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Record No. 1970/3

The Geology of the Cape Scott, Port Keats, Fergusson River and Delamere 1: 250,000 Sheet Areas, Northern Territory

by

C.M. Morgan, I.P. Sweet, J.R. Mendum, and I.R. Pontifex

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SUMMARY

This report presents the results of field work carried out by a Bureau of Mineral Resources field party during 1968. The Precambrian of the Cape Scott, Port Keats, Fergusson River and Delamere Sheet areas was mapped, and in addition, Lower Cambrian volcanics on the latter two sheet areas were examined. An area on the Fergusson River Sheet area, previously thought to be Precambrian, is now regarded as Cambrian and Ordovician.

The oldest rocks, the Hermit Creek Metamorphics, are probably of Archaean age, and are poorly exposed in the north of the area. Unconformably overlying this ancient basement is the Finniss River Group, a sequence of turbidites and acid volcanics of Lower Proterozoic age, which was deposited in the Pine Creek Geosyncline. The Chilling Sandstone overlies, and intertongues with, the Finniss River Group. The Henschke Breccia, a coarse-grained, ferruginous, quartz-rich sedimentary breccia, may grade eastwards into Chilling Sandstone. The Lower Proterozoic rocks were intensely folded and intruded by gabbro, dolerite and granophyre, and later by acid plutonic rocks. The age of the intrusive rocks ranges from late Lower Proterozoic to early Carpentarian.

A major northnortheast trending belt of intensely faulted sandstone, the Fitzmaurice Group, overlies the igneous and metamorphic rocks with pronounced unconformity. This faulted belt, known as the Fitzmaurice Mobile Zone, is separated from a tectonically more stable area known as the Sturt Block by a major lineament, the Victoria River Fault.

The oldest rocks cropping out within the Sturt Block are shallow water carbonate and siltstone known as the Bullita Group. The base of the group is not exposed, but it is overlain unconformably by glauconitic sandstone and shale (Wondoan Hill Formation). These rocks were gently folded and eroded before deposition of the Auvergne Group, a sequence of shallow water siltstone, sandstone and dolomite. These too, are only gently folded, and faulted.

Another sedimentary sequence, the Tolmer Group, which crops out only on the Fergusson River Sheet area, is to the east of the northern extension of the Victoria River Fault. Although it overlies the Finniss River Group with pronounced unconformity, it is isolated from the Fitzmaurice, Bullita and Auvergne Groups, and its age relationship with these groups is unknown.

The Antrim Plateau Volcanics, which are unconformable on all Precambrian units, comprise tholeiitic basalt with lenses and interbeds of tuff, sandstone, conglomerate and limestone. The linear outcrop of some sandstone beds suggests an aeolian origin.

An area of 650 sq. km on the Fergusson River Sheet area, previously mapped as Waterbag Formation (Tolmer Group) is now regarded as Jinduckin Formation of Cambrian or Ordovician age. This results from recognition of the Dorisvale Fault, a major structure which forms the western margin of the Daly Basin.

The Mullaman Beds, of Cretaceous age, form extensive outcrops, and are generally capped by laterite; the latter are generally siliceous and low in alumina content.

Geophysical work carried out includes gravity, aeromagnetic, seismic and radiometric surveys.

Gold and tin, associated with the Carpentarian granites, have been produced from a number of localities in the north of the area. Barytes reefs in Antrim Plateau Volcanics, and Tertiary laterites (for iron content) may have economic potential.

Surface water supplies are abundant in the north. Ground water is sought for pastoral use in the south. Bores in Precambrian rocks produce small flows unless fractured rocks are encountered; some bores in the Antrim Plateau Volcanics have very high yields.

INTRODUCTION

This record consists of a description of the geology of the Precambrian rocks and of the Antrim Plateau Volcanics on the Cape Scott, Port Keats, Fergusson River and Delamere 1:250,000 Sheet areas. A section on the Ordovician Jinduckin Formation is also included as part of the formation was originally mapped as Precambrian and has not been described previously.

The data was collected during the 1968 field season as part of a programme of regional reconnaissance mapping of the Victoria River District. The Auvergne 1:250,000 Sheet area was mapped in 1967 and has been described by Pontifex et al. (1968). The remaining four sheet areas (Victoria River Downs, Wave Hill, Waterloo, Limbunya) were mapped in 1969.

Location and Access

The area surveyed lies within latitudes 13° and 16° south and between longitudes 129° and 131° east, in the Northern Territory of Australia (See Fig. 1) and includes parts of the Cape Scott, Port Keats, Fergusson River and Delamere 1:250,000 Sheet areas.

Main access is from the Stuart Highway to the east, by way of:

1. the track to Daly River Police Station. This provides access to areas south and north of the Daly River, including the Moyle River area.
2. a graded road into Collia Waterhole via Oolloo.
3. a track to Dorisvale homestead, and beyond to Wombungi outstation of Coolibah station. The track continues through to Bradshaw outstation and Coolibah homestead, thus providing a means of access to a very large area.
4. the Katherine-Wyndham road which branches from the Stuart Highway at Katherine. It is the main road through the southern part of the area and has a sealed surface as far as Willeroo (112 kilometres). Sealing is in progress to Timber Creek and 175 kilometres of sealed road links Willeroo and Top Springs.

Using these roads and minor station tracks, combined with cross country work, it was possible to cover about half of the area by vehicle. The large scarps surrounding plateaux are in most cases impassable to vehicles, and much of this country is accessible only by horse, on foot, or by helicopter. The Fitzmaurice and Victoria Rivers are navigable for a limited distance (Pontifex, et al., 1967), but these avenues were not exploited on this survey.

Habitation and Industry

The area is extremely sparsely inhabited. Apart from a number of stations in the area, the only centres of permanent population are Daly River Mission and settlement, and the Port Keats Mission. The population of the Daly River Police District in 1966 was 783 aborigines, and 239 Europeans and others. Temporary population is significant, and includes road and bridge construction gangs, fencing and boring contractors.

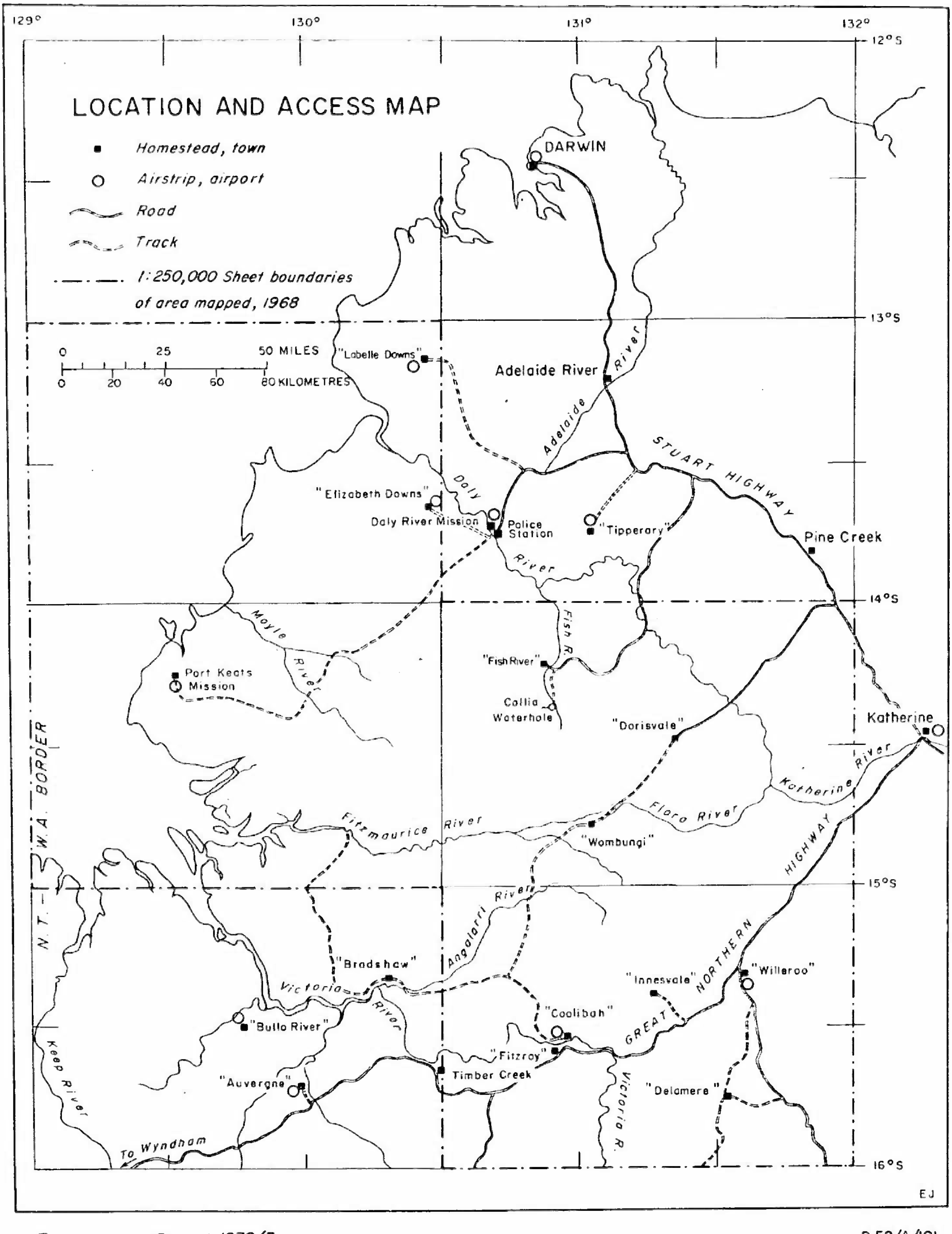
By far the largest centre of population is the Port Keats Mission, with over 500 aboriginal and about 20 European residents. Most of the stations shown in Fig. 1 have a European population of less than 10, but may have a larger number of aboriginal stockman and their families. Coolibah Station, including Bradshaw and Wombungi outstations, had, at the time of the survey, about 30 Europeans and possibly 60 Aboriginals.

The only industry in the area is beef cattle raising. Properties are large, between 2500 and 10,000 square kilometres, and control of cattle is minimal. The situation is changing rapidly, and many properties have been improved in the last few years since a market has been found for their cattle.

An area of 13,300 square kilometres, constituting the Daly River Aboriginal Reserve, is practically unused, except for limited cattle grazing.

In past years the northern part of the area has been prospected extensively, and gold and tin have been won from the Buldiva-Fish River

Fig. I



To accompany Record 1970/3

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TABLE 1. CLIMATIC DATA FOR PORT KEATS AND KATHERINE

PORT KEATS		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
	Mean Daily Max.	32.5	32.2	33.1	33.6	32.7	30.4	30.8	32.4	32.5	33.4	34.2	33.3	32.6
Temperature (°C)	Mean Daily Min.	23.9	24.3	23.3	20.7	17.5	14.7	14.1	14.8	18.6	22.4	24.0	24.4	20.3
	Mean	28.4	28.3	28.2	27.2	25.1	22.6	22.5	23.4	25.5	28.0	29.0	28.5	26.4
Rainfall (mm)	Mean monthly	343.5	363.9	253.4	61.8	39.4	6.2	5.3	1.0	4.3	26.4	78.5	222.5	1386.2
KATHERINE														
	Mean Daily max.	37.1	34.5	34.6	34.1	32.5	30.2	30.6	32.3	35.6	38.2	38.3	36.5	34.4
Temperature	Mean daily min.	23.5	23.5	23.0	20.2	16.8	14.1	13.7	14.9	19.3	23.8	24.7	24.5	20.1
	Mean	29.3	29.0	28.5	27.2	24.4	22.1	22.2	24.7	27.6	31.0	31.4	30.5	27.2
Rainfall	Mean monthly	232.1	201.5	156.2	34.2	5.6	2.0	0.8	0.5	5.8	29.8	83.8		963.5

area. Tin is still being recovered at Collia tinfield, where up to 10 men have been working for a portion of the year for the last few years.

Climate & Vegetation

The climate is monsoonal; there is a long dry season, from about April to November, with prevailing southeasterly winds, and a short wet season, with northwesterly winds.

The inflow of moisture from the northwest occurs spasmodically from October, with resulting thunderstorm activity, which shows in the rainfall figures in Table 1. The true monsoonal influence occurs in January and February, bringing very heavy falls in these months. Cyclones occasionally result in heavy falls as late as April. The rainfall is greatest in the northwest, and decreases from 137 cm average at Port Keats to about 64 cm in the southeast.

Temperature figures (Table 1) show that the coolest months are June and July, with the period from October to December the hottest. This occurs when the sun is directly overhead at midday, and before the heavier cloud and higher humidity of the wet season causes a reduction in insolation. At the end of the wet season, as cloud lessens and the sun is again directly overhead at midday, a slight rise in daily maximum temperatures occurs in some areas. This is noticeable in the figures for Port Keats.

The effect of proximity to the coast can be seen in the maximum temperatures. Daily, monthly, and yearly range of temperature is greater away from the coast. The whole area is frost free, although inland there have been recorded minimum temperatures below 40^{o}F in June and July.

Vegetation changes noticeably from northwest to southeast due to the reduction in annual rainfall. The well drained sandy plains southeast of Port Keats support open forest, comprising eucalypts between 15 and 30 metres high. The understorey includes cycads, palm trees, and grasses. The black soil areas support pandanus palms and tall grasses, and the swamps, varieties of paper bark tree and reeds.

Most of the sandstone ranges in the northern part of the area are thickly clothed by "cane grass" which is an annual sorghum. This grows very rapidly in the wet season to a height of between 1 and 2 metres, dries out early, and is usually burnt off by pastoralists to allow regrowth of fresh green shoots. Eucalypts and other trees are studded thickly throughout this country. In valleys and gullies spear grass and kangaroo grass are common.

Further south, open forest gives way to savannah woodland. On the ridges and hillsides spinifex is more common than cane grass. Large paperbarks line waterholes, and ghost gums stud the adjacent areas. Bauhinia trees are common.

Christian and Stewart (1953) describe in some detail the vegetation of the northern part of the area.

Survey Methods

The survey was carried out in 1968 from May to September (inclusive). Five geologists were engaged in mapping for the first half of the season, and three in the second half. Most time was spent doing ground surveys, using Land Rovers. Areas which were inaccessible to vehicle were studied during a six-week helicopter programme in which 130 hours were flown. The aircraft used was a Bell G3-B1 helicopter, capable of carrying 2 passengers with equipment.

Positions of observations were plotted straight on to aerial photographs. Geological information was plotted onto overlays on alternate photos on which photogeology had been delineated (Perry, 1966).

Photographs available were:-

1. 1:30,000 scale 1948; Cape Scott area and some of Fergusson River.
2. 1:50,000 1948-50 Port Keats and Delamere areas.
3. 1:85,000 1962 Fergusson River.
4. 1:85,000 1967 Delamere.

Quality varies from poor to moderate for the earlier photographs, to excellent for the latest photographs.

Previous Geological Investigations

Captain Stokes, in 1839 (Stokes, 1846), first commented on the geology of the area. The Rev. J.E. Tenison-Woods, (1886) made a passing comment on the "fluviatile sandstones and conglomerates" near the mouth of the Victoria River, and the ".......good volcanic country ......higher up..."

H.Y.L. Brown (1895) made the first accurate observations on the geology of the area. He carried out traverses along the tidal reaches of the Victoria and Fitzmaurice Rivers. Assays of a quartz reef near the mouth of the Fitzmaurice River showed traces of gold and one sample showed 1 oz. 17 dwts. of silver to the ton. The country rocks of the area he called "Fitzmaurice River Rocks", which are referred to in this report as the Fitzmaurice Group, comprising four formations. Brown also collected fossils from the locality named Fossil Head by Stokes (1846). Late in the same year Brown traversed the country from Fountain Head to Victoria River Downs, and described the country and rocks of the route he took across the Fergusson River and Delamere Sheet areas (Brown op. cit.).

Wells (1907) gives a general description of the country in the Delamere - Victoria River Downs area, and Jensen (1915) passed through the area en route to the Tanami Goldfield.

More recently, Hossfeld (1937a,b) described the Fletcher's Gully gold and tin deposits, and the Buldiva - Collia tin deposits.

Major geological reports, with accompanying maps of the regions, have been produced by Noakes (1949), and Traves (1955). These investigations have provided the main background knowledge for more recent regional mapping.

The recent work includes that of Randal (1962), and Walpole et al. (1968), the latter being the most comprehensive report available on the geology of the Katherine - Darwin region.

Seismic and radiometric surveys have been carried out over the western part of the area; a gravity survey on a seven-mile grid spacing was carried out over the whole area (Whitworth, 1970); and all of the area apart from the eastern part if the Fergusson River Sheet area has been covered by an airborne magnetometer survey. All of these surveys are more fully discussed under the heading "Geophysical Work".

Present Geological Investigations

At the time of this survey (1968), the company, Planet Gold had an Authority to Prospect (A.P.) over much of the Precambrian of the Port Keats area, and were searching for uranium mineralization. In the southern part of the area, from about Willeroo southwards, Metals Exploration have an A. P. on much of the country underlain by volcanics. A stream sediment sampling programme has been carried out.

PHYSIOGRAPHY

The four sheet areas have been divided into seven physiographic units. Four of these, the Cambridge Gulf Lowlands, the Victoria River Plateau, the Delamere Plains and Benches,* and the Sturt Plateau were originally delineated by Paterson (1970). The first three are sub-regions of his Ord-Victoria Region. The Daly River Basin and Northern Uplands have been taken from Walpole et al. (1968). The Victoria River Plateau has been subdivided into three informal units. The Litchfield and Cullen Plains, which have been delineated and named by us are part of the Western Plains of Walpole, et al. (1968). The distribution of the units is shown in Fig. 2; also Fig. 3.

The Cambridge Gulf Lowlands form a coastal strip up to 60 kilometres wide which occupies the north-western part of the survey area. They are underlain almost entirely by the Palaeozoic rocks of the Bonaparte Gulf Basin. The lowlands include a few small hills and elevated plains but for the most part consist of very flat and low-lying soil and alluvial plains. The coast and river estuaries are surrounded by salt flats, and mangrove thickets line the water's edge at the river mouths. At several places the coast is lined by sand dunes which have very low relief and support considerable vegetation. The hills and soil plains are quite heavily vegetated whereas the alluvial plains are marshy and open.

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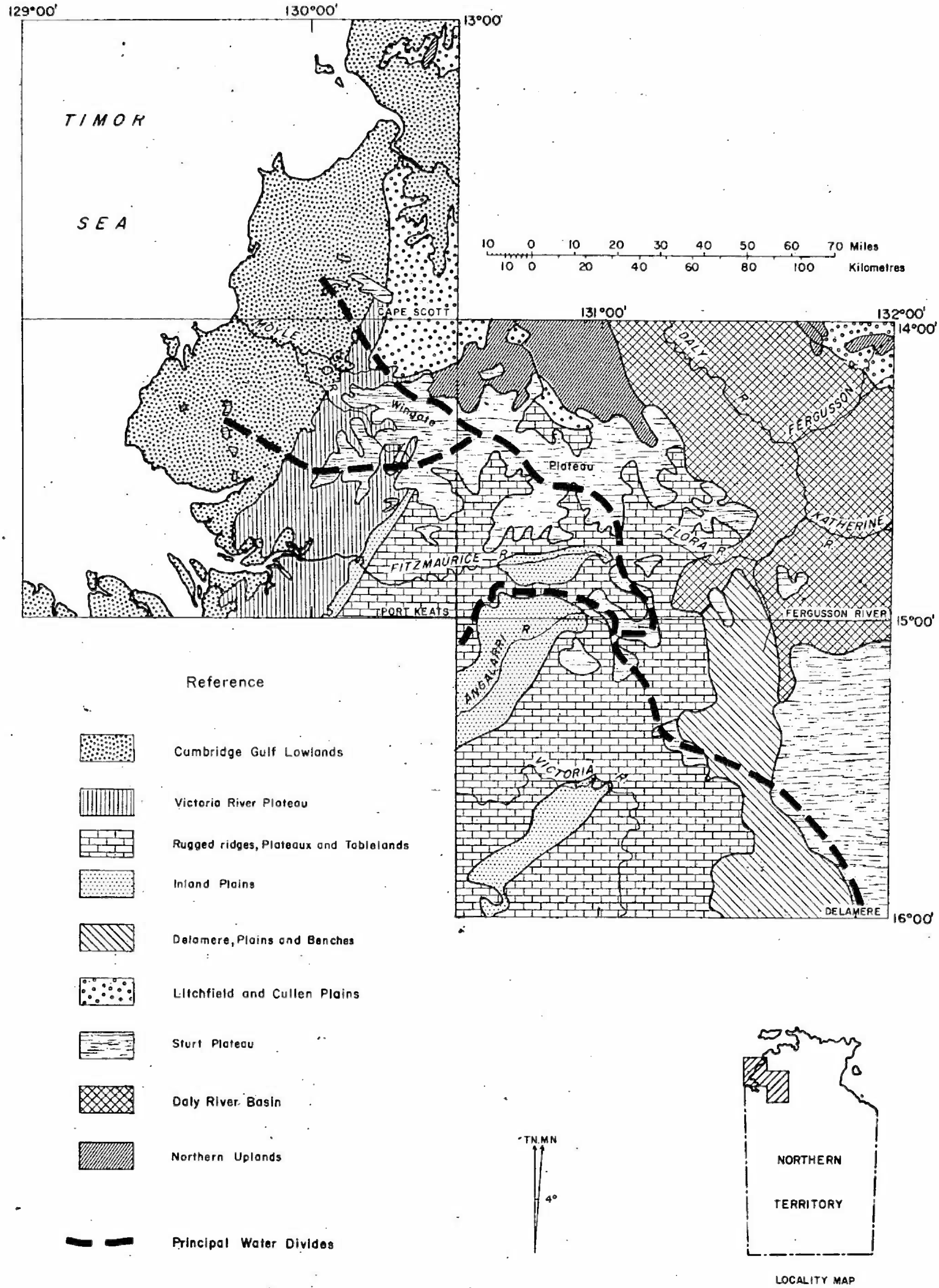
* Paterson's Victoria River Plains and Benches have here been renamed Delamere Plains and Benches.

FIG.2. PHYSIOGRAPHIC SKETCH MAP OF CAPE SCOTT, PORT KEATS, FERGUSSON RIVER AND DELAMERE 1:250,000 SHEET AREAS



To accompany Record 1970/3

The Victoria River Plateau includes the rugged ridges and plateaux, which form a north-east-trending belt up to 40 km wide which runs across the Port Keats and Cape Scott Sheet areas. The ranges are formed of the deformed sediments of the Fitzmaurice Mobile Belt. The ranges consist of very rugged ridges, cuestas, and small plateaux predominantly of sandstone, and a few narrow alluvium-filled valleys where softer rocks such as siltstone have been preferentially weathered out. The ruggedness is also enhanced by extensive faulting and the lack of vegetation or soil on many of the hills. Local relief is up to about 150 metres.

The tablelands occupy a large part of the southern half of the survey area. They are underlain by the Auvergne, Bullita and Tolmer Groups which are gently dipping sequences of Proterozoic sandstone, siltstone and carbonates, and consist of structural plateaux, benches, mesas, buttes, cuestas, hogbacks and karst areas. The plateau rises up to 300 metres above surrounding areas. The Newcastle and Bynoe Ranges in the western part of the Delamere Sheet area comprise a large north-west dipping cuesta capped by the Jasper Gorge Sandstone. Large areas are capped by sandstones which produce a very rough and inaccessible surface.

The inland plains comprise three large north-east-trending valleys within the Victoria River Plateau. They are formed in siltstone units of the Proterozoic sediments and consist of flat soil-filled valleys which in most places are separated from the tablelands, and ridges by steep scarps.

The Delamere Plains and Benches form a north-trending belt in the east of the Delamere Sheet area. They are formed on the basic extrusive rocks and interbedded sediments of the Antrim Plateau Volcanics. The unit consists of rounded and terraced hills strewn with boulders of volcanics and separated by undulating grassy plains. Black soil plains are quite common. Relief does not exceed 100 metres. The interbedded sandstone units form long north-west-trending rocky outcrops some of which have sharp cliffs up to 6 metres high.

The Litchfield and Cullen Plains are extensive in the north of the area. They overlie granite, the Hermit Creek Metamorphics and small areas of basic rock. They are flat soil plains with a dendritic drainage pattern. Most of the granite crops out as sporadic piles of boulders up to 30 metres high. The metamorphics and in some places the granites form rugged hills up to 200 metres high.

The Daly River Basin is a wide north-west-trending valley on the Fergusson River Sheet area. It is formed on the predominantly carbonate rocks of the Daly River Group. It is a fairly flat soil plain with scattered outcrops of carbonate giving rise to a karst topography. All outcrops are of low relief except for the few scattered mesas of the Wingate Plateau unit.

