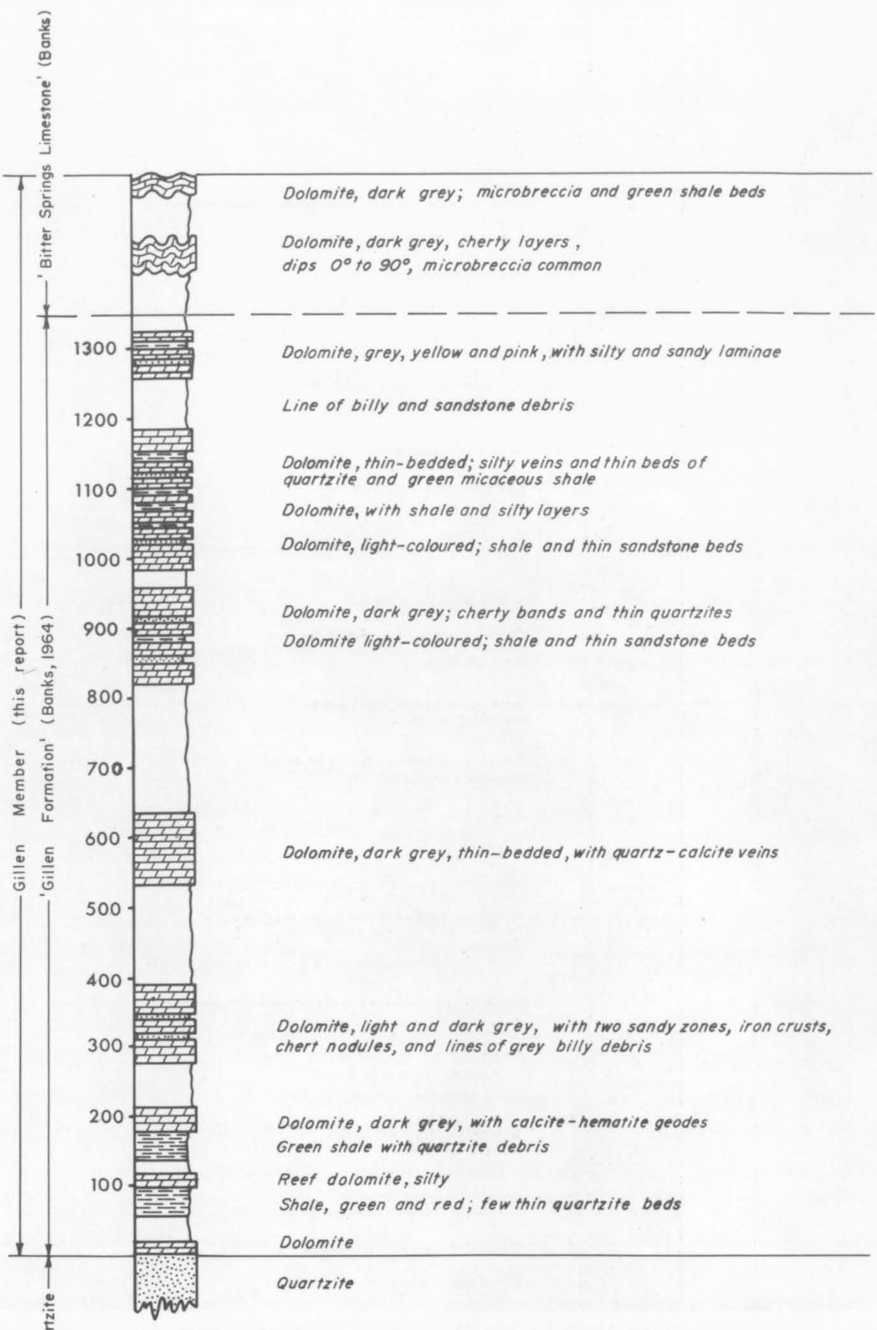

Fig. 6. Type section of the Gillen Member, south of Mount Gillen, Alice Springs Sheet area (modified from Banks (1964, fig. 41))

The Gillen Member rests conformably on the Heavitree Quartzite, and is generally overlain conformably by the Loves Creek Member, but 3 miles east-south-east of Shannon Bore, in the Alice Springs Sheet area, it is overlain with angular unconformity by conglomerate of the Areyonga Formation, and north of Ringwood homestead large areas of the Gillen Member are overlain disconformably by the Areyonga Formation.

It is difficult to measure sections because the member has generally been folded incompetently (Pl. 1, fig. 1), but Banks (1964) has recorded a thickness of 1350 feet in the type section at Mount Gillen (see Fig. 6). The contorted dolomite immediately above Banks' type section (Banks' Bitter Springs Limestone) has been included in the Gillen Member as it is similar to the dolomite in the lower part of the section.

In the Jay Creek/Alice Springs area, the Gillen Member consists mainly of dolomite, with subordinate sandstone, siltstone, and shale. Most of the dolomite occurs in the middle and upper parts of the unit; it is dark grey, bluish grey, or grey-brown, fine-grained, laminated, very closely jointed and fractured, and tough, and weathers grey-green. Veins of white quartz occur in the joints normal to the bedding in several places, and a few veins of calcite and masses of earthy magnesite are also present.

Siltstone is present throughout the member, but mostly near the base. It is commonly white or green and less often red or brown, slightly micaceous, laminated to thin-bedded, tough, with interbeds of green micaceous shale. The siltstone interbedded with the dolomite higher in the sequence is similar.

Subordinate sandstone is found in the lower part of the Member, mostly near Jay Creek. It is white to pale grey, friable, poorly bedded, medium to coarse-grained, and slightly kaolinitic.

Around Ringwood homestead, and south of the Fergusson Range, the Gillen Member consists of grey-brown to brown dolomite interbedded with green shale and some clean fine-grained sandstone. Pseudomorphs after halite are present in the siltstone at locality AS36, 5 miles north-west of Pulya Pulya Dam, and the Ringwood Dome, 5 miles south-west of Ringwood homestead, is composed of gypsum of the Gillen Member. The salt in the Bitter Springs Formation in Ooraminna No. 1 and Mount Charlotte No. 1 Wells is also referred to the Gillen Member.

In the Illogwa Creek Sheet area, the Gillen Member consists of a few hundred feet of fractured grey dolomite at the base, overlain by purple gypsiferous siltstone, followed by green micaceous shale with interbeds of dolomite. The micaceous shale is overlain by a prominent ridge-forming interval of white silicified granule conglomerate and fine to coarse-grained pale purplish brown cross-bedded sandstone which weathers white. The ridge is about 200 feet wide, and extends from 4 miles south-west to 14 miles north-east of Limbla homestead. At locality IC103, 2 miles north-west of Numery homestead, the fine-grained sandstone contains pseudomorphs after halite 1 inch across. The sandstone is succeeded by a sequence of interbedded dolomite, green micaceous shale, and sandstone, which varies in thickness. At Limbla homestead the interbedded dolomite, shale, and sandstone are overlain by the Loves Creek Member, about 300 feet of algal dolomite with chert nodules, followed by red siltstone.

PLATE 1

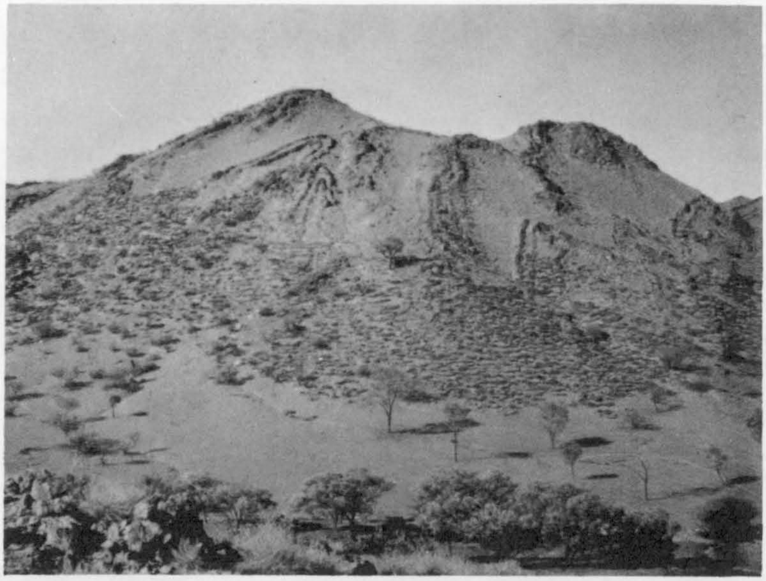

Fig. 1. Incompetent folding in the Gillen Member of the Bitter Springs Formation, 1 mile north of Allua Well, Alice Springs Sheet area.

Fig. 2. Hemispherical stromatolite colonies, Loves Creek Member of the Bitter Springs Formation, 2 miles south-south-west of Shannon Bore, Alice Springs Sheet area (AS186)

In the Hale River Sheet area, the Gillen Member is reduced in thickness; it consists of interbedded dolomite and shaly sandstone, and a prominent ridge of coarse-grained white sandstone and granule conglomerate, similar to the succession in the Illogwa Creek Sheet area.

The Gillen Member was deposited in a shallow sea; fine and some coarse-grained clastics alternate with carbonate rocks. The original carbonate rock was probably limestone, which has subsequently been converted to dolomite.

Loves Creek Member (new name)

The name Loves Creek Member is here given to the upper member of the Bitter Springs Formation. Loves Creek joins the Ross River 5 miles west of the Ross River Tourist Chalet in the Alice Springs Sheet area. The member is well exposed on the northern side of its valley.

The unit is widespread in the MacDonnell Ranges, and is the only part of the Bitter Springs Formation to crop out on the Rodinga Sheet area. It gives rise to bare steep rounded hills of dolomite, and narrow ridges of limestone. The unit rests conformably on the Gillen Member, and is overlain disconformably by the Areyonga Formation. On the eastern side of Fenn Gap, 18 miles south-west of Alice Springs, it is overlain disconformably by the Pertatataka Formation, where the Areyonga Formation is missing for about a mile along the strike. No section has been measured through the Loves Creek Member, but a generalized sequence, 1500 feet thick, has been compiled from several localities (Fig. 7).

Between Jay Creek and Alice Springs, the unit is about 700 feet thick and consists mostly of siltstone, with interbeds of chert, dolomite, and rare limestone. The siltstone is commonly calcareous, red-brown, poorly bedded or massive, friable to tough, with white bleached spherical spots up to an inch in diameter. Hematite concretions, up to 15 inches across, are also present. Chert is plentiful, and much of it is banded grey and white, poorly bedded, and closely fractured. A few spherical concretions, up to 9 inches across, with concentric and radial joints, are present in the cherts. Silicified and brecciated siltstone is also common. The dolomite is mostly yellowish brown, tough, laminated, and fine-grained, and contains 'biscuits' and nodules of chert. The dolomite contains interbeds of fine to coarse-grained 'edgewise' conglomerate composed of angular chips of dolomite in a dolarenitic matrix. Limestone is rare, but some is exposed 2 miles east of Fenn Gap. It is dark grey, very tough, and cavernous, and contains elongated nodules of chert near the base.

East of Alice Springs, the member is well exposed between Julie Dam and No. 6 Bore, and west of Williams Bore. In the Julie Dam/No. 6 Bore area the member is about 1500 feet thick (Fig. 7) and comprises 500 feet of grey-brown fine-grained dolomite with abundant Collenia-type algae (Pl. 1, fig. 2; Pl. 2, fig. 1), overlain by 1000 feet of red-brown calcareous siltstone. The siltstone has the characteristic white bleached spots, and contains thick interbeds of algal limestone and a few beds of dolomite.

Only the upper part of the member is present 2 miles north-north-west of Williams Bore, where the contact with the Gillen Member is faulted. It consists of about 1200 feet of red-brown calcareous siltstone and fine-grained sandstone, with a few thin beds of pebbles, overlain by the Areyonga Formation. No algal dolomite is present (because of the faulting),

PLATE 2

Fig. 1. Silicified stromatolite colonies, Loves Creek Member of the Bitter Springs Formation, near Mosquito Bore, Alice Springs Sheet area.

Fig. 2. Angular unconformity (bottom of hammer handle) between conglomerate of the Areyonga Formation and quartzite and green shale of the Gillen Member, 3 miles east-south-east of Shannon Bore, Alice Springs Sheet area.

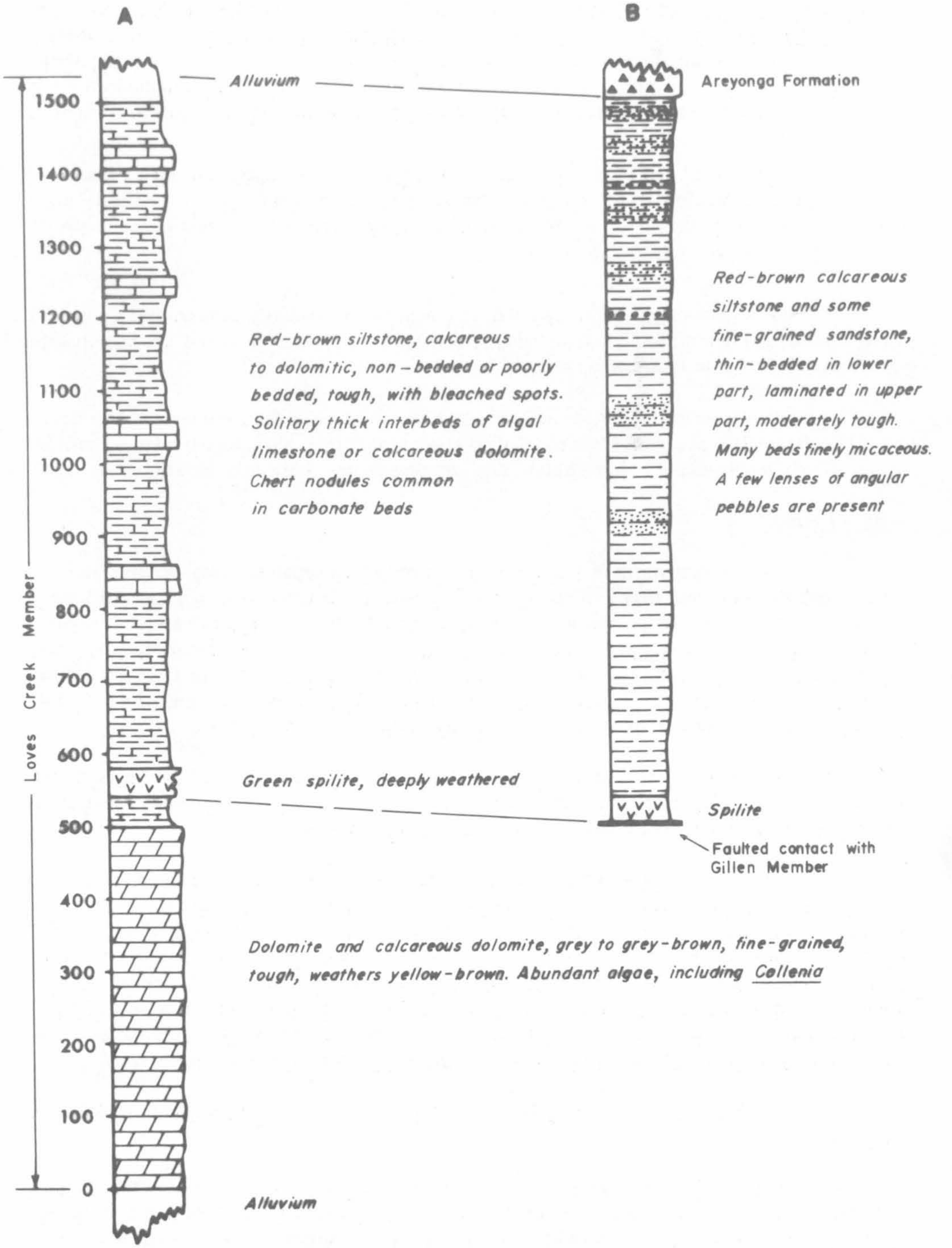

Fig. 7. Generalized sequences in the Loves Creek Member

and there are no interbeds of limestone or dolomite in the red-beds (Fig. 7). The difference in the lithology between this area and No. 6 Bore suggests that there has been considerable movement of blocks of sediment (decken) along thrust planes (see also p. 74), so that sequences which were originally far apart have been brought close together. The sediments shown in column B of Figure 7 were probably deposited closer to shore than those shown in column A.

Throughout the rest of the area east of the Ross River, the unit also consists of dolomite with abundant algae, red siltstone with white bleached spots, and thick solitary algal limestone interbeds in the siltstone. Some 'edgewise' conglomerate is present in the sequence in the Hale River Sheet area.

In the Rodinga Sheet area the unit consists essentially of brecciated grey and brown foetid algal dolomite, containing nodules and laminae of chert, and red-brown calcareous siltstone with white bleached spots.

The fine grain and calcareous nature of most of the sediments in the Loves Creek Member and the presence of abundant algae suggest that they were deposited in a shallow-marine shelf environment, into which fine detritus came only very slowly or not at all.

Basic Volcanics

The rocks mapped as basic volcanics are typical spilites. They occur within the Loves Creek Member; they have not been named as a member, but in places they are sufficiently extensive to be shown on the map as a separate unit (Pue_1). They are found at several localities east of Alice Springs, and in the north-east part of the Rodinga Sheet area; they are generally deeply weathered and poorly exposed. The largest exposure is in the Illogwa Creek Sheet area, where the spilite forms an arc around the north-western end of the Limbla Syncline. About 140 feet of spilite was intersected in Ooraminna No. 1 Well.

The spilite is generally found in the middle or upper parts of the Loves Creek Member, but in a few places, notably near Mosquito Bore in the Alice Springs Sheet area, spilite is found near the base as well as at the top of the member.

The fresh rock is grey-green, fine-grained, tough, in places amygdaloidal, and ophitic. The spilite consists of oligoclase or albite, augite, and iron oxides, and common alteration products include chlorite (penninite), actinolite, hematite, leucoxene, calcite, zeolites, epidote, antigorite, and rare quartz. The plagioclase is mostly sericitized. In the least altered specimen (B15, TS14425), augite is abundant as phenocrysts intergrown with oligoclase, and in the groundmass. Calcite forms 30 percent of specimens AS40 and AS43, and amygdules in specimens AS39 and AS40 are filled with calcite, chlorite, and zeolites. Interstitial devitrified glass and veinlets of zeolites are present in specimen AS39.

Interbedded with and overlying the volcanics are ferruginous cherty rocks up to 5 feet thick.

The spilites are regarded as extrusive because they are conformably interbedded with the sediments, and because of the presence of recognizable flow tops and interbedded chert. The altered rocks have probably been formed by low-temperature hydrous soda metasomatism of basalt (Vallance, 1960).

Areyonga Formation (Prichard & Quinlan, 1962)

The Areyonga Formation is a lenticular unit composed predominantly of poorly sorted conglomerate, conglomeratic siltstone and sandstone, and dolomite, which rests disconformably or with angular unconformity on the Bitter Springs Formation and is overlain conformably by the Pertatataka Formation.

The formation crops out in the west near Jay Creek Aboriginal Settlement and discontinuously in the MacDonnell and Fergusson Ranges. The most easterly exposure is about 4 miles north of Numery homestead. In the south, the formation crops out about 5 miles north-north-west of Allambi homestead, and discontinuously for 20 miles to the east.

Exposures are generally poor, except for ridges of tough siliceous arkosic sandstone. The matrix of the Areyonga Formation sediments is generally calcareous or silty, and easily weathered.

On the north-eastern margin of the Amadeus Basin, the Areyonga Formation lies disconformably on the Gillen and Loves Creek Members of the Bitter Springs Formation, and in places with angular unconformity on the Gillen Member. The angular discordance (Pl. 2, fig. 2) is well exposed 3 miles east-south-east of Shannon Bore, where the contact can be traced for about 2 miles along the strike. The Gillen Member dips at 20^{o} to the east-north-east and the Areyonga Formation at 32^{o} to the north. The contact is very irregular, and the harder quartzite beds in the Gillen Member beneath the unconformity form hills with a relief of 30 to 40 feet. A poorly sorted basal conglomerate, generally with abundant angular chert, caps the quartzite hills, whereas the valleys between are filled with poorly sorted silt and sand. In the south, the contact between the Areyonga and Bitter Springs Formations is not exposed, but the presence of phenoclasts of Bitter Springs dolomite in the Areyonga Formation suggests the presence of a disconformity.

The Areyonga Formation is equivalent to the Inindia Beds (Ranford, Cook, & Wells, 1966) in the southern part of the Amadeus Basin. The Inindia Beds are much thicker than the Areyonga Formation and contain a considerable thickness of marine and possibly continental sandstone in addition to the interbedded glacial boulder beds.

The Areyonga Formation consists of boulder clay, pebble and cobble conglomerate, arkose, poorly sorted sandstone and siltstone, and dolomite. Arkose is prominent at the base of the unit in the north-east, mainly north of Ringwood and Limbla homesteads. It can be traced for many miles, but in places it forms small lenticular bodies. The arkose is coarse, angular, and poorly sorted, and is generally underlain by a conglomerate 3 to 4 feet thick, which rests directly on the Bitter Springs Formation. North of Limbla homestead, the arkose is overlain by a thick sequence of boulder clay, siltstone, and some sandstone.

The lithology changes rapidly along the strike. Near Jay Creek Aboriginal Settlement, the formation consists of about 150 feet of white kaolinitic porous poorly rounded and sorted coarse and medium-grained sandstone, but near Ross River Tourist Chalet, it consists of poorly sorted cobble beds and dolomite. Farther east, the composition changes even more rapidly over short distances; in one outcrop it contains rounded phenoclasts of dolomite, but a mile away it comprises arkose and conglomerate with quartz and granite fragments.

The proportion of granitic and arkosic constituents generally increases towards the east. Subrounded, rounded, faceted, and some striated boulders up to 6 feet across are present in the Areyonga Formation north of Limbla homestead. The boulders, which are set in a matrix of green and grey sandy siltstone, and poorly sorted sandstone, include granite, gneiss, porphyry, quartz, and quartzite. Some of the thin beds of sandstone interbedded with the boulder beds contain pseudomorphs of limonite after pyrite.

Similar changes in lithology are found in the south. Siltstone, dolomite, sandstone, and chert crop out 15 miles south-east of Santa Teresa Mission. Angular to well-rounded fragments of chert and quartz are common. About 12 miles farther east, the formation includes beds of calcareous siltstone and sandstone, with scattered erratics of pegmatite, gneiss, vein quartz, sandstone, and chlorite schist, up to 3 feet in diameter.

The sediments show few depositional structures and cross-bedding is rare. A cast of possible organic origin (Pl. 3, fig. 1) was found in sandstone about 8 miles west of Fenn Gap; it is about 6 inches long, tubular, and divided into several segments.

The greatest exposed thickness of the formation is estimated to be 1200 to 1500 feet between Bull Hole and Bronco Bores, north of Limbla homestead; elsewhere it generally ranges from 40 to 600 feet, but in places the formation may be extremely thin or absent. Thicknesses of 170 feet were measured near Ross River Chalet (ASR5), 575 feet on the south flank of the Gaylad Syncline (ASR3), and 490 feet about 15 miles south-east of Santa Teresa Mission (RdR7). The measured sections are shown on Plate 10.

It is considered that in the 600-foot section interpreted as Areyonga Formation in the Ooraminna No. 1 well by Planalp & Pemberton (1963) only some 350 feet belongs to the Areyonga; the remaining part of the section is placed in the Pertatataka Formation (see p. 25). In Mount Charlotte No. 1 an unconformity is interpreted in the carbonate sequence in the lower part of the well. Assuming that this unconformity represents the contact between the Bitter Springs and Areyonga Formations, the Areyonga Formation is about 600 feet thick, but it is possible that the carbonate section belongs to the Loves Creek Member of the Bitter Springs, and that the Areyonga Formation is absent.

At Pulya-Pulya Dam, lenticular beds of phosphate rock, up to 9 inches thick, occur near the contact of the basal conglomerate and the overlying arkose (Pl. 3, fig. 2).

The unsorted nature of the Areyonga Formation; the presence of a rock flour matrix, striated cobbles, and phenoclasts of many rock types foreign to the outcrop area; the rapid lateral changes in lithology; and the lenticular nature of the unit; indicate that the formation was probably deposited in a marine glacial environment.

The formation is presumed to be Upper Proterozoic as it occurs below Lower Cambrian sediments.

Pertatataka Formation (Prichard & Quinlan, 1962)

The Pertatataka Formation was probably deposited over the whole of the north-eastern part of the Amadeus Basin, and is well exposed in the northern part of the area.

PLATE 3

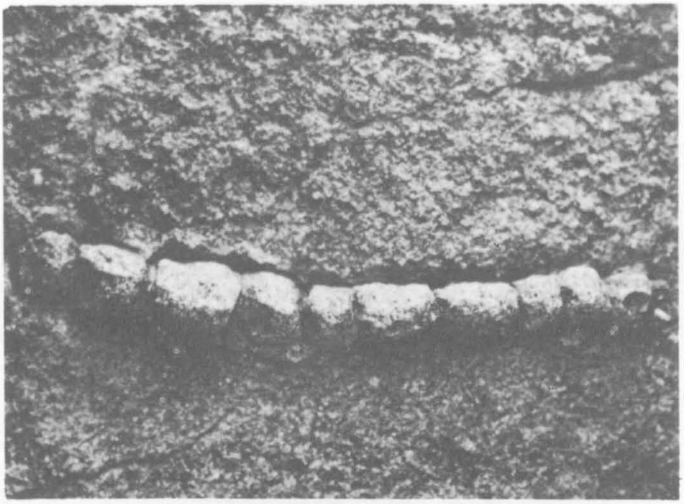

Fig. 1. Cast of possible organic origin, Areyonga Formation, 8 miles west of Fenn Gap, Alice Springs Sheet area.

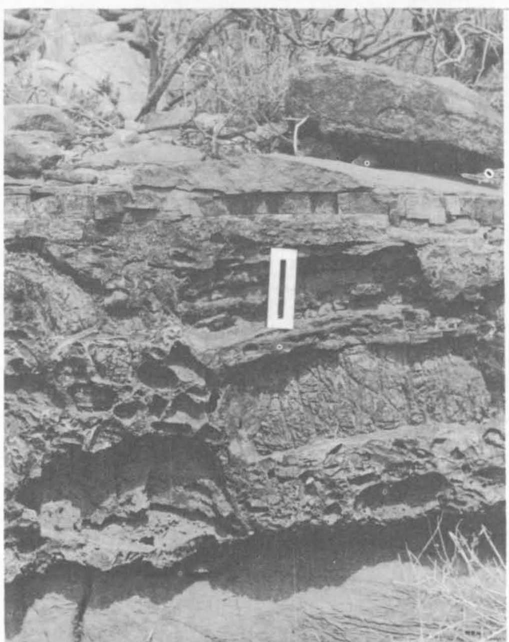

Fig. 2. Contact of Areyonga and Bitter Springs Formations, 1 mile north-west of Pulya-Pulya Dam, Alice Springs Sheet area. A 3-inch bed of phosphate rock occurs in the Areyonga Formation about 3 inches above top of the 6-inch scale.

PLATE 4

Fig. 1. Incompetent folding in dolomite and shale of the Pertatataka Formation, near Allambi homestead, Rodinga Sheet area.

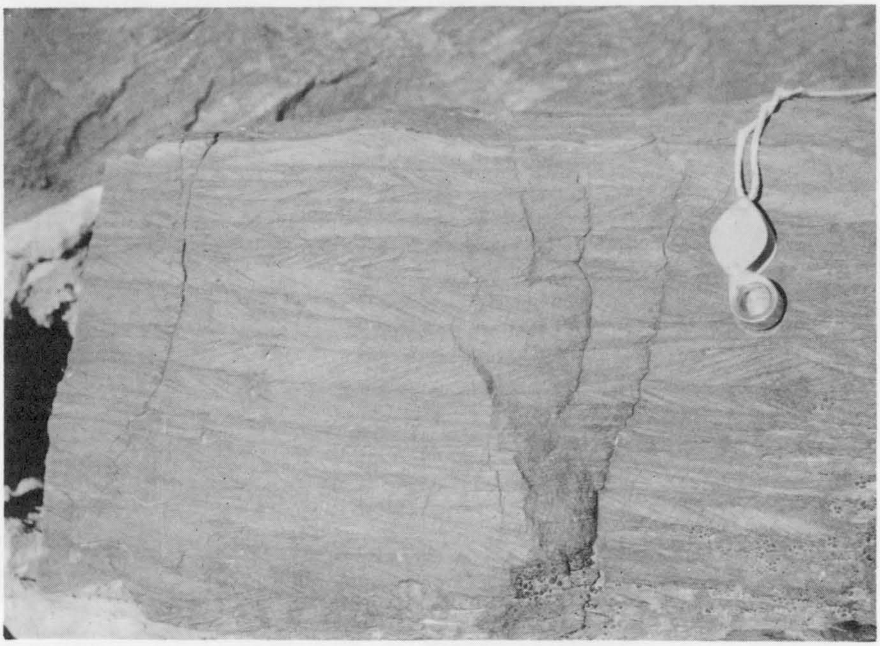

Fig. 2. Concave and diagonal cross-laminations in sandstone in upper part of the Limbla Member of the Pertatataka Formation, 7 miles west-south-west of No. 6 Phillipson Bore, Hale River Sheet area.

It is moderately well exposed in the Mount Burrell Anticlinorium, but the sequence is complicated by faulting and folding. Only the arenite and carbonate rocks generally crop out, although they form only a small proportion of the unit.

In the north-eastern part of the Amadeus Basin, the Pertatataka Formation is generally conformable with the Arumbera Sandstone above and the Areyonga Formation below. At Fenn Gap, west of Alice Springs, the Pertatataka Formation rests on the Bitter Springs Formation in one small outcrop. In the south, the base of the formation is not exposed and in several places the formation is either overlain disconformably or unconformably by the Cambrian Chandler Limestone, or with an angular unconformity by the Pertnjara Formation.

The formation ranges in thickness from about 2220 feet at Ross River (ASR5), Jay Creek, and Giles Creek (ASR3), to over 4500 feet south of Ringwood (ASR4) and over 6000 feet 14 miles east-north-east of Allambi homestead (RDR7 and 8). These measured sections are shown in Plate 10. In the Mount Charlotte No. 1 well the Pertatataka Formation is at least 1600 feet thick. In the Ooraminna No. 1 well the thickness is reinterpreted as about 2500 feet (Cf. Table 3 and p. 22).

In the north-west, an older Cyclops Member and a younger Julie Member have been recognized. They are separated from each other and from the underlying and overlying formations by green and red-brown siltstone and shale.

In the extreme north-east, six members have been mapped, and the total thickness of the formation may be 7000 feet. The Julie Member persists into this area, but the Cyclops Member has not been identified.

The Olympic Member includes some boulder beds of probably glacial origin.

A conglomeratic unit, Bup(c), also occurs in the Pertatataka Formation in the Mount Burrell area: it consists of grey conglomeratic sandstone and conglomerate from 50 to 200 feet thick. The cobbles and boulders are mainly of quartzite with minor dolomite, chert, and vein quartz, and are mostly well rounded and poorly sorted. Striated cobbles were found in the unit about 7 miles west of Mount Burrell well. The unit is similar to the Areyonga Formation and overlies a sequence of dolomite similar to the dolomite in the Bitter Springs Formation farther east on the Rodinga Sheet area and is considered more likely to belong to this formation. The conglomerate is probably equivalent to the Olympic Member.

The age of the Pertatataka Formation is probably Upper Proterozoic. The formation lies below the Arumbera Sandstone, which is overlain by the Lower Cambrian Todd River Dolomite.

Rubidium/strontium age determinations have been carried out on the shale from the Pertatataka Formation in the Ooraminna No. 1 and Mount Charlotte No. 1 wells. The age of the shale in Ooraminna No. 1 was found to be 760 ± 33 m.y., and the specimen from Mount Charlotte No. 1 has an apparent age of 822 ± 8 m.y. (V.M. Bofinger, pers. comm.).

Cyclops Member (new name)

The Cyclops Member is here defined as an evenly thin-bedded and laminated silicified tough fine grey sandstone, in the basal part of the Pertatataka Formation, separated from the overlying Julie Member and from the base of the formation by several hundred feet of green siltstone. The member crops out in the eastern MacDonnell Range from near Williams Bore to the Ross River Tourist Chalet, and from here to Box Hole Bore, Giles Creek, and Pulya-Pulya Dam, and in the Mulga Syncline. It is not exposed to the south of these localities.

The name is derived from Cyclops Bore, about 8 miles west of the Ross River Tourist Chalet. The type section ASR 5 (Pl. 10) is about half a mile north of the Chalet. The relationship of the Cyclops Member to the members occurring below the Julie Member to the south and east of Ringwood homestead is not known.

The Cyclops Member crops out in low sharp ridges generally about 10 to 20 feet high. The measured type section (ASR5), north of the Ross River Gorge, is 160 feet thick. The member is probably thicker to the east, and in one locality the thickness estimated from the air-photographs is about 250 feet.

The most characteristic feature of the Cyclops Member is the even rhythmic thin bedding and lamination. The fine tough grey siliceous sandstone splits easily into large flat plates. It weathers orange-brown and shows some small slumps and indistinct sedimentary structures on the bedding-planes.

The member was probably deposited in a shallow sea, during a stable period with gentle subsidence and a regular supply of detrital material.

Ringwood Member (new name)

The Ringwood Member is here defined as the sequence of calcarenite, dolomite, limestone, and siltstone near the base of the Pertatataka Formation in the area roughly bounded by Ringwood homestead, Bullhole Bore, Aralka Bore, and a point near the south-east end of the Phillipson Pound. The type section (ASR4, Pl.10), about 5 miles south-east of Ringwood homestead, is 540 feet thick. Ringwood homestead, after which it is named, is in the south-eastern corner of the Alice Springs Sheet area.

The tough dolomite and limestone beds in the Ringwood Member are only moderately resistant to erosion and crop out in low rounded ridges and mounds up to 100 feet high. The best exposures occur in the Limbla Syncline north of Limbla homestead, where the unit crops out in steep ridges about 200 feet high.

The Ringwood Member is the oldest member of the Pertatataka Formation cropping out south and east of Ringwood homestead. In most places it is separated from the Areyonga Formation below and the Limbla Member of the Pertatataka Formation above by considerable thicknesses of green siltstone and shale. In a few exposures south of Ringwood homestead it appears to rest disconformably on the Bitter Springs Formation, but the sequence here may be complicated by structure, as the outcrops lie within a large folded thrust-zone, the Olympic/Ringwood folded thrusts (see p. 69).

The lowest part of the Member consists of evenly bedded green siltstone and shale and in many respects it is similar to the Cyclops Member.

The thickness of 540 feet measured in the type section is probably about the average thickness in the exposures between Ringwood homestead and Hi Jinx Bore. The thickest exposed section occurs in the hills north of Limbla homestead.

The association of tough cherty algal dolomite overlain by grey-green and dark grey cross-laminated fragmental dolomite and limestone is characteristic. The carbonate rocks are dark grey, yellow, grey-brown, blue-grey, and mottled where they contain pellets. They are oolitic, thin to medium-bedded, cross-laminated, and in places consist entirely of pellets of silty carbonate. Some of the dolomite and limestone beds are sandy. A thin sequence of fine yellow oolitic dolomite forms a good marker bed near the base of the member. In most places it is succeeded by fine dolomite, weathering light yellow-brown, which contains irregular stromatolite colonies. The individual stromatolite colonies range up to 1 foot across and are roughly hemispherical. The algae begin as irregular cabbage-like growths and grow into irregular connected columns. The overlying carbonate rocks are mostly thin-bedded, dark blue-grey, and fragmental. Cross-bedding, lenses and laminae of fine limestone, irregular nodules of oolitic chert, and pellets of silt and silty dolomite are common in places.

