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THE GEOLOGY OF THE NORTH-EATERN PART OF THE AMADEUS BASIN, NORTHERN TERRITORY.

by

A.T.Wells, L.C.Ranford, A.J.Stewart, P.J.Cook, and R.D.Shaw.

Note: The original Record contains an overlay for the Alice Springs 1:250,000 Preliminary Geological Map. If you wish to view the original, please contact the N.H. (Doc) Fisher Geoscience Library.

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SUMMARY

More than 18,000 feet of sediments of Upper Proterozoic to Tertiary age are preserved in the north-eastern part of the Amadeus Basin. The Upper Proterozoic rocks are up to 10,000 feet thick, and include a basal sandstone overlain by marine carbonate and shale with some evaporites and volcanics. These 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 in this area one of the members is probably of glacial origin. If confirmed this is the first record of a younger Precambrian glaciation in the Amadeus Basin.

The Cambrian Pertaoorrta Group is up to 5,000 feet thick and the oldest formation within the Group is a red-bed sand facies. In the Ross River area this is overlain by about 2,500 feet of dolomite and limestone, with a glauconitic sandstone at the top. To the west the carbonate content of the Group decreases and the amount 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 part of the area the sediments may have been up to 7,000 feet thick but most of the units have been eroded and the Pacoota Sandstone is the only formation in the Larapinta Group now present, whereas in the south less than 1,000 feet of Larapinta Group sediments (with the Stairway Sandstone at the base) were deposited disconformably on the Pertaoorrta Group.

The Mereenie Sandstone unconformably overlies the Larapinta or Pertaoorrta Groups and is in turn unconformably overlain by the Pertnjara Formation.

The Upper Proterozoic and Palaeozoic sediments in the north-eastern part of the Amadeus Basin were folded and faulted during the Alice Springs Orogeny, which started in the late Ordovician and reached a climax in the Upper Devonian. Nappes formed along the present northern margin of the Amadeus Basin, involving basement and the older Upper Proterozoic units. The overlying Upper Proterozoic and Palaeozoic sediments were pushed in front of the nappes forming a decollement 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 way in which the sediments have been deformed.

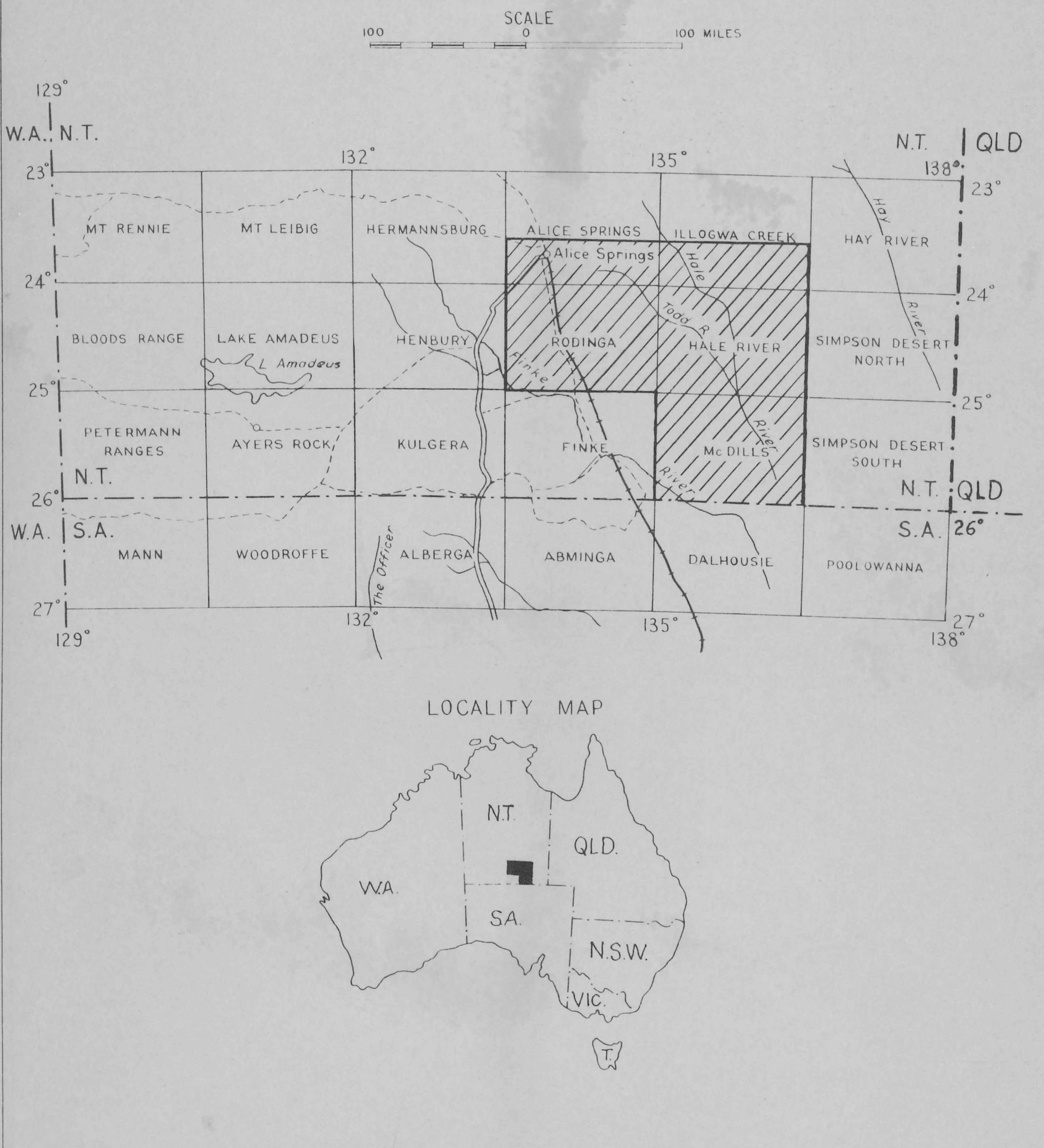
A synorogenic continental unit, the Pertnjara Formation, was deposited in the synclines, and folded during the last pulses of the orogeny.

Subsequent sedimentation in the north-west part of the area was limited to lacustrine and fluviatile sediments of Cainozoic age, but, in the south-east part of the area, sediments of Permian, Mesozoic and Cainozoic age are preserved in the relatively undisturbed Great Artesian Basin. Geophysical surveys indicate that the Amadeus and Great Artesian Basins are separated by a basement ridge, but it is probable that in some areas, Amadeus Basin sediments are present unconformably below the Great Artesian Basin sediments.

Several oil wells have been drilled in the north-eastern part of the Amadeus Basin, and shows of oil and gas have been obtained. 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-Permain rocks. One oil well is being drilled in the Great Artesian Basin on the McDills Sheet area.

Fig 1

POSITION OF AREA MAPPED AND REFERENCE TO AUSTRALIAN 1:250,000 AND 1:253,440 MAP SERIES



INTRODUCTION

General

From June to October of 1964, two field parties from the Bureau of Mineral Resources, Geology and Geophysics mapped the Rodinga (G53-2), McDills (G53-7) and Hale River (G53-3) Sheet areas, the southern third of the Alice Springs Sheet area (F53-14), and the southern quarter of the Illogwa Creek (F53-15) 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. A complementary study of the Arunta Complex and marginal structures of the north-eastern Amadeus Basin, undertaken concurrently by D.J. Forman and E.N. Milligan, has been made the subject of a separate record (Forman and Milligan, 1965).

Palaeontologists J.G. 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 1964 mapping completed the field work of the Bureau's programme to map the Amadeus Basin at a scale of 1:250,000.

Location and Access

The area investigated is situated in the Northern Territory between latitudes 23°30' and 26° south and 133°30' and 136°30' east (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 a graded road, and to Darwin by the sealed Stuart Highway. Graded roads radiate from Alice Springs to Jay Creek Native Settlement, Atnarpa, Numery, Deep Well and Rodinga homesteads and Santa Teresa Mission. Andado Homestead, on the McDills Sheet area, has a gravel road connecting it to the Alice Springs - Adelaide road. The more important station tracks are shown on the maps.

Climate

The region is located in the 4 to 10 inch rainfall belt and the rainfall, which is extremely irregular, increases progressively northwards. The seasonal regime usually shows a summer maximum. Serious drought conditions prevail at present.

Temperatures are characterized by marked diurnal and seasonal fluctuations. The mean daily maximum may exceed 100°F for many weeks. In winter, mean average temperatures for any month 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 months of 1964.

Development

Most of the population is engaged in the cattle industry. Permanent settlements include Temple Bar, Atnarpa, Todd River, Ringwood, Limbla, Numery, Deep Well, Rodinga and Andada homesteads. Native 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 3,500, provides town facilities for the southern part of the Northern Territory.

Survey Method

The north-eastern part of the Amadeus Basin was mapped by means of reconnaissance traverses using four wheel drive vehicles. A helicopter was used for about two weeks to map the more inaccessible areas and for quick comparisons of widely separated sections.

The geology was plotted onto air photographs (scale 1:46,500) taken by the R.A.A.F. in 1950, and was later transferred to controlled photo-scale overlay sheets. The photo-scale maps were reduced photographically to 1:250,000 scale and the maps redrafted at this scale for Preliminary Edition.

Sections were measured at selected localities using tape, compass and abney level.

PREVIOUS INVESTIGATIONS

The previous investigations of the area are discussed under the following headings.

1. Early exploration, and subsequent general geological, geophysical, and geomorphological investigations.
2. Investigations by the Bureau of Mineral Resources and C.S.I.R.O.
3. Oil company investigations.

1. Early Exploration, and Subsequent General Geological, Geophysical, and Geomorphological Investigations.

The first white man in the area was John McDouall Stuart (1865). On each of his three journeys through Central Australia, from 1860 to 1862 he travelled along the Finke River, which he named, together with Chambers Pillar, the MacDonnell Ranges, the James Range, and the Waterhouse Range. F.G.Waterhouse (1863) accompanied Stuart on his last trip, and made notes of the geological succession at Polly Spring (on the Finke Sheet area). E.Giles (1889) passed by Chambers Pillar on his way to the MacDonnell Ranges, soon after the start of his first expedition in 1872. East (1889) made observations on the topography and geology of the MacDonnell Ranges, and south from there along the Overland Telegraph Line. Chewings (1891, 1894, 1914, 1928, 1931), wrote several articles on the stratigraphy of the area and first used the term Amadeus Sunkland (1935). Brown (1889, 1890, 1891, and 1895) made a number of trips into the area, and some of his reports included identifications by Etheridge (1892) of the fossils collected. Tietkins (1891) led a prospecting party which travelled in the area west and south-west from Alice Springs.

The first systematic geological work was carried out by Tate and Watt (1896, 1897; Tate, 1896), geologists with the Horn Scientific Expedition. They believed that there were no Cambrian rocks in the area, and regarded the whole of the Amadeus Basin succession below the Pertnjara Formation as Ordovician in age. George (Murray, 1907), led a prospecting expedition from Alice Springs into the south-western part of the Territory and back. Day (1916) travelled extensively through the McDills, Hale River, and Rodinga Sheet areas. Ward (1925) briefly discussed the structure of the Central Australian region, and followed Tate and Watt (1896) in considering that all the pre-Pertnjara Formation sediments of the Amadeus Basin were Ordovician. Mawson and Madigan (1930) divided the sediments of the area into Proterozoic, Cambrian, and Ordovician 'Series', and Madigan (1930, 1932 and 1938) continued the work in more detail. He traversed across the section at Ross River, observed that the Pertataka, Pertaoorrta, and Larapintine 'Series' were all present, as at Ellery Creek, and discovered the archaeocyathans in the limestone directly above the 'No.3 Quartzite' (Arumbera Sandstone of this report) (Madigan, 1932). Tindale (1931) made a few geological notes as he travelled along the northern side of the Eastern MacDonnell

Ranges during an anthropological excursion. Smith (1932) discussed aspects of the geology and mineralogy of the area, and Andrews (1937) mentioned the Amadeus Basin in his paper on the Palaeozoic structural history of Australia. Hossfeld (1941) reported on deposits of limestone near Alice Springs, and included a discussion of the Amadeus Basin in his general account of the Geology of the Northern Territory in 1954. Voisey (1939a, 1939b) published two articles on aspects of the stratigraphy of the area and Jensen (1944) described the geology of the whole Central Australian region. Hills (1946) mentioned the Amadeus Basin in his article on the tectonics of Australia. Mawson (1957) recognized the glacial nature of what was later defined as the Areyonga Formation at Ellery Creek. Balme (1959) identified the spores from Malcolm's Bore as being of Permian age. Brunnschweiler (1961) put forward some ideas on the tectonics of the Amadeus Basin. McCarthy (1965) spent six weeks with a BMR field party, and has carried out a petrological investigation of the north-east margin of the Amadeus Basin. The phosphate deposits of the area are described briefly by Pritchard and Cook (1965) and the general mineral deposits of the area by Woolley and Rochow (1965).

Marshall and Narain (1954) briefly describe the nature of the gravity field around Alice Springs, and the area is mentioned in King's presentation of his views on the geomorphological development of Australia (1950).

2. Investigations by the Bureau of Mineral Resources and C.S.I.R.O.

(a) Geological

The water supply of Alice Springs has been investigated over many years by Owen (1952a, 1952b), Jones (1957), and Quinlan and Woolley (1962, 1963). The mica resources of the Harts Range (east-north-east of Alice Springs) formed the material for a detailed study by Joklik (1955). Öpik et al (1957) summarized aspects of the Upper Proterozoic and Cambrian geology of the Amadeus Basin as then known. Condon and Smith (1959) described the effects of the Upper Palaeozoic glaciation in Central Australia.

In 1956, the Bureau of Mineral Resources started systematic mapping of the Amadeus Basin and the first published results of this appeared in Prichard and Quinlan (1962). Since 1960, the Bureau has regularly had field parties mapping in the area, as part of the Commonwealth Government's Oil Search programme, and their work is in the course of publication (Forman, 1965; Forman, Milligan, and McCarthy, 1965; Ranford, Cook, and Wells, 1965; Wells, Forman, and Ranford, 1965a, 1965b; Wells, Ranford, Stewart, Cook, and Shaw, 1965 (this report); Wells, Stewart, and Skwarko, 1965). The Institute Français du Petrole prepared photogeological maps for use by the parties (Scanvic, 1961), and later reviewed the petroleum prospects of the basin (Trumpy and Tissot, 1963). Aspects of the palaeontology of the area have been described in Terpstra and Evans (1963), Evans (1964), Hodgson (1964), and Tomlinson (1964), but no results of systematic work have yet been produced. Morgan (1963) described a sample of Spilite from the Bitter Springs Formation from Ooraminna No.1 Oil Well, Barrie (1964) discussed the potential of the Amadeus Basin as a producer of rock phosphate, and Crook and Cook (1964) have been carrying out detailed sedimentological studies of the phosphorites. The geology of the Tertiary rocks of the area has been documented by Lloyd (1965), and McMichael (1965) has described the non-marine molluscs from these rocks.

(b) Geophysical

The first geophysical work undertaken by the Bureau of Mineral Resources was in connection with the water supply of Alice Springs (Dyson and Wiebenga, 1957). Since then, Moss (1962, 1963) has reported on the results of seismic surveys, Langron (1962a, 1962b) and Lonsdale and Flavelle (1963) on gravity surveys, and Quilty and Milsom (1964) on aeromagnetic work.

The major contribution by the C.S.I.R.O. has been a general report on the whole of the Alice Springs area, with articles on geomorphology, geology, climate, water resources, soils, vegetation, and pastures (Perry et al, 1962). A study of the possibilities of introducing irrigation was made by Perry Quinlan, Jones, and Basinski (1963).

3. Oil Company Investigations

(a) Geological

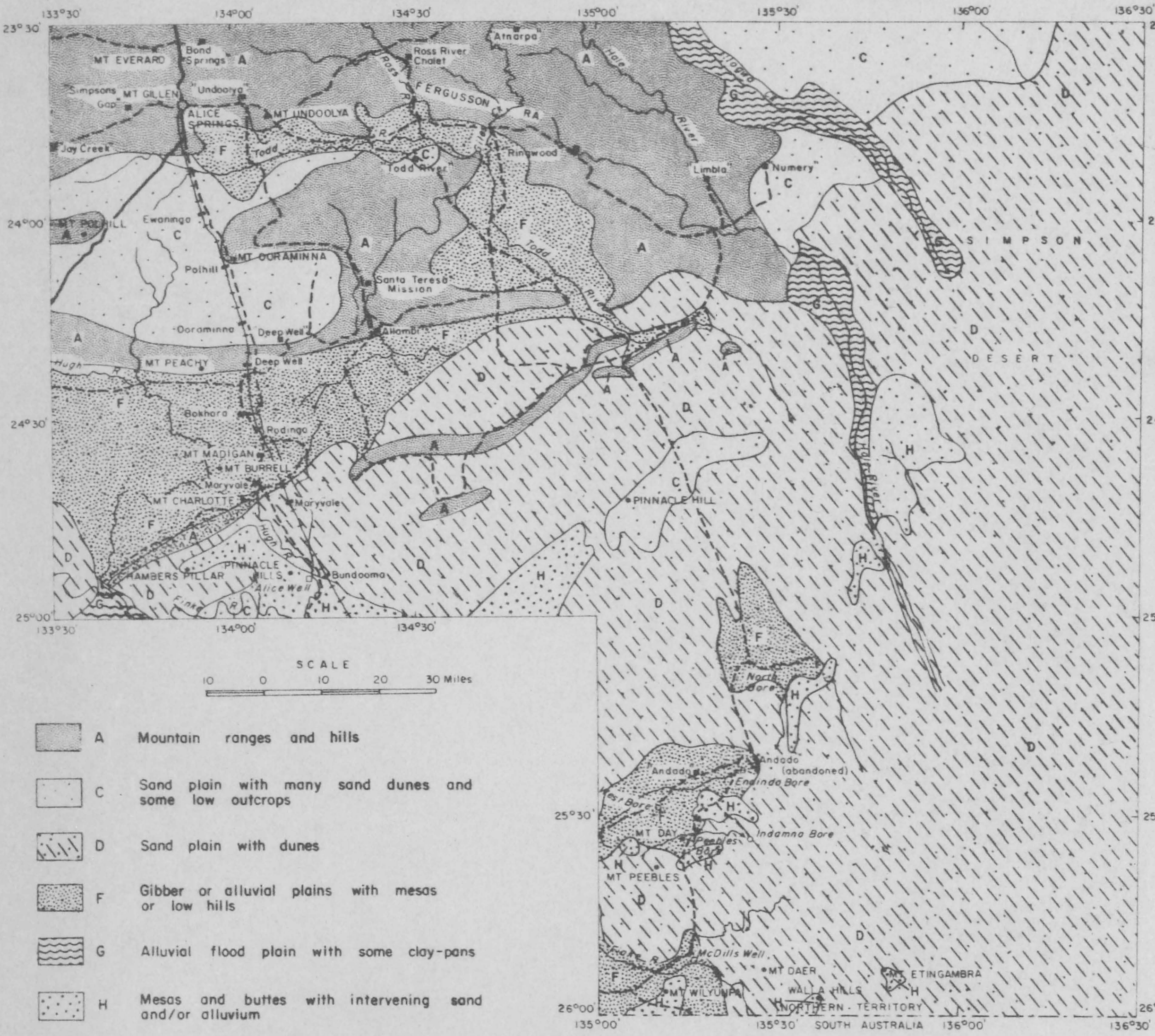
Frome-Broken Hill was the first company to become interested in the petroleum possibilities of the Amadeus Basin. Thomas (1956) reviewed the geology of the basin, MacLeod (1959), Phillips (1959), and Wulff (1960) worked in the eastern parts of the basin, and Taylor (1959) identified the fossils collected by the parties. The leases were relinquished by the company, to be taken up by several others, or with both Australian and overseas connections. Geosurveys of Australia have done a considerable amount of work in the eastern part of the area (the Great Artesian Basin), (Sprigg, 1958, 1961, 1962a, 1962b, 1962c, 1963; Sprigg, Johnson, and Charles, 1960). For the other companies, Burbury (1961a), Jaccard (1961), McNaughton (1962), Stelck and Hopkins (1962), Grasso (1963) and Ranneft (1963) have all written informatively on the geology and petroleum prospects of parts of the eastern half of the Amadeus Basin and overlapping Great Artesian Basin. Three oil wells have been drilled, and two more, Waterhouse No.1 and McDills No.1 are being drilled in the area covered by this report. The completion reports of the first three, Ooraminna No.1 (Planalp and Pemberton, 1963), Alice No.1 (Pemberton, Chambers, Planalp, and Webb, 1963) and Mt.Charlotte No.1 (McTaggart, Pemberton and Planalp, 1965) are now available. The most recent work by company geologists is described in reports by Hopkins (1964), and Michoud, Eyssautier, and Gates (1964), and Banks (1964).

(b) Geophysical

Private companies have been carrying out geophysical investigations in the area since 1960. Gravity surveys have been made mostly in the area of the Great Artesian Basin (Burbury, 1960, 1961b; Denton and Dennison, 1960a, 1960b; Denton, 1962a; Sprigg and Stackler, 1962; Stackler, 1964a, 1964b, 1965). The results of seismic work in the Artesian Basin have been described by Denton (1961a, 1961b, 1962b, 1963), Stackler, Yakunin, and Sprigg (1962), Yakunin (1964a, 1964b, 1965), Bowman (1963a, 1963b), and Campbell (1965). Seismic surveys in the Amadeus Basin have been discussed by Bowman (1963c, 1963d) and Campbell (1964a, 1964b). Aeromagnetic surveys have been carried out by Aeroservice Pty. Ltd. (Hartman 1963, 1964; Isaacs and Hartman, 1963).

Fig. 2

PHYSIOGRAPHIC DIVISIONS
NORTH-EASTERN PART OF THE AMADEUS BASIN



PHYSIOGRAPHY

The physiographic divisions described below are shown in Figure 2, and the letters A, B, C, etc. refer to the legend of that map.

A. Mountain ranges and hills are present mainly in the northern and western parts of the area. In the north, the ranges are formed of steeply dipping Upper Proterozoic and some Lower Palaeozoic sediments; in the Waterhouse Range, near Mount Polhill, in the vicinity of Deep Well, around Santa Teresa Mission, and near Mount Charlotte, the ranges are composed of gently dipping Lower Palaeozoic sediments; the ranges east of Maryvale Homestead are of steeply dipping Mereenie Sandstone. The ranges, which are commonly east-west strike ridges, have peaks ranging from 200 to 1300 feet above the general level of the plain. The highest ranges of division A. are situated in the MacDonnell and Fergusson Ranges. The Heavitree Quartzite forms the most prominent ridge of these ranges, reaching 1300 feet above the level of the plain at Mount Gillen (3123 feet a.s.l.). There is a well defined drainage pattern which generally follows the strike valleys.

B. Not present in the area.

C. Sand plains with many sand dunes and some low outcrops occupy areas around Ewaninga Siding, east and north-east of Numery Homestead, and east of Pinnacle Hill on the Hale River Sheet area. These areas have no well defined drainage pattern. At the eastern end of the Missionary Plain, around Ewaninga Siding, undulating sandy country with rises composed of conglomerate has a relief of up to 30 feet. The large area of sand covered flats and undulating plains north-east of Numery Homestead has some low hills, whereas the smaller area in the neighbourhood of the Homestead includes hills up to 200 feet above the plain.

The sand plains around Pinnacle Hill have a few outcrops which average 20 feet high; a few hills attain 50 feet.

D. Sand plain with dunes covers a large portion of the area, especially in the east and south-east (i.e. the Simpson Desert). Outcrops are absent or very rare. The whole of division D is probably underlain by flat-lying or very 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 above the interdune areas. The dunes are more closely spaced than those of division C and the narrow interdune areas are unable to support much vegetation. A few creeks flow through the area to the south-east, but in general the drainage is poorly defined.

F. Gibber or alluvial plains with mesas and low hills are present east and west of Bokhara Homestead, east of Alice Springs, south of Ringwood Homestead, and also in the vicinity of North Bore, Andado Homestead and McDills Well. The whole of the Rodinga Anticlinorium is covered by gibber plains which surround discontinuous strike ridges up to 100 feet above the plain.

The calcareous alluvial plains shown near Ringwood are relatively stable. Small areas of active flood plains adjacent to the Todd River and a small sand dune field at the margin of the plain have been included in this division. Coalescent flood-plains of the Todd River and tributaries occur east of Alice Springs.

The gibber and alluvial plains near Andado and North Bore contain areas of iron-pisolite (buckshot) travel and some sand, but have few mesas or low hills.

The area of division F near McDills Well includes some sandy flood plains.

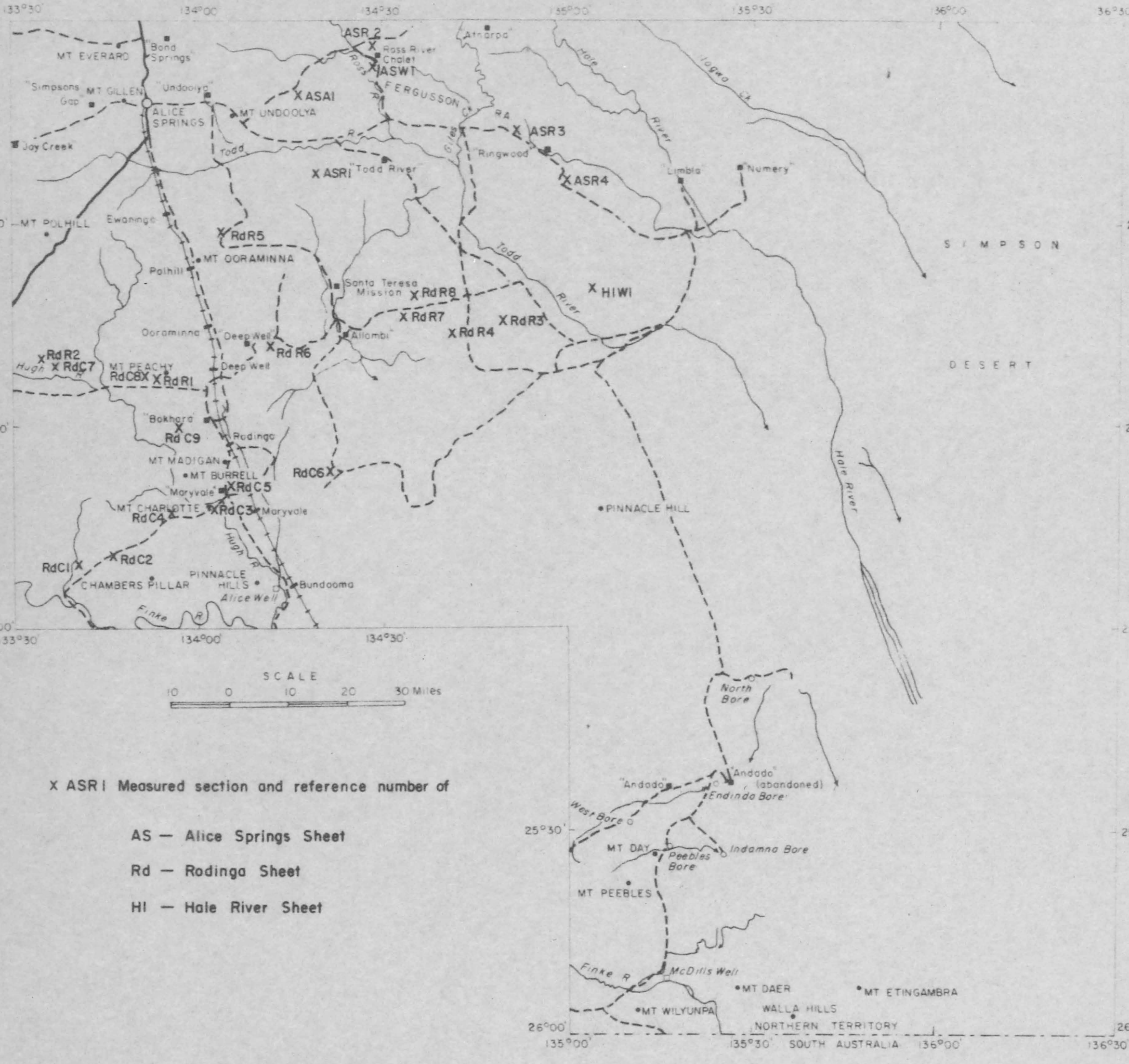
G. Alluvial flood plains with some clay pans are located along the present drainage patterns of the Illogwa and Hale Rivers in the east and around the Finke River in the west. The areas are of very low relief with outcrops completely absent or very rare.

H. Mesas and buttes with intervening sand or alluvium occur in the south-eastern parts of the area and comprise the areas of outcrop of flat-lying Mesozoic sandstones. The mesas may rise up to 200 feet above the general level of the plain and in many areas appear to be the remnants of old peneplained surfaces. The mesas characteristically have prominent steep scarps on their upper slopes. Some fairly prominent creeks occur on the flanks of the mesas but the intervening areas have a poorly defined drainage pattern.

Fig. 3

LOCATION OF MEASURED SECTIONS

NORTH-EASTERN PART OF THE AMADEUS BASIN



X ASR1 Measured section and reference number of

AS — Alice Springs Sheet

Rd — Rodinga Sheet

HI — Hale River Sheet

Bureau of Mineral Resources, Geology and Geophysics *To accompany Record 1965/108* *July 1965*

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STRATIGRAPHY

General

The relationships of the sediments 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 are shown in Table II.

Specimen localities and reference points on the geological map of Rodinga are prefixed by Rd, and those on the McDills geological map by McD. Specimen localities on the Alice Springs, Illogwa Creek, and Hale River geological maps are shown by numbers with no letter prefix. Specimens are marked with the prefix AS for those collected in the Alice Springs Sheet area, IC for the Illogwa Creek Sheet area, and Hl for the Hale River Sheet area. All specimen localities and reference points referred to in the text are written with both letter prefix and numbers.

UNDIFFERENTIATED PRECAMBRIAN

Precambrian Arunta Complex

The only basement rocks described in this report are those which crop out between the two ridges of Heavitree Quartzite of the Blatherskite Nappe at Alice Springs (described below in the section on structure). The rocks are poorly exposed, as most of the area is covered by alluvium, but on the north side of the southern ridge, beneath the scarp of Heavitree Quartzite, weathered granite and gneiss can be observed beneath the scree. There are also a few hills of basement quartzite and schist 3 miles west of Temple Bar Homestead, and a prominent hill of granite 1½ miles north-east of the homestead.

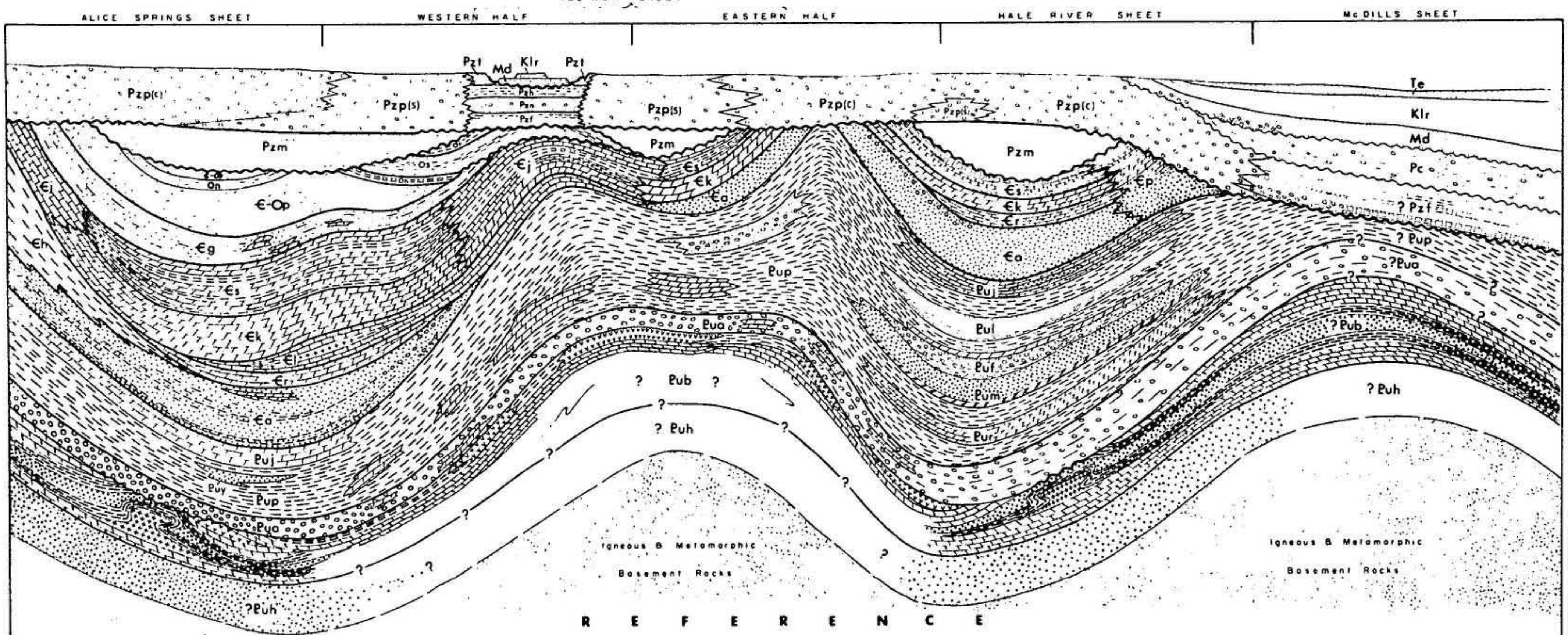
Gneiss is present at locality AS 139, 1 mile east of Temple Bar Homestead. The rock is a sheared granite, and consists of drawn-out and granulated quartz grains, coated with thin films of feldspar and biotite. The foliation strikes west-north-west and dips at 55 degrees to the south; this results in a marked unconformity with the overlying Heavitree Quartzite.

Granite crops out at several localities. Two miles west of Mt. Blatherskite, beneath the scarp of Heavitree Quartzite, the granite is leucocratic, even-grained in some places, and porphyritic in others where it carries euhedral crystals of potash feldspar up to 3 inches long. It has a south-dipping foliation, which strikes at an angle to the strike of the Heavitree Quartzite. Two miles west-north-west of Mt. Blatherskite, the granite is dominantly a medium-grained, foliated, muscovite granite, 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 1½ miles north-east of Temple Bar Homestead (locality AS 116) is composed of weathered and kaolinized, medium-grained granite, with some pegmatite and reef quartz. At locality AS 119, graphic granite and reef quartz are exposed; crystals of potash feldspar in the granite are up to 6 inches long.

Schist, observed at locality AS 117 (on the north side of the prominent hill north-east of Temple Bar Homestead), is a friable, green rock containing layers of pink feldspar. Some unsheared material is also present, and this is a very tough, dark green, fine-grained rock which contains indistinct phenocrysts; it may be an acid dyke. At locality AS 137, 3 miles west of Temple Bar Homestead, bands of fine-grained sericite-quartz schist are interbedded with the coarser quartzite described below. The schist has been contorted into small isoclinal folds whose axes are a b-lineation of the rock. The axial planes of the folds dip at 75° to the north-east and the axes have a rake of about 75 degrees to the south-east.