The Sturt Plateau and outliers(which includes the Wingate Plateau) consists of a number of areas which form a north-west-trending belt in the south-east of the area. It is formed exclusively of a laterite profile developed on the Cretaceous Mullaman Beds. The unit consists of extensive flat-topped plateaux and small mesas edged by vertical breakaways and steep slopes. It represents an uplifted Neogene surface, designated the Tennant Creek Surface by Hays (1967).

The Northern Uplands are underlain in most areas by metamorphosed sediments of the Pine Creek Geosyncline, and in part by the Tolmer Group. The topography developed is quite rugged, with relief up to 250 metres. Strike ridges and valleys are developed in the north-east corner of the Port Keats Sheet area on rocks of the Finniss River Group.

Drainage

Two major rivers flow through the survey area; these are the Victoria River and the Daly River. Other large rivers in the area are the Fergusson, Katherine and Flora which are tributaries of the Daly, and the Fitzmaurice and Moyle Rivers. These, and in particular the Daly and its tributaries, run for most or all of the dry season. Several other small rivers which are fed by springs at the base of the Wingate Plateau also flow for most or all of the dry season. The great majority of water courses in the area only flow after heavy falls of rain.

Fig.3: Oblique aerial view of the Fitzmaurice River taken from a point near its mouth. In the foreground are salt flats with mangrove thickets lining the waters' edge (Cambridge Gulf Lowlands). In the centre of the photo the river flows across the strike of the sediments of the rugged ridges and plateaux. Near the top of the photo can be seen the flat tablelands of the Victoria River Plateau with the inland plains (Meeway plain and Koolendong Valley) between it and the rugged ridges and plateaux.

The water divides between the main river systems are shown in Fig. 2 . It can be seen that they tend to follow areas of the Wingate Plateau physiographic unit. The latter represents areas of land which have not been eroded at all by this generation of rivers.

The courses of the major rivers are only partly dependent on the geological structure. Thus while the Daly River follows the axis of the Daly River Basin, the Fitzmaurice and Victoria Rivers cut across the strike of the 'Mobile Belt' (see "Structure"). Paterson (1970) considers that "..... the present river system is possibly due to a combination of the revival of a little altered drainage system that existed on an early Neogene Surface (now the Wingate Plateau Surface) and of drainage consequent on new slopes. Both the revival of drainage and the formation of new slopes results from the epeirogenic uplift of the Neogene Surface as a whole....." Thus in some places the river systems were unrelated to the structure below the cover (mostly Mullaman Beds) of the Neogene surface and have now been superimposed on it, whereas in other places the rivers follow structures which were already reflected in the Neogene surface before uplift.

Many of the secondary streams in the mobile belt are subsequent to the structure and follow the north-easterly strike. On the stable shelf the sediments are virtually flat-lying and there is therefore little structural control on river courses. However, in the north-west of the Delamere Sheet area the secondary streams do run parallel to the north-westerly dip.

SUMMARY OF GEOLOGY (Fig. 4)

Pine Creek Geosyncline (Walpole et al., 1968), (Tables 2a,2b)

The oldest rocks in the area described in this record are the Archaean, Lower Proterozoic and early Carpentarian rocks which form the western part of the Pine Creek Geosynclinal Belt. The oldest unit is the Archaean Hermit Creek Metamorphics which are low-grade quartz-muscovite schists. It is unconformably overlain by the Lower Proterozoic Finniss River Group which consists mainly of turbidites and acid volcanics which have suffered low-grade metamorphism. They are overlain, probably conformably and with an intertonguing relationship by an orthoquartzite, the Chilling Sandstone. The sediments and metamorphics were intensely folded and intruded by gabbro, dolerite and granophyre in late Lower Proterozoic or early Carpentarian time, and then intruded by acid plutonic rocks ranging from granite to tonalite. The latter have been dated at about 1800 m.y. (Compston & Ariens, 1968). In the northwest of the Fergusson River 1:250,000 Sheet area the granite is cut by the acid Edith River Volcanics which also give a date of about 1800 m.y.

Fitzmaurice Mobile Belt (Table 2c)

A belt of intensely faulted (though only gently folded) sediments, the Fitzmaurice Group, trends north-north-east across the Port Keats 1:250,000 Sheet area. The group consists of very thick sandstone and minor siltstone, grit and conglomerate. It unconformably overlies all units of the Pine Creek Geosyncline and is therefore thought to be of Carpentarian or Adelaidean age. The belt is separated from the Bonaparte Gulf Basin to the west by the north-trending Moyle River Fault which has a very large downthrow to the west, and from the Sturt Stable Block to the east by another major fault, the Victoria River Fault, which has a downthrow to the east. It is thought that the mobile belt was active in Precambrian times but the Palaeozoic rocks which overlap it are also intensely faulted. The Fitzmaurice Group has been correlated with the Carr Boyd Group in Western Australia.

Victoria River Basin (Tables 2d, 2c)

The Victoria River Basin is a large sedimentary basin only the north-eastern part of which is included in the area described by this record. The sediments filling it are of Carpentarian or Adelaidean age. They were deposited on a very stable area - the Sturt Stable Block - which has moved little since the time of deposition so that the sediments are mostly sub-horizontal. The block is bounded on the west, north and east by major faults so that no stratigraphic relationships with the Fitzmaurice or Tolmer Groups or units of the Pine Creek Geosyncline have been observed. All the faults

FIG 4 GEOLOGICAL SKETCH MAP
OF CAPE SCOTT, PORT KEATS, FERGUSSON RIVER AND DELAMERE 1:250,000 SHEET AREAS

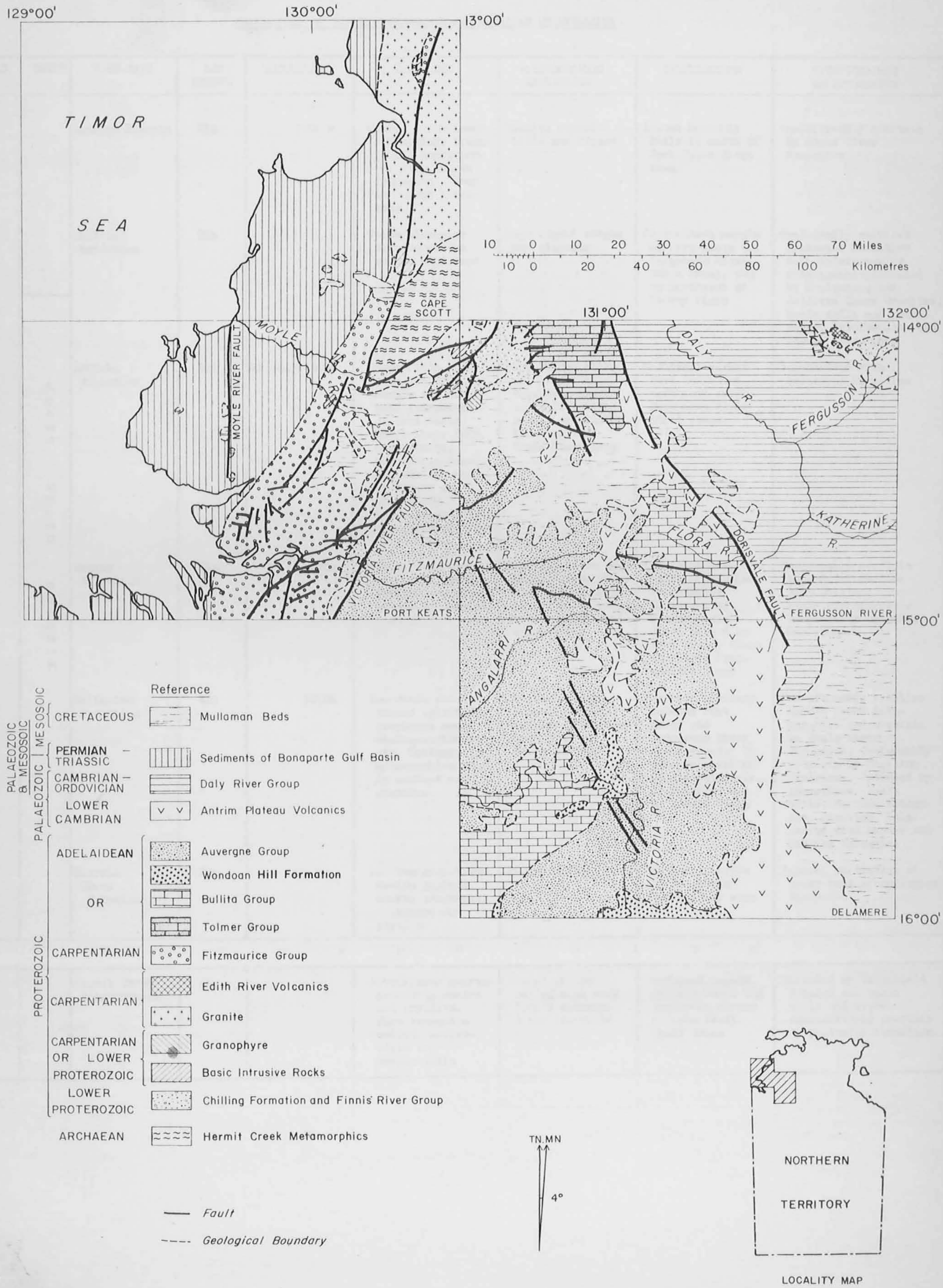


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TABLE 2(a) : LOWER PROTEROZOIC AND ARCHAEAN STRATIGRAPHY

ERA	PERIOD	GROUP	ROCK UNIT	MAP SYMBOL	THICKNESS	LITHOLOGY	PHYSIOGRAPHIC EXPRESSION	DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS
PROTEROZOIC	LOWER PROTEROZOIC		Henschke Breccia	Blg	900+ m	Coarse ferruginous sedimentary breccia and conglomerate with quartz fragments. Some sandstone interbeds	Massive rugged hills and ridges	Around Henschke Falls in north of Port Keats Sheet area	Unconformably overlain by Moyle River Formation
			Chilling Sandstone	Blh		White blocky or massive medium quartz sandstone	High rugged ridges and plateaux	On northern margin of Port Keats and Fergusson River Sheet areas, and to northwest of Meeway Plain	Conformably overlies Noltenius Formation with intertonguing relationship; intruded by Koolendong and Soldiers Creek Granites, basic sills and granophyre. Interbedded with Meeway Volcanics.
		FINNISS RIVER GROUP	Berinka Volcanics	Bli	at least 840m	Porphyritic grey rhyolite and dacite and minor acid intrusives on Port Keats Sheet area. Tuff, agglomerate, rhyolite, altered spherulitic acid volcanics and amygdaloidal intermediate flows on Fergusson River Sheet area.	Very rugged hills and ridges on Fergusson River and valley with gently undulating floor on Port Keats Sheet area	Northeast corner Port Keats and northwest corner Fergusson River Sheet areas.	Interbedded with Noltenius Formation
			Meeway Volcanics	Bla	1700m	Porphyritic rhyolite, tuff, sandy tuff, some outcrops intensely sheared.	Rhyolite forms high rounded tors. Tuffs form rugged angular hills and steep slopes below sandstone units	West of Meeway Plain and Koolendong Valley. Northwest of Meeway Plain. Small area 8 km west Meeway Plain and north Fitzmaurice River	Conformably overlain by and interbedded with Chilling Sandstone. Unconformably overlain by Lalngang Sandstone.
			Noltenius Formation	Bln	4200m	Low-grade metamorphosed siltstone, greywacke sandstone, conglomerate. Contact metamorphism where in contact with granites	Extremely rough country. Ridges, angular hills. Some low-lying but rough country	Northern boundary between Port Keats and Fergusson River Sheet areas. In area to north of Collia Waterhole. In valleys west of Meeway Plain	Unconformably overlies Hermit Creek Metamorphics and overlain by Moyle River Formation. Conformably overlain by Chilling Sandstone. Intruded by granophyre, basic sills, Berinka Volcanics, granites. Interbedded with Meeway and Berinka Volcanics
			Burrell Creek Formation	Blb		Massive grey-brown medium grained quartz greywacke, siltstone and phyllite	Rugged hills	Northeast corner of Fergusson River Sheet area	Lateral equivalent of lower part of Noltenius Formation
U N C O N F O R M I T Y									
ARCHAEAN			Hermit Creek Metamorphics	Ah		Ferruginous quartz-muscovite schist and phyllite. Rare tremolite schist, amphibolite and serpentinite	Plains of low relief with very little outcrop. A few low hills	Northeast corner of Port Keats and southeast corner of Cape Scott Sheet areas	Intruded by Litchfield Complex and basic sills and dykes. Unconformably overlain by Noltenius Formation.

TABLE 2(b) : PROTEROZOIC STRATIGRAPHY (CARPENTARIAN IGNEOUS ROCKS)

ERA	PERIOD	GROUP	ROCK UNIT	MAP SYMBOL	THICKNESS	LITHOLOGY	PHYSIOGRAPHIC EXPRESSION	DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS
PROTEROZOIC	CARPENTARIAN		Edith River Volcanics	Bue	105 m	Coarse porphyritic toscanite	Rugged hills and ridges	Northeast corner of Fergusson River Sheet area. North-west corner Fergusson River Sheet area.	Dykes in Cullen Granite and flows overlying it.
			Allia Granite	Bga		Medium to coarse porphyritic biotite-muscovite adamellite, granodiorite and tonalite	Soil plain with sporadic piles of boulders. Also rough slopes below sandstone capping.	Northwest corner Fergusson River Sheet area.	Intrudes Noltenius Formation. Unconformably overlain by Depot Creek Sandstone
			Cullen Granite	Bgc		Medium and even grained biotite granite; and coarse porphyritic biotite-hornblende granite and adamellite	Soil plain with sporadic outcrops	Northeast corner Fergusson River Sheet area	Intrudes Burrell Creek Formation and is intruded by Edith River Volcanics
			Koolendong Granite	Bgk		Even-grained and minor porphyritic coarse biotite and biotite-hornblende granite, adamellite and granodiorite. In southern outcrops the adamellite intrudes the granodiorite	Pavements and boulder piles in soil plains, rough slopes below sandstone cappings	In west of Koolendong Valley and Meeway Plain, and in valleys to northwest of Meeway Plain	Unconformably overlain by Moyle River Formation. Intrudes Noltenius Formation and Chilling Sandstone
			Soldiers Creek Granite	Bgs		Porphyritic and even-grained coarse, muscovite-biotite granite and adamellite. Numerous greisen and pegmatite veins. Cassiterite and tourmaline in greisen veins	Rugged hills up to 100 m. high separated by soil plains.	North of Collia Waterhole on Fergusson River Sheet area	Intrudes Chilling Sandstone and Noltenius Formation and contains roof pendants of the latter. Unconformably overlain by Depot Creek Sandstone and Antrim Plateau Volcanics
			Litchfield Complex	Bgl		Coarse even-grained biotite granite, adamellite, granodiorite tonalite. Becomes more acid towards west of Port Keats Sheet area. Garnetiferous on Fergusson River Sheet area. Mafic xenoliths abundant. Migmatic zones at contacts with Hermit Creek Metamorphics	Boulder piles on flat soil plains. A few rough hills up to 100m high.	Northwest Fergusson River, northeast Port Keats Sheet area. East of Cape Scott Sheet area.	Intrudes Hermit Creek Metamorphics and probably Basic Sills. Unconformably overlain by Moyle River Formation
			Ti-Tree Granophyre	Bgi	Sills up to 300m. thick and totalling 600m.	Pink or grey medium mesocratic granophyre	Forms valleys in sequences it intrudes. Outcrop restricted to a few small piles of boulders	32 km. east Tom Turners Crossing; 24 km. southwest and 14 km. east of Fletchers Gully mine	Forms sills in Noltenius Formation and between the Noltenius Formation and Chilling Sandstone. Most relationships are concordant
			Basic Sills and Dykes	Bio		Medium and coarse quartz diorite and gabbro. Some traces of chalcopyrite	Low boulder strewn hills	Northeast Port Keats and northwest Fergusson River Sheet areas. 8 km. northwest and southwest Tom Turners Crossing, 19 km. southwest Hermit Hill.	Unconformably overlain by Moyle River Formation. Probably intruded by Litchfield Complex. Intrudes Hermit Creek Metamorphics, Noltenius Formation and Chilling Sandstone.

TABLE 2(c) : PROTEROZOIC STRATIGRAPHY (FITZMAURICE GROUP)

ERA	PERIOD	GROUP	ROCK UNIT	MAP SYMBOL	THICKNESS	LITHOLOGY	PHYSIOGRAPHIC EXPRESSION	DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	FITZMAURICE GROUP	Legune Formation	Bfe	2100 m	Interbedded grey white, green or brown fissile laminated siltstone, white, grey or green, poorly sorted, fine, medium and coarse sandstone	Gently undulating plains, finely dissected slopes, and rounded hills	In centre of mobile belt on Port Keats Sheet area	Apparently conformable conformable on Lalngang Sandstone
			Lalngang Sandstone	Bfl	1800 m	Interbedded fine, medium and coarse, grey feldspathic sandstone, grit, minor pebble beds and siltstone. One 120 m. bed of grey-green siltstone south of Port Keats Sheet	Rugged steep ridges up to 150 m. high. Lower and less rugged hills to west of Madjellindi Plain	In mobile belt on Port Yeats Sheet area	Apparently conformably overlain by Legune Formation; maybe unconformable on Moyle River, and Goobaieri Formation
			Goobaieri Formation	Bfg	600 m	Interbedded grey and green siltstone and fine sandstone interbeds of medium and coarse white sandstone in upper part of formation	Forms valleys with gently undulating floors. Coarser sandstone beds form ridges and cliffs in sides of scarps	In mobile belt on Port Keats Sheet area	May be unconformably overlain by Lalngang Sandstone. Apparently conformable on Moyle River Formation
			Moyle River Formation	Bfm	1050 m in south east Port Keats Sheet may be 10,000 m. in northwest	White, fine or medium sandstone with a few thin interbeds of siltstone and coarse sandstone. Several beds up to 450 m northwest of Madjellindi Plain	Forms rugged, steep-sided ridges. In Macadam Range they are truncated by Mesozoic peneplain surface	In mobile belt on Port Keats and Cape Scott Sheet areas	Unconformable on Carpentarian and Lower Proterozoic rocks. Overlain conformably by Goobaieri Formation and possibly unconformably by Lalngang Sandstone
			U N C O N F O R M I T Y						

TABLE 2(d) : PROTEROZOIC STRATIGRAPHY

ERA	PERIOD	GROUP	ROCK UNIT	MAP SYMBOL	THICKNESS	LITHOLOGY	PHYSIOGRAPHIC EXPRESSION	DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS
PROTEROZOIC	CARPENTARIAN OR ADELAIDEAN		Wondoan Hill Formation	Bw	Up to 105 m	Green glauconitic shale and sandstone, quartz sandstone, dolomitic siltstone	Smooth scarps	Central and southern part of Delamere Sheet area	Unconformable on Bullita Group; overlain unconformably by Stubb Formation or Jasper Gorge Sandstone.
			U N C O N F O R M I T Y						
		BULLITA GROUP	Banyan Formation	Bbb	Probably 315 m in centre of basin. Much thinner at edges	Stromatolitic and oolitic dolomite and limestone, minor siltstone and sandstone	Flat to undulating plains, some low, rounded hills.	Central southern part of Fergusson River Sheet area.	Overlies, probably unconformably, Bynoe Formation. Overlain unconformably by Stubb and Jasper Gorge Sandstone, locally by Antrim Plateau Volcanics
			Bynoe Formation	Bby	Up to 200 m	Purple to red-brown and grey-green micaceous siltstone, grey dolomitic siltstone and fine-sandstone and dolomite	Smooth scarps where capped by sandstone. Low hills and spurs with prominent terracing.	Southwestern quarter of Delamere Sheet, and central southern portion of Fergusson River Sheet.	Overlies Skull Creek Formation, probably conformably.
			Skull Creek Formation	Bbs	About 180 m	Grey, fine to coarsely crystalline dolomite with interbedded siltstone and minor sandstone. Some stromatolitic	Banded and terraced scarps, undulating country of low and moderate relief, latter with closely spaced streams.	Southwestern quarter of the Delamere Sheet. Also minor outcrop in north, extending on to Fergusson River Sheet.	Overlain by Bynoe Formation. Grades conformably into underlying Timber Creek Formation.
			Bardia Chert Member	Bbm	Up to 15 m	Pink to pink-brown laminated chert, some brecciated and re-cemented by coarser silica.	Flat or gently dipping surfaces, rough and uneven in detail.	Southwestern quarter of the Delamere Sheet area.	Underlain conformably by remainder of Skull Creek Formation. Overlain by Bynoe Formation.
			Timber Creek Formation	Bbt	75m+	Interbedded purple and grey-green quartz siltstone, fine sandstone and finely crystalline dolomite.	Smooth scarps, or if no hard caprock, terraced slopes.	Western portion of Delamere Sheet, along Victoria River.	Older formations not seen. Grades up into the Skull Creek Formation.
U N C O N F O R M I T Y									

TABLE 2(e) : PROTEROZOIC STRATIGRAPHY (AUVERGNE GROUP)

ERA	PERIOD	GROUP	ROCK UNIT	MAP SYMBOL	THICKNESS	LITHOLOGY	PHYSIOGRAPHIC EXPRESSION	DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS
PROTEROZOIC	CARPENTARIAN OR ADELAIDEAN	AUVERGNE GROUP	Shoal Reach Formation	Bah	up to 60 m	Brown and grey-green siltstone, with minor dolomite and sandstone	Steep slopes bordering plateaux capped by Mullaman Beds or laterite	Between Alligator Creek (Port Keats Sheet) and old Coolamon H.S. (Fergusson River Sheet)	Conformable on Spencer Sandstone. Overlain unconformably by Mullaman Beds
			Spencer Sandstone	Bae	up to 60 m	Fine grained sandstone, some dolomitic. Thin bedded, with ripple marks and halite casts. Some silty sandstone	Moderate smooth slopes bordering plateaux, and low banded hills	Southeast and southwest quarters of Port Keats and Fergusson River sheet areas respectively	Upper and lower contacts, with Shoal Reach and Lloyd Creek Formations respectively, are conformable
			Lloyd Creek Formation	Bal	up to 75 m	Grey-green siltstone, algal and oolitic dolomite, and dolarenite. Sandy and silty dolomite	Low hills, smooth to vaguely terraced	As for Spencer Sandstone	Upper and lower contacts, with Spencer and Pinkerton Sandstones respectively, are conformable
			Pinkerton Sandstone	Bap	up to 50 m	Fine to medium-grained, well sorted, white quartz sandstone. Cross bedded and ripple marked. Minor silstone and shale	Forms cliffs, caps scarps and forms plateaux cuestas or hogbacks depending on dip of beds	From Victoria River. Fault, east and north-east to near Wombungi and Collia Waterhole on Port Keats and Fergusson River Sheets. Minor occurrence on Delamere Sheet	Upper and lower contacts, with Lloyd Creek and Saddle Creek Formations respectively, are conformable
			Saddle Creek Formation	Bad	20 m to 90 m	Fine to medium-grained sandstone. Reddish clayey, to white clean quartz sandstone. Strongly cross bedded. Interbedded with and overlain by ferruginous siltstone	Basal sandstone forms cliffs, generally capped by slope of siltstone, and then another cliff of Pinkerton Sandstone	As for Pinkerton Sandstone	Upper and lower contacts, with Pinkerton Sandstone and Angalarri Siltstone, are conformable
			Angalarri Siltstone	Baa	Unknown, in excess of 300 m	Grey-green fissile chloritic siltstone, minor fine-grained sandstone, minor dolomite	Undulating plains, or steep smooth scarp below overlying sandstone	East and south-east of Victoria River Fault as far as the Ikymbon River. Northwards to vicinity of Collia Waterhole	Upper and lower contacts are conformable with Saddle Creek Formation and Jasper George Sandstone
			Jasper Gorge Sandstone	Baj	45 m to 105m	Medium-grained well sorted, quartz sandstone. Basal conglomerate at some localities. Siltstone interbeds in parts	Prominent cliffs, capping mesas and forming plateaux	Throughout much of central and Western Delamere Sheet and northwards on southern Fergusson River Sheet	Overlain conformably by Angalarri Siltstone. Conformably overlies Stubb Formation but where latter absent unconformably overlies Wondoan Formation or Bullita Group
			Stubb Formation	Bat	Approx. 200 m	Grey and purple micaceous siltstone and shale, flaggy, fine-grained sandstone	Scarps, capped by cliffs of Jasper Gorge Sandstone or upper Stubb Formation	Central part of Delamere Sheet area and south-central part of Fergusson River Area	Overlies, unconformably, Bullita Group or Wondoan Formation, and is overlain conformably by Jasper Gorge Sandstone

UNCONFORMITY

TABLE 2(f) : PROTEROZOIC STRATIGRAPHY (TOLMER GROUP)

ERA	PERIOD	GROUP	ROCK UNIT	MAP SYMBOL	THICKNESS	LITHOLOGY	PHYSIOGRAPHIC EXPRESSION	DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS
PROTEROZOIC	CARPENTARIAN OR ADELAIDEAN	TOLMER GROUP	Waterbag Formation	Btg	150 m to 300 m	Thin to medium-bedded, chocolate and red-brown friable sandstone and siltstone. Rare dolomitic sandstone and dolomite in lower part becoming abundant in upper part. Halite casts	Lower rounded hills and areas of low relief. Soft beds commonly covered by Cainozoic units	Formation crops out in a zone about 10 km wide northwards from about 22 km NW of Dorisvale homestead	Conformable on Hinde Dolomite. Unconformably overlain by Antrim Plateau Volcanics
			Hinde Dolomite	Bth	120 m	Pink, grey and yellow-brown, flaggy to blocky, thin-bedded dolomite with interbeds of dark-grey and yellow-brown siltstone	Low relief areas usually with small sharp ridges cropping out on soil covered interfluves. Outcrop poor.	Areas 5 km wide extending northwards from 16 km E. of Collia Waterhole	Conformable with Waterbag Formation above and Stray Creek Sandstone Member below.
			BULDIVA SANDSTONE: Stray Creek Sandstone Member	Bty	180 m	Green to purple, flaggy to fissile, thin-bedded coarse siltstone and fine-grained sandstone. Glauconitic and micaceous commonly. Coarser sandstone near base. Current lineations and skip casts	Softer beds form low relief areas - gentle slopes and low rises. Harder beds form hills with moderately steep slopes.	A belt 5-13 km wide extending northwards from 10 km NW of Collia Waterhole	Conformable with Hinde Dolomite above and Depot Creek Sandstone Member below.
			BULDIVA SANDSTONE: Depot Creek Sandstone Member	Bto	300 m to 600m	White to red-brown, flaggy to massive, thin to medium-bedded, poorly sorted quartz sandstone. Pebble beds. Induration common.	Forms cliffs. Cap rock for plateaux. Also forms cuestas where steeply dipping. Rivers commonly cut gorges in this unit.	NNW trending zone north of Collia Fault on Fergusson River Sheet area. Small outcrop in NE part of sheet	Conformably overlain by Stray Creek Sandstone Member. Unconformably overlies granites and Noltenius Formation

except the Dorisvale Fault to the east involve a downthrow of the block and it appears that the basin was formed by the depression of this block. The units deposited in the basin are the Bullita Group (carbonates and siltstone), the Wondoan Hill Formation (silty sandstone) and the Auvergne Group (sandstone, siltstone and minor carbonates). The Auvergne Group rests on the Wondoan Hill Formation and Bullita Group with a low-angle unconformity. The Wondoan Hill Formation has a similar relationship to the Bullita Group.