The basal beds are well exposed in the Limbla Syncline to the north of Limbla homestead. They consist of thin-bedded siltstone, with a gradually increasing proportion of limestone higher in the sequence. The limestone is silty, dark grey to black, and contains stromatolites. The siltstone contains a few lenses of calcareous breccia with fragments of tough silty dolomite. In places the breccia appears to have been derived from the disintegration of the stromatolite colonies.

The presence of oolitic and pelletal carbonate rocks and stromatolites suggests that the Ringwood Member was deposited in a shallow-marine environment.

Limbla Member (new name)

The Limbla Member is here defined as a sequence consisting of an upper cross-laminated fine-grained sandstone overlying sandy calcarenite with minor interbedded siltstone, slumped sandstone, and intraformational conglomerate; it is separated from the Ringwood Member below by a thick sequence of siltstone, and is probably disconformably overlain by the Olympic Member. The Olympic Member contains boulders derived from the Limbla Member and older formations. The type section (ASR4, Pl. 10), 5 miles south-east of Ringwood homestead, is 470 feet thick. Another measured section (RdR8, Pl. 10), on the Rodinga Sheet, has a minimum thickness of 375 feet. The member is named after Limbla homestead in the south-west part of the Illogwa Creek Sheet area.

The sandstone of the upper part of the Limbla Member is generally well exposed in several parallel sharp-crested ridges. The carbonate rocks in the lower part of the unit are much less resistant to erosion, but are usually well exposed on the steep scarps under the protective sandstone ridges.

The Limbla Member is exposed over a comparatively small area south and south-east of Ringwood homestead southwards to Hi Jinx Bore, in the area south of Limbla homestead, and in the north-eastern part of the Rodinga Sheet area. The unit lenses out to the west and is not found elsewhere in the Amadeus Basin.

The contact of the Limbla Member with the overlying Olympic Member is generally obscured by scree. The contact is placed at the change from the cross-laminated fine-grained sandstone to the more massive sandstone, dolomite, or siltstone (which may be conglomeratic) of the Olympic Member. The base of the Limbla Member is placed at the change from shale and siltstone to dominantly sandy limestone of the Member.

The lower part of the Limbla Member consists of medium and coarse-grained grey, brown, and pink very sandy thin-bedded and cross-laminated carbonate rock, and cross-laminated fine and medium-grained tough calcareous sandstone with slumped laminae. The sediments are generally poorly sorted and in many places oolitic. They contain interbeds of red-brown and purple-brown siltstone. The sandy calcarenite contains medium grains and some coarse grains of subangular quartz, silty carbonate pellets, and calcareous oolites set in a calcareous cement. Lateral change from calcareous sandstone to sandy limestone is common. The fine tough sandstone commonly weathers black and shows intricately slumped cross-laminations. In places it contains coarse pink and white chert and some quartz. Some of the sandstone is porous and has clay pellet impressions.

The upper part of the member consists of fine thin-bedded and laminated flaggy cross-laminated light grey sandstone, which weathers cream and pale brown, overlying massive to medium-bedded cross-bedded sandstone with weathered-out pits and cavities generally about a quarter of an inch across. Concave and diagonal cross-laminations are characteristic (Pl. 4, fig. 2) and occur in sets generally from three-quarters to $1\frac{1}{2}$ inches thick.

In places the lowermost part of the Olympic Member consists of thick-bedded silicified sandstone and the contact with the Limbla Member is difficult to define. However, in most places the members are separated by an interval of siltstone, clay pellet sandstone, or silty laminated platy limestone.

The Limbla Member was laid down on unstable slopes in fast-flowing currents; erosion of the source areas was rapid and the supply of detritus abundant. It is unfossiliferous and may be partly equivalent to the Cyclops Member.

Olympic Member (new name)

The Olympic Member is here defined as the variable sequence which disconformably overlies the Limbla Member and is separated from the Waldo Pedlar Member above by a small thickness of siltstone. The contacts are poorly exposed. The member consists of lenses of sandstone, siltstone, conglomerate, shale, boulder clay, some dolomite, and silicified sandstone in varying proportions. It varies in thickness and lithology over short distances. The type section ASR4 (Pl. 10), 5 miles south-east of Ringwood homestead, is 630 feet thick. The name is derived from Olympic Bore in the south-eastern corner of the Alice Springs Sheet area.

The lenticular beds of silicified sandstone form the resistant cap to scarps that are up to 200 feet high, but otherwise the member is poorly exposed. The member crops out 5 miles south-east of Ringwood homestead, in rubbly exposures about 6 miles east-north-east of Teds Dam, and in the core of the Hi Jinx Syncline in the north-western corner of the Hale River Sheet area. In the Rodinga Sheet area the best exposures occur in the core of an anticline about 16 miles east-north-east of Santa Teresa Mission.

The Olympic Member may be partly equivalent to the Cyclops Member, and is possibly equivalent to the conglomerate (Bup(c)) in the Mount Burrell area.

The phenoclasts in the beds and lenses of conglomerate have been derived mainly from the Bitter Springs and Areyonga Formations; they also include igneous and metamorphic rocks, and sandstone fragments apparently derived from the Limbla Member.

In some areas the top of the Olympic Member is defined by a distinctive horizon of dolomite. The dolomite is pink and grey, weathers cream, is thin-bedded, shows manganese staining, and contains pseudomorphs of limonite after pyrite.

A lens of white thick to thin-bedded medium-grained sandstone is present near the top of the member. The sandstone is well exposed in a cuesta south of Olympic Bore. In outcrops between Olympic and No. 6 Phillipson Bores, it is underlain by another sandstone from which clay galls have been weathered, leaving a network of angular cavities. Below the clay pellet bed there is generally a poorly exposed interval underlain by siltstone which grades downwards into coarse sandstone, boulder clay, conglomerate, and 'edgewise' conglomerate with dolomite plates. The conglomerate and boulder clay contain rounded phenoclasts of dolomite, sandstone, quartz, and a variety of igneous and metamorphic rocks; some of the dolomite and limestone phenoclasts have probably been derived from the Limbla Member. The largest phenoclast seen was a weathered and disintegrated boulder of coarse-grained gneiss, probably originally about 10 feet in diameter. The matrix of the conglomerate consists of poorly sorted dark grey-green siltstone. In the Hi Jinx Syncline the conglomerate is underlain by grey-green and purple thin-bedded siltstone and laminated silty and platy limestone which overlies the Limbla Member. The conglomerate lenses out rapidly: it crops out in the core of the syncline but is absent in the steep hills on the north-west flank of the fold.

South of Olympic Bore the equivalent horizon comprises coarse-grained sandstone to fine-grained conglomerate with angular white quartz clasts, and breccia with pink and yellow plates of fine laminated dolomite. Many of the boulders and cobbles in the conglomerate are striated, and most are soled. The conglomerate is underlain by grey friable sandstone and shale, and deeply weathered fawn and grey silicified dolomite. The contact with the Limbla Member is not exposed.

A glacial environment is indicated by the great variety of rock types in the conglomerate, the presence of striations and facets on the pebbles, the texture of the deposits, and their lenticular nature. The member is similar to parts of the Areyonga Formation. The boulders in the conglomerate show that the glacier eroded older formations as well as older members of the Pertatataka Formation.

<u>Waldo Pedlar Member</u> (new name)

The Waldo Pedlar Member is here defined as the sequence of thin-bedded silicified sandstone with interbeds of green siltstone and shale which is separated from the Olympic Member below by a small thickness of grey siltstone. The top is eroded or obscured by recent deposits and the contact with the Julie Member is not exposed.

The member is named after Waldo Pedlar Bore in the south-east corner of the Illogwa Creek Sheet area. There is no type section. The type locality includes the outcrops in the north-west corner of the Hale River Sheet area, about 8 miles west-north-west of No. 6 Phillipson Bore.

The Waldo Pedlar Member forms dark rounded hills generally less than 200 feet high. It crops out between Waldo Pedlar Bore and No. 6 Phillipson Bore, and in the extreme north-eastern corner of the Rodinga Sheet area. Similar beds occur in the Pertatataka Formation on the western side of the Rodinga Sheet area, but their position in the sequence is not clear.

The contacts of the Waldo Pedlar Member are not well exposed. In the north-eastern part of the Hale River Sheet area it is separated from the marker bed of dolomite at the top of the Olympic Member by about 200 feet of green shale and siltstone. The thickness of the unit is estimated at about 200 feet.

The Waldo Pedlar Member consists of dark grey fine-grained thin-bedded tough silicified sandstone with some interbeds of green siltstone and shale. The sandstone weathers dark red-brown. Some ripple and current flow markings are preserved on the bedding-planes, and in places it contains clay pellets.

Julie Member (new name)

The Julie Member is here defined as the sequence of dolomite, limestone, and siltstone, with lenses of sandstone, which is conformably overlain by the Arumbera Sandstone; in the west, the unit is separated from the Cyclops Member by several hundred feet of siltstone, and in the east it is separated from the older members of the Pertatataka Formation by an unknown thickness of siltstone. The type section is at the Ross River Tourist Chalet, where 420 feet was measured (ASR5, Pl. 10).

The Julie Member is the most widespread member of the Pertatataka Formation. It crops out throughout most of the north-eastern part of the Amadeus Basin and it can be correlated with the carbonate rocks at the top of the formation to the west of the Alice Springs and Rodinga Sheet areas. The Julie Member crops out around the south-eastern and eastern margins of the Phillipson Pound, is present in the Ooraminna No. 1 well, and is probably equivalent to part of the Pertatataka Formation in the intricate structures to the east of Allambi homestead. The most easterly outcrops are those near Illogwa Creek about 23 miles east of Numery homestead.

The limestone and dolomite generally crop out in ridges 100 to 200 feet high at the base of the more prominent scarp of the red-brown Arumbera Sandstone.

The unit is commonly 300 to 500 feet thick, but 15 miles east-south-east of Santa Teresa Mission the thickness is 1800 feet; it appears to thicken rapidly towards this locality and there is a marked increase in the proportion of sandstone. In the Ooraminna No. 1 well the unit is about 400 feet thick, but it is apparently absent in the Mount Charlotte No. 1 well.

The prominent ridge-forming dark grey dolomite is thick-bedded and massive, medium to coarse-grained, oolitic, and sandy; it contains spherical oolitic chert nodules. The interbeds of dolomite are pink, yellow, and grey, oolitic, and sandy. Dark grey and blue-grey foetid limestone usually occurs near the base of the member. The sandstone commonly forms lenticular bodies between the ridges of dolomite and the underlying limestone; it is generally white, kaolinitic, poorly sorted, medium to coarse-grained, and thick-bedded. Sandstone is generally more prevalent in the southern and south-eastern part of the Alice Springs Sheet area; in the Todd River Anticline it forms about 25 percent of the unit, mainly in the lower part.

The uppermost part of the member consists of red-brown and grey siltstone, generally with interbeds of fine pink and red-brown sandy and oolitic dolomite.

In a few places, poorly preserved stromatolites, with an indistinct wavy bulbous outline, are preserved in the dolomite.

The Julie Member is considered to be Upper Proterozoic in age.

CAMBRIAN

Pertaoorrta Group

The Pertaoorrta Group was originally defined by Prichard & Quinlan (1962); the name was changed to Pertaoorrta Formation by Wells, Forman, & Ranford (1965) and back to Pertaoorrta Group by Ranford, Cook, & Wells (1966). The name Ross River Group was proposed by Joklik (1955) for 'the Cambrian sediments of the post-Proterozoic succession' which 'outcrops in the valley between old Loves Creek homestead (now Ross River Tourist Chalet) and the southern border of the Fergusson Ranges'. However, the name 'Pertaoorrta' has priority as it was used by Madigan (1932b) as equivalent to his Pertaoorrta Series in the western MacDonnell Ranges. In this Report the unit is accepted as equivalent to the Pertaoorrta Group plus the Arumbera Greywacke of Prichard & Quinlan (1962), as proposed by Ranford et al. (op. cit.).

The Pertaoorrta Group includes the following formations in the north-eastern part of the Amadeus Basin: the Arumbera Sandstone (revised name), Todd River Dolomite (new name), Chandler Limestone, Giles Creek Dolomite (new name), Jay Creek Limestone, Hugh River Shale, Shannon Formation (new name), and Goyder Formation.

The relationships between the formations in the Pertaoorrta Group are as shown in Figure 4.

Arumbera Sandstone (Prichard & Quinlan, 1962)

This unit was originally defined by Prichard & Quinlan (1962) as the 'Arumbera Greywacke' and was later redefined by Wells et al. (1965) as the 'Arumbera Greywacke Member' of the Pertaoorrta Formation. The name is here changed to Arumbera Sandstone as the unit consists predominantly of sandstone.

The Arumbera Sandstone crops out on the southern half of the Alice Springs Sheet area, the south-western corner of the Illogwa Creek Sheet area, the north-western corner of the Hale River Sheet area, and the northern half of the Rodinga Sheet area. In the south, the outcrops are thought to correspond approximately with the southern margin of the basin in which the formation was laid down. The formation generally crops out as two prominent ridges, but in the south it is much thinner and forms a single strike ridge.

In the north-eastern part of the Amadeus Basin, the Arumbera Sandstone rests conformably on the Pertatataka Formation, and in some areas (e.g. around Phillipson Pound) the contact is apparently gradational. In the north-west (e.g. between Jay Creek Aboriginal Settlement and Alice Springs), the Arumbera Sandstone is overlain by the Hugh River Shale; but in the south-west (e.g. James Ranges), the formation is overlain by the Chandler Limestone and, in the north-east, it is succeeded by the Todd River Dolomite (Pl. 5, fig. 1). The boundary between the Arumbera Sandstone and the Hugh River Shale and Chandler Limestone has been placed at the top of the sandstone sequence; and between it and the Todd River Dolomite at the change from red-brown tough sandstone to pale yellow-brown and cream calcareous sandstone and siltstone.

In the Phillipson Pound area the Arumbera Sandstone is estimated to be 270 feet thick. A thickness of 2240 feet was measured on the western flank of the Todd River Anticline (ASR1), and 2335 feet was measured by Hopkins (1964) about 10 miles east-north-east of Deep Well homestead. Sections were also measured through the Arumbera Sandstone at Ross River Gorge (ASR5, 1110 feet), about 13 miles south of Gaylad Dam (ASR3, 1530 feet), near Williams Bore (ASA1, 1800 feet), about 3 miles south of Hi Jinx bore (HIW1, 1265) feet), about 4 miles south of Mount Peachy (RdR1, 670 feet), and about 4 miles east of Deep Well homestead (RdR6, 1400 feet). It is estimated that the Ooraminna No. 1 well begins about 370 feet below the top of the Arumbera Sandstone (Planalp & Pemberton, 1963), which, together with the 1520 feet penetrated in the well, gives a total thickness of about 1900 feet.

The Arumbera Sandstone includes four lithological units. In the thickest sections, the basal unit consists predominantly of red-brown micaceous siltstone and shale with minor sandstone. The unit is friable and easily eroded, and is preserved only in areas of low dip, where it is capped by resistant sandstone. The second unit is well exposed, and forms a prominent dark red-brown and purple-brown strike ridge. It consists predominantly of medium and coarse-grained cross-bedded slump-folded sandstone. Clay pellets are common in some beds, and pebbles of chert, quartzite, and jasper occur in thin beds or are scattered irregularly through the sandstone. Along an east-west line immediately south of Phillipson Pound, the top of the second unit is defined by a bed of conglomerate up to about 10 feet thick; it contains subangular to well-rounded phenoclasts, up to 3 inches in diameter, of grey, white, and green chert, and red-brown and white silicified sandstone.

The third unit weathers recessively and comprises siltstone and shale with minor sandstone and dolomite. The siltstone, shale, and sandstone are mainly dark red-brown and micaceous. In places, the beds are glauconitic and calcareous; worm burrows, trails (Pl. 6, fig. 1), and occasional arthropod tracks may also be present. In some areas (e.g. near Ross River Gorge and 2 miles east of Snow Bore), the dolomite forms lenses up to a few feet thick. A very coarse-grained white glauconitic lenticular sandstone crops out near Undoolya Gap, Williams Bore, and in part of the Todd River Anticline. The sandstone occurs near the top of the third unit, and contains a few trails on the bedding planes.

The uppermost or fourth unit also forms a resistant strike ridge and consists of red-brown and buff medium-grained sandstone. The sandstone is cleaner and more porous than those described above. The unit varies considerably in thickness over short distances, and is absent in the south.

The Arumbera Sandstone is interpreted as a postorogenic molasse type of sediment deposited in a transitional marine and deltaic environment.

The impressions in the basal sandstone beds about 4 miles east of Deep Well have been assigned to Rangea arborea by Glaessner (Taylor, 1959) and are considered to be of Upper Precambrian age. However, Joyce Gilbert-Tomlinson (pers. comm.) considers that the arthropod tracks and Scolithus in the third unit are more likely to be of Cambrian age.

PLATE 5

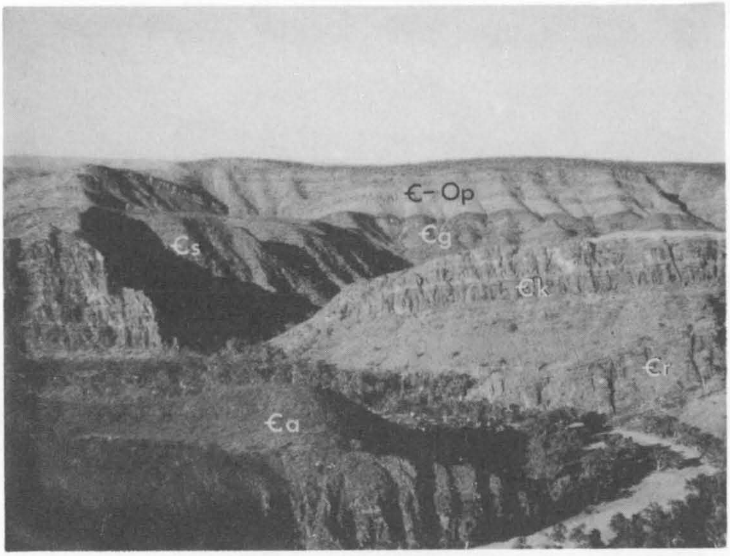

Fig. 1. Arumbera Sandstone (€a), Todd River Dolomite (€r), Giles Creek Dolomite (€k), Shannon Formation (€s), Goyder Formation (€g), and Pacoota Sandstone (€-Op), in the Ross River Gorge, Alice Springs Sheet area (looking south)

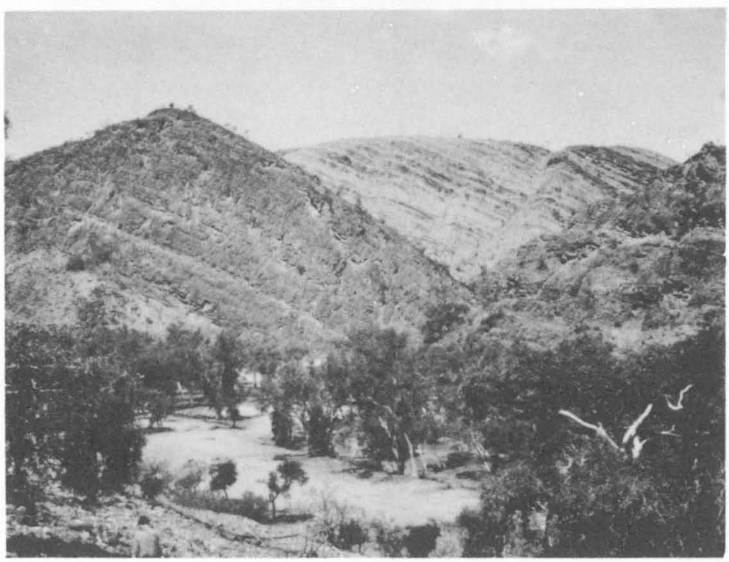

Fig. 2. Giles Creek Dolomite and overlying Shannon Formation, north flank of the Ross River Syncline, Ross River Gorge, Alice Springs Sheet area (looking south-east)

PLATE 6

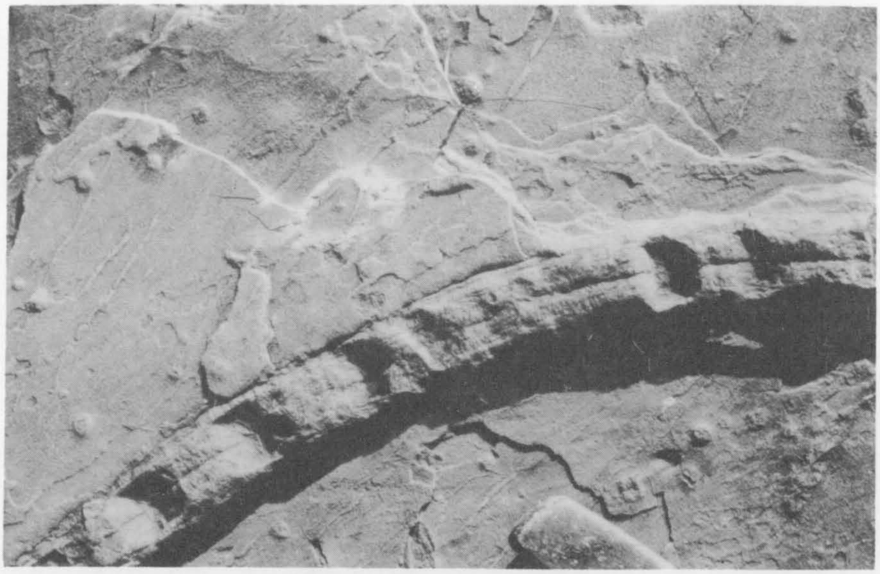

Fig. 1. Cast of large trail and some small worm casts, upper part of the Arumbera Sandstone. AS320A, 7½ miles east of Shannon Bore, Alice Springs Sheet area.

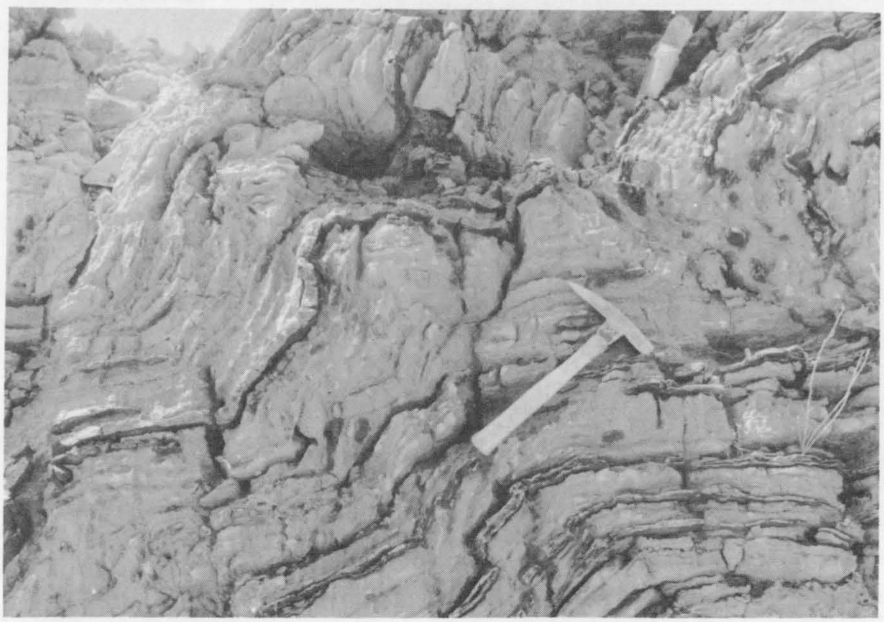

Fig. 2. Chandler Limestone, about 13 miles north of Mount Rodinga, showing contortions and chert laminae, Rodinga Sheet area.

PLATE 7

Fig. 1. Girvanella, Giles Creek Dolomite, western end of the Gaylad Syncline, Alice Springs Sheet area.

Fig. 2. Stromatolite colonies, upper part of Jay Creek Limestone, eastern end of the Waterhouse Range, Alice Springs Sheet area.

PLATE 8

Fig. 1. Santo Sandstone at Chambers Pillar, Rodinga Sheet area.

Fig. 2. Bitter Springs Formation cutting the Arumbera Sandstone and Julie Member of the Pertatataka Formation, 3 miles east of Allua Well, Alice Springs Sheet area.

The Arumbera Sandstone is generally overlain by the Lower Cambrian Todd River Dolomite, and the contact is conformable and possibly gradational. The Arumbera Sandstone is tentatively regarded as Cambrian, but it may range from late Upper Proterozoic to Lower Cambrian.

Todd River Dolomite (new name)

The Todd River Dolomite is here defined as the sequence of pink and grey thick-bedded dolomite at whose base is thin-bedded calcareous sandstone, red-brown sandstone, siltstone, and thin beds of dolomite. The lower beds form a transitional zone from the Arumbera Sandstone. The type section (ASW1) is in the Ross River Gorge (Pl. 5. fig. 1), and the name is derived from the Todd River.

The Todd River Dolomite conformably overlies the Arumbera Sandstone and is conformably, or in places possibly disconformably, overlain by the Giles Creek Dolomite or the Chandler Limestone.

The formation is moderately resistant and crops out in low scarps, low rounded hills, or discontinuous ridges. Exposures are poor near the southern limit of deposition. On the northern margin of the Amadeus Basin the formation crops out in the Ross River, and in the Fergusson and Gaylad Synclines. The most easterly exposure is a small outcrop about 4 miles east of Kangaroo Well. It is not known in outcrop west of the Ooraminna Anticline.

Five sections have been measured: it is thickest in the Ross River Gorge (510 feet in ASW1), and thins gradually eastward in the Gaylad Syncline (455 feet in ASR3) and in the north-western part of the Hale River Sheet area (365 feet in HlW1); and more rapidly westwards: at Williams Bore it is only 260 feet thick. On the north flank of the Ooraminna Anticline it is 325 feet thick (ASR1), but on the south flank (RdR5) it is only about 150 feet thick. The McDills No. 1 well penetrated 1491 feet of dolomite (9024 to 10,515 feet T.D.) part of which, from fossil evidence and lithology in a core (9632 to 9642 feet), has been identified with the Todd River Dolomite. The upper part of this dolomite interval possibly includes other formations of the Pertaoorrta Group.

The Todd River Dolomite consists mainly of pink, pale brown, and grey, silty poorly thick-bedded richly fossiliferous and partly glauconitic crystalline dolomite. The fossils are mainly archaeocyathans and brachiopods. The lower part of the formation is made up of medium and thin-bedded cross-bedded calcareous sandstone, red-brown tough fine-grained thin-bedded sandstone, siltstone, and some thin beds of dolomite. In the south, the formation includes grey, fawn, and cream cross-laminated sandy oolitic and pelletal dolomite, and varying proportions of calcareous siltstone and shale.

The contact between the Arumbera Sandstone and Todd River Dolomite is gradational and the boundary has been placed where the predominantly red-brown fine-grained tough sandstone at the top of the Arumbera Sandstone passes into pale brown calcareous siltstone and fine to coarse-grained friable sandstone. In several places the basal part of the Todd River Dolomite consists of interbedded brown-grey coarse-grained well rounded sandstone and pale red-brown fine-grained sandstone.

The top of the Todd River Dolomite has been placed where the pink dolomite passes into interbedded grey and dark grey dolomite, limestone, and shale of the Giles Creek Dolomite, or at the change to shale and grey foetid carbonate rock of the Chandler Limestone.

The Todd River Dolomite is the only known fossiliferous Lower Cambrian formation in the Amadeus Basin; it may be equivalent to part of the Hugh River Shale, or it may have no time-rock equivalents. One of us (L.C.R.) has suggested that it may be equivalent to part of the Chandler Limestone beyond the north-eastern corner of the basin, but where the two units occur together, the Chandler Limestone overlies the Todd River Dolomite.

The Todd River Dolomite was probably deposited in a shallow sea. The Lower Cambrian marine transgression was apparently restricted to the north-eastern corner of the Amadeus Basin.

Joyce Gilbert-Tomlinson (pers. comm.) has supplied the following notes on the faunal content of the formation: 'On faunal grounds the dolomite may be divided into two parts. In the lower part, the archaeocyathans are associated with the South Australian Lower Cambrian brachiopod "Micromitra" etheridgei (Tate). As this species has never been noted in association with Middle Cambrian fossils, a Lower Cambrian age may be accepted, though its position in the Lower Cambrian scale is not yet clear.

'"Micromitra" etheridgei does not extend into the upper Todd River Dolomite, its place being taken by other brachiopods of unknown range. A few hyolithids and trilobite fragments are also present, the latter not generally determinable. This part of the sequence may be provisionally dated as Lower Cambrian.'

Chandler Limestone (Ranford, Cook, & Wells, 1966)

The Chandler Limestone has been mapped in scattered localities in the western half of the Rodinga Sheet area and in the northern flank of the Ooraminna Anticline on the Alice Springs Sheet area. The limestone and dolomite form low ridges and hills, and are commonly tightly folded and contorted (Pl. 6, fig. 2). The breaks in the outcrops along the strike are probably due to tectonic disturbance.

On the western side of the Rodinga Sheet area, the Chandler Limestone is overlain by the Jay Creek Limestone and underlain by the Arumbera Sandstone or the Pertatataka Formation, but north-east of Deep Well homestead, in Phillipson Pound, and around the Ooraminna Anticline the Chandler Limestone is overlain by the Giles Creek Dolomite and underlain by the Todd River Dolomite. The contacts with the underlying and overlying formations are not exposed.

The Chandler Limestone is invariably folded, and it is difficult to measure the thickness, but measured sections indicate that it is between 180 and 460 feet thick in the Rodinga Sheet area (RdR6, 180 feet; RdR4, 460 feet; RdR5, 200 feet; RdR1, 260 feet). About 500 feet of halite and shale in Alice No. 1 well is included in the Chandler Limestone, and 740 feet of halite and shale was penetrated in Mount Charlotte No. 1 well.

The Chandler Limestone consists mainly of pale and dark grey laminated limestone and dolomite, with numerous thin white and grey chert laminae. The beds are intensely folded and, in places, brecciated. The carbonate rock is fine-grained and has a foetid odour when freshly broken. The concealed part of the unit probably consists of red-brown shale and evaporites. The evaporites do not crop out, but about 360 feet of halite was intersected in Alice No. 1 well, and the incompetent type of folding in the Chandler Limestone probably indicates the presence of evaporites.

The Chandler Limestone is underlain by fossiliferous Lower Cambrian sediments and overlain by fossiliferous lower Middle Cambrian sediments. No fossils have been found in the formation, and the nature of the contacts with the overlying and underlying units is uncertain. The Chandler Limestone is tentatively regarded as Lower Cambrian.

Giles Creek Dolomite (new name)

The Giles Creek Dolomite is here defined as the sequence of green and purple siltstone and shale, with interbeds of dark grey fossiliferous limestone, overlain by grey-brown thick-bedded dolomite. The name is derived from Giles Creek, about 55 miles west of Alice Springs, and the type section (ASW1, Pl. 12) is in the Ross River Gorge (Pl. 5, figs 1 & 2).

The Giles Creek Dolomite crops out as far west as the railway line and as far south as latitude 24°30'; to the east, it extends to a point 15 miles east-south-east of No. 6 Phillipson Bore.

The dolomite is resistant to erosion and forms sharp ridges with steep gorges. It is usually separated from the underlying and overlying units by strike valleys.

The Giles Creek Dolomite rests conformably or in places possibly disconformably on the Todd River Dolomite, or, where that formation is absent, the Chandler Limestone. It is overlain conformably by the Shannon Formation or unconformably by the Pertnjara Formation. The base of the formation is the lowermost siltstone and shale associated with the limestone and dolomite, and the top has been placed where the dolomite passes into the interbedded siltstone, shale, and dolomite of the Shannon Formation.

Eight sections have been measured. The type section at Ross River is 830 feet thick (ASW1), but at Williams Bore, in the west, the formation is 960 feet thick (ASA1), and on the southern flank of the Gaylad Syncline (ASR3) it is 1090 feet thick. South-east of Ringwood homestead (HlW1), it is only 550 feet thick. The formation is thickest in the Ooraminna Anticline: on the northern flank (ASR1) it is 1320 feet thick and on the southern flank (RdR5) it is 1100 feet thick. In the Alice No. 1 well the formation is about 1170 feet thick. The formation thins rapidly to the south of Ooraminna Anticline; at RdR6, 4 miles east of Deep Well, it is 610 feet thick and at RdR4, 8 miles west of Camel Flat Bore, it is 495 feet thick. The measured sections are shown in Plates 11 and 12.

The lower half of the formation generally consists of interbedded limestone and shale. The limestone is blue-grey, fine, medium-bedded, and in places dolomitic, and contains fragments of trilobites and hyolithids. Pseudomorphs of limonite after pyrite occur in places. The upper half generally consists of grey, grey-brown, yellow, and cream, tough thick-bedded recrystallized dolomite. In places it is oolitic and contains a few irregular masses of chert. The lower part of the dolomite is massive and in places contains Girvanella-like structures (Pl. 7, fig. 1).

Away from the type section, the formation generally contains up to 50 percent of red-brown and grey-green micaceous, calcareous siltstone and shale. The dolomite is mostly thin-bedded to laminated, fine and medium-grained, with a few stromatolite colonies. The colonies are of a different type and are less abundant than those in the Shannon Formation. Some of the dolomite is foetid and much of it has been recrystallized. Some ripple marks and a few pseudomorphs after halite have been noted.

The Giles Creek Dolomite is equivalent to at least part of the Jay Creek Limestone and possibly part of the Hugh River Shale. In the north-western and southern parts of the Rodinga Sheet area the lower part of the Jay Creek Limestone is equivalent to the Giles Creek Formation.

The Giles Creek Dolomite was probably deposited in a shallow sea. Joyce Gilbert-Tomlinson (pers. comm.) has supplied the following information on the faunal content: 'The fossils consist of hyolithids (including Biconulites), brachiopods, gastropods, and trilobites, indicating an early Middle Cambrian age. The alga Girvanella is also present. The gastropods and some of the trilobites point to a correlation with the Tempe Member of the western part of the Basin. The lower part of the Jay Creek Limestone, as exposed in the western MacDonnell Range and the Waterhouse Range, is also contemporaneous.'

Shannon Formation (new name)

The Shannon Formation is here defined as the sequence of interbedded green and brown shale, siltstone, grey, grey-brown and pink limestone, and recrystallized grey, fawn, and yellow thin-bedded and laminated dolomite. The proportion of limestone to dolomite varies considerably. Stromatolites are more abundant in the limestone. Many of the carbonate rocks are oolitic and some thin beds are fragmented. The name is derived from Shannon Bore, 8 miles south of the Ross River Tourist Chalet. The type section is in the Ross River Gorge (ASW1, Pl. 12; Pl. 5, figs 1 & 2).

The Shannon Formation conformably overlies the Giles Creek Dolomite and the contact has been chosen at the change from the thick-bedded tough dolomite to the overlying sequence of shale, siltstone, and interbedded limestone and dolomite of the Shannon Formation. To the south of the Fergusson and MacDonnell Ranges, the basal part of the Shannon Formation consists predominantly of shale, which forms a wide strike valley between the carbonate beds above and the Giles Creek Dolomite.

The contact with the overlying Goyder Formation is conformable and gradational.

In the east, the formation is overlain disconformably by the Mereenie Sandstone and unconformably by the Pertnjara Formation. South and east of Deep Well, the Shannon Formation is overlain disconformably by the Pacoota Sandstone and Stairway Sandstone, and disconformably or possibly unconformably by the Mereenie Sandstone.

The Shannon Formation generally crops out in low rounded hills and in a series of strike ridges and valleys. Exposure is comparatively poor. It crops out near Undoolya Gap and as far east as 10 miles south of Casey Bore in the north-eastern part of the Hale River Sheet area. On the Rodinga Sheet area it crops out as far south as latitude 24^{o}30'S.

The Shannon Formation comprises lutite and carbonate rocks in about equal proportions. The ratio of limestone to dolomite varies considerably; at Williams Bore it is 4:1, but in the Ross River Gorge it is about 1:5. In the Ooraminna Anticline the limestone predominates.