FIG 4

RELATIONSHIP OF ROCK UNITS
NORTH - EASTERN PART OF THE AMADEUS BASIN



R E F E R E N C E

TERTIARY

- Te — Etingambra Formation

LOWER CRETACEOUS

- Klr — Rumbalala Shale

? JURASSIC

- Md — De Souza Sandstone

PERMIAN

- Pc — Crown Point Formation

DEVONIAN TO CARBONIFEROUS

- Pzt — Santo Sandstone
- Pzf — Finke Group
  - Pzh — Horseshoe Bend Shale
  - Pzn — Langra Formation
- Pzp — Pertnjara Formation
  - (c) — conglomerate
  - (s) — sandstone

ORDOVICIAN TO DEVONIAN

- Pzm — Mereenie Sandstone

CAMBRIAN TO ORDOVICIAN

- €-Ol — Larapinta Group
  - Ot — Stokes Formation
  - Os — Stairway Sandstone
  - Oh — Horn Valley Siltstone
  - €-Op — Pacoota Sandstone
    - On — N'Dahla Member

CAMBRIAN

- €p — Pertaoorrta Group
  - €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

UPPER PROTEROZOIC

- Ꝑup — Pertatataka Formation
  - Ꝑuj — Julie Member
  - Ꝑuy — Cyclops Member
  - Ꝑul — Waldo Pedlar Member
  - Ꝑuf — Olympic Member
  - Ꝑum — Limbla Member
  - Ꝑur — Ringwood Member
- Ꝑua — Areyonga Formation
- Ꝑub — Bitter Springs Formation
- Ꝑuh — Heavitree Quartzite

TABLE 1

STRATIGRAPHY OF THE NORTH-EASTERN PART OF THE AMADEUS BASIN

AGE	FORMATION	MAP SYMBOL	MAXIMUM THICKNESS (in feet)	LITHOLOGY	TOPOGRAPHIC EXPRESSION	HYDROLOGY	REMARKS
QUATERNARY	Undifferentiated	Q		Alluvium, conglomerate, travertine, and sand			Section only
		Qa		Alluvial gravel, sand & silt.	Stream deposits, alluvial flats and scree slopes.	Good potential for high-quality water in places.	
		Qs		Aeolian sand	Dunes and sand plains	Poor prospects	
		Ql		Travertine	Low flat areas	Poor prospects	
		Qg		Gypsum	Low areas with mounds	Poor prospects	
		Qc		Conglomerate and scree	Gibber plains and scree slopes.	Poor prospects	May cover Tc
TERTIARY	Undifferentiated	T		Sandstone, calcareous sandstone limestone, travertine, conglomerate and chalcedony			
		Tl	100; east 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 northern part of McDills	Conglomerate and sandstone	Mesa cappings	Deposits are above water level	Known only in the Hale R. and McDills Sheet areas.
MESOZOIC — LOWER CRETACEOUS	Rumbalara Shale	Klr	700; Anacoora Bore, southern margin of McDills Sheet area	Siltstone, shale, porcellanite, and minor sandstone. Contains marine fossils.	Mesa cappings		Flat-lying; usually has a thin capping of billy
MESOZOIC — ?JURASSIC	De Souza Sandstone	Md	300 (approx); Malcolms Bore, southern margin of Hale River Sheet area.	Conglomerate, sandstone, and siltstone	Mesas		
PERMIAN	Crown Point Formation	Pc	1200 (approx); in Malcolms Bore	Sandstone, siltstone, boulder beds, [illegible].	Mesas and low mounds		Probably fluvioglacial
PALAEOZOIC — DEVONIAN TO CARBONIFEROUS	Santo Sandstone	Pzt	200 South of Mt. Charlotte	Kaolinitic sandstone with conglomerate bands	Mesas		Commonly has a billy capping
	Finke Gr.: Horseshoe Bend Shale	Pzh	450 South of Mt. Charlotte	Micaceous siltstone and shale	Plains		Very poorly exposed.
	Finke Gr.: Langra Formation	Pzn	500 (est.); south of Mt. Charlotte	Coarsely conglomeratic sandstone			Known only subsurface south of Mt. Charlotte

TABLE 1. (ii)

ERA	AGE	GROUP	FORMATION	MAP SYMBOL	MAXIMUM THICKNESS (in feet)	LITHOLOGY	TOPOGRAPHIC EXPRESSION	HYDROLOGY	REMARKS
PALAEOZOIC	Devonian to Carboniferous		Pertnjara Formation	Pzp(c)	5000 est. in Brewer Plain	Coarse, very thickly bedded conglomerate	Rounded hills		
				Pzp(s)	1300;Williams Bore (ASA-1),Alice Sprgs. Sheet area	Red-brown,silty sandstone, with pebbles	Prominent ridges and ranges	Some beds could supply large quantities of moderate to good quality 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.
	Ordovician to Carboniferous			Pz		Sandstone,pebbly sandstone		Good prospects	This unit consists of Pzp(s) + Pzm.
	Ordovician 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 Є-Ol	Stokes Formation	Ot	455; near Norma Bore,(RdC7), Rodinga Sheet area.	Siltstone,shale,and limestone	Strike valleys	Impermeable sequence, prospects poor.	Very poorly exposed.
			Stairway Sandstone	Os	590; near Norma Bore, (RdC7), Rodinga Sheet area.	Sandstone,siltstone, some 'red-beds'	Strike ridges	Some porous beds, but water generally saline.	Has thin phosphatic beds.
			Horn Valley Siltstone	Oh	145;near Norma Bore, (RdC7),Rodinga Sh.	Siltstone,shale and limestone.	Strike valleys	Low permeability, prospects poor.	Very poorly exposed.
			Pacoota Sandstone	Є-Op	3,100; near Ross River Tourist Chalet	Sandstone and silty sandstone.	Prominent strike ridges	Porosity and permeability highly variable. Could supply good water in some areas.	Thins markedly to the south.
			N'Dahla Member	On	500 (approx.);N'Dahla Gorge	Silty sandstone			Found only on northern limb at Ross River Syncline.
	Cambrian	Pertaoorrta Group Єp	Goyder Formation	Єg	1430; Williams Bore (ASA-1)	Silty sandstone, siltstone and limestone	Strike valleys and scarps	Upper part may provide small supply	Commonly poorly exposed
			Jay Creek Limestone	Єj	1400;western margin of Rodinga Sheet area (near Mt.Peachy, RdR-1)	Interbedded siltstone and algal limestone	Strike valleys with low limestone ridges	Porosity and permeability probably low, and prospects poor.	Present only in the western part of the area.
			Hugh River Shale	Єh	1600 (approx); at Jay Creek	Shale and siltstone with dolomite at base	Strike valley	Poor prospects	
			Shannon Formation	Єs	2340; in Todd R. Anticline (ASR-1)	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 the eastern part of the area.
			Giles Creek Dolomite	Єk	1320; in Todd R. Anticline (ASR-1)	Thick-bedded dolomite, limestone, shale, and siltstone.	Strike ridges		Limestones are fossiliferous.
			Chandler Limestone	Єl	300; Deep Well	Limestone and dolomite, with chert laminae	Low ridges and mounds	Very saline water	Generally highly contorted and incompetently folded. Existence of interbedded evaporites suspected, but nowhere seen in outcrop.
			Todd R.Dolomite	Єr	510; at Ross R. Tourist Chalet	Dolomite, sandstone, and siltstone.	Strike ridges	Poor prospects	Contains archaeocyathans.
			Arumbera Sandstone	Єa	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 to the south on the Rodinga Sheet area.

TABLE 1. (iii)

	AGE	FORMATION	MAP SYMBOL	MAXIMUM THICKNESS (feet)	LITHOLOGY	TOPOGRAPHIC EXPRESSION	HYDROLOGY	REMARKS
PRECAMBRIAN	Upper Proterozoic	Pertatataka Formation	Bup	6040; south-east of Phillipson Pound. (RdR7 & 8)	Mainly siltstone and shale, with some dolomite, limestone, and sandstone	Wide strike valleys, with prominent strike ridges.	Poor prospects	
			Bup(c)		Conglomeratic sandstone			Possibly tillitic
		Julie Member	Buj	1770south-east of Phillipson Pound	Dolomite, limestone, sandstone, and minor siltstone	Prominent strike ridges.	Porosity variable, prospects generally poor	Sandstone is lenticular in places.
		Waldo Pedlar Member	Bul	200; near Olympic Bore	Interbedded sandstone siltstone and shale	Low strike ridges	Poor prospects	Incompetantly folded in places.
		Olympic Member	Buf	630; near Ringwood Homestead (ASR-4)	Dolomite, shale, conglomerate, and sandstone	Strike valley	Poor prospects	Conglomerate is possibly tillitic. Poor outcrop.
		Limbla Member	Bum	470;near Ringwood Homestead (ASR-4)	Quartzose calcarenite siltstone, and sandstone	Low strike ridges	Poor prospects	Upper sandstone unit exhibits fine cross-laminae and slumps.
		Ringwood Member	Bur	540; near Ringwood Homestead (ASR-4)	Calcarenite, dolomite, and siltstone	Low strike ridges	Poor prospects	Contains irregular stromatolites.
		Cyclops Member	Buy	250; north of Gaylad Dam.	Fine-grained sandstone	Low strike ridges	Poor prospects	Very even, rhythmic, thin beds and laminae.
		Areyonga Formation	Bua	575; near Gaylad Dam (ASR-3)	Siltstone, dolomite, conglomerate, and sandstone	Prominent ridge in places	Porous sandstone could give moderate supply	Fluvio-glacial in part.
		Bitter Springs Formation	Bub	3500; est. for the northern part of the 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	Bue	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
			Bue_1		Green basic volcanics, much weathered	Rubbly outcrops		Typical, variable, spilitic composition.
		Gillen Member	Bug	1350; south of Mt.Gillen	Dolomite, siltstone, sandstone and shale.	Low ridges and hills	As for Bitter Springs Formation	Contains, evaporites (subsurface).
		Heavitree Quartzite	Buh	1000; estimated	Sandstone, conglomeratic in places	Very prominent ridges	Very poor prospects	Up to 30 feet of shale at base in places
	Undifferentiated	Arunta Complex	pGa		Gneiss schistose gneiss, schist, and quartzite	Low hills.	Prospects generally poor	

TABLE II

THICKNESS OF FORMATIONS - NORTH-EASTERN PART OF AMADEUS BASIN

SHEET AREA		ALICE SPRINGS						RODINGA													
FORMATION	Map Symbol	ASW1 ASR5	ASA1	ASR1 ASR2	ASR3	ASR4	HALE RIVER HC11	RdC7 RdR2	RdC8 RdR1	RdC9	RdC1	RdC2	RdC3	RdC4	RdC5	RdC6	RdR3	RdR4	RdR5	RdR6	RdR8 RdR7
Pertnjara Formation	Pzp	P	1340+	1220+	NPS	NPS	NE	NM	NM	NE	P	440+	P	NE	215+	NM	1720	P	P	P	NPS
Mereenie Sandstone	Pzm	NM	720	1200	NPS	NPS	P	1310	NM	P	A	A	A	A	70	NM	1000	NM	NM	NM	NPS
Larapinta Group																					
Stokes Formation	Ot	A	A	A	A	A	A	455	A	A	60+	P	P	105+	160	A	A	A	A	A	A
Stairway Sandstone	Os	A	A	A	A	A	A	590	355	410	335	NM	305	335	225	225	A	A	A	A	A
Horn Valley Siltstone	Oh	A	A	A	A	A	A	145	120	90	A	A	A	A	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	A	NM	260	NPS
Pertaoorrta Group																					
Goyder Formation	Єg	1230	1430	610	NPS	?A	A	P	1180	P	A	A	A	A	A	A	A	A	NM	680	NPS
Shannon Formation	Єs	1180	1700	2340	135+	NPS	830	A	A	A	A	A	A	A	A	A	NM	935	1800	1810	NM
Giles Creek Dolomite	Єk	830	960	1320	1090	NPS	550	A	A	A	A	A	A	A	A	A	P	495	1100	610	NM
Jay Creek Limestone	Єj	A	A	A	A	A	A	P	1400	NM	P	P	P	P	NM	NM	A	A	A	A	A
Chandler Limestone	Єl	A	A	A	A	A	A	P	260	NM	P	P	P	P	NM	NM	NE	660	200	180	NM
Todd River Dolomite	Єr	510	260	325	455	NPS	340	A	A	A	A	A	A	A	A	A	NE	A	150	A	NM
Arumbera Sandstone	Єa	1110	1800	2240	1530	NPS	1265	P	670	A	A	A	A	A	A	A	NPS	70+	P	1400	NM
Pertatataka Formation	Ƀup	2220	320+	480+	2215	4550+	430+	P	P	P	P	P	P	P	P	NE	NPS	P	NE	P	6040
Julie Member	Ƀuj	420	320	480	P	NPS	430+	A	A	A	A	A	A	A	A	A	NE	NE	NE	NE	1770
Cyclops Member	Ƀuy	160	NE	NE	NE	A	A	A	A	A	A	A	A	A	A	A	A	A	NE	NE	A
Olympic Member	Ƀuf	A	A	A	A	630	NPS	A	A	A	A	A	A	A	A	A	NE	NE	NE	NE	NE
Limbla Member	Ƀum	A	A	A	A	470	NPS	A	A	A	A	A	A	A	A	A	NE	NE	NE	NE	374+
Ringwood Member	Ƀur	A	A	A	A	540	NPS	A	A	A	A	A	A	A	A	A	NE	NE	NE	NE	76+
Areyonga Formation	Ƀua	170	NPS	NE	575	NE	NPS	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	490
Bitter Springs Formation	Ƀub	365+	NM	NE	1265+	NM	P	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	730+
Loves Creek Member	Ƀue	365+	NM	NE	840	NM	P	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	730+
Gillen Member	Ƀug	NM	NM	NE	425+	NM	P	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

A - Absent from sequence. P - Poor or incomplete exposure. NE - Not exposed (may be present).

NM - Not measured (good exposure). NPS - Not present due to structure and level of erosion.

Quartzite of the Precambrian basement is well exposed at AS 137. It is a coarse-grained, translucent, colourless to pale blue, schistose rock composed of quartz and a little sericite, with a texture not unlike that of a granite. The schistosity dips at about 75 degrees to the north-east. A poorly visible lineation in the plane of the schistosity is parallel to the b-lineation of the contorted schist interbeds. The attitude of the schistosity is markedly discordant with the strike and dip of the overlying Heavitree Quartzite, which crops out immediately to the south.

UPPER PROTEROZOIC

Heavitree Quartzite (Joklik, 1955)

Originally referred to as the No.1 Ridge quartzite (Ward, 1925), the unit was named the Heavitree Quartzite by Joklik (1955). It forms a prominent ridge up to 1300 feet above the plain, and extends across the map-area from Jay Creek in the west to north of the Ross River Tourist Chalet, and thence to the Illogwa Creek Sheet area in the east. In addition, a high dissected plateau of flat-lying Heavitree Quartzite is situated in the Waldo Pedlar-Casey Bore area, at the junction of the Illogwa Creek and Hale River Sheet areas.

Throughout its extent, the Heavitree Quartzite lies with a regional unconformity on the Precambrian Arunta Complex. It is overlain conformably by the Gillen Member of the Bitter Springs Formation, followed by the remainder of the Proterozoic and Palaeozoic succession. No stratigraphic section was measured through the formation. At Heavitree Gap, the estimated thickness is 600 feet (Prichard and Quinlan, 1962, p.8), and elsewhere the thickness is generally about 1000 feet or less (estimated from air photographs).

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, directly on top of the Precambrian basement. At Heavitree Gap and west of Mt. Blatherskite, the lower 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.

The major part of the formation is a clean, silicified, quartz sandstone. In the Jay Creek - Alice Springs area, the lower few hundred feet consists of pinkish brown to white sandstone, mostly fine-grained, laminated to thin-bedded, cross-bedded, pebbly in places, poorly rounded and tough. This is overlain by a sequence of silicified sandstones, and these include coarse-grained, well-rounded sandstone; fine-grained, poorly rounded pinkish brown sandstone; a few beds of conglomerate; some coarse sandstone with small pebbles; and some fine sandstone with a small content of coarse sand grains. The sandstones are laminated to thin-bedded, cross-bedded, and ripple-marked.

The top few hundred feet of the formation is commonly bluish white and coarse-grained, or pinkish brown and fine-grained. Moulds of euhedral pyrite crystals (pyritohedra) were found in the uppermost quartzite ½ mile south and 2 miles south-east of Jay Creek Native Settlement. The pyrite was probably authigenic. Possible organic markings are common 1 mile west of Temple Bar Homestead.

North of Ross River the lithology of the Heavitree Quartzite is practically unchanged from that of 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 is a brown, silicified, ferruginous sandstone, cross-bedded, coarse to very coarse-grained, and with small pebbles in some beds. Interbeds of ironstone are present.

The conditions of deposition appear to have been those of a shallow-water shelf environment, and the great lateral extent of the formation suggests that this was marine. The Heavitree Quartzite is placed in the Upper Proterozoic, as it lies beneath Collenia-bearing carbonates of the Bitter Springs Formation, and these in turn lie many hundreds of feet below the first Lower Cambrian fossils at Ross River; the formation contains no diagnostic fossils.

Bitter Springs Formation (Joklik, 1955)

Madigan (1932a and 1932b) mapped this unit in the Hermannsburg Sheet area, and included it in his Pertaknurra (B) Series. The formation was formally named the Bitter Springs Limestone by Joklik (1955), but the name has since been changed to Bitter Springs Formation (Ranford, Cook, and Wells, 1965). The change was made because the unit comprises a variety of lithologies, of which limestone is not the dominant one. In the present report, the formation has been divided into two members, the Gillen Member (lower) and the Loves Creek Member (upper). This division arose from work by Banks (1964) of Magellan Petroleum Corporation, who suggested that the Bitter Springs Limestone (as it then was) could be divided into three formations. It has not been possible in this surface survey to either identify or map his middle formation, as this was known only from subsurface information. Consequently, the formation has been divided into only two members, and Banks' middle formation has been included with the lower. As far as is known, both of the members were deposited throughout the whole extent of the Bitter Springs Formation.

The Bitter Springs Formation crops out south of the ridge of Heavitree Quartzite, 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 conformably overlies the Heavitree Quartzite, and is overlain by theAreyonga Formation. This upper contact is

Fig. 5 Incompetent folding in the Gillen Member of the Bitter Springs Formation, one mile north of Allua Well (Alice Springs Sheet area). Neg. No.G/7524

Fig. 6 Hemispherical stromatolite colonies in the Loves Creek Member of the Bitter Springs Formation, 2 miles SSW of Shannon Bore, Alice Springs Sheet area (AS 186)
Neg. No. G/7462

disconformable in the west, but east of Ross River a slight regional unconformity separates the two unites. An angular unconformity between the two formations is present 3 miles east-south-east of Shannon Bore.

There is no measured section through the Bitter Springs Formation, but its thickness is no more than 3,000 feet (cf. Banks, 1964). The age is Upper Proterozoic, as both members lie many hundreds of feet below the Lower Cambrian fossils at Ross River, and Collenia-type stromatolites are common in the formation (Figs. 6 and 8).

Gillen Member (new name)

This is the formal name given in this report to the lower member of the Bitter Springs Formation. The name is taken from Mt. Gillen, 4 miles west of Alice Springs. Mt. Gillen itself is composed of Heavitree Quartzite resting on Arunta Complex, but the Gillen Member crops out immediately to the south. This is the type locality.

The member is found throughout the MacDonnell Ranges on the south side of the ridge of Heavitree Quartzite, but it does not crop out in the Rodinga Sheet area. It forms small hills which are covered in spinifex, from which project ridges of dolomite. Slopes are short, and moderately to steeply inclined; the texture of dissection is close.

The Gillen Member follows conformably on the Heavitree Quartzite, and is generally overlain conformably by the Loves Creek Member. However, 3 miles east-south-east of Shannon Bore in the Alice Springs Sheet area, it is overlain with an angular unconformity by conglomerate of the Areyonga Formation, and north of Ringwood Homestead large areas of the Gillen Member are again overlain by the Areyonga Formation, but for the most part paraconformably.

It is not easy to measure sections through the member, because in most places it has folded incompetently (Fig.5). However, Banks (1964) measured a section through the member at Mt. Gillen, and recorded a thickness of 1350 feet. He designated this the type section, and a columnar diagram of the section, with thicknesses interpolated from his information, is shown in Figure 7. In this report, the contorted dolomite immediately above his type section (called Bitter Springs Limestone by him) is included in the Gillen Member, as it shows little difference from the dolomite in the lower part of the section. The 'carbonates' throughout his section are dolomites.

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

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

Sandstone is not common, and 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.

In the area around Ringwood Homestead, and south of the Fergusson Range, the lithology of the Gillen Member is similar, i.e., 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 AS 36, 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 (halite) in the bitter Springs Formation in the Ooraminna No.1 and Mt.Charlotte No.1 Oil Wells is also referred to the Gillen Member.

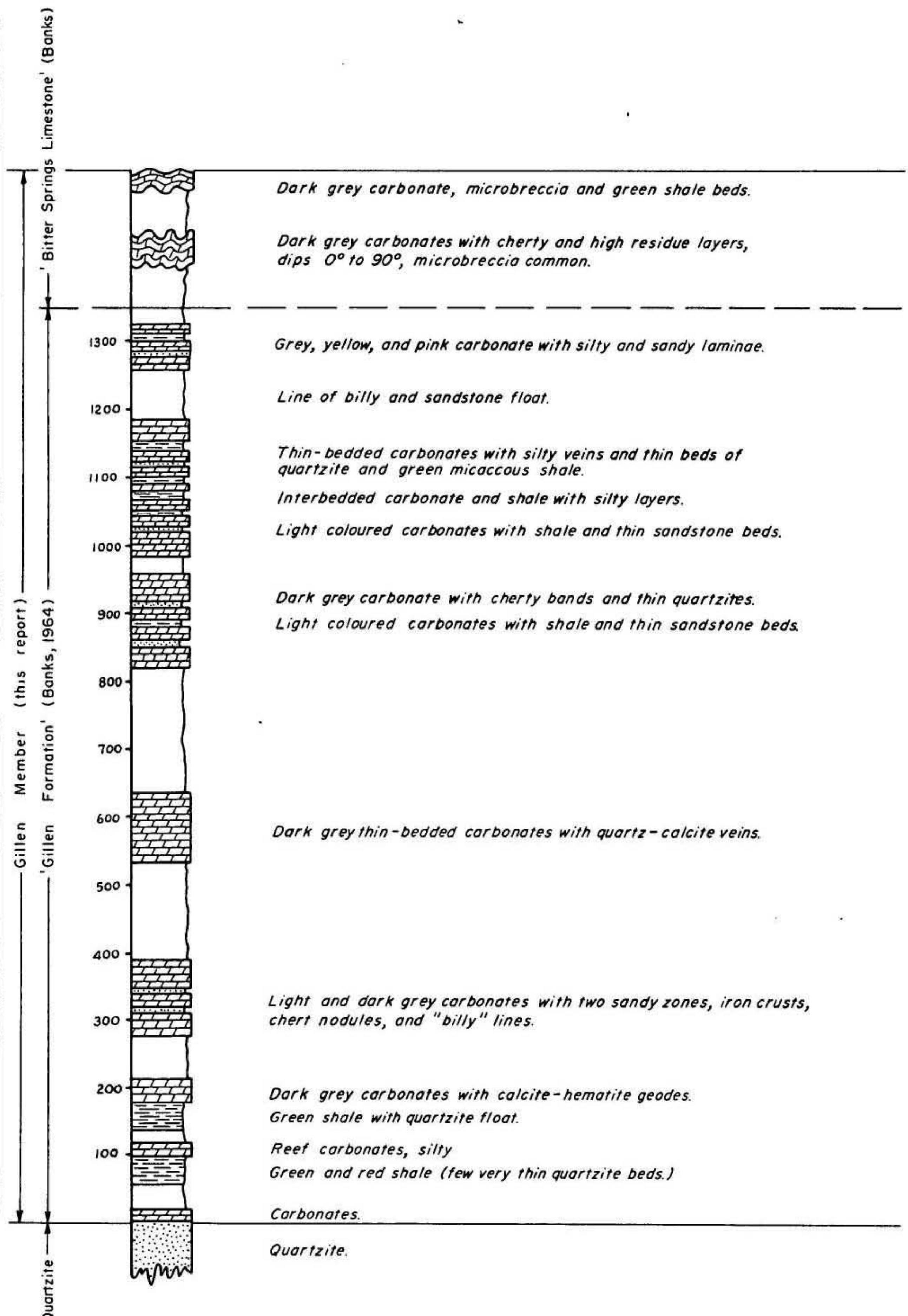
In the Illogwa Creek Sheet area, the Gillen Member has a few hundred feet of fractured grey dolomite at the base, overlain by purple gypsiferous siltstone, and then by green micaceous shale with interbeds of dolomite. This is overlain by a very prominent ridge-forming interval of white, silicified granule conglomerate and fine to coarse-grained, cross-bedded sandstone, pale purplish brown but weathering white. This ridge is about 200 feet thick, and crops out from 4 miles south-west to 14 miles north-east of Limbla Homestead. At locality IC 103, 2 miles north-west of Numery Homestead, the fine sandstone contains pseudomorphs after halite 1 inch across. The sandstone is succeeded by a sequence of interbedded dolomite, green micaceous shale, and sandstone; the thickness of this interbedded sequence is variable. At Limbla Homestead, it is overlain by the Loves Creek Member, about 300 feet of algal dolomite containing chert nodules, followed by red siltstone.

In the Hale River Sheet area, the Gillen Member is reduced in thickness, but consists of the same general lithologies as in the Illogwa Creek Sheet area, i.e., interbedded dolomites and shaly siltstones, and a prominent ridge of coarse white sandstone and granule conglomerate.

The conditions of deposition of the Gillen Member were shallow and marine; periods of influx of fine and some coarse clastics alternated with periods when no detritus came in, during which carbonate was laid down. This was probably limestone, which was subsequently converted to dolomite.

Fig. 7

TYPE SECTION OF GILLEN MEMBER



Type section of Gillen Member, south of Mt. Gillen, Alice Springs. Modified from Banks (1964, Fig. 41, "Mt. Gillen Traverse").

Gillen Formation of Banks now Gillen Member in this report.

NT/A124

Bureau of Mineral Resources, Geology and Geophysics

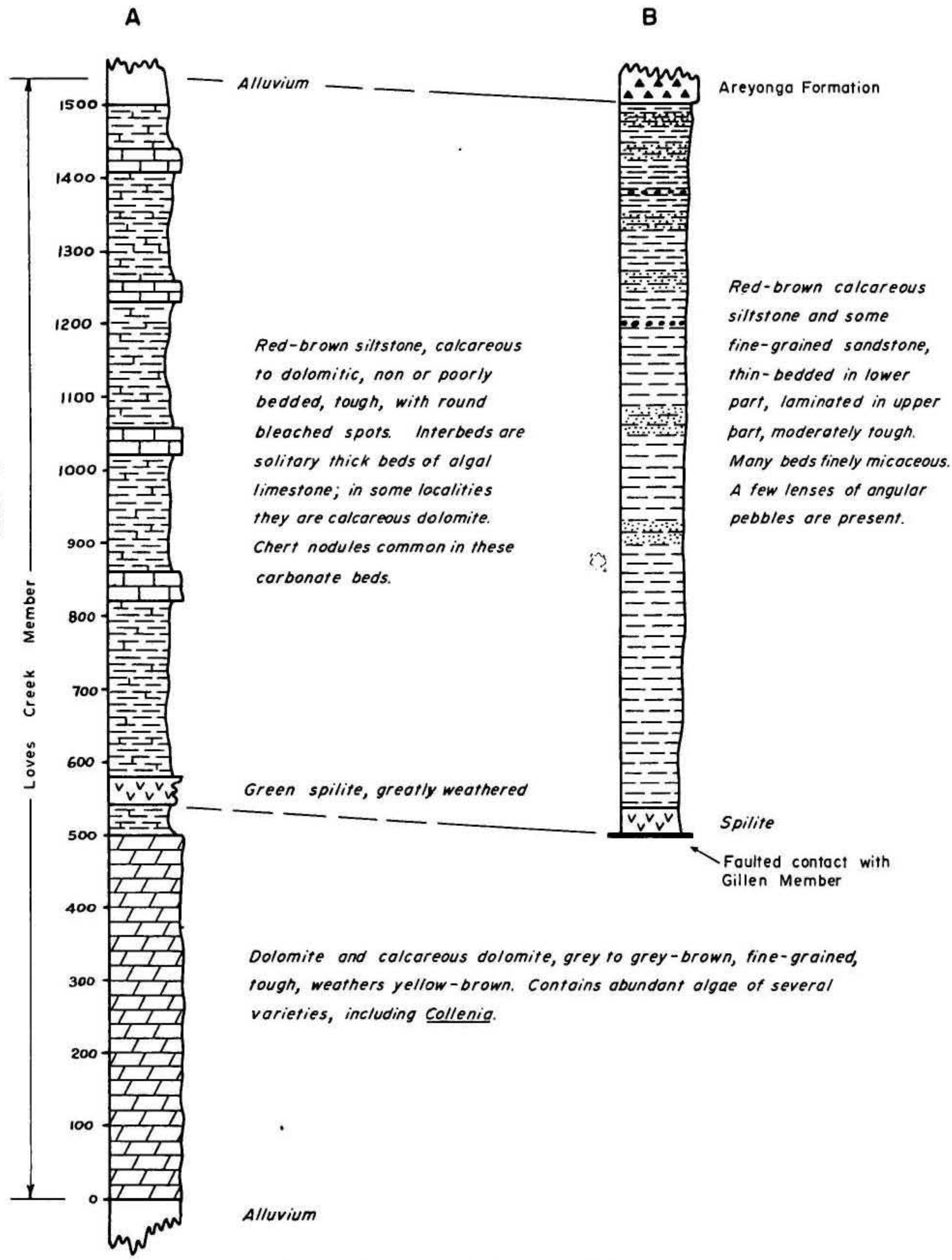
To accompany Record 1965/108

Fig.8 Silicified stromatolite colonies in the Loves Creek Member of the Bitter Springs Formation near Mosquito Bore (Alice Springs Sheet area).

Neg. No. M405-13

Fig. 9

GENERALIZED SEQUENCES IN THE LOVES CREEK MEMBER



Generalized sequences in Loves Creek Member. Column A is from Julie Dam - No. 6 Bore area, column B from area 2 miles north-north-west of Williams Bore.

NT/A125

Bureau of Mineral Resources, Geology, and Geophysics — To accompany Record 1965/108

Loves Creek Member (new name)

This is the new formal name for the upper member of the Bitter Springs Formation. The name comes from Loves Creek, which 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 north side of the valley of Loves Creek.

The unit is widespread through 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 rounded hills of dolomite generally bare and steep-sided. Limestone beds form thin prominent ridges. The member lies conformably upon 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 strike. No section has been measured through the Loves Creek Member in the area mapped, but a generalized sequence, compiled from several localities, is shown in column A, Figure 9. This gives a total thickness of 1,500 feet.

Between Jay Creek and Alice Springs, the member is about 700 feet thick and consists mostly of siltstone, with interbeds of chert, dolomite, and rare limestone. The siltstones are commonly calcareous, red-brown, poorly or non-bedded, friable to tough, and characterized by the presence of spherical, white (bleached) spots up to 1 inch in diameter. Hematite concretions up to 15 inches across have formed in the siltstones. 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 these cherts. Silicified and brecciated siltstone is also common. The dolomite is mostly yellowish brown, tough, laminated, fine-grained, and contains biscuits and nodules of chert. Fine to coarse-grained edgewise conglomerate, composed of angular chips of dolomite in a dolarenitic matrix, occur as interbeds in the dolomite. Limestone is rare, but some is exposed 2 miles east of Fenn Gap. It is dark grey, very tough and cavernous, and contains elongate 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 1,500 feet thick (Fig.9) and comprises 500 feet of grey-brown, fine-grained dolomite with abundant Collenia-type algae (Figs.6 and 8), overlain by 1,000 feet of red-brown calcareous siltstone. The siltstone has the characteristic white bleached spots, and contains thick interbeds of algal limestone and a few of dolomite.

Two miles north-north-west of Williams Bore, only the upper part of the member is present, owing to a faulted contact with the Gillen Member. It consists of about 1,200 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), and there are no interbeds of limestone or dolomite in the red beds. This is column B in Figure 9. The difference in the lithologies of this area and the No.6 Bore area suggests that there has been considerable movement of blocks of sediment (decken) along thrust planes (see the section below on structure), so that sequences which were originally far apart have been brought close together. The sediments shown in column B of Figure 9 were probably deposited closer to shore than those shown in column A.

Throughout the rest of the area east of the Ross River, the member consists of the same general rock-types, i.e. 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 member consists essentially of brecciated grey and brown fetid, algal, dolomite, containing nodules and laminae of chert, and red-brown calcareous siltstone with white bleached spots.

The Loves Creek Member contains some very weathered basic volcanic rock. In some places it is sufficiently thick to be mapped as a separate unit, and is described below.

The generally very fine-grained and calcareous nature of the clastics of the Loves Creek Member, and the existence of abundant algae suggest a shallow, marine, shelf environment, into which fine detritus came only very slowly or not at all.

Basic Volcanics

Though not formally named as a separate member of the Bitter Springs Formation, the basic volcanics are in places sufficiently extensive to be shown on the map as a separate unit, with the symbol Pue_1. The rocks are found at a number of localities east of Alice Springs, and in the north-east part of the Rodinga Sheet area; they are generally very weathered and poorly exposed. The largest exposure is in the Illogwa Creek Sheet area, where the volcanics form an arc around the north-western end of the Limbla Syncline. About 140 feet of volcanic rock was intersected in the Ooraminna No.1 Oil Well.

Where present, the volcanic unit is generally 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, volcanic rocks are present near the base of the member.

The rocks, where fresh, are grey-green, fine-grained, tough, and in places amygdaloidal; no pillows were seen. In thin section, the rocks are found to have a typical basaltic texture, being fine-grained and ophitic. The rocks are greatly altered, and their composition is different from place to place. However, in all the thin sections examined (seven), chlorite (pennine), sodic plagioclase (oligoclase in some specimens, albite in others), and ore minerals (hematite, and ilmenite+leucoxene) were present. The

Fig.10 Angular unconformity (bottom of hammer handle) between conglomerate of the Areyonga Formation and quartzite and green shale of the Gillen Member, three miles east-south-east of Shannon Bore (Alice Springs Sheet area).
Neg. No.M400-32

TOP

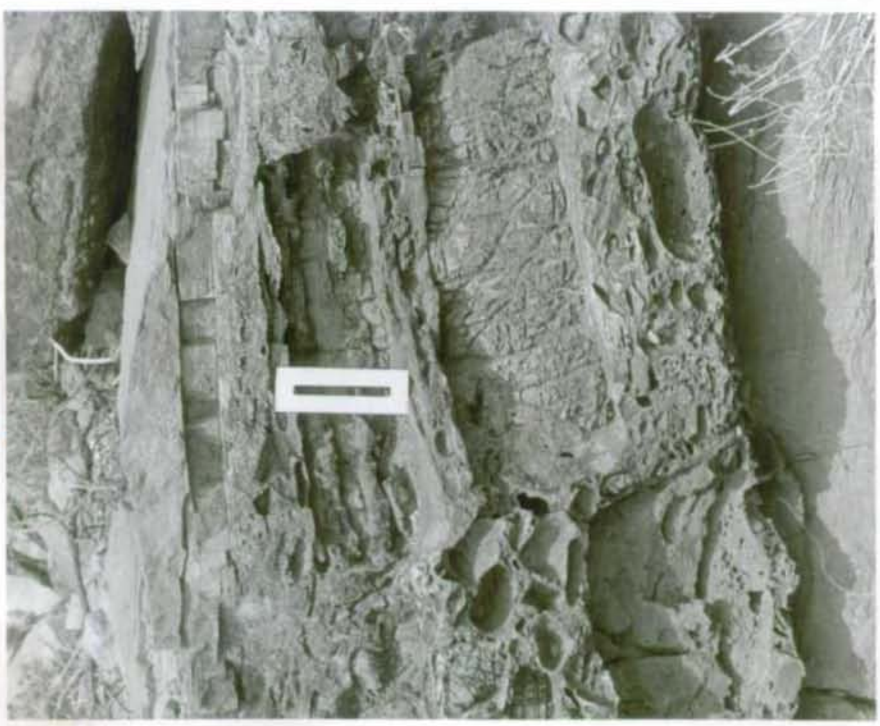


Fig.11 Contact of Areyonga Formation and Bitter Springs Formation one mile north-west of Pulya-Pulya Dam (Alice Springs Sheet area). Three inch bed of phosphate rock occurs in the Areyonga Formation about 3 inches above top of (6 inch) scale.
Neg. No.M398-52

The plagioclase is very much sericitized. Actinolite is common, both as well formed prisms and as aggregates of uralite. In the least altered example (B 15, T.S.14425), augite is plentiful, both as phenocrysts with included laths of oligoclase, and as a substantial part of the groundmass. Other minerals found are calcite, which forms 30% of the rock in AS 40 and AS 43, zeolites, epidote, antigorite, and rare quartz. Interstitial devitrified glass and veinlets of zeolites are present in AS 39, and calcite, chlorite, and zeolites fill the amygdales in this and AS 40. The rocks are typical spilites.

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

The spilites are regarded as extrusive because of their basaltic texture, their consistently conformable interbedded relationship with the other sediments, the existence of recognizable flow tops, and the associated cherts. Their very altered nature suggests an origin by low-temperature, hydrous, soda metasomatism of basalt, along one of the lines discussed by Vallance (1960).

Areyonga Formation (Prichard & Quinlan, 1962)

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

The Areyonga Formation crops out in the west near Jay Creek Native Settlement and discontinuously in the MacDonnell and Fergusson Ranges. The most easterly exposure is about four miles north of Numery Homestead. In the southern part of the area mapped, the formation is found 5 miles north-north-west of Allambi Homestead, and to the east of this point in discontinuous outcrops for about 20 miles.

Exposures of the formation are generally poor, except where the beds are composed of tough, siliceous, arkosic sandstone, which forms ridges. Generally the matrix of the sediment is calcareous or silty, and easily weathered.

Along the north-eastern margin of the Amadeus Basin, the Areyonga Formation lies paraconformably or disconformably on the Gillen and Loves Creek Members of the Bitter Springs Formation, and in places with an angular unconformity on the Gillen Member. The angular discordance (Fig.10) is well exposed 3 miles east-south-east of Shannon Bore and the contact can be traced for about 2 miles along strike. The beds in the Gillen Member dip at 20 degrees to the east-north-east and those in the Areyonga dip at 32 degrees to the north. The contact is very irregular and beneath the unconformity, the harder quartzite beds in the Gillen Member form hills which have a relief of 30 to 40 feet. A poorly sorted basal conglomerate, usually with a high content of angular chert, caps the quartzite hills whereas the valleys between are filled with poorly sorted silt and sand. In the southern outcrops, the contact of the Areyonga Formation with the Bitter Springs Formation is not exposed, but the presence of phenoclasts from the underlying formation suggests a disconformable contact.

A considerable period of erosion before and during deposition of the Areyonga Formation is indicated by the presence of large boulders of dolomite in the formation, and by the angular contact between the Areyonga and the Gillen Member of the Bitter Springs Formation.

The Areyonga Formation is laterally equivalent to the Inindia Beds (Ranford, Cook& Wells, 1965), exposed in the southern part of the Amadeus Basin. The Inindia Beds are a great deal thicker and contain large thickness of marine and possibly continental sandstone as well as interbeds of glacial boulder beds.

The Areyonga Formation consists of boulder clay, pebble and cobble conglomerate, arkose and poorly sorted sandstone and siltstone. Arkose forms a prominent basal unit of the formation in the north-eastern part of the area, mainly north of Ringwood and Limbla Homesteads. It can be traced for many miles but in places forms small lenticular bodies. The arkose is coarse, angular, poorly sorted, and is usually 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 clays, siltstone, and some sandstone.