Tolmer Group (Table 2f).

The Tolmer Group consists of carbonates, sandstone and silt- stones which crop out in the north of the Fergusson River 1:250,000 Sheet area. They unconformably overlie units of the Pine Creek Geo- syncline and are unconformably overlain by the Antrim Plateau Vol- canics. Their age is therefore Adelaidean or Carpentarian and they may be equivalent to part of the Victoria River Basin sequence although no contacts have been seen. It is also possible that they are equiva- lent to the Fitzmaurice Group. Outcrop of the group is confined to the margins of the Daly Basin and it is possible that it is of late Adelaidean age, having formed in the basin which also contains Palaeozoic sediments. The group does not lie on the Sturt Stable Block and is moderately folded and faulted.

Antrim Plateau Volcanics (Table 2g)

The Antrim Plateau Volcanics occupy a north-northwest-trend- ing belt in the east of the survey area. They are basic extrusive rocks believed to be of Lower Cambrian age, and are the northern part of a very extensive volcanic province. The volcanics are unconformably overlain by the Daly River Group and unconformably overlie the Pre- cambrian.

Daly Basin (Table 2g)

The Daly Basin is a northwest-trending shallow sedimentary basin which occupies the eastern half of the Fergusson River 1:250,000 Sheet area. It contains about 300 metres of Middle Cambrian to Ord- ovician sediments, mainly carbonates, known as the Daly River Group. Data obtained in the recent gravity survey suggests that the basin started to form in Precambrian time.(Whitworth, 1969).

Bonaparte Gulf Basin (Table 2g)

The Bonaparte Gulf Basin is a deep sedimentary basin which occupies the western part of the survey area and much of it is covered by the sea. It contains thick deposits of Palaeozoic to Mesozoic sediments represented at the surface by the Permo-Triassic Port Keats Group. Although the Moyle River Fault is the obvious structural margin of the basin, the sediments overlap the Precambrian rocks for at least 50 kilometres to the east.

Mullaman Beds (Table 2g)

Scattered outcrops of Mullaman Beds occupy a belt which runs north-west across the survey area. It consists of a thin layer of Cretaceous sandstone and siltstone which lies unconformably on all other units in the area apart from the Cainozoic. The unit is flat lying and crops out as a capping on extensive plateaux and small mesas. Laterite is very commonly developed on the surface.

Cainozoic (Table 2h)

Soil and alluvium are abundant throughout the area, particularly on the coastal plain, in the Daly River Basin, and in the large valleys in the Victoria River Basin.

TABLE 2(g) : MESOZOIC AND PALAEOZOIC STRATIGRAPHY

ERA	PERIOD	GROUP	ROCK UNIT	MAP SYMBOL	THICKNESS	LITHOLOGY	PHYSIOGRAPHIC EXPRESSION	DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS
MESOZOIC	LOWER CRETACEOUS	PORT KEATS GROUP	Mullaman Beds	Klm	Up to 30 m	Freshwater and marine sandstone, siltstone and conglomerate	Forms a flat capping on plateaux and mesas	The same as the laterite (see above)	Unconformable on all older rocks
MESOZOIC	TRIASSIC	PORT KEATS GROUP	Undifferentiated Triassic	R T+R		Micaceous sandy siltstone, sandstone, shale	Low hills	Southeast of Port Keats Mission	Conformable on Permian
PALAEOZOIC	PERMIAN	PORT KEATS GROUP	Undifferentiated Permian	P	About 2000 m	Conglomerate sandstone, siltstone, limestone	Low hills	Along coast line and southeast of Port Keats Mission	Unconformable on pre-Cambrian
PALAEOZOIC	CAMBRIAN TO LOWER ORDOVICIAN	DALY RIVER GROUP	Ooloo Limestone	Olo	60 m	Silicified limestone, cherty in places	Karst topography	Along Daly River on Fergusson River 1:250,000 Sheet area	Conformably overlies Jinduckin Formation
PALAEOZOIC	CAMBRIAN TO LOWER ORDOVICIAN	DALY RIVER GROUP	Jinduckin Formation	Є/Olj	60 m - 135 m	Ferruginous fine to medium-grained quartz sandstone and siltstone with halite pseudomorphs. Some marl; dolomitic and silicified limestone, conglomerate	Mesas and rocky hills to 60 m high	Eastern half of Fergusson River and northeastern corner of Delamere 1:250,000 Sheet areas	Conformably overlies Tindall Limestone
PALAEOZOIC	CAMBRIAN TO LOWER ORDOVICIAN	DALY RIVER GROUP	Manbulloo Member	Є/Olu	60 m	Silicified flaggy limestone	Karst topography	Western edge of Daly Basin on Fergusson River Sheet	Local development of limestone lenses within Jinduckin Formation
PALAEOZOIC	CAMBRIAN TO LOWER ORDOVICIAN	DALY RIVER GROUP	Tindall Limestone	Єnt	150 m	Fossiliferous calcilutite and crystalline limestone with chert nodules and bands; some sandstone	Karst topography	Along margins of Daly Basin on Fergusson River Sheet area and in northeast corner of Delamere Sheet area	Unconformably overlies Antrim Plateau Volcanics, Tolmer Group and Cullen Granite.
PALAEOZOIC	CAMBRIAN TO LOWER ORDOVICIAN	DALY RIVER GROUP	Montejinni Limestone	Єmm	78 m	Limestone, dolomite, calcareous siltstone, mudstone	Karst topography or savannah woodlands	East of Delamere Sheet area	Unconformably overlies Antrim Plateau Volcanics. Equivalent in part to Tindall Limestone
			UNCONFORMITY						
PALAEOZOIC	CAMBRIAN		Antrim Plateau Volcanics	Єla	180 m	Fine and medium-grained basalt. Some vesicular layers. Interbedded sandstone, conglomerate chert	Undulating plains, rounded and terraced hills. Sandstone forms small rocky hills	A belt running from near centre of Fergusson River Sheet area to southeast corner of Delamere Sheet area	Unconformable on Precambrian units
PALAEOZOIC	CAMBRIAN		Jarong Conglomerate	Єlj	15 m to 75 m	Poorly sorted boulder conglomerate with granite, volcanic, quartzite and dolomite boulders	Rounded hills up to 75 m. high. Outcrop on slopes commonly very poor	Scattered outcrops north and south of Collia Waterhole. Small areal distribution	Unconformable on Precambrian beds. Commonly conformably overlies L. Cambrian Sandstones.
			UNCONFORMITY						

TABLE 2(h) : CAINOZOIC STRATIGRAPHY

ERA	PERIOD	GROUP	ROCK UNIT	MAP SYMBOL	THICKNESS	LITHOLOGY	PHYSIOGRAPHIC EXPRESSION	DISTRIBUTION	STRATIGRAPHIC RELATIONSHIPS
CAINOZOIC	QUATERNARY		Coastal deposits	Qac		Mud, silt evaporites	Salt flats, generally free of vegetation but with mangroves along coast, rivers and inlets	Forms belts of varying width along coast	Superficial deposit
			Coastal sand dunes	Qcs		Sand, partly stabilized by vegetation	Dunes of very low relief	Along coast	Superficial deposit
			Alluvium	Qs		River silt, sand, gravel	River banks flood plains	Along creeks. Very abundant on coastal plain	Superficial deposit
			Terrace deposits	Qt	up to 15 m	Sand, silt	Flat terraces	Either side of Victoria River on Delamere 1:250,000 Sheet area	Superficial deposit
	UNDIFFERENTIATED CAINOZOIC		Soil	Czs		Residual sandy soils. Travertine, colluvium. Includes some small patches of black soil	Schrub covered plains with low relief	Extensive in coastal plains, overlying granite and metamorphic bodies in north of area, in Daly River Basin and on plateau in east of Delamere 1:250,000 Sheet area	Superficial deposits
			Black soil	Czb		Dark grey, clayey soil	Grassy plains with few or no trees. Clumps of grass produce very uneven surface	Mostly in a large area along Fitzmaurice River in west of Fergusson River Sheet area. Also in patches over lying Antrim Plateau Volcanics	Superficial deposit
			Laterite	Czl	Up to 6 m	Pisolitic ironstone mostly with large silica content. Underlined by mottled and pallid zones. Some detrital laterite	Thin capping on mesas and plateaux. Quite heavily wooded	Extensive in northeast half of Delamere southwest half Fergusson River and east Port Keats Sheet area	Invariably formed on Mullaman Beds

U N C O N F O R M I T Y

STRATIGRAPHY

ARCHAEAN

Hermit Creek Metamorphics

The Hermit Creek Metamorphics form the Archaean basement west of the Pine Creek Geosyncline. They consist of quartz-muscovite schist, tremolite schist and local amphibolite and serpentinite. Their Archaean age is inferred from structural and metamorphic comparison with the Lower Proterozoic sediments and from the unconformable relationship with the overlying Noltenius Formation.

Derivation of name: The name is derived from Hermit Creek, a north-flowing tributary of the Daly River, on the Cape Scott 1:250,000 Sheet area. Malone and Randal first used the term on the Muldiva Creek 1:63,360 Sheet and a brief account was later included in the Fergusson River Explanatory Notes (Randal, 1962).

Distribution and topographic expression: The metamorphics are limited to an area of about 310 square kilometres in the south-east corner of the Cape Scott area and on the adjoining Port Keats, Fergusson River and Pine Creek Sheet areas. They crop out sparsely as low rounded hills with very subdued relief. The only areas where the unit has high relief are where there is a protective, more resistant capping (e.g. Mullaman Beds in the Dilke Range) or in close proximity to the intrusive Litchfield Complex.

Stratigraphic relationships: The Hermit Creek Metamorphics are faulted down to the west by the Tom Turner's Fault. They are elsewhere intruded by the Litchfield Complex, which causes some degree of contact metamorphism; 29 km east of Tom Turner's Crossing on the Port Keats Sheet area, a quartz-orthoclase-andesine-cordierite-biotite hornfels is well exposed adjacent to and intruded by an adamellite of the Litchfield Complex. The metamorphics are unconformably overlain in the same area by Noltenius Formation (R.N. Walker, pers. comm.).

Permian conglomerate and Cretaceous sandstone unconformably overlie the unit on the Cape Scott Sheet area.

Lithology: The unit consists of schist, granulite and basic igneous rocks. This latter group includes plagioclase-amphibolite, tremolite schist and an altered serpentinite. These are metamorphic equivalents of an ancient ultra-basic to basic suite of rocks. They are undoubtedly not related to the Early Carpentarian Intrusives. The Archaean basement is very similar lithologically to the Tickalara Metamorphics and the Lamboo Complex in the Halls Creek Mobile Belt of Western Australia (Dow et al., 1964). The main rock-type is a ferruginous, quartz-muscovite schist which crops out widely on the Cape Scott Sheet area; a more phyllitic variant is widespread on the Port Keats Sheet area. Under the microscope the muscovite can be seen to be a post-orogenic mineral presumably developed during the metamorphism garnet which occurred after the major folding. The major folding had been accompanied by chlorite-grade metamorphism. Actinolite and tremolite schists crop out in places.

The schist is commonly invaded by pegmatite veins and partly migmatized where it is close to the Litchfield Complex. The pegmatite replaces the softer bands in the schist.

Plagioclase-amphibolite crops out near Hermit Creek on the Daly River - Port Keats track (13°55'S, 130°25'E). It is composed of green hornblende in an equigranular mosaic of labradorite. The rock has a weak foliation and is probably the product of regional metamorphism of a gabbro.

In the Dilke Range several interesting features occur within the metamorphics. At the eastern edge of the range, foliated Archaean mica schist overlies younger migmatites of the Litchfield Complex. The plane of contact dips about 10°S and is parallel to the foliation of the schist. This schist is not strongly contact metamorphosed but contains some granitic lenses. The Archaean here would appear to have been overthrust by a Carpentarian or younger orogenic movement onto the Litchfield Complex.

In the north-west Dilke Range several unusual rock-types were found. Tourmalinized quartz-muscovite schist which weathers very easily crops out close to the Litchfield Complex. A 10 metre band of cordierite-sillimanite-garnet gneiss overlies the schist and dips steeply west. It contains porphyroblasts of garnet and smaller crystals of sillimanite and corundum in a matrix of cordierite.

Biotite (after sillimanite) and chlorite are also present. The gneiss is overlain by monomineralic tremolite schist. A serpentinized and metamorphosed peridotite also occurs in the region. It consists of corroded olivine crystals and picotite, in a matrix of serpentine (replacing olivine and enstatite) and tremolite (replacing enstatite). The peridotite was presumably intruded into the sediments during the primary orogenesis of the Archaean rocks. Granite and pegmatite intrusions are widespread in the north-west Dilke Range.

The Tom Turner's Fault has exerted a marked influence on the structure of the Hermit Creek Metamorphics. Foliations near the fault are generally parallel to it and the rocks show a linear extension or "stretching" near the fault. No folding attributable to the faulting was seen and all the quartz grains are very elongate in the quartz siltstones and silty sandstones.

LOWER PROTEROZOIC

Finniss River Group

Burrell Creek Formation

A small area of the Burrell Creek Formation crops out in the north-east corner of the Fergusson River 1:250,000 Sheet area. It was originally mapped and described by Rattigan and Clarke (1955). In this area it consists mainly of massive cleaved grey-brown medium-grained quartz greywacke, siltstone and phyllite.

In general, the Burrell Creek Formation is similar to the Noltenius Formation and is regarded as a finer-grained lateral equivalent of the Noltenius Formation (Walpole et al., 1968).

Noltenius Formation

Distribution: The Noltenius Formation is a major component of the sediments in the western part of the Pine Creek Geosyncline.

In the area of this report it crops out in the north-west corner of the Fergusson River Sheet area with scattered inliers extending southwards to Collia Waterhole. The outcrop continues westwards into the northeast corner of the Port Keats Sheet area, and elsewhere in this latter sheet area the Noltenius Formation crops out in several widely separated localities. Small outliers occur near Tom Turner's crossing, and a large inlier crops out north-west of Meeway Plain. On the western edge of the Meeway Plain and Koolendong Valley sheared lutites and rudites have been tentatively mapped as Noltenius Formation.

Derivation of name: Hossfeld and others (1937a,b) mapped this formation in the Fletchers Gully, Buldiva and Collia areas and included it in the Muldiva Stage of the Mosquito Creek Series. Later mapping by White and Randal (1955) on the Daly River and surrounding 1-mile Sheet areas delineated the Noltenius Formation and Chilling Sandstone. The name was derived from Noltenius Billabong, north of Daly River Police Station on the Pine Creek Sheet area (Walpole et al., 1968).

Stratigraphic relationships: The Noltenius Formation lies conformably below the Chilling Sandstone and grades eastwards into the more argillaceous Burrell Creek Formation. It was thought by Walpole et al. (1968) to be a transitional lithology between the sandstones to the west and shales to the east. The 1968 mapping, however, showed that typical Noltenius Formation extends westwards onto the Port Keats Sheet area, and does not grade into a coarser lithology as previously thought. The Berinka and Meeway Volcanics are interbedded with the Noltenius Formation. The formation unconformably overlies the Archaean Hermit Creek Metamorphics on the Port Keats Sheet area. It is intruded by the early Carpentarian granites and by several basic igneous bodies. The formation is unconformably overlain by the Moyle River Formation, the Depot Creek Sandstone Member and the Mullaman Beds.

On the Port Keats Sheet area at 130°11'E 14°37'S an angular unconformity between Noltenius Formation and Moyle River Formation crops out.

A similar clear cut relationship between the Noltenius Formation and the Depot Creek Sandstone Member may be seen at two localities on the Fergusson River Sheet area. At 130°46'E 14°8'S white to red blocky, friable, pebbly quartz sandstone, dipping 20° NNE, overlies massive, indurated, unsorted sandstone and greywacke dipping 75°SW. Further south near Collia Waterhole at 130°57'E 14°21'S red massive, friable sandstone with a thin basal quartz conglomerate dips gently north-east over a sequence of foliated quartz greywacke and siltstone dipping 45°SW.

Lithology and thickness

The Noltenius Formation is a sequence of metamorphosed siltstone and greywacke which has been estimated from aerial photographs to reach 4,100 metres in thickness in the north-west part of the Fergusson River Sheet area. This figure may be high, due to possible repetition of beds by folding, and faulting. The actual thickness may be as little as 1500 to 1800 metres.

North-west of Meeway Plain on the Port Keats Sheet area, the formation is represented by a large thickness of uniformly red-purple, poorly-bedded siltstone, with bands of grey slate and sheared pebbly sandstone. The rocks are intruded by the Koolendong Granite and have a marked regional cleavage which strikes 030° and dips 85° east. The bedding ranges from 10°E to about 70°E suggesting that the rocks lie on the eastern flank of an anticline.

On the western margins of the Koolendong Valley and Meeway Plain for over 8 kilometres north and south of the Fitzmaurice River a sequence of highly deformed rocks crop out. Spotted schist and grey-green phyllite are commonly interbedded with sheared volcanics. Chevron folds and B lineations are common. North of the Fitzmaurice River these rock types contain 6 metre thick bands of conglomerate. The conglomerate contains many good examples of stretched pebbles, (Fig. 5,6). The pebbles approximate to a prolate ellipsoid with their long axes averaging 8 cm to 10 cm long, but in places reaching up to 30 cm in length. The plane of elongation of the pebbles is parallel to the regional cleavage and schistosity. The pebbles are mostly quartzitic and lie in a gritty, silty, poorly-sorted schistose matrix.

Near the Muldiva and Buldiva mines the rock types are grey-green phyllite with interbedded thin fine-grained sandstone. The rocks have a regional cleavage of 110°strike, 80°N dip.

A similar structural situation occurs at Fletchers Gully where gold has been mined from small quartz veins which are abundant around the nose of a north-westerly plunging anticline. The cleavage in the phyllite, greywacke, schist sequence is strike 115, dip 85°N.

The Noltenius Formation crops out extensively around the northern margin of the Soldiers Creek Granite; large xenoliths occur within the granite. The rocks near the granite show a higher degree of metamorphism than elsewhere. At 14°20'S 130°48'E there is a large outcrop of quartz-sericite schist in which andalusite (in the form of chiastolite) and garnet have been replaced by sericite and pyrophyllite. The suggestion of retrograde metamorphism is very common throughout the Noltenius Formation. Further north at 130°47'E 14°15'S quartz-muscovite schist is exposed close to the granite. Under the microscope sericite can be seen to have replaced syntectonically rotated porphyroblasts of garnet. The porphyroblasts are in a matrix of equigranular unstrained quartz and optically orientated muscovite flakes. Accessory biotite and later tourmaline are also present. These examples suggest regional metamorphism during folding to a garnet-grade and later retrograde metamorphism associated with the intrusion of the granite.

A well defined band of greywacke, conglomerate and phyllite crops out along Allia Creek about 10 kilometres south-east of Fletchers Gully. The beds consist of massive turbidites with thin bands of interbedded phyllite and conglomerate. The conglomerate consists of quartz pebbles in a greywacke matrix. The greywacke itself consists of angular unsorted grains of quartz and feldspar in a matrix of clay minerals, sericite, quartz and biotite. Larger biotite crystals are aligned within the rock and are probably of metamorphic origin. Some recrystallization of quartz has occurred. Megascopically the greywacke shows the features of a typical turbidite (Fig. 7). The greywacke falls into the feldspathic greywacke class (Pettijohn, 1957).

A sequence of poorly sorted, bedded, haematitic, clayey sandstone is exposed in the north-east corner of the Port Keats Sheet area. The sandstone is massive to flaggy and banded in places.

Fig. 5. Sheared conglomerate in Noltenius Formation. Bank of Fitzmaurice River on western margin of Koolendong Valley, Port Keats Sheet area. Neg.GA/1191.

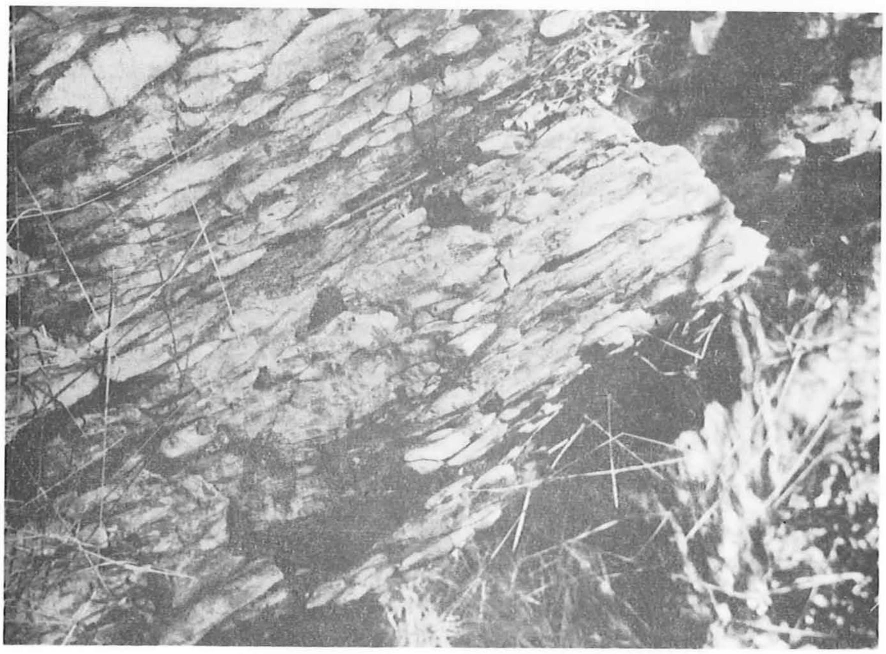


Fig.6. Sheared conglomerate in Noltenius Formation at same locality as Fig.5. Neg.GA/1168.

Fig.7. Turbidite unit within Noltenius Formation showing graded bedding, bottom structures, included boulders and a cleaved fine-grained shaly top. Allia Creek 10 km south-east of Fletchers Gully mine, Fergusson River Sheet area.
Neg. GA/1469.