The dolomite and limestone are grey, pink, fawn, and cream; they are oolitic and include some intraformational breccia. The carbonate rocks include numerous beds of stromatolites and thin irregular bodies and lenses of chert. In places, the dolomite is cross-laminated. The stromatolites are usually composed of limestone. The green and brown shale and siltstone are poorly exposed.

Seven sections have been measured. In the type section (ASW1) the thickness is 1230 feet and to the west at Williams Bore it is 1705 feet (ASA1). The thickest measured section is 2340 feet, on the north flank of the Ooraminna Anticline (ASR1). To the north, in Alice No. 1 well, the Shannon Formation is about 1630 feet thick. On the south flank of Ooraminna Anticline and near the eastern end of the James Ranges it is about 1800 feet thick (RdR5, RdR6) and in section RdR4, south of Phillipson Pound, it is 935 feet thick. Farther east, in the Hale River Sheet area, it is only 830 feet thick (HlW1). The measured sections are shown in Plates 11 and 12.

The Shannon Formation is equivalent to the upper part of the Jay Creek Limestone and in some places may be equivalent to part, if not all, of the Goyder Formation. The Goyder Formation thins to the east and south of the James Range whereas the Shannon Formation thickens to the east. It is difficult to distinguish the carbonate rocks at the base of the Goyder Formation from those in the top of the Shannon Formation, and it is possible that the latter takes the place of part of the Goyder Formation.

The Shannon Formation was deposited in a shallow-marine environment. It contains few recognizable fossils, and no fossils were found in southern outcrops. The formation is probably mainly Middle Cambrian in age, but it may extend well into the Upper Cambrian.

Joyce Gilbert-Tomlinson (pers. comm.) states that 'the fossils are of early Upper Cambrian age (late Mindyallan; zone of Glyptagnostus stolidotus) and are indistinguishable from those of the overlying lower (carbonate) part of the Goyder Formation. Fossils of the same age have been found in the upper part of the Jay Creek Limestone in the western MacDonnell Range and in the Waterhouse Range. By comparison with sections in western Queensland, the interval between the early Middle Cambrian (basal part of the Giles Creek Dolomite) and the early Upper Cambrian (Shannon Formation) covers at least thirteen zones'.

Hugh River Shale (Prichard & Quinlan, 1962)

The Hugh River Shale crops out in the area between Jay Creek and Alice Springs. It is very poorly exposed, and only the lowest part, which forms a discontinuous low ridge with projecting beds of dolomite, crops out. The unit conformably overlies the Arumbera Sandstone, and is conformably overlain by the Jay Creek Limestone. No section has been measured, but the thickness estimated from air-photographs is 1600 feet.

The bulk of the unit is probably composed of red-brown or grey-brown siltstone and shale. The lowest 100 feet consists of red-brown poorly bedded and slightly micaceous siltstone, with a few interbeds of grey chert. The next 100 feet comprise interbedded yellow calcareous dolomite, shale, siltstone, and minor sandstone. Nodules of chert are present in the dolomite, and concretions of limonite, up to 12 inches across, are found in the siltstone. A few algae are present in the dolomite in the lower part of the formation.

The age of the Hugh River Shale is tentatively regarded as Lower to Middle Cambrian because of its stratigraphical position between the Arumbera Sandstone and Jay Creek Limestone.

2146/67—4

Jay Creek Limestone (Prichard & Quinlan, 1962)

The Jay Creek Limestone is present between Alice Springs and Jay Creek, in the core of the Waterhouse Range Anticline, and in the western third of the Rodinga Sheet area. It forms low ridges with projecting beds of limestone. The unit conformably overlies the Hugh River Shale in the Alice Springs Sheet area and the Chandler Limestone in the Rodinga Sheet area, and is conformably overlain by the Goyder Formation. It is equivalent to parts of the Giles Creek Dolomite and Shannon Formation in the Ross River section, and in some parts of the Rodinga Sheet area the sediments are similar in lithology. The Giles Creek Dolomite and Shannon Formation have a combined thickness of 2000 feet at Ross River, and 2800 feet in Alice No. 1 well. The Jay Creek Limestone is 1400 feet thick near Mount Peachy (RdR1), and about 800 feet thick near Temple Bar homestead (from the air-photographs). Farther south, in Mount Charlotte No. 1 well, about 800 feet of Jay Creek Limestone was penetrated. Hence, in the Alice Springs/Jay Creek area, either the Jay Creek Limestone is a condensed sequence, or several large time breaks are present. The measured sections are shown in Plates 11 and 12.

In the Alice Springs Sheet area, the formation consists predominantly of limestone and interbedded siltstone, and some rare sandstone. The limestone is yellow-brown to grey, thin to thick-bedded, fine to medium-grained, and tough; it includes many thick beds of algal and oolitic limestone. Some of the algal limestone beds emit a petroliferous odour when hammered. The siltstone weathers recessively and is poorly exposed; it is red-brown or green, micaceous, and platy. The siltstone is interbedded with red sandstone near Temple Bar homestead.

In the Rodinga Sheet area, the Jay Creek Limestone consists chiefly of siltstone and shale, with up to 30 percent carbonate rocks. The siltstone and shale are partly calcareous and micaceous, and either grey-green or red-brown. The carbonate is mainly dolomite in the basal third of the formation, and mainly limestone in the remainder. The dolomite is light grey to pale brown and pink; most of the original texture has been destroyed by recrystallization. Lenses, biscuits, and laminae of chert are common. The limestone is dark grey, green, or blue-grey, and is largely calcarenite (oolitic, pelletal, and quartzose limestones). Some beds contain many algal bioherms up to 6 feet across and 3 feet high (Pl. 7, fig. 2). Pseudomorphs after halite are found near the base of the sequence.

The Jay Creek Limestone was deposited in a shallow sea, and the carbonate rocks were formed by detrital, organic, and chemical processes. The fossils include Girvanella and several other algae, Biconulites, and trilobites.

Joyce Gilbert-Tomlinson (pers. comm.) states that 'the top of the formation contains early Upper Cambrian (Mindyallan) fossils and is contemporaneous with the upper part of the Shannon Formation and the lower part of the Goyder Formation in the north-eastern part of the Amadeus Basin. The base of the formation is in part roughly contemporaneous with the lower Giles Creek Dolomite. The fossil evidence is inadequate to decide whether deposition was continuous during the interval (about 13 zones by Queensland standards) between the early Middle Cambrian base of the formation and its early Upper Cambrian top'.

Goyder Formation (Prichard & Quinlan 1962)

The Goyder Formation crops out in the Alice Springs/Jay Creek area, in the Waterhouse Range, around both limbs of the Ross River (Pl. 5, fig. 1) and Fergusson Synclines, on the north-west side of the Todd River/Ooraminna Anticline, and east and west from Mount Peachy on the Rodinga Sheet area. It generally forms a dissected pediment below the ridge of

Pacoota Sandstone, but in places on the south side of the Ross River Syncline, several mesas have been preserved by a ferruginous cap at the top of the formation. The unit is very poorly exposed on the Rodinga Sheet area.

The Goyder Formation conformably overlies the Jay Creek Limestone in the west, and the Shannon Formation in the east; it is conformably overlain by the Pacoota Sandstone. The unit is 1500 feet thick near Jay Creek (from the air-photographs), 1400 feet at Williams Bore (ASA1), 1230 feet at Ross River Gorge (ASW1), 1180 feet in the Mount Peachy area (RdR1), 850 feet in Alice No. 1 well, 680 feet 4 miles east of Deep Well (RdR6), and 600 feet on the western limb of the Todd River Anticline (ASR1). The measured section on the south-western flank of the Waterhouse Range (HyR6) indicates a thickness of 1180 feet (Ranford, Cook, & Wells, 1966). The formation therefore thins to the south and east. The measured sections are shown in Plates 11 and 12.

The Goyder Formation consists of quartz sandstone and siltstone, and interbedded sandstone, dolomite, and limestone (calcarenite). In the Jay Creek/Alice Springs area and the Waterhouse Range, carbonate rocks are absent; the sandstone is white or yellow-brown, fine-grained, generally well sorted, but slightly clayey and micaceous, poorly rounded, thinly cross-bedded, friable, flaggy, and in places slumped. Interbeds of micaceous siltstone are present. The top few feet of the sandstone forms a useful marker bed, as it is commonly impregnated with black oxides of manganese or browzn oxides of iron.

In the Ross River and Fergusson Synclines, the upper part is sandstone and the lower part interbedded sandstone and carbonate rocks. The carbonates are commonly oolitic limestone and quartzose dolomite, and calcarenite; they are cross-laminated, medium to coarse-grained, with some beds of intraformational carbonate conglomerate. The fine-grained interbeds of calcareous sandstone are friable and weather recessively. In places, the dolomite contains limonite concretions. The limestones and dolomites are lenticular, and the interbedded carbonate rocks and sandstone are also lenticular on a larger scale.

On the north-western side of the Todd River/Ooraminna Anticline, the formation is predominantly sandy, but includes a large lens of porcellanized calcarenitic siltstone. In the Rodinga Sheet area, calcareous siltstone, shale, and sandstone are predominant, and true carbonate rocks are absent.

The Goyder Formation was deposited in a shallow sea. Shelly fossils are common, and include trilobites, gastropods, and hyolithids. A few thick beds of algal limestone are also preserved. The following information on fossils from the Goyder Formation has been supplied by Joyce Gilbert-Tomlinson (pers. comm.).

'The lower part of the Goyder Formation contains fossils of early Upper Cambrian age, indistinguishable from those of the underlying Shannon Formation. The upper part of the Jay Creek Limestone of the Western Macdonnell Range is also contemporaneous. Middle Upper Cambrian (late Franconian) trilobites have been found at two levels near the top of the formation. Fossils of the same age have been found in the Goyder Formation at only one other locality in the Amadeus Basin: in the Gardiner Range south of Areyonga Native Settlement. A considerable time-break is evident within the heterogeneous sequence assigned to the Goyder Formation in the north-eastern part of the Amadeus Basin. By comparison with the succession in western Queensland, the interval between the disappearance of the early Upper Cambrian fauna of the lower Goyder and its contemporaries and the arrival of the late Franconian fauna of the upper Goyder is represented by the six zones of the Idamean stage together with an unknown number in the early Franconian'.

CAMBRIAN-ORDOVICIAN

Larapinta Group
(Prichard & Quinlan, 1962)

The name Larapintine Series was first used by Tate (1896), but the series was not formally defined. The Larapinta Group as defined by Prichard & Quinlan (1962) consists of four formations: in ascending order, Pacoota Sandstone, Horn Valley Siltstone, Stairway Sandstone, and Stokes Formation. The age of the group ranges from Upper Cambrian to early Upper Ordovician. Measured sections are shown in Plate 14.

Pacoota Sandstone (Prichard & Quinlan, 1962)

The Pacoota Sandstone crops out sporadically in the northern half of the area; it is exposed as prominent strike ridges in the Waterhouse and James Ranges, at the western end of the Ooraminna Anticline, near Bokhara homestead and Christmas Bore, along both limbs of the Ross River Syncline (Pl. 5, fig. 1), in the core of the Fergusson Syncline, along the MacDonnell Ranges to the west of Alice Springs, and in the western limb of the Todd River Anticline.

The Pacoota Sandstone rests conformably on the Goyder Formation. In many areas (e.g. near Bokhara homestead and in the James Range) it is conformably overlain by the Horn Valley Siltstone; elsewhere it is disconformably or unconformably overlain by the Mereenie Sandstone.

The measured sections have thicknesses of 2530 feet near Williams Bore (ASA1); 405 feet on the western limb of the Todd River Anticline (ASR1); 1200 feet just south of Alice Springs (measured by the Resident Geologist - pers. comm.); 1470 feet in the Waterhouse Range (HyR5, Ranford & Cook, 1964); 1015 feet near Mount Peachy (RdC8); 995 feet near Nomra Bore in the James Range (RdC7), and 345 feet near Bokhara homestead (RdC9). In Alice No. 1 well the formation is about 890 feet thick. The sections show that the Pacoota Sandstone thins to the west and the south, and is best developed in the northern and north-eastern parts of the Amadeus Basin.

The sandstone is generally fine to coarse-grained, but in places it is very coarse-grained and pebbly, with pebbles up to 2 inches in diameter. It is generally well sorted and rounded, and where it is not silicified it crumbles readily. Thin interbeds of silt are common, especially near the base and close to the top. The sandstone is white, grey, or pale brown, thin to thickly bedded, ripple-marked and cross-bedded. The current directions in the upper part of the Pacoota Sandstone in the Williams Bore area suggest that the main currents were from the south-west. Mud pellet markings and tracks and trails are common in the sandstone. The pebbles generally consist of vein quartz or silicified sandstone. The interbedded siltstone is variegated white, brown, red, yellow, or grey; it is laminated, and mostly poorly exposed. Rare thin glauconitic bands are present in the thin pelletal phosphorite layers in the upper part of the Pacoota Sandstone. Limestone is present near the base of the formation, 5 miles south of the Ross River Tourist Chalet and 2 miles south of N'Dahla Gorge. The limestone is ferruginous and glauconitic and has a maximum thickness of 10 feet.

Extensive collections of fossils have been made, especially in the Ross River area. The fossils include trilobites, brachiopods, lamellibranchs, gastropods, ribeirioids, nautiloids, and many tracks, trails, and burrows. Scolithus forms the characteristic pipe-rock in the Pacoota Sandstone. In the Amadeus Basin, Joyce Gilbert-Tomlinson (1965) has recognized three faunal units made up of eight assemblages. In the Ross River Syncline, only the lower two faunal assemblages are present. There are several fossil horizons of late Upper Cambrian and early Ordovician (Tremadocian and Arenigian) age in the Pacoota Sandstone (Joyce Gilbert-Tomlinson, pers. comm.).

N'Dahla Member (new name)

The N'Dahla Member is here defined as the thin sequence of clayey and pebbly sandstone, with minor beds of conglomerate and thin beds of limestone, in the Pacoota Sandstone. The name is derived from N'Dahla Gorge (the type locality), 4 miles south-west of the Ross River Tourist Chalet. The member is confined to the northern limb of the Ross River Syncline. At N'Dahla Gorge, the member weathers recessively and forms the waning slopes beneath a steep scarp of Mereenie Sandstone. In the west, it is more resistant and forms part of the ridge of Pacoota Sandstone.

At N'Dahla Gorge, and 2 miles north-west of Williams Bore, the N'Dahla Member is unconformably overlain by the Mereenie Sandstone. No section has been measured, but it is about 50 feet thick at the gorge.

The N'Dahla Member consists of dark red-brown to purple-brown medium to coarse-grained glauconitic poorly sorted friable porous and clayey sandstone. Pebbles are present, and also a few beds of conglomerate composed of fragments of siltstone and limestone in a coarse glauconitic sandstone matrix. Some thin beds of limestone are also present.

The fossils in the N'Dahla Member include trilobites, gastropods, nautiloids, and worm tracks which indicate a Lower Ordovician (late Tremadocian) age (J.G. Tomlinson, pers. comm.).

Horn Valley Siltstone (Prichard & Quinlan, 1962)

The Horn Valley Siltstone crops out in the Waterhouse and James Ranges and near Bokhara homestead on the western margin of the area mapped. The southern limit of the formation is latitude $24^{o}35$'S and the eastern limit is longitude $134^{o}5$'E. The formation weathers recessively and is exposed only rarely in alluvium-covered strike valleys.

The Horn Valley Siltstone conformably overlies the Pacoota Sandstone and is conformably overlain by the Stairway Sandstone in the James Range west of Mount Peachy and near Bokhara homestead. It is disconformably overlain by the Mereenie Sandstone on the southern flank of the Waterhouse Range and in the James Range east of Mount Peachy.

The Horn Valley Siltstone thins to the east and south from the Nomra Bore area. Thicknesses of 145 feet were measured near Nomra Bore (RdC7) at the western end of the James Range, 120 feet near Mount Peachy (RdC8), and 90 feet near Bokhara homestead (RdC9). The changes in thickness do not appear to be accompanied by any marked changes in lithology.

The Horn Valley Siltstone consists predominantly of grey-green and greenish brown siltstone: it is laminated to thin-bedded, calcareous in part, pyritic, and gypsiferous in places, friable, and easily eroded. Thin-bedded hackly pyritic and fossiliferous sandy limestone is commonly interbedded with the siltstone. The limestone is resistant to weathering, and is generally the only part of the formation to crop out. A few thin interbeds of sandstone, silty sandstone, calcareous sandstone, pelletal phosphorite, and oolitic limonite have been found in some areas. Glauconitic layers have been recorded in the Henbury Sheet area by Ranford, Cook, & Wells (1966), but were not seen in the north-eastern part of the Amadeus Basin.

The Horn Valley Siltstone contains many fossils, but only a few poorly preserved specimens were collected. The trilobites, brachiopods, pelecypods, nautiloids, ostracods, conodonts, and gastropods in the Horn Valley Siltstone indicate a Lower Ordovician (Arenigian) age (J.G. Tomlinson, pers. comm.).

Stairway Sandstone (Prichard & Quinlan, 1962)

The Stairway Sandstone crops out sporadically in the south-west corner of the Rodinga Sheet area as fairly prominent strike ridges. It is particularly well exposed in the James Range, near Bokhara homestead, and in the Mount Charlotte Range. The most southerly exposure is at latitude $24^{o}55'$S; though it is known to extend a considerable distance farther south in the subsurface (Wells, Stewart, & Skwarko, 1966). The most easterly exposure is at longitude $134^{o}35'$E: farther east the Stairway Sandstone is overlapped by the Mereenie Sandstone.

In the James Range and near Bokhara homestead, the Stairway Sandstone rests conformably on the Horn Valley Siltstone, but in the Mount Charlotte Range it rests disconformably on the Jay Creek Limestone. In the western half of the James Range, and possibly also in the Mount Charlotte Range, the Stairway Sandstone is conformably overlain by the Stokes Formation, but in the eastern part of the James Range, near Mount Rodinga and Bokhara homestead, the formation is unconformably overlain by the Mereenie Sandstone.

The thickness of the Stairway Sandstone is 590 feet in the James Range near Nomra Bore (RdC7); 410 feet near Bokhara homestead (RdC9), 355 feet near Mount Peachy (RdC8), 350 feet in the Mount Charlotte No. 1 well, 335 feet at the western end of the Mount Charlotte Range (RdC1), 335 feet 7 miles north-west of Mount Charlotte (RdC4), 305 feet at Mount Charlotte (RdC3) and 225 feet near Maryvale (RdC5) and at Mount Rodinga (RdC6). The sections show that the formation thins out to the south. 814 feet of fine to coarse-grained tough sandstone penetrated in the McDills No 1 Well between the Mereenie Sandstone and the Todd River Dolomite may be Ordovician and perhaps belongs to the Stairway Sandstone.

The Stairway Sandstone has been divided into lower, middle, and upper units. The lower unit (referred to as the 'Mount Charlotte Sandstone' by Wulff, 1960) consists mainly of white fine to coarse-grained massive sandstone, with a thin pebble bed at the top. The pebbles consist almost exclusively of vein quartz and are up to 2 inches in diameter. The sandstone is cross-bedded and ripple-marked, silicified, and in many places forms prominent scarps.

The middle unit includes more siltstone than the lower and upper units, and some red-beds; it weathers recessively. In the James Range and at the western end of the Mount Charlotte Range it consists of green or grey laminated siltstone with thin interbeds of white silty sandstone. The middle unit contains numerous fossil tracks and trails, and rare pelletal phosphorite. The red-beds occur in the ranges to the north of Bokhara Bore and in the eastern half of the Mount Charlotte Range. They consist of red and red-brown fine-grained sandstone, silty sandstone, and siltstone. The sandstone commonly contains green, purple, and grey variegated blebs. Some of the siltstone may be gypsiferous. The sandstone is moderately well sorted, poorly rounded, and thin to medium-bedded. In many places, the weathered rock has a characteristic knobbly appearance.

The upper unit is predominantly arenaceous, and comprises fine to very fine-grained sandstone interbedded with thin siltstone and sandy siltstone. The proportion of lutite increases towards the top of the unit and the boundary with the overlying Stokes Formation is gradational. The sandstone in the upper unit is white or pale brown, thin to medium-bedded, rarely cross-bedded, and forms low ridges. The siltstone is green and poorly exposed. Pelletal phosphorite is common, especially at Mount Charlotte and in the James Range near Nomra Bore. At Mount Charlotte the pellets range up to 3 inches in diameter. They appear to have been deposited on an irregular erosion surface.

The Stairway Sandstone contains fossiliferous beds with trilobites, brachiopods, gastropods, nautiloids, pelecypods, and numerous tracks, trails, and burrows. The fossils are assigned to two faunal stages (J. G. Tomlinson, pers. comm.): those of the older stage are related to those found in the underlying Horn Valley Siltstone and have been dated as late Lower or early Middle Ordovician, and those of the younger stage have been provisionally dated as Middle Ordovician.

Stokes Formation (Prichard & Quinlan, 1962)

The Stokes Formation is thought to be present in the James Range west of Mount Peachy, on the south side of the Mount Charlotte Range, near Maryvale, and 7 miles north-west of Mount Charlotte. The formation is poorly exposed under a thin cover of alluvium.

The Stokes Formation conformably overlies the Stairway Sandstone and is disconformably or unconformably overlain by the Mereenie Sandstone in the north and the siltstone unit of the Pertnjara Formation in the south.

Few sections were measured because of the poor exposures. The section near Nomra Bore (RdC7) at the western end of the James Range has a thickness of 455 feet, near Maryvale (RdC5) 160 feet, and 7 miles north-west of Mount Charlotte (RdC4) over 105 feet. In the middle of the Mount Charlotte Range (RdC2), the combined thickness of the Stokes Formation and the siltstone unit of the Pertnjara Formation is 300 feet. The sections indicate thinning of the Stokes Formation from north to south across the Rodinga Sheet area.

The Stokes Formation is composed mainly of green and grey siltstone and subordinate shale interbedded with minor limestone, sandy limestone, and silty sandstone. The siltstone is micaceous and laminated, and contains pseudomorphs after halite in places. Limestone occurs near Mount Charlotte; it is grey, sandy, and thin-bedded. The sandstone is grey, white, or yellow.

The brachiopods, gastropods, pelecypods, trilobites, echinoderms, and nautiloids found elsewhere in the formation indicate an early Upper Ordovician age (?early Caradocian) (J.G. Tomlinson, pers. comm.).

SILURIAN-DEVONIAN

Mereenie Sandstone (Madigan, 1932a)

The Mereenie Sandstone forms prominent strike ridges in the MacDonnell, Waterhouse, and James Ranges, around the Ooraminna Anticline, in the Ross River and Camel Flat Synclines, and in sharp anticlines of the Rodinga Ranges on the eastern side of the Rodinga Sheet area and the north-western side of the Hale River Sheet area. It was probably laid down over most of the north-eastern part of the Amadeus Basin, but is now preserved only in the broad synclines.

The Mereenie Sandstone rests on Cambrian and Ordovician sediments with a low-angle regional unconformity. The unconformity gradually reduces the section to the east: it rests on the Stokes Formation in the James Ranges on the western margin of the Rodinga Sheet area, and the Shannon Formation on the eastern margin of the Rodinga Seet area and the Hale River Sheet area. The low-angle unconformity is clearly visible on the air-photographs of the northern limb of the Ross River Syncline and the James Ranges west of Mount Peachy. At some localities (e.g. the James Ranges near Deep Well and the southern flank of the Ooraminna Anticline), the Mereenie Sandstone has a thin basal conglomerate or contains scattered pebbles and cobbles at or near the base.

The Mereenie Sandstone is overlain by the Pertnjara Formation with regional unconformity. South of Jay Creek Aboriginal Settlement on the Alice Springs Sheet area, north of Bingie Bore on the Hale River Sheet area, and south and west of Maryvale homestead, the Mereenie Sandstone has been removed at the unconformity, but over most of the area the Pertnjara Formation rests apparently conformably or disconformably on the Mereenie Sandstone. The contact is difficult to recognize on the ground, but can generally be identified on air-photographs.

In the eastern part of the Basin, the Mereenie Sandstone is estimated to be 1500 to 2000 feet thick, with the thickest section near the eastern limit of exposure. The Mereenie Sandstone was found to be 1310 feet thick in the James Ranges (RdR2), 1125 feet thick in the Todd River Anticline (ASR2), 720 feet thick near Williams Bore (ASA1), and 1000 feet thick about 2 miles north of Camel Flat Bore (RdR3). The formation is about 950 feet thick in Alice No. 1 well and about 1120 feet in McDills No. 1 well. The measured sections are shown in Plates 14 and 15.

Only the upper part of the Mereenie Sandstone, which corresponds to unit Pzm(2) of Wells et al. (1965b), is found in the north-eastern part of the Amadeus Basin. The formation consists mainly of cross-bedded fine to medium-grained white sandstone. It is laminated to medium-bedded, and generally contains scattered laminae of medium and coarse sand. Some ripple marks, mud cracks, and slumped cross-beds are present. The weathered sandstone is pale orange-brown, and a thin silicified crust protects the otherwise friable rock.

Lenses of conglomerate and conglomeratic sandstone occur near the base of the formation. Well-rounded pebbles and cobbles of white vein quartz, chert, and silicified sandstone are common. Massive beds with near-vertical and irregular worm tubes are common near the base of the formation and also near the top in some areas (e.g. Waterhouse Range).

The markings on the bedding planes in the upper part of the formation in the Waterhouse Range have been identified as arthropod tracks by A.A. Öpik (pers. comm.).

The Mereenie Sandstone is considered to be a shoreline deposit, partly marine and partly aeolian in origin. Diagnostic fossils have not been found, and the possible age ranges from Silurian to Upper Devonian.

SILURIAN-CARBONIFEROUS

On the eastern side of the Rodinga Sheet area, the Mereenie Sandstone is difficult to distinguish from the overlying sandstone of the Pertnjara Formation, and in places the two formations have been mapped as a single unit (Pz).

DEVONIAN-CARBONIFEROUS

Pertnjara Formation (Prichard & Quinlan, 1962)

The Pertnjara Formation crops out in the Jay Creek/Alice Springs area to the south of the MacDonnell Ranges, in the Brewer Plain, around the Waterhouse Range and Ooraminna Anticlines, in the Ross River and Camel Flat Synclines, along the northern margin of the James Ranges on the Rodinga Sheet area, a few miles north of Camel Flat bore, and in isolated localities in the south-western corner of the Rodinga Sheet area and the north-western corner of the Hale River Sheet area.

The Pertnjara Formation has been subdivided into three units. The basal siltstone member is present only in the south-western corner of the Rodinga Sheet area. It weathers recessively and is poorly exposed. Woolley (pers. comm.) has suggested that the red-brown micaceous silty claystone, at least 130 feet thick, beneath sandstone of the Pertnjara Formation in bores about 10 miles south-west of Alice Springs may belong to the basal siltstone unit. The middle sandstone unit is the most widespread, and forms prominent purple-brown and orange-brown strike ridges, mesas, and hills. The upper conglomerate unit crops out only in the Brewer Plain, the core of the Ross River Syncline, north of Camel Flat Bore, and in a few exposures in the north-western part of the Hale River Sheet area. The conglomerate generally forms low mounds and hills with a dendritic drainage pattern, but north of Camel Flat Bore it forms a prominent mesa.

The Pertnjara Formation rests on the older sediments with regional unconformity. Over most of the area, the formation rests disconformably on the Mereenie Sandstone, but in some areas it rests unconformably on the Larapinta Group, Pertaoorrta Group, and Pertatataka Formation. In places, the Mereenie Sandstone and Pertnjara Formation are apparently conformable (e.g. north of Camel Flat Bore). There is also an unconformity within the formation (for example, the boundary between the sandstone and conglomerate units in the Ross River Syncline). The Pertnjara Formation is unconformably and disconformably overlain by the Crown Point Formation, the De Souza Sandstone, and Tertiary beds.

The thickness of the Pertnjara Formation is probably extremely variable. The basal siltstone has an estimated maximum thickness of about 200 feet in the south-western part of the Rodinga Sheet area. The sandstone member has an estimated maximum thickness of 1500 feet around the Waterhouse Range and Ooraminna Anticlines, but is probably much thinner to the south and east. The conglomerate member is the most variable, and the thickness is estimated to range from a maximum of 4000 feet under Brewer Plain to about 600 feet in the

Ross River Syncline and about 400 feet near Bingie Bore. The incomplete measured sections in the Pertnjara Formation are shown in Plate 15. An incomplete sequence of 1154 feet was penetrated in Alice No. 1 well.

The basal siltstone member consists of green and red laminated micaceous siltstone and shale, with some pseudomorphs after halite on the bedding planes.

The sandstone member is a red-brown, yellow-brown, cream, or white kaolinitic micaceous cross-bedded fine to coarse-grained sandstone. It is slump-folded and moderately to poorly sorted; it contains pebbles and cobbles of chert, silicified sandstone, quartzite, and vein quartz. In places the sandstone member is similar to the Mereenie Sandstone, and they have been mapped as a single unit. But the Pertnjara sandstone can generally be distinguished by its red-brown or yellow-brown colour, poor sorting, coarser grainsize, and the presence of kaolin, mica, and scattered pebbles of chert.

The conglomerate member contains well rounded pebbles, cobbles, and boulders up to about 3 feet in diameter. The poorly sorted phenoclasts are contained in a matrix of grey-green calcareous micaceous fine to coarse-grained silty sandstone. The matrix is extremely friable and most of the outcrops consist of heaps of loose boulders. North of Camel Flat Bore the boulders are derived almost entirely from the Arumbera Sandstone and the Pertatataka Formation, but north-east of Bingie Bore on the Hale River Sheet area they consist mainly of carbonate rocks from the Pertaoorrta Group. South-east of Jay Creek Aboriginal Settlement and south of Alice Springs Airport, the base of the Pertnjara Formation contains fragments of Pertaoorrta Group sediments; these are overlain by sediments with phenoclasts derived from the Bitter Springs Formation and Heavitree Quartzite.

The Pertnjara Formation is considered to be a continental synorogenic facies deposited in front of the mountains formed during the Alice Springs Orogeny in the Devonian and possibly the Carboniferous Periods. The pulses of the orogeny controlled the type of sediment deposited and resulted in unconformities within the sequence. The basins of deposition were probably not all connected, and some of the isolated conglomeratic sequences may have been deposited in local structures. The sediments were presumably folded during the last phase of the orogeny.

Fossils have not been found in the Pertnjara Formation in the north-eastern part of the Amadeus Basin, but plates of the placoderm Bothriolepis have been identified by Joyce Gilbert-Tomlinson (1967), in a sandstone lens in the basal siltstone unit on the northern flank of the Mereenie Anticline; Hodgson (1967) has described a spore assemblage from about the same horizon in the same area. These fossils indicate a late Middle or early Upper Devonian age for the basal part of the Pertnjara Formation. The Pertnjara Formation is overlain disconformably or unconformably by the Lower Permian glacial sediments of the Crown Point Formation and is considered to be Middle Devonian to Carboniferous in age.

Finke Group
(Wells, Stewart, and Skwarko, 1966)

The Finke Group in the Finke Sheet area consists of the Polly Conglomerate, Langra Formation, Horseshoe Bend Shale, and Idracowra Sandstone. Only the Horseshoe Bend Shale crops out in the area described here, but the other formations have been tentatively identified in well sections. The Finke Group is probably partly equivalent to the Pertnjara Formation and is probably Devonian to Carboniferous in age. Although the Santo Sandstone is correlated with the Idracowra Sandstone it is not formally included in the Finke Group.

The initial 1200 feet of sediments penetrated in Mount Charlotte No. 1 well was interpreted by McTaggart et al. (1965) as part of the Pertnjara Formation (Table 3). It is probably best placed in the Finke Group and can be divided as follows:

Depth (feet)	
0-60	Cainozoic sands, possibly some Santo Sandstone.
60-520	Horseshoe Bend Shale - Shale, red, red-brown, tough, silty, slightly micaceous and calcareous with rare micaceous silt pellets and about 5 percent laminae of siltstone, grey-green, very micaceous (biotite) and slightly calcareous;
520-1050	Langra Formation - Sandstone, brown, grey, or tan, fine to medium thin-bedded, some coarse, friable, well rounded, frosted grains, poorly sorted, porous; siltstone, tough, chocolate; and shale, sandy, chocolate. The siltstone and shale have biotite on the bedding planes;
1050-1200	Unnamed shale, red, green, some purple, fine-textured.

In McDills No. 1 well, about 4100 feet of the Finke Group has been interpreted by Amerada Petroleum (1965) from 2987 to 7090 feet. However, plant microspores of Upper Carboniferous age occur in a core at 3647 feet (Evans, pers. comm.) and these suggest affinities with other Australian Permo-Carboniferous glacial sequences. The top of the Finke Group is therefore best placed at about 3800 feet in the well, which corresponds to the top of a red-brown shale sequence identified in the Horseshoe Bend Shale. This interpretation indicates that the Finke Group is about 3300 feet thick with the Idracowra Sandstone missing at the top (Table 3).

Polly Conglomerate (Wells, Stewart, & Skwarko, 1966)

The Polly Conglomerate is known only in the subsurface in McDills No. 1 well from 5800 to 7090 feet. Wells et al. (1966) measured a thickness of 80 feet at Horseshoe Bend in the Finke Sheet area where it rests unconformably on the Upper Proterozoic Winnall (?) Beds. In McDills No. 1 the formation is overlain by the Langra Formation and overlies the Mereenie Sandstone. It consists of red-brown, white, or light orange sandstone which is fine to very coarse-grained, subangular, and in places conglomeratic with quartzite and quartz pebbles, and is in part calcareous. The conglomerate is buff, red, and red-brown, with pebbles of red quartzite, quartz, chert, granite, and shale. The matrix is fine to coarse-grained, white to red, subangular, and calcareous. Both the sandstone and conglomerate contain interbeds of red fissile micaceous shale and siltstone.

Langra Formation (Wells, Stewart, & Skwarko, 1966)

The Langra Formation is present only in the subsurface. It was intersected in Mount Charlotte No. 1, McDills No. 1, and a water-bore 15 miles south-west of Maryvale homestead. In Mount Charlotte No. 1, the formation is 530 feet thick and lies conformably between the Horseshoe Bend Shale above and an unnamed shale unit below which is probably equivalent to the Polly Conglomerate. Wells et al. (1966) have estimated that the thickness of the Langra Formation at Horseshoe Bend is 500 feet.

In McDills No. 1 the interval 4070 to 5800 feet is identified with the Langra Formation (see Table 3). The interval consists mainly of sandstone with shale and silt interbeds, and is conglomeratic near the base. The sandstone is white, light grey, pink and red, very fine to coarse-grained, friable, and in places slightly calcareous and very pyritic. It contains clear red and orange quartz grains and some fragments of green shale, and is generally porous and in places cross-bedded. The interbeds of shale and siltstone are green and red to dark grey and black, and in places pyritic and glauconitic. Conglomerate occurs near the base of the formation; it is sandy and most of the pebbles consist of quartzite.

In the water-bore south-west of Maryvale homestead the Langra Formation consists of dark red-brown and pale greenish grey biotitic siltstone, minor pale grey to greenish grey very fine-grained calcareous sandstone with rare biotite flakes, and white fine-grained well-rounded and sorted quartz sandstone; some pebbles of grey and purple chert and calcareous nodules are also present.

In the Finke Sheet area the Langra Formation contains boulders of Stairway Sandstone (Wells et al., 1966). It is possibly equivalent to part of the Pertnjara Formation and is therefore considered to be Devonian or Carboniferous in age.

Horseshoe Bend Shale (Wells, Stewart, & Skwarko, 1966)

The Horseshoe Bend Shale crops out along the southern margin of the Rodinga Sheet area. It is poorly exposed in low flats covered by alluvium.

The Horseshoe Bend Shale rests conformably on the Langra Formation and is conformably overlain by the Santo Sandstone. Both boundaries may be gradational, but the contacts are poorly exposed.