The lithology of the formation changes very rapidly along strike. Near Jay Creek Native Settlement, the formation consists of about 150 feet of white, kaolinitic, porous, poorly rounded and sorted coarse and medium grained sandstone. Near Ross River Tourist Chalet, it consists of poorly sorted cobble beds and dolomite. Further east, the formation shows even more rapid changes in composition 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.

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

Similar changes in the lithology of the formation are found among southern exposures. 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 east of this locality, the formation includes beds of calcareous siltstone and sandstone, with scattered erratics of pegmatite, gneiss, vein quartz, sandstone, and chlorite schist. The boulders are up to 3 feet in diameter.

Fig.12 Cast of possible organic origin in the Areyonga Formation 8 miles west of Fenn Gap (Alice Springs Sheet area).

The sediments in the formation show few depositional textures. Cross bedding is rare. A cast of possible organic origin (Fig.12) was found in sandstone about 8 miles west of Fenn Gap. It is about six inches long, tubular and divided into several segments. No other organic remains were found.

The maximum exposed thickness of the formation is estimated to be 1200-1500 feet between Bull hole and Bronco Bores, north of Limbla Homestead. Elsewhere, the formation is from 40 to 600 feet thick, and in places may be extremely thin or absent. 170 feet was 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 (Rd R7). These measured sections are shown on Plate 8. In the Ooraminna No.1 Bore about 350 feet of Areyonga Formation is interpreted in the section. In the Mt.Charlotte No.1 Bore an unconformity is interpreted in the carbonate sequence in the lower part of the Bore. This unconformity is taken as the contact of the Bitter Springs Formation and Areyonga Formation. This would make the Areyonga Formation about 600 feet thick. It is also possible that this carbonate section may belong to the Pertatataka Formation and the Areyonga Formation may be 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 (Fig.11). The significance of this bed of phosphatic material is discussed in the section on economic geology.

A glacial depositional environment is suggested for the Areyonga Formation because of the unsorted nature of the deposits, the presence of a rock flour matrix, striated cobbles, and phenoclasts of many rock types foreign to the immediate outcrop area, the changes in lithology over short distances, and the lenticular nature of the unit.

The formation is considered to be Upper Proterozoic, as it occurs no less than 2000 feet 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 mapped. It is moderately well exposed in the Mount Burrell Anticlinorium but the sequence is complicated by faulting and folding. In general only the arenite and carbonate rocks crop out and these represent only a small percentage of the total thickness of the unit.

In most places in the north-eastern part of the Amadeus Basin, the Pertatataka Formation lies conformably between the Arumbera Sandstone above and the Areyonga Formation below. In the southern outcrops the base of the formation is not exposed and in several places it is overlain either disconformably or unconformably by the Cambrian Chandler Limestone, and in other places with an angular unconformity by the Pertnjara Formation.

The formation ranges in thickness from about 2,200 feet at Ross River (ASR-5), Jay Creek, and Giles Creek (ASR-3), to 2,600 feet in the Ooraminna No.1 Bore, over 4,500 feet south of Ringwood (ASR-4) and over 6,000 feet 14 miles east-north-east of Allambi Homestead (RDR7 and 8). In the Mt.Charlotte No.1 bore the Pertatataka Formation is at least 1,600 feet thick. These measured sections are shown in Plate 8.

In the north-western part of the area two members have been defined and mapped within the formation; the Julie Member and the older Cyclops Member. The two Members are separated from each other and from the underlying and overlying formations by green and red-brown siltstone and shale.

In the extreme north-eastern part of the area six members have been mapped within the formation and the total thickness may be 7,000 feet. The Julie Member persists into this area but the Cyclops Member cannot be identified and its relationship to the other members is not known.

One of the members of the Pertatataka Formation (the Olympic Member) includes some boulder beds with glacial features. These beds suggest a second period of Precambrian glacial deposition, younger than the glacials of the Areyonga Formation.

A conglomeratic unit also occurs in the Pertatataka Formation (Pup(c)) in the Mount Burrell area; it consists of grey, conglomeratic sandstone and conglomerate and is between 50 and 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 seven miles west of Mount Burrell Well. The unit is very similar to the Areyonga Formation and overlies a sequence of dolomite similar to that seen in the Bitter Springs Formation. However, all these lithologies are also known from the Pertatataka Formation further east on the Rodinga Sheet area and they are considered more likely to be part of the Pertatataka 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 Lower Cambrian Todd River Dolomite, and is separated from this dolomite by the Arumbera Sandstone.

Cyclops Member (new name)

The Cyclops Member is defined as a unit of very evenly thin bedded and laminated, silicified, tough, fine, grey sandstone. The Cyclops Member occurs in the basal part of the Pertatataka Formation and is separated from the overlying Julie Member and from the base of the formation by a large thickness of undifferentiated 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 south of these localities.

The Cyclops Member is named from Cyclops Bore about 8 miles west of the Ross River Tourist Chalet. The type section (Plate 8), ASR-5, is about half a mile north of the Ross River Tourist Chalet.

The relationship of the Cyclops Member to the members occurring stratigraphically below the Julie Member in the areas south and east of Ringwood Homestead is not known.

The Cyclops Member crops out in low but sharp ridges generally not much more than 20 to 30 feet high.

The only section measured in the member is the type section, ASR-5, north of the Ross River Gorge, where it is 160 feet thick. The member is probably thicker in eastern outcrops and at one locality about 250 feet was estimated from air-photographs.

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 is probably of shallow marine origin and deposited during a stable period with gentle subsidence of depositional area and even supply of detrital material.

The member is considered to be Upper Proterozoic because of its stratigraphic position.

Ringwood Member (new name)

The Ringwood Member is defined as a unit of calcarenite, dolomite, limestone and siltstone that occurs 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, ASR-4, (Plate 8), is about five miles south-east of Ringwood Homestead where it is 540 feet thick. Ringwood Homestead, after which it is named, is in the south-east 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 75-100 feet high. The best exposures of the member are in the Limbla Syncline north of Limbla Homestead where it crops out in steep ridges about 200 feet high.

The Ringwood Member is the oldest member of the Pertatataka Formation in the outcrops south and east of Ringwood Homestead. 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.

The lower part of the member is made up of evenly bedded, green siltstone and shale and is in many ways similar to the Cyclops Member.

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

The combination of very tough cherty, algal dolomite overlain by grey-green and dark grey, cross-laminated, fragmental dolomite and limestone is characteristic. The carbonates 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 are made up entirely of pellets of silty carbonate. Some of the dolomite and limestone beds are sandy. A thin sequence of yellow, fine, oolitic dolomite is a good marker bed near the base of the member. In most places it is succeeded by light yellow-brown weathering, fine dolomite which contains irregular stromatolite colonies. Individual stromatolite colonies are up to one foot across and roughly hemispherical. The algae commence as irregular 'cabbage' like growths which grow into irregularly shaped connected columns. The overlying beds of 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 silt and silty dolomite pellets are common in places.

North of Limbla Homestead the basal beds of the member are well exposed in the Limbla Syncline. They consist of very evenly thin bedded siltstone, with 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. The breccia appears in places to be derived from the disintegration of the stromatolite colonies.

The oolitic and pelletal carbonates and the stromatolites all suggest that the Ringwood Member was deposited in a shallow marine environment. The member is considered to be of Upper Proterozoic age.

Limbla Member (new name)

The Limbla Member is defined as a unit consisting of an upper cross-laminated, fine-grained sandstone overlying sandy calcarenite with minor interbedded siltstone, slumped sandstone and intra-formational conglomerate.

The Limbla Member is separated from the underlying Ringwood Member of the Pertatataka Formation by a large thickness of un-differentiated siltstone and is probably disconformably overlain by the Olympic Member. The disconformable contact is inferred from the presence of boulders in the Olympic Member, derived from the Limbla Member and older formations. The type section is ASR-4 (Plate 8), five miles south-east of Ringwood Homestead where it is 470 feet thick. The only other measured section is RdR8 (Plate 8) on the Rodinga Sheet area where the minimum thickness is 375 feet. The member is named from Limbla Homestead in the south-west part of the Illogwa Creek 1:250,000 Sheet area.

Generally the sandstone of the upper part of the Limbla Member is well exposed in 2 or 3 parallel, sharp crested ridges. The carbonates in the lower part of the member are much less resistant to erosion but are usually well exposed on the steep scarp slopes under the protective sandstone ridges.

Fig.13 Incompetent folding in dolomite and shale of the Pertatataka Formation, near Allambi Homestead (Rodinga Sheet area).
Neg. No.M371-20

Fig.14 Concave and diagonal cross-laminations in sandstone in the upper part of the Limbla Member of the Pertatataka Formation, seven miles west-south-west of No.6PHillipson Bore (Hale River Sheet area).
Neg.No. M404-12A.

The Limbla Member is exposed over a comparatively small area, south and south-east of Ringwood Homestead as far south as Hi Jinx Bore, in the area south of Limbla Homestead and in the north-eastern part of the Rodinga Sheet area. The member lenses out to the west and is not found in any other part of the Amadeus Basin.

The contact of the Limbla Member with the overlying Olympic Member is for the most part 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 dominantly sandy limestone to the underlying shale and siltstone typical of the undifferentiated Pertatataka Formation.

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 and cross-laminated, fine and medium-grained tough, calcareous sandstone showing slumped laminae. The sediments are generally poorly sorted and in many places oolitic. The beds contain interbedded red-brown and purple-brown siltstone. The sandy calcarenite consists of medium and some coarse-grains of subangular quartz, silty carbonate pellets and calcareous oolites set in a calcareous cement. The 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, that weathers cream and pale brown, overlying rather massive to medium-bedded, cross-bedded sandstone that shows weathered out pits and cavities generally about $\frac{1}{4}$" across.

Concave and diagonal cross-laminations in the sandstone are characteristic (Fig.14) and occur in sets generally $\frac{3}{4}$ to $1\frac{1}{2}$ inches thick.

Where the lowermost part of the Olympic Member is a silicified thick bedded sandstone, its contact with the Limbla Member is hard to define. However, in most places an interval of siltstone, clay pellet sandstone or silty, laminated, platy limestone separates the two members.

The sediments in the Limbla Member indicate the rapid erosion of source areas and the supply of abundant detrital material. The textures in the sediment indicate the action of fast flowing currents and deposition on generally unstable slopes.

The unfossiliferous Limbla Member is Upper Proterozoic. It may be partly equivalent to the Cyclops Member.

Olympic Member (new name)

The Olympic Member is here defined as a unit of extremely variable lithology that disconformably overlies the Limbla Member and is separated from the Waldo Pedlar Member above by a small thickness of undifferentiated Pertatataka Formation siltstone. Contacts are very poorly exposed. The Olympic Member consists of varying proportions of sandstone, siltstone, conglomerate, shale, boulder clay, some dolomite and lenticular bodies of silicified sandstone. The type section of the member is ASR-4 (Plate 8), five miles south-east of Ringwood Homestead where it is 630 feet thick. It is named from Olympic Bore in the south-eastern corner of the Alice Springs Sheet area.

The member is generally poorly exposed. The lenticular beds of silicified sandstone form resistant scarps up to 200 feet or more high. It crops out five miles south-east of Ringwood Homestead, in rubbly exposures about six miles east-north-east of Teds Dam, and in the core of the Hi Jinx Syncline in the north-west 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 laterally equivalent, at least in part to the Cyclops Member and it is possibly the lateral equivalent of the conglomerate (Pup (c)) mapped within the Pertatataka Formation in the Mount Burrell area. The Olympic Member varies in thickness and lithology over short distances more than any of the other members of the Pertatataka Formation, and appears to consist of lenses of the various constituent lithologies.

Beds and lenses of conglomerate in the member contain fragments derived largely from the Bitter Springs and Areyonga Formations. The phenoclasts also include some igneous and metamorphic rock types and some sandstone fragments apparently derived from the underlying Limbla Member.

A distinctive horizon of dolomite marks the top of the Olympic Member in some areas. The dolomite is pink and grey, weathers cream, is thin bedded, shows manganese staining and contains limonite pseudomorphs after pyrite.

A lenticular unit of white, thick to thin bedded, medium-grained sandstone is present near the top of the member. This sandstone is well exposed in a cuesta just south of Olympic Bore. In most places this sandstone is underlain by a sandstone from which clay galls have been weathered leaving a network of angular cacities. Below this 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 up to 10 feet across of dolomite, sandstone, quartz, and a variety of igneous

Fig.15 Large boulder of gneiss in conglomerate of the Olympic Member (Pertatataka Formation) one mile south of Olympic Bore (Alice Springs Sheet area). Neg. No.M404-5A

Fig.16. Sedimentary breccia of plates of dolomite, Olympic Member (Pertatataka Formation), one mile south of Olympic Bore (Alice Springs Sheet area). Neg. No.M404-3A

and metamorphic rocks (Fig.15). Some of the phenoclasts are of coarse-grained, sandy, oolitic and fragmental dolomite and limestone and are most likely derived from penecontemporaneous erosion of the Limbla Member. The largest phenoclast seen was a weathered and much disintegrated boulder probably originally 10 feet across of coarse-grained gneiss which was found near the centre of the Hi Jinx Syncline. The matrix of the conglomerate is poorly sorted, dark grey-green siltstone. In this syncline the conglomerate is poorly sorted, dark grey-green and purple, thin-bedded siltstone and laminated, silty and platy limestone which overlies the Limbla Member. The conglomerate lenses out rapidly over a short distance. 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 laterally equivalent horizon consists of coarse sandstone to fine conglomerate containing angular, white, quartz clasts, and a breccia containing pink and yellow plates of fine, laminated dolomite (Fig.16). 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 underlying Limbla Member is not exposed.

Glacial conditions during deposition of the unit are suggested by the variety of rock types in the conglomerate, their striations, soling and faceting, the texture of the deposits and their lenticular nature. The member is very similar to parts of the Areyonga Formation.

The composition of the conglomerate in the Olympic Member indicates formations older than the Pertatataka Formation as well as the older members of the Pertatataka Formation, were exposed and being eroded at least for part of the time during which the Olympic Member was being deposited. The Olympic Member is Upper Proterozoic.

Waldo Pedlar Member (new name)

The Waldo Pedlar Member is defined as a unit of thin bedded, silicified sandstone that is separated from the Olympic Member below by a small thickness of grey siltstone of the undifferentiated Pertatataka Formation. The top of the member is eroded or obscured by recent deposits and the contact with the Julie Member is not exposed.

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

The Waldo Pedlar Member forms dark, rounded, mound-like 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. Beds of similar lithology occur within 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 with older and younger units are not well exposed. In the north-east 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 undifferentiated green shale and siltstone. Generally there is an obscured area separating the two members.

The thickness of the unit is estimated at about 200 feet. Sections have not been measured in the member.

The Waldo-Pedlar consists of dark-grey, fine-grained, thin bedded, tough sandstone with some interbedded green siltstone and shale. The sandstone weathers a characteristic dark red-brown. It shows some ripple and current flow markings on the bedding planes and in places contains clay pellets.

The Waldo Pedlar Member is of Upper Proterozoic age.

Julie Member (new name)

The Julie Member is defined as a unit comprising dolomite, limestone and siltstone, with lenses of sandstone. The member is conformably overlain by the Arumbera Sandstone and in the western exposures is separated from the Cyclops Member by several hundred feet of undifferentiated siltstone of the Pertatataka Formation. In eastern exposures the Julie Member is separated from the older members of the Pertatataka Formation by an unknown thickness of undifferentiated siltstone of the Pertatataka Formation. The type section is at the Ross River Tourist Chalet where 420 feet of the member was measured in ASR5 (Plate 8).

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 a unit of carbonate occurring at the top of the formation in areas farther west. The Julie Member crops out around the south-eastern and eastern margins of the Phillipson Pound, is present in the Ooraminna No.1 Bore and is probably equivalent at least to part of the Pertatataka Formation mapped in the area of intricate structure 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 of the member generally crop out in moderately steep ridges 100-200 feet high at the base of the more prominent red-brown scarp of the Arumbera Sandstone.

It is commonly 300 to 500 feet thick, but 15 miles east-south-east of Santa Teresa Mission the member has a maximum thickness of 1800 feet. The member appears to thicken rapidly towards this locality and this thickening is associated with a marked increase in sandstone content. In the Ooraminna No.1 Bore, it is about 400 feet thick.

The prominent ridge-forming, dark grey dolomite of the member is thick-bedded and massive, medium to coarse-grained, oolitic, sandy,

Fig.17 Arumbera Sandstone (Ꞓa), Todd River Dolomite (Ꞓr) Giles Creek Dolomite (Ꞓk), Shannon Formation, (Ꞓs), Goyder Formation (Ꞓg) and Pacoota Sandstone (Ꞓ-Op) in the Ross River Gorge (Alice Springs Sheet area).

Neg.No. G/7540

Fig.18 Giles Creek Dolomite and overlying Shannon Formation, north flank of the Ross River Syncline, Ross River Gorge (Alice Springs Sheet area).
Neg.No.G/7509

and contains spherical oolitic chert nodules. Some interbeds of dolomite are pink, yellow and grey, oolitic and sandy. Dark grey and blue-grey, fetid limestone usually occurs near the base of the member. Commonly the sandstone is found in lenticular bodies between the ridge-forming 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 outcrops of the Julie Member in the southern and south-eastern part of the Alice Springs Sheet area. In the Todd River Anticline sandstone makes up about 25% of the member and occurs mostly in its lower part.

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

Poorly preserved stromatolites with an indistinct wavy bulbous outline occur in a few places in the dolomite.

The Julie Member is considered to be Upper Proterozoic.

CAMBRIAN

PERTAOORRTA GROUP (Prichard & Quinlan, 1962; Wells, Forman and Ranford, 1965; Ranford, Cook and Wells, 1965).

The Pertaoorrta Group was originally defined by Prichard and Quinlan (1962); the name was revised to Pertaoorrta Formation (Wells, Forman and Ranford, 1965b) and was again revised to Pertaoorrta Group (Ranford, Cook and Wells, 1965). The term Pertaoorrta Group is used in this Report in the same sense as used by Ranford, et al (1965) and is equivalent to the Pertaoorrta Group plus the Arumbera Greywacke as used by Prichard & Quinlan (1962).

The Pertaoorrta Group includes the following Formations in the north-eastern part of the Amadeus Basin - 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 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) who recognized the interval as being equivalent to his "Pertaoorrta Series" in the western MacDonnell Ranges.

The relationships between the various Formations included in the Pertaoorrta Group are shown in Figure 4 and the appearance of the formations in outcrop is shown in Figures 17 and 18.

Arumbera Sandstone (Prichard & Quinlan, 1962)

This unit was originally defined by Prichard and 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 unit is again redefined in this report to the Arumbera Sandstone and is included in the Pertaoorrta Group. The lithological part of the name has been changed because detailed mapping has shown the unit to be predominantly sandstone.

The Arumbera Sandstone crops out on the southern half of the Alice Springs Sheet area, thesouth-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. The southern limit of the outcrop is thought to be approximately the same as the margin of the basin during deposition.

The Arumbera Sandstone crops out as two prominent ridges separated by a valley in most areas, but near its southern outcrop limits, the unit is much thinner and forms a single strike ridge.

The Arumbera Sandstone conformably overlies the Pertatataka Formation throughout the north-eastern part of the Amadeus Basin and in some areas (e.g. around the Phillipson Pound), the contact between the two Formations is apparently gradational. In the north-western part of the area mapped (e.g. between Jay Creek Native Settlement and Alice Springs), the Arumbera Sandstone is overlain by the Hugh River Shale but in the south-western part of the area (e.g. James Ranges), the Formation is overlain by the Chandler Limestone and in the north-eastern part of the area, the Formation is succeeded by the Todd River Dolomite. The position of the boundary between the Arumbera Sandstone and the Hugh River Shale has been chosen at the top of the sandstone sequence and a similar boundary can be used between the Arumbera Sandstone and the Chandler Limestone. However, the Arumbera Sandstone-Todd River Dolomite boundary has been chosen at the change from red-brown sandstone to the pale yellow-brown and cream, calcareous sandstone and siltstone which occurs at the base of the Todd River Dolomite.

In the north-eastern part of the Amadeus Basin, the Arumbera Sandstone is thickest in the Phillipson Pound area where the unit has an estimated maximum thickness of 2700 feet. A thickness of 2240 feet (ASR1) was measured on the western flank of the Todd River Anticline, and a thickness of 2335 feet of Arumbera Sandstone was measured by Hopkins (1964) in the area about 10 miles E.N.E. 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 (H1W 1, 1265 feet), about 4 miles south of Mount Peachy (Rd R1, 670 feet) and about 4 miles east of Deep Well Homestead (RdR6, 1400 feet).

Fig.19 Cast of large trail and some small worm casts in the upper part of the Arumbera Sandstone, AS320A, $7\frac{1}{2}$ miles east of Shannon Bore (Alice Springs Sheet area).

Neg.No. G/7473

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

The third unit is recessive and consists of siltstone and shale with minor sandstone and dolomite. The siltstone, shale and sandstone are mainly dark red-brown and micaceous. This sequence is in places glauconitic and calcareous and contains some worm burrows, trails (Fig.19), and rare arthropod tracks. The dolomite occurs as lenses up to a few feet thick in some areas (e.g. near Ross River Gorge and 2 miles east of Snow bore).

A very coarse-grained, white, glauconitic sandstone which is characterised by its lenticular nature crops out near Undoolya Gap, Williams Bore and in part of the Todd River Anticline. It shows a few trails on its bedding planes and is present near the top of the third unit.

The uppermost or fourth unit forms a second resistant strike ridge and consists of red-brown and buff, medium-grained sandstone. The sandstone is cleaner and more porous than those previously mentioned in this formation. There is considerable variation in the thickness of this unit over very short distances and it is not present in the southernmost outcrops of the formation.

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

Impressions in sandstone beds in the basal part of the Arumbera Sandstone in the area 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, arthropod tracks and Scolithus occur in the third unit (recessive siltstone with minor sandstone) and these are considered more likely to be of Cambrian age (J.G.Tomlinson - pers.comm.). The Arumbera Sandstone is overlain by the Lower Cambrian Todd River Dolomite in much of the north-eastern part of the basin and the contact with this formation is conformable and possibly gradational. The Arumbera Sandstone is tentatively regarded as being of Cambrian age although the unit may range from late Upper Proterozoic to Lower Cambrian in certain areas.

Todd River Dolomite (new name)

The Todd River Dolomite is defined as a formation of pink, pale brown and grey, silty, thickly and poorly bedded, crystalline dolomite which is richly fossiliferous and in part glauconitic, underlain by medium and thin bedded, cross-bedded calcareous sandstone, red-brown, fine-grained, thin bedded sandstone, siltstone and some thin beds of dolomite. The lower beds are transitional between the Arumbera Sandstone and the overlying dolomite. The type section of the formation is ASW 1 in the Ross River Gorge, and the name is derived from the Todd River which flows from west to east across the southern part of the Alice Springs Sheet area.

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

The formation is moderately resistant and crops out in low scarps, low rounded hills or in discontinuous ridges. Exposures are very poor near what is considered to be its southern limit of deposition. It crops out along the northern margin of the Amadeus Basin in the Ross River, Fergusson and Gaylad Synclines. The most easterly exposure is a small outcrop about four miles south-east of Aralka Bore. The formation occurs in the Ooraminna Anticline, Phillipson Pound, and as far south as a point about four miles east of Kangaroo Well. It is not known in outcrop west of the Ooraminna Anticline.

Five sections have been measured through the formation. It is thickest in the Ross River Gorge, (510 feet in ASW 1) and thins gradually to the east in the Gaylad Syncline (455 feet in ASR 3) and north-west part of the Hale River Sheet area (365 feet in H1W1). The rate of thinning to the west is greater and at Williams Bore the unit is only 260 feet thick. On the north flank of the Ooraminna Anticline it is 325 feet thick (ASR 1) but on the south flank of the fold (RdR5) it is only about 150 feet thick.

The most characteristic rock type of the Todd River Dolomite is a pink and pink-brown dolomite with archaeocyathans and brachiopods. Much of the dolomite contains glauconite. In the southern exposures the formation contains 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 between the two is taken as the change from the predominantly red-brown, fine-grained, sandstone at the top of the Arumbera Sandstone to pale brown, calcareous siltstone, and fine to coarse-grained, friable sandstone. In several places the basal unit of the Todd River Dolomite consists of

Fig.20. Chandler Limestone about 13 miles north of Mount Rodinga, showing contorted nature of limestone and chert laminae (Rodinga Sheet area). Neg. No.M371-32

Fig.21 Contorted Cambrian Chandler Limestone (foreground) and overlying Giles Creek Dolomite about 13 miles north of Mount Rodinga (Rodinga Sheet area). Neg. No.M371-31.

interbedded brown-grey, coarse-grained, well rounded sandstone and pale, red-brown fine-grained sandstone.

The top of the Todd River Dolomite is placed at the change from pink dolomite to interbedded grey and dark-grey dolomite, limestone, and shale of the Giles Creek Dolomite or at the change to shale and grey, fetid carbonate of the Chandler Limestone.

The Todd River Dolomite is the only known fossiliferous Lower Cambrian formation in the Amadeus Basin and because its lateral relationships are obscured, correlation can only be based on position in sequence. The unit may be laterally equivalent to part of the Hugh River Shale or it may have no time-rock equivalents throughout most of the Amadeus Basin. It has been suggested by one of the authors (L.C.R.) that the Todd River Dolomite may be laterally equivalent to part of the Chandler Limestone in areas outside the north eastern corner of the basin but whereever the two units occur together the Chandler Limestone overlies the Todd River Dolomite.

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

Joyce Gilbert Tomlinson (Pers.comm.), has supplied the following information 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 generically determinable. This part of the sequence may be provisionally dated as Lower Cambrian'.

Chandler Limestone (Ranford, Cook and Wells, 1965)

The Chandler Limestone was originally defined by Ranford and Cook (1964) as a Member of the Pertaoorrta Formation and was raised to formational status by Ranford, et al. (1965).

The Chandler Limestone has been mapped at a number of 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 formation takes its name from the carbonate portion of the sequence as this is generally all that is exposed. The limestone and dolomite form low ridges and hills and characteristically are tightly folded and contorted (Figs. 20, 21). The outcrops are disconnected along strike, but these breaks are almost certainly tectonic rather than sedimentary in origin.

On the western side of the Rodinga Sheet area, the Chandler Limestone lies between the overlying Jay Creek Limestone and either the Arumbera Sandstone or where that unit is not present, the

Pertatataka Formation. However, north-east of Deep Well Homestead, in the Phillipson Pound, and around the Ooraminna Anticline, the Chandler Limestone lies between the Giles Creek Dolomite above and the Todd River Dolomite below. The contacts with the underlying and overlying formations are not exposed and the exact relationships are therefore not known.

As the Chandler Limestone is always folded in outcrop, it is not possible to give accurate measurements of thickness, but measured sections indicate that the unit occupies an interval of between 180 and 460 feet in the Rodinga Sheet area (RdR6; 180'), RdR4; 460'), (RdR5; 200'), (RdR1; 260'). About 500 feet of halite and shale in the Alice No.1 Bore is interpreted as belonging to the Chandler Limestone and a similar 600 feet thick sequence of the formation is present in the Mt.Charlotte No.1 Bore.

The Chandler Limestone is characterized by outcrops of pale and dark grey laminated limestone and dolomite with numerous thin, white and grey chert laminae. The sequence is intensely folded and in places, brecciated. The carbonate is fine-grained and has a fetid odour when freshly broken. The concealed part of the unit is considered to be a mixture of red-brown shale and evaporites. The evaporites are not known from outcrop but about 360 feet of halite was intersected in this stratigraphic position in Alice No.1 and the incompetent type of folding seen in the Chandler Limestone is thought to indicate the presence of evaporites.

The Chandler Limestone lies above the fossiliferous Lower Cambrian sediments and below the fossiliferous lower Middle Cambrian sediments. No fossils have been found within the formation and the exact nature of the contacts with the overlying and underlying units is uncertain. The Chandler Limestone is tentatively regarded as being of Lower Cambrian age.

Giles Creek Dolomite (new name)

The Giles Creek Dolomite is defined as a 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, which flows south between the Fergusson and Gaylad Synclines. The type section is ASW 1 (Plate 10) at Ross River.

The Giles Creek Dolomite crops out in the north-eastern part of the Amadeus Basin as far west as the railway line and as far south as latitude 24^{o} 30'. It crops out as far east as a point 15 miles east-south-east of No.6 Phillipson Bore.

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

The Giles Creek Dolomite conformably, or in places possibly disconformably, overlies the Todd River Dolomite or where that formation is absent, the Chandler Limestone. It is overlain conformably by the Shannon Formation or in some areas is unconformably overlain by the Pertnjara Formation. The base of the formation is taken as the

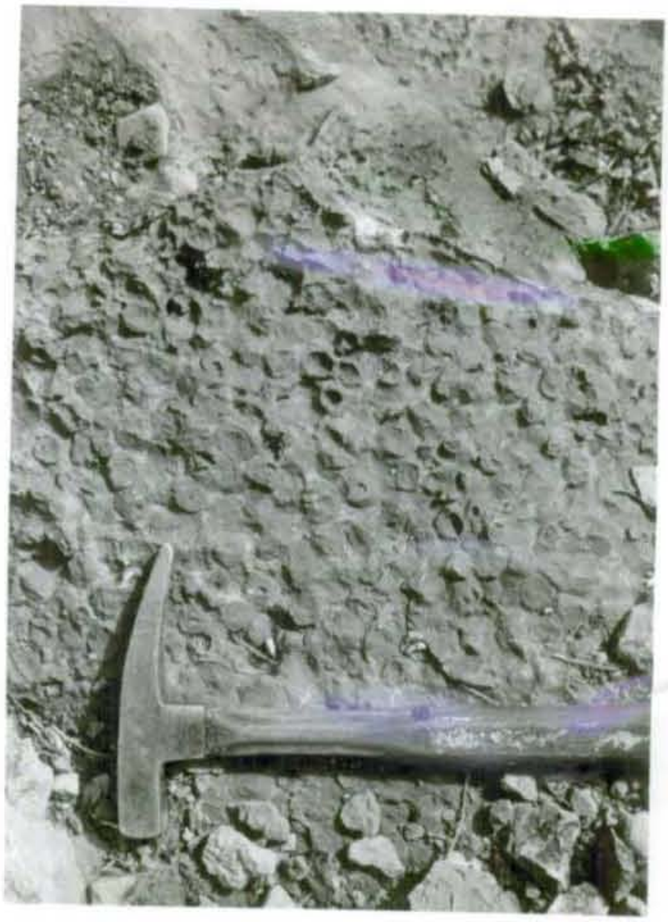


Fig.22. Girvanella in the Giles Creek Dolomite, western end of the Gaylad Syncline (Alice Springs Sheet area). Neg.No.M402-7

Fig.23. Stromatolite colonies in the Jay Creek Limestone, eastern end of the Waterhouse Range (Alice Springs Sheet area).
Neg. No.G/7527

lowermost occurrence of siltstone and shale associated with the limestone and dolomite as described above. The top of the formation is placed at the change from predominantly dolomite to the sequence of interbedded siltstone, shale and dolomite of the Shannon Formation.

Eight sections have been measured through the formation. In the type section at Ross River it is 830 feet thick (AWS1) but it is thicker in sections measured to the east, west, and south of this point. At Williams Bore, in the west, it is 960 feet thick (ASA1), and in the south flank of the Gaylad Syncline (ASR3) it is 1090 feet thick. South-east of Ringwood Homestead, (H1W1) it is only 550 feet thick. The formation is thickest in the Ooraminna Anticline. On the north flank (ASR 1) it is 1320 feet thick and on the south flank (RdR5) it is 1100 feet thick. In the Alice No.1 bore the formation is about 1170 feet thick. The formation thins rapidly to the south of Ooraminna Anticline and at RdR6 four miles east of Deep Well, it is 610 feet thick and RdR4, 8 miles west of Camel Flat Bore, it is 495 feet thick. The measured sections are shown in Plates 9 & 10.

The dominant lithology in the formation is grey, grey-brown, yellow and cream, tough, thick-bedded, recrystallised dolomite which generally makes up the upper half of the formation. In places the dolomite is oolitic, and contains a few irregular masses of chert. The lower part of this dolomite is massive and in some areas contains Girvanella like structures (Fig.22).

The lower half of the formation is usually made of interbedded limestone and shale. The limestone is blue-grey, fine, medium bedded, in places dolomitic, and contains fossil fragments including trilobites and Hyolithids. Pseudomorphs of limonite after pyrite occur in places in the limestone.

Away from the type section, the formation generally contains a higher proportion (up to 50%) of red-brown and grey-green, micaceous, calcareous, siltstone and shale. The dolomite is mostly thin bedded, to laminated, fine and medium, and as in the type section contains a few stromatolite colonies. The colonies are of a different type and less abundant than those in the overlying Shannon Formation. Some of the dolomite is fetid and much of it recrystallised. Some ripple marks and a few halite pseudomorphs were seen in the sediments.

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

The Giles Creek Dolomite was probably deposited under shallow marine conditions. 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 defined as a formation of interbedded green and brown siltstone, grey, grey-brown and pink limestone and recrystallised grey, fawn and yellow thin-bedded and laminated dolomite. The proportion of limestone to dolomite varies considerably from section to section. Stromatolites are more abundant in the limestone. Many of the carbonates are oolitic and some thin beds are fragmented. The name is derived from Shannon Bore eight miles south of the Ross River Tourist Chalet. The type section is ASW 1 at Ross River (Plate 10).

The Shannon Formation conformably overlies the Giles Creek Dolomite and contact between the two formations has been chosen at the change from the dolomite of the Giles Creek Formation to the sequence of shale, siltstone and interbedded limestone and dolomite of the Shannon Formation. In exposures south of the Fergusson and MacDonnell Ranges the basal part of the Shannon Formation is predominantly shale which forms a wide strike valley separating the carbonate beds of the formation from those of the underlying Giles Creek Dolomite.

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

In exposures in the eastern part of the area mapped the formation is disconformably overlain by the Mereenie Sandstone and unconformably overlain by the Pertnjara Formation. South and east of Deep Well the Shannon Formation is overlain paraconformably by the Pacoota Sandstone and Stairway Sandstone, and disconformably or possibly unconformably by the Mereenie Sandstone.

The Shannon Formation is only moderately resistant to erosion and generally crops out in low rounded hills and in a series of strike ridges and valleys. Exposure is generally less than 20%. It crops out near Undoolya Gap and as far east as ten miles south of Casey Bore on the north-east part of the Hale River Sheet area. On the Rodinga Sheet area it crops out as far south as latitude 24° 30'.

The Shannon Formation comprises about 50% lutite and 50% carbonate rocks. The ratio of limestone to dolomite varies considerably. At Williams Bore it is 4:1, whereas in the Ross River Gorge it is about 1:5. In the Ooraminna Anticline the carbonates in the formation are mostly limestone.

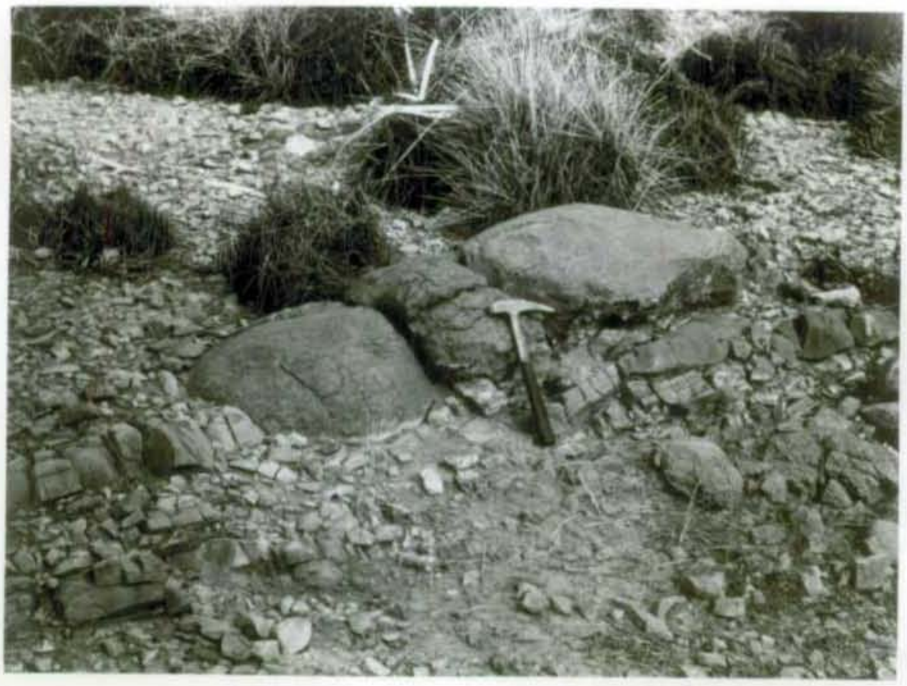


Fig.24 Algal bioherm of limestone in thin bedded dolomite of the Shannon Formation, ½ mile south of Williams Bore (Alice Springs Sheet area).
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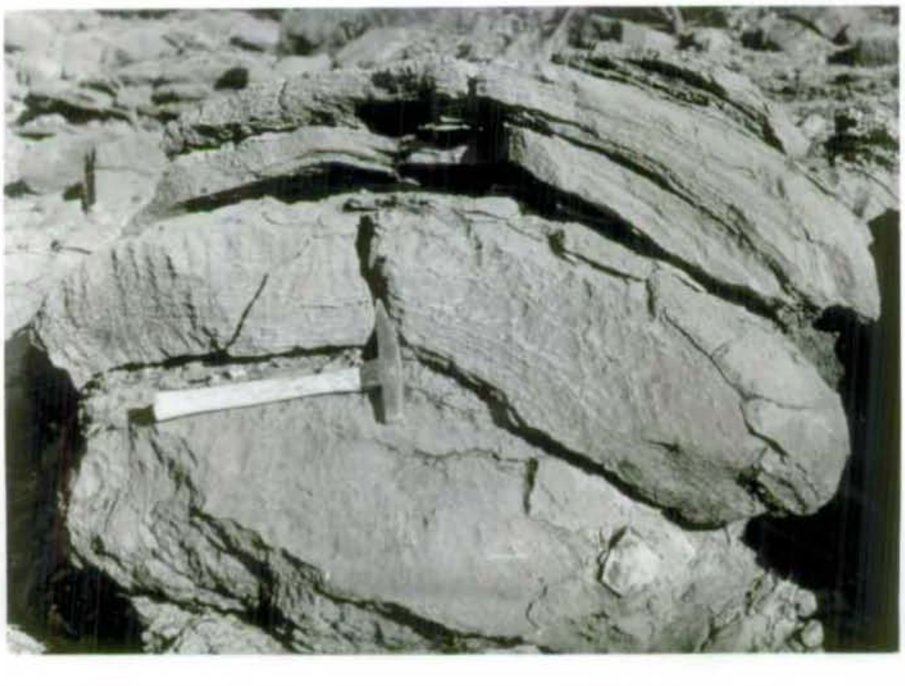


Fig.25 Hemispherical stromatolite colony in the Shannon Formation on the southern limb of the Ooraminna Anticline (Rodinga Sheet area).
Neg. No.G/7561

The dolomite and limestone are grey, pink, fawn and cream, and oolitic and include some intraformational breccias. The carbonates include numerous beds of stromatolites (Figs.24 & 25) and thin irregular bodies and thin lenses of chert in various parts of the section. In places the dolomite is cross-laminated. The stromatolites are usually composed of limestone (Fig.24). The green and brown shale and siltstone are poorly exposed so that only the carbonate beds are preserved in outcrop.