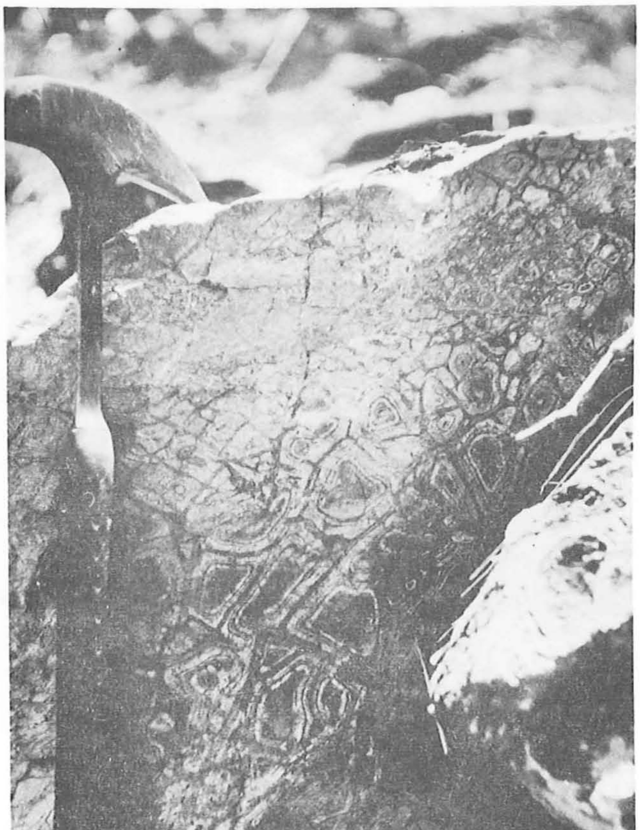


Fig.8. Polygonal (?shrinkage crack) structures in acid lavas of the Berinka Volcanics 30 km east of Tom Turners Crossing (Port Keats Sheet area). Neg. GA/1429.

It may represent a transitional phase between Noltenius Formation and Chilling Sandstone.

Distinguishing features: The Noltenius Formation is a medium to dark toned, photogeological unit with fairly high relief. Some of the more arenaceous bands show up as lighter-toned units. The formation is distinctive by virtue of its stratigraphic relationships and lithology. Although similar to the Hermit Creek Metamorphics in places, the Noltenius Formation shows a lesser degree of folding and metamorphism, is more phyllitic, less weathered and shows a more consistent regional cleavage. The mineral assemblages in the Noltenius Formation are commonly characteristic, andalusite being virtually restricted to this unit. The presence of greywacke, conglomerate and sandstone bands is also diagnostic.

Palaeogeographic significance: The Noltenius Formation was deposited in a deep water, probably reducing, environment close to the continental slope. It is a marine deposit as shown by the dominance of lutites and associated greywackes in the sequence. Walpole et al. (1968) suggest that the unit was deposited largely by turbidity currents in an environment intermediate between shelf and deep water facies. However, no evidence of a westwards transition to shelf facies was discovered during this survey.

Berinka Volcanics

Distribution: The Berinka Volcanics crop out in two principal areas.
(a) North-west corner of Fergusson River Sheet area acid volcanics crop out in an irregularly shaped area of rugged hills thirteen kilometres west of the Fletchers Gully mine. They consist of tuff, agglomerate, metarhyolite, highly altered sperulitic acid volcanics and amygdaloidal intermediate flows.

The volcanics are in contact with siltstones of the Noltenius Formation and are probably interbedded with them. In the northwest of the area they are separated from an outcrop of gabbro by a granophyre which has been included in the Ti Tree Granophyre.

(b) North-east corner of Port Keats Sheet area acid extrusives and what appear to be their high-level intrusive equivalents crop out.

The extrusives form a belt about 11 kilometres long and one kilometre wide within outcrop of the Noltenius Formation and Chilling Sandstone. The stratigraphic thickness is about 850 metres. Outcrop is poor and the unit forms a prominent valley between hills of sandstone and greywacke. The volcanics are separated from sandstone of the Noltenius Formation to the northwest by a fault and are overlain to the southeast by siltstone, sandstone and greywacke of the Noltenius Formation. Cretaceous sandstone overlies them to the southwest.

Lithology: The volcanics mainly consist of a medium or dark grey or grey-green crypto-crystalline rock most of which contains subhedral phenocrysts of quartz and feldspar and black blebs of chlorite.

Towards the southwest end of the outcrop some of the rock shows well defined polygonal structures on weathered surfaces. These consist of ridges standing a few millimetres up from the main body of the rock: they are in the form of irregular polygons with curved sides and rounded corners and are up to 15 cm wide. (see Fig. 8). It is probable that these are shrinkage cracks formed while the lava was cooling.

The volcanics contain interbeds of sandstone up to three metres thick, as well as several beds of haematite up to 15 cm thick.

Most of the thin sections examined were of porphyritic acid lavas. No evidence of shard structures were seen. The groundmass is cryptocrystalline and light brown. It is composed of very small radiating aggregates of devitrified glass. Phenocrysts are of quartz, plagioclase, alkali feldspar, augite and chlorite.

The quartz phenocrysts which are up to two millimetres in diameter, are either anhedral or are bipyramidal with considerably embayed margins. The plagioclase varies from oligoclase to andesine (An_{30} to An_{35}) and is very heavily sericitised. The grains are subhedral and up to 2 mm in diameter. In some sections the twin lamellae are very poorly developed. The alkali feldspar is microperthitic orthoclase somewhat sericitised and euhedral or subhedral.

The proportion of phenocrysts of plagioclase to those of alkali feldspar is as great as 10:1. Some sections contain augite which forms up to 10 percent of the phenocrysts. Irregularly shaped aggregates of chlorite are also common. One section consists of angular chunks of brown volcanic glass with perlitic cracks, and ragged and angular grains of feldspar, chlorite, quartz and augite, set in a fine groundmass, the texture of which flows round the larger particles.

In thin-section the polygonal lines in the rock (Fig. 8) consist of lines of cracks but they do not have a noticeably different composition from the main body of the rock, they are, however, slightly pinker and may be a little more weathered.

Intrusive rocks: The sandstone of the Noltenius Formation to the northwest and stratigraphically below the extrusives contains at least three separate sills of acid intrusives which are most probably high-level intrusive equivalents of the volcanics. Their appearance is very different from that of the Ti Tree Granophyre.

The sills are up to 75 metres thick and 5 kilometres long. They are conformable with the bedding over most of their length but are transgressive in places. The intrusive rock becomes noticeably finer grained towards the contact with the sandstone. The sandstone at the contact is hard and indurated.

The rock is medium to fine-grained, and grey with red-brown patches. Thin sections show the rock to be severely altered. The groundmass consists of fine sericite replacing a medium-grained mosaic of quartz and feldspar. Phenocrysts of feldspar are subhedral, up to 2 mm long and considerably sericitised. The most common type of phenocryst however, consists mainly of iron oxide with a little quartz; its shape suggests that it may replace feldspar phenocrysts.

Meeway Volcanics (New name)

Introduction: The Meeway Volcanics is the name given to a number of outcrops of Lower Proterozoic acid volcanics and rocks suspected of being acid volcanics. These crop out near the southeast corner of the Port Keats Sheet area. The four main outcrops are described separately.

(a) In the northwest corner of the Meeway Plain the volcanics cover about ten square kilometres. The eastern part consists of acid lavas; to the west, the lavas are apparently underlain by a tuff which becomes more sandy towards the west and grades into a clayey sandstone. The boundary is drawn at the scarp which separates the sandstone plateau from the rugged hills of tuff to the east. The lavas are bounded to the east by the Victoria River Fault which separates them from rocks of the Auvergne Group.

The lavas form high massive tors with good but quite deeply weathered outcrop. The tuff on the other hand forms rugged and more angular hills with less outcrop.

The stratigraphic thickness of the tuff is about 650 metres. The dip of the lava flows is not clear but assuming the dip of 60^{o} in the tuffs is maintained to the east this would give a thickness of about 1000 metres for the lavas.

The lavas consist of phenocrysts of anhedral to euhedral quartz and pink and green feldspar up to three mm long set in a fine red-brown matrix. Thin section shows the subhedral bipyramidal and embayed nature of the quartz. Most plagioclase phenocrysts are very sericitised. Only very few of the phenocrysts are of alkali feldspar. The groundmass is fine grained and consists of quartz, feldspar and minor chlorite. Immediately to the west of the rhyolite the rock which is suspected of being a tuff is brown or speckled grey-brown. It has a regular flaggy to massive parting and is fine to medium grained. In thin section the rock consists of rounded and angular fragments up to 3 mm long of fine-grained material consisting of quartz, feldspar, opaque minerals and sericite. Some of the fragments show a color banding. They are set in a groundmass similar to the material forming the fragments but coarser grained and with less opaque material and more sericite.

Further to the west the rock becomes progressively more typical of a sandstone. At the boundary with the underlying Chilling Sandstone it is blue-grey, blocky, fine grained, and with a high proportion of soft clay material. It consists of well separated angular-quartz grains (0.1 mm), opaques, tourmaline, and muscovite, in a matrix of fine sericite.

(b) Along the western side of Koolendong Valley and extending 10 kilometres to the south of the Fitzmaurice River volcanics form low rugged outcrops. They are difficult to distinguish from the other rocks in this area (mainly gritty sandstone or greywacke probably belonging to the Noltenius Formation) as they have been heavily sheared and altered.

They are fine-grained red-brown or green-grey rocks with small quartz grains visible in places. A thin section of one specimen showed euhedral to anhedral grains of sericitised plagioclase, and quartz which shows some evidence of the bipyramidal form and of embayment. These grains are contained within rounded blebs of quartz crowded with fine sericite: the quartz is in optical continuity throughout all or most of each bleb. The blebs are surrounded by a groundmass of fine quartz, opaque minerals, green chlorite and possibly feldspar. The acid volcanic nature of the rock is deduced from the euhedral form of the quartz and feldspar and the shape and embayment of the quartz.

Thin sections of other specimens are too sheared to retain evidence of their volcanic nature, but in hand specimen they are similar in appearance to the rock described above.

(c) In an area 11 kilometres west of the north-western corner of the Meeway Plain a belt of Chilling Sandstone about 1.5 kilometres wide strikes north-northeast. Rocks which resemble tuffs crop out at the base of the scarp which flanks the western edge of the belt. Another small outcrop of tuffaceous-looking rock was found at the southeast corner of the belt close to where it is overlain by the Moyle River Formation. The western outcrop has a stratigraphic thickness of about 60 metresand lies between the Noltenius Formation and Chilling Sandstone. The eastern outcrop appears to lie within the Chilling Sandstone.

The rocks are hard, purple-grey and flaggy or massive. They are fine to medium grained and muscovite rich. In places thin bedding is well defined by alternating bands of purple-brown and grey.

The rocks consist mainly of fine grained, angular quartz and an opaque mineral; ragged muscovite flakes are up to 0.2 mm long; fine sericite is very abundant in patches which in some cases are subhedral and may be pseudomorphs after mineral or rock grains. These rocks resemble the tuffs at the northern end of the Meeway Plain but there is no clear proof that they are of volcanic origin.

(d) 1.5 kilometres north of the Fitzmaurice River and 46 kilometres on a bearing of 125° from Table Hill a severely sheared and altered rock crops out over about eight square kilometres of rugged ground. It is overlain to the east by the Moyle River Formation.

The rock is dark grey-green with euhedral green feldspar grains up to 2 mm long. Thin section shows that it is strongly sheared. It contains euhedral and highly sericitised phenocrysts of feldspar (probably plagioclase) and anhedral phenocrysts of quartz. Alkali feldspar forms smaller rounded and unaltered phenocrysts. The groundmass is fine to medium grained and is of quartz, sericite, muscovite and chlorite.

Chilling Sandstone

Distribution: On the Port Keats and Fergusson River Sheet areas the Chilling Sandstone covers approximately 500 square kilometres. On the Fergusson River Sheet area the sandstone crops out in the northwest where it overlies and is faulted down against Noltenius Formation. This outcrop continues onto the north-east corner of the Port Keats Sheet area to a limited extent, but the major area of outcrop in the Port Keats Sheet area lies immediately northwest of the Meeway Plain. Much of the area previously mapped as Chilling Sandstone on the Port Keats Sheet area has now been assigned to the younger Fitzmaurice Group. Conversely on the Fergusson River Sheet area, south of the type area, a large area previously mapped as Depot Creek Sandstone Member has been assigned to the Chilling Sandstone.

Derivation of name: The name is derived from the headwaters of Chilling Creek on the Fergusson River Sheet area, where the sandstone is well exposed. This region has been designated the type area for the formation (Walpole et al., 1968). The unit was formerly included by Hossfeld and others in the Muldiva Stage of the Mosquito Creek Series (Hossfeld 1937a,b). It was first named and mapped by White and Randal (1955) on the Muldiva Creek 1-mile Sheet area. Walpole et al., (1968) give an account of the unit within the Katherine-Darwin region. The following notes are additional to their information.

Stratigraphic relationships: The Chilling Sandstone is the youngest unit in the Lower Proterozoic succession in this region. It conformably overlies the more argillaceous Noltenius Formation and is considered by Walpole et al. (1968) to be in part a lateral facies change of it, in the type area. Mapping in 1968 showed that the vertical relationships were correct but that the lateral change may be merely a local effect. Noltenius Formation was found to crop out beneath the Chilling Sandstone at its western boundary of outcrop and although correlation of actual beds is impossible due to faulting and lack of marker bands, there does not appear to be any strong evidence for a major lateral facies change.

In the north-east of the Port Keats Sheet area acid and basic igneous rocks (Litchfield Complex, Ti-Tree Granophyre, etc.) intrude the Chilling Sandstone in the form of sills, bosses, etc. Further south acid tuffs and lavas of the Meeway Volcanics are interbedded with the unit. The sandstone is intruded by several early Carpentarian granites (Soldiers Creek, Koolendong) and hence its age is thought to be Lower Proterozoic.

The Chilling Sandstone is unconformably overlain by sandstone of the Moyle River Formation and by the Mullaman Beds. Several contacts of the unit are faulted, especially those with the Litchfield Complex.

Lithology and thickness: The Chilling Sandstone is mainly a white, blocky to massive, silicified medium-grained quartz sandstone which may be termed an orthoquartzite. Some feldspathic sandstone crops out on the Port Keats Sheet area. About 4800 metres of the formation crops out immediately south of the type area. It is difficult to assess thicknesses in other areas as faulting and erosion have complicated the general picture.

The sandstone exhibits moderate to good sorting of grains, and commonly has a minor feldspar content. Shallow water sedimentary structures such as interference ripples, cross bedding and, more rarely, pebble bands are present. Silicification has commonly transformed the rock into a true metamorphic quartzite in the more southerly outcrops, removing all traces of original structure.

Walpole et al., (1968) report gradation between the Noltenius Formation and the Chilling Sandstone in the Fletcher's Gully area. In this area in 1968 we noted sandstone beds within the upper parts of the Noltenius Formation, and a very small thickness of poorly outcropping transitional beds which consist of silty sandstone and interbedded sandstone and siltstone.

The sandstone is commonly brecciated and extensively jointed. Faulting is very common within the formation, which appears to have acted as a brittle unit during deformation. Compression has, however, caused some large-scale open-fold structures such as the southerly plunging syncline in the type area. Steep dips are common within the formation.

Outcrop of the contact with intrusive bodies is common near the contact; the sandstone has been completely recrystallized to a simple equigranular mosaic of quartz grains (annealed texture). Addition of feldspar and biotite has occurred within a metre or so of rock adjacent to the contact.

Distinguishing features: The Chilling Sandstone is a light toned, high relief, bedded photogeological unit showing prominent jointing in places. It is commonly steeply dipping and forms plateau areas with steep bounding scarps. Several steep gorges are cut in the formation. The consistent nature of the lithology over a wide area is diagnostic. The stratigraphic position of the unit is also a distinctive feature. The interbedded tuffs and lavas characterize this formation northwest of the Meeway Plain.

Palaeogeographic significance: The Chilling Sandstone represents the last known sedimentation in the Lower Proterozoic. It signfiies a shallowing of water with the accomapnying change in facies from a deep-water environment, in which shales and greywackes were deposited, to an active, shallow water, shelf environment, in which clean, uniformly graded sandstone was deposited, and the sandstone was probably derived from the west since it is developed on the western side of the geosyncline.

This extremely thick sandstone formation was probably the source of much of the more mature sandstone material present in later Carpentarian and Adelaidean sequences.

Henschke Breccia

Distribution and derivation of name: The Henschke Breccia is known only from an area of about 20 square kilometres near Henschke Falls in the north of the Port Keats Sheet area.

Type area: The type area is at Henschke Falls (Lat. 14°11'S, Long. 130°11'E). No type section was measured because no complete sections of the formation are known.

Stratigraphic relationships: It is best exposed between Henschke Falls and a south trending fault about 2.5 kilometres west of the falls. At this locality steeply dipping Henschke Breccia is overlain with marked angular unconformity by basal conglomerate of the Moyle River Formation (Fig. 9 & 10). Such basal conglomerates have been seen only near the Henschke Breccia, and have obviously been derived from it. The resulting similarity in appearance of the two formations makes it almost impossible to distinguish between them further east where the unconformable relationship is not apparent. The mapped limits may therefore not be entirely correct.

The relationship between the Henschke Breccia and other formations older than the Moyle River Formation is unknown. The phyllite and granite to the north and east appear to be faulted against the breccia. The phyllite itself is tentatively regarded as Noltenius Formation.

Lithology and thickness: The Henschke Breccia is a formation composed of sedimentary breccia, conglomerate and sandstone.

In the eastern part of its outcrop the breccia is interbedded with white quartz sandstone, and may be 1000 metres thick. The sandstone is not unlike Chilling Sandstone. The breccia also contains at least one interbed of slate and phyllite, and it seems most likely that it is related in age to the Noltenius Formation and Chilling Sandstone. It could be a tongue or lens within either of these formations, or possibly a wedge of coarse clastics along a fault zone active during sedimentation. Alternatively, although the Henschke Breccia is older than the Fitzmaurice Group, it has not been proved conclusively to be as old as the Noltenius and related formations. It could be of intermediate age.

The breccia is medium to extremely thick bedded, and its parting varies from blocky to extremely massive. In some localities there is so little variation in lithology over many metres that bedding cannot be distinguished. Prominent joint sets give a false impression of bedding. Bedding appears to be vaguely graded in the west, but cross-bedding is common in the east. (See Fig. 11).

The rock-types present range from a well-sorted, white, medium-grained quartz sandstone to a dark purple or red-brown breccia with white clasts of quartz and other rocks. It is extremely poorly sorted, with clastic material from clay size through silt and sand sizes to pebbles and cobbles. Most grains are angular to subangular, with rare clasts subrounded.

Quartz is by far the most common detrital component of the rock. It is white, and displays strained extinction in thin sections. Rock fragments include muscovite schist, quartzite, and probable volcanics.

The matrix is composed of quartz, sericite, haematite and limonite. The sericite appears authigenic, and is presumably the product of diagenetic or metamorphic processes on a clay matrix. Very finely divided haematite throughout the rock gives its characteristic colour. The haematite has weathered to limonite in most specimens.

Fig.9. Strongly jointed Henschke Breccia overlain unconformably by basal conglomerate of the Moyle River Formation. 3 km west of Henschke Falls. Neg. 1445.

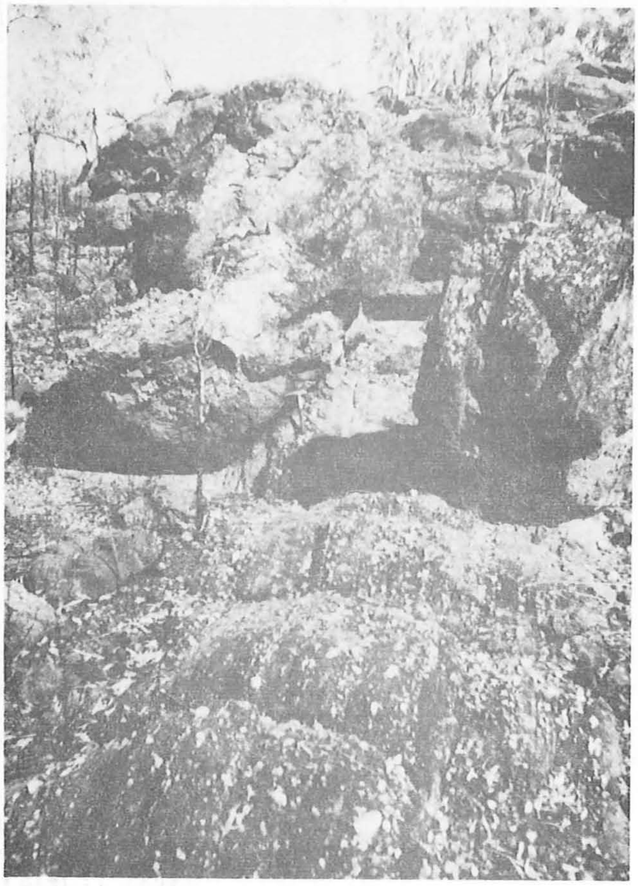


Fig.10. Vertically bedded Henschke Breccia containing prominent quartz clasts with fallen blocks of the overlying Moyle River Formation. 2 km west of Henschke Falls. Neg.1434.

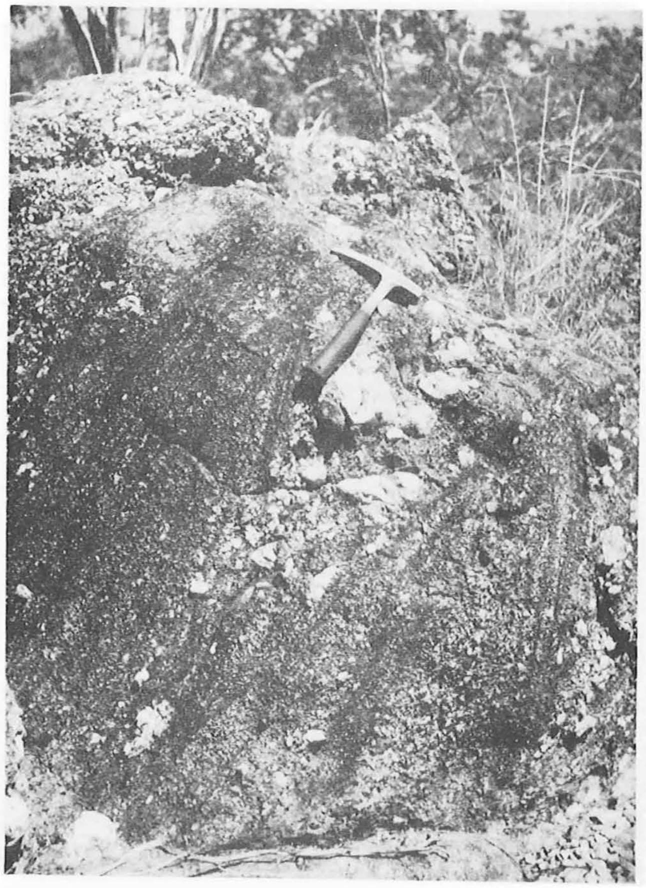


Fig.11. Steeply dipping, cross-bedded Henschke Breccia. Large and small white clasts are quartz. 6.5 km east of Henschke Falls. Neg. 1447.

Distinguishing features: The formation was at first considered to be easily distinguishable because of its massive nature and unusual lithology. However, similar rock types are present in the basal Moyle River Formation, which make the two formations difficult to distinguish except where their stratigraphic relationships are apparent. The boundary between the two units as mapped may therefore not be entirely correct.

Palaeogeographic significance: The unit was laid down rapidly by very strong currents. An apparent source for the quartz are the quartz veins in the Hermit Creek Metamorphics which crop out a few km to the north. Since the stratigraphic relationships are poorly known very little can be said about the geological and structural setting of the depositional environment.

CARPENTARIAN

Basic and Intermediate Intrusive Rocks

Basic and intermediate intrusive rocks crop out in a number of places in the Cape Scott Sheet area and in the northern halves of the Port Keats and Fergusson River Sheet areas. They intrude the Lower Proterozoic sediments of the Pine Creek Geosyncline and evidence suggests that they are older than the early Carpentarian granites.

An age of 1393-1525 m.y. obtained on a sample of gabbro from the Moyle No. 1 well to the west of Tom Turner's Crossing (Page, 1968) must be regarded as a minimum age and probably a metamorphic age.

(a) All the basic rock west of Tom Turner's Crossing is medium-grained quartz dolerite with pigeonite as the main mafic mineral.

Four outcrops of the dolerite are situated to the west of the main sandstone ranges near Tom Turner's Crossing. They range in size from one to five square kilometres.

Outcrop is in the form of low rises littered with dolerite boulders several centimetres in diameter.

The dolerite is in contact with sandstone of the Moyle River Formation and granite of the Litchfield Complex. Most of the contacts between the dolerite and sandstone are faulted. Other contacts are very poorly exposed but it appears that the sandstone is overlying the dolerite. The contact with the granite is also poorly exposed but the granite becomes finer grained towards the contact, suggesting that it intrudes the dolerite. A 1.2 metre-wide quartz vein in the dolerite supports this conclusion.