No sections have been measured, but the formation is about 460 feet thick in Mount Charlotte No. 1, and is overlain by a few feet of sandstone which may be Santo Sandstone. In McDills No. 1 it is estimated to be 280 feet thick and is overlain by the Permian Crown Point Formation.

The formation is composed of red, brown, and green shale, and minor siltstone. The lutites are rich in biotite, and contain numerous pseudomorphs after halite, ripple marks, and mud-cracks; in places they are calcareous and gypsiferous.

No fossils have been found in the Horseshoe Bend Shale. It is probably equivalent to the siltstone unit of the Pertnjara Formation, and is considered to be Devonian or Carboniferous.

Santo Sandstone (new name)

The Santo Sandstone is here defined as the sequence of white cross-bedded sandstone and pebbly sandstone, which conformably overlies the Horseshoe Bend Shale in the Chambers Pillar area (Pl. 8, fig. 1). The type locality is 12 miles south-west of Maryvale homestead, where the formation is exposed in a group of mesas. It has an exposed thickness of about 200 feet, but the upper part of the formation has been eroded. The name is derived from Mount Santo, a mesa 5 miles south-west of Chambers Pillar.

The Santo Sandstone crops out in the south-west corner of the Rodinga Sheet area where it forms prominent mesas rising up to 200 feet above the level of the sand plain.

It consists predominantly of white poorly sorted sandstone and minor silty kaolinitic sandstone and conglomeratic sandstone with pebbles and cobbles, up to 6 inches in diameter, of vein quartz, metamorphic quartzite, chert, and silicified sandstone. The pebbles and cobbles are generally well rounded, but the detrital quartz in the matrix is generally poorly rounded.

The Santo Sandstone is friable, thin to thick-bedded, and cross-bedded; a few of the beds contain concentrations of heavy minerals. The silt is intergranular or forms fairly large lenses and pellets. The tops of the mesas and talus slopes are covered with pebbles and cobbles weathered from the sandstone.

No fossils have been found in the Santo Sandstone. In the north, the formation is probably equivalent in part to the Pertnjara Formation; to the south of the type area the relationship to other formations is uncertain, but it is probably partly or wholly equivalent to the Idracowra Sandstone (Wells et al., 1966). The formation is considered to be Upper Devonian or Carboniferous in age.

PERMIAN

Crown Point Formation (Wells, Stewart, & Skwarko, 1966)

The name 'Crown Point Series' (Ward, 1925) was revised to Crown Point Formation by Wells et al. (1966). The formation crops out only in the south-western part of the Hale River Sheet area, and generally forms low mounds or banks of loose pebbles, cobbles, and boulders, weathered from the rudites. The sequence is exposed in a small mesa at Day Pinnacle, and in two other mesas 10 miles to the north-east (localities H150 and H151). Low cliffs of sandstone are found 8 miles south-east of Day Pinnacle (H157), and 6 miles south-west of Pinnacle Hill.

The Crown Point Formation is probably disconformable with the underlying Pertnjara Formation to the north. The De Souza Sandstone rests disconformably on the Crown Point Formation at Day Pinnacle, and at locality H151. No section has been measured, but about 1200 feet of the formation was penetrated in Malcolms Bore (K. Rochow, pers. comm.), and 1400(?) feet in McDills No. 1 well. Three interpretations of the sequence penetrated in McDills No. 1 well are shown in Table 3. The Resident Geologist at Alice Springs believes that the De Souza Sandstone may be only 400 feet thick or even absent and that this sandstone interval is part of the Crown Point Formation. These conflicting opinions have not yet been resolved, and the thickness of the De Souza Sandstone given in the text of this Report and in Table 1 is the thickness given in the completion report on McDills No. 1. The fossil evidence indicates that the Idracowra Sandstone is absent from the top of the Finke Group (see p.51), and the thickness of 1400(?) feet for the Crown Point Formation is greater than that given in the completion report.

The Crown Point Formation consists of tillite, conglomerate, sandstone, siltstone, and claystone. Tillitic sediments were found at three localities. At locality H151, the red-brown to white siltstone is micaceous, non-bedded, irregularly jointed, and moderately cohesive. It contains poorly rounded and unsorted grains of sand, granules, pebbles, and cobbles of indurated sandstone, and some fragments of white claystone. Six miles south-west of Day Pinnacle, a similar red-brown siltstone, containing coarse sand grains and granules of silicified siltstone, is exposed at the base of a low cliff of De Souza Sandstone. At locality H157, the tillite consists of white sandy non-bedded siltstone containing poorly to well rounded soled pebbles, cobbles, and boulders of quartzite.

Conglomerate is exposed at three localities. It is poorly stratified and sorted, and interbedded with conglomeratic sandstone. The pebbles, cobbles, and boulders include quartzite, sandstone, chert, and reef quartz; they are poorly to well rounded, polished, faceted, and striated. Other structures include impact marks and cracks, angular gouged holes, and irregular re-entrant hollows. These features can also be seen in the weathered-out phenoclasts forming the pebble mounds. At localities H150 and H151, two small mesas are capped with conglomerate; it is massive and unsorted and contains phenoclasts up to 4 feet across. The conglomerate at Day Pinnacle is described below.

Sandstone occurs at several places. At locality H150, it is white, coarse-grained, poorly sorted, poorly rounded, very clayey, and contains irregular layers of pebbles. At localities H156 and H157, white kaolinitic sandstone is exposed at the base of several low cliffs; it is coarse to medium-grained, porous, steeply cross-laminated, and moderately friable. The sandstone is highly contorted at locality H157.

Siltstone is present at localities H156 and H157. It is non-bedded, moderately friable, and slightly flaky. (Locality H156 was examined for microfossils, but none were found.)

Claystone was found only at Day Pinnacle, where about 3 feet is exposed at the base. It is pinkish brown mottled with yellow, friable, and non-bedded. No sand grains are present.

The stratigraphical position of the sequence at Day Pinnacle is uncertain. The succession above the pink claystone comprises 10 feet of white coarse-grained friable kaolinitic and poorly thin-bedded sandstone. The contact with the underlying claystone is uneven, and the claystone is bleached yellow for about 2 inches below the contact. Overlying the sandstone is 5 feet of pale grey-brown clayey friable non-bedded and slightly micaceous siltstone. This is overlain by 12 feet of conglomerate and conglomeratic sandstone, with granules, pebbles, and small cobbles set in a coarse matrix of clayey sandstone. The top of the hill is composed of about 15 feet of yellow sandstone, which is poorly sorted, fairly clean, thinly cross-bedded, blocky, and with pebbles at the base. The contact with the underlying conglomerate is uneven, and the uppermost sandstone is regarded as the basal unit of the De Souza Sandstone, but the base of the De Souza Sandstone could be placed at the lower uneven surface above the claystone.

The Crown Point Formation sediments were probably transported by glaciers and deposited in a fluvial or marine-glacial environment. The presence of lutites suggests that less torrential periods existed from time to time.

The spores from Malcolms Bore (Balme, in Sprigg et al., 1960) in the southern part of the Hale River Sheet area, and from bores in the north-western part of the Finke Sheet area (Evans, 1964) indicate that the Crown Point Formation is Permian (Sakmarian?). Spores of Lower Permian and Upper Carboniferous age were also found in the Crown Point Formation in McDills No. 1 well (P.R. Evans, pers. comm.). The Lower Permian spores were found in core samples from 2387, 2908, and 3128 feet and Upper Carboniferous spores in a core sample from 3647 feet.

JURASSIC

De Souza Sandstone (Sullivan & Öpik, 1951).

The De Souza Sandstone crops out in the southern parts of the Illogwa Creek and Rodinga Sheet areas, and in widely separated parts of the Hale River Sheet area. It generally forms mesas up to 300 feet high, but the outcrops in the north-eastern part of the Hale River Sheet area are low dark-coloured ledges, probably composed of ferruginized sandstone, at the margins of clay pans.

The De Souza Sandstone rests disconformably on the Crown Point Formation in the Hale River Sheet area. In the Rodinga Sheet area, it rests disconformably on the Horseshoe Bend Shale, and a Palaeozoic sandstone (Pz) equivalent to the Mereenie Sandstone or Pertnjara Formation. The De Souza Sandstone is overlain by the Rumbalara Shale; in the Finke Sheet area the formations are unconformable (Wells et al., 1966). No section has been measured, but the formation is at least 300 feet thick in Malcolms Bore (K. Rochow, pers. comm.) and 920(?) feet in McDills No. 1, including about 800 feet of transition beds at the top.

In the Illogwa Creek Sheet area and the northern part of the Hale River Sheet area the De Souza Sandstone consists of interbedded white siltstone, mottled red and white kaolinitic sandstone, and fine ferruginous conglomerate. The cylindrical rod-like structures on the bedding planes in the conglomerate may be of organic origin. Six miles south-west of Day Pinnacle, in the south-western part of the Hale River Sheet area, the exposures consist of about 10 feet of medium-grained kaolinitic sandstone, which is slightly micaceous, poorly sorted, and poorly rounded; a few pebbles are present. One mile south-west of locality H151, the De Souza Sandstone is preserved as an incomplete capping on the top of a mesa of the Crown Point Formation; it consists of a few feet of dark brown ferruginous sandstone and pebbly sandstone, which is medium to coarse-grained, poorly rounded, and non-bedded. The ferruginous sandstone is exposed at several places south of localities H151 and west of locality H156.

In the southern part of the Rodinga Sheet area, the De Souza Sandstone generally consists of white or pale brown fine to coarse-grained and pebbly kaolinitic sandstone. Cross-bedding, slumps, and ripple marks are common. Lenses and thin interbeds of white claystone or siltstone are present, particularly towards the top. Conglomerate bands, boulders of silicified sandstone, up to 12 inches across, are also common. Edgewise conglomerate is present in places as a result of the break-up of thin lutite beds.

The succession in the south-east corner of the Rodinga Sheet area is well exposed in the large mesa 24 miles south-east of Desert Bore. The sequence from top to bottom is :

Thickness (feet)	
65	Sandstone, medium to coarse-grained and conglomerate with phenoclasts up to cobble size;
3	Claystone, white and yellow, non-bedded;
25	Sandstone, very coarse, kaolinitic, slightly slumped; contains lumps of claystone;
10	Sandstone, very coarse, kaolinitic, with abundant lumps of claystone and quartzose granules and pebbles;

Thickness (feet)	
5	Sandstone, yellow, micaceous, fine-grained, laminated;
1	Sandstone, dark brown, ferruginous, fine to coarse-grained; forms a prominent flat bench;
2	Claystone, dark brown, ferruginous;
1	Claystone, yellow;
40	Sandstone, cream to white, kaolinitic, micaceous, medium-grained;
20	Sandstone, white to pale yellow-brown, poorly sorted;
10	Sandstone, white, kaolinitic, friable;
3	Siltstone, white, micaceous, and claystone, pink;
100	Sandstone, white, kaolinitic, steeply cross-bedded, well sorted; and a few interbeds of white claystone.
285	Total thickness.

The only fossils found are indeterminate plants and trails. The De Souza Sandstone lies between Permian and Lower Cretaceous rocks and may be Jurassic.

CRETACEOUS

Rumbalara Shale (Sullivan & Öpik, 1951)

The Rumbalara Shale crops out in the south-east corner of the Rodinga Sheet area, in Allitra Tableland in the centre of the Hale River Sheet area, and forms the main part of the outcrops in the McDills Sheet area.

The Rumbalara Shale rests on the De Souza Sandstone in mesas 20 miles south-east of the Pillar Range. The contact appears to be conformable, but Wells et al. (1966) have shown that the two formations are unconformable in the Finke Sheet area. The Rumbalara Shale is overlain with an angular unconformity by the Etingambra Formation, which is probably Tertiary.

The maximum exposed thickness of the flat-lying Rumbalara Shale is about 200 feet. About 300 feet was penetrated in Malcolms Bore in the Hale River Sheet area, about 1300 feet in Peebles Bore, and over 450 feet in Birthday Bore, north of Andado homestead. An incomplete section of 1300(?) feet of the formation was penetrated in McDills No. 1.

The Rumbalara Shale consists predominantly of white thin-bedded shale, white claystone, minor siltstone, and interbeds of fine silty sandstone. The lutites are commonly kaolinitic, mostly bleached, and in places are ferruginized. The Rumbalara Shale is reported to be blue-grey below the weathering profile in bores.

A typical section (McD2) through the exposed part of the formation in the McDills Sheet area is as follows:

Thickness (feet)	
5	Grey billy, in large boulders. Originally a conglomeratic sandstone;
20	Siltstone, white with granular kaolin, slightly silicified in part;
1	Claystone, ferruginous, yellow-brown, ochreous;
2	Siltstone, kaolinitic, with coarse pods of kaolin;
10	Claystone, white, conchoidal fracture, non-bedded, some salt encrustation including halite.

In most places the Rumbalara Shale is covered by a thick capping of silcrete.

The top of the formation is generally deeply weathered. The sediments are deeply opalized with white and translucent chalcedony, and ferruginized and stained by iron oxides. The areas underlain by the deeply weathered Rumbalara Shale are covered by ferruginized claystone or pisolitic ironstone. Partly silicified yellow ochre is common in joints and as irregular bodies in the kaolinitic claystone and siltstone.

Interbedded kaolinite and claystone are the most common rock types. In places, the granular kaolinite contains pellets and laminae of siltstone. The claystone is unctuous, hackly, poorly thin-bedded, and in places contains intertonguing laminae of silt and clay. The subordinate siltstone is partly micaceous, and contains some worm tubes, cross-laminations, irregular patches of fine kaolinitic claystone, and yellow ochre. Some sections show interbedded breccia with angular clay fragments in a ferruginized granular kaolinitic matrix.

The Rumbalara Shale is a shallow-marine deposit. The pelecypods, porifera, and gastropods found by Sullivan & Öpik in the type area indicate a Lower Cretaceous age (see also Skwarko, 1966); this is supported by the microfossils from Birthday Bore near Andado (Terpstra & Evans, 1963).

TERTIARY

Sediments of probable Tertiary age are widespread in the north-eastern part of the Amadeus Basin. Only the Etingambra Formation has been defined, but a number of informal groupings have been erected on the basis of lithology, fossils, and their age relative to the silcrete (grey billy).

Etingambra Formation (new name)

The Etingambra Formation is here defined as the thin sequence of sandstone which overlies the Rumbalara Shale. It crops out in the centre of the southern half of the Hale River Sheet area, around Andado homestead, and on the McDills Sheet area. It forms the cappings of mesas which are up to 100 feet high.

The formation rests on weathered Rumbalara Shale. At Mount Etingambra, in the southern part of the McDills Sheet area, 50 miles south-east of Andado homestead, the contact is a low-angle unconformity; elsewhere the formations are disconformable. The top of the Etingambra Formation has been eroded and the unit generally averages about 15 feet thick. It is 30 feet thick at Mount Etingambra, and up to 40 feet thick in the northern part of the McDills Sheet area.

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The formation consists predominantly of sandstone, with subordinate siltstone and lenses of conglomerate. The sandstone is medium to coarse-grained, yellow-brown, poorly sorted, poorly rounded, poorly to non-bedded, and moderately friable. Interbedded with the sandstone are lenses, irregular beds, and pockets of fine conglomerate with poorly to moderately rounded phenoclasts. In a few localities (notably at Mount Etingambra), white to yellow-brown kaolinitic siltstone overlies the sandstone and conglomerate. The top of the exposure is capped with about 5 feet of grey pisolitic silcrete.

The Etingambra Formation is probably a fluviatile type of 'torrent gravel'. It is unconformable on the Lower Cretaceous Rumbalara Shale and is probably Tertiary in age. A somewhat similar formation overlies the equivalent of the Rumbalara Shale in the northern part of South Australia.

Pre-silcrete Tertiary Sediments

The pre-silcrete Tertiary sediments include claystone, siltstone, sandstone, and conglomerate. Isolated outcrops occur near the MacDonnell and Fergusson Ranges, in the ranges south-east of Ringwood homestead, near Phillipson Bore in the centre of Phillipson Pound, and near Gum Tree Creek to the south of the James Ranges. They are mostly subhorizontal and form mesas with a capping of silcrete. The siltstone is white, kaolinitic, friable, poorly bedded, and partly sandy. The sandstone is white, grey-brown, and yellow-brown, fine to coarse-grained, massive, poorly rounded, poorly sorted, friable, porous, and kaolinitic; the conglomerate is composed of well rounded pebbles and cobbles of vein quartz, black chert, and quartzite in a matrix of poorly sorted, coarse-grained sandstone.

The sediments intersected in water-bores in the Alice Springs Farm area, and in the Phillipson Pound about 10 miles north of Santa Teresa Mission, are probably of the same age. In the Alice Springs Farm area the sediments include carbonaceous claystone and siltstone and have yielded Tertiary pollens. P.R. Evans (pers. comm.) states that 'The Alice Springs microflora was obtained from ditch samples from the Alice Springs Farm area Bore WRB/ZG at depths of 929 to 959 feet, 997 to 1006 feet and 1015 to 1038 feet. Each sample contained abundant triporate pollens, including forms similar to Triorites harrisii Couper (which Cookson & Pike (1954) record from Australian Eocene-Pliocene deposits) in association with Dacrydiumites cf. D. florinii Cookson & Pike, which is known to range from Palaeocene to Pliocene in age (Cookson & Pike, 1953). Fairly common, but at present unidentifiable (?) aquatic micro-organisms, consisting of very thin psilate membranes fitting closely to inner and likewise thin sacs, occurred at 929 to 959 feet. The environmental significance of these assemblages is unknown. The lack of variety in the pollen assemblage as a whole is remarkable in view of other records of Australian Eocene-Pliocene floras which seem to always include at least a Nothofagus and Myrtaceidites content (e.g. Balme & Churchill, 1959; Evans & Hodgson, 1963.)'

Lloyd (1967) has suggested that the pre-silcrete Tertiary sediments may range from Eocene to Miocene in age.

Tertiary Silcrete ('grey billy')

Silcrete occurs in many scattered localities in the north-eastern part of the Amadeus Basin; silcrete cappings have been mapped in the MacDonnell and Fergusson Ranges, around the nose of the Ooraminna Anticline, and throughout the core of the Mount Burrell Anticlinorium. Extensive areas of silcrete also cap mesas of Santo Sandstone, De Souza Sandstone, Rumbalara Shale, and Etingambra Formation in the Rodinga, Hale River, and McDills Sheet areas.

The silcrete has formed over some sediments of Tertiary age and is overlain by late Tertiary and younger sediments.

The silcrete has a maximum known thickness of about 10 feet. In places it has a nodular appearance, and in others it contains structures which are similar to coarse pipe-rock. The 'pipes' vary from regularly spaced vertical types to irregular forms. Most of the silcrete occurs as subhorizontal or low-dipping sheets, but a similar rock-type forms vertical dyke-like bodies in the Pertnjara Formation and Mereenie Sandstone in some areas (e.g. on the northern flank of Ooraminna Anticline, and also about 5 miles west of Deep Well homestead).

The silcrete was probably formed by near-surface silicification during a prolonged period of weathering, and the vertically dipping 'dykes' were probably formed by the migration of silica along joints.

The silcrete forms a capping on sediments of possible Eocene to Miocene age and is overlain by sediments of probably Miocene age. It probably ranges from Eocene to Miocene in age.

Ferricrete (Laterite)

Ferruginized sediments occur at a few scattered localities (e.g. north of Ooraminna Anticline), but no true laterite profiles have been recorded. The ferruginization appears to have taken place before the deposition of the younger Tertiary sediments and may have been contemporaneous with the formation of the silcrete. A younger ferricrete has been recorded about 4 miles north-east of Wallaby Gap Dam.

Post-Silcrete Tertiary Sediments

The post-silcrete sediments have been subdivided into two units on the basis of lithology, but the field relationships in the central part of the Amadeus Basin (Ranford, Cook, & Wells, 1966), suggest that they are probably of the same age. The conglomerate contains phenoclasts derived from the older sediments (including the silcrete) and Precambrian basement. It is exposed in the banks of the major rivers (e.g. Hugh and Finke Rivers), and to the south of the James Ranges on the western side of the Rodinga Sheet area. The conglomerate forms low rounded hills and mounds; it is composed of rounded pebbles, cobbles, and boulders up to 2 feet in diameter set in a matrix of poorly sorted calcareous sandstone.

The other post-silcrete Tertiary sediments consist of interbedded limestone, sandstone, siltstone, and claystone which crop out at scattered localities. The sediments are generally subhorizontal and form mesas capped with fine chalcedonic limestone. The sediments west of Phillipson Pound, between Limestone Bore and Deep Well homestead, form an arcuate strike ridge with a low dip to the west and north-west, and the sediments 15 miles south-east of Todd River homestead are preserved in a shallow basin with an arcuate longer axis.

The lithology of the sediments varies, but the capping of grey-weathering chalcedonic limestone is characteristic. Much of the cryptocrystalline chalcedonic limestone is a type of caliche or kunkar formed in the soil profile on the younger Tertiary sediments. The sediments were deposited in small basins, which may have been partly joined by the major streams such as the Finke, Hugh, and Todd Rivers.

Gastropods are present in the post-silcrete Tertiary sediments at a number of localities, and ostracodes and vertebrate remains are also found west of Phillipson Pound. The gastropod occurrences have been described by McMichael (1967) and Lloyd (1967).

R.H. Tedford (pers. comm. in Lloyd, 1967), has suggested a later Miocene age for the vertebrate fauna near Deep Well, and Lloyd (1967) has suggested that the gastropods in the sediments may be of Miocene age and that the post-silcrete sediments may be Miocene or younger.

Similar Middle Tertiary sediments at Alcoota, about 80 miles north-east of Alice Springs, have been named the Waite Formation (Woodbourne, 1966). The formation rests on Precambrian basement and on the laterite profile developed on these rocks with an angular unconformity. The early sediments with gastropods and animal remains were lacustrine siltstone and minor limestone and are disconformably overlain by fluviatile sandstone and conglomerate. The fossil vertebrates are late Miocene or early Pliocene and the laterite here is considerably older. A chalcedonic limestone caprock on the sediments was probably formed by silicification of calcium carbonate formed in the soil profile.

It is unlikely that the widespread deposits formed a lithogenetic unit; they seem to occur as old fillings of present day river valleys.

QUATERNARY

Most of the Quaternary sediments were deposited under semiarid conditions which followed the subsidence of the Lake Eyre Basin in South Australia, and the dissection of the Tertiary weathered land surface (Mabbutt, 1962). Subsequently, the climate became more arid and the present internal drainage pattern was formed, followed by the development of the Simpson Desert dune system. Earlier alluvial deposits were incised in late Quaternary time, which indicates renewed stream erosion. Erosion has probably been less active recently.

Conglomerate and Scree

The slopes of the ridges (Fig. 2) are mantled with scree and boulders which are associated with colluvial and alluvial fans and aprons. In the south-eastern part of the Hale River Sheet area, blocks of De Souza Sandstone form the scree around the mesas. Rounded boulders of the Crown Point Formation form low hills in the neighbourhood of Day Pinnacle on the Hale River Sheet area. South of Limbla homestead, pebble gravel crops out along the banks of the Hale River. Similar deposits are found along the major creeks east and south-east of No. 6 Phillipson Bore and just north of Casey Bore in the Hale River Sheet area. The gravels are only a few feet thick and cap terraces up to 15 feet high.

Alluvium

Extensive deposits of alluvial sand, gravel, and clay occur along the larger streams, which have their headwaters in the MacDonnell and Fergusson Ranges (see Fig. 2).

Stable gently sloping plains of alluvium and outwash deposits occur in the middle of the Todd Plain and in the more restricted valleys extending from Giles Creek to the Hale River. The sediments are commonly calcareous.

Active flood plains containing patches of coarse sandy and minor loamy alluvium occur along the Todd, Finke, and Hale Rivers, the lower part of Giles Creek, and the upper part of Illogwa Creek. The plains are up to 2 miles wide. The alluvium is generally less than 40 feet thick, but deposits up to 150 feet are known in the Alice Springs Farm area. Minor sand-filled channels are present in the valleys in the ranges.

A few small claypans occur in the centre of basins of internal drainage in the Simpson Desert, particularly in the north-eastern corner of the Hale River Sheet area. A few drainage channels with minor marginal alluvial deposits converge on the flat pan surfaces of clay and fine sand. The claypans and drainage channels lie in the interdune swales and probably postdate the dunes.

Gypsum

Mounds of white earthy gypsum crop out near Gypsum Bore on the Rodinga Sheet area. The mounds are up to 3 feet high and are separated by alluvial flats.

Travertine

Travertine has been formed by the precipitation of limestone from groundwater. The deposits consist of grey or white vuggy concretionary masses. Apart from the rare thin veneers on gentle slopes in limestone areas, the travertine is largely restricted to the alluvium north of Mount Ooraminna and east of the Waterhouse Range.

Aeolian Sand

The extensive seif-type sand dunes of the Simpson Desert cover about half the area mapped (see Fig. 2). Most of the dunes are parallel and reticulate, and have been fixed by spinifex, but minor areas of mobile sand are known. The dunes average 50 feet high, and trend north-north-west. Their formation was apparently controlled by anticyclonic winter winds. The avalanche sides of dunes face east, and the interdune swales are flat and mainly sandy. At the margin of the desert the reticulated dunes are up to 40 feet high and tend to be formed of braided sand ridges or connected smaller dunes. Irregular short dunes occur near some of the larger streams, such as the Hale River.

Isolated areas of sand plain and low dunes with small alluvial flats are present near Numery homestead in the south-western part of the Illogwa Creek Sheet and on the Brewer Plain in the Alice Springs Sheet area.

To the west of Andado homestead and west of North Bore on the McDills Sheet area, the numerous closely spaced small claypans have a thin surface layer of pisolitic buckshot gravel.

STRUCTURE

Amadeus Basin

The Amadeus Basin, in its present form, contains Upper Proterozoic and Palaeozoic sediments, and is a basin of preservation rather than a basin of deposition. A tectonic interpretation of the north-eastern part of the basin is shown in Plate 16. The northern

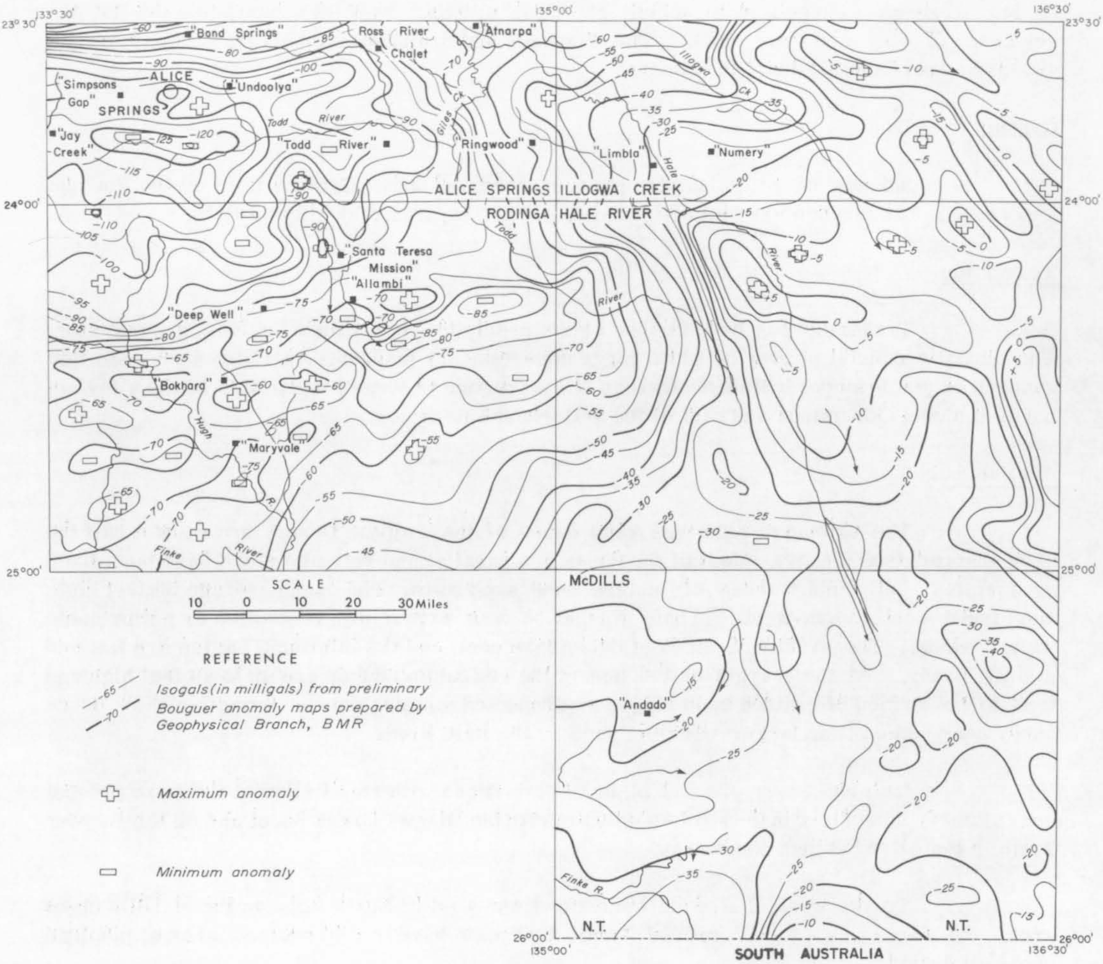


Fig. 8 Bouguer anomalies

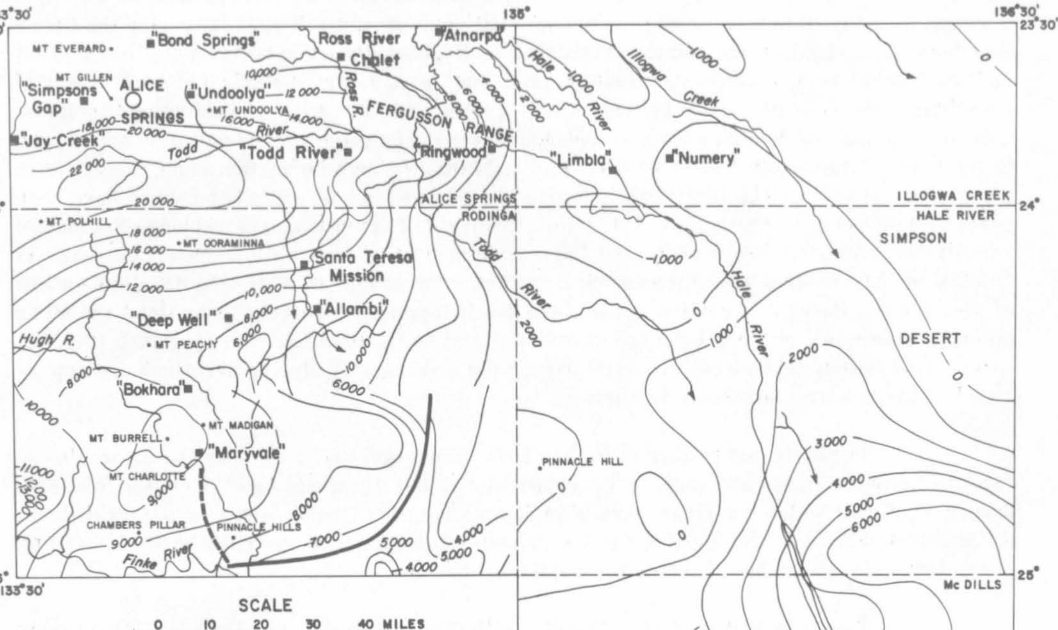


Fig. 9 Aeromagnetic basement contours

margin is defined by the exposed contact between the Proterozoic sediments and the metamorphic and igneous Precambrian Arunta Complex. The southern and eastern margins are concealed beneath the overlapping Permian and Mesozoic sediments of the Great Artesian Basin, but the general configuration of the basin is indicated by the regional Bouguer anomalies (Fig. 8) and the depth to basement contours based on the aeromagnetic survey (Fig. 9). About 20,000 feet of sediments have been preserved in the north-eastern part of the basin. The stratigraphic sections and seismic traverses to the south of Alice Springs indicate that the sediments thin to the south. The main structures in the basin were formed by the Alice Springs Orogeny (Forman, 1965; Forman, Milligan, & McCarthy, 1966) during the Upper Devonian to Carboniferous, and the axes of the folds generally trend between east-north-east and east-south-east. Other lineaments, trending in a south-westerly and south-easterly direction, are considered to be related to earlier fractures in the underlying basement. Two main styles of folding have been recognized: (i) The large recumbent folds and nappes in the Upper Proterozoic Heavitree Quartzite and Bitter Springs Formation along the northern margin of the basin. The Blatherskite Nappe is discussed below, and other nappes have been described by Forman, Milligan, & McCarthy (1966); (ii) Part of the Bitter Springs Formation and all the overlying Proterozoic and Palaeozoic sediments have been pushed southwards in front of the nappes over a décollement surface. The folds developed above the décollement are of two types: those nearest the nappes are gently dipping symmetrical synclines and steep complex anticlines, showing evidence of folded thrust faults and imbricate structure (Fig. 13) within their cores; farther away from the nappes the broad gently dipping synclines are separated by sharp narrow box-shaped anticlines.

The style and pattern of folding have been largely controlled by the evaporites in two and possibly three horizons. The evaporites in the Bitter Springs Formation formed a décollement over which the great mass of sediments has been pushed, and in many localities a décollement has also been developed in the Chandler Limestone, or near the base of the Giles Creek Dolomite where the Chandler Limestone is absent.

The presence of folded thrust faults (Fig. 14) in the complex anticlinal regions suggests that the early compression was absorbed by thrusting. There is no evidence of any time break between the thrusting and later folding, and they are considered to represent two stages of deformation in a single continuous orogenic episode.

Great Artesian Basin

The structure of the western part of the Great Artesian Basin cannot be determined from outcrop, but some of the main structural features have been outlined by regional gravity, aeromagnetic, and seismic surveys in the Hale River, McDills, and part of the Rodinga Sheet areas.

The gravity survey suggests that most of the Hale River and McDills Sheet areas are platform areas with thicker sediments present in parts of the McDills Sheet area. The thickest sediments are present in the central-western part of the Hale River Sheet area on the eastern margin of the Amadeus Basin.

The estimated depth to basement, based on the aeromagnetic surveys (Fig. 9), suggests that the Great Artesian Basin sediments gradually thicken to the east and south-east from the north-western corner of the Hale River Sheet area and from the western side of the McDills Sheet area. The sediments are estimated to be over 9000 feet thick about 40 miles east of Mount Etingambra. In the north-western part of the Hale River Sheet area, the estimated depths to basement do not agree with the thicknesses as measured in outcrop. In places, the depth to basement was estimated to be about 1000 feet below surface, but the measured thickness of the sediments is about 10,000 feet.

The aeromagnetic survey indicates that the outcropping basement rocks in the north-western part of the Hale River Sheet area do not continue as a ridge to the south-east. The aeromagnetic survey also indicates the presence of a similar ridge of Precambrian rocks trending south-east across the north-east corner of the Sheet area.

Campbell (1965) has suggested that the seismic survey in the Hale River flood-out area indicates that the sediments have a regional south-easterly dip and that they gradually increase in thickness to the south-east. A total thickness of 15,000 feet of sediments is suggested by the seismic reflection records in the southern part of the Hale River Sheet area.

In their report on a gravity survey of the Simpson Desert, Sprigg & Stackler (1962) have described the McDills area as part of a broad gravity minimum flanked by gravity highs around Andado to the east, and south of Mount Etingambra. The thickness of the sediments is estimated to be 10,000 to 20,000 feet, and may include Upper Proterozoic rocks. The more symmetrical linear gravity anomalies within the area of low Bouguer values are related to folds.

One of these folds, the McDills Anticline, which extends north-east from a point 15 miles north of Mount Etingambra, was outlined in detail by the Anacoora Bore gravity survey (Stackler, 1964 a, b).