Seven sections have been measured in the formation. In the type section, ASW 1, it is 1230 feet thick and to the west at Williams Bore it has thickened to 1705 feet. The thickest measured section is 2340 feet on the north flank of the Ooraminna Anticline. To the north in the Alice No.1 Bore the Shannon Formation is about 1630 feet thick. On the south flank of Ooraminna anticline and also near the eastern end of the James Ranges it is about 1800 feet thick and at Rd R4 south of Phillipson Pound it is 935 feet thick. Further east on the Hale River Sheet area it is only 830 feet thick (H1W1). The measured sections are shown in Plates 9 and 10.

The Shannon Formation is laterally equivalent to the upper part of the Jay Creek Limestone and may be laterally 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 of this range. It is very difficult to distinguish the carbonates in the base of the Goyder Formation from those in the top of the Shannon, so it is possible that the Shannon Formation may be taking the place of part of the Goyder Formation.

The Shannon Formation was deposited in a shallow marine environment. It contains few recognisable fossils and no fossils were found in southern outcrops. The formation is probably largely Middle Cambrian but 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)

Originally named by Prichard and 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 was seen in outcrop. The unit conformably overlies the Arumbera Sandstone, and is conformably overlain by the Jay Creek Limestone. No section has been measured, but from air photographs it is estimated to be 1600 feet thick.

Judging from its recessive nature and the lithologies exposed at Ellery Creek, the bulk of the unit is probably composed of a red-brown or grey-brown siltstone and shale. The lowest part consists of 100 feet of red-brown, poorly bedded siltstone, slightly micaceous, with a few interbeds of grey chert. Above this is 100 feet of 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 were found in the siltstone. A few algae are present in the dolomite in the lower part of the formation.

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

Jay Creek Limestone (Prichard & Quinlan, 1962)

First named by Prichard and Quinlan (1962), the Jay Creek Limestone is present in the area between Alice Springs and Jay Creek, in the core of the Waterhouse Anticline, and in the western third of the Rodinga Sheet area. It gives rise to low ridges, from which project beds of limestone. The unit conformably overlies the Hugh River Shale on the Alice Springs Sheet area and the Chandler Limestone on the Rodinga Sheet area, and is conformably followed by the Goyder Formation. It is laterally equivalent to parts of the Giles Creek Dolomite and Shannon Formation of the Ross River section, and lithologies of both these formations can be recognized within the Jay Creek Limestone in some parts of the Rodinga Sheet area. The Giles Creek Dolomite and Shannon Formation total 2000 feet at Ross River, and 2800 feet in Alice No.1 Oil Well. The Jay Creek Limestone is 1400 feet thick near Mt.Peachy (RdR-1), and about 800 feet thick near Temple Bar Homestead (from air photographs). Further south in Mt.Charlotte No.1 Well about 1000 feet of Jay Creek Limestone was penetrated. Hence, in the Alice Springs-Jay Creek area, the Jay Creek Limestone is either a condensed sequence, or large time breaks are present in the formation. The measured sections are shown in Plates 9 and 10.

In the Alice Springs Sheet area, the formation consists dominantly 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 touch, and includes many thick beds of algal limestone, and oolitic limestones. Some beds of algal limestone give off a petroliferous smell when hammered. The siltstone is recessive, and very poorly exposedm but where visible is red-brown or green, micaceous, and platy. Red sandstone is interbedded with the siltstone near Temple Bar Homestead.

On the Rodinga Sheet area, the Jay Creek Limestone is chiefly siltstone and shale, with up to 30% carbonate. The siltstone and shale are partly calcareous and micaceous, and either grey-green or red-brown in colour. The carbonate is mostly dolomite in the basal third of the formation, and nearly all limestone in the remainder. The dolomite is light grey to pale brown and pink, and has been recrystallized, so that most of the original textures have been destroyed. 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, which measure up to 6 feet across and 3 feet high (Fig.23). Pseudomorphs after halite were found near the base of the sequence.

The Jay Creek Limestone was deposited in a shallow marine environment, and formation of the carbonate took place by detrital, organic, and chemical processes. The fossils contained are several varieties of algae (including Girvanella and rare Collenia), Biconulites, and trilobites.

Joyce Gilbert-Tomlinson (pers.comm.) states that, 'the top of the formation 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 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 (Prichard & Quinlan, 1962) crops out in the Alice Springs-Jay Creek area, the Waterhouse Range, around both limbs of the Ross River and Fergusson Synclines, on the north-west side of the Todd River - Ooraminna Anticline, and east and west from Mt.Peachy on the Rodinga Sheet area. It generally forms a dissected pediment below the ridge of Pacoota Sandstone, but in a number of places on the south side of the Ross River Syncline, weathering has toughened and made resistant a ferruginous layer at the top of the formation, so that several prominent mesas have been left. The unit is very poorly exposed on the Rodinga Sheet area.

The Goyder Formation conformably overlies the Jay Creek Limestone in the western areas, 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 air photographs), 1400 feet at Williams Bore (ASA-1), 1230 feet at Ross River Gorge (ASW-1), 1180 feet in the Mt.Peachy area (RdR-1), 850 feet in the Alice No.1 Well, 680 feet 4 miles east of Deep Well (RdR-6), and 600 feet on the western limb of the Todd River Anticline (ASR-1). A measured section on the south-west flank of the Waterhouse Range (HyR6) indicated a thickness of 1180 Feet (Ranford & Cook, 1964). Thinning to the south and east is therefore indicated. The measured sections are shown in Plates 9 and 10.

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, carbonates are absent, and the sandstone is white or yellow-brown, fine-grained, generally well sorted, though slightly clayey and micaceous, poorly rounded, thinly cross-bedded, friable, flaggy, and in places slumped. Interbeds of micaceous siltstone are present. At the top, a thickness of a few feet of the sandstone is commonly impregnated with black oxides of manganese or brown oxides of iron, and this interval forms a convenient marker for the top of the formation.

In the Ross River and Fergusson Synclines, the unit comprises a sandstone upper part and a lower part of interbedded sandstone and carbonate. The carbonates are commonly oolitic limestones and quartzose dolomites and calcarenites, cross laminated, medium to coarse-grained, with some beds of intraformational carbonate conglomerate. The sandstone interbeds are friable and recessive, calcareous, and fine-grained. Limonite concretions have formed in the dolomite at several localities. The beds of limestone and dolomite are lenticular, and the masses of interbedded carbonate and sandstone are also lenticular on a large scale, with sandstone between them.

On the north-west side of the Todd River-Ooraminna Anticline, the formation is dominantly sandy, but includes a large lens of porcellanized, calcarenitic siltstone. In the Rodinga Sheet area, calcareous siltstone, shale, and sandstone are the dominant lithologies; true carbonates are absent.

The Goyder Formation was deposited in a shallow marine environment. Shelly fossils are common, and include trilobites, gastropods, and hyolithids. Algae are also preserved, and form thick beds of limestone in a few places. According to Joyce Gilbert-Tomlinson (pers.comm.), the age of the fossils in the Goyder Formation range from early Upper Cambrian (Mindyallan) in the lower carbonate part of the formation to middle Upper Cambrian (late Franconian) in the upper arenitic part of the formation.

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 and 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 through the formations of the Larapinta

Group are shown in Plate 12.

Pacoota Sandstone (Prichard & Quinlan, 1962)

The Pacoota Sandstone crops out sporadically over the northern half of the area studied and is exposed as prominent strike ridges in the Waterhouse Range, in the James Range, at the western end of the Ooraminna Anticline, near Bokhara Homestead, near Christmas Bore, along both limbs of the Ross River Syncline, 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 conformably overlies the Goyder Formation throughout the area mapped, and in many areas (e.g. near Bokhara Homestead and in the James Range) the formation is conformably overlain by the Horn Valley Siltstone. In the north-eastern part of the Amadeus Basin the Pacoota Sandstone is disconformably or unconformably overlain by the Mereenie Sandstone. A separate unit, the N'Dahla Member, has been distinguished in the Pacoota Sandstone, and is described separately.

Sections measured through the Pacoota Sandstone gave thicknesses of 2530 feet in section ASA-1 near Williams Bore; 405 feet in section ASR-1 on the western limb of the Todd River Anticline; 1200 feet in a section just south of Alice Springs (measured by the Resident Geologist - pers.comm.); 1470 feet in the Waterhouse Range (HyR5, Ranford & Cook, 1964); 1015 feet in section RdC8 near Mount Peachy; 995 feet in section RdC7 near Norma Bore in the James Range and 345 feet in section RdC9 near Bokhara Homestead. In the Alice No.1 Oil Well the formation is about 890 feet thick. These thicknesses indicate that the Pacoota Sandstone thins to the west and the south. The maximum development of Pacoota Sandstone is in the northern and north-eastern part of the Amadeus Basin.

The formation is fine to coarse-grained and in places 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 is crumbly and saccharoidal. Thin silt interbeds are common in the formation, especially near the base and close to the top. The sandstone is white, grey or pale brown in colour, thin to thickly bedded, ripple marked and cross-bedded. Current directions measured in the Williams Bore area in the upper part of the Pacoota Sandstone, suggest that the predominating current direction was from the south-west. Mud pellet markings and tracks and trails are common in the sandstones of the formation. The pebbles are generally of vein quartz or silicified sandstone. The interbedded siltstone is variegated white, brown, red, yellow or grey, laminated and mostly very poorly exposed. Rare, thin glauconitic bands in thin pelletal phosphorite layers are present in the upper part of the Pacoota Sandstone. Limestone is present near the base of the formation, 5miles south of the Ross River

Tourist Chalet and two miles south of N'Dahla Gorge. The limestone is ferruginous and glauconitic and has a maximum thickness of 10 feet.

The Pacoota Sandstone is fossiliferous, especially in the Ross River area, where extensive collections of fossils have been made. The fossils collected are trilobites, brachiopods, lamellibranchs, gastropods, ribeirioids, nautiloids and many tracks, trails and burrows. Scolithus, the vertical worm tube, forms the very characteristic 'pipe-rock' of the Pacoota Sandstone. Study of the fossils in the Pacoota Sandstone throughout the Amadeus Basin has enabled Tomlinson (1965) to recognize three faunal units made up of eight assemblages. In the Ross River Syncline, only the lower two faunal assemblages are present. The faunas of the Pacoota Sandstone indicate that the age of the formation ranges from late Upper Cambrian to Lower Ordovician (Tomlinson, 1965).

N'Dahla Member (new name)

The N'Dahla Member is the new name for a thin unit of unusual and distinctive lithology in the Pacoota Sandstone. The name is taken from N'Dahla Gorge (the type locality), 4 miles south-west of the Ross River Tourist Chalet. The member is present only on the Alice Springs Sheet area, and is confined to the northern limb of the Ross River Syncline. At N'Dahla Gorge, the member is recessive and forms the waning slops 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 through the Member; it is about 50 feet thick at the gorge.

The 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.

Fossils in the N'Dahla Member include trilobites, gastropods, nautiloids, and worm tracks; they indicate a Lower Ordovician age.

Horn Valley Siltstone (Prichard & Quinlan, 1962)

The Horn Valley Siltstone is present only on the western margin of the area mapped in the Waterhouse and James Ranges and near Bokhara Homestead. The southern limit of the formation is latitude 24°35'S and the eastern limit is longitude 134°5'E. The formation weathers recessively and crops out 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 the south from the Norma Bore area. A thickness of 145 feet was measured in section RdC7 near Norma Bore at the western end of the James Range; the formation is 120 feet thick in section RdC8 near Mount Peachy and 90 feet thick in section RdC9 near Bokhara Homestead. 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. The siltstone is laminated to thin-bedded, calcareous in part, pyritic, and gypseous in places, friable, and easily eroded. Sandy limestone, which is thin-bedded, hackley, pyritic and fossiliferous, is commonly interbedded with the siltstone. The limestone is resistant to weathering, and in most areas is 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 the formation in some areas. Glauconitic layers have been described from the Henbury Sheet area by Ranford, Cook & Wells (1965), but were not seen within the north-eastern part of the Amadeus Basin.

The Horn Valley Siltstone contains many fossils, but in the area under discussion the few that were collected are poorly preserved. The trilobites, brachiopods, pelecypods, nautiloids, ostracods, conodonts, and gastropods found in the Horn Valley Siltstone indicate a Lower Ordovician age.

<u>Stairway Sandstone</u> (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 especially well exposed in the James Range, near Bokhara Homestead and in the Mount Charlotte Range. The most southerly exposure of Stairway Sandstone in the area is at latitude 24°55'; though it is known to extend subsurface a considerable distance south of this latitude (Wells, Stewart, and Skwarko, 1965). The most easterly known exposure of Stairway Sandstone is at longitude 134°35'. East of this longitude the Stairway Sandstone is overlapped by the Mereenie Sandstone.

In the James Range and near Bokhara Homestead, the Stairway Sandstone conformably overlies the Horn Valley Siltstone, but in the Mount Charlotte Range it disconformably overlies 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 section RdC7 in the James Range near Nomra Bore; 410 feet in section RdC9 near Bokhara Homestead; 355 feet in section RdC8 near Mount Peachy; 350 feet in the Mount Charlotte No.1 Oil Well; 335 feet in section RdC1 at the western end of the Mount Charlotte Range; 335 feet in section RdC4, seven miles north-west of Mount Charlotte, 305 feet in section Rd63 at Mount Charlotte and 225 feet in both section RdC5 near Maryvale and RdC6 at Mount Rodinga. These thicknesses indicate a thinning of the formation to the south.

The Stairway Sandstone is divided into lower, middle and upper units on lithology.

The lower unit (referred to as the Mount Charlotte Sandstone by Wulff (1960))is made up mainly of white, fine to coarse-grained, massive sandstone, with a thin pebble bed at the top of the unit. The pebbles are almost exclusively vein quartz and are up to two 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 other Stairway Sandstone units, as well as some red-beds.

In the James Range and at the western end of the Mount Charlotte Range the middle unit consists of green or grey laminated siltstones with thin interbeds of white silty sandstones. This middle unit weathers recessively. It 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 varigated 'blebs'. Some of the siltstone may be gypseous. The sandstone is moderately sorted, poorly rounded and thin to medium-bedded. In many places, it weathers to give a very characteristic knobbly appearance.

The upper unit of the Stairway Sandstone is predominantly an arenaceous unit with fine to very fine-grained sandstone interbedded with thin siltstone and sandy siltstone. The percentage 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 quite common in this upper unit, especially at Mount Charlotte and in the James Range near Nomra Bore. At Mount Charlotte the pellets are up to three inches in diameter. They appear to have been deposited on an irregular erosional surface. The Stairway

Sandstone contains fossiliferous beds with trilobites, brachiopods, gastropods, nautiloids, pelecypods and numerous tracks, trails and burrows. The fossils in the Stairway Sandstone are assigned to two faunal Stages (Joyce Gilbert-Tomlinson - pers.comm.). The fossils of the older Stage are related to those found in the underlying Horn Valley Siltstone and are dated as late Lower or early Middle Ordovician and the fossils of the younger Stage are provisionally dated as late 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 at a locality seven miles north-west of Mount Charlotte. In all of these areas the Formation crops out poorly through a thin alluvial cover.

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 exposure. A section (RdC7) measured at the western end of the James Range near Norma Bore gave a thickness of 455 feet for the Stokes Formation; at section RdC5 near Maryvale the formation is 160 feet thick and at section RdC4 seven miles north-west of Mount Charlotte it is over 105 feet thick. At section RdC2 in the middle of the Mount Charlotte Range, the combined thickness of the Stokes Formation and the siltstone unit of the Pertnjara Formation is 300 feet. The thicknesses suggest a fairly marked 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 with some shale interbedded with minor limestone, sandy limestone, and silty sandstone. The siltstone is micaceous, laminated, and contains pseudomorphs after halite in places. The only limestone seen occurs near Mount Charlotte and is grey in colour, sandy and thin-bedded. The sandstone is grey, white, or yellow.

The fossils obtained from this Formation elsewhere in the Amadeus Basin include brachiopods, gastropods, pelecypods, trilobites, echinoderms and nautiloids, and indicate an early Upper Ordovician age (Tomlinson, 1965).

ORDOVICIAN-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 un-named anticlinal structures on the eastern side of the Rodinga Sheet area and the north-western side of the Hale River Sheet area. The unit was probably present over most of the north-eastern part of the Amadeus Basin, but is now preserved only in the broad synclines.

In the north-eastern part of the Amadeus Basin, the Mereenie Sandstone overlies Cambrian and Ordovician sediments with a low angle regional unconformity. The unconformity gradually cuts down section to the east and, whereas the formation overlies Stokes Formation in the James Ranges on the western margin of the Rodinga Sheet area, it overlies the Shannon Formation on the eastern margin of the same Sheet area and on the neighbouring Hale River Sheet area. The nature of this low angle unconformity is clearly visible on air photographs of the northern limb of the Ross River Syncline and the James Ranges west of Mount Peachy. At some localities (e.g. James Ranges near Deep Well and 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 Pertnjara Formation overlies the Mereenie Sandstone with regional unconformity. In some areas, (south of Jay Creek Native Settlement on the Alice Springs Sheet area; north of Bingie Bore on the Hale River Sheet area; south and west of Maryvale homestead) the Mereenie Sandstone has been removed at the unconformity but over most of the north-eastern part of the basin, the Pertnjara Formation lies apparently conformably or disconformably on the Mereenie Sandstone. The contact between the Pertnjara Formation and the Mereenie Sandstone is very difficult to recognize on the ground in some areas, but can generally be recognized on air-photographs.

In the eastern part of the basin, the Mereenie Sandstone has an estimated maximum thickness of between 1500 and 2000 feet. The unit is probably thickest 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 a couple of miles north of Camel Flat Bore (RdR3). The formation is about 890 feet thick in the Alice No.1 Bore. The measured sections are shown in Plates 12 and 13.

Only the upper part of the Mereenie Sandstone (Pzm(2)) is known to occur in the north-eastern part of the Amadeus Basin.

This upper unit is characteristically cross-bedded, fine to medium-grained, white sandstone. It is laminated to medium-bedded and commonly has scattered laminae of medium and coarse sand grains in the predominantly fine-grained rock. The unit contains some ripple marks, mud cracks and slumped cross-beds. The weathered sandstone is pale orange-brown and has a thin surface silicified crust which protects the otherwise friable rock.

Conglomerate and conglomeratic sandstone occur in lenses 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 irregularly directed worm tubes are common near the base of the formation and also occur near the top in some areas (e.g. Waterhouse Range).

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

The Mereenie Sandstone is considered to be partly of transitional, marine origin and partly of aeolian origin. Diagnostic fossils have not been found within the formation and the age limits are Upper Ordovician to Upper Devonian.

ORDOVICIAN-CARBONIFEROUS

On the eastern side of the Rodinga Sheet area, the Mereenie Sandstone is difficult to differentiate from the overlying sandstone unit of the Pertnjara Formation and where there is doubt about the position of the boundary, the two units have been mapped as a single unit, Pz. The lithologies of the two Formations are described separately.

DEVONIAN-CARBONIFEROUS

Pertnjara Formation (Prichard & Quinlan, 1962)

The Pertnjara Formation has been mapped in the Jay Creek-Alice Springs area, 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; in an area a few miles north of Camel Flat bore; and in a number of isolated localities in the south-western corner of the Rodinga Sheet area and the northwestern corner of the Hale River Sheet area.

The Pertnjara Formation is divided into three units in the north-eastern part of the Amadeus Basin. The basal siltstone member is present only in the south-western corner of the Rodinga Sheet area. This member weathers recessively and is very poorly exposed. The middle unit of the Pertnjara Formation is sandstone and is the most widespread. It forms prominent purple-brown and orange-brown strike ridges, mesas and hills. The upper unit is conglomerate and is known in outcrop only from the Brewer Plain, the core of the Ross River Syncline, the area north of Camel Flat bore and a few exposures in the north-western part of the Hale River Sheet area. The conglomerate forms low mounds and hills with a dendritic drainage pattern in most areas, but north of Camel Flat bore, the unit forms a prominent mesa.

The Pertnjara Formation overlies the older sediments with a regional unconformity. Over most of the area, the Pertnjara 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) and in other places, the Pertnjara Formation unconformably overlies older strata and also has an unconformity within its limits (e.g. Pzp(s) - Pzp(c) boundary in the Ross River Syncline). The Pertnjara Formation is unconformably and disconformably overlain by the Crown Point Formation, De Souza Sandstone and the various Tertiary units.

The thickness of the Pertnjara Formation can only be estimated from incomplete sections and is probably extremely variable.

The basal siltstone (Pzp(a)) has an estimated maximum thickness of about 200' in the south-western part of the Rodinga Sheet area. The sandstone member (Pzp(s)) has an estimated maximum thickness of 1500 feet in the area around the Waterhouse Range and Ooraminna Anticlines but is probably much thinner south and east from that area. The conglomerate member Pzp(c) is by far the most variable, and the thickness is estimated to range from a maximum of 4,000' under Brewer Plain to 600' in the Ross River Syncline and about 400' in the Bingie Bore area. Incomplete sections measured in the Pertnjara Formation are shown in Plate 13.

The basal siltstone member of the Pertnjara Formation consists of green and red, laminated, micaceous (some biotite) siltstones and shale and has 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, moderately and poorly sorted and contains pebbles and cobbles of chert, silicified sandstone, quartzite and vein quartz. This unit is, in places, very similar to the Mereenie Sandstone and where the units are paraconformable and strongly weathered, they have been mapped as a single unit (Pz). However, in most areas, the sandstone of the Pertnjara Formation can be distinguished by its red-brown or yellow-brown colour, by its poor sorting, coarser grain-size and the presence of kaolin, mica and scattered pebbles of chert.

The conglomerate member (Pzp(c)) 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. In many areas, the source of the phenoclasts is known (e.g. north ofCamel Flat bore the boulders are almost entirely derived from the Arumbera Sandstone and the Pertatataka Formation and north-east of Bingie Bore on the Hale River Sheet area they consist mainly of carbonates from the Pertaoorrta Group) and in some areas a number of formations are represented in the reverse order of deposition (e.g. south-east of Jay Creek Native settlement and south of the Alice Springs airport, the base of the Pertnjara Formation contains fragments of Pertaoorrta Group sediments and these are overlain in turn by 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 by the Alice Springs orogeny during the Devonian and possibly the Carboniferous periods. The pulses of this 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 resulted from relatively local structures. The sediments are presumed to have been folded during the last phase of the orogeny.

Fossils have not been found within the Pertnjara Formation in the north-eastern part of the Amadeus Basin, but plates of the dermal armour of the placoderm Bothriolepis have been identified by Joyce Gilbert-Tomlinson (pers.comm.) in collections from a sandstone lens in the basal siltstone unit (Pzp(a)) of the Pertnjara Formation on the northern flank of the Mereenie Anticline and Hodgson (1964) has described a spore assemblage from approximately the same horizon in the same area. These fossils from the central part of the Amadeus Basin indicate a late Middle or early Upper Devonian age (Hodgson, 1964) for the basal part of the Pertnjara Formation. Disconformably or unconformably overlying the Pertnjara Formation are the Lower Permian glacial sediments of the Crown Point Formation. Hence, the Pertnjara Formation is considered to be Middle Devonian to Carboniferous in age.

Langra Formation (Wells, Stewart and Skwarko, 1965)

The Langra Formation of the Finke Group is present only in the subsurface in the north-eastern part of the Amadeus Basin. It was intersected in the Mount Charlotte No.1 Well and in a water bore 15 miles south-west of Maryvale Homestead. In Mount Charlotte No.1 Well, the formation is 530 feet thick and is conformable between the Horseshoe Bend Shale above and an unnamed shale unit of the Finke Group below; the unnamed shale unit is probably a lateral equivalent of the Polly Conglomerate of the Finke Group. Wells et al (1965) estimated the thickness of the Langra Formation to be 500 feet at Horseshoe Bend.

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 containing rare biotite flakes, white fine-grained, well rounded and sorted quartz sandstone, and some pebbles of grey and purple chert and some calcareous nodules.

In the Finke Sheet area the Langra Formation contains boulders of Stairway Sandstone (Wells et al, 1965). It is possibly a lateral equivalent of part of the Pertnjara Formation and is therefore considered to be Devonian to Carboniferous.

Horsheshoe Bend Shale (Wells, Stewart & Skwarko, 1965)

The Horseshoe Bend Shale crops out only along the southern margin of the Rodinga Sheet area. It is very poorly exposed and forms low flats which are mostly covered by alluvium.

The Horseshoe Bend Shale is conformably underlain by the Langra Formation and is conformably overlain by the Santo Sandstone. Both boundaries may be gradational but exposure is too poor to be certain.

No sections have been measured through the Horseshoe Bend Shale in the north-eastern part of the Amadeus Basin. The formation is about 460 feet thick in the Mount Charlotte No.1 Oil Well, and is overlain by a few feet of sandstone which may be Santo Sandstone.

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

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

Santo Sandstone (new name)

The Santo Sandstone is defined as the white, cross-bedded sandstone and pebbly sandstone, which conformably overlies the Horseshoe Bend Shale in the Chambers Pillar area. The type locality is situated 12 miles south-west of Maryvale Homestead where the formation is exposed in a group of mesas and has an exposed thickness of about 200 feet. The upper part of the formation has been eroded in the type locality. The name of the formation is taken from Mount Santo, a mesa situated five miles south-west of Chambers Pillar.

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

Fig.26 Santo Sandstone at Chambers Pillar (Rodinga Sheet area)
Neg. No.M371-13

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

The Sandstone is friable, thin to thick-bedded and cross-bedded, and contains heavy mineral concentrations in a few beds. Silt is either intergranular or else forms fairly large lenses and pellets. The pebbles and cobbles weather from the sandstone matrix and cover the tops of the mesas and their talus slopes.

No fossils have been found in the Santo Sandstone. The formation is probably equivalent in part to the Pertnjara Formation to the north. South of the type area the relationship of the Santo Sandstone to other formations is uncertain but the unit is probably partly or wholly equivalent to the Idracowra Sandstone (Wells, Stewart & Skwarko, 1965). The formation is considered to be of Upper Devonian or Carboniferous age.

PERMIAN

Crown Point Formation (Wells, Stewart and Skwarko, 1965)

The Crown Point 'Series' (Ward, 1925), was revised to Crown Point Formation by Wells, Stewart and Skwarko (1965). In the area mapped, 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 in the sequence. The sequence is exposed in a small mesa at Pinnacle Hill, and in two more mesas situated 10 miles north-east from there (localities H150 and H151). Low cliffs of sandstone are found at H157 (8 miles south-east of Pinnacle Hill), and at another locality 6 miles south-west of Pinnacle Hill.

The unit's stratigraphic relations are not well known. The Pertnjara Formation crops out close by, to the north of the Crown Point Formation, and probably disconformably underlies it throughout much of the area. The De Souza Sandstone disconformably overlies the Crown Point Formation at Pinnacle Hill, and at H151. No section has been measured through the Crown Point Formation; about 1200 feet was penetrated in Malcolms Bore (Rochow, pers.comm.).

The Crown Point Formation consists of tillite, conglomerate, sandstone, siltstone, and claystone. Tillitic textured sediments were found at three localities. At H151, a red-brown to white siltstone, micaceous, non-bedded, irregularly jointed, and moderately cohesive, contains poorly rounded and unsorted sand grains, and granules, pebbles and cobbles of indurated sandstone. Some fragments of white claystone are also included. Six miles south-west of Pinnacle Hill, 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 H157, a white, sandy, non-bedded siltstone, containing pebbles, cobbles, and boulders of quartzite; these are poorly to well rounded, soled, and irregularly shaped.

Conglomerate (<u>in situ</u>) was found at three localities. It is poorly stratified, poorly sorted, and interbedded with conglomeratic sandstone. The pebbles, cobbles, and boulders are of quartzite, sandstone and chert and reef quartz and are poorly to well rounded, polished, faceted, soled, and striated. Other structures shown include perlitic cracks, impact marks, sharply-edged holes formed by gouging, and irregular, re-entrant hollows. All these features are also shown by the weathered out phenoclasts which form the pebble mounds throughout the area. At H150 and H151, conglomerate forms the tops of the two small mesas; it is non-bedded, non-sorted, and contains phenoclasts up to 4 feet across. The conglomerate at Pinnacle Hill is described below.

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

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

Claystone was found only at Pinnacle Hill, 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 in the claystone.

The stratigraphic position of the sequence at Pinnacle Hill is not certain. The succession above the pink claystone comprises 10 feet of white, coarse-grained sandstone, friable, very kaolinitic, and poorly thin bedded. The contact of this sandstone and the underlying claystone is uneven, and the claystone is bleached yellow for about 2 inches below this surface. Overlying the sandstone is 5 feet of pale grey-brown siltstone, clayey, friable, non-bedded, and slightly micaceous. This is overlain by 12 feet of conglomerate and conglomeratic sandstone, with granules, pebbles, and small cobbles in a coarse, very clayey sandstone matrix. The top of the hill is composed of about 15 feet of yellow sandstone, poorly sorted, fairly clean, thinly cross-bedded, blocky, and with pebbles at the base. The contact between this and the underlying conglomerate is uneven, and the uppermost sandstone is regarded as the basal unit of the De Souza Sandstone. Nevertheless, the base of the De Souza Sandstone could be placed at the lower uneven surface, above the claystone.

The environment of deposition of the Crown Point Formation is not fully understood. The sediments have probably been through a phase of glacial transport, followed by deposition in fluvial or marine-glacial conditions, together with the poorly sorted sandstones. The lutites suggest that less torrential periods existed from time to time.

The Crown Point Formation is Permian (?Sakmarian) from the evidence of spores obtained from Malcolms Bore, 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).

JURASSIC

De Souza Sandstone (Sullivan & Opik, 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 characteristically 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 which adjoin clay pans. They are probably composed of ferruginized sandstone.

The De Souza Sandstone disconformably overlies the Crown Point Formation in the Hale River Sheet area. On the Rodinga Sheet area, it disconformably overlies the Horseshoe Bend Shale, and a Palaeozoic sandstone (Pz) equivalent to the Mereenie Sandstone or Pertnjara Formation. The De Souza is overlain by the Rumbalara Shale, and Wells et al describe the relationship between these two units in the Finke Sheet area as being unconformable. No section has been measured through the formation; it is at least 300 feet thick in Malcolms Bore (Rochow, pers.comm.).

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 ferruginous fine conglomerate. Cylindrical, rod-like structures were found on the bedding planes in the conglomerate, and these may be of organic origin. In the south-western part of the Hale River Sheet area, at a locality 6 miles south-west of Pinnacle Hill, exposures of the formation consist of about 10 feet of medium-grained, kaolinitic sandstone, slightly micaceous, poorly sorted, and poorly rounded; a few pebbles are present. One mile south-west of H151, the De Souza Sandstone is preserved as an incomplete capping on top of a mesa of Crown Point Formation; it consists of a few feet of dark brown, ferruginous sandstone and pebbly sandstone, medium to coarse-grained, poorly rounded, and non-bedded. This ferruginous sandstone is exposed at several places south of H151 and west of H156.

In the southern part of the Rodinga Sheet area, the De Souza Sandstone is generally a white or pale brown, kaolinitic sandstone, fine to coarse-grained, and pebbly. Cross-bedding, slumps, and ripple marks are common. Lenses and thim interbeds of white claystone or siltstone are present in the formation, particularly towards the top. Conglomerate bands are also numerous, and the boulders of silicified sandstone are up to 12 inches across. 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 at a large mesa 24 miles south-east of Desert Bore. The generalized sequence is:-

TOP	65 feet	Medium to coarse-grained sandstone and conglomerate (phenoclasts are up to cobble size).
	3 feet	White and yellow claystone, non-bedded.
	25 feet	Very coarse, kaolinitic sandstone, slightly slumped; contains lumps of claystone.
	10 feet	Very coarse, kaolinitic sandstone, with abundant lumps of claystone and quartzose granules and pebbles.
	5 feet	Yellow, micaceous sandstone, fine-grained, laminated.
	1 foot	Dark brown, very ferruginous, fine to coarse sandstone; forms a very prominent and extensive flat bench.
	2 feet	Dark brown, very ferruginous claystone.
	1 foot	Yellow claystone.
	40 feet	Cream to white, kaolinitic sandstone, micaceous, medium-grained.
	20 feet	White to pale yellow-brown, poorly sorted sandstone.
	10 feet	White, kaolinitic sandstone, very friable.
	3 feet	White, micaceous siltstone and pink claystone.
	100 feet	White, kaolinitic sandstone, steeply cross-bedded, well sorted.
BOTTOM	285 feet	a few interbeds of white claystone are present

Diagnostic fossils have not been found in the formation; those found include 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 a large mesa in the centra of the Hale River Sheet area, and forms the main part of the outcrops in the McDills Sheet area.

The Rumbalara Shale overlies the De Souza Sandstone in mesas 20 miles south-east of the Pillar Range. The contact appears to be conformable but Wells, Stewart and Skwarko (1965) describe the relationship between the two formations in the Finke Sheet area as unconformable. The Rumbalara Shale is overlain with an angular unconformity by the Etingambra Formation which is probably Tertiary in age.

The outcrop sections of the flat-lying Rumbalara Shale have a maximum thickness of about 200 feet. Thicknesses penetrated in bores are much greater: about 300 feet thick in Malcolms Bore in the Hale River Sheet area; about 1300 feet thick in Peebles Bore; and more than 450 feet in Birthday Bore, north of Andado Homestead.

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 through the formation in the McDills Sheet area (McD2) is as follows:-

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

In most places the Rumbalara Shale is covered by a thick siliceous, grey-billy capping.

The top of the formation is usually deeply weathered. The sediments are deeply opalized with white and translucent chalcedony, and ferruginized and stained by iron oxides. 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 more common rock types in the formation. The granular kaolinite in places contains pellets and laminae of siltstone. The claystone of the formation is unctuous, hackly, poorly thin-bedded, and in places contains intertongueing laminae of silt and clay. The less common siltstone in the formation is in part micaceous, 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. In the type area Sullivan and Öpik found lamellibranchs, porifera, gastropods, microfossils, and tracks and trails. The fossils in the type area indicate a Lower Cretaceous age for the formation and this is supported by a study of microfossils from Birthday Bore near Andado by Terpstra and Evans (1963).

TERTIARY (T)

Sediments of probable Tertiary age are widespread throughout the north-eastern part of the Amadeus Basin. So far only one unit (the Etingambra Formation) has been formally defined, but informal units have been erected on the basis of lithology, age relative to the time of formation of silcrete (Grey Gilly) and the presence of fossils. The informal units are not formations in the true sense; they were probably deposited in a number of small basins and were not continuous rock bodies.

Etingambra Formation (Te) (new name)

This is the new name for a thin sandstone unit 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 north-east and south-east from there on the McDills Sheet area. It forms the cappings of mesas which are up to 100 feet high.

The Etingambra Formation overlies weathered Rumbalara Shale at all localities. 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 contact is disconformable. The top of the Etingambra Formation has been eroded and the unit averages about 15 feet thick over most of the area. It is 30 feet thick at Mount Etingambra, and is up to 40 feet thick in the northern part of the McDills Sheet area.

The formation consists of sandstone, siltstone, and lenses of conglomerate. The dominant lithology is a medium to coarse-grained, yellow-brown sandstone: 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 well 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 billy.

The Etingambra Formation is probably of non-marine, fluviatile, 'torrent gravels' origin. It is unconformably younger than the Lower Cretaceous Rumbalara Shale and is probably Tertiary. It is tentatively correlated with the "Macumba Sandstone" (unpublished name) which contains Tertiary gastropods and overlies the equivalent of the Rumbalara Shale in the northern part of South Australia.