In hand specimen the dolerite is medium-grained and melanocratic. Thin sections show that the rock has a sub-ophitic texture. Laths of andesine (An_{45}) vary from fresh to quite severely saussuritised; some are enclosed in the anhedral and subhedral grains of pigeonite which is partly altered to iron oxide and a bright green hornblende which in turn has been partly altered to chlorite. Microcline and quartz form about five percent of the rock and are commonly graphically intergrown. Biotite and skeletal or subhedral grains of opaque mineral are accessories.

(b) Outcrops in granite on the northern margins of the Port Keats and Fergusson River Sheet areas.

About twenty square kilometres of basic intrusives crop out on the northern margin of the Port Keats and Fergusson River Sheet areas and a smaller body crops out a few km to the south-west; both these bodies are surrounded by granite.

The rocks form low bounder-strewn hills with limited outcrop.

Contacts with the granite are not exposed but the granite does appear to become finer grained towards the contact.

The most common rock type is a melanocratic medium-grained quartz dolerite with small quantities of opalescent quartz.

A coarse quartz gabbro also occurs and contains mafics up to two and a half centimetres long and feldspar and quartz up to half a centimetre long. Owing to poor outcrop it is difficult to see the relationship between this type and the dolerite but it appears to form irregular and vaguely defined bodies in the dolerite.

Another feature of the dolerite is the presence of straight cross-cutting ridges on the weathered surfaces. These are up to 2 mm wide and are raised a few mm from the main surface of the rock. On a fresh surface they are slightly darker than the rest of the rock. They appear to have formed along joints.

In thin section the rock is similar to the dolerite west of Tom Turner's Crossing but differs in the following ways.

The plagioclase is labradorite (An_{50} to An_{60}) and forms stumpy anhedral or subhedral grains. Alkali feldspar and micro-pegmatite are absent, but there is up to 20 percent interstitial quartz. Most of the pyroxene is pigeonite with varying degrees of alteration to a yellow-brown hornblende, but in one section hypersthene is the only pyroxene. Opaque minerals are rare and they are in small anhedral grains, which are generally associated with minor biotite.

In the material forming the cross cutting bands, the plagioclase is very heavily altered. The pyroxene has been completely altered to hornblende, or else to a mixture of chlorite, biotite and a pleochroic blue-green mineral. In some of the bands the quartz content is twice as high as in the main body of the rock and is as much as 40 percent. The bands seem to be a more highly altered form of the dolerite. The higher quartz content suggests that they have been formed by the migration of siliceous fluids along joint planes in the dolerite. The nearby granite of the Litchfield Complex is a likely source of these fluids.

(c) Diorite intruding Noltenius (and Chilling?) Formations in north-east of Port Keats 1:250,000 Sheet area.

At least two small sills (Up to 30 metres wide and 1.6 km long of medium grained diorite intrude greywacke and siltstone of the Noltenius Formation. The surrounding sediments are hard and indurated within a metre or so of the sills. A small valley following the strike in the Chilling Sandstone in the same area may also be underlain by the intrusive body. The rock is a medium-grained mesocratic diorite. Laths of andesine are heavily saussuritised. The pyroxene is completely converted to a green-brown hornblende, and a little chlorite. Interstitial quartz and skeletal crystals of iron oxide are quite abundant. Calcite is also patchily distributed.

(d) Outcrops north-west of Collia Waterhole.

About twelve square kilometres of gabbro crop out twenty kilometres north-west of Collia Waterhole. It forms low hummocky ground littered with boulders of gabbro and gives a smooth medium-toned photo-pattern. The gabbro probably intrudes rocks of the Noltenius Formation and is faulted against Angalarri Siltstone.

The rock is grey or grey-green, and ranges from mesocratic to melanocratic and from medium to coarse grained. In thin section it consists mainly of plagioclase and amphibole with accessory iron oxide. The plagioclase is quite fresh and is andesine or labradorite and forms subhedral to anhedral grains from 0.1 to 2 mm long. In one section the fine grain size and angular fragments appear to be at least partly due to shearing. The amphibole is a brown hornblende and is considerably altered; grains are up to one millimetre but patches of amphibolite and its alteration products are up to three millimetres long.

(e) Outcrops in south of Cape Scott Sheet area.

Diorite or gabbro crops out sporadically over several square kilometres either side of the Tom Turner's Fault about 20 kilometres westsouth-west of Hermit Hill.

To the east of the fault a small body of gabbro crops out between outcrops of Hermit Creek Metamorphics and granites of the Litchfield Complex. Its relationship to the latter is not known. The rock is medium to coarse grained and melanocratic. Virtually all the pyroxene is converted to amphibole.

Gabbro also crops out in a narrow strip about eight kilometres long to the west of the fault. It is coarse grained and consists of light brown amphibole (75 to 80 percent of rock) and laths of feldspar which are almost completely sericitised. A few small outcrops of deeply weathered schist of the Hermit Creek Metamorphics occur along the western edge of the gabbro. Granite and granodiorite of the Litchfield Complex also crops out to the west of the gabbro but contacts are not exposed. However, a fine-grained gabbro which crops out near one of the outcrops of the Hermit Creek Metamorphics may be a chilled margin of the gabbro. Both the gabbro and its fine-grained equivalent are cut by leucocratic aplite veins up to four feet wide. The most likely source of these veins is the granite of the Litchfield Complex which once again suggests that the gabbro is older than the granite.

(f) Outcrops in the north of Cape Scott Sheet area.

Medium-grained mesocratic dolerite crops out in a northerly trending sill on the western side of Murrenja Hill. The sill is about 400 metres wide and 3 kilometres long. It appears to intrude the sediments forming the hill, but it may be faulted against the sediments to the west and overlain by those to the east. The latter is the most logical explanation since the sediments overlie granite which is thought to be younger than the dolerite.

Ti Tree Granophyre

Derivation of name: The name is derived from Ti Tree Creek in the southeast corner of the Cape Scott Sheet area.

Type area: The type area is on the north-east part of the Port Keats Sheet area, where fresh granophyre forms a number of sills in Noltenius Formation.

Distribution and relationships: The granophyre crops out in several places in the northeast corner of the Port Keats and northwest corner of the Fergusson River Sheet areas.

(a) Fergusson River Sheet area, 14 kilometres west of Feltcher's Gully Mine

The granophyre crops out between the Berinka Volcanics and an outcrop of gabbro, west of Fletcher's Gully. It is in contact with the gabbro but relationships are inconclusive. "At the contact there is a micropegmatitic mixture of gabbro and granophyre and the granophyre is contaminated with gabbro. Field relationships (also) suggest that the granophyre intrudes the gabbro" (Walpole, et al., 1968).

(b) Fergusson River Sheet area, 24 kilometres south-west of Fletcher's Gully.

Granophyre crops out over an area of about 40 square kilometres. It is bounded to the north west by the Chilling Sandstone, to the south-east by what appears to be the Noltenius Formation and is overlain to the south and east by the Cretaceous Mullaman Beds. Outcrop is mostly very sparse and deeply weathered, however, a small area of fresh granophyre crops out in the south-west part of the area, (Grid ref. 418667) near a prominent west-trending ridge. The ridge consists of granophyre with an increased quartz content. The fresh granophyre contains about two percent of disseminated pyrrhotite.

(c) Port Keats Sheet area, 35 kilometres east of Tom Turner's Crossing

The granophyre forms several sills in the Noltenius Formation up to 300 metres thick and ten kilometres long. The total thickness of all the sills is at least 600 metres. No discordant contacts with the sediments were found but photo-interpretation suggests that they may exist.

The granophyre is not considered to be an intrusive equivalent of the Berinka Volcanics since it intrudes sediments overlying the latter. It may however, be associated with the basic rocks, and be a late stage differentiate of them.

Topographic expression: Outcrop is poor and virtually restricted to large loose boulders strewn over hummocky ground. The sills weather preferentially to form valleys in the sedimentary sequence. On air photos they give a similar pattern to the basic sills.

Lithology: The granophyre on the Fergusson River Sheet area is a pink leucocratic to mesocratic medium-grained rock with dark green blebs of chlorite, subhedral quartz and pink and cream feldspar grains. Thin sections show that the plagioclase is zoned and almost completely altered to sericite and epidote. The quartz is granophyrically intergrown with the feldspars. A green-yellow pleochroic hornblende is considerably altered to chlorite. Small grains of iron ore are common. The rock has the composition of adamellite.

On the Port Keats Sheet area the granophyre is a grey mesocratic medium-grained rock with phenocrysts of green plagioclase and black aggregates of biotite both up to half a centimetre long.

In thin section it consists of quartz, microcline, plagioclase, chlorite, relict amphibole, calcite and iron oxide. The microcline forms anhedral to euhedral grains up to 2 mm long and is mostly quite fresh. The plagioclase is andesine and forms subhedral to euhedral grains up to half a centimetre long. It is severely altered to sericite and zoisite. Twinning is rather poorly developed. The quartz forms anhedral pools up to about half a centimetre across. Graphic intergrowths between quartz and microcline are common and form a large proportion of the rock. Anhedral opaque grains and elongated flakes of chlorite containing relict grains of amphibole are common.

No variation in composition or petrology is apparent from thin sections taken at various points across one of the sills.

Litchfield Complex

Introduction: The Litchfield Complex is a large area of acid and minor intermediate plutonic igneous rocks and associated migmatites. It covers an area of 3100 square kilometres and extends from 14°15'S to 12°40'S in a zone about 80 kilometres wide. Walpole et al., (1968) have described the area north of Litchfield homestead in some detail. In the area described in this record the complex crops out along the eastern edge of the Cape Scott Sheet area and in the north-east corner of the Port Keats and north-west corner of the Fergusson River Sheet areas.

Derivation of name: The name was derived from Mount Litchfield, west of Litchfield homestead. The term Mt. Litchfield Granite was first used locally by Hossfeld (1937a) and later extended to cover all the granitic rocks on the western margin of the Pine Creek Geosyncline by Noakes (1949). On account of the diversity in lithology the name was later revised by Malone (1962) and Randal (1962) to Litchfield Complex.

Distribution: A part of the Litchfield Complex crops out over about 520 square kilometres in the north-east and north-west corners of the Port Keats and the Fergusson River Sheet areas respectively. This mass is separated from outcrops on the Cape Scott Sheet area by a belt of Hermit Creek Metamorphics. A small stock of about 2.5 square kilometres crops out within this belt of metamorphics 24 kilometres east of Tom Turners crossing.

In the Cape Scott Sheet area the complex forms a north-south zone about 25 kilometres wide on the eastern edge of the sheet area. Its western margin is the Tom Turner's Fault for much of its outcrop length. Near the Daly River however, granitic rocks crop out west of the fault. The Litchfield Complex is also known to occur below 216 m of Permian sediments in the Cliff Head Bore (Grid ref. 301289). 20 kilometres west of Tom Turners Fault (Grid ref. 301289) (Brown, 19). An isolated zone of granitic rocks crops out west of Murrenja Hill in the northern part of the sheet area.

Topographic expression: The granite crops out as rare isolated hills or tors with large rounded exfoliated boulders up to 12 metres in diameter. The hills have a maximum relief of 180 metres. The migmatite has a more irregular outcrop pattern and the more basic rocks crop out as low rounded knolls. Most of the complex is covered by alluvium or black stony soil. Quartz veins and aplite bodies crop out through the alluvium as marked ridges or low irregularly rounded hills.

Contact relationships: The Litchfield Complex intrudes the Archaean Hermit Creek Metamorphics causing strong contact metamorphic effects for up to 1 kilometre from the intrusion margin. Garnet is well developed in the granite, and associated pegmatites in parts of the metamorphic rocks. Tourmaline is in the pegmatite and schist in close to the intrusive contact. In the East Dilke Range the contact of the granitic complex with Archaean schist appears to be an overthrust.

An intrusive contact between adamellite and a quartz-orthoclase-plagioclase-andesine-cordierite-biotite hornfels derived from the Hermit Creek Metamorphics is well exposed 29 km east of Tom Turners crossing.

The contact between the basic intrusives and the Litchfield Complex was not seen but it is thought gabbro intrusion occurred prior to that of granite. Some hybridization of basic and intrusives has occurred near the contact causing the development of garnetiferous granodiorite. The basic and ultrabasic rocks within the Hermit Creek Metamorphics are undoubtedly intruded by the Litchfield Complex.

The unit is unconformably overlain by the Moyle River Formation and by Permian conglomerate and sandstone. The topographic surface of the Litchfield Complex on which the sediments were deposited was extremely irregular.

Lithology: Granite forms a large part of the exposed outcrop of the Litchfield Complex. The granite shows a range in composition from a true leucocratic biotite granite to melanocratic garnetiferous granodiorite to tonalite.

In the Port Keats and Fergusson River Sheet areas the complex consists of leucocratic and mesocratic coarse and generally even-grained granitic rocks. Mafic xenoliths are ubiquitous and very abundant. The rock becomes noticeably more leucocratic towards the south-west of the area. It is porphyritic in two small areas. One is about 16 km east of Tom Turners crossing, and the other is a stock 24 km east-north-east of the crossing. The phenocrysts are of microcline microperthite; they are euhedral or subhedral, generally about 1 cm long and quite abundant. Blebs of pink garnet (mostly partly converted to biotite) appear to be restricted to the more basic granitic rocks which crop out on the Fergusson River Sheet area.

Examination of thin sections shows that the rock ranges in composition from adamellite to tonalite. It is generally coarse grained with a hypidiomorphic texture. Quartz grains are equant, up to five mm in diameter, and considerably strained. The plagioclase is andesine and ranges from An_{30} to An_{45}; it forms subhedral to anhedral grains which are partially or completely altered to sericite and a little epidote. The grains are commonly zoned. Microcline microperthite occurs both as phenocrysts and in the groundmass. Myrmekitic intergrowth between the plagioclase and alkali feldspar is common. Biotite forms between 10 and 25 percent and muscovite between 5 and 10 percent of the rock. The two micas are commonly intergrown and form flakes up to two mm long. Common accessories are apatite, zircon and iron oxide. Some tourmaline also occurs. It appears that there is a gradation in composition of the rock from the north-east to the south-west. In the north-west corner of the Fergusson River Sheet area and on the eastern margin of the Port Keats Sheet area the rock is granodiorite and tonalite with around 25 percent of biotite; towards the south-west adamellite with 10 to 20 percent of biotite is more common. This trend continues towards the west, the granite around Dawson Hill to the north west of Tom Turners crossing being a true granite and very leucocratic.

Walpole et al. (1968) report an increase in garnet content towards the Hermit Creek Metamorphics and the presence of sillimanite and cordierite near the contact which they suggest indicates possible hybridization with the metamorphics.

In the Hermit Hill - Mount Holder - Nacoolya Hills region of the Cape Scott Sheet area granite and pegmatite are well exposed. The rocks are medium-grained, leucocratic biotite granites and adamellites which occur as massive rounded outcrops with widely - spaced joints. The typical adamellite consists of 35% orthoclase, 25% quartz, 25% plagioclase, 10% biotite and 5% sericite. Preferential replacement of the plagioclase (oligoclase - andesine), by sericite has occurred in the centre of the crystals. Graphic intergrowth of quartz and orthoclase occurs in places.

The granite in the Hermit Hill region shows a distinctive mineralogical banding striking 110° and dipping between 60°S and vertical. Quartz, biotite and rarely feldspar are concentrated in the bands. The quartz is commonly aggregated (aggregates average 5 cm diam.) in zones within the granite. Small rounded biotitic xenoliths are common but in places the xenoliths are very large and show various stages of assimilation by the granite. "Ghost" fold structures from the original schist are now preserved as biotite-quartz bands within the granitic lithology.

In the Mount Holder - Nacoolya Hills area, the granite contains few biotite xenoliths and is a more even-grained leucocratic rock. Banding, dipping 80°NE, is rare but zones of quartz aggregates are common.

The granite cropping out west of Tom Turners Fault is more variable in composition. At 13°49'S 130°16'E extensive outcrops of contaminated granite were seen. Amphibolitic and biotitic xenoliths averaging 12 cm in diameter are common and exhibit reaction rims about 1 cm wide with the surrounding granodiorite. Further east near Tom Turners Fault garnetiferous granodiorite crops out in association with gabbro and Archaean schist.

At Woolbannah and Billawock Hills metamorphosed mesocratic biotite granite and adamellite crops out, commonly with biotite-quartz xenoliths. Some of the smaller biotite xenoliths are the product of the retrograde metamorphism of garnet porphyroblasts. In thin section it can be seen that garnet growth was a late event of granite crystallization with some further retrogression to chlorite in parts. A weak foliation penetrates the rock and tourmaline and quartz veins are common.

In the Elizabeth Downs region the relief is very low and the only visible outcrops are composed of quartz and rarely aplite.

Pegmatites consisting of quartz, feldspar, muscovite and garnet are common throughout the Litchfield Complex. Feldspar crystals commonly reach 75 cm in length, mica crystals 18 cm and tourmaline crystals 60 cm. The pegmatite veins range in width from 15 cm to 12 metres. Three sets may be distinguished: a gentle dipping (10°-15°) north-west set; a conjugate south-east dipping set; and a vertical set with variable strike. Pegmatites commonly form a marginal facies of the granite and also penetrate the Archaean schists in many places.

Much of the Litchfield Complex may be termed a migmatite. On the southern slopes of the Dilke Range and in outcrops directly south of this locality, large and small "rafts" of highly folded reconstituted Archaean schist lie in a mass of quartz, feldspar and muscovite with minor tourmaline and garnet. Ptygmatic quartz veins and flow structures in the quartz and feldspar are common. The migmatite grades into a more orderly pegmatitic rock towards the granite and into a recrystallized schist towards the Archaean rocks. In the recrystallized schist the original structure is still retained but quartz, feldspar and biotite are dominant new minerals.

In the north-east Dilke Range a fine to medium-grained granite intrudes a migmatite complex which in places shows some layering characteristics (i.e. euhedral feldspar crystals up to 15 cm long form definite bands). Archaean schist appears to be thrust over the top of the migmatite, the plane of discontinuity about 10°S. Thin zones of dipping intrusive granite occur within the schist. In the south Nacoolya Hills area migmatization has not been sufficiently strong to obliterate the original foliation of the Archaean(085/75°N). This is preserved in large xenoliths of altered biotite schist enclosed within the migmatite.

The granite to the west of Murrenja Hill on the Cape Scott Sheet area, differs from the majority of the Litchfield Complex in that it crops out extensively, forming tor-like outcrops 6 to 9 metres thick with associated massive boulders. The granite is a leucocratic alkali adamellite. It contains large euhedral phenocrysts of microcline in a matrix of albite, quartz, biotite and hornblende. The albite shows zoning structures.

Xenoliths are abundant throughout the Litchfield Complex. The most common type is mesocratic to melanocratic, fine to medium-grained and spotty due to small blebs of biotite. Some are banded. In thin section they are hornfels ranging in composition from that of granite to tonalite. They are up to 1 metre in diameter and form up to about ten percent of the rock. The formation of xenoliths by a stoping mechanism can be seen at the contact with a hornfels 28 km east of Tom Turners crossing.

Age: The Litchfield Complex has been dated by several methods on the surrounding sheet areas. Rb/Sr whole rock isochron determinations by Leggo give an age of 1760 m.yrs for the intrusion (Walpole et al., 1966). A re-assessment of this data suggests an age of a little over 1800 m.yrs.(Compston & Arriens, 1968). K/Ar determinations give younger ages for the biotites and muscovites in the complex. The

The complex is generally considered to be Early Carpentarian in age.

Soldiers Creek Granite

Derivation of name: The Soldiers Creek Granite was named by Hossfeld (1937a) after Soldiers Creek which flows through the area of outcrop.

Distribution: The main body of the granite occupies an area 24 km long and up to 8 km wide between the Buldiva and Collia tin mines in the north-west of the Fergusson River Sheet area. A separate body of granite covering about 2.5 sq. km. crops out immediately north of the Buldiva mine, and another outcrop of a similar size is situated 13 km west-south-west of the mine.

The granite forms pavements, and ridges and tors up to 30 metres high, which are separated by an uneven and dissected gravel plain. On air photos the granite shows a typical dendritic drainage pattern.

Contact relationships: The granite is unconformably overlain by the Cretaceous Mullaman Beds, the Cambrian Antrim Plateau Volcanics (with a basal conglomerate) and the Depot Creek Sandstone Member. It intrudes rocks of the Noltenius Formation and bodies (probably mostly roof pendants) of this formation are scattered throughout the main area of outcrop. Near contacts with the granite, the latter formation has been metamorphosed to msucovite and andalusite - muscovite schist. The south and east margins of the granite are defined largely by faults.

The granite in the body 13 kilometres to the west-south-west of Buldiva intrudes the Chilling Sandstone.

No radiometric dates have been obtained from the granite but it has the same relationships as the Allia Granite which is dated at 1820 m.y. (Compston & Arriens, 1968).

Lithology: Most of the rock is a coarse-grained leucocratic muscovite biotite granite or adamellite. Much of it is porphyritic with phenocrysts of microcline up to one and a half centimetres long. In places porphyritic and even-grained varieties are intertongued.

In the outcrop 3 km west of Buldiva the granite is coarse and even grained. Veins of it intrude the Chilling Sandstone and blocks of the latter are caught up in it.

Areas of tectonic breccia occur in several places in the granite. In some of the breccias the granite fragments are rounded and the rock has the appearance of a granite containing granite xenoliths. Thin sections, however, confirm that the matrix is intensely sheared and brecciated and is not a solidified liquid phase. The fragments are up to 1 metre in diameter.

Thin sections show that the composition ranges from granite to adamellite. The feldspar phenocrysts are of microcline and are up to one and a half centimetres long. The groundmass is formed of anhedral to subhedral grains of microcline, plagioclase, quartz and biotite. The plagioclase composition ranges from An_{28} to An_{34}. It is generally heavily altered to sericite and kaolin and in many cases is completely converted to these minerals. In a few places it is myrmekitically intergrown with the alkali feldspar. The quartz shows severe strained extinction and is mostly in the form of mosaics of grains of widely varying size with sutured contacts. The muscovite and biotite tend to be intergrown. They form up to about five percent of the rock each but the muscovite is more abundant and forms larger flakes near the greisen zones. The biotite is partially replaced by chlorite and an opaque mineral (probably iron oxide). The cleavage traces of the micas are commonly distorted. Apatite and iron oxide are accessories. The rock has apparently been heavily sheared in most places.

The granite is cut by numerous intersecting veins of greisen. These are generally from a few centimetres up to 60 centimetres wide and are generally straight. They are harder and less weathered than the remainder of the granite and hence stand up from it on weathered surfaces. Where several veins are close together in a swarm they form prominent ridges up to 30 metres high. The veins are formed of fine, white or light grey quartzite which commonly contains large muscovite flakes and in places quartz grains and anhedral pink rotten felspars up to half a centimetre long. Veins of white quartz up to 15 metres wide also occur, but are not very common. Quartz-feldspar-muscovite-tourmaline pegmatites with grain size up to 15 cm are very common at the contacts with the Noltenius Formation and Chilling Sandstone.

Small (1 to 3 mm) grains of black cassiterite occur in areas where the greisens are abundant. The main areas are the tin mines at Buldiva, Muldiva and Collia, but tin is reported to have been found at other positions in the granite. At Collia the tin is within greisens within the granite. At Muldiva and Buldiva, however, it is in greisens which have invaded the Noltenius Formation. Flaky specularite forms pods up to three centimetres long in the greisen veins and in the granite near them. Tourmaline is found in the greisens in the north of the body.

The greisen veins consist of a groundmass of quartz and sericite (and possibly kaolin). Flakes of muscovite up to three millimetres long are abundant in most veins, and relict grains of biotite and somewhat altered alkali feldspar are also found. In the granite in the vicinity of the veins the plagioclase is completely altered to sericite and kaolin but the crystal form of the grains is still retained. This granite also commonly contains patches of the fine quartz-sericite groundmass flowing round the constituent minerals, and represents a transition from the normal granite to the greisen.

In the north-east corner of the granite the greisen veins contain numerous prisms of green tourmaline up to three millimetres long.

The presence of tin and tourmaline and increased muscovite, the alteration of other constituents, and the appearance of the quartz in the groundmass all point to a hydrothermal origin for the veins.

The abundance of greisen, and pegmatite, and the numerous roof pendants of the Noltenius Formation suggest that the granite represents the top of an acid pluton.

Koolendong Granite (new name)

Distribution and derivation of name: Several outcrops of Lower Proterozoic granite, adamellite and granodiorite have been collectively called the Koolendong Granite. The name is derived from the Koolendong Valley, in the southeast of the Port Keats Sheet area. All known outcrops occur in, and adjacent to, this valley and its northerly extension, the Meeway Plain.

Type Area: The type area is the granite outcrop (Lat. 14°58'S, Long. 130°05'E) 16 km. south of the Fitzmaurice River.