The seismic results over the McDills Anticline (Yakunin, 1965) suggest that the Permian sediments thin over the crest of the structure. It is asymmetrical with dips of 15° to 20° to the north-north-west and 10° to 12° to the south. The structural closure probably occurs in the Permian rocks.

DESCRIPTIONS OF SELECTED STRUCTURES

Blatherskite Nappe (Fig. 10)

The term 'Blatherskite Nappe' was first used in a lecture by R.O. Brunnschweiler in 1957, and Banks (1964) referred to the Blatherskite Isocline. The structure is situated to the south of Alice Springs, and extends for 22 miles from Fenn Gap in the west to Emily Gap in the east. Between these localities, two strike ridges of Heavitree Quartzite crop out. Both quartzites dip and face south, except at Emily Gap, where the beds of the southern ridge have been overturned and dip north at 45°. On the northern side of each ridge, basement granite, gneiss, schist, and quartzite are exposed, and both ridges are succeeded to the south by the Bitter Springs Formation. These are the only formations involved in the nappe. Only the Gillen Member of the Bitter Springs Formation, including the type section (Fig. 6), is exposed in the nappe.

The Blatherskite Nappe has the following structural features :

1. A general arcuate form; the northern edge of the structure forms an embayment in the basement.

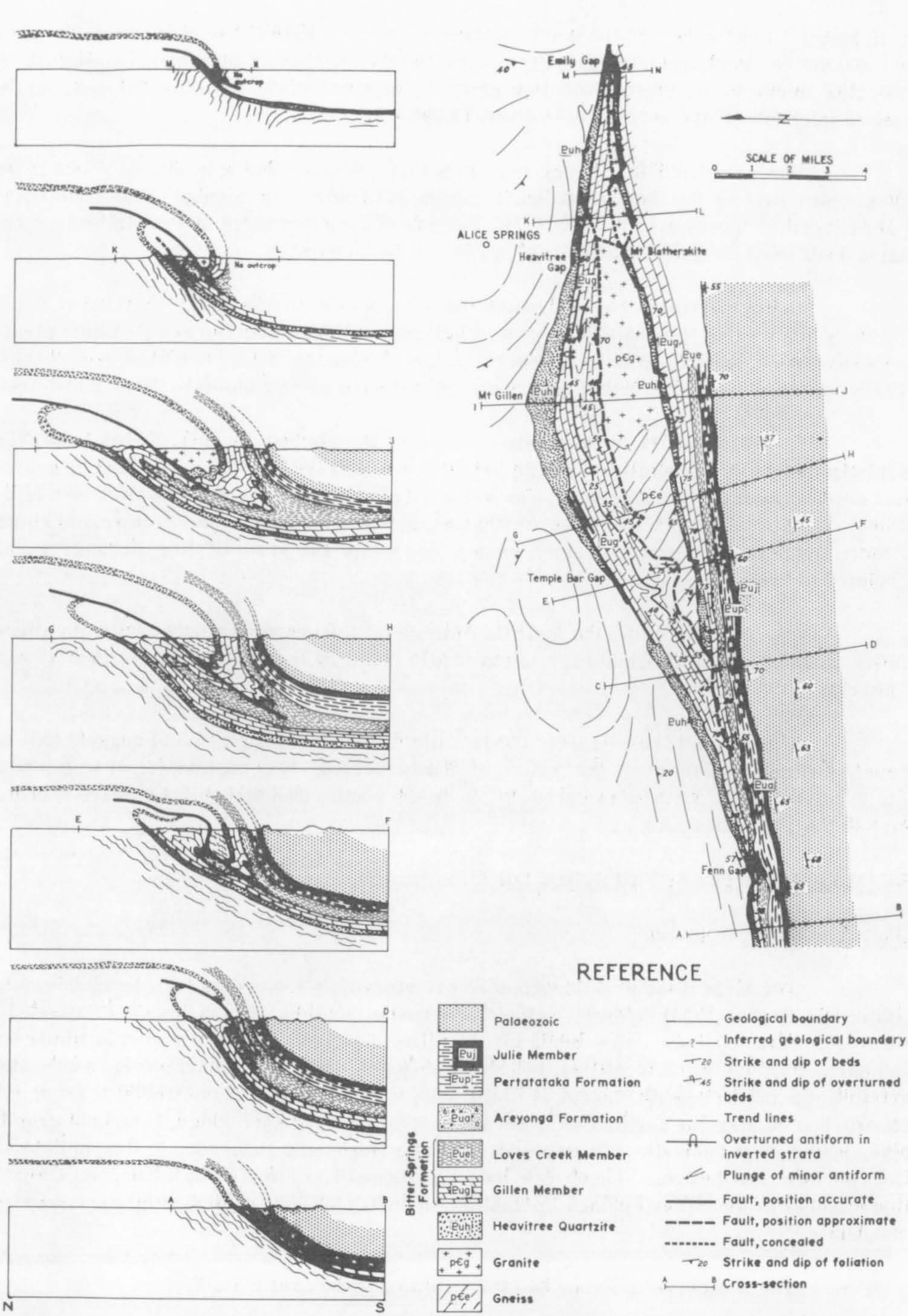


Fig. 10. Geological map and cross sections of the Blatherskite Nappe, Alice Springs Sheet area

2. In the area south of Mount Gillen, and 8 miles to the west, the Gillen Member sequence is repeated in the reverse stratigraphic order (Fig. 6). The sediments are faulted against basement, and water-bores have shown that the sediments dip south beneath the basement for some distance. The normal and repeated sequences both dip south at about 45°, but the facings in the repeated part are inverted. The contorted dolomite between the two sequences is regarded as the axis of an isoclinal fold.

3. The inverted part of the Gillen Member is separated from the basement rocks to the south by a major fault. A small ridge of mylonite, about 4 feet high, crops out at several places along the fault. The mylonite consists of broken angular grains of dolomite set in a matrix of crystalline quartz.

4. Minor antiforms and synforms are present in many places. Two of the larger antiforms on the south side of the axis of the fold are well exposed 1 1/2 miles east of Temple Bar Gap, just east of the White Gums Dairy; the facings on all the limbs are inverted.

5. A décollement antiform occurs south of Temple Bar Gap, with a strike fault at its base where the Heavitree Quartzite has been removed.

At least two interpretations of the structure are possible:

1. an isoclinal syncline and anticline; with the ridge of contorted dolomite forming the core of the syncline, the basement rocks forming the anticline, and the middle limb sheared out along the major fault.

2. an isoclinal antiform and synform in inverted rocks; with the ridge of dolomite forming the core of the antiform, the basement rocks forming the synform, and the middle limb sheared out.

Because of the inverted facings of the minor drag-folds on the south side of the axis of the isoclinal fold in the White Gums Dairy area, the second interpretation is regarded as the more likely. Several sections across the structure, based on this interpretation, are shown in Figure 3. Supporting evidence for the overthrust from the north is provided by a similar though smaller structure in the same ridge of Heavitree Quartzite 2 miles east of Jay Creek, where the antiform of quartzite can be observed from the east, and the dolomite of the Gillen Member is clearly visible in the core.

The structure seems to have been developed by overthrusting from the north. A recumbent anticline of Bitter Springs Formation, Heavitree Quartzite, and basement rocks (in the core) was pushed southwards over the Bitter Springs Formation, which was deformed into a recumbent syncline. As thrusting from the north continued, the middle limb of the fold was sheared out along the thrust plane of the Blatherskite Nappe. The whole nappe was then monoclinally folded, and the recumbent anticline assumed the shape of a synform, and the recumbent syncline the shape of an antiform. The later folding may also have been responsible for the bending of the nappe into the basement on its northern side. The whole area has been eroded, and only the lower half of the nappe has been preserved.

Hi Jinx Folded Thrust (Fig. 11)

The cross-section shown in Figure 11 is drawn across the folded thrust-zone in the north-eastern part of the Hale River Sheet area near Hi Jinx Bore. In the western

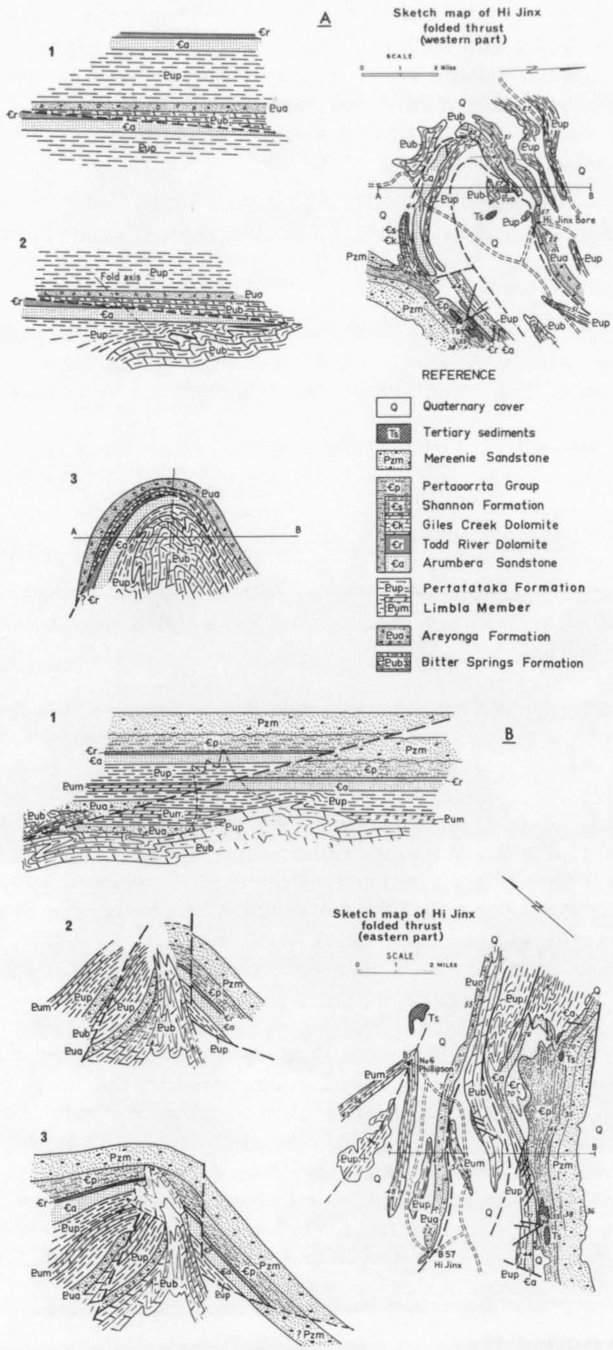


Fig. 11. Structural development of the Hi Jinx folded thrust in the north-western part of the Hale River Sheet area. A, western part; B, eastern part

section, the Bitter Springs Formation was thrust over the Arumbera Sandstone (or possibly the Todd River Dolomite). The small thickness of Pertatataka Formation exposed between the Bitter Springs Formation and Arumbera Sandstone in the core of the fold can be explained if it is assumed that the Bitter Springs Formation was forced into this position during the folding of the thrust, so that only the Julie Member is exposed. It is also possible that because the upper thrust plate has moved several miles laterally it has displaced a thick sequence of the Pertatataka Formation, containing several members, over a thinner part of the formation which contained few members. In this case, it would not be necessary to postulate injection of the Bitter Springs Formation into the Pertatataka Formation during folding. It is possible but unlikely that the Bitter Springs Formation was thrust under the Julie Member before folding.

Similarly, in the eastern cross-section, the lower part of the Pertatataka Formation is missing in the core of the fold. The absence of the lower part of the sequence can be explained by intrusion of the incompetent beds into the Pertatataka Formation during folding, or by the displacement of a part of the Pertatataka formation that contains many members and is relatively thick over a thinner part of the formation with few members, as outlined above. Alternatively, a normal fault may occur between the Bitter Springs Formation and Julie Member in the core of the fold; but normal faults are uncommon in that area, and the presence of a normal fault cannot be reconciled with the western cross-section.

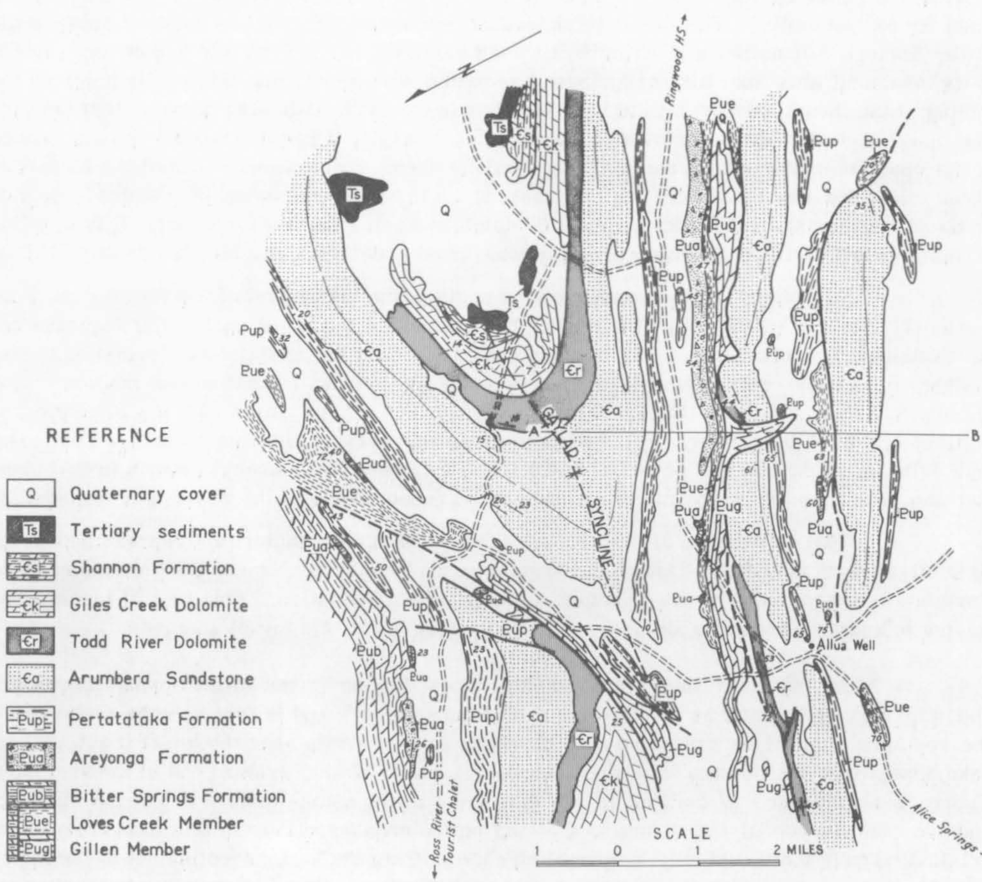
Two alternative cross-sections through the same structure are represented on the Hale River map (Pl. 20). These interpretations explain the absence of the lower part of the Pertatataka Formation by incompetent folding in the formation. This type of incompetent folding is known in the Julie Member near the eastern end of the thrust zone.

In the first interpretation, the thrust begins in the Bitter Springs Formation and migrates up section at the western end of the structure and is then seen to continue into the southern limb of the structure as a thrust or zone of strain near the top of the Arumbera Sandstone, thereby joining the exposed décollement at the eastern end of the structure. There is no evidence of faulting in the exposures at the south-western end of the structure and the continuation of the thrust is queried on the cross-section. In this interpretation an original warp in the thrust as it migrated up section from the lower décollement to the higher décollement is seen as being related to the anticlinal structure, one tending to localize the other as the structure developed.

In the second interpretation, which excludes the queried fault, the two thrusts or décollements are seen as separate entities converging in a compressed zone. The western folded thrust may be inferred to continue east-west as the thrust-front from its last point of definition towards the western boundary of the Sheet area. One of us (A.T.W.) considers that as the Julie Member is relatively undisturbed where the displacement by the thrust is greatest, it is more likely that most of the incompetent folding took place in the Bitter Springs Formation and that a piercement developed during folding.

Allua Well Thrust-Zone (Fig. 12)

In the Allua Well thrust-zone the rocks are cut by two thrusts acting on glideplanes in the Todd River Dolomite and the top of the Arumbera Sandstone. The small tongue of the Gillen Member in the northernmost thrust was injected during the folding after the thrust movements (Pl. 8, fig. 2). The Gillen Member was probably squeezed along a small fault-plane trending normal to the beds. The displacement of the Todd River Dolomite on either side of the intrusive body of Bitter Springs Formation suggests the presence of a small fault.



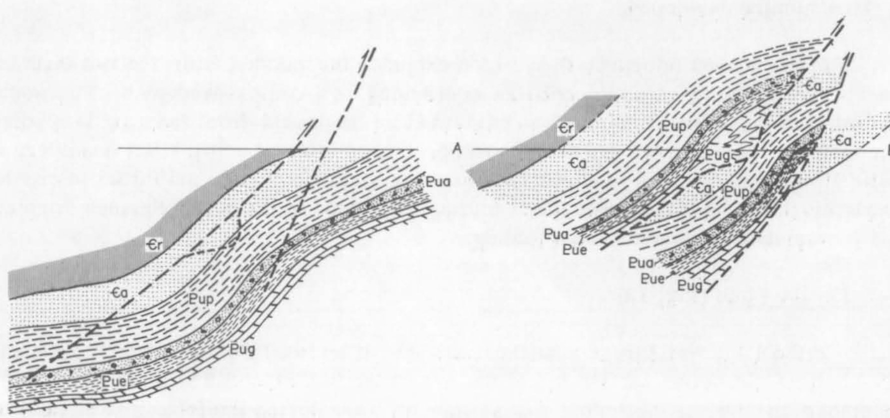


Fig. 12. Structural development of the southern flank of the Gaylad Syncline near Allua Well

The Allua Well thrust zone is part of the much larger Olympic/Ringwood folded thrust structure. The distribution of the eroded outcrops in the south-eastern part of the Alice Springs Sheet area is interpreted as a complex series of folded thrusts (see the most easterly cross-section in Pl. 18). The cross-section shows two thrust plates, lying one on top of the other, both of which have been folded into a large anticline. Both thrusts probably originally dipped to the north. In both, a décollement formed at the top of the Bitter Springs Formation and considerable movement of the younger formations was possible by gliding on the incompetent beds of the Bitter Springs Formation. The top of the Arumbera Sandstone provided a second gliding plane, as it probably also contains incompetent salt beds. It is obvious from the cross-sections that the sediments have been transported southwards for many miles.

Ringwood Dome

The Gillen Member has been domed around a mass of gypsum about a mile long and half a mile wide. The gypsum, which has been derived from the Gillen Member, is contorted and brecciated, and is capped by large masses of brecciated dolomite. It is not certain whether the gypsum dome is a diapir or whether it squeezed up as a result of thrusting.

Folded Thrust and Imbricate Structure 12 miles east of Allambi Homestead (Fig. 13)

Figure 13 includes a geological map and three cross-sections of a faulted anticline south of Phillipson Pound on the Rodinga Sheet area. The northern limb of the anticline has been repeated by a thrust along a bedding plane near the top of the Arumbera Sandstone. During later compression, the thrust has been folded and cut by a series of smaller thrusts in the anticlinal core to form an imbricate structure. The southern limb of the anticline shows a normal succession and was apparently unaffected below the main thrust.

This type of structure is thought to have formed by the 'peeling off' of large masses of sediment as they were pushed along the décollement in the Bitter Springs Formation. The stress was relieved by thrust-faulting in the section between the Bitter Springs Formation décollement and the evaporites above the Arumbera Sandstone where a second décollement developed. Judging by the number of thrusts which die out at this level, this favourable horizon must have been widespread in the north-eastern part of the Amadeus Basin.

Mount Burrell Anticline (Fig. 14)

The Mount Burrell Anticline lies north-west of Maryvale homestead in the Rodinga Sheet area. The structure is interpreted as part of the Pertatataka Formation which has been repeated by thrusting and then folded. The thrust cuts progressively younger rocks to the south, which suggests that the thrust plane dipped to the north before being folded. The anticline plunges to the west and has a slightly overturned northern limb and a gently dipping southern limb near its nose, but farther east it passes into a 'fan fold' with both limbs overturned.

There is no evidence of erosion between the thrusting and the later folding, and the structure is considered to have been formed during a single orogeny. The thrusts are thought to have originated in the décollement surface in the Bitter Springs Formation as a result of compression from the north during the Alice Springs Orogeny.

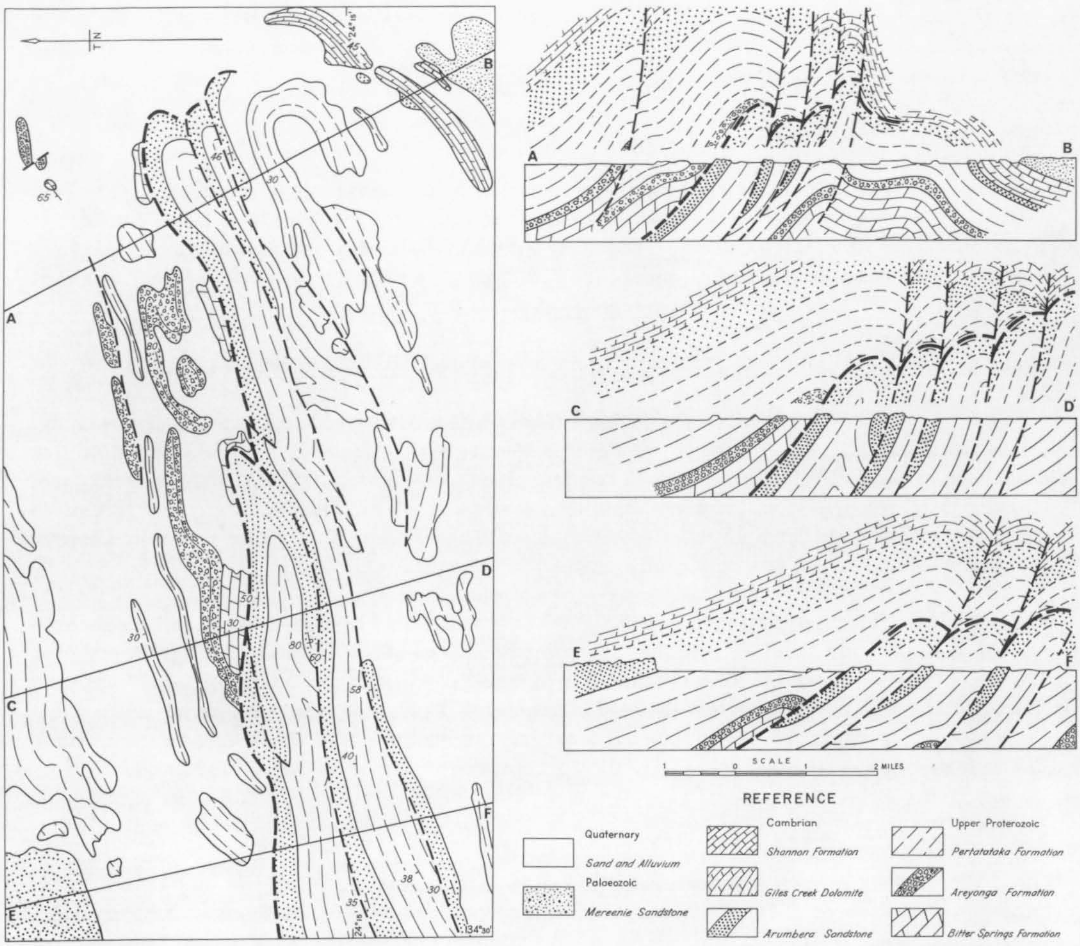


Fig. 13. Imbricate structure and folded thrusts, east of Allambi homestead

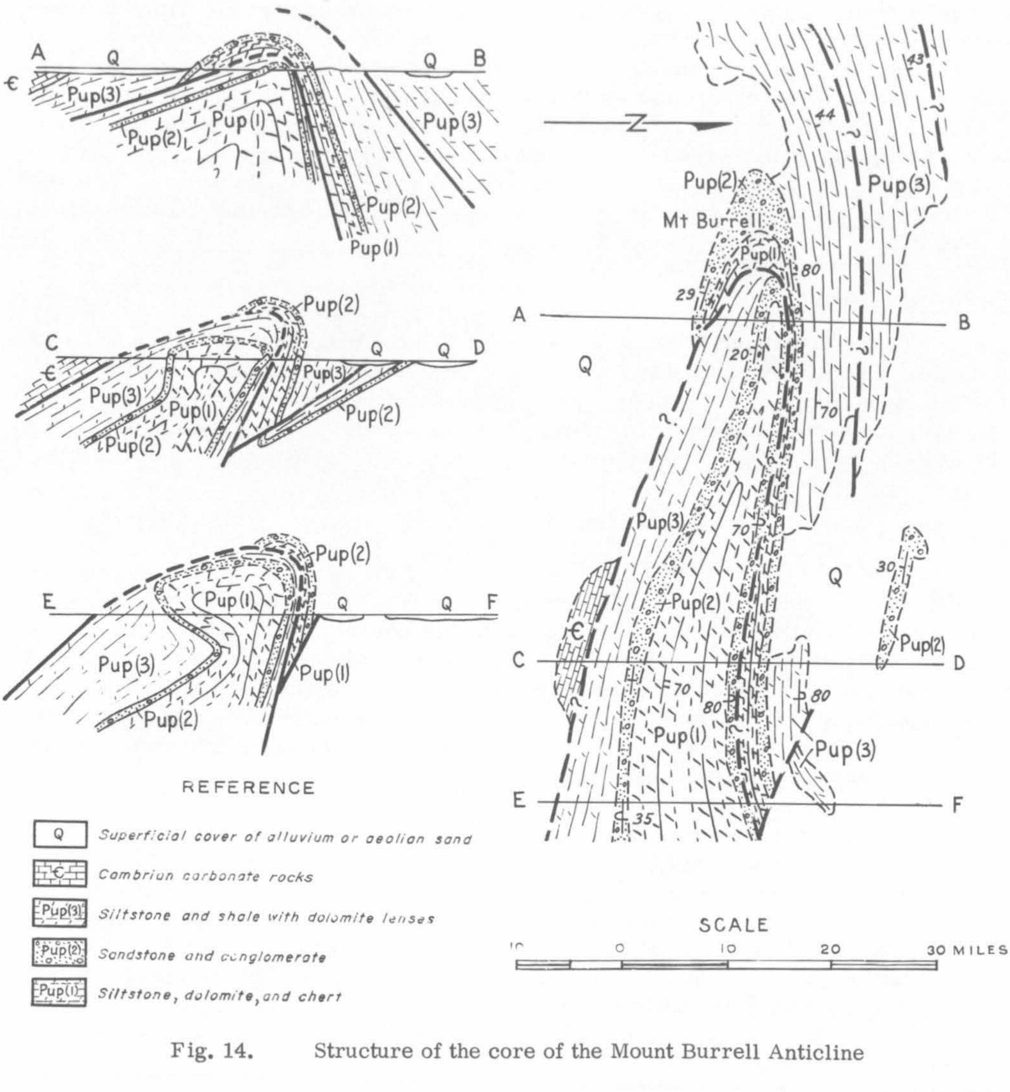


Fig. 14. Structure of the core of the Mount Burrell Anticline

Structure of the Williams Bore/Julie Dam Area

A map and two tentative cross-sections of the Williams Bore/Julie Dam area are shown in Figure 15, and a third cross-section, based on a slightly different interpretation, appears on the Alice Springs geological sheet (Pl. 18). The structure is an intensely faulted synclinorium which forms the western end of the Ross River Syncline. The sediments have been tightly folded, particularly towards the eastern end of the structure, and in the rhythmic dolomite-siltstone sequence of the Shannon Formation the folding became chaotic. The major faults are all thrusts, dipping to the north. As the Bitter Springs Formation is known to be very plastic and incompetent, the faults have been shown as listric surfaces (Suess, 1909, v. 4, p. 536), curving under and uniting to form a single décollement plane. A mass of sandstone, siltstone, and carbonate rock was compressed from the north and slid to the south; it was then buckled, and finally thrust and broken into slices along the listric surfaces. The most southerly fault has been shown in Figure 15 as a south-dipping thrust, which implies a later compressive phase from the south. It is equally possible that this fault is part of one of the major north-dipping thrusts which has been folded and later separated into two parts by erosion, as shown in the Alice Springs Sheet (Pl. 18).

Illogwa Creek Thrust

The large fault 7 miles north-east of Numery homestead on the Illogwa Creek Sheet area (Pl. 19) separates the Archaean basement from the Arumbera Sandstone. The structure is interpreted as a shallow north-dipping thrust in which the Arunta Complex has been thrust over the Arumbera Sandstone. The two outcrops of Bitter Springs Formation in basement to the north of the thrust are regarded as windows of the underlying thrust block.

GEOLOGICAL HISTORY

Sedimentation in the north-eastern part of the Amadeus Basin began with the rapid deposition of sand and gravel of the Heavitree Quartzite in a shallow sea. The presence of pyrite crystals in the upper part of the Heavitree Quartzite reflects a reduction in the rate of clastic sedimentation before the deposition of the carbonate rocks, shale, siltstone, and minor sandstone of the Bitter Springs Formation. During the deposition of the lower part of this formation (the Gillen Member) evaporites were deposited in lagoons and barred basins. Extensive algal carbonate rocks were formed in a less restricted marine environment during the deposition of the Loves Creek Member.

Epeirogenic movements, including possibly some slight folding, affected the area before deposition of the Areyonga Formation, which includes some probable glacial sediments. After the glacial period, the sea deepened, and the Pertatataka Formation was deposited conformably on the Areyonga Formation. The Pertatataka Formation consists predominantly of shale, with some fine sandstone; in the north-east, the basin deepened more quickly, and limestone and sandstone are common, and there is also an interval of conglomerate of probable glacial origin. The rate of deposition may have fallen off towards the end of the period during which the Julie Member was deposited, and the top of the member probably marks the end of Proterozoic sedimentation.

In the south-western part of the Amadeus Basin, the Petermann Ranges Orogeny (Forman, 1965) in late Upper Proterozoic or early Cambrian times resulted in a considerable reduction in the size of the basin, but in the north-east sedimentation was apparently uninterrupted, and the only effect of the orogenic episode was the change in lithology from shale

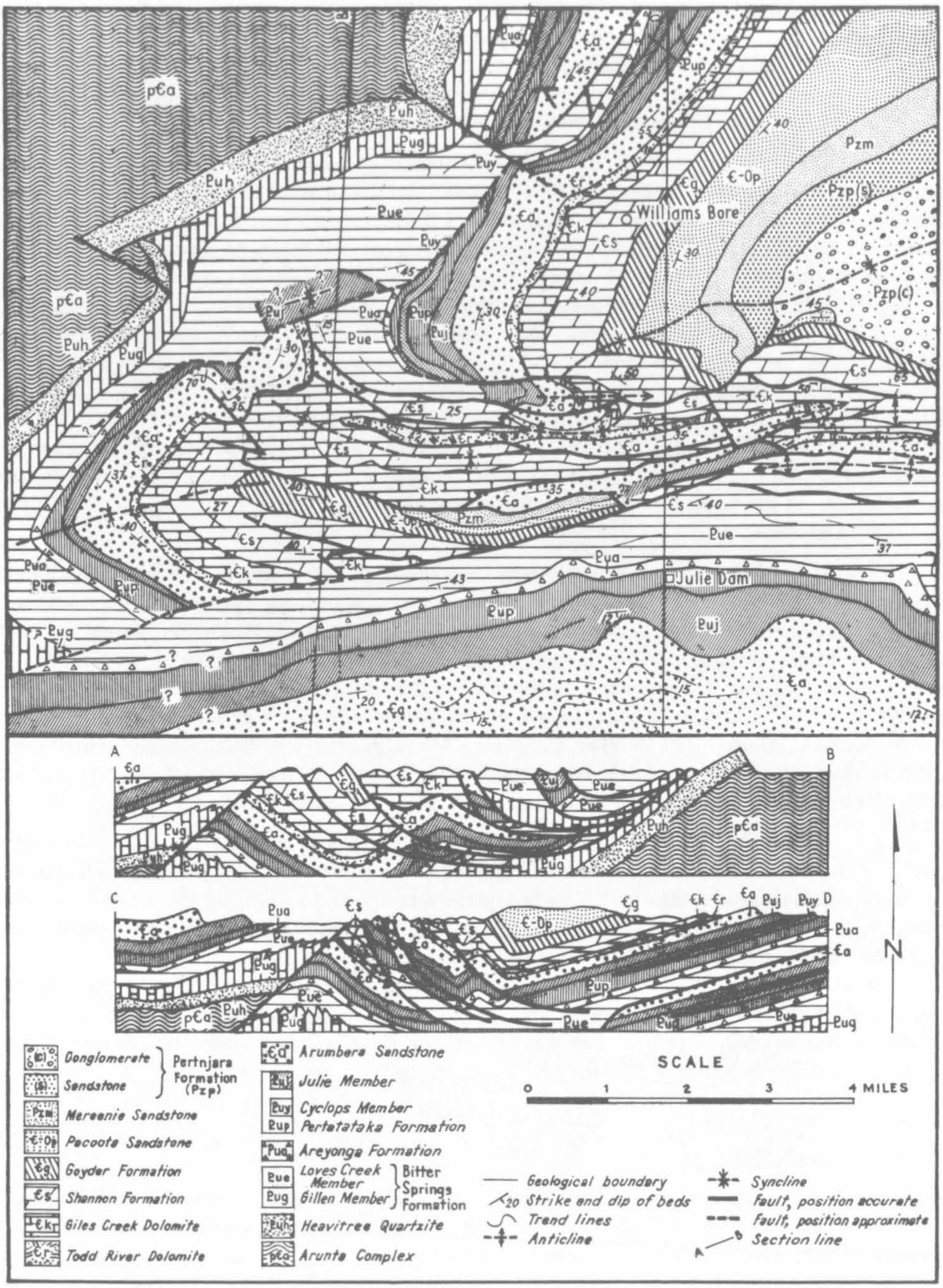


Fig. 15. Geological map and cross-sections of the Williams Bore/Julie Dam area

and carbonate rocks to the arkosic and glauconitic sandstone of the Arumbera Sandstone. The Arumbera Sandstone is a red-bed sequence which was probably deposited in an environment transitional between marine and non-marine. The influx of sediment ceased, and glauconitic carbonate rocks with archaeocyathans and other fossils were laid down in a restricted part of the basin. In the shallow seas which then became widespread, evaporites, limestone, and chert (the Chandler Limestone) were deposited.

The predominantly chemical sediments of the Giles Creek Dolomite were formed in the widespread lower Middle Cambrian sea. There followed a period of rhythmic sedimentation of oolitic limestone and siltstone of the Shannon Formation. In the early Upper Cambrian, the incoming detritus became coarser and the sea more turbulent; the sediments laid down comprise a mixture of sand and silt with some lenses of carbonate rock. During the late Upper Cambrian, marine fossiliferous sands were deposited over most of the northern half of the Amadeus Basin. The deposition of marine sandstone, shale, and limestone continued in two broad cycles with gradual onlap over the margin of the basin until at least the Upper Ordovician. Epeirogenic movements (possibly the first pulses of the Alice Springs Orogeny) occurred in the late Ordovician, causing uplift and erosion of the sediments above the Pacoota Sandstone. The Mereenie Sandstone, which was deposited in a transitional marine and aeolian environment, spread over most of the basin, unconformably overlapping the older units in the north-east. The formation was deposited between the lowermost Silurian and Middle Devonian.

As the Alice Springs Orogeny increased in intensity, synorogenic continental sandstone and conglomerate were deposited in local basins in front of the newly formed highlands. In the north, sandstone was followed by thick molasse conglomerate during the main paroxysms of the orogeny. The deposition of the Pertnjara Formation and its deformation mark the end of the development of the Amadeus sedimentary basin. The Carboniferous, Permian, and Mesozoic were times of long-continued erosion over the greater part of the basin. Lower Permian glacial and marine sediments transgressed the Amadeus Basin sediments in the south-east, and were followed by the Great Artesian Basin sediments of Jurassic and Lower Cretaceous age.