Pre-silcrete Tertiary Sediments (Ts)

The pre-silcrete Tertiary sediments include claystone, siltstone, sandstone, and conglomerate. Isolated outcrops of these sediments have been mapped near the MacDonnell and Fergusson Ranges, in the ranges south-east of Ringwood Homestead, near Phillipson bore in the centre of Phillipson Pound, and south of the James Ranges near Gum Tree Creek. They are mostly subhorizontal and form mesas with a silcrete (Billy) capping. 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, and the conglomerate comprises well rounded pebbles and cobbles of vein quartz, black chert, and quartzite in a matrix of poorly sorted, coarse-grained sandstone.

Sediments intersected in bores drilled for water in the Alice Springs Farm area, and in the Phillipson Pound about 10 miles north of Santa Teresa Mission, have also been included in this division. The sediments drilled in theAlice Springs Farm area 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 W.R.B./Z.G. at depths of 929-959 feet, 997-1006 feet, and 1015-1038 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 unidentifable (?) aquatic micro organisms, consisting of very thin psilate membranes fitting closely to inner and likewise thin sacs, occurred at 929-959 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)."

The age of the pre-silcrete Tertiary sediments cannot be stated with certainty but Lloyd (1965) has suggested they may be Eocene to Miocene.

Tertiary Silcrete ("Grey Billy") (Tb)

Silcrete occurs in many scattered localities throughout the north-eastern part of the Amadeus Basin and 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 on 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 or 'Billy' has a maximum known thickness of about 10 feet in the area mapped. In some places it has a nodular appearance, and in others it contains structures which are similar to a coarse 'pipe-rock'. The 'pipes' vary from regularly spaced vertical types to completely irregular forms. Most of the silcrete occurs as subhorizontal or low-dipping sheets, but a similar lithology 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 in the area about 5 miles west of Deep Well Homestead).

The silcrete is presumed to have formed as a result of near-surface silicification during a prolonged period of weathering. The vertically-dipping 'dykes' of silcrete probably formed as a result of migration of silica along joints during this same period.

The age of the silcrete can be determined only from its stratigraphic position. It forms a capping on sediments of possible Eocene to Miocene age and is overlain by sediments of probable Miocene age. The age is therefore Eocene to Miocene.

Ferricrete (Laterite)(Ta)

Ferruginized sediments occur at a few scattered localities in the north-eastern part of the Amadeus Basin (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 (Tl) and may have been contemporaneous with the formation of the "Billy". However, a younger ferricrete has been described from an outcrop about 4 miles north-east of Wallaby Gap dam and it is possible that ferruginization may have occurred on a number of occasions during the Tertiary.

Post-Silcrete Tertiary Sediments (Tl and Tc)

These sediments have been divided into two units on a lithological basis, but from evidence in the central part of the Amadeus Basin (Ranford, Cook & Wells, 1965), they are probably time equivalents. The conglomerate (Tc) contains phenoclasts derived from older sediments (including "Billy") and from Precambrian basement. It is exposed in the banks of the major rivers (e.g. Hugh and Finke Rivers), and in the area south of the James Ranges on the western side of the Rodinga Sheet area. The conglomerate forms low rounded hills and mounds, and comprises rounded pebbles, cobbles, and boulders up to 2 feet in diameter in a matrix of poorly sorted, calcareous sandstone.

The other post-silcrete Tertiary sediments (Tl) consist of interbedded sequences of limestone, sandstone, siltstone, and claystone. These sediments crop out at scattered localities throughout the north-eastern part of the Amadeus Basin. In most areas, the sediments are subhorizontal and form mesas capped with very fine chalcedonic limestone. However, 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 structure which has an arcuate, longer axis.

The lithologies in these sediments are quite variable, but the capping of grey-weathering chalcedonic limestone is characteristic. Much of the cryptocrystalline, chalcedonic limestone is considered to be a caliche or kunkar type of deposit deriving from a soil profile that had formed on the highly variable but relatively thin sequence of younger Tertiary sediments. The sediments were almost certainly deposited in small basins, which may have been partly joined by means of the major drainage channels such as the Finke, Hugh and Todd Rivers.

The post-silcrete Tertiary sediments contain fossils at a number of localities in the north-eastern part of the Amadeus Basin. The most widespread fossils are gastropods, but in outcrops west of Phillipson Pound, the gastropods are associated with ostracodes and vertebrate remains. The gastropods have been described by McMichael (1965) and the known outcrops and their fossil content have been discussed by Lloyd (1965).

R.H.Tedford (pers.comm. in Lloyd, 1965), has suggested a 'later Miocene' age for a vertebrate fauna found near Deep Well and Lloyd (1965) has suggested that the gastropods in these sediments may be of Miocene age and that the post-silcrete sediments may be Miocene or younger.

QUATERNARY

General

Most of these sediments were deposited early in the Quaternary under the semi-arid climatic conditions which followed the subsidence of the Lake Eyre Basin in South Australia, and the dissection of the Tertiary weathered land surface (Mabbut, 1962). Subsequently, conditions became more arid and the present internal drainage pattern was formed, followed by development of the Simpson Desert dune system. Some incision of earlier alluvial deposits took place in late Quaternary time, and this indicates some resumption of drainage. The effectiveness of this final erosional phase may have decreased in recent times.

Conglomerate and Scree

Along the ridges of the physiographic division A (Fig.2), the hill slopes are mantled with scree and boulders and these 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 scree deposits around mesas. Rounded boulders of the Crown Point Formation form low hills in the neighbourhood of Pinnacle Hill on the Hale River Sheet area. South of Limbla Homestead, pebble gravel crops out along the banks of the Hale River. Similar material is found along the major creeks east and south-east of No.6 Phillipson Bore and just north of Casey Bore on the Hale River Sheet area. These 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 and are included in physiographic divisions F and G (Fig.2).

Stable, gently sloping plains of alluvium and wash occupy areas in the middle of the Todd Plain and in the more restricted valleys which extend from Giles Creek to the Hale River. These sediments are commonly calcareous.

Active flood plains containing coarse sandy and minor loamy alluvium form patchy areas along the Todd, Finke and Hale Rivers, the lower part of Giles Creek and upper part of Illogwa Creek. The plains are up to two 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 within the higher ranges.

A few small clay pans, which form centres for restricted internal surface drainage are dispersed throughout the Simpson Desert, particularly in the north-eastern corner of the Hale River Sheet area. A few crainage channels which have minor marginal alluvial deposits converge on flat pan surfaces of clay and fine sand. These clay pans and drainage channels lie in the interdune swales and appear to be controlled by the dune system. Hence the clay pans probably post-date the time of formation of 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

The term travertine is used for deposits of calcium carbonate precipitated from ground-water. They consist of grey or white concretionary masses which commonly are very vuggy. Apart from rare, thin veneers on shallow slopes in limestone areas, the travertine is largely restricted to deposits within the alluvium north of Mount Ooraminna and east of the Waterhouse Range.

Aeolian Sand

Extensive, seif-type sand dunes of the Simpson Desert system form a surficial cover over about half the area mapped. (Physiographic Division D, Fig.2). Most of the dunes are parallel and reticulate, and their flanks have been fixed by spinifex, but minor areas of mobile sand are known. The dunes average 50 feet high, and trend north-northwest. Their formation was apparently controlled by anticyclonic winter winds. Avalanche faces of dunes are to the east. Interdune swales are flat and mainly sandy. At the desert margins reticulated dunes up to 40 feet high tend to be made up 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 in the south-western part of Illogwa Creek Sheet area near Numery Homestead and on the Brewer Plain of the Alice Springs Sheet area.

In areas west of Andado Homestead and west of North Bore on the McDills Sheet area, the numerous closely spaced small clay pans have a thin surface layer of pisolitic iron stone (buckshot gravel).

STRUCTURE

INTRODUCTION

The area dealt with in this report includes the north-eastern part of the Amadeus Basin and part of the western margin of the Great Artesian Basin. The regional structure of each basin will be outlined in this section and will be followed by more detailed descriptions of individual structures.

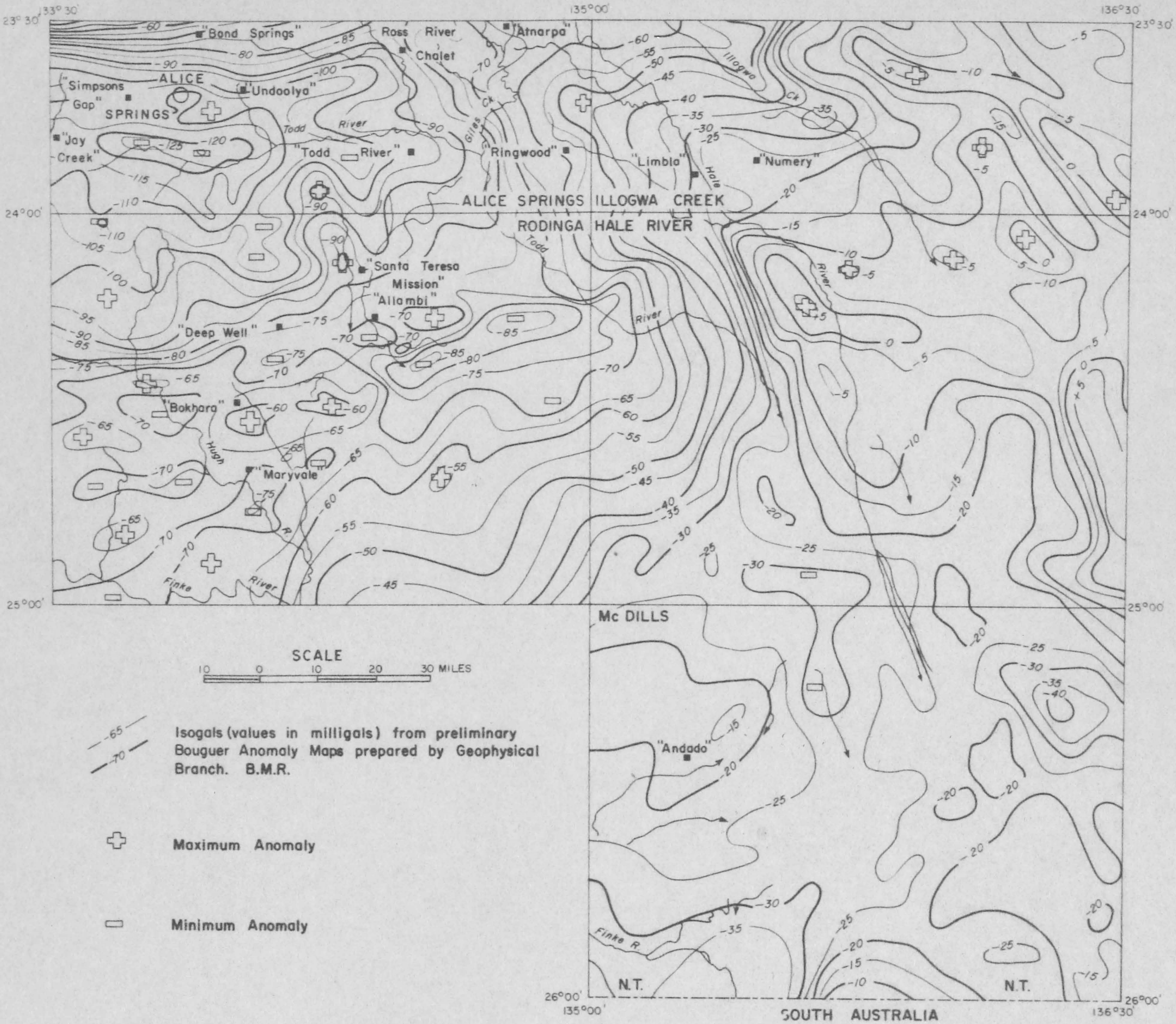
Amadeus Basin

The Amadeus Basin contains Upper Proterozoic and Palaeozoic sediments and is a basin of preservation rather than a basin of deposition. The general distribution of the sediments and a tectonic interpretation of the north-eastern part of the Amadeus Basin is shown in Plate 6. The northern margin is marked by the exposed contact between the Proterozoic sediments and the igneous and metamorphic rocks of the 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 can be estimated from the Regional Bouguer Anomaly Map (Fig.28) and the depth to basement contours calculated from aeromagnetic anomalies (Fig.29). A maximum thickness of about 20,000 feet of sediments is preserved in the north-eastern part of the Amadeus Basin. Stratigraphic sections and seismic traverses to the south of Alice Springs indicate that the sediments thin to the south. The structures which characterize this part of the Amadeus Basin were formed by the 'Alice Springs Orogeny' (Forman, 1965; Forman & Milligan, 1965) during the Upper Devonian or Carboniferous and the axes of the folds mostly trend between east-north-east and east-south-east. Other lineaments which trend in a south-westerly and south-easterly direction are considered to be reflections of basement fractures which probably developed before the Alice Springs Orogeny. Two main styles of folding are recognised within the north-eastern part of the Amadeus Basin. (i) Along the northern margin the Upper Proterozoic Heavitree Quartzite and Bitter Springs Formation are involved in large recumbent folds and nappes. One of these structures - the 'Blatherskite Nappe' is discussed below and other nappes in this area are discussed in a separate report by Forman and Milligan (1965). (ii) In front of the nappes, part of the Bitter Springs Formation and all the overlying Proterozoic and Palaeozoic sediments have been pushed southwards to form a decollement. The folds developed within the decollement are of two types. Those nearest the nappes are shallow dipping symmetrical synclines and steep complex anticlines, showing evidence of folded thrust faults and imbricate structure (Fig.35) within their cores. Farther away from the nappes the broad shallow dipping synclines are separated by sharp, narrow, box-shaped anticlines.

BOUGUER ANOMALIES

Fig. 28

NORTH-EASTERN PART OF THE AMADEUS BASIN



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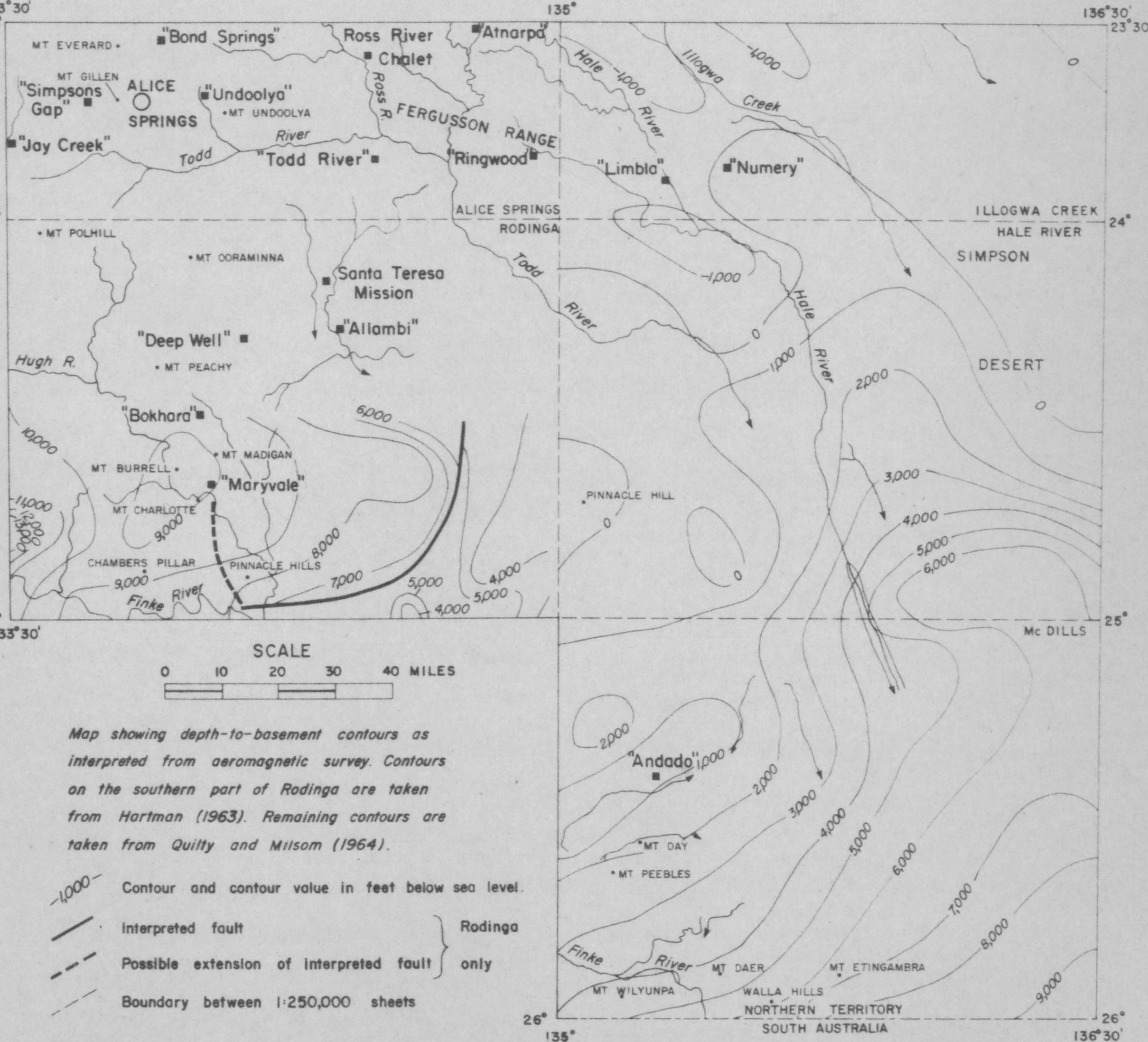
NT/A126

Fig. 29

AEROMAGNETIC BASEMENT CONTOURS
NORTH-EASTERN PART OF THE AMADEUS BASIN



Map showing depth-to-basement contours as interpreted from aeromagnetic survey. Contours on the southern part of Rodinga are taken from Hartman (1963). Remaining contours are taken from Quilty and Milsom (1964).

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The style and pattern of folding in the north-eastern part of the Amadeus Basin are due largely to the thickness and type of sediments present in the area. The presence of evaporites in at least two and possibly three horizons has been responsible for many of the features of the structure. The evaporites within the Bitter Springs Formation appear to have made the major contribution to the style of folding by providing a plane of slippage or decollement over which the great mass of the sedimentary pile has been pushed. However, it appears that in many instances a plane of decollement has also developed within the Chandler Limestone or near the base of the Giles Creek Dolomite where the Chandler Limestone is not present.

Examination of the complex anticlinal regions indicates the presence of folded thrust faults (Fig.36) and suggests that early compression was absorbed by thrusting. However, there is no evidence for any break between the thrusting and later folding and they are considered to represent stages of deformation within the one continuous orogenic episode.

Great Artesian Basin

The structure of the western part of the Great Artesian Basin cannot be determined from outcrop but geophysical surveys have outlined some of the structural features. These surveys include a regional gravity survey, and an aeromagnetic survey and seismic surveys on the Hale River, McDills, and part of the Rodinga Sheet areas.

The regional 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 which covers the eastern end of the Amadeus Basin.

The basement depth estimates from aeromagnetic surveys (Fig.29) suggest 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 thickest sediments are estimated to be over 9,000 feet about 40 miles east of Mount Etingambra. In the north-west part of the Hale River Sheet area the estimates of depth to igneous and metamorphic basement do not agree with the thickness of sediments measured in outcrop. In areas where depth to basement was estimated to be at about 1,000 feet above sea level (i.e. less than 1,000 feet below the surface) the thickness of sediments is actually about 10,000 feet.

The aeromagnetic survey indicates that the outcropping basement rocks in the north-west part of the Hale River Sheet area do not continue to the south-east as a ridge. A similar south-easterly trending ridge of Precambrian rocks inferred from the aeromagnetic work cuts across the north-east corner of the Sheet area.

In a report on a seismic survey in the Hale River floodout area, Campbell (1965) suggested a regional south-east dip of the sediments with gradually increasing thickness in this direction. A total thickness of 15,000 feet of sediments is suggested by the seismic reflection records on the southern part of the Hale River Sheet area.

In a report on a gravity survey of the Simpson Desert, Sprigg & Stackler (1965) describe the McDills area as lying in a broad gravity minimum flanked by gravity 'highs' around Andado, to the east of the Sheet area and south of Mount Etingambra. Sedimentary thicknesses are estimated at from 10,000 to 20,000 feet which may include Upper Proterozoic rocks. The more symmetrical linear gravity anomalies within the area of low gravity Bouguer values are related to folds.

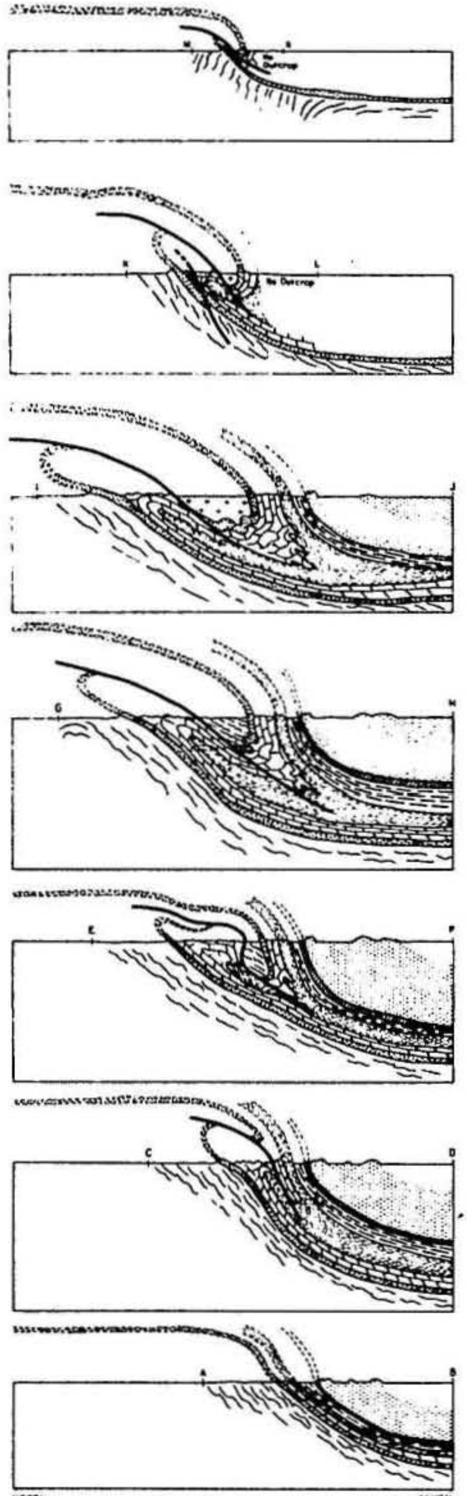
One of these folds, the McDills Anticline, which extends north-east from a point 15 miles north of Mount Etingambra was outlined in detail by the Anacoora Bore gravity survey (Stackler, 1964).

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 15-20° to the north-north-west and 10-12° to the south. Structural closure was shown within what is thought to be Permian rocks.

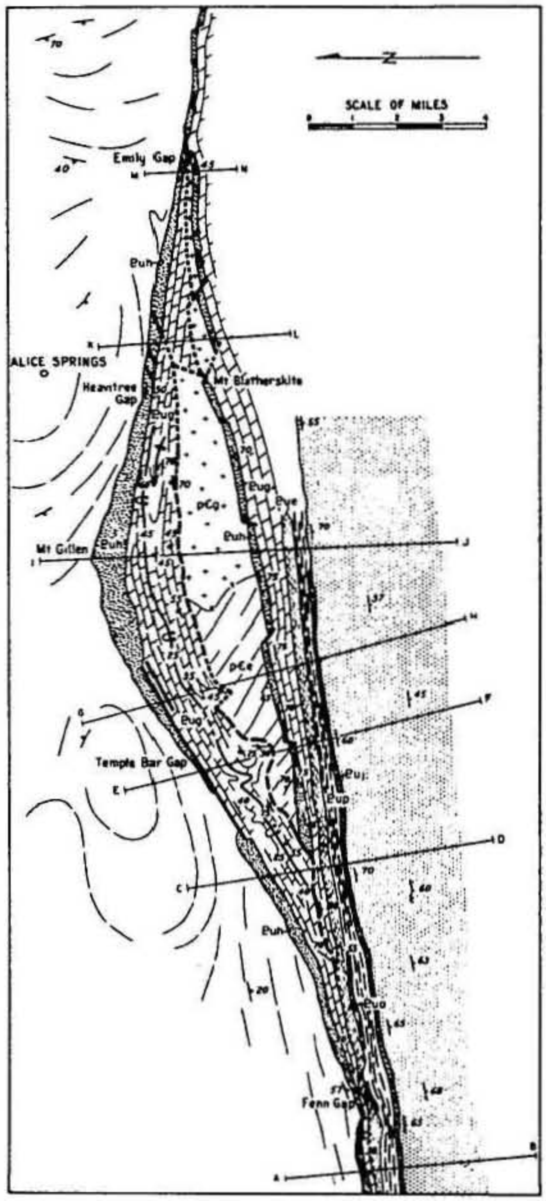
DESCRIPTIONS OF SELECTED INDIVIDUAL STRUCTURES

Blatherskite Nappe (Fig.30)

The term 'Blatherskite Nappe' was first used in a lecture to the Geological Society of Australia in Sydney by R.O.Brunnschweiler in 1957, and Banks (1964) referred to the Blatherskite Isocline. The structure is situated just south of Alice Springs, and extends from Fenn Gap in the west to Emily Gap in the east, a distance of 22 miles (Fig.30). 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 an overturned north dip of 45 degrees. On the north side of each ridge, basement rocks (granite, gneiss, schist, and quartzite) are exposed, and both ridges are succeeded on the south by the Bitter Springs Formation. These are the only formations involved in the nappe. The rocks of the Bitter Springs Formation constitute the type section of the Gillen Member, depicted in Figure 7.



GEOLOGICAL MAP AND CROSS SECTIONS OF BLATHERSKITE NAPPE, ALICE SPRINGS (Figs. 30 & 31)



REFERENCE

- Palaeozoic
- Bitter Springs Formation:
  - Julie Member
  - Pertatataka Formation
  - Areyonga Formation
  - Loves Creek Member
  - Gillen Member
- Heavitree Quartzite
- Granite
- Gneiss

- Geological boundary
- Inferred geological boundary
- Strike and dip of beds
- Strike and dip of overturned beds
- Trend lines
- Overturned antiform in inverted strata
- Plunge of minor antiform
- Fault, position accurate
- Fault, position approximate
- Fault, concealed
- Strike and dip of foliation
- Cross section line

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The Blatherskite Nappe has the following structural features:

1. Its general shape; the northern edge of the structure makes an embayment into the basement.
2. In the area south of Mt.Gillen, and 8 miles to the west from there, the Gillen Member sequence is repeated. The repeated part is in the reverse stratigraphic order to the first, i.e. moving south from Mt.Gillen, one traverses up the sequence to a prominent ridge of contorted dolomite (the topmost two ridges in Figure 7) and then down the sequence in the reverse order, to the interbedded dolomite and shale at the base of the member. These sediments are faulted against basement, and water bores have shown that the sediments dip south beneath the basement for some distance. The repeated sequence has the same dip as the normal sequence, about 45 degrees south, but facings (from algae) in the repeated part are everywhere inverted. The contorted dolomite between the two sequences is regarded as the axis of an isoclinal fold.
3. A major fault separates the inverted part of the Gillen Member from the basement rocks to the south. In several places along the fault, mylonite crops out as a small ridge up to 4 feet high. In thin section, it consists of broken, angular grains of dolomite in a crystalline, quartz matrix. No signs of fusion are present.
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 1½ miles east of Temple Bar Gap (just east of the White Gums Dairy), and here the facings on all the limbs are inverted.
5. A decollement antiform is situated just south of Temple Bar Gap, with a strike fault at its base where the Heavitree Quartzite has been removed. It will not be discussed further.

From the information available, at least two interpretations of the structure are possible:

1. The structure could be an isoclinal syncline and anticline; the ridge of contorted dolomite forms the core of the syncline, the basement rocks form the anticline, and the middle limb has been sheared out along the major fault.
2. The structure could be an isoclinal antiform and synform in inverted rocks; the ridge of dolomite forms the core of the antiform, the basement rocks form the synform, and the middle limb has again been 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 cross-sections across the structure are shown in Figure 3, using this interpretation. Supporting evidence for this 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. Here, the actual antiform of quartzite can be viewed from the east, and dolomite of the Gillen Member is clearly visible in the core.

The structure seems to have developed by an overthrust movement from the north. This pushed a recumbent anticline of Bitter Springs Formation, Heavitree Quartzite, and basement rocks (in the core) 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 major thrust plane of the Blatherskite Nappe. The whole nappe was then monoclinally folded, so that the recumbent anticline took the shape of a synform, and the recumbent syncline the shape of an antiform. This later folding may also have been responsible for the bending of the nappe into the basement on its northern side. The whole area has since then been eroded, so that only the lower half of the nappe is now preserved.

<u>Hi Jinx Folded Thrust</u> (Figs.32 and 33)

The two cross-sections shown in Figs.32 and 33 are drawn across the folded thrust zone in the north-east part of the Hale River Sheet area near Hi Jinx Bore. Fig.32 is drawn near the centre of the thrust sheet and Fig.33 is drawn across the eastern end of the thrust zone where there is much less displacement on the thrust. Each figure shows how the structure may have formed.

In the western 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 outcrop of 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 folding of the thrust, so that only the Julie Member is exposed. It is also possible that because the upper thrust plate has moved laterally several miles 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. A more unlikely explanation is that the Bitter Springs Formation was thrust under the Julie Member before folding.

SKETCH MAP OF WESTERN PART OF HI JINX FOLDED THRUST NORTH-WEST HALE RIVER SHEET AREA AND INTERPRETED CROSS-SECTIONS

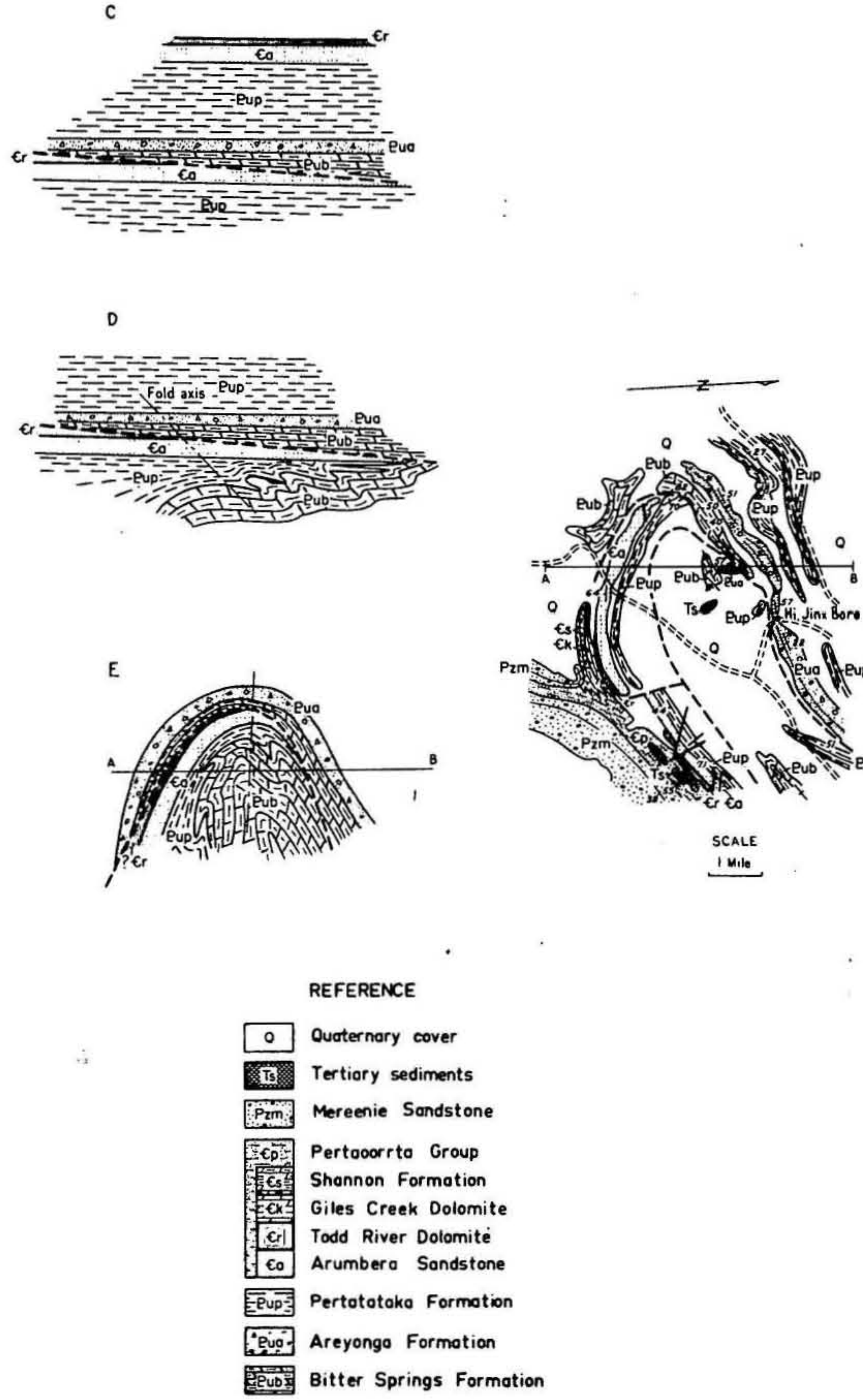

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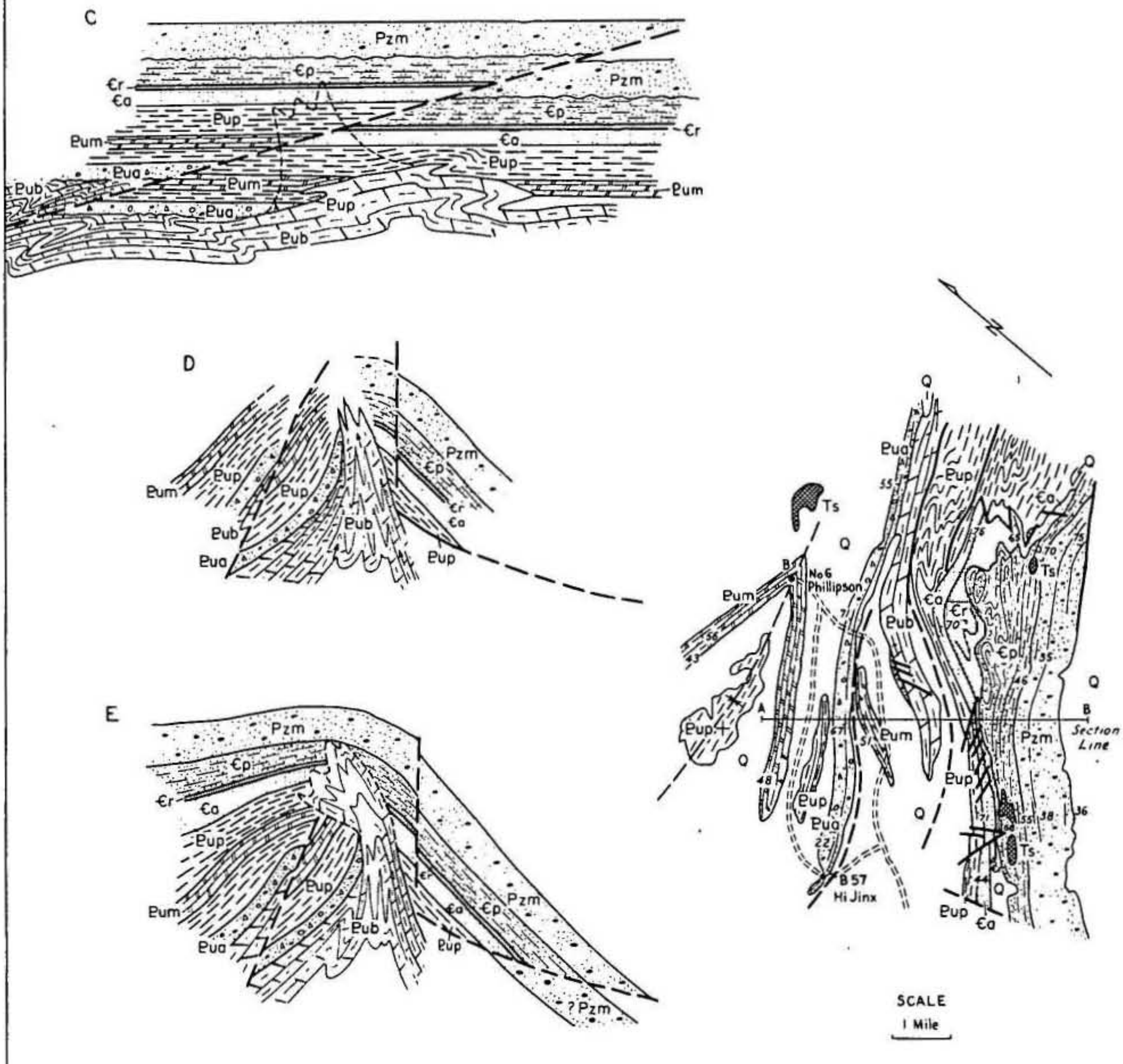
Fig. 33

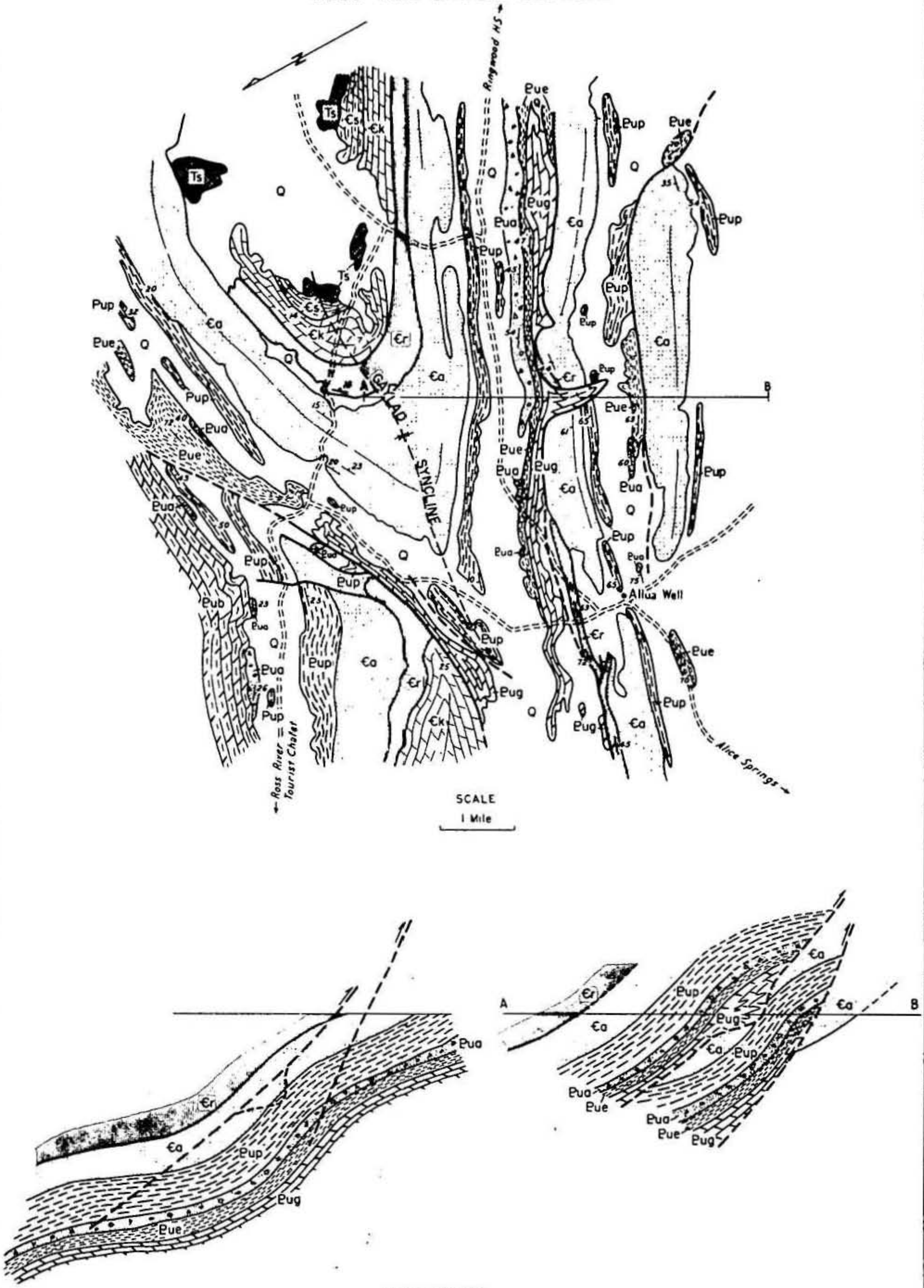
SKETCH MAP OF EASTERN PART OF HI JINX FOLDED THRUST, NORTH-WEST HALE RIVER SHEET AREA AND INTERPRETED CROSS-SECTIONS



REFERENCE

Q	Quaternary cover
Ts	Tertiary sediments
Pzm	Mereenie Sandstone
€p	Pertaoorrta Group
€r	Todd River Dolomite
€a	Arumbera Sandstone
Pup	Pertatataka Formation
Pum	Limbla Member
Pua	Areyonga Formation
Pub	Bitter Springs Formation

SKETCH MAP OF SOUTH FLANK OF GAYLAD SYNCLINE, NEAR ALLUA WELL AND CROSS-SECTIONS



REFERENCE

Q	Quaternary Cover
Ts	Tertiary Sediments
Єs	Shannon Formation
Єk	Giles Creek Dolomite
Єr	Todd River Dolomite
Єa	Arumbera Sandstone
Pup	Pertatataka Formation
Pua	Areyonga Formation
Pub	Bitter Springs Formation
Pue	Loves Creek Member
Pug	Gillen Member

A similar situation is present in the eastern cross-section where the lower part of the Pertatataka Formation is missing in the core of the fold. The absence of this part of the section can be explained by intrusion of the incompetent beds into the Pertatataka Formation during folding, or by the displacement of a thick part of the Pertatataka Formation over a thinner sequence in the formation as outlined above. An alternative explanation is to place a normal fault between the Bitter Springs Formation and Julie Member in the core of the fold. This is improbable as normal faulting of any scale has not been demonstrated in this area. Also the presence of a normal fault in the sequence cannot be reconciled with the western cross-section.