Stratigraphic relationships: The Koolendong Granite intrudes the Lower Proterozoic Noltenius Formation and probable Chilling Sandstone. Xenoliths of sandstone occur, and the granite becomes noticeably finer grained towards the contact. Its relationship to the Auvergne Group is unknown, as it is separated from the group by the Victoria River Fault.

Lithology: In the type area granite and adamellite crop out over about 10 sq. km. Fresh, undeformed rock is restricted to a few small flat pavements, and rounded boulders lying on the soil plain. The photo-pattern of the granite area is virtually the same as much of the rest of the plain. Sheared and weathered rock crops out to the west in scarps capped by Moyle River Formation.

Most or all of the pavements are of a mesocratic, biotite granodiorite, but individual boulders up to one metre in diameter and piles of these boulders up to 3 metres across are exclusively of leucocratite adamellite. In some boulders the two types are interbanded. A thin section cut from one of these had alternating bands about one cm. wide with modes very similar to the modes for the two types given above.

Several large boulders of granodiorite contain single sharply defined veins of adamellite up to ½ metre thick. This suggests that the adamellite has intruded the granodiorite. The presence of epidote euhedra in both types suggests that they were derived from the same source.

The granodiorite is laced by a network of quartz and pegmatite veins, these vary from a few mm. to at least ½ metre thick Fig. 12. They are straight or considerably contorted and well defined or vaguely defined and discontinuous. Quartz and pegmatite also form discrete segregations up to ½ metre long, some of these have muscovite rich central zones.

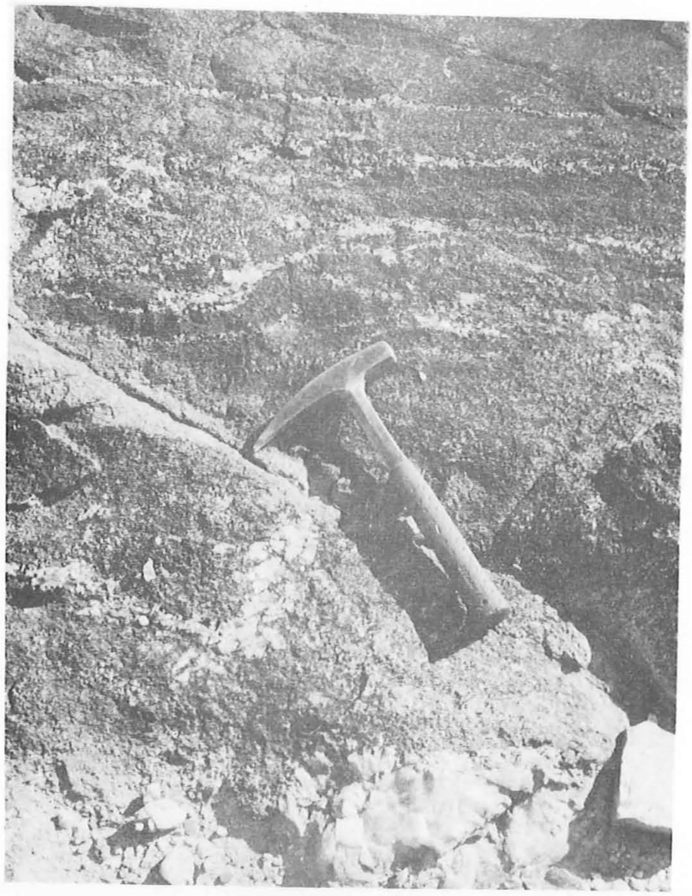


Fig.12. Vaguely defined pegmatite veins in Koolendong Granite; Koolendong Valley, 16 km south of Fitzmaurice River.
Neg. M/1545.

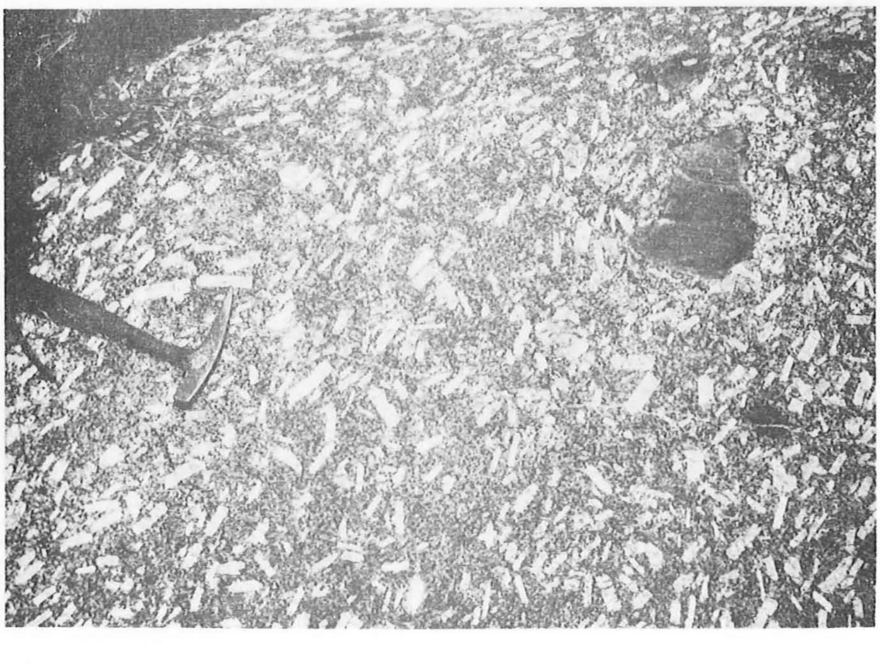


Fig.13. Allia Creek Granite with large microcline phenocrysts, and xenoliths. Near centre of granite body - north-west corner of Fergusson River Sheet area. Neg. GA/1741.

The pegmatites consist of quartz, plagioclase, biotite and muscovite. Some are even grained, others contain euhedral feldspar phenocrysts up to 2 mm. long and muscovite looks of similar size.

Granite crops out on the western side of Koolendong Valley 8 km. south of the Fitzmaurice River. It forms 2 outcrops both in the scarp below Moyle River Formation, and in the northern occurrence in deep creeks in the plains. As in all other outcrops the granite immediately below the Moyle River Formation is extremely altered; fresh granite is found lower in the scarp.

The granite is leucocratic, and of coarse, even-grained texture. A thin section showed that its composition is granite but approaching adamellite. Biotite forms only about 2% of the rock.

The northernmost outcrops border the western side of the Meeway Plain. In the scarp the granite is well exposed but deeply weathered; further west it is very poorly exposed and outcrop is restricted to a few creek beds where it is intensely weathered.

In hand specimen the fresher granite is leucocratic and porphyritic, with ovoid alkali feldspar phenocrysts up to 2 cm, anhedral and subhedral quartz and plagioclase phenocrysts up to ½ cm, and black aggregates of biotite up to 3 mm diameter.

Petrography: In hand specimen the granodiorite is coarse grained, with rare euhedral phenocrysts of plagioclase up to 1 cm long. In places a foliation is defined by an elongation of the quartz aggregates and alignment of the feldspars.

Thin sections show that the texture is hypidiomorphic granular and some signs of shearing are generally evident. Grains are up to 5 mm long. The plagioclase varies from oligoclase to andesine and is partly altered to sericite and epidote. The alkali feldspar is microcline microperthite and this has formed myrmekitic intergrowths where it is in contact with the plagioclase. Grains of biotite, green hornblende and sphene occur separately, and in segregations with magnetite, epidote and muscovite. Small euhedral grains of apatite are ubiquitous.

In many instances the epidote which is not included in grains of plagioclase contains a very well defined six-sided central zone, this is possibly of zoisite but is considerably altered. In some cases the outer epidote zone is the same shape as the inner zone but more often it has anhedral outlines. This six sided zone boundary is similar to the normal epidote-zoisite form. Small biotite flakes are commonly included between the two zones. These grains are up to one mm long and are commonly included in biotite grains.

An average mode for the granodiorite is: quartz 50%; plagioclase 31%, microcline 3%, biotite 14%, epidote 1%; accessory zircon, sphene, hornblende, apatite and muscovite.

The <u>adamellite</u> is medium, even grained; the small quantity of biotite is evenly distributed. In sections it is similar to the granodiorite except that there is no sphene or hornblende, and most if not all the epidote euhedra do not have the central zone of altered zoisite.

An average mode for the adamellite is: quartz 34%, plagioclase 31%, microcline 28%, biotite 5%, muscovite 1%, epidote 1%; accessory apatite and zircon.

In thin section the rocks in the Meeway Plains locality vary from granite to adamellite. Modal analyses for two thin sections are given below.

R68770183 (W222): quartz 49%, plagioclase 11%, potash feldspar 38%, biotite 2%; accessory muscovite, zircon and apatite.
R68770184 (W223): quartz 40%, plagioclase 32%, potash feldspar 21%, biotite 7%; accessory muscovite, zircon and apatite.

The alkali feldspar is microcline microperthite. The plagioclase is andesine, and is very intensely sericitised. The biotite is considerably altered to chlorite.

The groundmass consists mainly of quartz and microcline microperthite which are commonly graphically intergrown.

The absence of migmatites or wide contact aureoles suggest that this is a high level granite.

Cullen Granite

The Cullen Granite forms a large batholith in the centre of the Pine Creek Geosyncline and has been described by Walpole et al. (1968). A small portion of the granite, about 500 square kilometres, crops out in the north-east corner of the Fergusson River Sheet area.

In the Fergusson River Sheet area the granite intrudes rocks of the Burrell Creek Formation and is intruded by the Edith River Volcanics. It consists of two main types. One is a medium-grained and even-grained leucocratic biotite granite. The other is coarse and porphyritic biotite - hornblende granite or adamellite. The phenocrysts are of pink potash feldspar and are up to five centimetres across. The groundmass is of white microcline microperthite, pink or yellow-green plagioclase, quartz, hornblende and biotite with accessory apatite, sphene, iron oxide clinozoisite and zircon.

Two samples of biotite from the Cullen Granite from near the Edith River and near Pine Creek have been dated by Hurley et al. (1961) at 1695 m.y. by the K/Ar method; a check determination by the Rb/Sr method on the Edith River sample gave an age of 1765 ± 90 m.y. Later work by the Rb-Sr method on total rock indicates an age of about 1830 m.y. (Compston & Arriens, 1968).

Allia Creek Granite

The Allia Creek Granite was described by Walpole et al. (1968) and little additional work was carried out during the survey. The following description is taken from Walpole's account.

Derivation of name: The name is derived from Allia Creek, a tributary of Muldiva Creek which runs across the granite.

Distribution and topographic expression: Two bodies of granite have been included in the Allia Creek Granite but only one of these is in the area covered by this record. It is a mass with an area of outcrop of about 50 square kilometres and it crops out 3 km north-west of Fletcher's Gully on the Fergusson River Sheet area.

The granite forms massive exfoliated pavements boulders and ridges up to 5 metres high scattered throughout the soil plane. It also crops out in a scarp which is capped by the Depot Creek Sandstone Member.

Contact relationships: The granite intrudes schists of the Noltenius Formation. At the immediate contact with granite the Noltenius Formation is intruded by veins of aplite and pegmatite and has been metamorphosed to a quartz-microcline-muscovite-biotite-andalusite-sillimanite rock with minor iron ore and tourmaline. Garnet-mica schist, cordierite schist and mica schist have also been found in the contact zone.

The unit is unconformably overlain by the Depot Creek Sandstone Member.

Lithology: The granite consists of medium to coarse-grained grey porphyritic biotite-muscovite adamellite, granodiorite and tonalite, with a pronounced platy flow structure except in the centre where it is very coarse grained and almost pegmatitic. In the adamellite the oligoclase-andesine has been partly replaced by microcline perthite and also contains myrmekitic intergrowths. The microcline forms crystals up to 10 cm long. The biotite and muscovite are intergrown. In the granodiorite and tonalite the plagioclase is andesine - labradorite and biotite is more abundant. A little chlorite, apatite, zircon and iron oxide are present.

The foliation is due to the alignment of the large feldspar crystals and tabular mafic xenoliths which are up to ½ metre long. The foliation is parallel to the margins of the granite and dips steeply towards the centre (Fig. 13).

Age: The granite was dated at 1650 m.y. (biotite) and 1640 m.y. (muscovite) by Hurley et al. (1961). Compston & Arriens (1968) quote an age of 1830 m.y. from total rock Rb/Sr data.

Edith River Volcanics

The Edith River Volcanics form a number of outcrops in the north-east corner of the Fergusson River Sheet area. In all, the outcrops cover about 40 square kilometres. The formation is described by Walpole et al. (1968). The following is an excerpt from that Bulletin.

"Dykes and sills of Edith River Volcanics occur in the Fergusson River area, where they appear to have pierced the Cullen Granite and been extruded as hoods over it. The volcanics are toscanites in this locality. The extrusive rocks have a maximum thickness of 350 feet (105 metres); they are commonly flow-lined and chilled near the base, but the central part is relatively coarse in grain. Some of the dyke rocks are markedly porphyritic. These extrusive and hypabyssal rocks have previously been called "Fergusson Toscanite" (Carter, 1952) - and Fergusson Volcanics (Rattigan & Clarke, 1955)."

Leggo dated samples of the volcanics at about 1750 m.y. (Compston & Arriens, 1968).

ADELAIDEAN AND YOUNGER

FITZMAURICE GROUP

The Fitzmaurice Group is a thick sequence of interbedded siltstone, sandstone, and minor pebble conglomerate. It crops out in a mobile belt 8 to 40 km wide which extends from near the south-west corner of the Auvergne Sheet area, to the south-west corner of the Cape Scott Sheet area. It is entirely restricted to the mobile belt. The sediments are very severely faulted but are not tightly folded except near major faults.

The group has been divided into four formations which from top to bottom are:

Legune Formation
Lalngang Sandstone
Goobaieri Formation
Moyle River Formation

The Legune Formation was previously not incorporated in the group as its relationships to the group on the Auvergne Sheet area were not clear (Pontifex et al., 1968). However, it has been incorporated in the group subsequent to mapping on the Port Keats Sheet area in 1968.

Stratigraphic relationships: The group rests unconformably on Lower Proterozoic rocks of the Pine Creek Geosyncline and is unconformably overlain by Palaeozoic rocks. It is therefore of Adelaidean or Carpentarian age. It has been correlated with the Carr Boyd Group which crops out in the East Kimberley region, and which has been dated at between 1365 and 900 m.y. by Rb/Sr dating on illites (Dow & Gemuts, 1969). The Carr Boyd Group and Fitzmaurice Group have the following similarities:

(a) They are both very thick deposits of sandstone, grit, conglomerate and siltstone. The Carr Boyd Group is about 9,000 metres thick in places.
(b) Black and dark grey shale and siltstone occurs in both sequences especially near the base.
(c) The two sequences are confined to a mobile belt (the Halls Creek (W.A.) and Fitzmaurice(N.T.) Mobile Belt). Outcrops of the two groups are separated by only about 20 km near the Western Australian border.

The Fitzmaurice Group is faulted against rocks of the Auvergne Group and the relationship between the two are not known.

Stratigraphic relationships: Most or all of the contacts within the group appear to be conformable and gradational; however, unconformities are common within the Carr Boyd Group and may also occur in this group. The complete sequence of four formations is present throughout most of the area of outcrop of the group; the Goobaieri Formation is absent in two small areas, onewest of Meeway Plain and just north of the Fitzmaurice River and the other in the southern part of the Macadam Range on the Port Keats Sheet area.

The local absence of the Goobaieri Formation in these areas may be due to nondeposition or an unconformity at the base of the Lalngang Formation. On the other hand it may merely be the result of faulting. It is worth noting, however, that a thick siltstone band which lies in the middle of the Lalngang Formation where it crops out to the north and south of the first point mentioned above, is locally not present at the point. This suggests that the point may have been a fairly stable shelf or ridge which inhibited deposition.

Lithology and thickness: The mobile belt on the Port Keats Sheet area appears to comprise a synclinorium of faulted Fitzmaurice Group. The rocks on the eastern limb are readily identified as Fitzmaurice Group, and total about 3000 m. The sequence in the west limb appears to be over 12,000 m thick. It contains a great thickness of sandstone, and also two major siltstone members which do not occur in the east. However, the sequence has been tentatively differentiated into the four formations recognized elsewhere.

The sandstones to the north of Tom Turners crossing on the Port Keats and Cape Scott Sheet areas are also mapped as Fitzmaurice Group due to the similarity of thickness and rock types to the sequence on the west of the Mobile Belt.

Palaeogeography and genesis: Sediments of the Fitzmaurice Group appear to have been deposited in a mobile trough and on the edge of a stable shelf.

The scarcity of large-scale cross beds, ripple marks and the absence of mud cracks suggest that most deposition offshore with no non-marine intercalations. However, cross bedding and ripple marks are common in the Lalngang Sandstone this and the local absence of the underlying formation suggests that there was a period of uplift around the time of deposition of the Lalngang Formation.

The prevalance of sandstone with a silty and clayey matrix, and siltstone in the west suggest a low energy environment. Stagnant reducing conditions prevailed periodically and gave rise to the black siltstones and shale. No carbonates appear in the sequence.

The high feldspar content in much of the sandstone suggests a relatively close source of supply. Most of the coarser grains are of quartz or quartzite and could be derived from pre-existing sedimentary rocks. No greywackes or volcanics have been found in the sequence.

The type of environment suggested for these sediments in therefore a rapidly subsiding shelf or trough with a close and copious source of sediment.

For the most part sedimentation kept pace with subsidence, with sandstone being deposited. When the sediment supply decreased, or the rate of subsidence increased, water depth increased, and siltstone and shale were deposited in the very low energy environment.

It is probable, that the trough was formed by fault action. The greater thickness of the sediments in the north-west part of the belt suggests that the source of sediment supply was in that direction.

Moyle River Formation

Distribution: The Moyle River Formation crops out along the eastern edge of the mobile belt in the southern half of the Port Keats Sheet area, and there is a small outcrop in the centre of the southern margin of the sheet area. The formation also forms almost the whole of the Macadam Range and its northerly extension on the western side of the mobile belt on the Port Keats Sheet area. The outcrops of sandstone extending north-north-east from Tom Turners crossing on the Port Keats Sheet area as far as the Docherty Hills in the south of the Cape Scott Sheet area probably belong to the Moyle River Formation also. The sandstone and conglomerate forming Murrenja Hill in the north of the Cape Scott Sheet area have been mapped as Moyle River Formation.

Derivation of name: The formation was named in 1968 after the Moyle River on the Port Keats Sheet area (Pontifex, 1968).

Stratigraphic relationships: The formation is the basal unit of the Fitzmaurice Group. It lies unconformably on igneous and sedimentary rocks of the Lower Proterozoic along most of its eastern and northern boundaries on the Port Keats Sheet area. In some places near the Victoria River Fault, particularly in the Koolendong Valley, there has been movement along this unconformity which has sheared and brecciated the base of the Moyle River Formation as well as the underlying rocks.

The formation is overlain by the Goobaieri Formation and the contact is conformable and gradational.

Lithology and thickness: On the eastern side of the mobile belt the formation consists of a monotonous succession of fine and medium-grained sandstones with a few interbeds of siltstone and coarse sandstone and grit; thin pebble beds occur at its base. The thickness ranges from 450 to 1000 metres. On the western side, however, the character of the formation is considerably different. It contains several thick siltstone units and a thickness of 10,000 metres was estimated from air photos and measured dips although this may only be an apparent thickness due to the repeated measurement of the same unit deposited as a series of deltaic foreset beds.

The sequence of sandstone in the ranges north of Tom Turners crossing is also mapped as Moyle River Formation due to its similarity to the sequence south of the crossing. This sequence also appears to be about 10,000 metres thick.

On the eastern side of the mobile belt, the formation consists almost entirely of white, grey, purple-grey or pink sandstone which is blocky or massive with a few flaggy interbeds, thin to thick bedded but mostly thin or medium, and fine to coarse grained but mostly fine or medium grained; sorting is moderate or poor. The sandstone contains up to five percent of a matrix of soft white clay and is slightly friable. A few interbeds up to several centimetres thick consist of grey and purple micaceous siltstone and of coarse sandstone. At the base of the formation interbeds of pebble conglomerate are present in some places. The pebbles are of quartzite and shale and are subrounded. The interbeds are up to 30 cm thick. In the north of the Koolendong Valley sedimentary breccia occurs in isolated patches immediately overlying the granite.

Cross bedding is common and consists of planar units from 2 cm to about 25 cm thick. Ripple marks are also present. The cross-bedding suggests that the sediment was supplied from the north-west.

No sections were measured on the ground and thicknesses have been estimated from air photographs and measured dips. On the bands of the Fitzmaurice River, the formation is 400 metres thick but some may have been removed by strike faulting. In the gorge 30 kilometres north-north-west of the mouth of the Little Fitzmaurice River it is 1000 metres thick and 34 kilometres north-north-west of the mouth it is at least 700 metres thick.

On the western side of the mobile belt south of Tom Turners crossing, the following composite sequence has been estimated.

Overlain by Goobaieri Formation

Thickness in metres	gradational contact
1300	Sandstone: white or red-brown, massive or blocky, thin-bedded, medium and fine-grained, well or moderately sorted, friable, cross-bedded. A few thin shale interbeds.
450	Siltstone: purple, laminated, fissile. Interbeds of white quartz siltstone and very fine-grained sandstone which is fissile or flaggy, and micaceous.
3200	Sandstone: grey to white, blocky to massive, fine to coarse-grained (mostly fine to medium), friable, with small and large-scale cross beds. Interbeds of siltstone and fine sandstone.
450	Siltstone grey and purple, fissile to flaggy.
1350	Sandstone: grey, massive, thin-bedded, fine to medium-grained, some gritty poorly sorted interbeds. Some thin cross-bedded units.
420	Siltstone
3330	Sandstone: grey or light brown, massive, fine or medium-grained, friable. Minor thin lenticular interbeds of coarse sandstone and pebble conglomerate.

120	Sandstone: pink and red-grey massive, thin or thick-bedded, medium or coarse-grained. One or two percent of clay matrix; somewhat friable; thin cross-bedded units. Silty interbeds common. Friable and very poorly sorted coarse sandstone at base
Total 10,620 metres	Underlain by granite

At the top of this succession the formation grades up into the Goobaieri Formation through a series of interbedded sandstone and white siliceous siltstone.

North from Tom Turners crossing to Docherty Hills information is very sketchy but the following composite section has been estimated.

Overlain by Permian and Cretaceous

Thickness in metres	
2440	Sandstone: white or grey-purple, blocky medium-grained with minor coarse interbeds. Mudflakes and ripple marks occur.
1560	Very little outcrop. Probably predominantly siltstone: one prominent band of sandstone in centre of unit.
6000	Sandstone.
Total 10,000 metres	

From 10 to 27 kilometres east of Tom Turners crossing granites of the Litchfield Complex are overlain by a sandstone which most probably belongs to the Moyle River Formation.

The sandstone is pink, massive, thin bedded, medium grained, well sorted and contains well rounded grains. Discontinuous lenses of coarse sandstone up to 15 cm thick are common in the lower part of the sandstone. About 2 metres of conglomerate overlain by 2 metres of coarse sandstone form the bottom part of the formation. The conglomerate consists of rounded and angular cobbles of quartzite in a very poorly sorted sandstone matrix. The coarse sandstone is similar but the maximum size of the grains is only about half a centimetre. About 8 km east of Tom Turners crossing the basal part of this unit consists of a thick sequence of sedimentary breccia. This unconformably overlies the Henschke Breccia which is very similar to it.

Distinguishing features: The sandstone units form ridges and plateaux many of which have flat tops corresponding to the Mesozoic land surface. On air photos the bedding in the sandstone units commonly shows up as a fine black and white banding.

Goobaieri Formation

Introduction and distribution: The Goobaieri Formation was first recognized on the Auvergne Sheet area (Pontifex, et al., 1968). On that sheet it is a thick sequence predominantly of siltstone and fine sandstone. Outcrops of the formation continue north from the Auvergne sheet onto the Port Keats Sheet area, as far as the Fitzmaurice River. The formation does not crop out for at least eight kilometres to the north of the river. Further north, on the east side of the Madjellindi Valley a thick sequence predominantly of siltstone has been mapped as the Goobaieri Formation. On the west side of the Madjellindi Valley the Fitzmaurice Group is considerably thicker and different in character from that on the eastern side. In particular it contains a number of thick siltstone units. One of these consists predominantly of dark grey siltstone which is typical of the Goobaieri Formation in the type area and is therefore tentatively mapped as Goobaieri Formation.

Derivation of name: The formation was named (Pontifex, 1968) after Goobaieri Bay on the Victoria River, on the Auvergne Sheet area (Pontifex et al., 1968).

Stratigraphic relationships: As on the Auvergne Sheet area the Goobaieri Formation overlies the Moyle River Formation and is overlain by the Lalngang Formation. Both contacts are conformable and gradational, though the lower contact is the most abrupt.