During the Tertiary, erosion was predominant, and the detritus collected in small basins and valleys. Erosion and weathering combined to form a peneplain covered by a thin layer of silcrete and laterite. The peneplain was uplifted and dissected around the Plio-Pleistocene; the drainage was internal, and a great chain of lakes was formed between the Musgrave and MacDonnell Ranges. As the climate became arid, the lakes dried up, and the area between the ranges was covered by a sheet of sand. Later, when the climate became less arid, the dunes were fixed by vegetation, and alluvium was brought down by rivers. A description of the various forms of the weathered land surface and a discussion of geomorphic history is included in Mabbutt (1965).

ECONOMIC GEOLOGY

Petroleum Prospects

Five exploratory wells (Ooraminna No. 1, Alice No. 1, Mount Charlotte No. 1, Waterhouse No. 1, and McDills No. 1) have been drilled in the north-eastern part of the Amadeus Basin. Oil bled from an impermeable zone between 6090 and 6165 feet in Cambrian limestone in Alice No. 1, which was drilled to a total depth of 7518 feet. The well was drilled in a zone which was thought from seismic evidence to be a biohermal development in the Cambrian limestone, but no reef development was found in the well. The well confirmed that the gravity minimum is due to the presence of salt.

The well demonstrated the presence of oil in the Cambrian sediments, and the presence of potential reservoir beds in the Arumbera Sandstone, Pacoota Sandstone, Mereenie Sandstone, and Pertnjara Formation.

Ooraminna No. 1, on the axis of the Ooraminna Anticline on the northern margin of the Rodinga Sheet area, was drilled to a total depth of 6107 feet and encountered gas (mainly methane) in the interval 3761 to 3906 feet. The gas was tested at the rate of 12,000 cubic feet per day. The well also produced important stratigraphic information: spilite was intersected at a depth of 4654 feet and halite at 5964 to 6107 feet in the Bitter Springs Formation.

Mount Charlotte No. 1 was drilled about 12 miles south-west of Maryvale homestead, on an anticline detected by seismic work. The well penetrated 1140 feet of the Finke Group, 350 feet of Stairway Sandstone, 785 feet of Jay Creek Limestone, 742 feet of Chandler Limestone, about 1600 feet of Pertatataka Formation, and terminated at 6934 feet in dolomite and black shale with halite and anhydrite (Bitter Springs Formation).

McDills No. 1 was drilled on a concealed anticline defined by seismic surveys in the Simpson Desert, where the surface outcrops have flat dips. The well penetrated 2700 feet of Mesozoic and Permian rocks, about 3300 feet of the Finke Group, 1160 feet of Mereenie Sandstone, 814 feet of an unnamed sandstone unit, and terminated at 10,515 feet after penetrating about 1500 feet of dolomite, part of which at least is Lower Cambrian. No hydrocarbons were found, and porosity was limited to the Mereenie Sandstone and younger beds.

In the north-eastern part of the Amadeus Basin, possible source rocks for hydrocarbons include the siltstone, shale, and limestone of the Horn Valley Siltstone, the Stairway Sandstone and Stokes Formation, the limestone and dolomite of the Pertaoorrta Group, and possibly the carbonate rocks of the Pertatataka and Bitter Springs Formations.

Possible reservoir rocks include the Mereenie Sandstone, Pacoota Sandstone, Stairway Sandstone, Arumbera Sandstone, and sandstone lenses in the Pertatataka Formation.

The shale and siltstone of the Areyonga Formation, Pertatataka Formation, Pertaoorrta Group, Horn Valley Siltstone, Stokes Formation, and Pertnjara Formation and its equivalents, could provide suitable cap-rocks. The Bitter Springs Formation, Chandler Limestone, and possibly the Pertatataka Formation are all thought to contain evaporites which would act as cap-rocks.

Anticlines which may provide structural traps for petroleum include the Waterhouse Range, the Ooraminna and Todd River Anticlines, and several smaller anticlines closed in the Giles Creek Dolomite in the Phillipson Pound area. Other structures may occur below the Pertnjara Formation and younger sediments in the Brewer Plain, Camel Flat Syncline, and part of the Simpson Desert.

In the Simpson Desert, geophysical surveys have indicated the possibility of up to 15,000 feet of Palaeozoic sediments beneath a thin cover of Mesozoic rocks. The seismic sections across parts of the McDills Sheet area show several buried anticlines with sediments thinning over the crests of the folds.

Phosphate

Phosphorites have been recorded in the Areyonga and Tempe Formations and in all the formations of the Larapinta Group. The phosphorites in the Areyonga Formation and Stairway Sandstone appear to have the most potential.

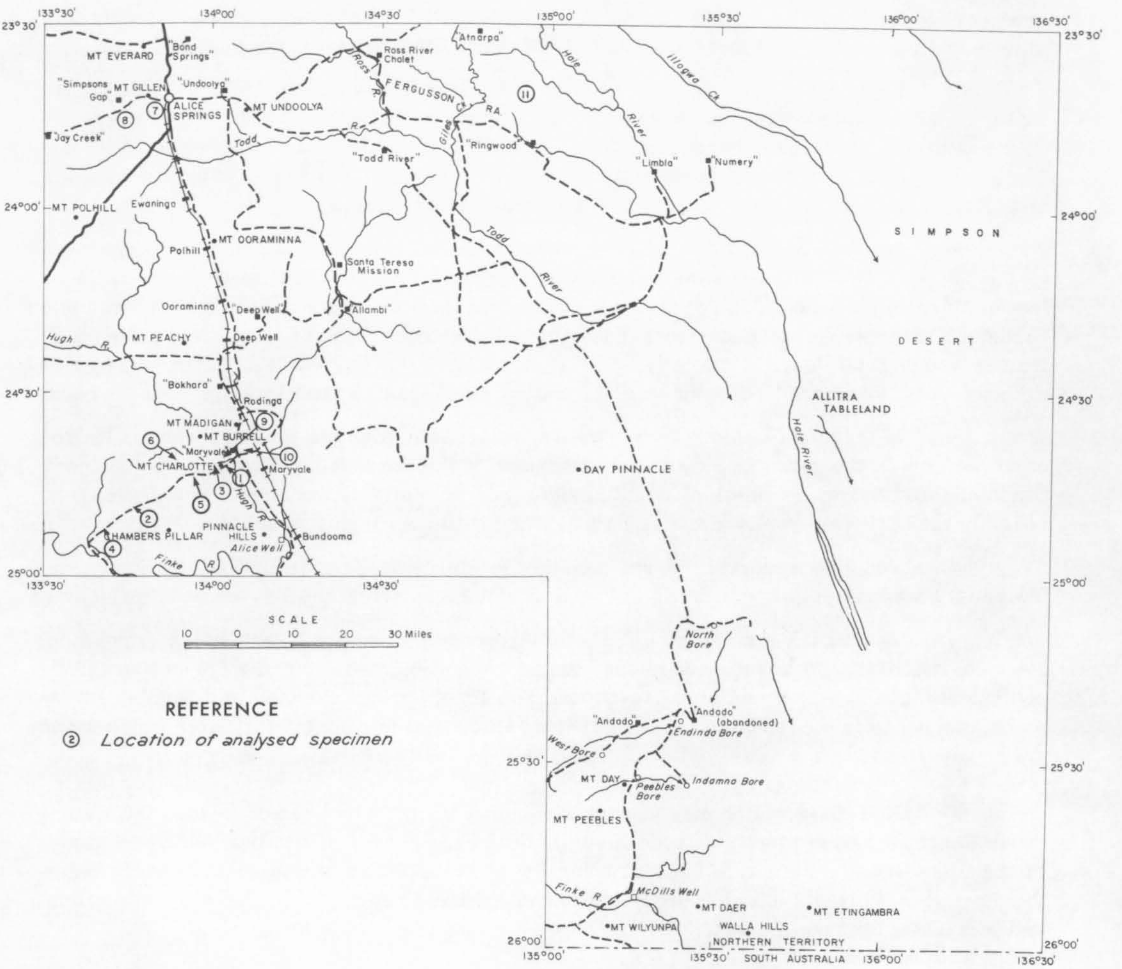


Fig. 16. Location of analysed specimens

TABLE 4: QUANTITATIVE PHOSPHATE ANALYSES

Age	Specimen No.	General Location	Locality No.	Lithology	P_2O_5 (%)
Areyonga Formation	AS 34	2 miles N.W. of Pulya-Pulya Dam	11	Dark grey phosphorite with chert laminae	30.0
	Rd 119	Mt Charlotte	1	Purple pelletal phosphate	13.7
	Rd 110	W. end of Mt Charlotte	2	Green pelletal phosphate	13.5
	Rd 118	Mt Charlotte	1	Purple pelletal phosphate	11.1
	Rd 153	Mt Charlotte	1	White pelletal phosphate	6.6
	Rd 153	Mt Charlotte	1	White pelletal phosphate	6.2
	Rd 100	Mt Charlotte	3	White pelletal phosphate	5.2
Stairway Sandstone	Rd 111	W. end of Mt Charlotte Ra.	4	Pelletal phosphate	5.1
	Rd 109	W. end of Mt Charlotte Ra.	4	Vuggy pelletal phosphate	3.0
	Rd 103B	Mt Charlotte	5	Coarse sandstone with pellets	2.8
	Rd 103D	Mt Charlotte	5	White pelletal phosphate	2.45
	Rd 103C	Mt Charlotte	5	Sandstone with phosphate laths	0.60
	Rd 158	7 miles N.W. of Mt Charlotte	6	Red silty sandstone	0.29
	Rd 117	Mt Charlotte	1	Red silty sandstone	0.17

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TABLE 4: (CONT'D)

Age	Specimen No.	General Location	Locality No.	Lithology	P_2O_5 (%)
	AS 115 c	4 miles S.S.W. of Alice Springs	7	Yellow-brown silic. sandstone	0.40
	AS 115 b	4 miles S.S.W. of Alice Springs	7	Yellow-brown silic. sandstone	0.35
Tertiary	AS 115 a	4 miles S.S.W. of Alice Springs	7	Yellow-brown silic. sandstone	0.25
	AS 119 b	9 miles W.S.W. of Alice Springs	8	Yellow silic. sandstone	0.25
	AS 119 a	9 miles W.S.W. of Alice Springs	8	Yellow silic. sandstone	0.20

Stairway Sandstone Phosphorites: The Stairway Sandstone phosphorites have been discussed by Cook (1966), Ranford, Cook, & Wells (1966), and Barrie (1965).

The phosphorites in the Rodinga Sheet area occur in pelletal form; they are distinguished from the phosphorites in many other parts of the basin by their white or more rarely purple colour. In the Mount Charlotte area, the pelletal phosphorite commonly occurs in depressions in non-phosphatic material, which suggests that it may have been deposited on an eroded surface or precipitated in depressions. In the Rodinga Sheet area, the phosphorite occurs mostly in the upper part of the Stairway Sandstone; farther west most of the phosphorite is found in the middle part of the formation.

The phosphate content of the analysed specimens (Table 4, Fig. 16), suggests that the phosphorites may be lower in grade than those in the Stairway Sandstone to the west. The results of spectrochemical analyses (Table 5, fig. 16) indicate that certain trace elements are more abundant in the phosphorites than in the normal sediments (e.g. 70 ppm of beryllium in a specimen of white pelletal phosphorite). A similar association with trace elements has been noted in many other phosphorite deposits (e.g. in the Phosphoria Formation of the U.S.A., see McKelvey, Swanson, & Sheldon, 1953).

Areyonga Formation Phosphorites: Thin beds of phosphorite are present in the basal part of the Areyonga Formation 8 miles north of Ringwood homestead. The formation, which overlies the Gillen Member of the Bitter Springs Formation, is only 30 to 140 feet thick and includes a basal conglomerate, or fossil regolith, generally about 4 feet thick; it contains subangular cobbles and boulders of dolomite, some chert, and in places rounded pebbles of quartzite 3 to 4 inches across (Pl. 3, fig. 1). The matrix is a coarse angular poorly sorted phosphatic quartz sandstone. The overlying sediments consist of thick-bedded grey tough poorly sorted angular siliceous arkose. The phosphorite beds occur in the upper part of the basal conglomerate; they range from 3 inches to 1 foot thick, and are lenticular. Individual

TABLE 5: SPECTROCHEMICAL ANALYSES STAIRWAY SANDSTONE

Specimen No.	Lithology	General Location	Locality No.	Ni	Co	Zn	Cu	V (ppm)	Mo	Sn	Pb	Be	P
Rd119	Purple pelletal phosphorite	Mt Charlotte	1	80	50	a	12	100	a	a	80	a	p
Rd120	Mottled red and green sandstone	1/2 mile N. of Charlotte Well	9	5	10	a	5	20	2	a	10	a	a
Rd139	Pelletal phos-phorite	W. end of Mt Charlotte Ra.	4	50	10	a	50	40	2	a	150	2	a
Rd153	White pelletal phosphorite	Mt Charlotte	1	12	12	a	150	5	a	a	20	70	p
Rd158	Red silty sand-stone	7 miles N.W. of Mt Charlotte	6	5-	a	a	2-	5	a	a	5	2	a
Rd167	Red and green sandstone	1 mile N.E. of Maryvale homestead	10	10	12	a	15	30	2	a	50	2	a

5: less than 5 ppm
a: not detected
p: present in percentage amounts

beds can be traced laterally for only 5 to 10 feet. The beds are composed of a dark brown to black phosphate mineral interlaced by thin stringers of dark grey chert; a few angular fragments of quartz are also present. The phosphorite weathers blue-grey and has a well-developed rhomboidal cleavage pattern. The matrix of the conglomerate contains from 1 to 7 percent P_2O_5 and the phosphorite beds up to 27 percent.

The phosphate mineral is apatite and occurs as weakly anisotropic fine layers and as isotropic cement in beds rich in clastic fragments (N.A. Trueman, AMDL, pers. comm.).

The origin of the phosphate is unknown. The Areyonga Formation was deposited on an irregular surface and it is possible that the phosphate was concentrated on the higher parts of the unconformity.

Water Supply

Water is obtained from natural waterholes, dams, bores, and wells. The wells are less than 100 feet deep; most of the bores are less than 400 feet deep, but several have been drilled to more than 1000 feet in the McDills Sheet area in the Great Artesian Basin. The water resources of the region have been discussed by Perry et al. (1962).

Surface Water: Waterholes are present at Emily Gap, 5 miles south-east of Alice Springs; 6 miles north of Mount Ooraminna; 8 miles north-west and 3 miles east of Idracowra homestead; and around the Allitra Tableland in the Hale River Sheet area. A spring (Limbla Spring) is situated in the Hale River at Florence Gap, in the Illogwa Creek Sheet area.

Numerous earth tanks are used to store surface water and water pumped from bores.

Groundwater: The folded and faulted sandstones and jointed limestones in the Amadeus Basin succession, the flat-lying sandstones in the Great Artesian Basin, and the Cainozoic sands and gravels form the main aquifers. The piezometric surface (Perry et al., 1962) has a regional gradient to the south-east. At Alice Springs it is about 2000 feet above sea level, and at Andado homestead about 400 feet above sea level. The surface is generally about 100 feet or more below ground level, and good supplies of water can generally be obtained wherever it is underlain at an economic depth by the Mereenie Sandstone, De Souza Sandstone, or Cainozoic sand and gravel. The sandstones of the Larapinta and Pertaoorrta Groups also provide good water in some areas. The joints in the carbonate rocks may contain available water, but the water in the Upper Proterozoic carbonate rocks is usually too saline for human consumption.

In the Alice Springs Sheet area, the Mereenie Sandstone provides good supplies around the Alice Springs aerodrome, in the Ewaninga/Wallaby Gap Dam/Junction Bore area, and on the flanks of the Waterhouse Range. Perched aquifers in the sands along the Todd River may yield good supplies. The deep exploratory wells which penetrated the Cambrian sediments have indicated the possibility of obtaining groundwater from the Pertaoorrta Group (mainly the Jay Creek Limestone and Hugh River Shale) immediately south of Alice Springs. A large supply of water may be available to supplement the Alice Springs town supply, but the Mereenie Sandstone is probably the best prospect.

In the Rodinga Sheet area, the northern margin of the James Range and the northern and southern margins of the Camel Flat Syncline are especially favourable for the siting of water-bores to reach the Mereenie Sandstone. The Tertiary sands at the eastern end of the Missionary Plain may also contain useful aquifers. The Quaternary sand and gravel are probably the most widely used aquifers in the Rodinga Sheet area, and can produce reasonable supplies at shallow depths. The sandstones of the Bitter Springs and Areyonga Formations, the Pertaoorrta and Larapinta Groups, and the Pertnjara Formation may contain water suitable for stock.

In the Illogwa Creek Sheet area, the Cainozoic gravels in the Hale River and Illogwa Creek probably offer the most promise. In the Hale River Sheet area, the gravels in the same rivers should yield water, and the De Souza Sandstone is a possible aquifer which could be intersected by deeper drilling. In the north-western part of the Hale River Sheet area bores sited on the flanks of the anticlines of Mereenie Sandstone might produce water. Bores in the south-eastern half of the area would probably intersect the De Souza Sandstone, but they would be relatively deep. The same considerations apply in the McDills Sheet area.

McDills No. 1 was completed as a water-well with a production of 2000 gallons per hour, probably from the De Souza Sandstone in the interval 1950 to 1955 feet. Artesian water was encountered in the Crown Point Formation at a depth of 2375 feet. The water contained 2423 ppm dissolved salts. Mount Charlotte No.1 was completed as a water-well in the interval 1540 to 1545 feet with potential production from the coarser-grained basal part of the Stairway Sandstone. Alice No. 1 was abandoned as a capped water-well with potential production from the Mereenie Sandstone. Ooraminna No. 1 was abandoned as a dry hole. A nearby water-bore was drilled to 156 feet in the Arumbera Sandstone and produced 10,000 gallons of water per day containing 1158 ppm total dissolved salts.

Other Mineral Deposits

Building stone is obtained for local use from the Mereenie Sandstone and Pertnjara Formation around Mount Ooraminna, and from the Jay Creek Limestone near the Santa Teresa Mission. Abundant supplies of limestone are available.

Lignite of Tertiary age has been found in the cuttings from Yam Junction Bore; the quality is poor, and the depth of cover uncertain.

Minor manganese and iron are present in the Goyder Formation, and iron is also present in the Tertiary laterite.

In places, the Bitter Springs Formation is covered by deposits of secondary iron oxides (e.g. 2 miles east-north-east of Mosquito Bore on the Alice Springs Sheet area). Individual deposits may contain a few thousand tons, but larger deposits may exist. The oxides show botryoidal and stalactitic structures.

The Rumbalara ochre mines lie a few miles to the south of the area mapped, and ochre of similar quality may occur at the base of the Rumbalara Shale in some of the mesas in the south-eastern corner of the Rodinga Sheet area. The Rumbalara ochre mine has been closed owing to the lack of demand.

Large deposits of gypsum are present in the dome 6 miles south-west of Ringwood homestead, and abundant gypsum and salt are present at depth in the Gillen Member of the Bitter Springs Formation. Detailed investigations may reveal the presence of deposits of potash, sulphur, and nitrates.

Minor copper mineralization was found in a diamond drillhole in the Bitter Springs Formation near Undoolya Gap (D. Woolley, pers. comm.). The drillhole terminated at 350 feet and penetrated 150 feet of weathered basic igneous rock within carbonate rocks of the Bitter Springs Formation. Minor copper sulphide mineralization was present in the carbonate rock near the hangingwall contact and in dark shale several feet beyond the footwall contact. Minor disseminated copper sulphide occurred at several places within the igneous rock. The hole was drilled by the Mines Branch, Northern Territory Administration. Minor copper mineralization has also been noted in the Bitter Springs Formation a few miles south-west of Limbla homestead and in the Areyonga Formation near Hi Jinx Bore.

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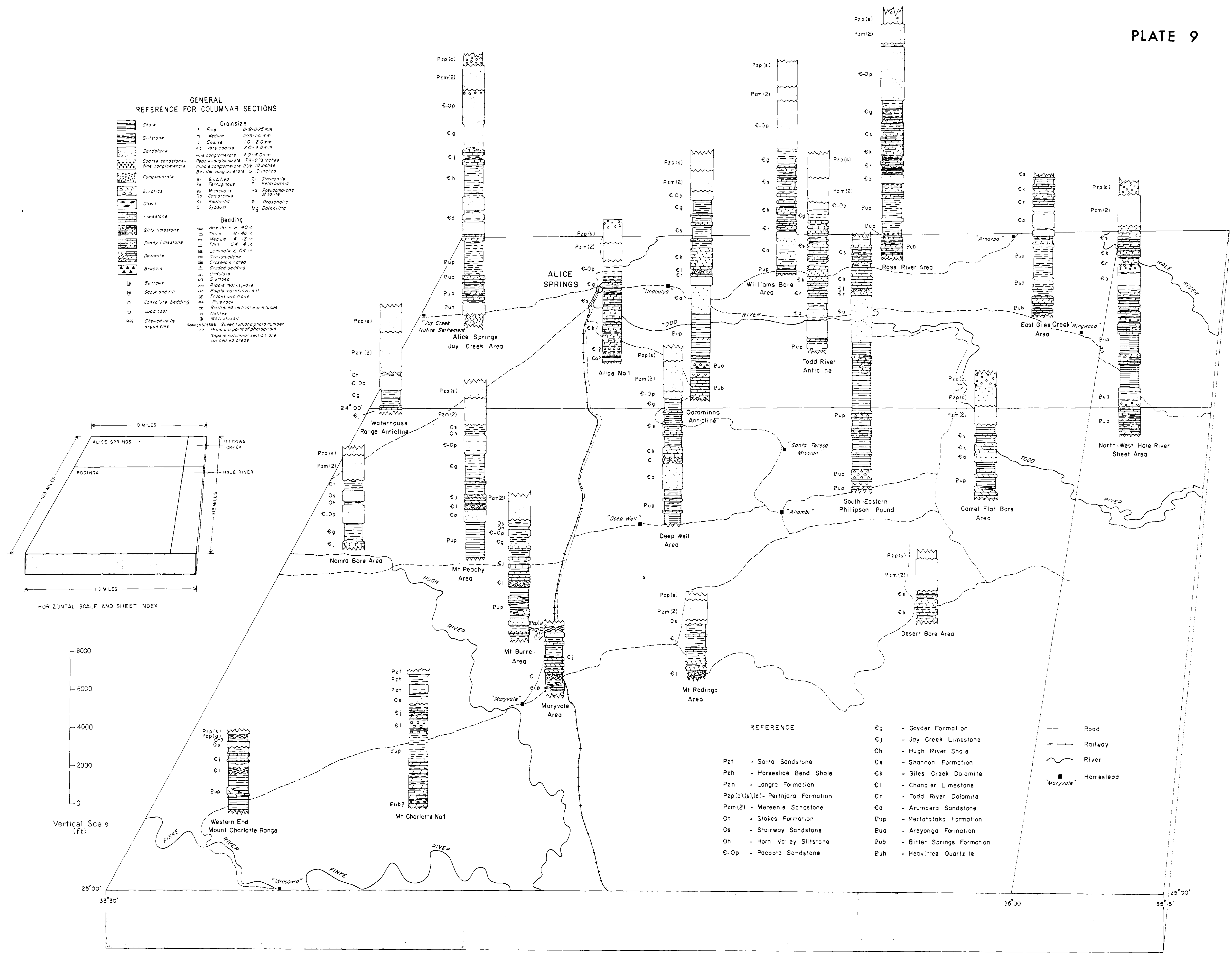
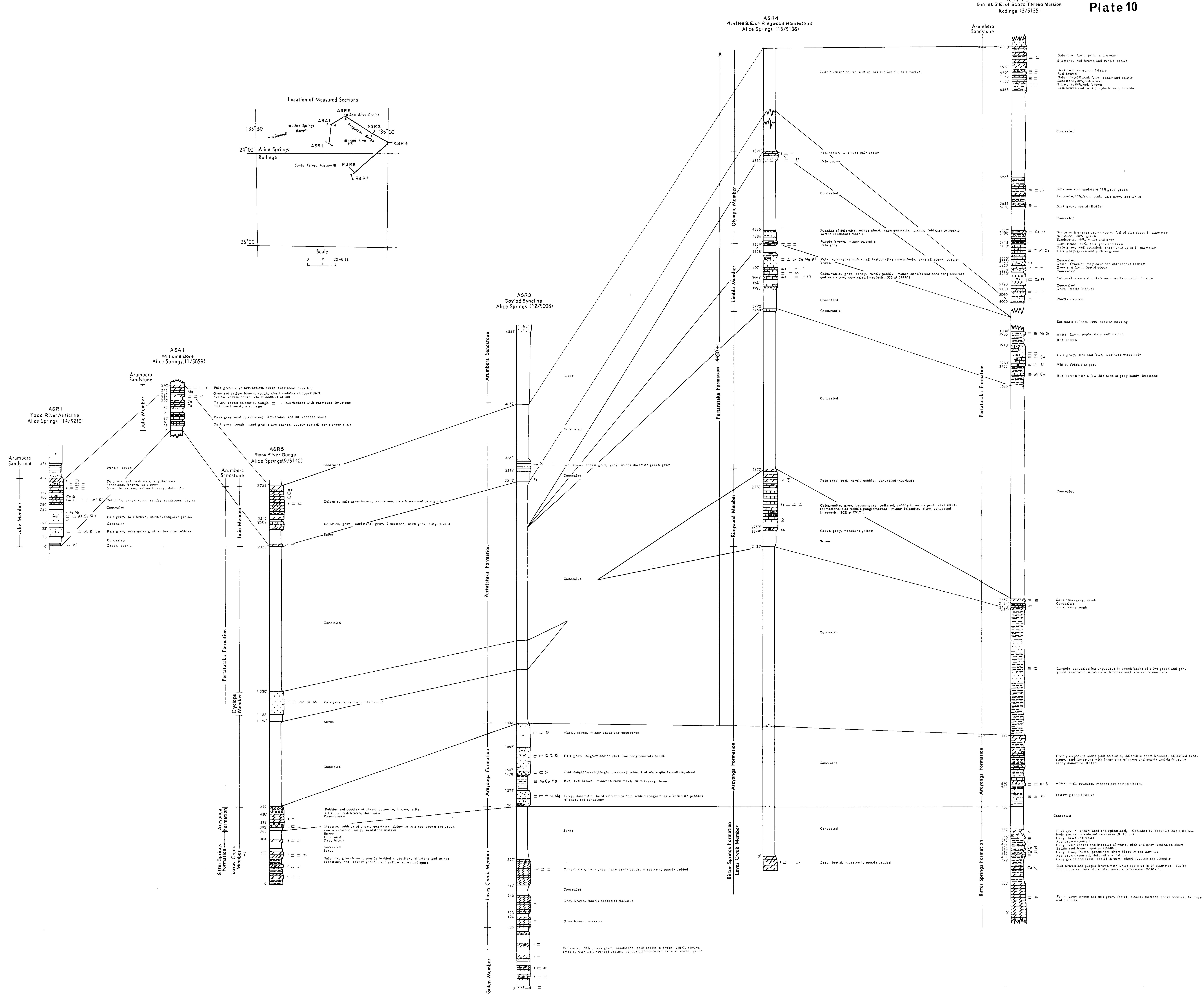
PLATE 9



GENERAL
REFERENCE FOR COLUMNAR SECTIONS
Shale
Siltstone
Sandstone
Coarse sandstone-fine conglomerate
Conglomerate
Erratics
Chert
Limestone
Silty limestone
Sandy limestone
Dolomite
Breccia
Burrows
Scour and fill
Convolute bedding
Load cast
Chewed up by organisms
Grainsize
f Fine 0·12-0·25 mm
m Medium 0·25-1·0 mm
c Coarse 1·0-2·0 mm
v.c Very coarse 2·0-4·0 mm
Fine conglomerate 4·0-16·0 mm
Pebble conglomerate 3/4-2 1/2 inches
Cobble conglomerate 2 1/2-10 inches
Boulder conglomerate > 10 inches
Si Silicified
Fe Ferruginous
Mi Micaceous
Ca Calcareous
Ki Kaolinitic
G Gypsum
Gl Glauconite
Fl Feldspathic
Ha Pseudomorphs of halite
P Phosphatic
Mg Dolomitic
Bedding
Very thick > 40 in
Thick 12-40 in
Medium 4-12 in
Thin 0·4-4 in
Laminate < 0·4 in
Cross-bedded
Cross-laminated
Graded bedding
Undulate
Slumped
Ripple marks, wave
Ripple marks, current
Tracks and trails
Pipe rock
Scattered vertical worm tubes
Oolites
Macrofossil
Rodinga 6/5556 Sheet, run, and photo number
PP Principal point of photograph
Gaps in columnar section are concealed areas
10 MILES
ALICE SPRINGS
ILLOGWA CREEK
RODINGA
HALE RIVER
103 MILES
HORIZONTAL SCALE AND SHEET INDEX
8000
6000
4000
2000
0
Vertical Scale (ft)
ALICE SPRINGS
Alice Springs Jay Creek Area
"Jay Creek Native Settlement"
Alice No 1
Waterhouse Range Anticline
Nomra Bore Area
Mt Peachy Area
Mt Burrell Area
Maryvale Area
"Maryvale"
Western End Mount Charlotte Range
Mt Charlotte No 1
Oorominna Anticline
Deep Well Area
"Deep Well"
"Undoolya"
"Allambi"
"Santa Teresa Mission"
Williams Bore Area
Todd River Anticline
Ross River Area
South-Eastern Phillipson Pound
East Giles Creek Area
"Ringwood"
"Arltunga"
Camel Flat Bore Area
North-West Hale River Sheet Area
Mt Rodinga Area
Desert Bore Area
"Idracowra"
TODD RIVER
HALE RIVER
HUGH RIVER
FINKE RIVER
24°00'
25°00'
133°30'
135°00'
135°15'
REFERENCE
Pzt - Santo Sandstone
Pzh - Horseshoe Bend Shale
Pzn - Langra Formation
Pzp(a),(s),(c) - Pertnjara Formation
Pzm(2) - Mereenie Sandstone
Ot - Stokes Formation
Os - Stairway Sandstone
Oh - Horn Valley Siltstone
€-Op - Pacoota Sandstone
€g - Goyder Formation
€j - Jay Creek Limestone
€h - Hugh River Shale
€s - Shannon Formation
€k - Giles Creek Dolomite
€l - Chandler Limestone
€r - Todd River Dolomite
€a - Arumbera Sandstone
Pup - Pertatataka Formation
Pua - Areyonga Formation
Pub - Bitter Springs Formation
Puh - Heavitree Quartzite
Road
Railway
River
Homestead

Plate 10



Location of Measured Sections
Alice Springs
Rodinga
Scale
ASR1
Todd River Anticline
Alice Springs (14/5210)
ASA1
Williams Bore
Alice Springs (11/5059)
ASR5
Ross River Gorge
Alice Springs (9/5140)
ASR3
Gaylad Syncline
Alice Springs (12/5008)
ASR4
4 miles S.E. of Ringwood Homestead
Alice Springs (13/5136)
RdR7 & 8
5 miles S.E. of Santa Teresa Mission
Rodinga (3/5135)
Arumbera Sandstone
Julie Member
Pertatataka Formation
Cyclops Member
Areyonga Formation
Bitter Springs Formation
Loves Creek Member
Gillen Member
Olympic Member
Lambia Member
Ringwood Member
Concealed
Scree