The cross-section drawn through this structure on the Hale River 1:250,000 sheet geological map shows an alternative interpretation of the thrust zone and explains the lack of section from the lower part of the Pertatataka Formation by incompetent folding in the Julie Member and a decollement at the top of the formation. This type of folding is present in the outcrop of the Julie Member near the eastern end of the thrust zone. Some incompetent folding is also shown in the Bitter Springs Formation. One of the authors (A.T.Wells) considers that as the Julie Member is relatively undisturbed in the area where there is most displacement by the thrust it is more likely that most of the incompetent folding took place in the Bitter Springs Formation and a piercement developed during folding.

<u>Allua Well Thrust Zone</u> (Fig.34)

Fig.34 is a cross-section and map of the area near Allua Well. The rocks are cut by two thrusts acting on glideplanes in the Todd River Dolomite and the top of the Arumbera Sandstone. The small "apophysis" of Gillen Member (Bitter Springs Formation) associated with the northern-most thrust was injected down section during folding after the thrust movements (Fig.39). The Gillen Member was probably emplaced along a small fault plane striking normal to the beds. The displacement of the outcrop of the Todd River Dolomite on either side of the intrusive body of Bitter Springs Formation suggests the presence of a small fault.

The Allua Well thrust zone is part of a much larger structure which is called the Olympic-Ringwood folded thrusts. The distribution of the eroded outcrops in the south-eastern part of the Alice Springs Sheet area is interpreted as indicating a complex of folded thrusts and is shown in the eastern-most cross-section on the Alice Springs geological map (Plate 2). The cross-section shows two thrust plates lying one on top of the other and both folded into a large anticline. Both thrusts probably originally dipped to the north. In both thrusts a decollement formed at the top of the Bitter Springs Formation so that considerable movement of the younger formations was possibly 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 many miles.

Ringwood Dome

The beds of the Gillen Member are domed around a gypsum mass, about 1 mile by $\frac{1}{2}$ mile. The gypsum is derived from the Gillen Member and is contorted and brecciated and is capped by large masses of brecciated dolomite. It is not certain if the gypsum dome has resulted by halokinesis or if it has been emplaced as a result of thrusting movements.

Folded Thrust and Imbricate Structure 12 miles east of Allambi Homestead (Fig.35)

Figure 35 shows a geological map of and three cross-sections through 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. With later compression this thrust has been folded and cut by a series of smaller thrust faults in the anticlinal core to give an imbricate structure. The southern limb of the anticline shows a normal succession and apparently was unaffected below the initial 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 plane of decollement within the Bitter Springs Formation. The stress was relieved by thrust faulting in the section between the Bitter Springs Formation decollement and a 'favourable horizon' (evaporites) above the Arumbera Sandstone at which leval a second decollement developed. Judging by the number of thrusts which die out at this level in the section, this 'favourable horizon' must have been very widespread in the north-eastern part of the Amadeus Basin.

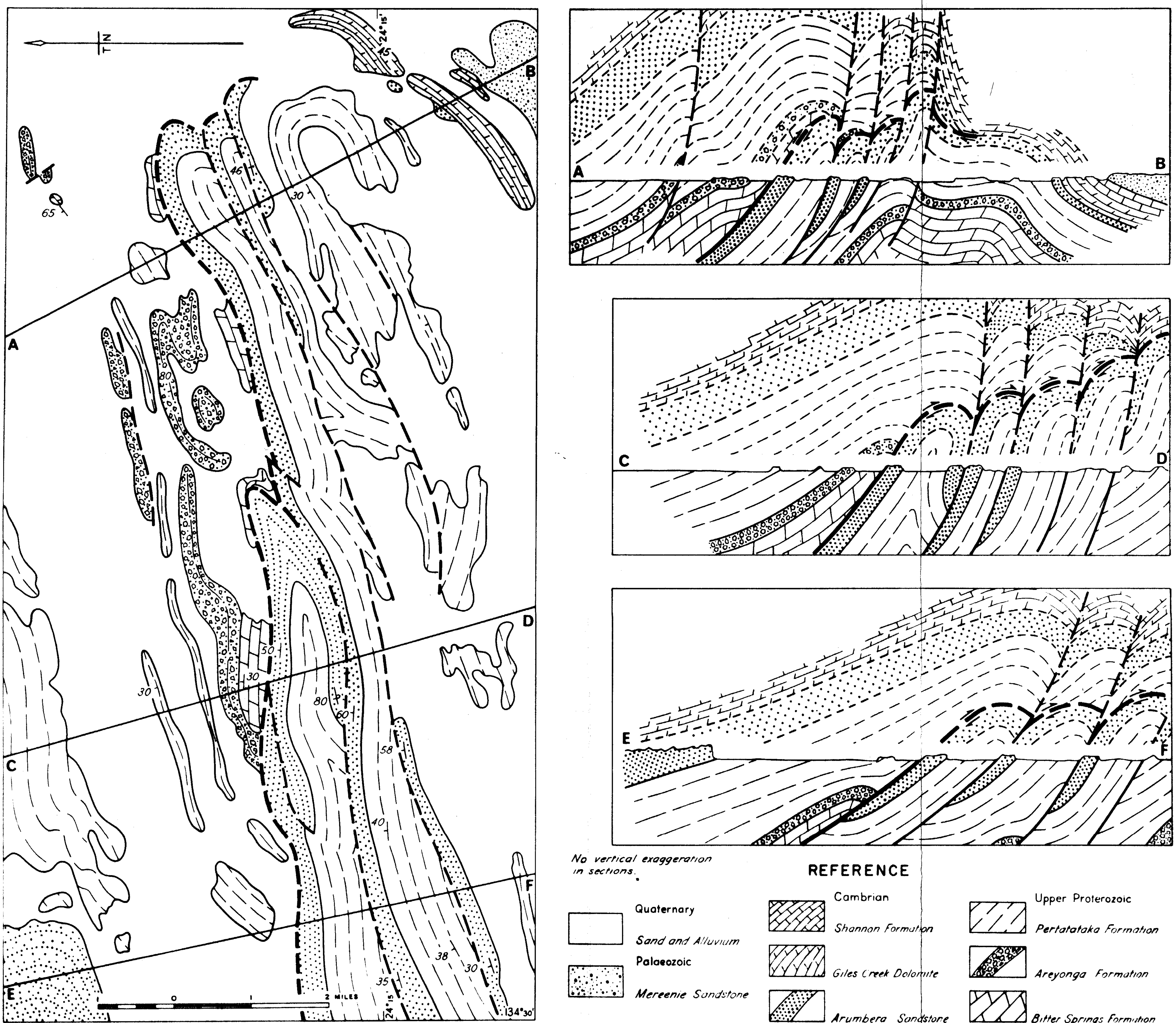
Mount Burrell Anticline (Fig.36)

The Mount Burrell Anticline lies to the north-west of Maryvale Homestead on the Rodinga Sheet area. The outcrop is interpreted as being part of the Pertatataka Formation which has been repeated by thrusting and then folded. The thrust cuts up section to the south suggesting a northerly dip for the thrust plane prior to folding. The anticline plunges to the west and has a slightly overturned northern limb and a shall dipping southern limb near its nose but further east it becomes a 'fan fold' with both limbs overturned.

There is no evidence of any erosion between the initial thrusting and the later folding and the structure is considered to have formed as a result of a single orogeny. The thrusts are thought to have originated at the decollement surface in the Bitter Springs Formation as a result of compression from the

Fig 35

MAP AND SECTIONS ILLUSTRATING THE IMBRICATE STRUCTURE AND FOLDED THRUST FAULTS IN THE AREA EAST OF ALLAMBI H.S.



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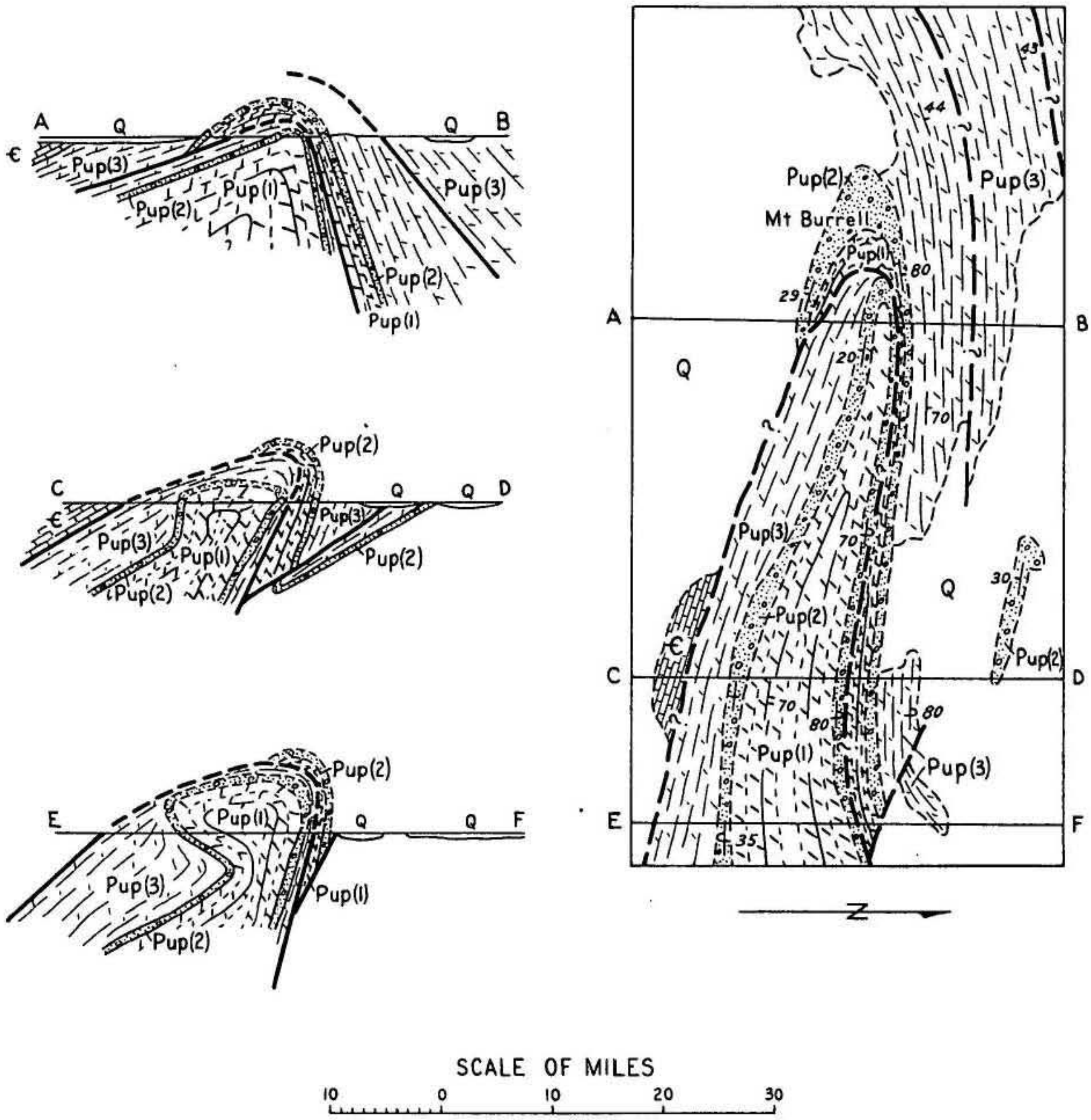
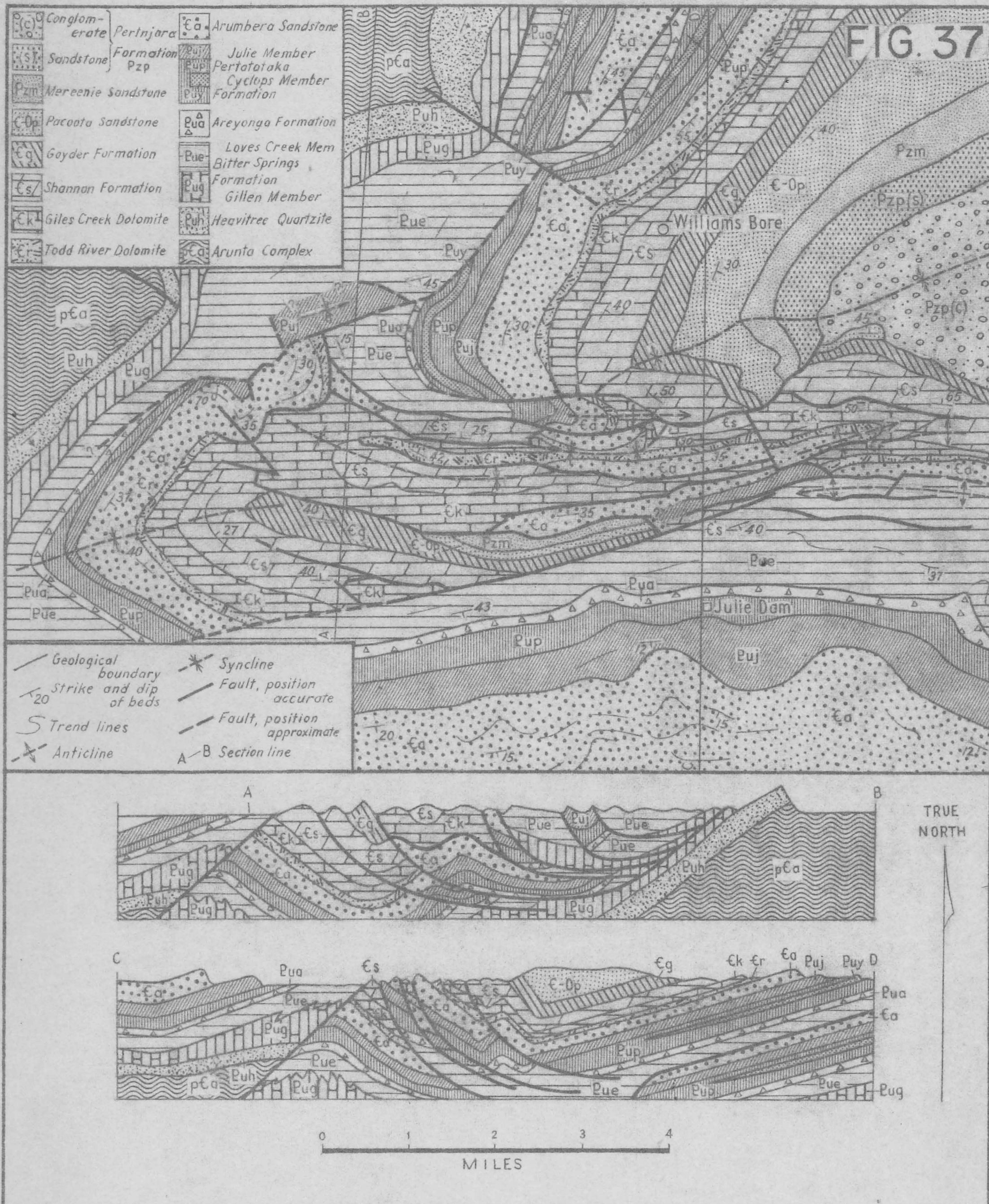
THE STRUCTURE OF THE CORE OF THE MOUNT BURRELL ANTICLINE



REFERENCE

Q	*Superficial cover of alluvium or aeolian sand*
€	*Cambrian carbonates*
Pup(3)	*Siltstone and shale with dolomite lenses*
Pup(2)	*Sandstone and conglomerate*
Pup(1)	*Siltstone, dolomite and chert*

G53/A2/3



GEOLOGICAL MAP AND CROSS SECTIONS OF THE WILLIAMS BORE - JULIE DAM AREA

Vertical and horizontal scales equal

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To accompany Record 1965/108

Fig.38 Anticline in sediments of the Pertaoorta Group, two miles north-north-east of Julie Dam. Arumbera Sandstone in the core (Alice Springs Sheet area).
Neg. No.G/7467

Fig.39 Bitter Springs Formation cutting the Arumbera Sandstone and Julie Member (Pertatataka Formation) three miles east of Allua Well (Alice Springs Sheet area).
Neg. No.G/7541

north during the Alice Springs Orogeny.

Structure of the Williams Bore-Julie Dam Area

A map and two tentative cross-sections of this area are shown in Figure 37, and a third cross-section, which uses a slightly different interpretation, appears on the geological map of the Alice Springs Sheet area (Plate 2). The area is an intensely faulted synclinorium which forms the western end of the Ross River Syncline. The sediments were tightly folded, particularly towards the eastern end of the area (e.g. Fig.38), and in the rhythmic dolomite-siltstone sequence of the Shannon Formation, the folding became chaotic. The major faults are all thrust faults, and where visible, the faults dip to the north. Because the Bitter Springs Formation is known to be so plastic and incompetent, the faults have been shown as listric surfaces (Suess, 1909, Vol.IV, p.536), curving under and uniting to form one decollement plane in this formation. We thus have the picture of a mass of sandstone, siltstone and carbonate which was compressed from the north, so that it slid to the south, buckled, and was finally thrust and broken into slices along the listric surfaces. The southern-most fault in the area has been shown in Figure 37 as a south-dipping thrust fault, implying a later compressive phase from the south. However, it is equally likely that this fault belongs to the same system as the others of the area, and that it may be part of one of the major north dipping thrust faults which folded during the thrusting, and was then separated by erosion into two parts. This alternative interpretation is shown on the geological map of the Alice Springs Sheet area (Plate 2).

Illogwa Creek Thrust

The large fault 7 miles north-east of Numery Homestead, shown on the Illogwa Creek Geological Map (Plate 3), separates outcrops of Archaean basement rocks from outcrops of Arumbera Sandstone. The structure is interpreted as a shallow north-dipping thrust which has displaced rocks of the Archaean Arunta Complex over the Arumbera Sandstone. The two outcrops of Bitter Springs Formation mapped in the area of basement rocks north of the thrust fault are regarded as windows of the formation from the underlying thrust block.

GEOLOGICAL HISTORY

The sedimentary history of 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. Pyrite crystals in the upper part of the Heavitree Quartzite relfect the falling off in the rate of clastic sedimentation preceding the deposition of the carbonate, shale, siltstone, and minor sandstone, of the Bitter Springs Formation. During the deposition of the lower member of this formation (the Gillen Member) evaporites were deposited in lagoons and barred basins formed in parts of the area. Extensive algal carbonates were formed in a more unrestricted 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 sediments with glacial affinities. After the 'glaciation' came a widespread marine transgression, during which the Pertatataka Formation was deposited conformably upon the Areyonga Formation. The Pertatataka Formation is mostly shale, with some fine sandstone; in the north-eastern part of the area, the basin deepened more quickly, and limestone and sandstone members are prominent in the section, as well as an interval of conglomerate of glacial [illegible] aspect. The rate of deposition may have been slackening towards the end of 'Julie Member time', and the top of the Julie Member probably marks the end of Proterozoic sedimentation.

The history of the south-western part of the Amadeus Basin reached a climax with the Petermann Ranges Orogeny (Forman, 1965), in late Upper Proterozoic or early Cambrian times, which resulted in a considerable reduction in the size of the basin. In the north-eastern part of the basin sedimentation was apparently uninterrupted and the only effect of the orogenic episode was the change in sediment from shale and carbonate to the arkosic and glauconitic sandstone of the Arumbera Sandstone. This is a red bed sequence, and was probably deposited in an environment transitional between marine and non-marine conditions. The influx of sediment ceased and the deposition of the glauconitic carbonate with archaeocyathans and other fossils took place in a more restricted part of the basin. Following this, shallow seas became widespread, and from these seas evaporites, limestone, and chert (the Chandler Limestone) were deposited.

In the Lower Middle Cambrian, the sea was widespread and in the north-east parts of the Amadeus Basin, received no clastic sedimentation, so that the dominantly chemical sediments of the Giles Creek Dolomite accumulated. This was followed by rhythmic sedimentation of oolitic limestone and siltstone of the

Shannon Formation. In the lower part of the Upper Cambrian, the incoming detritus became coarser, the sea more turbulent, and the sediments laid down comprised a mixture of sand and silt with some carbonate lenses. During the late Upper Cambrian, extensive, marine fossiliferous sands were deposited throughout most of the northern half of the Amadeus Basin. Marine deposition of sandstone, shale and limestone continued in two broad cycles with gradual onlap of the basin margins at least until the Upper Ordovician. Epeirogenic movements (possibly the first pulses of the Alice Springs Orogeny) occurred in the late Ordovician, causing uplift and erosion of sediments younger than the Pacoota Sandstone in the north-eastern corner of the basin. The Mereenie Sandstone, which was deposited in a transitional marine and aeolian environment, spread over most of the basin, unconformably overlapping older units in the north-east. This formation was deposited sometime between uppermost Ordovician and Middle Devonian.

As the Alice Springs Orogeny increased in intensity, continental, synorogenic facies were deposited in local basins in front of newly formed highlands. In the north, sandstone was followed by thick, molasse conglomerates as the main paroxysms of the orogeny occurred. The deposition of the Pertnjara Formation and its deformation, mark the end of the development of the Amadeus Basin as a major 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-eastern part of the area. The Permian sediments were followed by Great Artesian Basin sediments of Jurassic and Lower Cretaceous age.

The Tertiary was also a time when erosion was dominent, the detritus collecting in small basins and valleys. Erosion and weathering combined to produce a peneplain covered by a thin layer of 'billy' and laterite. The peneplain was uplifted and dissected around the Plio-Pleistocene; the drainage was internally directed, and this caused the formation of the great chain of lakes situated between the Musgrave and MacDonnell Ranges. The climate became arid, the lakes dried up, and a sheet of sand covered the landscape between the ranges. Later the climate became less arid, the dunes were fixed by vegetation, and some alluvium was brought down by rivers.

ECONOMIC GEOLOGY

Petroleum Prospects

Three oil wells (Ooraminna No.1, Alice No.1, and Mount Charlotte No.1) have been drilled to completion in the north-eastern part of the Amadeus Basin. Two more, Waterhouse No.1, and McDills No.1, are being drilled at present. Oil bled from an impermeable zone between 6090 and 6165 feet in the Jay Creek Limestone in the Alice No.1 Well. The total depth of the well is 7,518 feet. The well was drilled on a seismically anomalous zone that was thought to be a biohermal development in the Jay Creek Limestone. The well did not prove the presence of reef development in the Cambrian formations but confirmed that the gravity minimum at that locality is due to the presence of salt.

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

Ooraminna No.1 Well sited 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 3761-3906 feet. A drill stem test gave a supply of gas which tested at the rate of 12,000 cubic feet per day. The well also produced important stratigraphic information. Spilite was intersected at 4,654 feet and halite in the interval 5964-6107 feet. Both are in the Bitter Springs Formation.

Mount Charlotte No.1 Well was drilled about 12 miles south-west of Maryvale Homestead. The well was sited on an anticline interpreted from seismic work. The well penetrated 1160 feet of the Finke Group,?40 feet of Stokes Formation, 350 feet of Stairway Sandstone, 700 feet of Jay Creek Limestone, 830 feet of Chandler Limestone, about 1600 feet of Pertatataka Formation, and bottomed at 6934 feet in dolomite and black shale with halite and anhydrite (Bitter Springs Formation).

In the north-eastern part of the Amadeus Basin, possible source rocks for petroleum include the siltstone, shale and limestone of the Horn Valley Siltstone, the Stairway Sandstone and the 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, 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, Ooraminna and Todd River Anticlines and several smaller anticlines closed in the Giles Creek Dolomite in the Phillipson Pound Area. Other areas which may contain structures unconformably below the Pertnjara Formation and younger sediments, are the Brewer Plain, Camel Flat Syncline and part of the Simpson Desert.

In the Simpson Desert area geophysical surveys have indicated the possibility of a thick sequence of Palaeozoic sediments beneath a thin cover of Mesozoic rocks. In some areas the sediments may be 15,000 feet thick. The age of these sediments is not known. Seismic cross sections across parts of the McDills Sheet area show several buried anticlines with sediments thinning over the crests of the folds.

Phosphate

Phosporites have been found in the Areyonga Formation, the Tempe Formation and in all the formations of the Larapinta Group. The phosphorites in the Areyonga Formation and the Stairway Sandstone appear to have the most potential.

Stairway Sandstone Phosphorites

The Stairway Sandstone phosphorites have been discussed by Cook (1963); Ranford, Cook and Wells (1965) and Barrie (1965) and little can be added as a result of investigations in the Rodinga Sheet area.

The phosphorites are in a pelletal form but differ from the phosphorites found in many other parts of the Amadeus Basin by being white and more rarely purple in colour. In the Mount Charlotte area the pelletal phosphorite commonly occurs in depressions in non-phosphatic material suggesting that the phosphorite may have been deposited on eroded surfaces or may have been precipitated in depressions. In the Rodinga Sheet area phosphorite occurs mostly in the upper part of the Stairway Sandstone; further west most of the phosphorite is in the middle part of the formation.

Analyses of specimens for P_2O_5 content (Table III, Fig.40), suggest that the phosphorites may be of a lower grade than those from outcrops of the Stairway Sandstone to the west but the number of analyses is too small to be conclusive. Results of spectrochemical analyses (Table IV, Fig.40), suggest that there is a higher percentage of trace elements in the phosphorites than in normal sediments (e.g. 70 parts per million of beryllium recorded 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. - McKelvey, Swanson & Sheldon, 1953).

Areyonga Formation Phosphorites

Thin beds of phosphorite are present in the basal part of the Areyonga Formation eight miles north of Ringwood Homestead. The Areyonga Formation, which overlies the Gillen Member of the Bitter Springs Formation has a basal conglomerate or fossil regolith generally about four feet thick containing subangular dolomite cobbles and boulders, some chert, and in places rounded quartzite pebbles three to four inches across (Fig. 11). 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 total thickness of the Areyonga Formation is probably only about thirty to forty feet. The phosphorite beds occur in the upper part of the basal conglomerate and are from three inches to one foot thick and lenticular. Individual beds can be traced laterally for five to ten feet. The beds comprise dark brown to black phosphate mineral interlaced by thin stringers of dark grey chert. There are a few included angular quartz fragments. The phosphorite weathers blue-grey and shows a well developed rhomboidal cleavage pattern. The matrix of the conglomerate contains from about one to seven percent P_2O_5 and the phosphorite beds up to 27% P_2O_5.

The reason for the localisation of the phosphate is not known. However, the surface on which the Areyonga Formation was deposited, was quite irregular and it is possible that the phosphate was concentrated on highs on the unconformity.

Water Supply

Introduction

Water in the area is provided by natural waterholes, dams, bores, and wells. The wells are less than 100 feet deep, and most of the bores are less than 400 feet deep; several have been drilled to 1,000 feet or more in the sediments of the Great Artesian Basin in the McDills Sheet area. The water resources of the whole region have been discussed by Perry et al (1962).

Surface Waters

(a) Natural

Waterholes are present at the following localities:-

1. At Emily Gap, 5 miles south-east of Alice Springs.
2. Six miles north of Mount Ooraminna.
3. Eight miles north-west of Idracowra Homestead.
4. Three miles east of Idracowra Homestead.
5. Adjacent to the large mesas in the central and southern part of the Hale River Sheet area.

A spring (Limbla Spring) is situated in the Hale River at Florence Gap, in the Illogwa Creek Sheet area.

(b) Artificial

Many earth tanks store the surface run-off and water pumped

Fig. 40

LOCATION OF SPECIMENS FOR SPECTROCHEMICAL & P_2O_5 ANALYSIS
NORTH-EASTERN PART OF THE AMADEUS BASIN

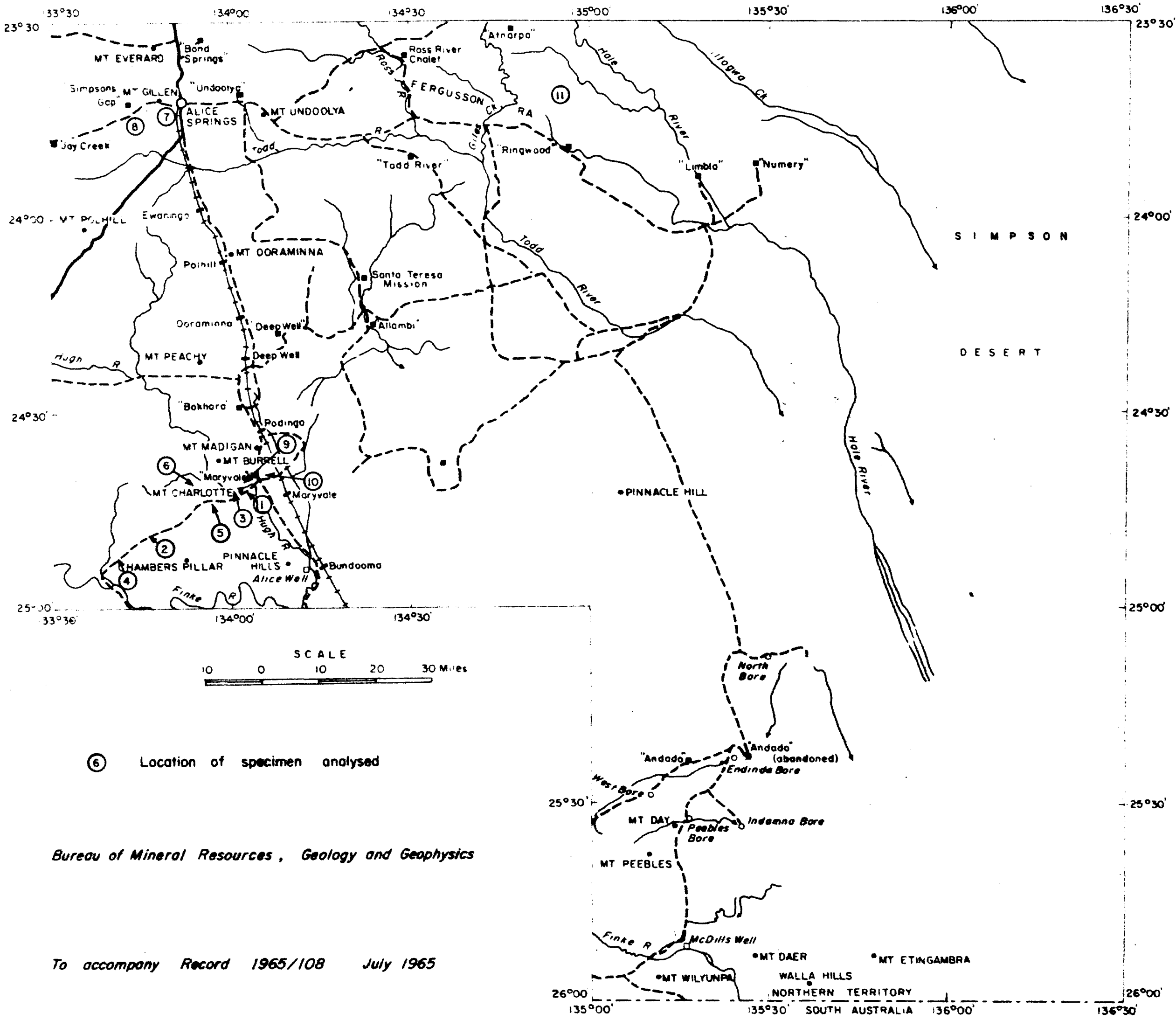

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TABLE III - QUANTITATIVE PHOSPHATE ANALYSES

	Spec. Number	General Location	Loc. No.	Lithology	Percentage P_2O_5
AREYONGA FORMATION	AS 34	2 miles north-west of Pulya-Pulya Dam	11	Dark grey phosphorite with chert laminae	30.0
STAIRWAY SANDSTONE	Rd 119	Mt.Charlotte	1	Purple pelletal phos.	13.7
	Rd 110	W. end of Mt. Charlotte	2	Green pelletal phos.	13.5
	Rd 118	Mt.Charlotte	1	Purple pelletal phos.	11.1
	Rd 153	Mt.Charlotte	1	White pelletal phos.	6.6
	Rd 153	Mt.Charlotte	1	White pelletal phos.	6.2
	Rd 100	Mt.Charlotte	3	White pelletal phos.	5.2
	Rd 111	W. end of Mt. Charlotte Ra.	4	Pelletal phos.	5.1
	Rd 109	W. end ofMt. Charlotte Ra.	4	Vuggy pelletal phos.	3.0
	Rd 103B	Mt.Charlotte	5	Coarse sstn. with pellets	2.8
	Rd 103D	Mt.Charlotte	5	White pelletal phos.	2.45
	Rd 103C	Mt.Charlotte	5	Sstn. with phos. laths	0.60
	Rd 158	7 mls. N.W. of Mt.Charlotte	6	Red silty sstn.	0.29
	Rd 117	Mt.Charlotte	1	Red silty sstn.	0.17
TERTIARY	AS 115 c	4 mls. S.S.W. of Alice Springs	7	Yellow-brown silic sstn.	0.40
	AS 115 b	4 mls. S.S.W. of Alice Springs	7	Yellow-brown silic sstn.	0.35
	AS 115 a	4 mls. S.S.W. of Alice Springs	7	Yellow-brown silic sstn.	0.25
	AS 119 b	9 mls. W.S.W. of Alice Springs	8	Yellow silic sstn.	0.25
	AS 119 a	9 mls. W.S.W. of Alice Springs	8	Yellow silic sstn.	0.20

TABLE IV SPECTROCHEMICAL ANALYSES - STAIRWAY SANDSTONE

Spec. No.	Lithology	General Location	Loc. No.	Spectrochemical results in parts per million (p.p.m.) Ni	Co	Zn	Cu	V	Mo	Sn	Pb	Pe	P
Rd 119	Purple pelletal phosphorite	Mt.Charlotte	1	80	50	a	12	100	a	a	80	a	p
Rd 120	Mottled red & green sandstone	½ ml. N. of Charlotte Well	9	5	10	a	5	20	2	a	10	a	a
Rd 139	Pelletal phosphorite	W. end of Mt.Charlotte Ra.	4	50	10	a	50	40	2	a	150	2	a
Rd 153	White pelletal phosphorite	Mt.Charlotte	1	12	12	a	150	5	a	a	20	70	p
Rd 158	Red silty sandstone	7 mls. N.W. of Mt.Charlotte	6	5-	a	a	2-	5	a	a	5	2	a
Rd 167	Red and green mottled sandstone	1 ml. N.E. of Maryvale Homestead	10	10	12	a	15	30	2	a	50	2	a

5 - less than 5 p.p.m.

a - sought but not detected

p - present in percentage amounts

from bores in the area.