<u>Lithology and thickness</u>: The formation consists of interbedded siltstone and fine sandstone with several bands of medium and coarse-grained sandstone in the upper part. The siltstone and fine sandstone is commonly grey and crops out poorly whereas the coarser sandstone is white and forms prominent ridges with good outcrop.

South of the Fitzmaurice River the bulk of the lower part of the formation consists of siltstone with thin interbeds (three to five cm) of fine sandstone. The siltstone is grey or green, fissile or flaggy and laminated. The sandstone is grey, flaggy and laminated.

The upper part of the formation consists of alternate bands of interbedded siltstone and fine sandstone (the sandstone bands are up to 120 metres thick but become thinner towards the top of the formation) and medium and coarse-grained sandstone (bands up to 10 metres thick). The medium and coarse-grained sandstone is white, blocky, thin-bedded, poorly to well sorted, locally micaceous and in many places friable where it contains a few percent of a clay matrix. It becomes coarser towards the top of the formation.

The siltstone is white or light greeny blue, flaggy or fissile, laminated and hard. The fine sandstone is white, flaggy, laminated and micaceous; it becomes more abundant than the siltstone toward the top of the formation.

The following section is of the top 170 metres of the formation measured 13 km north-west of Koolendong yard. At least two major sandstone bands occur below this section but do not crop out at the point where the section was measured.

Overlain by Lalngang Formation

Thickness in metres	
9	<u>Siltstone</u>: interbedded with <u>sandstone</u>. Sandstone is white or light blue-green, flaggy, laminated very fine; mud cracks are common.
3	<u>Sandstone</u>: white, blocky to flaggy, medium-grained well sorted; about two percent kaolinised feldspar.

33	No outcrop. Scree includes ferruginous fissile siltstone, and also sandstone: white, flaggy to fissile, laminated, very fine-grained.
6	Sandstone: white, blocky, thin-bedded, medium-grained well sorted.
108	No outcrop. Scree includes siltstone: red-brown, flaggy and fissile, laminated. Sandstone: white very fine and micaceous.
6	Sandstone: white, blocky, thin-bedded, medium-grained, poorly sorted with about two percent of white clay grains, possibly kaolinised feldspar. Also interbeds of coarse sandstone: poorly sorted with sub-angular to sub-rounded grains.
5	No outcrop.
3	Sandstone white, blocky, thin-bedded, fine well sorted, slightly friable with about one percent of msucovite.
Total 173	soil plain - no outcrop

18 km west of Koolendong yard the thickness of the upper part of the formation (from the lowest prominent sandstone band) was estimated to be about 420 m from air photos and measured dips. The lower part of the formation was estimated to be a minimum of 120 m thick.

North of the Fitzmaurice River on the eastern side of the Madjellindi Valley the lithology of the formation is essentially similar to that south of the Fitzmaurice River. However, the siltstone and fine sandstone is green rather than grey, and the bands of coarser sandstone are not so prominent and are probably fewer. A minimum thickness, of about 700 metres has been estimated for the formation in this region. Thrust faulting has occurred in the region and appears to have taken place within the Goobaieri Formation.

On the west side of the Madjellindi Valley outcrops mapped as Goobaieri Formation are separated from each other by the Chalanyi Creek

Fault. To the west of the fault the following sequence is exposed. Thicknesses are estimated from air photos and measured dips.

Faulted Against Lalngang Formation

Thickness in metres	
90	Grey siltstone
30	Sandstone - white blocky, fine
90	Siltstone: grey, fissile and flaggy, laminated
180	Interbedded siltstone and sandstone. Siltstone: grey or brown, flaggy to fissile, laminated, micaceous. Some is dark grey and slaty. Sandstone: green and grey, blocky, fine to medium-grained, poorly sorted, muscovitic.
240	Siltstone: very dark grey, fissile to flaggy, laminated.
Total 630	Underlain by Moyle River Formation

The top of the Moyle River Formation does not crop out where the section was measured but the photopattern suggests that it consists of interbedded sandstone and siltstone. The contact is therefore vaguer here than it is in other parts of the sheet area.

To the east of the Chalanyi Creek Fault the formation crops out in a belt about 27 km long which trends north-north-east. In the south of the belt the formation consists of an estimated 480 metres of interbedded grey siltstone and fine sandstone. The sandstone is poorly sorted and contains sporadic coarse sand grains, it also contains interference ripples. In the north, on the Moyle River, the sequence is only about 240 metres thick and consists of dark grey-green fissile and laminated siltstone with a prominent band of coarse sandstone in the centre: the sandstone contains sub-rounded quartz grains in a dark green argillaceous matrix.

<u>Distinguishing features</u>: The formation invariably forms well defined valleys. Outcrop of the siltstone and fine sandstone is scarce and

generally restricted to the scarps below outcrops of sandstone. The sandstone bands form prominent ridges in the valleys.

In the field the thick sequence predominantly of grey or green siltstone and fine sandstone between the monotonous sequences of sandstone of the Lalngang and Moyle River Formation is distinctive in most places. Ripple marks including interference ripples are more common than in other units of the Fitzmaurice Group.

Lalngang Sandstone

Distribution: The Lalngang Sandstone crops out extensively in the centre of the mobile belt on the Port Keats Sheet area. It has not been proved that the areas that have been mapped as Lalngang Sandstone to the west and north of Madjellindi Valley do in fact belong to this formation; this is discussed under "lithology and thickness".

Derivation of name: The formation was named after Lalngang Creek on the Auvergne Sheet area (Pontifex et al., 1968).

Stratigraphic relationships: In most places where it crops out the formation is conformably overlain by the Legune Formation and conformably underlain by the Goobaieri Formation, both contacts being gradational. However in the southern part of the Macadam Range the Goobaieri Formation is apparently absent and the Lalngang Sandstone lies directly on the Moyle River Formation. The Goobaieri Formation is also absent just west of Meeway Plain where its absence is probably due to faulting, although it is possible that there is an unconformity below the Lalngang Sandstone.

Lithology and thickness: On the banks of the Fitzmaurice River 40 km south-east of Table Hill the formation consists of interbedded fine, medium and coarse sandstone, minor pebble beds and also siltstone. The sandstone is light grey when fresh but is generally weathered to red-brown: it is blocky or massive, poorly to moderately sorted and thin to thick bedded. Soft green or white grains of clay (possibly altered feldspar) form up to 15 percent of the rock. Cross beds and ripple marks are common. The pebble beds are up to 25 cm thick. The rock is very well exposed and supports little vegetation, it tends to have a black weathering surface.

In the syncline a few kilometres to the east of this exposure the lithology of the formation is similar but it contains bands up to 3 metres thick of thin-bedded to laminated sandstone and siltstone which comprise about five percent of the formation.

The formation grades down into the Goobaieri Formation through a sequence of interbedded siltstone and sandstone. The sandstone is white, blocky, thin bedded and medium-grained. It is interbedded with white siliceous siltstone and fine sandstone. The boundary between the two formations is taken at the top of the uppermost thick siltstone band.

The top of the formation consists of interbedded white medium sandstone and coarse sandstone which grades up into the Legune Formation. The boundary between the formations is an arbitary one and is taken as the point at which the rounded "soft" photopattern of the Legune Formation is first detected.

Several kilometres south of the Fitmaurice River, the rock types are similar but about 450 m from the base of the formation there is a 120 metre thick sequence composed predominantly of siltstone. Due to its soft nature this band is easily recognised in the field and on air photographs. The siltstone is grey, green or red-brown, fissile or flaggy, laminated and slightly micaceous. It is interbedded with finegrainedflaggy sandstone, and also white or brown coarse sandstone. The latter is very poorly sorted and generally has a soft silty matrix.

The band crops out in the centre of the syncline 8 km north-west of the Koolendong Valley. The soft unit forming a small hill 48 km south-east of Swamp Point probably belongs to the same band. The band grades laterally into sandstone between 3 and 11 kilometres south of the Fitzmaurice River.

A minimum estimated thickness of 1500 metres of the formation is exposed in the cliffs either side of the Fitzmaurice River 40 km south-east of Table Hill.

In the north-north-east trending band between the Madjellindi Valley and Meeway Plain the following section is present.

Overlain by Legune Formation

Thickness in metres	
510	Sandstone: white blocky to massive, thin-bedded with alternate beds of medium and coarse grains, very poorly sorted, friable in places with 2-5% soft white clay matrix. Towards the base the sandstone is moderately sorted and medium-grained.
210	Siltstone: purple fissile to flaggy, laminated, with interbeds of blocky and medium to coarse-grained sandstone
510	Sandstone: white, blocky to massive, thin-bedded, medium-grained very poorly sorted with some grains up to half a cm diameter, contains a soft clay matrix.

Total 1230 metres underlain by Goobaieri Formation

The central siltstone unit appears to grade southward into sandstone 13 km north of the Fitzmaurice River. However, the disappearance of the unit may in fact be due to faulting.

West of the Madjellindi Valley the rocks of the Fitzmaurice Group are not typical of the group elsewhere. In this region the rocks mapped as Lalngang Sandstone comprise a sequence of interbedded sandstone and siltstone between the extrapolated upper horizon of the Moyle River Formation and the inferred lower boundary of the Legune Formation. A very roughly estimated thickness of the sequence is 1800 metres. The upper part consists of interbedded fine flaggy sandstone and fissile siltstone both of which are grey-brown, laminated and micaceous. At the base of the formation the sandstone ranges from flaggy to blocky, thin to medium-bedded and from fine to coarse-grained, and is very poorly sorted.

Sandstone to the north of Madjellindi Valley has also been mapped as Lalngang Sandstone. Most of this is overlain by Cretaceous sandstone but it does crop out in creek beds and sporadically in the shallow valleys which the creeks occupy. The sandstone is white, massive or blocky, thin-bedded, medium-grained, moderately to poorly sorted and contains a few percent of a soft white clay matrix.

Distinguishing features: South and immediately north of the Fitzmaurice River the formation forms ranges with very rough surfaces of well exposed sandstone supporting little vegetation. The stepping produced by the bedding gives a characteristic photopattern. On the east side of the Madjellindi Valley the formation forms high rugged ridges while on the west of the valley it forms low hills: in both these areas it supports quite abundant vegetation. To the north of the Madjellindi Valley outcrop is mostly limited to the creek beds which consist of flat sandstone pavements.

In the field the coarse and gritty material is quite characteristic and helps to distinguish the formation from the Moyle River Formation.

Legune Formation

Distribution: The Legune Formation crops out in a belt running from near the southwest corner of the Auvergne Sheet area to the north of the Madjellindi Valley on the Port Keats Sheet area. On the Auvergne and Port Keats Sheets it forms the majority of the northwestern half of the mobile belt south of the Fitzmaurice River. North of the Fitzmaurice River it crops out in the Madjellindi Valley where it occupies the core of a major syncline in the centre of the mobile belt.

Derivation of name: The formation was named (Pontifex et al., 1968) after Legune Station on the Auvergne Sheet area (Pontifex et al., 1968).

Stratigraphic relationships: The Legune Formation is the youngest Precambrian unit cropping out in the mobile belt. On the Auvergne Sheet area where the unit was first recognised the relationships between it and the rest of the Fitzmaurice Group are not entirely clear, but interbedded siltstone and sandstone conformably overlying the Lalngang Sandstone north of Bullo Homestead are thought to be part of the Legune Formation. On the Port Keats Sheet areas also relationships between these units are not everywhere clear.

South of and just to the north of the Fitzmaurice River the Legune Formation is faulted against older rocks of the Fitzmaurice Group. On the east side of the Madjellindi Valley interbedded shale and siltstone of the Legune Formation grade down over a few metres into sandstone of the Lalngang Sandstone. This contrasts with the western side of the Madjellindi Valley where siltstone and shale of the Legune Formation grades down through a thick sequence of interbedded siltstone and sandstone into sandstone. The sequence on the western side is much thicker and considerably different from that on the eastern side. The boundary between the Legune and Lalngang formations has been taken as the point at which the siltstone and shale give way to siltstone and sandstone.

Lithology and thickness: On the Auvergne Sheet area the formation consists of a monotonous succession of interbedded sandstone and siltstone. This type of lithology continues onto the Port Keats Sheet area to a few miles north of the Fitzmaurice River. The Madjellindi Valley is occupied predominantly by interbedded siltstone and shale.

Along the banks of the Fitzmaurice River the formation consists of interbedded siltstone and fine, medium and coarse sandstones. The interbeds of all these types range from a few millimetres to several feet in thickness, and are generally lenticular. The hills are composed predominantly of sandstone and the intervening tidal flats appear to be underlain by a high proportion of siltstone.

The siltstone is grey, white, green or reddish brown; it is fissile, thin-bedded or laminated and generally quite hard. It consists of fine angular quartz grains (0.05 mm) with a matrix of fine sericite and in some specimens, limonite. The bedding is defined by varying amounts of the fine matrix which constitutes as much as 80 percent of some beds. Iron oxide and tourmaline are accessories.

Commonly two types of sandstone are present; a fine or medium-grained type and a coarse or very coarse type with grains commonly 3 mm and rarely up to 10 mm in diameter. Both types are grey, white or light green, flaggy, blocky or massive, thin to thick-bedded, generally poorly sorted and commonly contain up to ten percent of white or light green grains of clay which is possibly a replacement after feldspar.

The sandstone consists of varying proportions of clay, silt and sand grains. In places it is distinctly bimodal, having moderately well sorted grains of quartz and quartzite up to one centimetre set in a matrix of clay, limonite and angular silt grains. Other samples contain a very poorly sorted assemblage of grains from half a centimetre down to fine clay flakes. Where there is a high proportion of silt and clay matrix the larger grains are separated from each other. [illegible]. As the proportion of larger grains increases there are patches of rock in which the larger grains are in contact with each other, and have wide syntaxial rims. Some sandstone contains up to 95 percent of the coarser grains.

The larger grains are rounded or subrounded. They consist of clear quartz, generally with marked undulose extinction, coarse polycrystalline quartzite and a few grains of microcrystalline quartz. Fine grains of tourmaline and iron oxide are common accessories.

24 km north of the Fitzmaurice River on the east side of the Madjellindi Valley the formation consists of interbedded hard, white, siliceous siltstone and shale with sandstone interbeds near the contact with the Lalngang Sandstone. The sandstone is white, blocky and flaggy, thin-bedded and fine-grained. The siltstone is white or light grey, flaggy or fissile and thin-bedded or laminated. The shale is browny green, very fissile, laminated and micaceous.

The siltstone consists of small (0.05 mm) angular grains of quartz with syntaxial rims forming a mosaic with about five percent of a matrix of sericite and limonite. The shale consists of small angular quartz grains which are not in contact with each other but surrounded by a matrix of limonite and clay which forms up to 50 percent of the rock.

In the extreme north and northwest of the Madjellindi Valley the formation consists predominantly of siltstone which is greyish brown or purple brown and fissile. This grades down into the Lalngang Formation through a series of interbedded shale, siltstone and fine sandstone. The siltstone is pale blue, green or grey, hard, laminated and flaggy but with poor fissile partings. The shale is white, very soft and has poor fissile partings. Interbeds of both types vary from about 2.5 cm to 15 cm thick. Fine flaggy sandstone becomes more abundant towards the base of the formation.

Thickness: Only a minimum thickness can be estimated since the formation is the highest Precambrian unit in the mobile belt. The measurement is also difficult as the formation occupies the core of a syncline.

At the head of the Madjellindi Valley a thickness of about 675 metres was estimated from air photos and measured dips. On the banks of the Fitzmaurice River a minimum thickness of about 2100 metres was estimated from air photos and measured dips.

Distinguishing features: South of the Fitzmaurice River the formation forms a rugged terrain of sharp sandstone ridges and hills with intervening areas of low undulating country underlain by siltstone. Along the banks of the Fitzmaurice River the formation forms isolated rounded hills and ridges separated by tidal flats. In the Madjellindi Valley it rarely crops out although hard sandstone bands form a few isolated ridges. At the northern end of the valley the siltstone and shale form very finely dissected hills.

TOLMER GROUP

The Tolmer Group is a sequence of shallow-water sandstone, siltstone and limestone, which crops out in the northern part of the Fergusson River Sheet area. It is about 1000 metres thick and unconformably underlies the Palaeozoic sediments of the Daly River Basin. It overlies Lower Proterozoic sediments and early Carpentarian granites with a marked unconformity. The group is considered to be Adelaidean in age. It is moderately faulted and only gently folded.

The age relationship between the Tolmer Group and the lithologically similar Bullita and Auvergne Groups is not known.

Buldiva Sandstone

The Buldiva Sandstone is the oldest unit of the Tolmer Group and comprises the Depot Creek and Stray Creek Sandstone Members.

Depot Creek Sandstone Member

Distribution: The Depot Creek Sandstone Member, which is the basal unit of the Tolmer Group, crops out on the Fergusson River Sheet area in a northwesterly trending zone, north of the Collia Fault. There is also a small linear outcrop about 10 km east of Jindare homestead. The unit extends north onto the Pine Creek Sheet area where it was originally recognized and defined. The extensive distribution of the Depot Creek Sandstone Member previously mapped on the Wingate Plateau (Randal, 1962) has been found by the present survey to be incorrect. The unit is now known to be restricted in outcrop solely to the margins of the Daly River Basin.

Derivation of name: The name is derived from Depot Creek which lies on the eastern side of the Daly River Basin on the Pine Creek Sheet area. The unit was originally defined by Randal (1962).

Stratigraphic relationships: The Depot Creek Sandstone Member unconformably overlies early Carpentarian granite and folded Lower Proterozoic sediments. In the south the unit is faulted against Angalarri Siltstone. The relationships of the unit to the Auvergne and Bullita Groups are not known.

The unit is conformably overlain by the Stray Creek Sandstone Member, the transition in places being gradational. It is also unconformably overlain by the Antrim Plateau Volcanics and the Mullaman Beds.

Lithology: The Depot Creek Sandstone Member has been described in detail by Walpole et al. (1968). Our notes refer only to the work done on the Fergusson River Sheet area during 1968.

At its most southerly extent, the unit crops out against the Collia Fault, 3 km east-southeast of Collia Waterhole. The beds dip steeply south and consist of white, blocky, thin-bedded, medium-grained, poorly sorted sandstone with abundant pebble beds. The pebbles are up to 2 cm in diameter. The rock contains about 1% of muscovite with aggregates up to 3 mm long.

About 3 km northwest of Collia Waterhole the Depot Creek Sandstone Member unconformably overlies steeply dipping Noltenius

Formation. The rock consists of white and red, blocky to massive, medium-bedded, very friable, medium-grained sandstone, which is composed of uniformly sized, sub-rounded quartz grains, commonly stained by iron oxides.

A good section through the formation crops out in the Fish River Gorge. Here the unit is composed of white, pink and brown, blocky, indurated, medium-grained sandstone. The induration may be only a near surface effect. A few kilometres west of the gorge ripple marks with a wavelength of 4 cm and an amplitude of 1 cm occur near the pebbly base of the unit. Small blebs of white clay (possibly a decomposition product of feldspar) were noted near the base of the member at this point.

Thirteen kilometres north of Fletcher's Gully, white, massive, thin-bedded, medium-grained, moderately to well sorted sandstone, with poorly-sorted pebbly zones, crops out. It unconformably overlies Allia Granite and Noltenius Formation.

The member has a comparatively uniform lithology over a large area and characteristically exhibits prominent vertical jointing. The sandstone is extensively silicified along fault zones where specular haematite occurs sparingly.

Palaeogeographic significance: The Depot Creek Sandstone Member marks the beginning of a marine transgression over the area of the Daly River Basin, and its margins. A large time break prior to the deposition of the unit is suggested by the angular unconformity and marked erosion surface at the base of the unit. The gently dipping friable sandstone overlies strongly folded, metamorphosed Lower Proterozoic sediments and the peneplained surfaces of early Carpentarian granite intruding them. The sandstone was probably deposited in a quiet, shallow-water environment since oscillation ripples, pebble bands, etc., are common. Cross-bedding, however, is not abundant in the unit. The member lies at the base of a sequence of marine siltstone, dolomite, mudstone and sandstone.

Stray Creek Sandstone Member

Distribution: A band of Stray Creek Sandstone Member crops out for some 48 km northeast from Collia Waterhole, on the Fergusson River Sheet area. The outcrop boundaries are substantially as mapped by Randal (1962).

A small area of outcrop has been delineated immediately north of Collia Waterhole; and another between the Fish River and Bamboo Creek about 32 km north of the waterhole.

The member also occurs on the eastern side of the Fergusson River Sheet area, and extends onto the Pine Creek Sheet area.

Derivation of name: The formation was named by Randal (1962) after Stray Creek, which runs westwards past Jindare homestead, into the Daly River.

Reference area: Although the formation has its type area on the eastern side of the Daly River Basin, good exposures occur on the western side of the basin, in the outcrops east of Collia Waterhole. A fairly complete section exists about 10 km northeast of the waterhole.

Stratigraphic relationships: The Stray Creek Sandstone Member conformably overlies the Depot Creek Sandstone Member of the Buldiva Sandstone, and is apparently conformably overlain by the Hinde Dolomite. The boundary with the Depot Creek Sandstone Member is gradational and is defined at the base of the lowest fine-grained fissile sandstone bed.

Lithology and thickness: The member consists of fine-grained silty quartz sandstone, commonly glauconitic, with minor flaggy medium-grained sandstone interbeds in the lower part.

A section measured northeast of Collia Waterhole gave a thickness of 96 metres for the lower half of the member. The whole of the member is probably about 180 metres thick.

Nearly all of the section measured consisted of fissile, grey-green coarse-grained siltstone or fine-grained sandstone which are commonly micaceous and chloritic . At least three flaggy, white to pink, medium-grained, quartz sandstone beds occur in the lower part of the sequence. They are identical lithologically to the Depot Creek

Sandstone Member.

The typical fine-grained sandstone is extremely glauconitic or chloritic, and is in places a bright green colour and commonly weathers to a purple colour. It is generally thin-bedded to laminated, and the surface of beds commonly contain very prominent current lineations, and some skip or prod casts. These features are very widespread and are useful in identifying the member in areas of poor outcrop.

Near the top of the lower half of the member several flaggy beds between 15 cm and 1.5 metres thick, have a peculiar composition. The most prominent bed ranges between 60 and 150 cm thick along strike, and is quite massive. It is reddish purple due to the presence of a large percentage of haematite and has green patches and specks up to 5 mm across. The green patches, which resemble malachite, are composed of a mineral of the illite group, probably glauconite. The rock also contains very coarsely crystalline carbonate, through which the haematite and glauconite are scattered.

The upper half of the Stray Creek Sandstone Member consists of very fissile fine sandstone or siltstone which crops out very poorly.

Distinguishing features: The predominance of fine-grained, green-grey sandstone and siltstone distinguishes this member from other units in the area. On aerial photographs it is distinguished from the Depot Creek Sandstone Member by its slightly darker tone and the more subdued, rounded topography.

Hinde Dolomite

Distribution: The Hinde Dolomite crops out prominently between 11 and 13 km to the northeast of Collia Waterhole. It is probably present beneath superficial cover further north, to the west of the Fish River. It has been observed on the limbs of an anticline about 35 km north of Collia Waterhole.

Derivation of name: The Hinde Dolomite was named by Randal (1962) after Mount Hinde, on the Pine Creek Sheet area.

Reference area: The type area is on the eastern side of the Daly River Basin, on the south branch of the Adelaide River (Walpole et al., 1968).

In 1968, a complete section was measured through the Hinde Dolomite 13 km northeast of Collia Waterhole.

Stratigraphic relationships: The Hinde Dolomite appears to be conformable with the underlying and overlying formations.

There is an abrupt change from clastic rocks to carbonate at its base, which is therefore easy to define. Its upper limit is marked by a chert bed which is followed by brown siltstone and fine-grained sandstone of the Waterbag Formation.

Lithology and thickness: Near the northern margin of the Fergusson River Sheet area, the following section was measured through the Hinde Dolomite:

Thickness in metres	Top of hill
15	Flaggy to blocky, medium-bedded, pink to purple, crystalline dolomite.
12	Flaggy to blocky, medium-bedded, pink, finely crystalline dolomite.
37	Pink blocky dolomite at top overlying a stromatolitic grey crystalline dolomite with some intraclasts. Large colonial stromatolites are interbedded with fawn silty dolomite bands and many thin siltstone bands.
Total 67	Bottom of hill.

This section is overlain by massive chert, which commonly forms a hard ridge on the hill top.

Thirteen kilometres northeast of Collia Waterhole, a complete section through the formation revealed the following:

Thickness in metres	Top of hill
	Chert and sandstone on hilltops.
63	Poor outcrop. Some dolomite, but probably mostly dolomitic siltstone. Some scree of almost black shale.