Plate 11

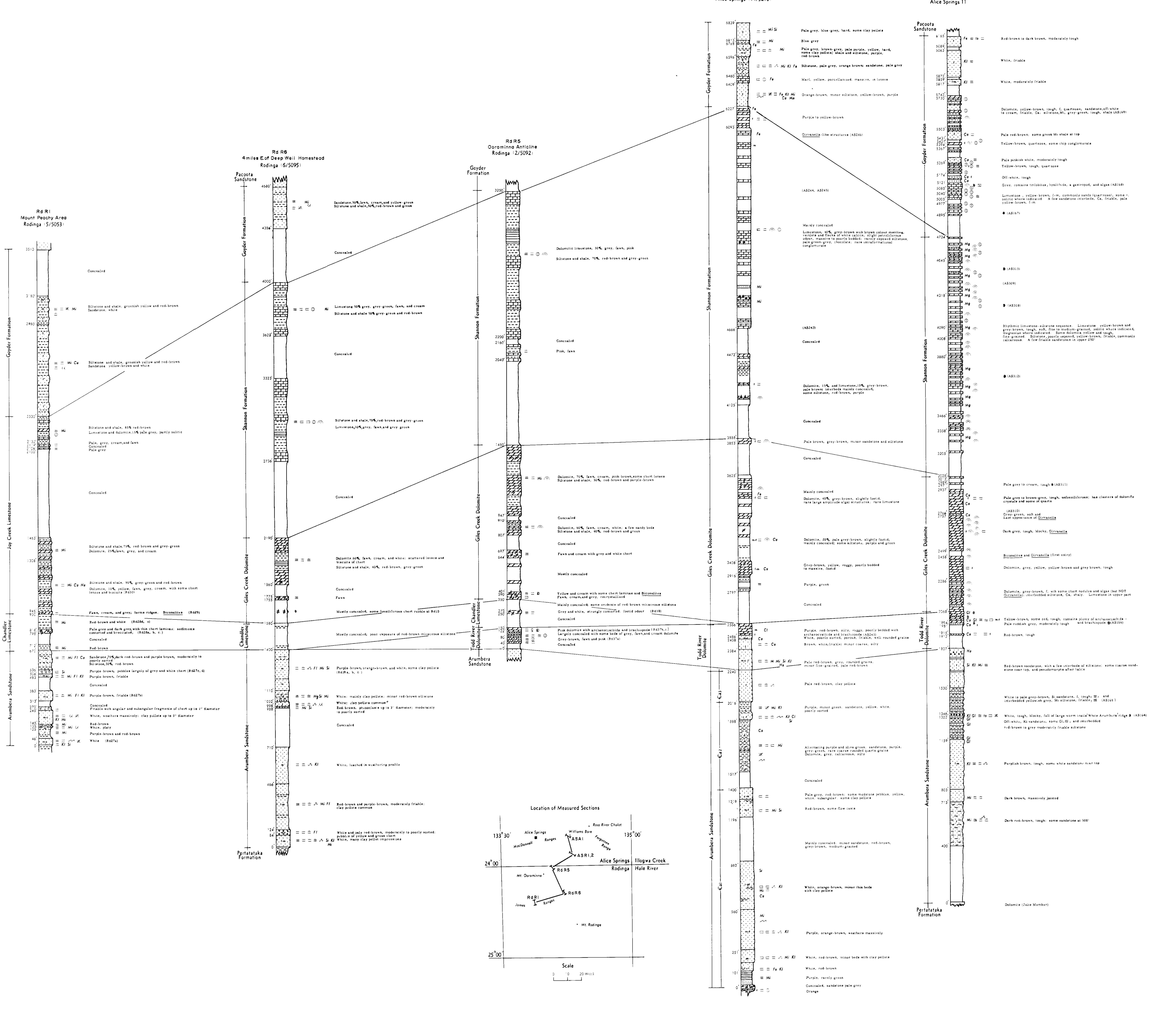
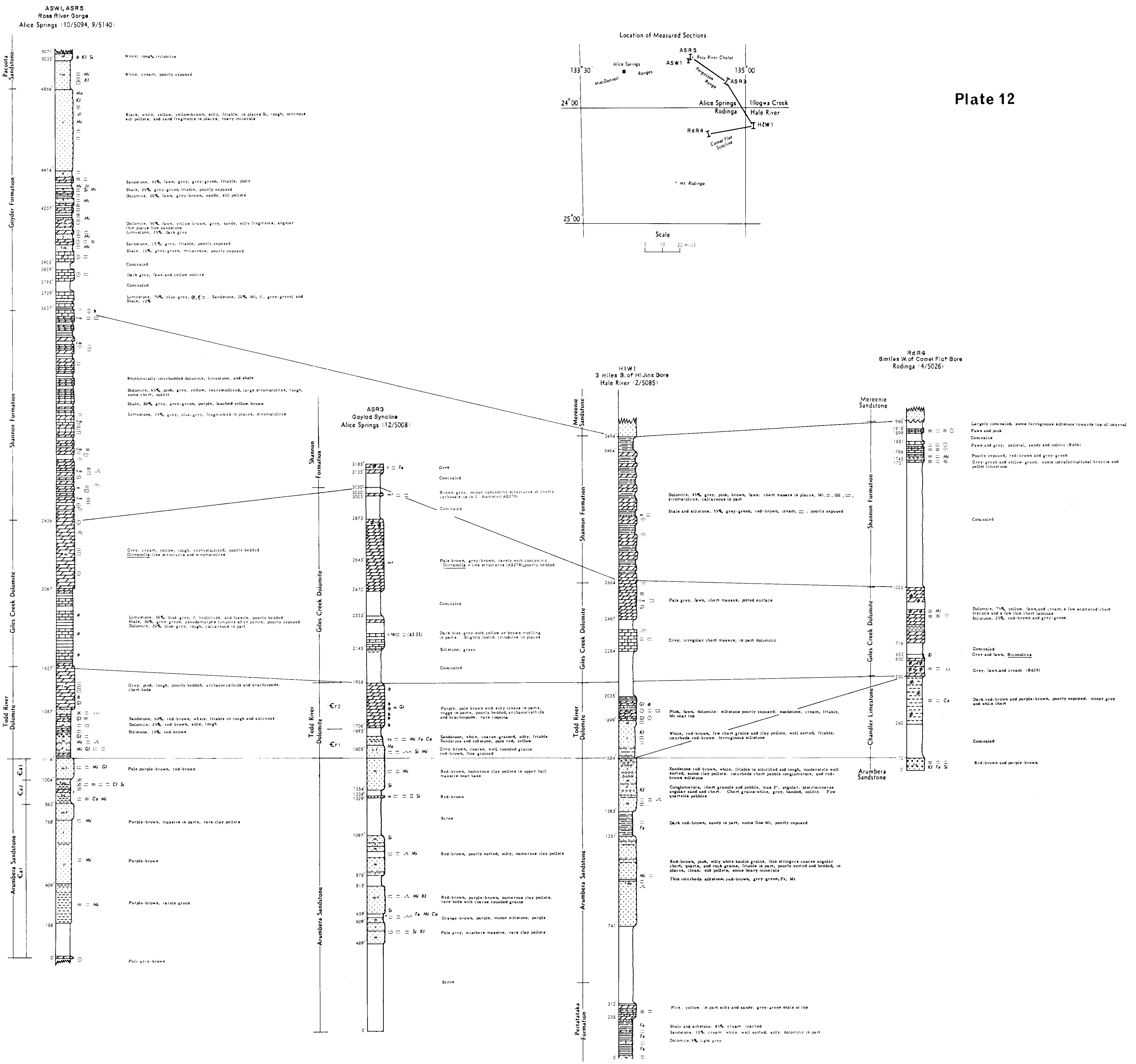
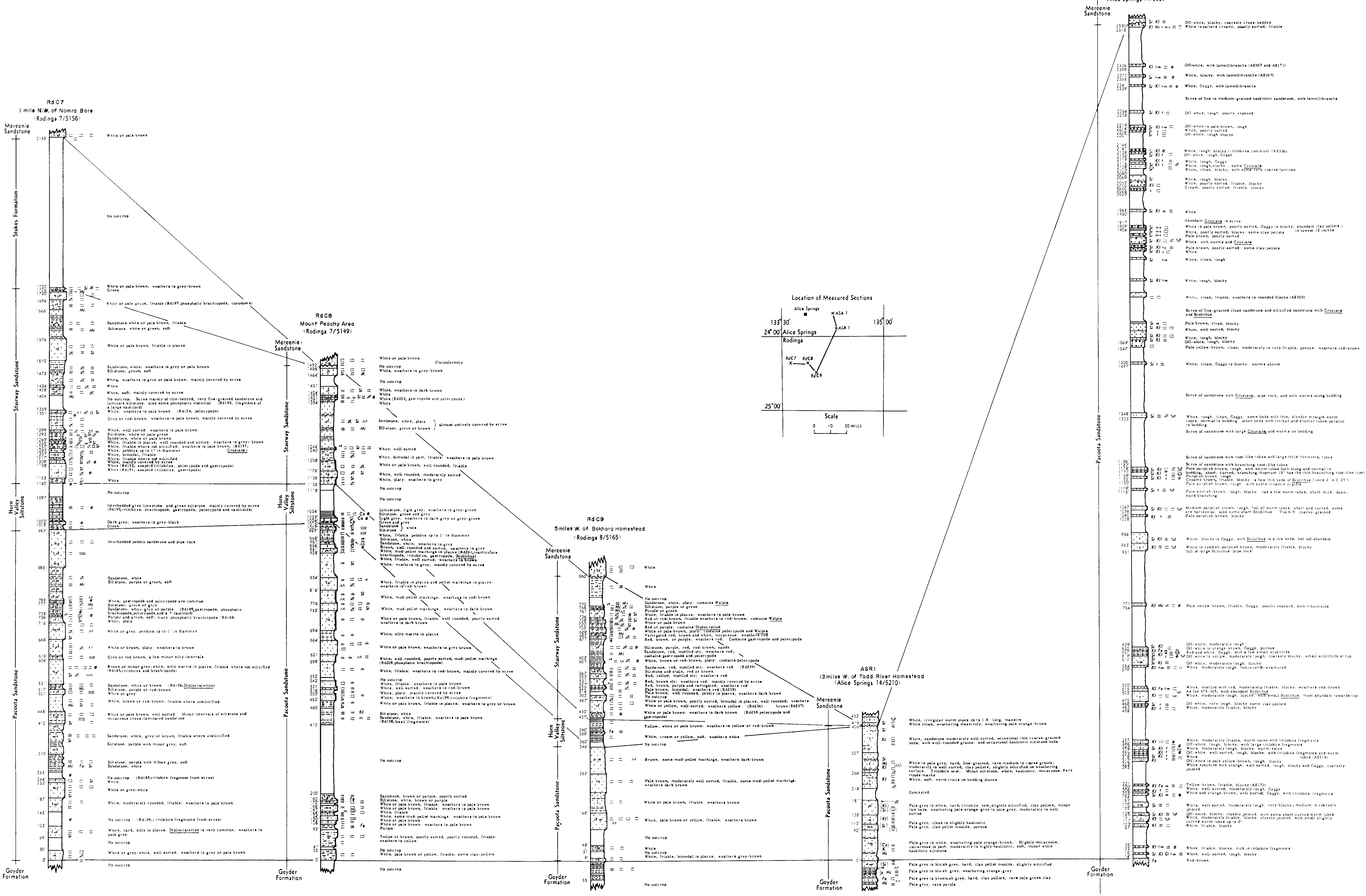

Rd R1
Mount Peachy Area
Rodinga (5/5053)
Rd R6
4 miles E. of Deep Well Homestead
Rodinga (6/5095)
Rd R5
Ooraminna Anticline
Rodinga (2/5092)
ASR1
Todd River Anticline
Alice Springs (14/5210)
ASA1
Williams Bore
Alice Springs 11
Pacoota Sandstone
Goyder Formation
Shannon Formation
Jay Creek Limestone
Giles Creek Dolomite
Chandler Limestone
Todd River Dolomite
Arumbera Sandstone
Pertatataka Formation
Concealed
Location of Measured Sections
Alice Springs
Williams Bore
Ross River Chalet
MacDonnell Ranges
ASA1
ASR1,2
Alice Springs
Illogwa Creek
Rodinga
Hale River
Mt. Ooraminna
Rd R5
Rd R1
Rd R6
James Ranges
Mt. Rodinga
133°30'
135°00'
24°00'
25°00'
Scale
0 10 20 Miles

Plate 12



ASW1, ASR5
Ross River Gorge
Alice Springs (10/5094, 9/5140)
Location of Measured Sections
Alice Springs
MacDonnell Ranges
ASR5
ASW1
Ross River Chalet
Fergusson Range
ASR3
Alice Springs
Rodinga
Illogwa Creek
Hale River
HLW1
RdR4
Camel Flat Syncline
Mt Rodinga
Scale
0 10 20 MILES
ASR3
Gaylad Syncline
Alice Springs (12/5008)
HLW1
3 miles S. of Hi Jinx Bore
Hale River (2/5085)
RdR4
8 miles W. of Camel Flat Bore
Rodinga (4/5026)
Pacoota Sandstone
Goyder Formation
Shannon Formation
Giles Creek Dolomite
Todd River Dolomite
Arumbera Sandstone
Mereenie Sandstone
Pertatataka Formation
Chandler Limestone
Concealed
Scree

Plate 13



Rd C7
1 mile N.W. of Nomra Bore
(Rodinga 7/5156)
Mereenie Sandstone
Stokes Formation
Stairway Sandstone
Horn Valley Siltstone
Pacoota Sandstone
Goyder Formation
Rd C8
Mount Peachy Area
(Rodinga 7/5149)
Rd C9
5 miles W. of Bokhara Homestead
(Rodinga 8/5165)
ASR 1
13 miles W. of Todd River Homestead
(Alice Springs 14/5210)
ASA 1
Williams Bore
Alice Springs 11/5059
Location of Measured Sections
Alice Springs
Rodinga
Scale
0 10 20 MILES

MEASURED SECTIONS, LARAPINTA GROUP AND MEREENIE SANDSTONE
SOUTH-WESTERN PART OF RODINGA SHEET AREA

Plate 14

MEASURED SECTIONS, MEREENIE SANDSTONE AND PARTS OF THE PERTNJARA FORMATION

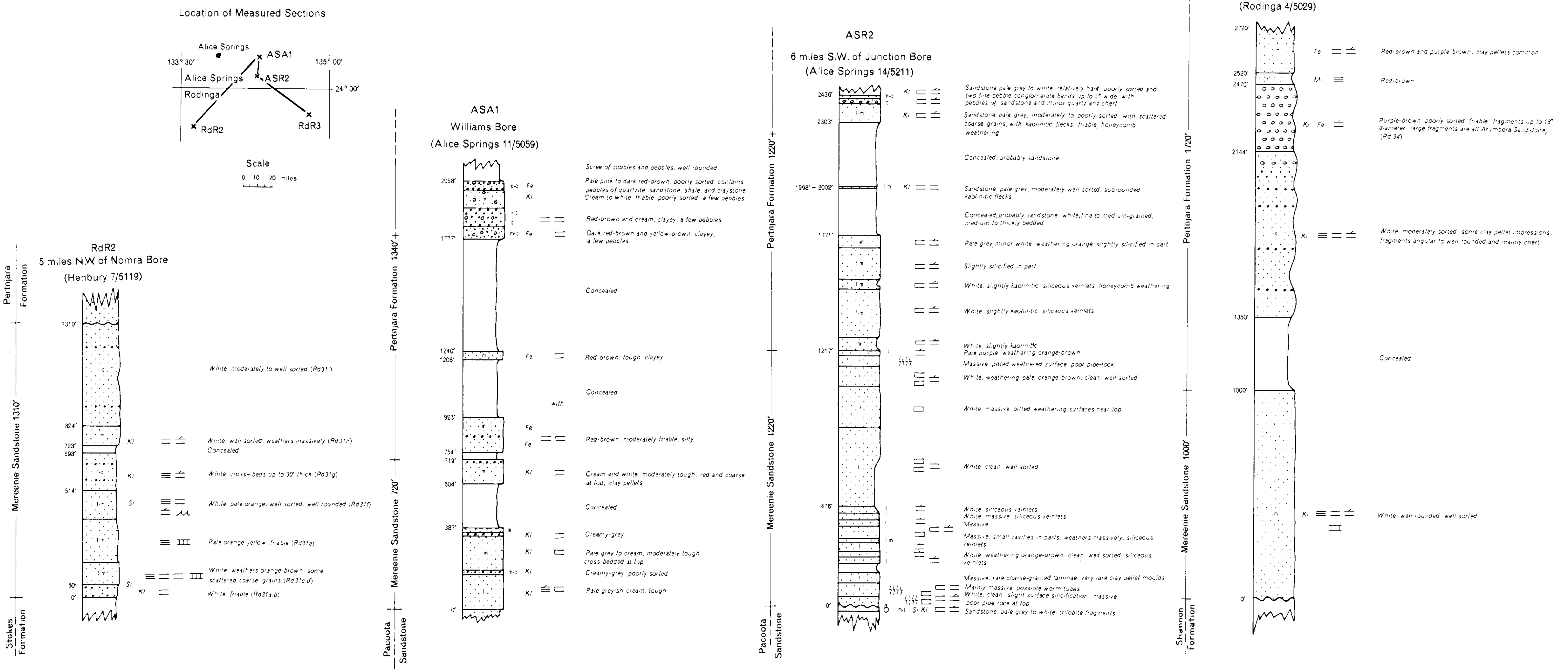


PLATE 16

ALICE SPRINGS
ILLOGWA CREEK
RODINGA
HALE RIVER
133°30'
134°00'
134°30'
135°00'
135°30'
136°00'
136°30'
23°00'
23°30'
24°00'
24°30'
25°00'
GILES CREEK SYNFORM
ATNARPA ANTIFORM
BLATHERSKITE NAPPE
ROSS RIVER
FERGUSSON
GAYLAD
LIMBLA
TODD RIVER
ORAMINNA
PHILLIPSON POUND
WATERHOUSE RANGE
OLYMPIC
HI JINX
TERESA
JOKER BORE
DEEP WELL
CAMEL FLAT
MT BURRELL ANTICLINORIUM
GREAT ARTESIAN BASIN
Scale 1:500,000
10 8 6 4 2 0 10 20 30 MILES
AGE
SYMBOL
ROCK UNITS
CAINOZOIC
Cz
MESOZOIC
M
Rumbalara Shale
De Souza Sandstone
PALAEOZOIC
PERMIAN
CARBONIFEROUS
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
Crown Point Formation
Pertnjara Formation
Finke Group
Pzm
Mereenie Sandstone
Pzl
Larapinta Group
Pertaoorrta Group
PRECAMBRIAN
UPPER PROTEROZOIC
Pertatataka Formation
Areyonga Formation
Bitter Springs Formation
Heavitree Quartzite
p€q
p€
Quartzite
Arunta Complex
Arltunga Nappe Complex
Synclinal core of White Range Nappe
Synclinal core of Winnecke Nappe
REFERENCE
Geological boundary
Fault or thrust
Anticline showing plunge
Syncline showing plunge
Overturned anticline
Overturned syncline
Axis of fold
Trend of lineation
Trend of lineation (with prevailing dip)
Trend of bedding
Dip < 15°
Dip 15°- 45°
Dip > 45°

PRELIMINARY EDITION, 1965

SUBJECT TO AMENDMENT

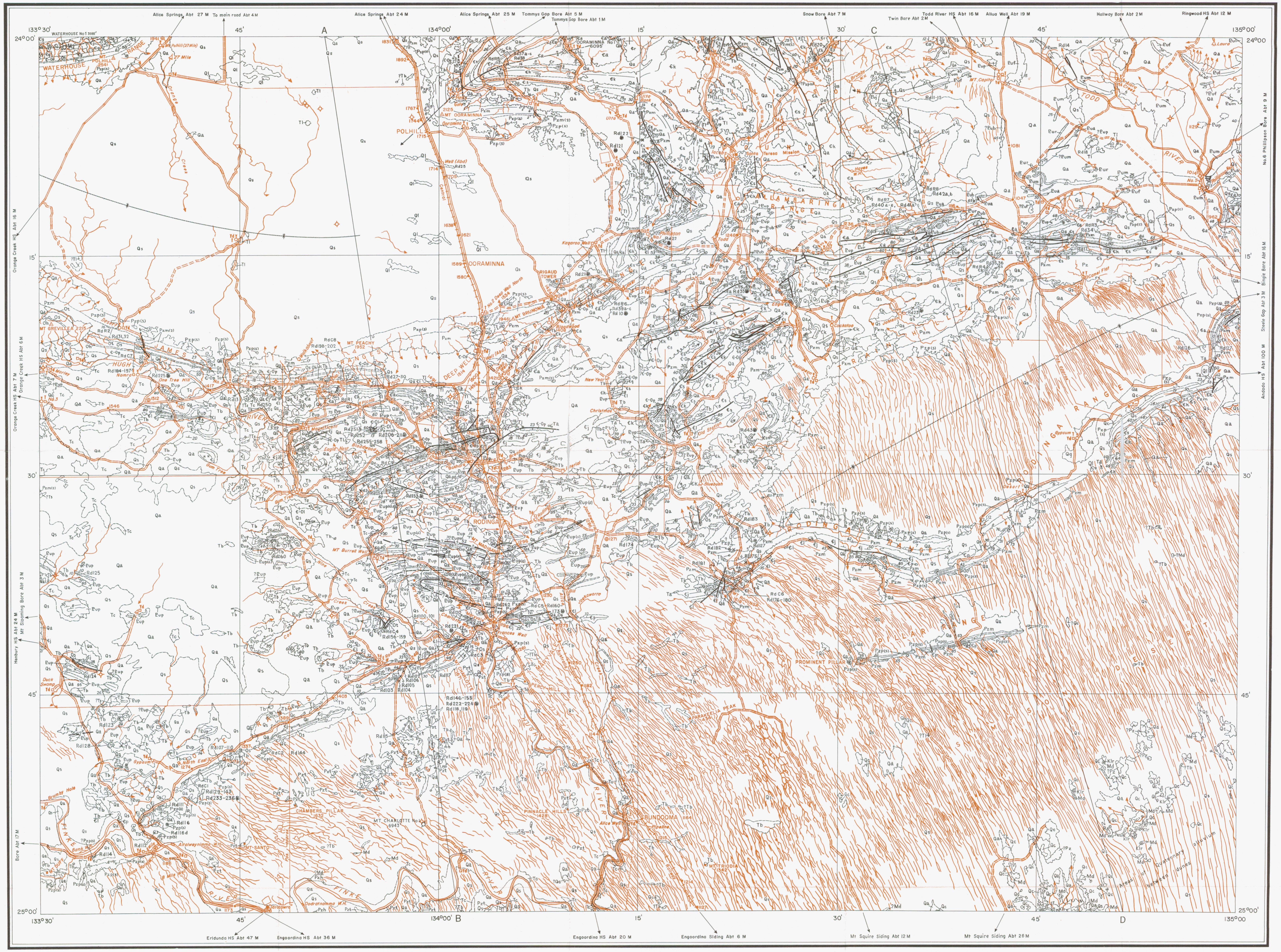
PLATE 17

AUSTRALIA 1:250,000

RODINGA

NORTHERN TERRITORY

1:250,000 GEOLOGICAL SERIES SHEET SG 53-2



Reference

CAINOZOIC	QUATERNARY	Undifferentiated	Q	Alluvium, sand, travertine, gypsum, conglomerate (section only)
			Qa	Alluvium, river gravel
			Qs	Aeolian sand
			Ql	Travertine
			Qg	Gypsum
			Qc	Conglomerate
	TERTIARY	Undifferentiated	T	Calcareous silty sandstone, conglomerate, limestone
			Tl	Chalcedonic limestone and calcareous sandstone containing freshwater gastropods
			Tc	Conglomerate
			Tb	Silcrete (grey billy)
			Ta	Laterite, ferricrete
			Ts	Sandstone, siltstone, some lignite
MESOZOIC	CRETACEOUS	Rumbalara Shale	Klr	Fossiliferous shale, siltstone, sandstone
	? JURASSIC	De Souza Sandstone	Md	Sandstone, pebbly sandstone, conglomerate
PALAEOZOIC	DEVONIAN TO CARBONIFEROUS	Finke Group: Santo Sandstone	Pzt	Sandstone, pebbly sandstone, minor claystone
		Finke Group: Horseshoe Bend Shale	Pzh	Red-brown biotite shale, grey-green calcareous siltstone
		Finke Group: Langra Formation	Pzn	Sandstone, pebbly sandstone, conglomerate, siltstone
		Pertnjara Formation	Pzp	Sandstone, pebbly sandstone, conglomerate, siltstone
			Pzp(c)	Conglomerate
			Pzp(s)	Sandstone, pebbly sandstone
			Pzp(a)	Siltstone, shale
	? SILURIAN TO CARBONIFEROUS	Undifferentiated	Pz	Sandstone, pebbly sandstone
	? SILURIAN TO DEVONIAN	Mereenie Sandstone	Pzm	White cross-bedded sandstone
	ORDOVICIAN TO CAMBRIAN	Larapinta Group: Undifferentiated	€-Ol	Fossiliferous sandstone, siltstone, shale, limestone
		Larapinta Group: Stokes Formation	Ot	Siltstone, shale, fossiliferous limestone
		Larapinta Group: Stairway Sandstone	Os	Fossiliferous sandstone, silty sandstone, siltstone, limestone
		Larapinta Group: Horn Valley Siltstone	Oh	Fossiliferous siltstone and limestone
		Larapinta Group: Pacoota Sandstone	€-Op	Fossiliferous sandstone and silty sandstone
	CAMBRIAN	Pertaoorta Group: Undifferentiated	€p	Sandstone, siltstone, shale, dolomite, limestone
		Pertaoorta Group: Goyder Formation	€g	Silty sandstone, siltstone, limestone
		Pertaoorta Group: Jay Creek Limestone	€j	Limestone, shale, dolomite
		Pertaoorta Group: Shannon Formation	€s	Siltstone, shale, limestone
		Pertaoorta Group: Giles Creek Dolomite	€k	Dolomite, limestone, siltstone, shale
		Pertaoorta Group: Chandler Limestone	€l	Limestone and dolomite with chert laminae
		Pertaoorta Group: Todd River Dolomite	€r	Pink fossiliferous glauconitic dolomite
		Pertaoorta Group: Arumbera Sandstone	€a	Red-brown sandstone, silty sandstone, siltstone
PRECAMBRIAN	UPPER PROTEROZOIC	Pertatataka Formation	Ꝑup	Siltstone and shale with lenses of sandstone, limestone and conglomerate
			Ꝑup(c)	Conglomeratic sandstone
		Julie Member	Ꝑuj	Dolomite, limestone, lenses of calcareous sandstone
		Waldo-Pedlar Member	Ꝑul	Siltstone, fine grained, thin-bedded sandstone
		Olympic Member	Ꝑuf	Conglomerate, siltstone, sandstone
		Limbla Member	Ꝑum	Cross-laminated sandstone, sandy limestone
		Ringwood Member	Ꝑur	Algal dolomite and limestone
		Areyonga Formation	Ꝑua	Conglomeratic siltstone, sandstone; minor dolomite with red chert
		Bitter Springs Formation	Ꝑub	Dolomite, limestone, siltstone, some volcanics

Geological boundary

Anticline, showing plunge

Syncline, showing plunge

Fault

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

23 Strike and dip of strata

Bore

Abandoned bore

Windpump

Well

Tank

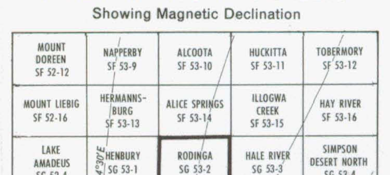
Earth tank

Spring

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:46,500 scale.
Transverse Mercator Projection.

INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

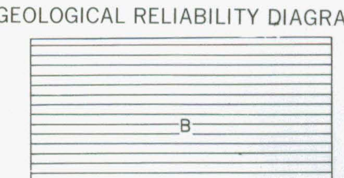


Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM



B Detailed reconnaissance — numerous traverses with air-photo interpretation.

Geology, 1964, by: L.C. Ranford and P.J. Cook
Compilation, 1964, by: L.C. Ranford, P.J. Cook and J.M. Fetherston
Drawn, 1964, by: J.M. Fetherston

AUSTRALIA 1:250,000

ALICE SPRINGS

NORTHERN TERRITORY

1:250,000 GEOLOGICAL SERIES SHEET SF53-14

PRELIMINARY EDITION, 1966

PLATE 18

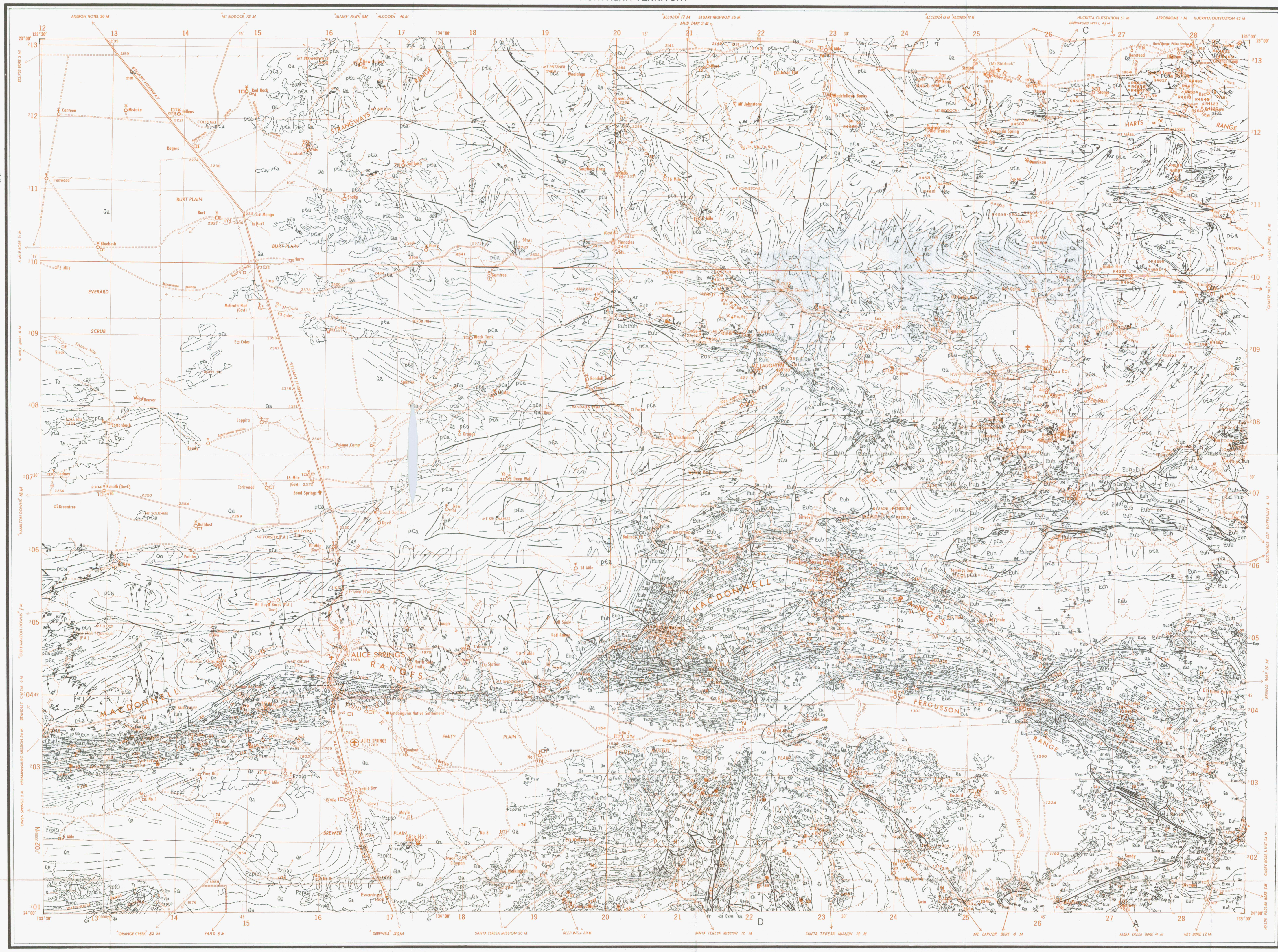
SUBJECT TO AMENDMENT

Reference

Geological boundary
Anticline, showing plunge
Syncline, showing plunge
Overturned anticline showing general direction of plunge
Overturned syncline showing general direction of plunge
Overturned (downward facing) antiform
Fault
Low-angle thrust fault
High-angle reverse fault

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

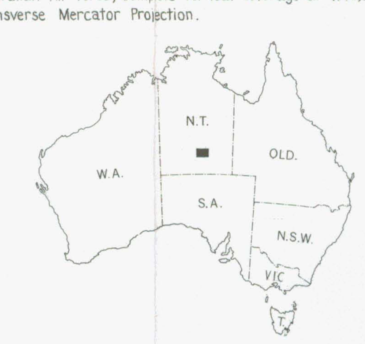
Strike and dip of strata
Vertical strata
Horizontal strata
Overturned strata
Dip < 15° (air-photo interpretation)
Dip 15°-45° (air-photo interpretation)
Dip > 45° (air-photo interpretation)
Trend lines (air-photo interpretation)
Joint pattern (air-photo interpretation)
Vertical joint
Strike and dip of foliation
Vertical foliation
Foliation with trend of lineation
Trend of lineation
Vertical lineation
Plunge of lineation on vertical foliation
Macrofossil locality
x 157 Specimen locality. Specimens are marked with prefix AS.
x R4753 Registered B.M.R. collection number
R-4 Measured section
Dyke; dl-dolerite, p-pegmatite
Sand dunes
Bore
Bore with windpump
Abandoned bore
Well
T Tank
E Earth tank
Dam
WH Waterhole
Spring
Mine
Minor mineral occurrence
Ag Silver
Au Gold
Sn Tin
Nb Niobium
Ck Kaolin
Cu Copper
Gp Gypsum
Mi Mica
Pb Lead
Ph Phosphate
Ta Tantalum
Th Thorium
U Uranium
Abandoned well with show of oil
Road
Vehicle track
Railway with siding
Telegraph line
Fence
"Atnarpa" Homestead or hut
Aerodrome
Landing ground
Yd Yard
Astronomical station
·1958 Trignometric station
·1976 Height in feet, barometric; datum: mean sea level
(P.A.) Position approximate



Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium, river gravel
			Qs	Aeolian sand
			Qc	Conglomerate, scree
	TERTIARY	Undifferentiated	T	Sandstone, conglomeratic sandstone, calcareous silty sandstone, limestone, travertine, conglomerate, chalcedony
			Tl	Chalcedonic limestone and calcareous sandstone
			Tb	Silcrete (grey billy)
			Ta	Laterite, ferricrete
			Ts	Sandstone, siltstone, some lignite
PALAEOZOIC	DEVONIAN TO CARBONIFEROUS	Pertnjara Formation	Pzp(c)	Conglomerate
			Pzp(s)	Sandstone, pebbly sandstone
	? SILURIAN TO DEVONIAN	Mereenie Sandstone	Pzm	White, cross-bedded sandstone
	CAMBRIAN TO ORDOVICIAN	Larapinta Group: Pacoota Sandstone	€-Op	Fossiliferous sandstone and silty sandstone
		N'Dahla Member	On	Purplish-brown sandstone and siltstone
	CAMBRIAN	Pertaoorrta Group: Undifferentiated	€p	Sandstone, siltstone, shale, dolomite, limestone
		Goyder Formation	€g	Silty sandstone, siltstone, limestone, dolomite
		Jay Creek Limestone	€j	Limestone, shale, dolomite
		Hugh River Shale	€h	Siltstone, shale, limestone
		Shannon Formation	€s	Siltstone, shale, limestone, dolomite
		Giles Creek Dolomite	€k	Dolomite, limestone, siltstone, shale
		Chandler Limestone	€l	Limestone and dolomite with chert laminae
		Todd River Dolomite	€r	Pink fossiliferous dolomite
		Arumbera Sandstone	€a	Red-brown sandstone, silty sandstone, siltstone
			€a3	Sandstone
			€a2	Siltstone, sandstone, some dolomite
			€a1	Sandstone, siltstone, some pebbly sandstone
PRECAMBRIAN	UPPER PROTEROZOIC	Pertatataka Formation	Eup	Siltstone and shale with lenses of sandstone, limestone, conglomerate
		Julie Member	Euj	Dolomite, limestone, lenses of sandstone and calcareous sandstone
		Waldo Pedlar Member	Eul	Siltstone, fine-grained, platy sandstone
		Olympic Member	Euf	Conglomerate, siltstone, sandstone, dolomite
		Limbla Member	Eum	Cross-laminated sandstone, sandy calcarenite
		Ringwood Member	Eur	Algal dolomite and calcarenite
		Cyclops Member	Euy	Platy, even-bedded, fine-grained sandstone
		Areyonga Formation	Eua	Sandstone, arkose, siltstone, conglomerate, dolomite
		Bitter Springs Formation	Eub	Dolomite, limestone, siltstone, sandstone, and some basic volcanics
		Loves Creek Member	Eue	Massive, algal dolomite, red siltstone, and sandstone
			Eue1	Basic volcanics
		Gillen Member	Eug	Dolomite, green siltstone, sandstone, gypsum
		Heavitree Quartzite	Euh	Quartzite
		Schaber Hornblende Granite	p€c	Porphyroblastic hornblende oligoclase-microcline granite
		Bungitina Granodiorite	p€t	Biotite-microcline-oligoclase granodiorite
			p€g	Granite
			p€q	Meta-quartzite, quartz-sericite schist
		Arunta Complex	p€a	Mica-quartz-feldspar schist and gneiss, garnet-mica-feldspar gneiss, quartzo-feldspathic gneiss, amphibolite, meta-basic rocks, meta-limestone, quartzite, pegmatite

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development Base map compiled by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; Complete vertical coverage at 1:46,500 scale Transverse Mercator Projection.



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

MOUNT THEO SF 52-8	MOUNT PEAKE SF 53-5	BARROW CREEK SF 53-6	ELKEDRA SF 53-7	SANDOVER RIVER SF 53-8
MOUNT DOREEN SF 52-12	NAPPERBY SF 53-9	ALCOOTA SF 53-10	HUCKITTA SF 53-11	TOBERMORY SF 53-12
MOUNT LIEBIG SF 52-16	HERMANNSBURG SF 53-13	ALICE SPRINGS SF 53-14	ILLOGWA CREEK SF 53-15	HAY RIVER SF 53-16
LAKE AMADEUS SG 52-4	HENBURY SG 53-1	RODINGA SG 53-2	HALE RIVER SG 53-3	SIMPSON DESERT NORTH SG 53-4
AYERS ROCK SG 52-8	KULGERA SG 53-5	FINKE SG 53-6	McDILLS SG 53-7	SIMPSON DESERT SOUTH SG 53-8

ANNUAL CHANGE 1'30"E

Scale 1:250,000

5 0 5 10 15 MILES

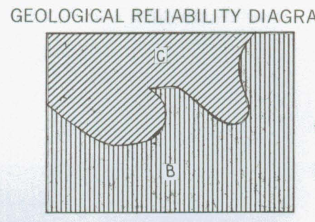
5 0 5 10 15 20 25 KILOMETRES

Sections

Cainozoic sediments omitted from section

Scale: $\frac{V}{H} = 1$

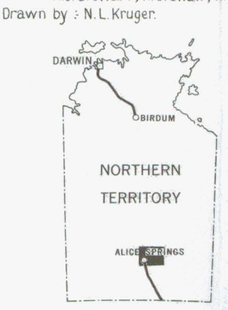
GEOLOGICAL RELIABILITY DIAGRAM



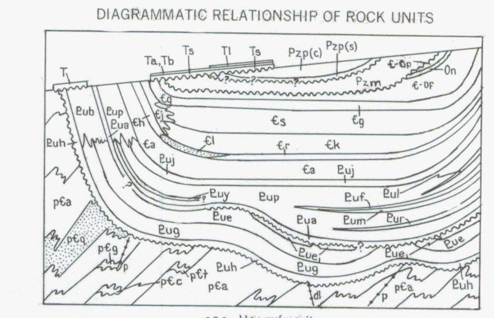
B Detailed reconnaissance, general reconnaissance, reconnaissance, and air-photo interpretation.