Ground Water

Folded and faulted sandstones and jointed limestones of the Amadeus Basin succession, flat-lying sandstones of the Great Artesian Basin, and sands and gravels of the Cainozoic valley fills and piedmont deposits form the main aquifers in the area. The piezometric surface has been contoured by Perry et al (1962), and has a regional gradient to the south-east. At Alice Springs it is about 2,000 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 wherever it is underlain at an economic depth by the Mereenie Sandstone, De Souza Sandstone, or Cainozoic sands and gravels, is usually a good site for a water bore. Sandstones of the Larapinta and Pertaoorrta Groups also provide good water in some areas. The joints in carbonates contain available water in some areas, but the Upper Proterozoic carbonates usually provide water that is too saline for human consumption.

In the Alice Springs Sheet area, the most favourable places for water bores to intersect the Mereenie Sandstone are around the Alice Springs aerodrome, in the Ewaninga-Wallaby Gap Dam - Junction Bore area, and on the flanks of the Waterhouse Range. The sands along the Todd River may yield water supplies from areas with a perched water table.

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. Tertiary sands may be of importance at the eastern end of the Missionary Plain. The sands and gravels of the Quaternary are probably the most widely used aquifers in the Rodinga Sheet area, and are capable of producing reasonable supplies at fairly shallow depths. The sandstones of the Bitter Springs and Areyonga Formations, the Pertaoorrta and Larapinta Groups, and the Pertnjara Formation may produce stock water.

In the Illogwa Creek Sheet area, the Cainozoic gravels of the Hale River and Illogwa Creek probably offer the most promise. On the Hale River Sheet area, the gravels of the same rivers should yield water, and the De Souza Sandstone is a possible aquifer which should be intersected by deeper drilling. In the north-west part of the Hale River Sheet area bores sited on the flanks of the anticlines of Mereenie Sandstone might produce water. Any bore in the south-eastern half of the area should eventually intersect the De Souza Sandstone and the siting of suitable bores will be governed by the cost of getting to the site, plus drilling to a deep aquifer. The same considerations affect boring operations in the McDills Sheet area.

Miscellaneous

There are few minerals of economic potential in the area.

Building stone is obtained for local use from the Mereenie Sandstone and Pertnjara Formation of the Mount Ooraminna area and also from the Jay Creek Limestone near the Santa Teresa Mission. There are abundant supplies of limestone but these are of no commercial importance for lime.

Lignite of Tertiary age has been found in the core cuttings from Yam Junction Bore but it is suspected to come from too great a depth and is of too poor a quality to be of any economic potential.

Manganese and iron are present in the Goyder Formation and iron is also present in laterite of the Tertiary weathering profile.

In several areas 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). The deposits are small, probably only a few thousand tons in one deposit, but are relatively pure. The oxides show botryoidal, specular and stalactitic structures. The large areas of Bitter Springs Formation that were not examined during the mapping may be worthwhile prospecting for large deposits.

The Rumbalara Ochre mines lie just to the south of the southern edge of the area mapped and ochre of a similar quality to that at the mines is likely to occur at the base of the Rumbalara Shale in some of the mesas in the south-east corner of the Rodinga Sheet area. The Rumbalara Ochre Mine has closed owing to lack of demand, and there is little likelihood of any active prospecting for ochre in the foreseeable future.

Large deposits of gypsum are present in the dome structure 6 miles south-west of Ringwood Homestead and there is evidence throughout the Amadeus Basin of abundant gypsum and salt in the Gillen Member of the Bitter Springs Formation. Detailed investigations could reveal deposits of more valuable salts such as potash and nitrate compounds.

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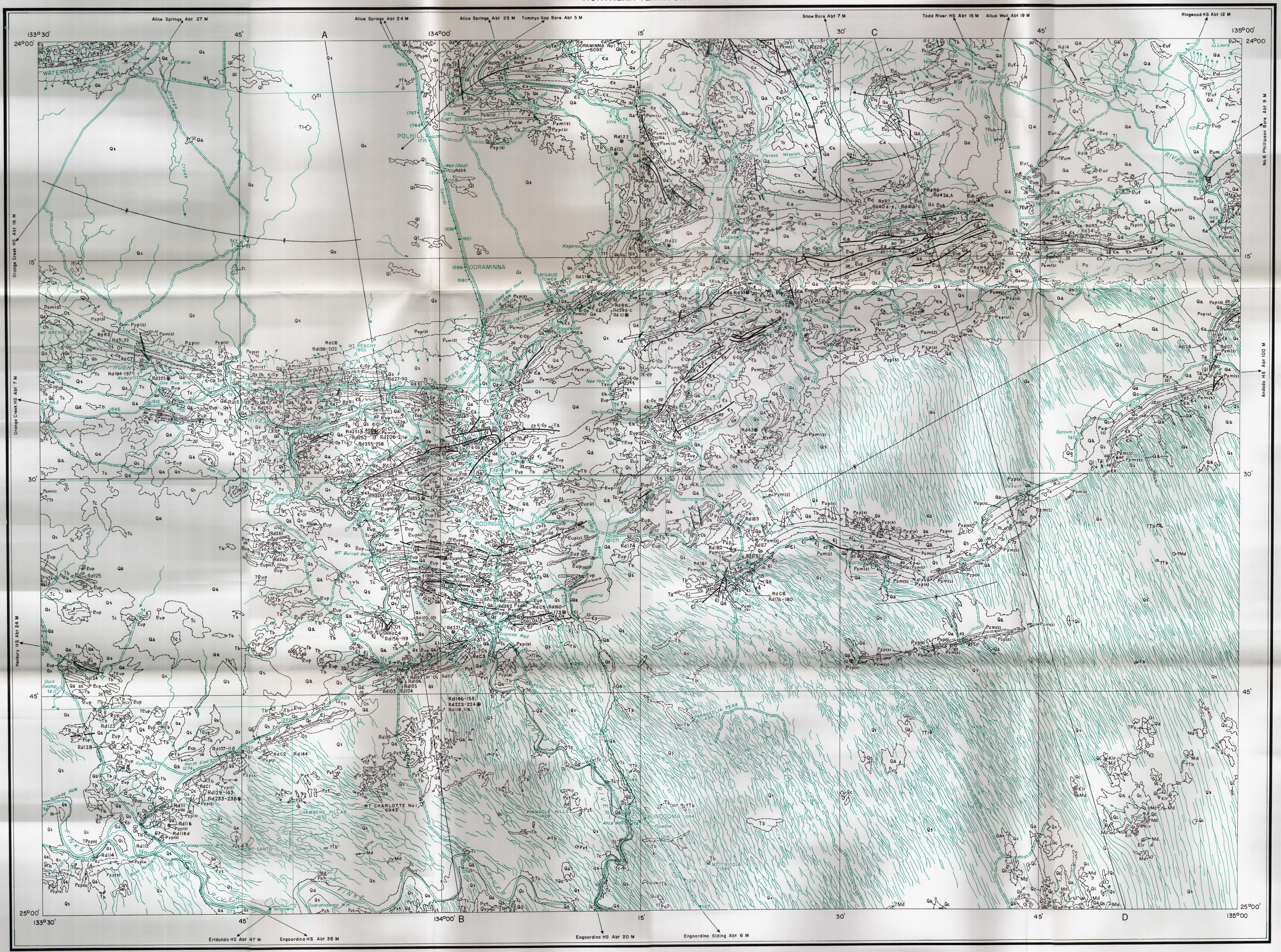
AUSTRALIA 1:250,000

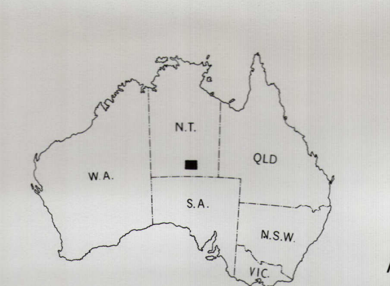
RODINGA

NORTHERN TERRITORY

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



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.



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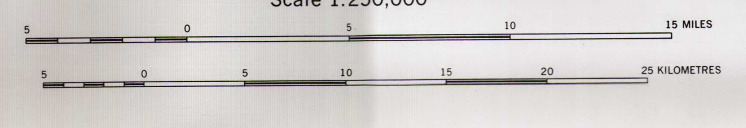
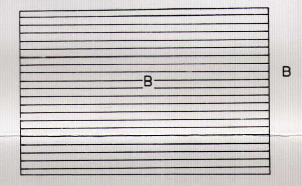
ANNUAL CHANGE 1°30'E

Scale 1:250,000



GEOLOGICAL RELIABILITY DIAGRAM



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

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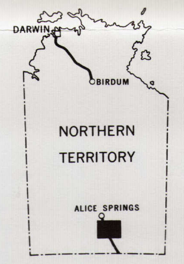
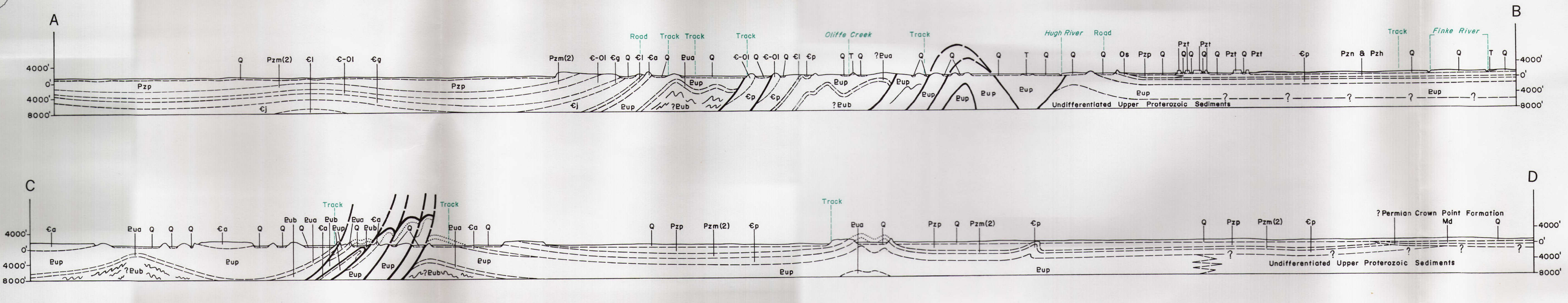
Compilation, 1964, by: L.C. Ranford, P.J. Cook and J.M. Fetherston
Drawn, 1964, by: J.M. Fetherston

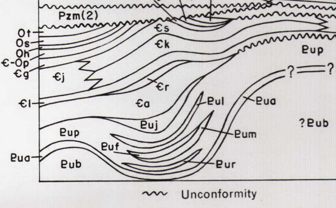


Sections

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



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



PRELIMINARY EDITION, 1965

SUBJECT TO AMENDMENT

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	Santo Sandstone	Pzt	Sandstone, pebbly sandstone, minor claystone
		Horseshoe Bend Shale	Pzh	Red-brown biotite shale, grey-green calcareous siltstone
		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
	ORDOVICIAN TO CARBONIFEROUS		Pz	Sandstone, pebbly sandstone
	ORDOVICIAN TO DEVONIAN	Mereenie Sandstone	Pzm(2)	White cross-bedded sandstone
	ORDOVICIAN TO CAMBRIAN	Larapinta Group: Undifferentiated	€-Ol	Fossiliferous sandstone, siltstone, shale, limestone
		Stokes Formation	Ot	Siltstone, shale, fossiliferous limestone
		Stairway Sandstone	Os	Fossiliferous sandstone, silty sandstone, siltstone, limestone
		Horn Valley Siltstone	Oh	Fossiliferous siltstone and limestone
		Pacoota Sandstone	€-Op	Fossiliferous sandstone and silty sandstone
	CAMBRIAN	Pertaoorrta Group: Undifferentiated	€p	Sandstone, siltstone, shale, dolomite, limestone
		Goyder Formation	€g	Silty sandstone, siltstone, limestone
		Jay Creek Limestone	€j	Limestone, shale, dolomite
		Shannon Formation	€s	Siltstone, shale, limestone
		Giles Creek Dolomite	€k	Dolomite, limestone, siltstone, shale
		Chandler Limestone	€l	Limestone and dolomite with chert laminae
		Todd River Dolomite	€r	Pink fossiliferous glauconitic dolomite
		Arumbera Sandstone	€a	Red-brown sandstone, silty sandstone, siltstone
PRECAMBRIAN	UPPER PROTEROZOIC	Pertatataka Formation	Pup	Siltstone and shale with lenses of sandstone, limestone and conglomerate
			Pup(c)	Conglomeratic sandstone
		Julie Member	Puj	Dolomite, limestone, lenses of calcareous sandstone
		Waldo-Pedlar Member	Pul	Siltstone, fine grained, thin-bedded sandstone
		Olympic Member	Puf	Conglomerate, siltstone, sandstone
		Limbla Member	Pum	Cross-laminated sandstone, sandy limestone
		Ringwood Member	Pur	Algal dolomite and limestone
		Areyonga Formation	Pua	Conglomeratic siltstone, sandstone; minor dolomite with red chert
		Bitter Springs Formation	Pub	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
- Prevailing strike and dip of strata
- 35 Strike and dip of strata, facing not known
- Vertical strata
- Horizontal strata
- 52 Overturned strata
- Dip < 15° } air-photo interpretation
- Dip 15°-45°
- Dip > 45°
- Trend lines
- Joint pattern
- Macrofossil locality
- ×Rd23 Text reference to specimen locality
- RdC4 Measured section
- Oil well, dry hole (abandoned)
- Abandoned oil well with show of gas
- Bore
- Abandoned bore
- Windpump
- Well
- T Tank
- E Earth tank
- Spring
- Dam
- W.H. Waterhole
- Sand dunes
- Road
- Vehicle track
- Railway with siding
- Telephone line
- Fence
- "Allambi" Homestead
- Landing ground
- Yard
- Astronomical station
- •1261 Height in feet; datum: mean sea level Port Augusta

RODINGA

SHEET SG 53-2

AUSTRALIA 1:250.000

ALICE SPRINGS

NORTHERN TERRITORY

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PRELIMINARY EDITION, 1965

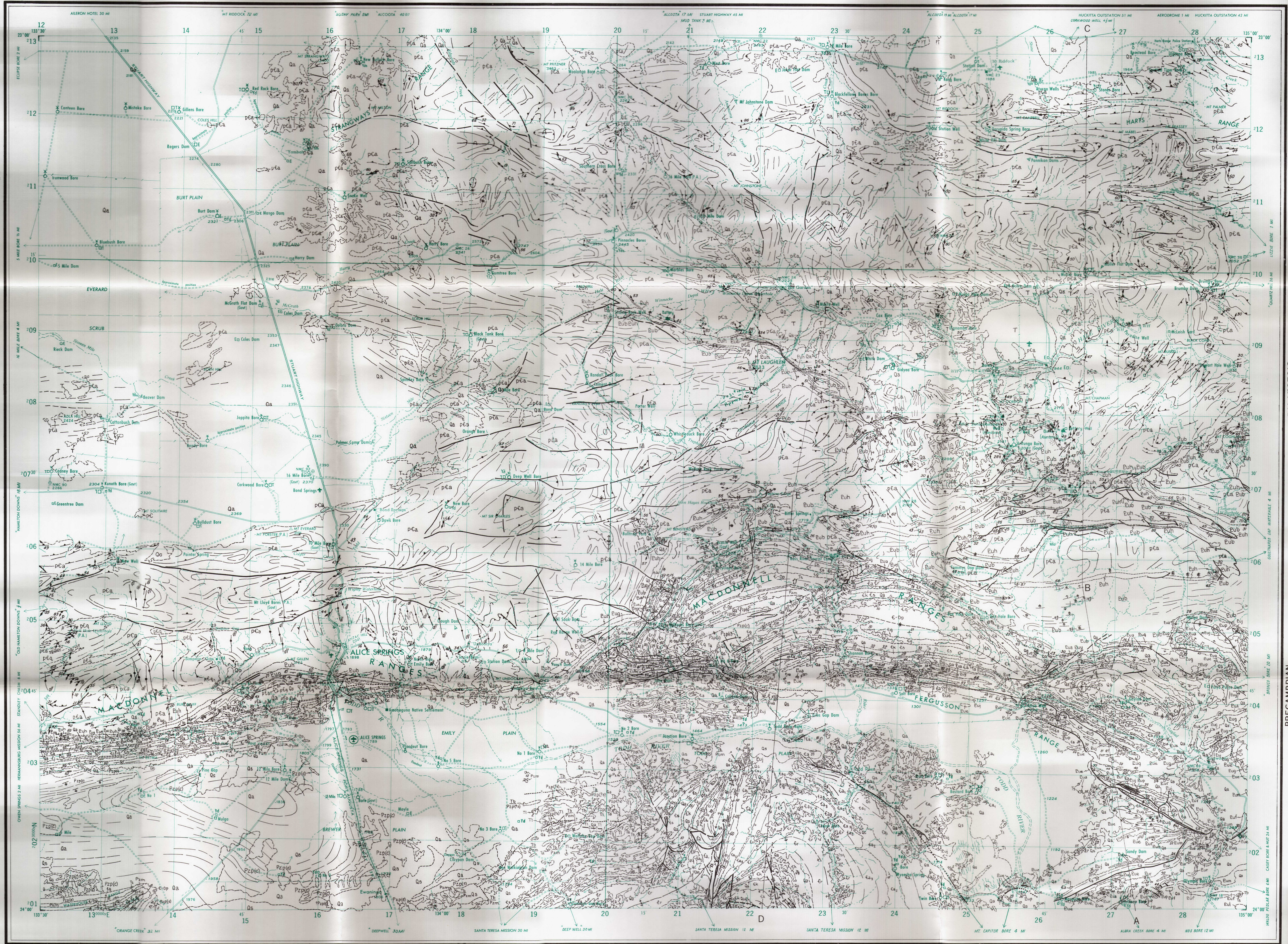
SUBJECT TO AMENDMENT

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.

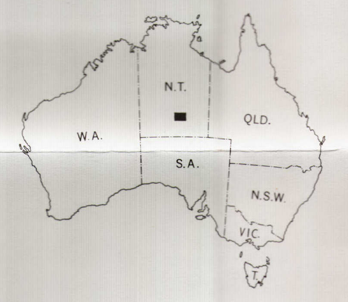
- Strike and dip of strata
- Vertical strata
- Horizontal strata
- Overturned strata
- Dip < 15° (air-photo interpretation)
- Dip 15°-45° (air-photo interpretation)
- Dip > 45° (air-photo interpretation)
- Trend lines (air-photo interpretation)
- Joint pattern (air-photo interpretation)
- Vertical joint
- 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
- Specimen locality. Specimens are marked with prefix AS.
- Registered B.M.R. collection number
- Measured section
- Dyke; dl-dolerite, p-pegmatite
- Sand dunes
- Bore
- Bore with windpump
- Abandoned bore
- Well
- Tank
- Earth tank
- Dam
- Mine
- Minor mineral occurrence
- Silver
- Gold
- Tin
- Niobium
- Kaolin
- Copper
- Gypsum
- Mica
- Lead
- Phosphate
- Tantalum
- Thorium
- Uranium
- Abandoned well with show of oil
- Road
- Vehicle track
- Railway with siding
- Telegraph line
- Fence
- "Atnarpa" Homestead
- Aerodrome
- Landing ground
- Yd Yard
- N.M.H.1 Astronomical station
- 1958 Trignometric station
- 1976 Height in feet, barometric; datum: mean sea level



Reference

Era	Period	Unit	Symbol	Lithology
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
	ORDOVICIAN TO DEVONIAN	Mereenie Sandstone	Pzm	White, cross-bedded sandstone (Pzm(z))
	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
			$€a_3$	Sandstone
			$€a_2$	Siltstone, sandstone, some dolomite
			$€a_1$	Sandstone, siltstone, some pebbly sandstone
PRECAMBRIAN	UPPER PROTEROZOIC	Pertatataka Formation	Pup	Siltstone and shale with lenses of sandstone, limestone, conglomerate
		Julie Member	Puj	Dolomite, limestone, lenses of sandstone and calcareous sandstone
		Waldo Pedlar Member	Pul	Siltstone, fine-grained platy sandstone
		Olympic Member	Puf	Conglomerate, siltstone, sandstone, dolomite
		Limbla Member	Pum	Cross-laminated sandstone, sandy calcarenite
		Ringwood Member	Pur	Algal dolomite and calcarenite
		Cyclops Member	Puy	Platy, even-bedded, fine-grained sandstone
		Areyonga Formation	Pua	Sandstone, arkose, siltstone, conglomerate, dolomite
		Bitter Springs Formation	Pub	Dolomite, limestone, siltstone, sandstone, and some basic volcanics
		Loves Creek Member	Pue	Massive, algal dolomite, red siltstone, and sandstone
			Pue_1	Basic volcanics
		Gillen Member	Pug	Dolomite, green siltstone, sandstone, gypsum (Gp)
		Heavitree Quartzite	Puh	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.



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AYERS ROCK SG 52-8	KULGERA SG 53-5	FINKE SG 53-6	McDILLS SG 53-7	SIMPSON DESERT SOUTH SG 53-8

4°30'E · 5°E · 5°30'E

ANNUAL CHANGE 1'30"E

Scale 1:250,000

5 0 5 10 15 MILES

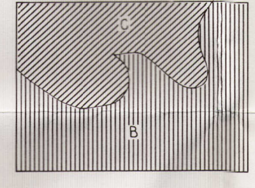
5 0 5 10 15 20 25 KILOMETRES

Sections

Cainozoic sediments omitted from section

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

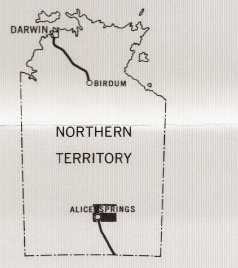
GEOLOGICAL RELIABILITY DIAGRAM



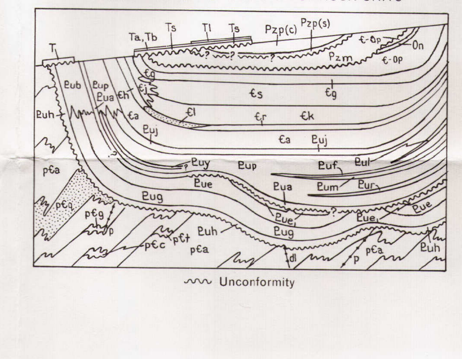
B Detailed reconnaissance, general reconnaissance, reconnaissance, and air-photo interpretation.

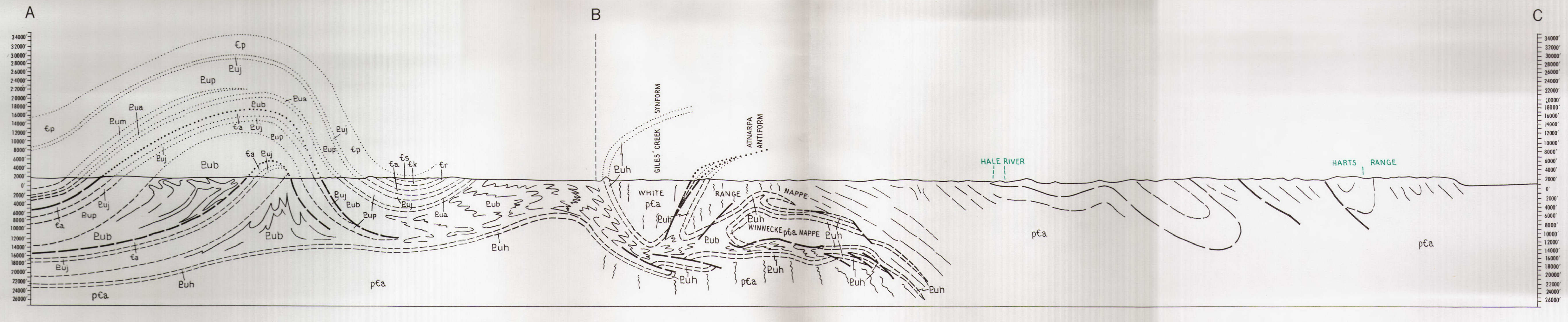
C Air-photo interpretation with helicopter reconnaissance.

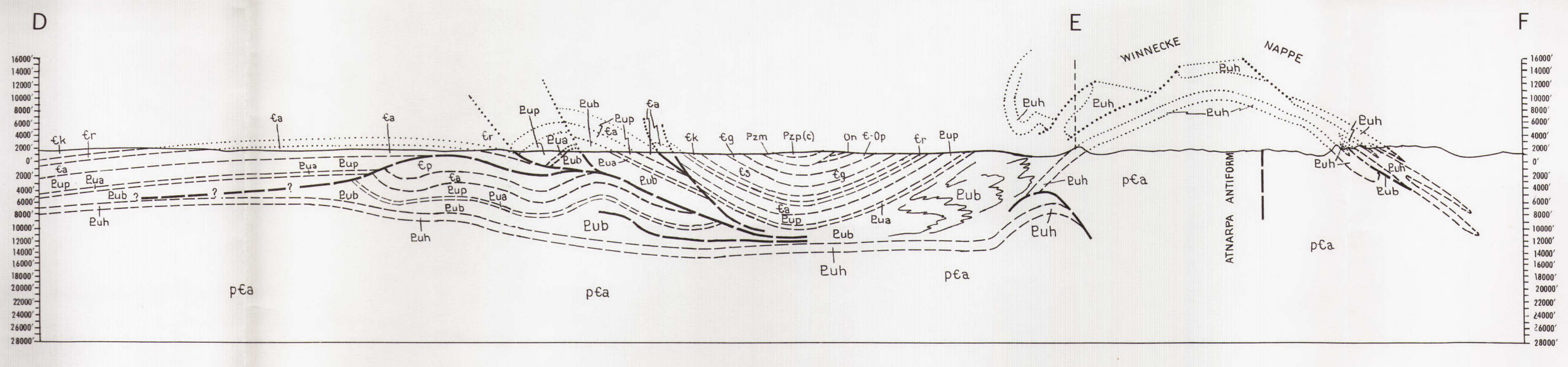
Geology by, 1964:- D.J. Forman, E.N. Milligan, A.T. Wells, A.J. Stewart, R.D. Shaw.
1949 to 1951: G.F. Joklik et al
Compiled by, 1964:- D.J. Forman, E.N. Milligan, A.T. Wells, A.J. Stewart, R.D. Shaw, N.L. Kruger.
Drawn by: N.L. Kruger



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS







ALICE SPRINGS

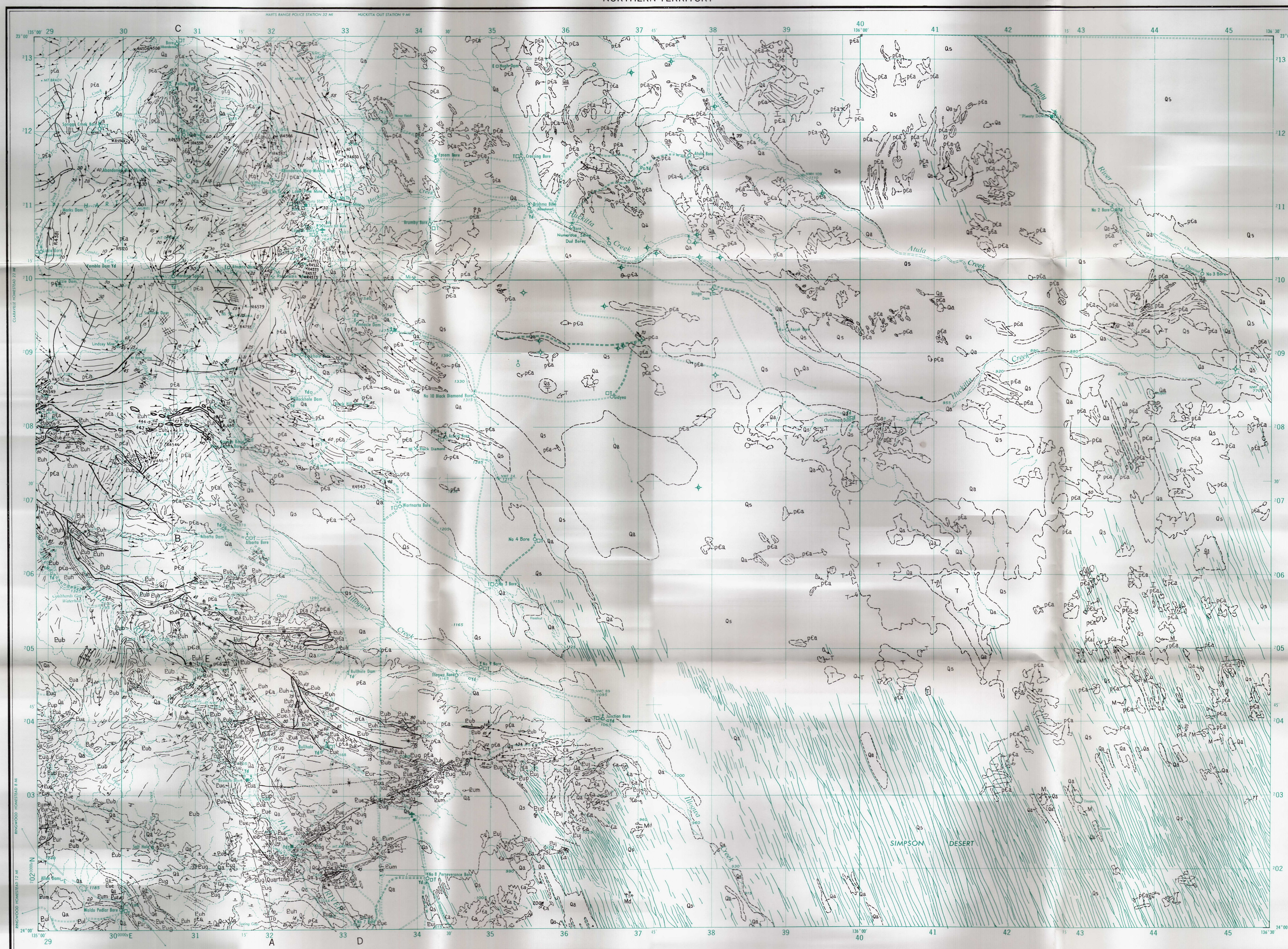
SHEET SF 53-14

AUSTRALIA 1:250,000

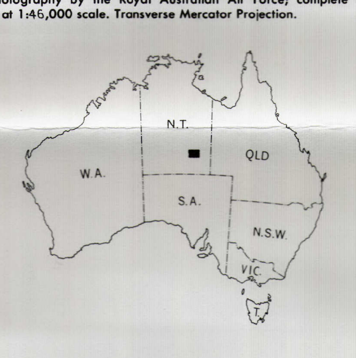
ILLOGWA CREEK

NORTHERN TERRITORY

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



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

4°30'E 5°E 5°30'E 6°E

ANNUAL CHANGE 1'30"E

Scale 1:250,000

5 0 5 10 15 MILES

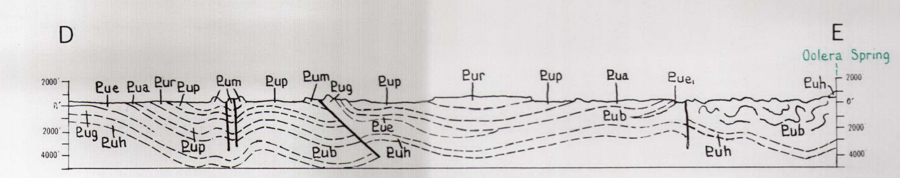
5 0 5 10 15 20 25 KILOMETRES

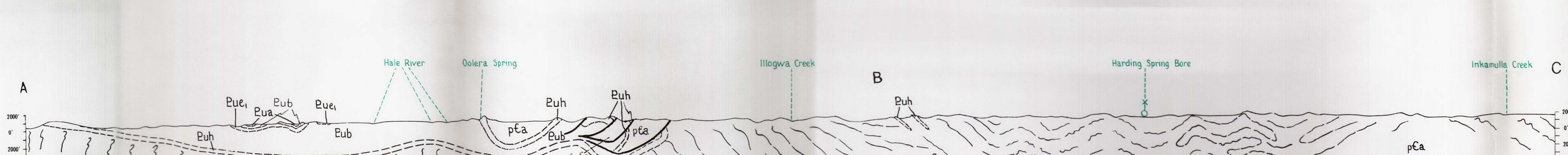
Sections

A-B-C D-E

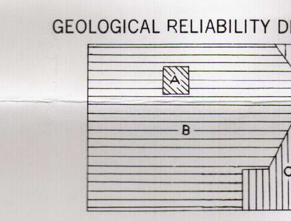
Scale $\frac{V}{H} = 1$

Cainozoic sediments omitted from section





GEOLOGICAL RELIABILITY DIAGRAM

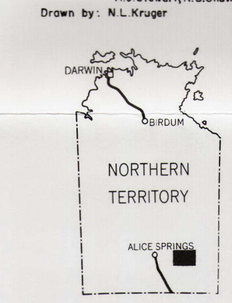


A Detailed mapping

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: D.J. Forman, A.T. Wells, E.N. Milligan, A.J. Stewart, R.D. Shaw, D.R.G. Woolley
Compiled, 1964-1965, by: D.J. Forman, A.T. Wells, E.N. Milligan, A.J. Stewart, R.D. Shaw, N.L. Kruger
Drawn by: N.L. Kruger



PRELIMINARY EDITION, 1965

SUBJECT TO AMENDMENT

Reference

Era	Period	Unit	Symbol	Description
CAINOZOIC	QUATERNARY	Undifferentiated	Q	Alluvium, sand, conglomerate. (Section only)
			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	Eup	Siltstone, shale
		Julie Member	Euj	Dolomite, limestone, lenses of sandstone and calcareous sandstone
		Waldo Pedlar Member	Eul	Siltstone, fine-grained platy sandstone
		Limbla Member	Eum	Cross-laminated sandstone, sandy calcarenite
		Ringwood Member	Eur	Algal dolomite, calcarenite
		Areyonga Formation	Eua	Sandstone, arkose, boulder clay, conglomerate, dolomite
		Bitter Springs Formation	Eub	Dolomite, limestone, siltstone, sandstone, basic volcanics
		Loves Creek Member	Eue	Massive algal dolomite, red siltstone, quartzite
			Eue1	Basic volcanics
		Gillen Member	Eug	Dolomite, green siltstone, sandstone
		Heavitree Quartzite	Euh	Quartzite, conglomeratic sandstone
		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

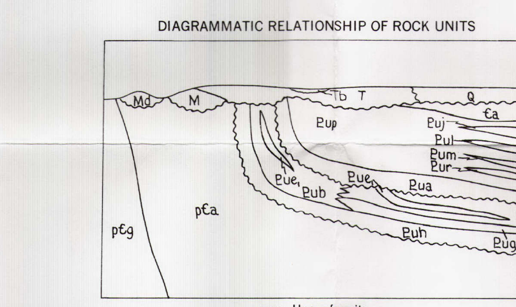
- Strike and dip of strata
- Horizontal strata
- Overturned strata
- Dip < 15° (air-photo interpretation)
- Dip 15-45° (air-photo interpretation)
- Dip > 45° (air-photo interpretation)
- Trend lines (air-photo interpretation)
- Joint pattern (air-photo interpretation)
- Strike and dip of foliation
- 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
- ⊕ MNF1 Astronomical station
- · 920' Height in feet, barometric; datum: mean sea-level

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity

ILLOGWA CREEK

SHEET SF 53-15

PRELIMINARY EDITION, 1965

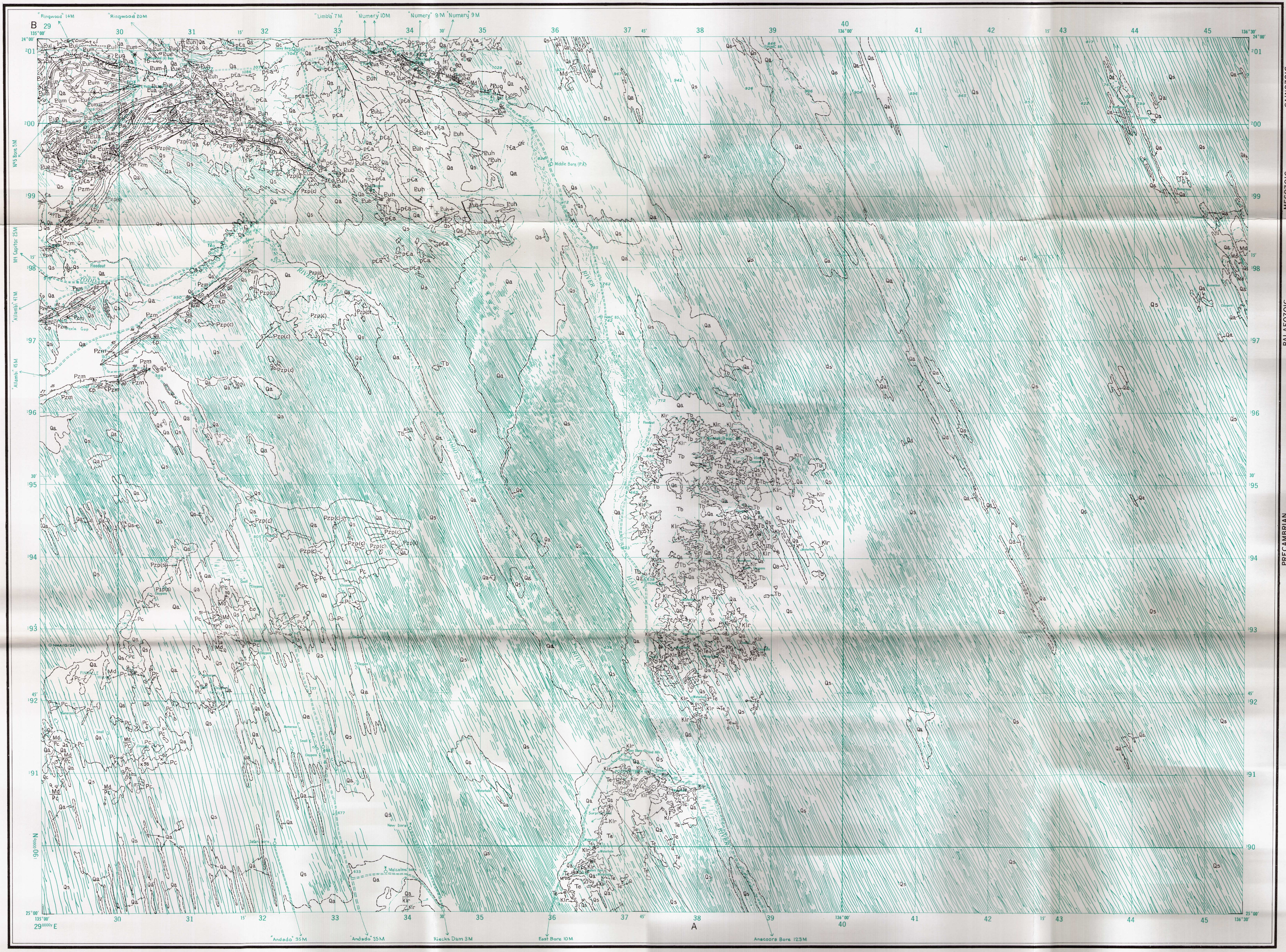
SUBJECT TO AMENDMENT

AUSTRALIA 1:250,000

HALE RIVER

NORTHERN TERRITORY

1:250,000 GEOLOGICAL SERIES SHEET SG 53-3



Reference

Era	Period	Unit	Symbol	Description
CAINOZOIC	QUATERNARY		Q	Undifferentiated (section only)
			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 T CARBONIFEROUS	Pertnjara Formation	Pzp(c)	Pebble and cobble conglomerate
			Pzp(s)	Sandstone
	ORDOVICIAN TO DEVONIAN	Mereenie Sandstone	Pzm	White, cross-bedded sandstone
	CAMBRIAN	Pertaoorrta Group: Shannon Formation	€s	Siltstone, dolomite, limestone
		Pertaoorrta Group: Giles Creek Dolomite	€k	Dolomite, limestone, shale
		Pertaoorrta Group: Todd River Dolomite	€r	Dolomite, shale
		Pertaoorrta Group: Arumbera Sandstone	€a	Red-brown sandstone, siltstone, chert-pebble conglomerate
		Pertaoorrta Group: Undifferentiated	€p	Dolomite, limestone, siltstone
		Undifferentiated	Pz	Sandstone, limestone, dolomite, siltstone, shale (Section only)
PRECAMBRIAN	UPPER PROTEROZOIC	Pertatataka Formation	Ɐup	Siltstone and shale with lenses of sandstone, limestone and conglomerate
		Julie Member	Ɐuj	Oolitic dolomite, limestone, lenses of sandstone, and calcareous sandstone
		Waldo Pedlar Member	Ɐul	Siliceous, platy, fine sandstone, siltstone
		Olympic Member	Ɐuf	Sandstone, siltstone, conglomerate, dolomite
		Limbla Member	Ɐum	Cross-laminated sandstone, oolitic and sandy limestone and dolomite
		Ringwood Member	Ɐur	Limestone, algal dolomite, siltstone
		Areyonga Formation	Ɐua	Boulder clay, arkosic sandstone, siltstone, sandstone, conglomerate
		Bitter Springs Formation	Ɐub	Dolomite, limestone, siltstone, sandstone and basic volcanics
		Loves Creek Member	Ɐue	Algal dolomite, limestone, red siltstone and dolomitic siltstone
			Ɐue,	Basic volcanics
		Gillen Member	Ɐug	Green siltstone, sandstone, dolomite, gypsum
		Heavitree Quartzite	Ɐuh	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
} air-photo interpretation

Strike and dip of foliation, unmeasured

Strike and dip of foliation

Macrofossil locality

Specimen locality.