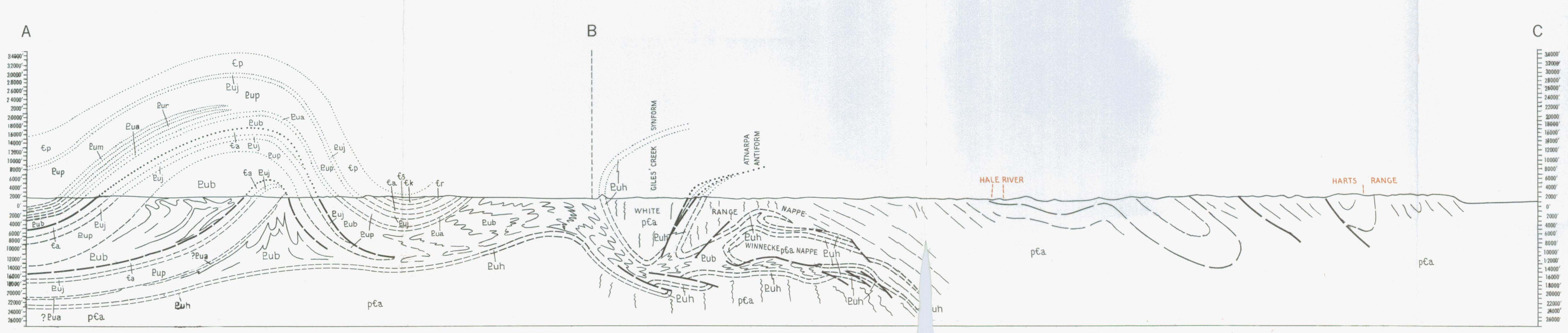
C Air-photo interpretation with helicopter reconnaissance.

Geology by, A.T. Wells, D.J. Forman, E.N. Milligan
A.J. Stewart, R.D. Shaw.
1949 to 1951 : G.F. Joklik et al
Compiled by, A.T. Wells, D.J. Forman, E.N. Milligan
A.J. Stewart, R.D. Shaw, N.L. Kruger.
Drawn by : N.L. Kruger.



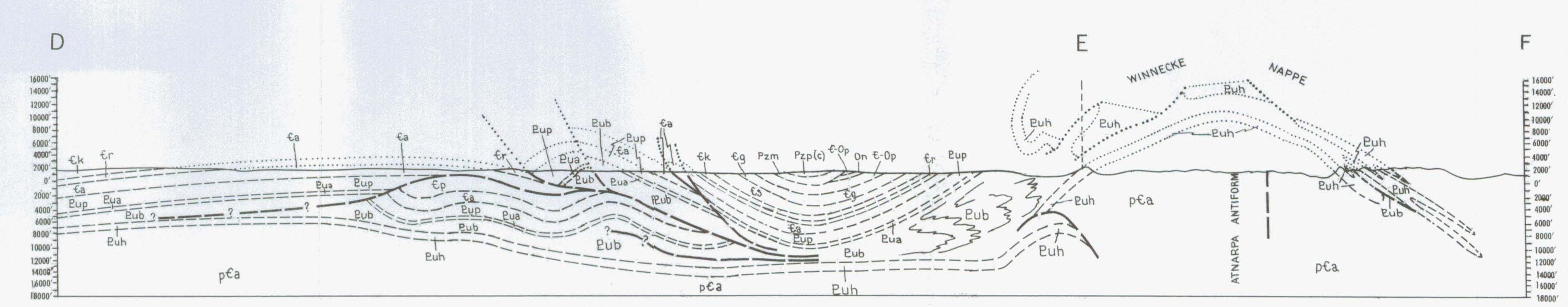
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS





ALICE SPRINGS

SHEET SF 53-14



Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T., or Darwin, N.T.

AUSTRALIA 1:250,000

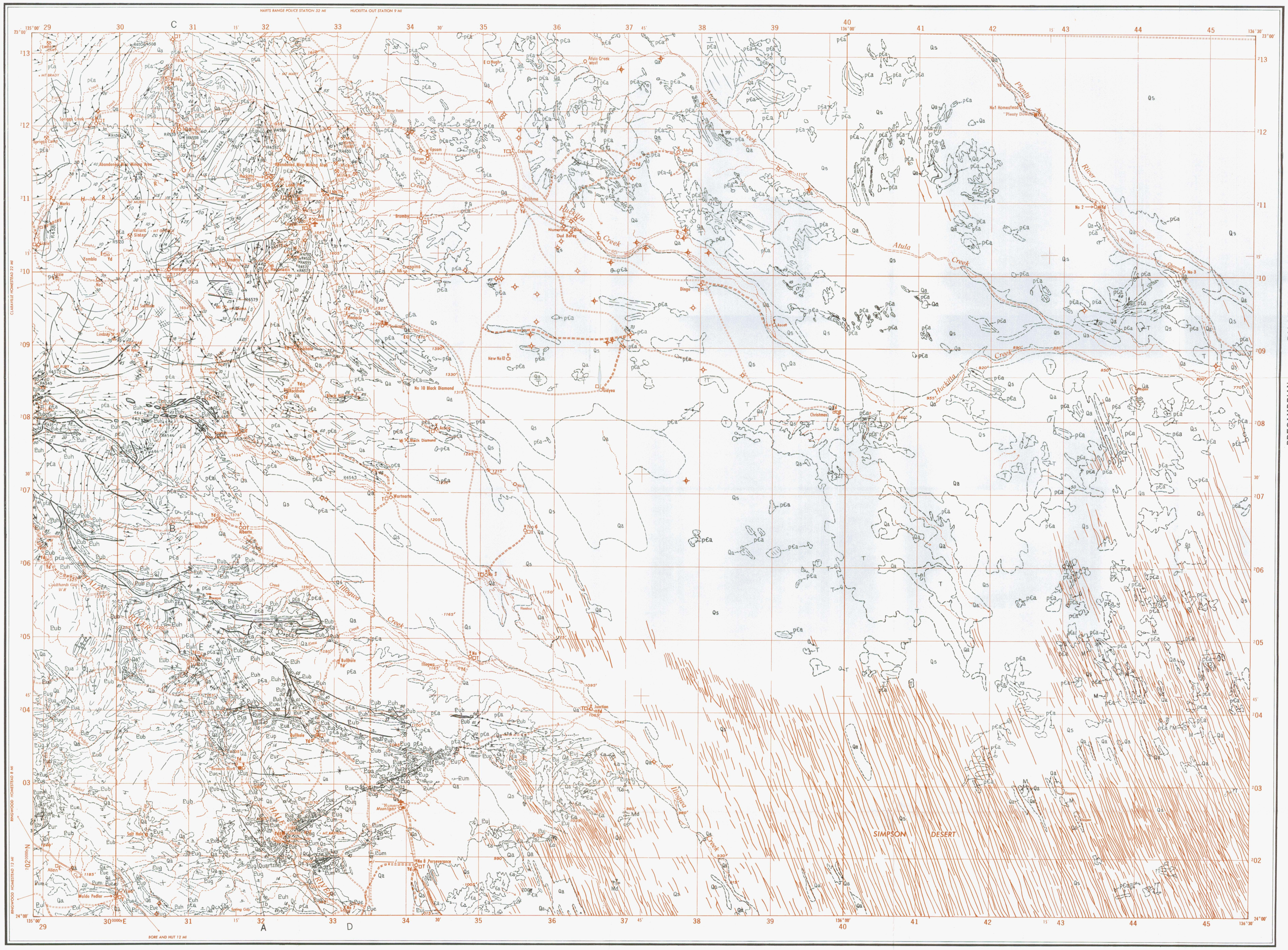
ILLOGWA CREEK

NORTHERN TERRITORY

1:250,000 GEOLOGICAL SERIES SHEET SF 53-15

PRELIMINARY EDITION, 1966 — PLATE 19

SUBJECT TO AMENDMENT



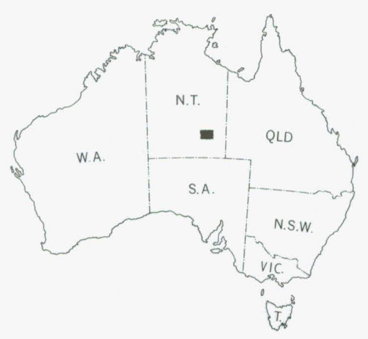
Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium, river gravel
			Qs	Aeolian sand
			Qc	Conglomerate, scree
	TERTIARY		Tb	Silcrete (greybilly)
		Undifferentiated	T	Sandstone, conglomeratic sandstone, calcareous silty sandstone, chalcedony, conglomerate, siltstone, laterite
MESOZOIC	? JURASSIC	De Souza Sandstone	Md	Coarse ferruginous sandstone, siltstone, conglomeratic sandstone
		Undifferentiated	M	Ferruginous sandstone, siltstone, conglomerate
PALAEOZOIC	CAMBRIAN	Pertaoorrta Group Arumbera Sandstone	€a	Red-brown sandstone, silty sandstone, siltstone
PRECAMBRIAN	UPPER PROTEROZOIC	Pertatataka Formation	Ꞓup	Siltstone, shale
		Julie Member	Ꞓuj	Dolomite, limestone, lenses of sandstone and calcareous sandstone
		Waldo Pedlar Member	Ꞓul	Siltstone, fine-grained platy sandstone
		Limbla Member	Ꞓum	Cross-laminated sandstone, sandy calcarenite
		Ringwood Member	Ꞓur	Algal dolomite, calcarenite
		Areyonga Formation	Ꞓua	Sandstone, arkose, boulder clay, conglomerate, dolomite
		Bitter Springs Formation	Ꞓub	Dolomite, limestone, siltstone, sandstone, basic volcanics
		Loves Creek Member	Ꞓue	Massive algal dolomite, red siltstone
			Ꞓue₁	Basic volcanics
		Gillen Member	Ꞓug	Dolomite, green siltstone, sandstone
		Heavitree Quartzite	Ꞓuh	Quartzite, conglomeratic sandstone, quartzite
		Huckitta Granodiorite Inkamulla Granodiorite	p€g	Massive hornblende granodiorite Biotite granodiorite
		Arunta Complex	p€a	Gneiss, amphibolite, meta-quartzite; metamorphosed limestone, basalt, dolerite, porphyrite, gabbro

- Geological boundary
- Anticline, showing plunge
- Syncline, showing plunge
- Fault
- Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted
- Strike and dip of strata
- Horizontal strata
- Overturned strata
- Dip < 15° (air-photo interpretation)
- Dip 15-45° (air-photo interpretation)
- Dip > 45° (air-photo interpretation)
- Trend lines (air-photo interpretation)
- Joint pattern (air-photo interpretation)
- Strike and dip of foliation
- Strike and dip of foliation—unmeasured
- Foliation with trend of lineation
- Vertical foliation
- Fossil locality—general
- × I Specimen locality. Text reference prefixed by IC
- ×R4573 Registered B.M.R. collection number
- Measured section
- Vein; p—pegmatite, q—quartz

- Mine
- Minor mineral occurrence
- Ce Cerium
- Cu Copper
- Au Gold
- Gp Gypsum
- Mi Mica
- Nb Niobium
- Ta Tantalum
- Th Thorium
- U Uranium
- Bore
- Abandoned bore
- Abandoned saline bore
- Windpump
- T Tank
- E Earth tank
- Dam on stream
- Spring
- WH Waterhole
- Sand dunes
- Road
- Vehicle track
- Fence
- Homestead
- Yd Yard
- Landing ground
- ⊕1095′ Astronomical station, with height in feet
- ·920′ Height in feet, barometric; datum: mean sea-level

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:46,000 scale. Transverse Mercator Projection.



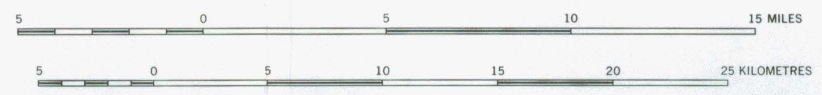
INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

MOUNT PEAKE SF 53-5	BARROW CREEK SF 53-6	ELKEDRA SF 53-7	SANDOVER RIVER SF 53-8	URANDANGI SF 54-5
NAPPERBY SF 53-9	ALCOOTA SF 53-10	HUCKITTA SF 53-11	TOBERMORY SF 53-12	GLENORMISTON SF 54-9
HERMANNSBURG SF 53-13	ALICE SPRINGS SF 53-14	ILLOGWA CREEK SF 53-15	HAY RIVER SF 53-16	MOUNT WHELAN SF 54-13
HENBURY SG 53-1	RODINGA SG 53-2	HALE RIVER SG 53-3	SIMPSON DESERT NORTH SG 53-4	BEDOURIE SG 54-1
KULGERA SG 53-5	FINKE SG 53-6	McDILLS SG 53-7	SIMPSON DESERT SOUTH SG 53-8	BIRDSVILLE SG 54-5

ANNUAL CHANGE 1′30″E

Scale 1:250,000

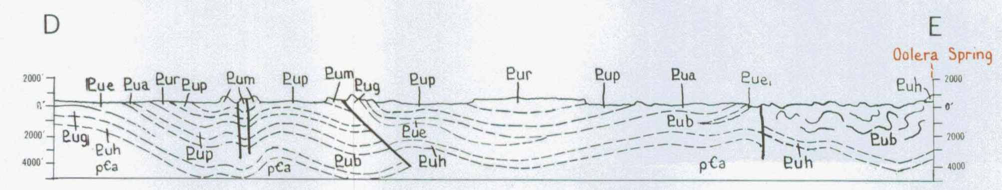


Sections

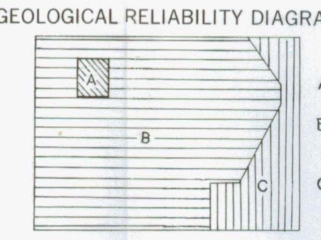
A-B-C D-E

Scale V/H = 1

Cainozoic sediments omitted from section



GEOLOGICAL RELIABILITY DIAGRAM

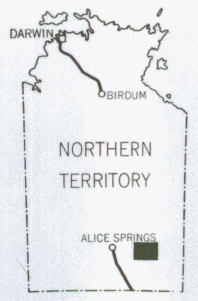


A Detailed mapping

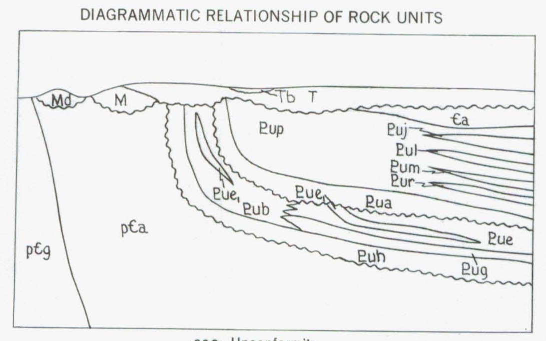
B Detailed reconnaissance, general reconnaissance, reconnaissance and air-photo interpretation

C Air-photo interpretation

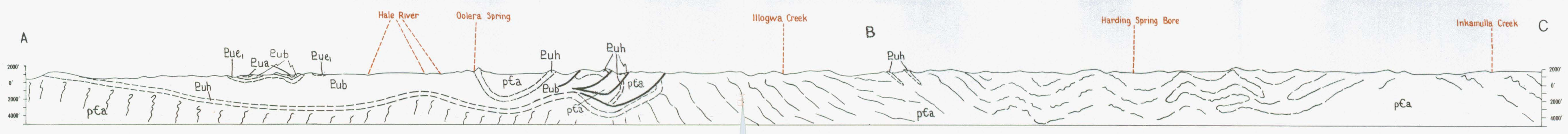
Geology, 1949 to 1951, by: G.F. Joklik et al
1964, by: A.T. Wells, D.J. Forman, E.N. Milligan, A.J. Stewart, R.D. Shaw, D.R.G. Woolley
Compiled, 1964-1965, by: A.T. Wells, D.J. Forman, E.N. Milligan, A.J. Stewart, R.D. Shaw, N.L. Kruger
Drawn by: N.L. Kruger



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity



ILLOGWA CREEK

SHEET SF 53-15

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

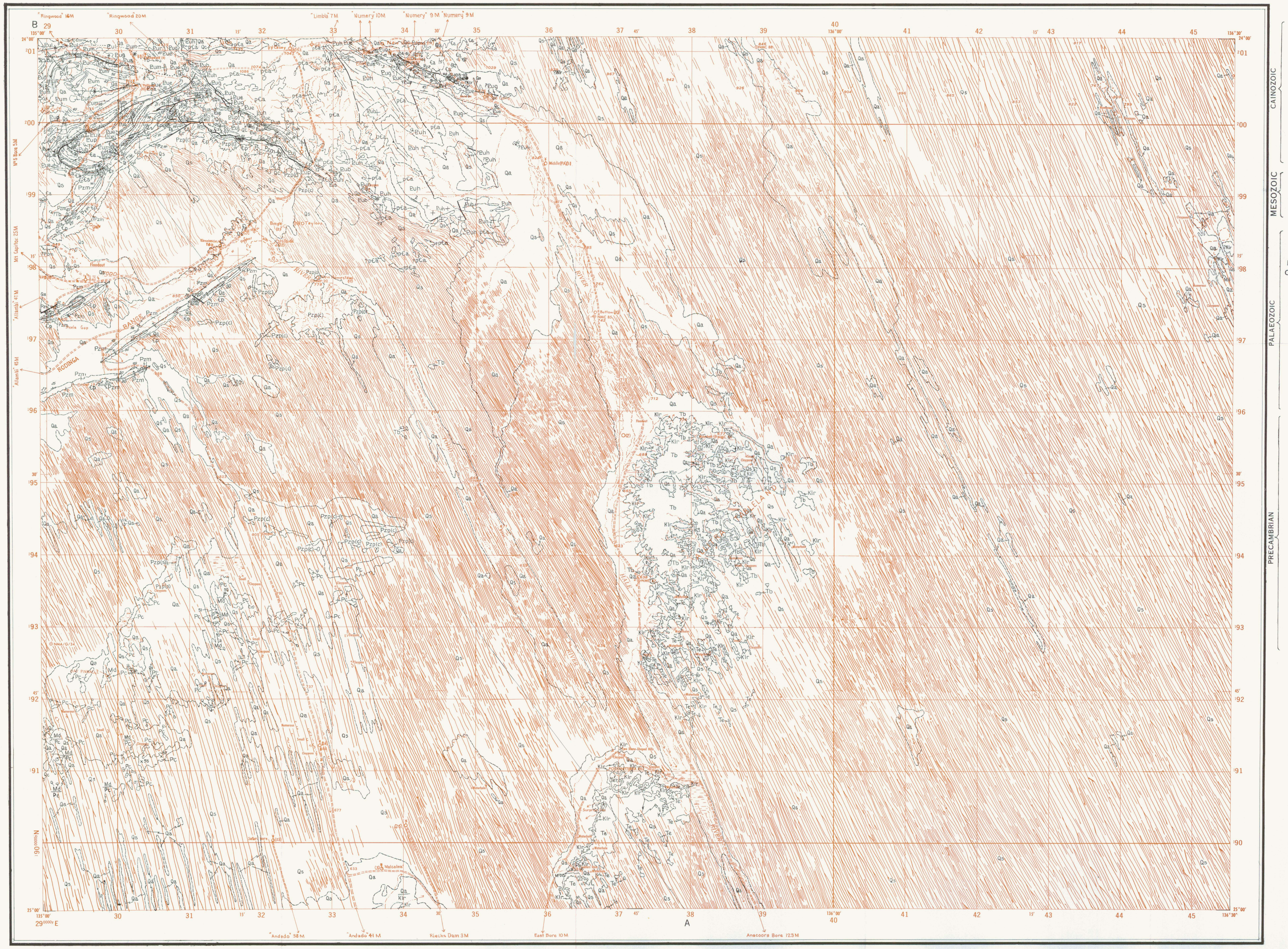
HALE RIVER

NORTHERN TERRITORY

SHEET SG 53-3

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
FIRST EDITION 1966

PLATE 20



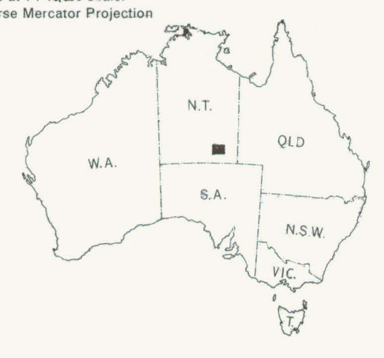
Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium, river gravel
			Qs	Aeolian sand
			Qc	Conglomerate, gravel, scree
	TERTIARY		Tb	Silcrete (grey billy)
			Ts	Sandstone, silty sandstone, siltstone, conglomerate, claystone, chalcedony
		Etingambra Formation	Te	Coarse sandstone, granule conglomerate
MESOZOIC	LOWER CRETACEOUS	Rumbalara Shale	Klr	Shale, claystone, kaolinitic sandstone, sandstone
	? JURASSIC	De Souza Sandstone	Md	Cross-bedded, ferruginous sandstone, pebbly sandstone, conglomerate, siltstone
PALAEOZOIC	PERMIAN	Crown Point Formation	Pc	Sandstone, pebbly sandstone, siltstone, boulder conglomerate tilloid
	DEVONIAN TO CARBONIFEROUS	Pertnjara Formation	Pzp(c)	Pebble and cobble conglomerate
			Pzp(s)	Sandstone
	? SILURIAN TO DEVONIAN	Mereenie Sandstone	Pzm	White, cross-laminate sandstone
	CAMBRIAN	Pertaoorrta Group: Shannon Formation	€s	Siltstone, dolomite, limestone
		Giles Creek Dolomite	€k	Dolomite, limestone, shale
		Todd River Dolomite	€r	Dolomite, shale, sandstone
		Arumbera Sandstone	€a	Red-brown sandstone, siltstone, chert-pebble conglomerate
		Undifferentiated	€p	Dolomite, limestone, siltstone
PRECAMBRIAN	UPPER PROTEROZOIC	Undifferentiated	Pu	Sandstone, limestone, dolomite, siltstone, shale (Section only)
		Pertatataka Formation	Eup	Siltstone and shale with lenses of sandstone, dolomite limestone and conglomerate
		Julie Member	Euj	Oolitic dolomite, limestone, lenses of sandstone, and calcareous sandstone
		Waldo Pedlar Member	Eul	Siliceous, platy, fine sandstone, siltstone
		Olympic Member	Euf	Sandstone, siltstone, conglomerate, dolomite
		Limbla Member	Eum	Cross-laminated sandstone, oolitic and sandy limestone and dolomite interformational conglomerate, siltstone
		Ringwood Member	Eur	Limestone, algal dolomite, siltstone
		Areyonga Formation	Eua	Tilloid, arkosic sandstone, siltstone, sandstone, conglomerate
		Bitter Springs Formation	Eub	Dolomite, limestone, siltstone, sandstone and basic volcanics
		Loves Creek Member	Eue	Algal dolomite, limestone, red siltstone and dolomitic siltstone
			Eue₁	Basic volcanics
		Gillen Member	Eug	Green siltstone, sandstone, dolomite, gypsum
		Heavitree Quartzite	Euh	Silicified sandstone, pebbly sandstone
		Arunta Complex	p€a	Gneiss, schistose gneiss, schist, quartzite

Geological boundary
Anticline, showing plunge
Syncline, showing plunge
Fault
Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults shown by short dashes
Strike and dip of strata
Horizontal strata
Overturned strata
Dip < 15°
Dip 15-45°
Dip > 45°
Trend lines
(Dip < 15°, Dip 15-45°, Dip > 45°, Trend lines: air-photo interpretation)
Strike and dip of foliation, unmeasured
Strike and dip of foliation
Macrofossil locality
Specimen locality.
Measured section

Bore
Abandoned bore
(Bore, Abandoned bore: numbers refer to records of Resident Geologist, Alice Springs.)
Windpump
Tank
Earth tank
Dam on stream
Waterhole
Swamp
Sand dunes
Road
Vehicle track
Building
Yard
Astronomical station
.677 Height in feet, instrument levelled,
·1124 Height in feet, barometric;
(datum: mean sea level)

Published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. David Fairbairn, Minister for National Development. Base map compiled by the Division of National Mapping, Department of National Development, aerial photography by the Royal Australian Air Force; complete vertical coverage at 1 : 46,600 scale.
Transverse Mercator Projection



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

NAPPERBY SF 53-9	ALCOOTA SF 53-10	HUCKITTA SF 53-11	TOBERMORY SF 53-12	GLENORMISTON SF 54-9
HERMANNSBURG SF 53-13	ALICE SPRINGS SF 53-14	ILLOGWA CREEK SF 53-15	HAY RIVER SF 53-16	MOUNT WHELAN SF 54-13
HENBURY SG 53-1	RODINGA SG 53-2	HALE RIVER SG 53-3	SIMPSON DESERT NORTH SG 53-4	BEDOURIE SG 54-1
KULGERA SG 53-5	FINKE SG 53-6	McDILLS SG 53-7	SIMPSON DESERT SOUTH SG 53-8	BIRDSVILLE SG 54-5
ALBERGA SG 53-9	ABMINGA SG 53-10	DALHOUSIE SG 53-11	POOLOWANNA SG 53-12	PANDIE PANDIE SG 54-9

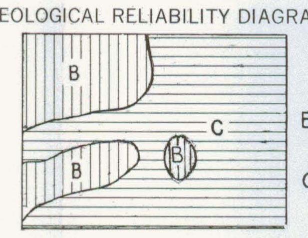
ANNUAL CHANGE 1'30"E

Scale 1:250,000

5 0 5 10 15 MILES

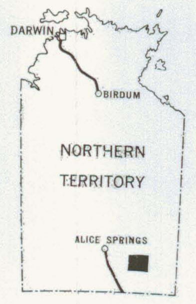
5 0 5 10 15 20 25 KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM

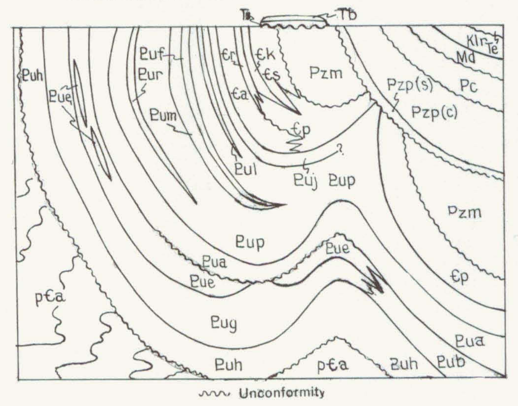


B Detailed reconnaissance, general reconnaissance, reconnaissance and air-photo interpretation.
C Air-photo interpretation

Geology 1964, by : A.T. Wells, A.J. Stewart, R.D. Shaw, D.J. Forman, E.N. Milligan.
Compiled 1964, by : A.T. Wells, A.J. Stewart, R.D. Shaw, L. Kerec
Cartography by: Geological Branch, B.M.R.
Drawn by:



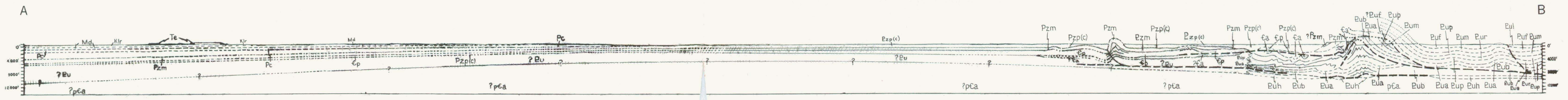
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Section

Cainozoic sediments omitted from section

Scale V/H = 1



HALE RIVER

SHEET SG 53-3

AUSTRALIA 1:250,000

Mc DILLS

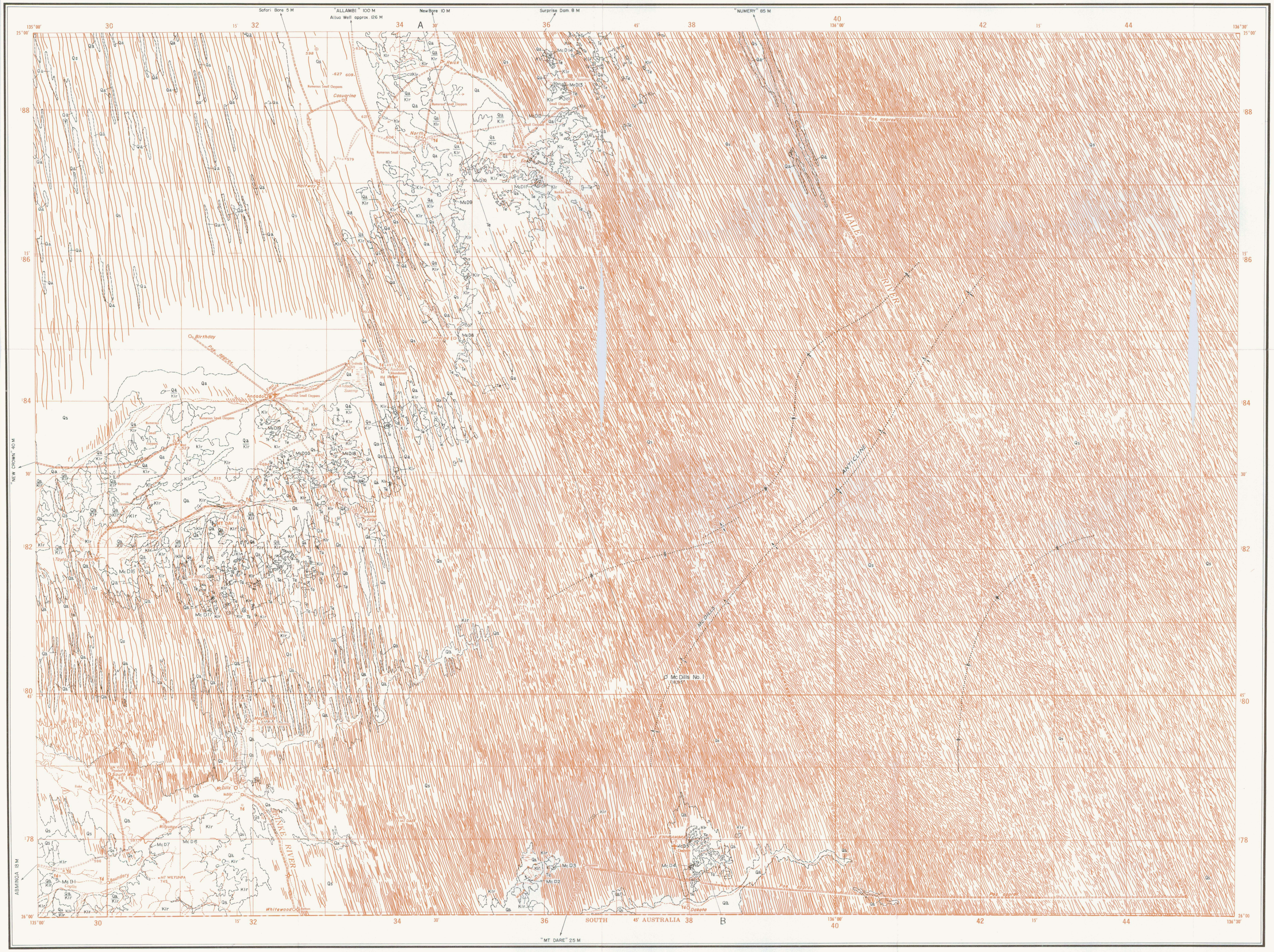
NORTHERN TERRITORY

1:250,000 GEOLOGICAL SERIES SHEET SG 53-7

PRELIMINARY EDITION, 1966

SUBJECT TO AMENDMENT

PLATE 21



Reference

CAINOZOIC	QUATERNARY		Q	Undifferentiated (section only)
			Qa	Alluvium
			Qs	Sand
	TERTIARY	Etingambra Formation	Te	Pale yellow-brown coarse unsorted sandstone, conglomeratic sandstone, granule and pebble conglomerate, some kaolinitic siltstone
MESOZOIC	LOWER CRETACEOUS	Rumbalara Shale	Klr	White, yellow-brown, and purple kaolinitic siltstone, white claystone, silty claystone, yellow ochreous claystone, gypsiferous claystone
	? JURASSIC	De Souza Sandstone	Md	Sandstone, pebbly sandstone (section only)
PALAEOZOIC	LOWER PERMIAN	Crown Point Formation	Pc	Sandstone, conglomerate, siltstone (section only)
	DEVONIAN TO CARBONIFEROUS	Finke Group	Pzf	Sandstone, shale, conglomerate (section only)
	? SILURIAN TO DEVONIAN	Mereenie Sandstone	Pzm	Red-brown, fine to coarse-grained sandstone and red and white fine-grained sandstone (section only)
	CAMBRIAN	Pertaoorrta Group	Ꞓp	Dolomite, thin interbeds of limestone and shale. Marine fossils. (section only)

Geological boundary

Anticline, Syncline — from seismic survey

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

Strike and dip of strata

Horizontal strata

Dip < 15°, air-photo interpretation

× McD1. Text reference to specimen locality

Oil well, dry hole (abandoned)

Bore

Abandoned bore

Well

Abandoned well

Windpump

Tank

Earth tank

Dam on stream

Sand dunes

Swamp

Vehicle track

State boundary

Fence

"Andado" Homestead

Landing ground

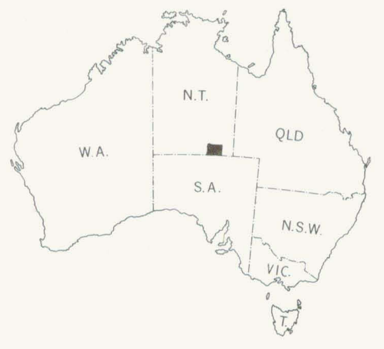
Yd Yard

Astronomical station

Trigonometrical station

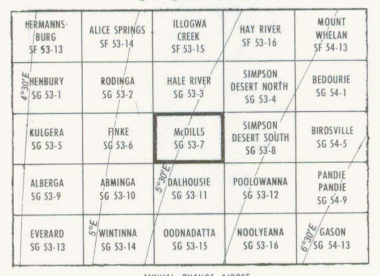
578 • Height in feet, instrument levelled; 440 • Height in feet, barometric; — datum: mean sea level, Port Augusta.

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:46,500 scale. Transverse Mercator Projection.



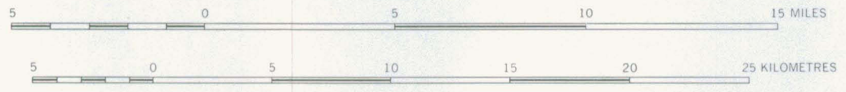
INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

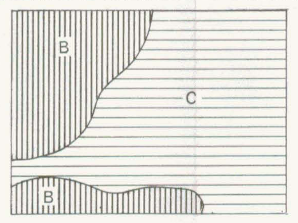


ANNUAL CHANGE 1°30'E

Scale 1:250,000



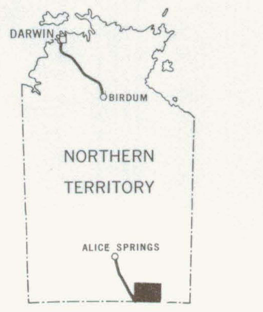
GEOLOGICAL RELIABILITY DIAGRAM



B. General reconnaissance, with air-photo interpretation

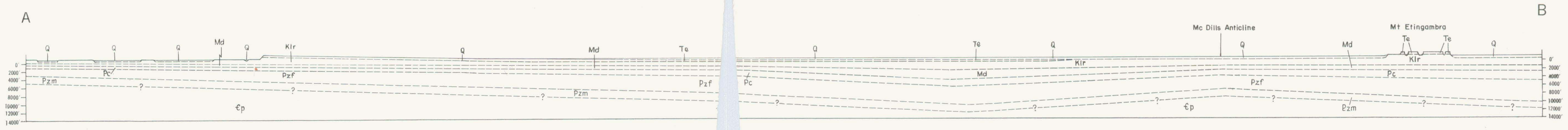
C. Air – photo interpretation

Geology, 1964, by: A.T. Wells and A.J. Stewart.
Compilation, 1965, by: A.T. Wells, A.J. Stewart, and L. Kerec.
Drawn, 1965, by: J.M. Fetherston and G.J. Squire.



Section

Scale: $\frac{V}{H} = 1$



Mc DILLS

SHEET SG 53-7

Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T., or Darwin, N.T.