Measured section

Bore

Abandoned bore

Windpump

Tank

Earth tank

Dam on stream

Waterhole

Sand dunes

Road

Vehicle track

Fence

Building

Yard

Astronomical station

.677 Height in feet, instrument levelled;
·1124 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 1:46,500 scale. Transverse Mercator Projection.

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ALBERGA SG 53-9	ABMINGA SG 53-10	DALHOUSIE SG 53-11	POOLOWANNA SG 53-12	PANDIE PANDIE SG 54-9

4°30'E 5°30'E 6°E

ANNUAL CHANGE 1'30"E

Scale 1:250,000

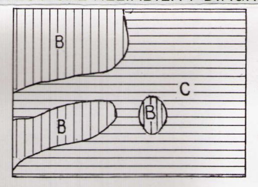
5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

Section

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

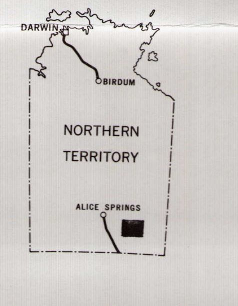
GEOLOGICAL RELIABILITY DIAGRAM



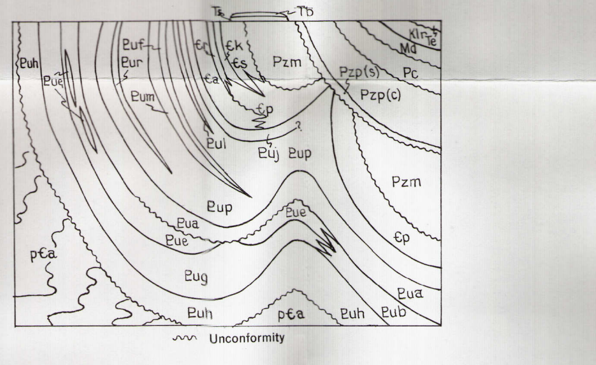
B Detailed reconnaissance, general reconnaissance, reconnaissance and air-photo interpretation.

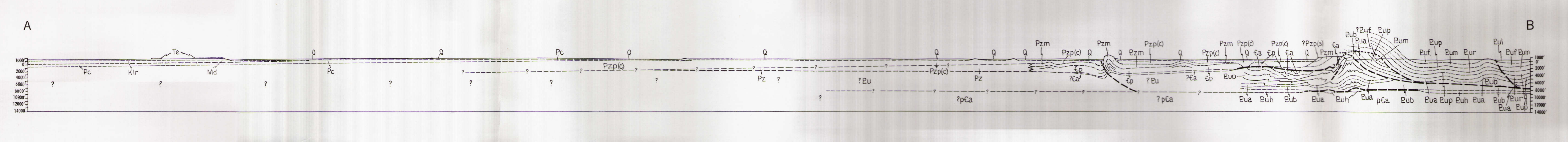
C Air-photo interpretation.

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
Drawn by: N.L. Kruger



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS





HALE RIVER

SHEET SG 53-3

PRELIMINARY EDITION, 1965

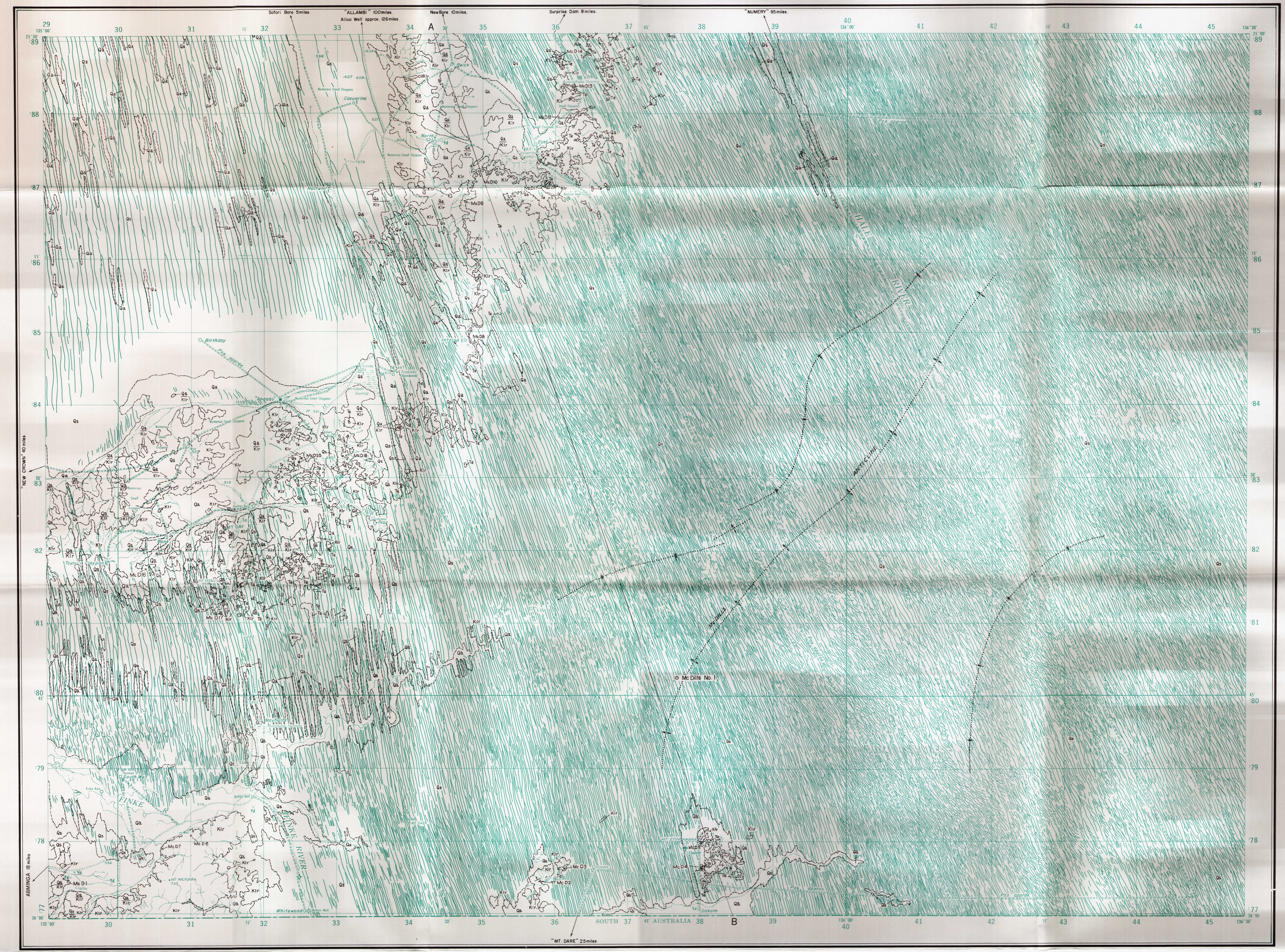
SUBJECT TO AMENDMENT

AUSTRALIA 1:250,000

Mc DILLS

NORTHERN TERRITORY

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



Reference

Era	Period	Unit	Symbol	Description
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	PERMIAN	Crown Point Formation	Pc	*Sandstone, conglomerate, siltstone (section only)*
	UNDIFFERENTIATED	Finke Group	Pzf	*Sandstone, shale, conglomerate (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*

Well being drilled

Bore

Abandoned bore

Well

Abandoned well

Windpump

Tank

Earth tank

Dam on stream

Sand dunes

Vehicle track

State boundary

Fence

"Andado" *Homestead*

Landing ground

Yd *Yard*

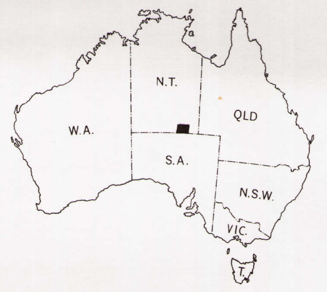
Astronomical station

Trigonometrical station

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

440• *Height in feet, barometric;*

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.



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EVERARD SG 53-13	WINTINNA SG 53-14	OODNADATTA SG 53-15	NOOLYEANA SG 53-16	GASON SG 54-13

ANNUAL CHANGE 1'(E?)

Scale 1:250,000

5 0 5 10 15 MILES

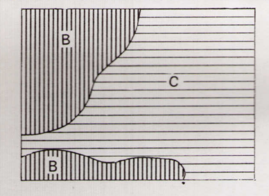
5 0 5 10 15 20 25 KILOMETRES

Section

Folding schematic

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

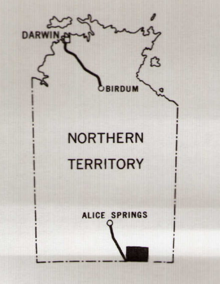
GEOLOGICAL RELIABILITY DIAGRAM



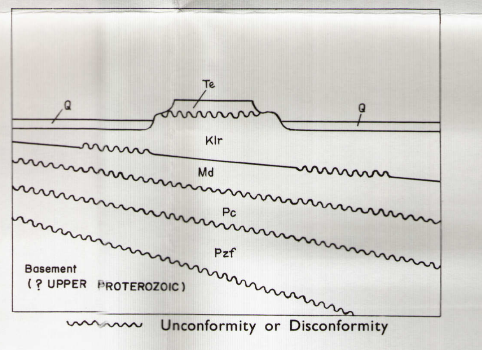
B. General reconnaissance, with air-photo interpretation

C. Air – photo interpretation

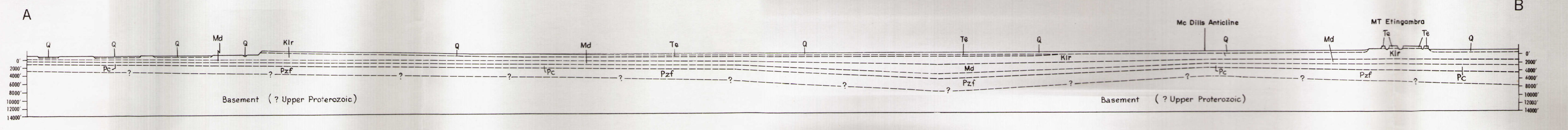
Geology, 1964, by: A.T. Wells and A.J. Stewart.
Compilation, 1965, by: A.T. Wells, A.J. Stewart, and L. Kerec.
Drawn, 1965, by: J.M. Fetherston and G.J. Squire.



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity or Disconformity



Mc DILLS

SHEET 53-7

TECTONIC INTERPRETATION 1:500,000
(NORTH-EASTERN AMADEUS BASIN)

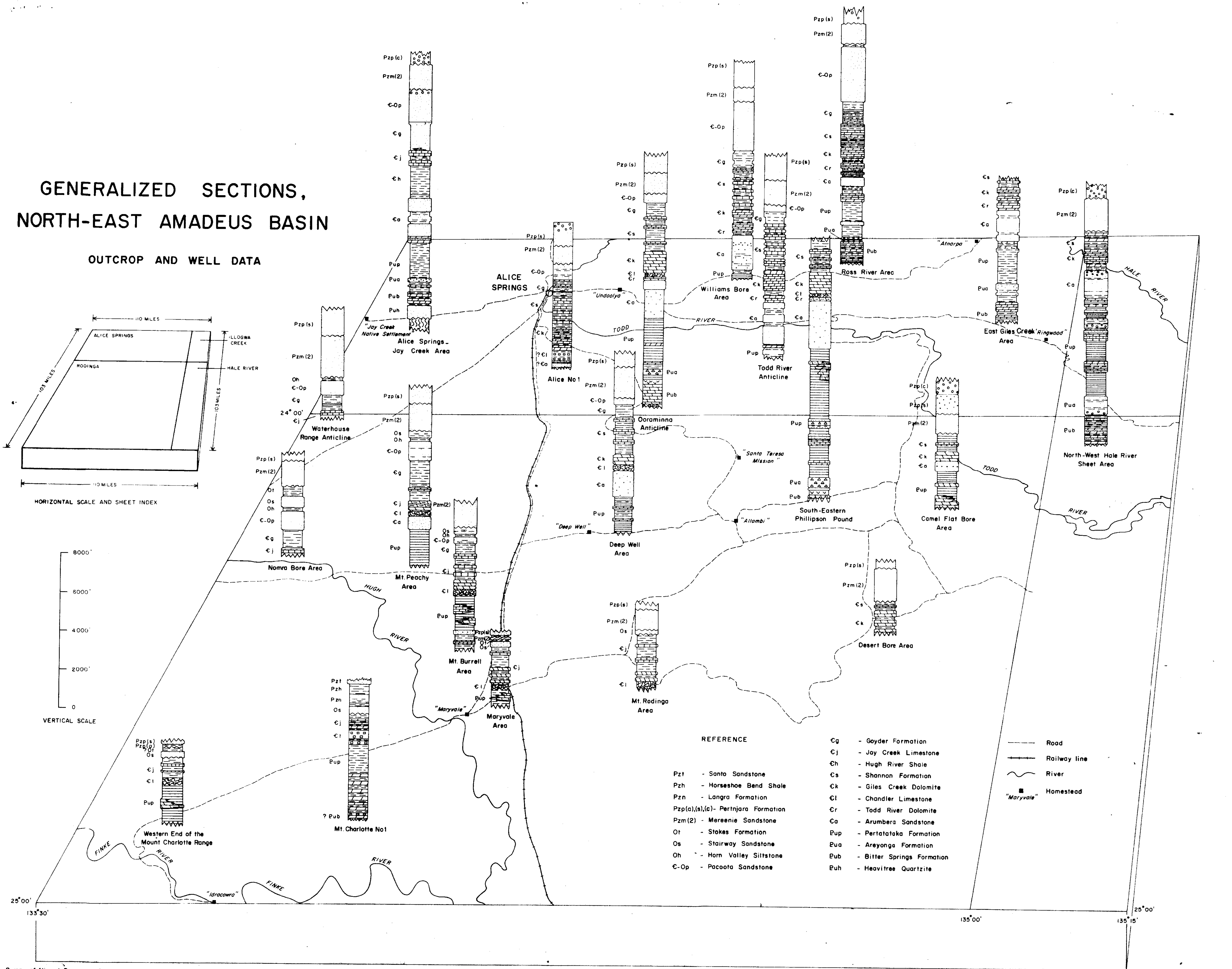
Bureau of Mineral Resources, Geology & Geophysics. May 1965.

To accompany Record No. 1965/44/108

NT/A/111

GENERALIZED SECTIONS, NORTH-EAST AMADEUS BASIN

OUTCROP AND WELL DATA

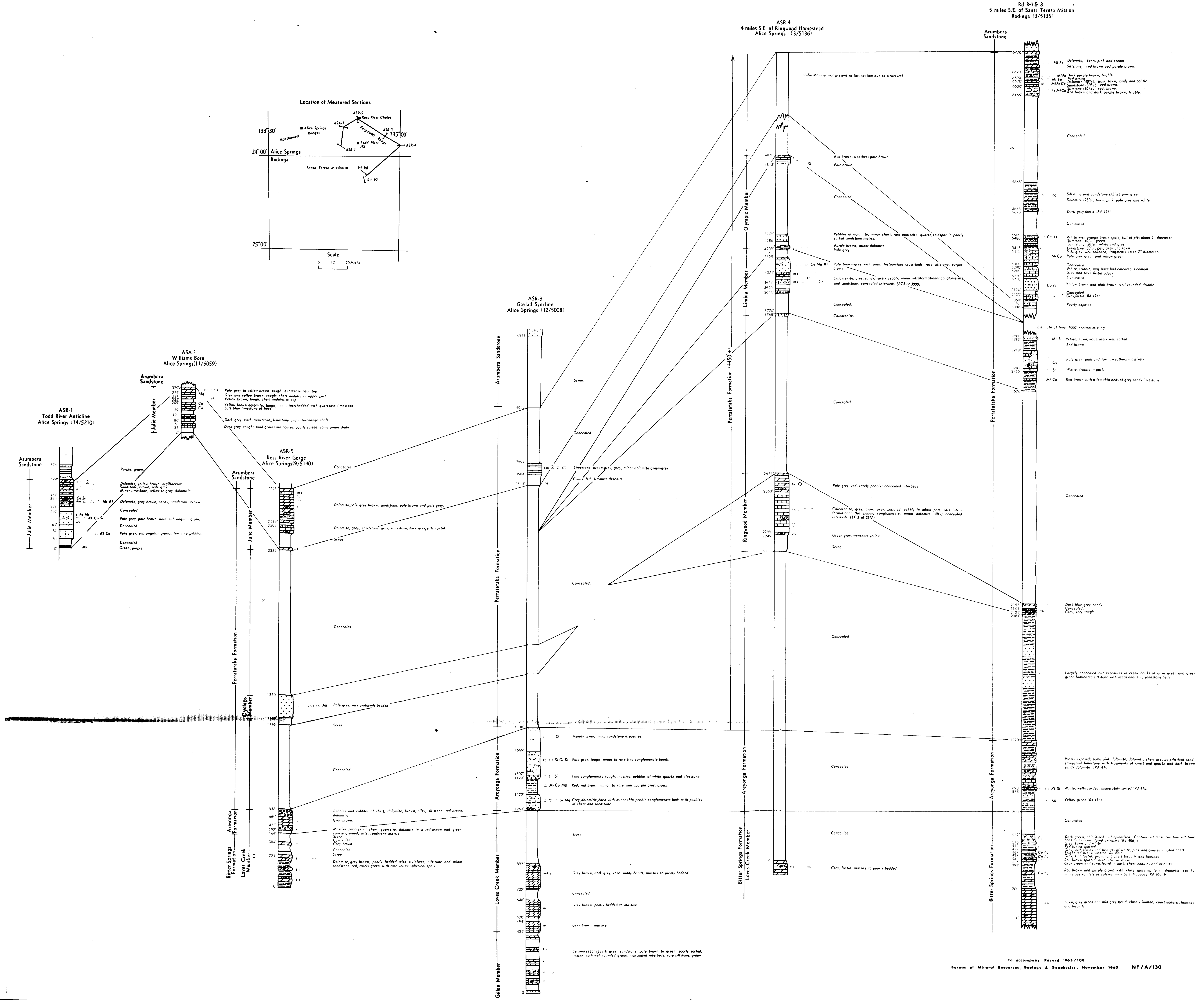


Bureau of Mineral Resources, Geology and Geophysics July 1965. To accompany Record 1965/108.

NT/A129

MEASURED SECTIONS OF UPPER PROTEROZOIC UNITS

Plate 8

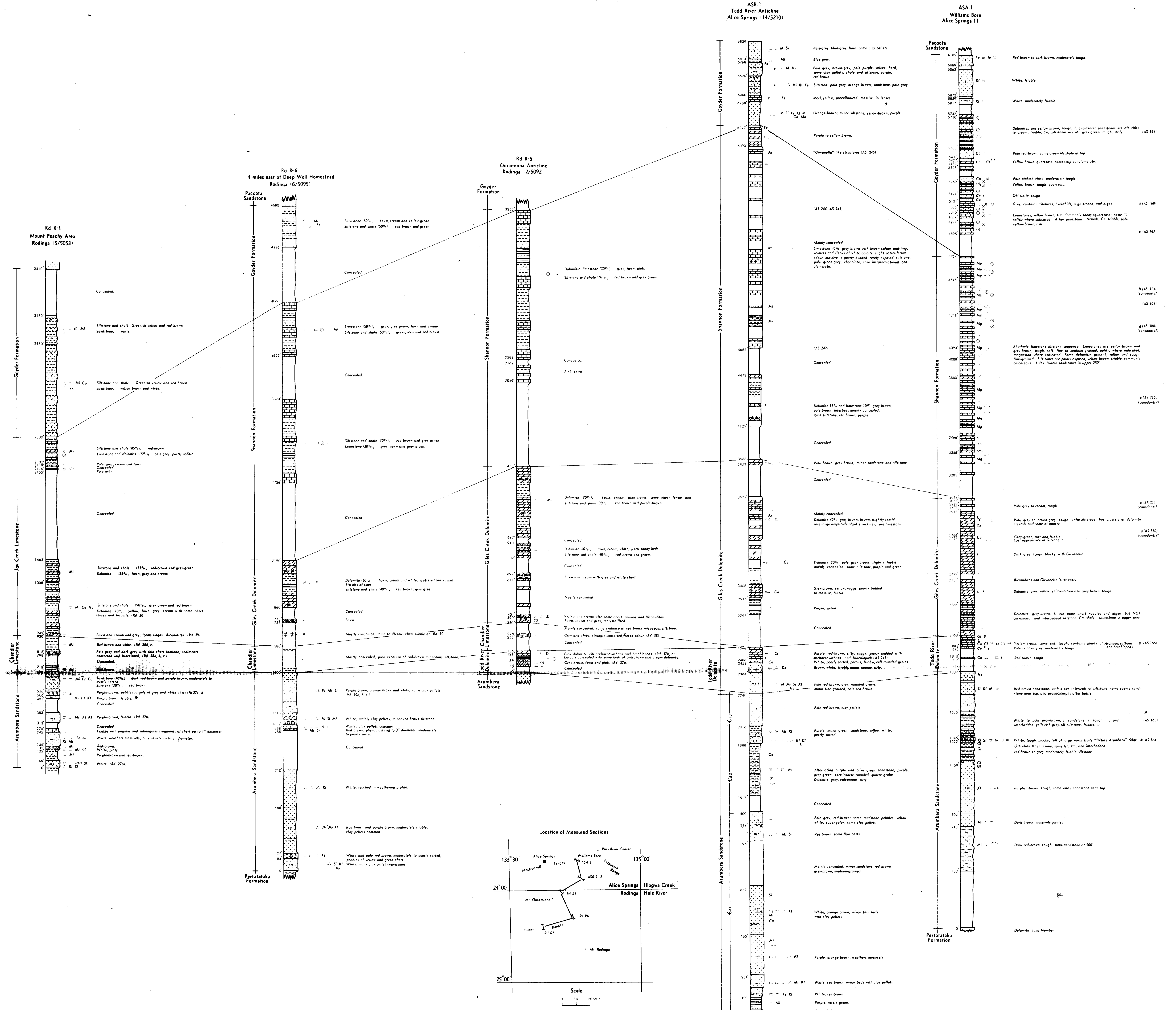


To accompany Record 1965/108

Bureau of Mineral Resources, Geology & Geophysics, November 1965. NT/A/130

MEASURED SECTIONS OF THE PERTAOORRTA GROUP
-JAMES RANGES TO WILLIAMS BORE

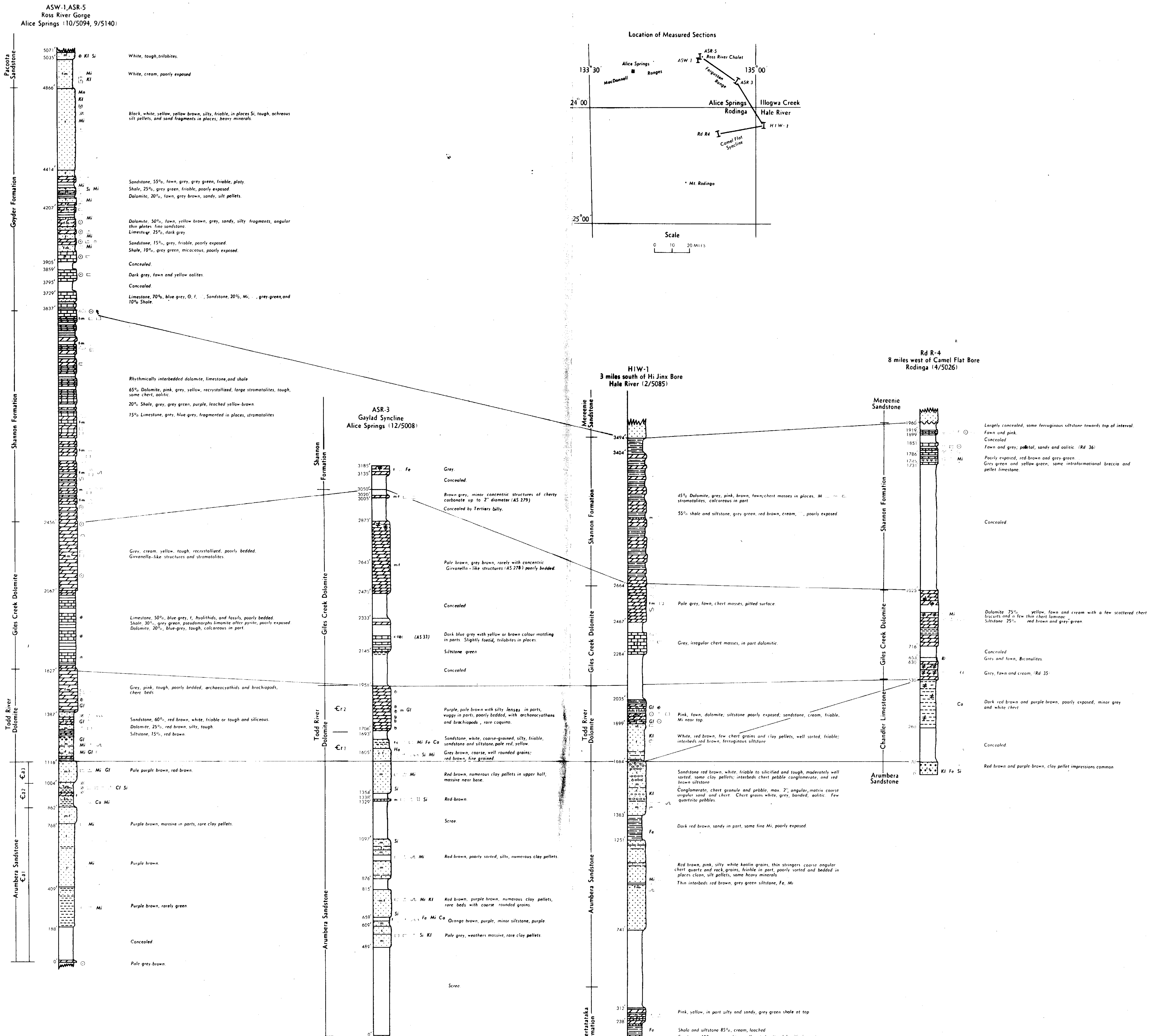
Plate 9



To accompany Record 1965/108
Bureau of Mineral Resources, Geology & Geophysics. November 1965. NT/A/131

MEASURED SECTIONS OF THE PERTAOORRTA GROUP
–ROSS RIVER CHALET TO CAMEL FLAT SYNCLINE

Plate 10

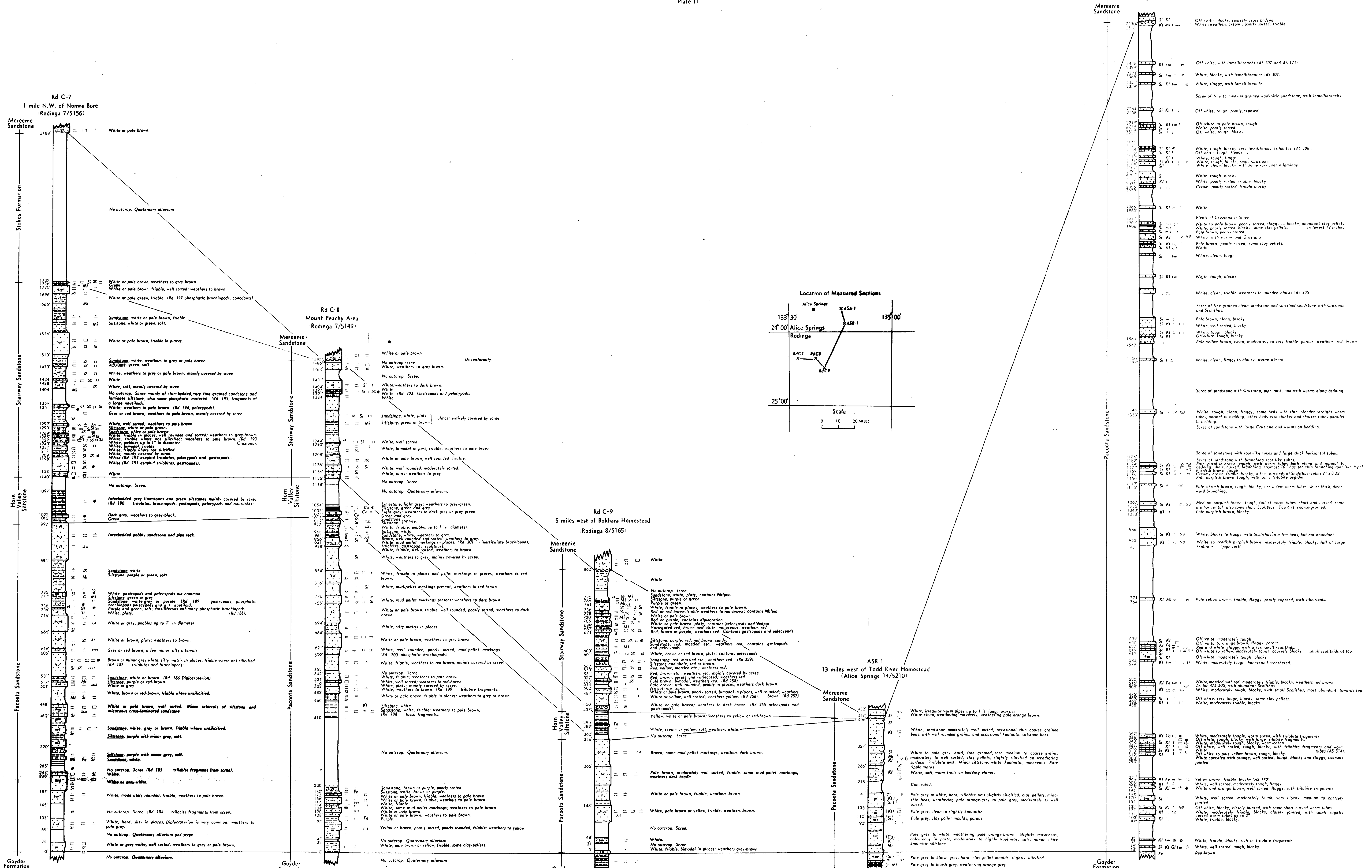


To accompany Record 1965/108

Bureau of Mineral Resources, Geology & Geophysics, November 1965 NT/A/133

MEASURED SECTIONS OF LARAPINTA GROUP UNITS
ALICE SPRINGS AND NORTHERN PART OF RODINGA SHEET AREAS

Plate 11



To accompany Record 1965/108

Bureau of Mineral Resources, Geology & Geophysics - November 1965 NT/A/132

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

MEASURED SECTIONS OF MEREENIE SANDSTONE AND PARTS OF THE PERTNJARA FORMATION
NORTH-EASTERN PART OF THE AMADEUS BASIN

PLATE 14.

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

Load cast

Chewed up by organisms

Grain Size

f	*fine*	*0·12-0·25 mm*
m	*medium*	*0·25-1·0 mm*
c	*coarse*	*1·0 - 2·0mm*
v.c.	*very coarse*	*2·0 - 4·0mm*
	Fine conglomerate	*4·0-16·0mm*
	Pebble conglomerate	*3/4-2 1/2 inches*
	Cobble conglomerate	*2 1/2-10 inches*
	Boulder conglomerate	*> 10 inches*

Si	*Silicified*	Gl	*Glauconite*
Fe	*Ferruginous*	Fl	*Feldspathic*
Mi	*Micaceous*	Ha	*Pseudomorphs of halite*
Ca	*Calcareous*		
Kl	*Kaolinitic*	P	*Phosphatic*
G	*Gypsum*		

Bedding

Very thick > 40 inches

Thick 12 - 40 inches

Medium 4 - 12 inches

Thin 0·4 - 4 inches

Laminate < 0·4 inches

Cross bedded

Cross laminated

Graded bedding

Undulate

Slumped

Ripple marks-wave

Ripple marks-current

Tracks and trails

"Pipe rock"

Scattered vertical worm tubes

o *Oolites*

Macrofossil

Rodinga 6/5556 *Sheet, run and photo number*

P.P. *Principal point of photograph*

Gaps in columnar section are concealed areas.

Bureau of Mineral Resources, Geology and Geophysics. August 1965. To accompany Record 1965/108. M(C)16

E J