10	Grey and yellow-brown, flaggy blocky and massive, finely crystalline dolomite.
5.8	Poor outcrop. Some dolomitic siltstone in scree.
3.6	Blocky and flaggy dolomite with some yellowish fissile siltstone bands.
4.3	Flaggy dolomite, poor outcrop. Probably some interbedded siltstone.
3.6	Flaggy and blocky, grey dolomite. Some beds contain intraclasts or pellets which appear to be of finely crystalline dolomite.
28	No outcrop.
0.45	Yellow-brown weathering dolomite. Medium-grained crystalline carbonate with some minor black specks of iron mineral.
Total 118.75	Stray Creek Sandstone Member

The chert at the top of the formation appears to be in the sequence, between the Hinde Dolomite and the Waterbag Formation. It comprises massive pink to brown chert with patches of more coarsely crystalline quartz. It is brecciated and re-cemented in some areas. Its mode of formation could be similar to that of the Bardia Chert Member of the Skull Creek Formation (page 85).

Distinguishing features: The formation stands out on aerial photographs by virtue of its light tone, and strongly banded pattern. In the field it is fairly prominent, being the only thick sequence of massive fairly pure dolomite in the area.

Palaeographic significance: The presence of stromatolites is taken to indicate an intertidal environment; otherwise little is known of depositional environment of the formation.

Waterbag Formation

Distribution: The Waterbag Formation crops out on the Fergusson River Sheet area from its northern margin, between the Fish River and Bamboo Creek, southwards to an area about 23 km northwest of Dorisvale homestead.

Some of the area originally delineated by Randal (1962) as Waterbag Formation is now considered to be Jinduckin Formation. This is the area east of the Dorisvale Fault, in the area around Dorisvale homestead. The rocks to the west of the fault are now mapped as Bynoe Formation.

Derivation of name: The name is derived from Waterbag Creek, a tributary of the Flora River. It was first used by Randal (1962). The area through which the creek runs is now considered to be Bynoe Formation but the original type area is still considered to be Waterbag Formation. The name is therefore still valid.

Type area: Good outcrops of the formation are seen to the south-west of Beantree Spring; although it does not appear in the literature, this is regarded as the type area for the formation (Randal, pers. comm.).

Stratigraphic relationships: The Waterbag Formation overlies the Hinde Dolomite, apparently conformably, although the presence of chert at the top of the latter introduces a degree of uncertainty into the relationship. The Waterbag Formation is overlain, unconformably, by basalt and minor sandstone of the Antrim Plateau Volcanics. Its original thickness in the area is therefore unknown.

Lithology and thickness: The total thickness cannot be measured for the whole formation, as its upper limit is unknown, and the portion preserved dips northeast at a low angle, making it difficult to measure. However, over 150 metres can be seen in the lower part of the formation, and there could be over 300 metres preserved.

The formation contains a variety of rock types, and these are generally in thin to medium beds. These are interbedded in apparently random fashion, and comprise siltstones, sandstones, some of which are dolomitic, and dolomite.

The best exposure of the basal 60 metres occurs 13 km north-east of Collia Waterhole. The base of the hill comprises grey-green sericitic siltstone, and fine to medium-grained quartz sandstone. The sandstone contains numerous pits 2 to 3 mm across on its surface, caused by the leaching out of patches of coarse-grained carbonate.

The sandstone weathers a light red-brown, and generally contains specks of limonite. Most of the hill is made up of chocolate-and red-brown, fissile, siltstone, mostly dolomitic, interbedded with sandstone similar to that lower in the sequence. Mudflakes are common. There are a few flaggy interbeds of white dolomitic quartz siltstone, and grey fine-grained dolomite with halite casts.

Further northeast, flaggy and blocky dolomite is the predominant lithology in the upper part of the formation. The dolomite is grey, fine-grained, and contains chert which stands out from the weathered surface of the dolomite. The chert bodies are generally sub-parallel to the bedding, but their boundaries are irregular, and cut across laminations, suggesting a replacement origin. Such dolomite is exposed near the track from Beantree Spring to Collia Waterhole, some 11 km from the spring. It is interbedded with red-brown, dolomitic siltstone. Most of the Waterbag Formation occurs in low hills with limited outcrop of siltstone, but covered with much rubble of fine-grained sandstone. The sandstone is thin-bedded, and commonly contains ripple marks, halite casts, and mud flakes.

Purple-violet laminated shale with halite casts occurs as thin partings between siltstone beds, in the bank of the Fish River 16 km from Beantree Spring.

Distinguishing features: Neither topographic expression or lithology are really useful in recognising the Waterbag Formation, since the Jinduckin Formation and the Bynoe Formation are similar to these respects. The only useful feature is its position in the sequence above the Hinde Dolomite

Palaeogeographic significance: Sedimentary structures indicate that at least some of the formation was deposited in very shallow water with periods of subaerial exposure. Little is known of areal changes in thickness or environment of deposition.

BULLITA GROUP

The Bullita Group comprises a sequence of dolomite, dolomitic siltstone, and minor sandstone and chert. Although the base of the group is not exposed within the area described in this record, a thickness of about 540 metres has been measured from the southwestern part of the Delamere Sheet area. A greater thickness may exist in the north if the thickest part of the Banyan Formation is included. The group crops out to the west of Dorisvale homestead on the Fergusson River Sheet area and in the south-western part of the Delamere Sheet area. Other outcrops occur to the south of the area covered by this record.

The age of the Bullita Group is not known, but is regarded as being Adelaidean or Carpentarian. This is based only on relationships with the Auvergne Group.

Timber Creek Formation

Distribution: The Timber Creek Formation crops out on the western margin of the Delamere Sheet area where it is seen in scarps near the Victoria River for a distance of about 13 km from the sheet margin. It is present in the adjacent Auvergne Sheet area (Pontifex et al., 1968), and extends to the south of the area mapped in 1968.

Derivation of name: The unit was named informally by Laing and Allen (1956), and has been defined by Pontifex et al. (1968).

Reference area: The type section for the formation is about 1.6 km west of the Timber Creek Store, on the Auvergne Sheet area (Pontifex et al., 1968). Other good exposures occur within a few kilometres of the Timber Creek Store.

Stratigraphic relationships: The relationships can only be observed for the upper boundary of the formation, since its base is not exposed in the area described in this record. However, further south on the Victoria River Downs 1:250,000 Sheet area it passes down conformably into a sequence of interbedded sandstone, siltstone and dolomite.

Contrary to the ideas of Laing and Allen (1956), who believed that the Timber Creek Formation was a lateral equivalent of the Skull Creek Formation, mapping in 1968 has shown that it underlies the latter formation.

This relationship is best shown near Mount Sellars, 8 km south-southeast of Timber Creek. In Fig. 14 Timber Creek Formation forms the floor of the valley, and is overlain by massive dolomite of the Skull Creek Formation. The relationship is also apparent along both sides of the Victoria River upstream from Timber Creek for a distance of about 19 km.

Around Timber Creek the formation is overlain unconformably by Jasper Gorge Sandstone. Plate 54 shows the very slight angular discordance between Jasper Gorge Sandstone and Skull Creek Formation. About one kilometre further west the Skull Creek Formation has been completely eroded, and Timber Creek Formation underlies the sandstone.

Lithology and thickness: A detailed description of the lithology of the formation is given by Pontifex et al. (1968).

A number of excellent exposures were seen along the Victoria River.

The formation is predominantly siltstone, with lesser amounts of fine-grained sandstone, shale, and dolomite. Some of the siltstone is dolomitic. It is generally quartz-rich, coarse siltstone, red-brown or chocolate, with green patches or spots in places. Light grey-green siltstone also occurs. The siltstone is commonly thin to medium-bedded, with flaggy to blocky partings.

Most of the sandstone is fine-grained and silty, but just west of Timber Creek several interbeds of clean, medium-grained quartz sandstone were observed.

Shale and mudstone are common, and range from fissile to flaggy, and laminated to thin-bedded. They are commonly grey-green, but ferric iron colours such as purple and chocolate are not uncommon.

Sedimentary structures, such as halite casts, mudcracks, and small-scale ripple marks, are very common.

The several rock types are randomly interbedded, and their flaggy nature and varying resistance to weathering results in etched exposures, of slope and ledge topography.

The thickness of the formation is more than the 80.4 metres observed in the type-section (Pontifex et al., 1968), where the lower part is unexposed and the upper part is eroded and overlain unconformably by Jasper Gorge Sandstone.

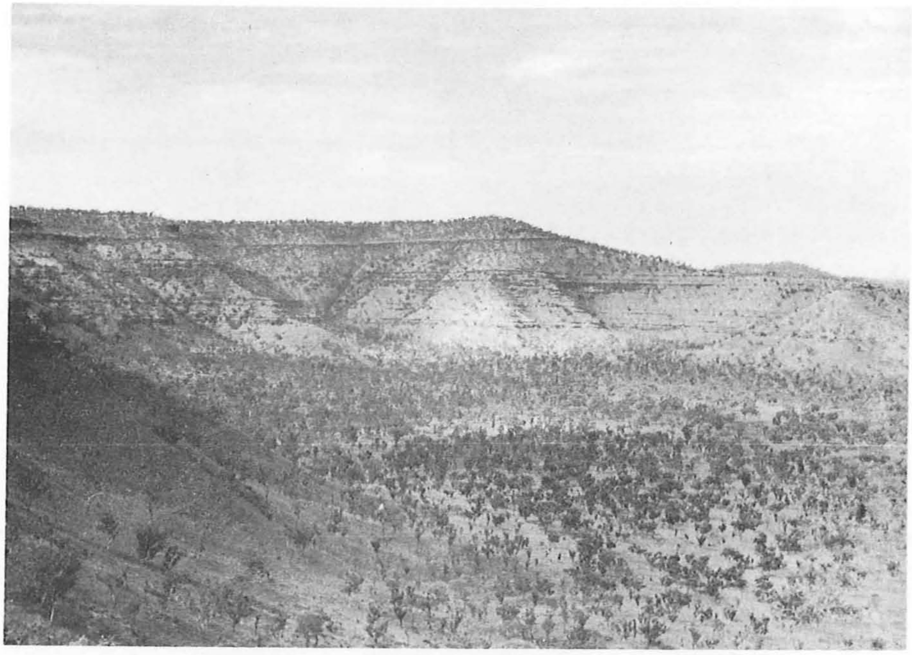


Fig. 14. Near Mount Sellars, 8 km south southeast of Timber Creek. Timber Creek Formation forms valley floor, and is overlain by dolomite (well bedded rocks) of the Skull Creek Formation. The capping of Jasper Gorge Sandstone lies with angular unconformity on Skull Creek Formation. Neg. M/796.

The second section recorded by Pontifex et al. includes some of what is now defined as Skull Creek Formation. Although massive dolomite occurs in the Timber Creek Formation, the unit as a whole does not appear to be very dolomitic. The upper boundary of the Timber Creek Formation is now placed at the change from predominantly non-dolomitic to dolomitic siltstone.

In the area mapped the Timber Creek Formation definitely underlies the Skull Creek Formation. However, the possibility that elsewhere the two formations have an intertonguing, or laterally gradational contact, as suggested by Laing and Allen (1956), cannot be dismissed.

Palaeogeographic significance: Laing and Allen (1956) suggest that the Timber Creek Formation is a near-shore facies, with mainly fine detrital material being supplied, along with lime, magnesia and silica in solution. The occurrence of halite casts and mudcracks show that the sediments were deposited from bodies of hypersaline water which periodically evaporated completely. The environment is thus probably paralic, with lagoonal and some shallow marine deposits.

Skull Creek Formation

Distribution: The Skull Creek Formation crops out in the southeast and southwest corners of the Auvergne and Delamere Sheet areas respectively. These outcrops continue to the southwards.

The formation crops out extensively between Timber Creek and Fitzroy Station on the scarps of a dissected plateau. The best outcrops occur between the main Katherine-Wyndham highway and the Victoria River. South of the highway outcrop is generally poor. Good exposures occur in low hills, which run northwest for about 13 km near the southern margin of the Delamere Sheet area.

Derivation of name: The formation was designated "Skull Creek Limestone" in an unpublished report by Laing and Allen (1956). The name was modified to Skull Creek Formation and formally defined by Pontifex et al. (1968).

<u>Type area</u>: The type locality for the formation is 1 km west of the Timber Creek - Victoria River Downs road, in the southwest corner of the Delamere Sheet area (Grid Ref. 351992). Although the core of the anticline at the type locality is faulted, the base of the formation may occur at the southeast end of the hills.

<u>Stratigraphic relationships</u>: The formation overlies the Timber Creek Formation in the Delamere Sheet area (see Fig. 14). It is overlain conformably by the Bynoe Formation, which in some areas lies directly on dolomite, and in others, on the Bardia Chert Member. The Skull Creek Formation is overlain with angular unconformity by the Jasper Gorge Sandstone in some areas.

<u>Lithology and thickness</u>: The Skull Creek Formation comprises pure and impure dolomite, dolomitic siltstone and sandstone, and chert. One particularly thick bed or series of beds of chert has been mapped as the Bardia Chert Member.

The Skull Creek Formation has a fairly uniform lithology over large areas and it is difficult to trace stratigraphic horizons within the formation. This difficulty has been partly resolved by the delineation of a prominent marker horizon of massive dolomite. It is probably the same bed as that designated by Laing and Allen (1956) as their "upper marker", and will be referred to as such in this record. A second prominent marker of massive and blocky dolomite crops out near the Victoria River on the Delamere Sheet area and is referred as the "lower marker". Laing and Allen (op. cit.) discuss a "lower marker" also, but this was not identified during the 1968 field season.

It has not been possible to measure the complete thickness of the Skull Creek Formation at any one locality. Several sections have been measured through parts of the formation and, by using the upper and lower markers as points of reference, it has been possible to build up a composite section of the formation.

Pontifex <u>et al</u>. (1968) record a section measured 10 km south-southwest of Timber Creek which they refer to as the Timber Creek Formation, but later mapping has shown that only the basal 3 metres is Timber Creek Formation. The overlying Skull Creek Formation was recognized as such by the presence of the "lower marker". The section as measured by Pontifex <u>et al</u>., is repeated below:

Top of hill

Formation	Thickness in metres	Description
Skull Creek Formation	15	Flaggy dolomite alternating with bands of light purple, fissile siltstone and shale.
	24	The "lower marker" horizon. Massive and blocky dolomite; contains minor siltstone and sandstone. Ripple marks and halite casts.
	1.5	Very fine-grained, purple-brown indurated sandstone. Fine-scale cross-bedding and contorted laminae (slumped foresets).
	6	Massive silty dolomite with minor interbedded white friable siltstone. Halite casts and minor small chert lenses.
	40.5	Mostly dolomitic siltstone with fissile or flaggy, very fine-grained dolomite.
	1.5	Flaggy, fine-grained quartz sandstone.
	4.5	Massive, laminated, partially re-crystallized dolomite. Contains numerous sub-spherical and elongate chert bodies up to 30 cm across. Bedding laminations continue through them and are contorted within them.
	Total 93	
Timber Creek Formation	3 +	Fine-grained sandstone, light brown, contains mudflakes and pellets.

Base of hill

There is thus about 54 metres of dolomite, sandstone and siltstone below the "lower marker". This part of the formation, capped with the massive layer of dolomite, forms steep-sided small hills, generally with a characteristic slope-and-ledge-type topography.

Another section, 8 km north-northeast of the one above, near Mount Sellars, was measured through the same part of the formation. The non-outcropping zones probably indicate the presence of siltstone.

Top of hill

Thickness in metres	
45 +	Medium-grained, massive to blocky, cross-bedded sandstone. Conglomeratic at base.
Angular Unconformity	
44.8	Very little outcrop. Minor beds of dolomite.
1.5	Very dark grey-weathering, medium, crystalline dolomite.
13.7	Flaggy grey dolomite and flaggy, fine-grained dolomitic sandstone; finely laminated and ripple-marked ("lower marker"?)
8.8	No outcrop.
8.8	Flaggy and blocky grey dolomite.
3.0	No outcrop.
0.9	Flaggy dolomite.
8.8	No outcrop.
11.9	Flaggy and blocky fine-grained dolomite.
5.2	Fissile dolomite or dolomitic siltstone.
8.5	Flaggy to massive fine-grained dolomite.
13.7	No outcrop.
0.9	Massive dolomite band.
5.5	No outcrop.
Total 136	Bottom of hill

Timber Creek Formation forms the floor of the valley. The top of the Skull Creek Formation has been eroded, and Jasper Gorge

Sandstone deposited directly on the lower part of the formation. The "lower marker" is not as distinctive as elsewhere, but is probably represented by the 13.7 metres of flaggy dolomite near the top of the section.

The formation between the two marker units is well exposed on both sides of the Victoria River from near its confluence with Skull Creek to the region near Trinity Reach-Wickham Heights. A section was measured on the east bank of the river about one and a half kilometres west of Wickham Heights, and revealed a thickness of 68 metres between markers. This part of the section does not crop out very well, and may be largely dolomitic siltstone. However several beds of grey, flaggy, fine-grained dolomite, from 30 cm to 150 cm thick do crop out in this interval. The upper marker in this region is about 27 metres thick.

A section measured by barometer through the upper part of the formation about 5 km southeast of Wickham Heights revealed a thickness of 70 metres from the top of the "upper marker" to the base of the Bynoe Formation. The rocks are flaggy and blocky dolomite, with some poorly outcropping fissile dolomite and dolomitic siltstone. Most of the dolomite is fine-grained, but a few beds are medium or coarsely crystalline.

By combining the sections measured south of Timber Creek, and west and southeast of Wickham Heights, it is possible to give an estimation of the total thickness of the formation is estimated as below:

Above "upper marker"	70
"Upper marker"	27
Between markers	67
"Lower marker"	24?
Below lower marker	55
Total	243 metres

A section was measured across the limb of an anticline 8 km southwest of where the Victoria River Downs road crossed Skull Creek. This is the locality of Laing and Allen's type section for the Skull Creek Formation. The uppermost outcrop is a massive grey dolomite, and is the "upper marker" of Laing and Allen.

The section is as follows:

TOP

Thickness in metres	
30	Massive grey dolomite; karst-type weathering. "Upper marker"
15	Softer, flaggy dolomite, does not crop out as prominently as beds above.
15	Massive, dark grey, karst-weathering dolomite. Fine to medium crystalline; some hemispherical stromatolites.
23	Light grey, flaggy, finely crystalline dolomite. Some irregular chert lenses.
41	Interbedded flaggy grey dolomite (30-60 cm interbeds) and more fissile, dolomitic siltstone. The dolomite is very finely crystalline.
18	Flaggy, ripple-marked, very fine-grained dolomitic sandstone and sandy dolomite. A few 30 cm interbeds of pure dolomite.
1.5	Massive, laminated, fine and medium grained crystalline dolomite. Chert bodies are very abundant and parallel to bedding.
6	Dolomitic siltstone.
3	Blocky, smooth, buff-weathering, very finely crystalline, grey or pink dolomite.
Total 152.5	Bottom of exposure - core of anticline

The oldest beds exposed in the core of the anticline are probably somewhere in the sequence between the two markers.

The "upper marker" is easily recognized on aerial photographs by its dark mottled texture. This is due partly to the occurrence of extensive bare outcrops on hillsides, almost devoid of soil and vegetation. These areas weather to a dark grey, and result in an almost black tone on photos. The marker also supports a small tree with dark green, very dense, foliage. This also gives a dark texture on the photos, and is commonly the distinguishing feature of the marker even where it does not form large bare outcrops. The appearance of the "upper marker" is shown in Fig. 15, 16, 17 and 18.

The "lower marker" crops out very prominently near the Victoria River between Trinity Reach and The Brothers, a distance of 32 km. It is not as prominent on aerial photos as the "upper marker", perhaps because of its very regular jointing, which causes it to be eroded more easily. The marker horizons are lithologically similar, however. They both are composed of fine to medium-grained crystalline dolomite, in thick beds with blocky to massive partings. Laminations are absent or ~~very~~ faint on most fresh surfaces. However, many weathered surfaces have been etched by solution, and reveal the presence of stromatolites in the rocks (see Figs. 16, 17 and 18).

Stromatolites are ubiquitous in the upper marker. Similar structures have been observed in the "lower marker" in a small cliff section at Trinity Reach, on the northern bank of the Victoria River.

Chert occurs in the purer dolomite beds throughout the formation. It forms small lenses and nodules generally parallel to bedding. In outcrops about 40 km south of the Timber Creek turnoff on the road to Bullita Station the chert occurs as resistant beds, up to several centimetres thick and running many metres along strike. It is laminated in the same manner as the surrounding dolomite, and is considered to have replaced the dolomite. In the same area chert occurs as brecciated, silica-cemented masses, also parallel to bedding.

The most notable chert occurrence is at the top of the Skull Creek Formation, where there is a massive unit at least 15 metres thick which has been named the Bardia Chert Member. It is described later.

Most of the purer carbonate rocks are micrites (Folk, 1959, 1962). The carbonate is extremely finely crystalline, and most specimens have no allochems. In fact, only one oolitic dolomite was seen, in a bed near the top of the formation. Many specimens contain some coarser carbonate, which is considered to be recrystallized micrite rather than sparite because of the general absence of allochems. (Sparite is usually found only as a cement in rocks containing allochems - Folk, 1959).

A particularly coarsely crystalline carbonate occurs at the top of the formation on the northern side of the Victoria River. Its grainsize ranges from 0.5 mm up to about 5 mm. It is quite dense, and some beds are limonitic or haematitic. Specimens W68 (68770220) and W69, D (68770073) are very coarsely crystalline, and both have low Ca/Mg ratios (Table 3). X-ray diffraction shows that they contain magnesite. They also contain appreciable quantities of manganese and iron but the X-ray work did not reveal the presence of siderite or ankerite. The Skull Creek Formation has been recognized in the cores of two anticlines within the Jasper Gorge Sandstone, one near the northern edge of the Delamere Sheet area 26 km east of J41 Yard, and the other one about 13 km further north, on the Fergusson River Sheet area.

At the first locality the "upper marker" has been recognized. It comprises several massive beds, totalling about 7.5 metres. A pink-grey bed near the top contains abundant stromatolites. Three rocks sampled from this area are apparently all calcitic dolomites (Y209, 210, 213, Table 3). Numerous patches and lenses of chert occur, and a concordant barytes vein, up to 1.5 metres wide, and 3.5 to 4.5 metres long, was seen.

At the second locality the marker was not recognized. A hundred metres or so of grey, flaggy dolomitic siltstone is interbedded with thick beds of grey to pink finely crystalline dolomite. Small barytes veins and limonite pseudomorphs after pyrite were noted.

Table 3

CHEMICAL ANALYSES OF SKULL CREEK FORMATION

Field No.	Reg. No.	Mg%	Ca%	Ca/Mg (molar)	Residue %
W4	68770213	1.05	36.2	21.	6.7
W9a	" 214	11.1	21.6	1.19	7.9
W11	" 215	10.1	20.7	1.24	3.0
W15	" 216	10.1	20.9	1.31	9.8
W19	" 217	10.7	21.8	1.24	8.9
W22	67770067	5.8	10.6	1.26	55.6
W40B	" 0070	8.9	20.9	1.50	5.2

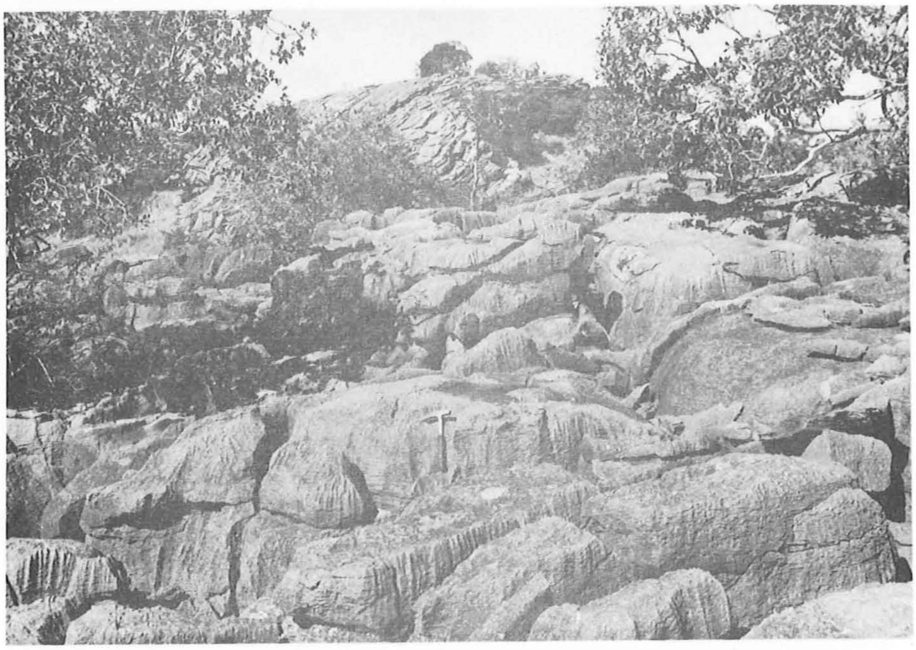


Fig.15. "Upper marker" of Skull Creek Formation showing clints and grikes. Near southern margin Delamere Sheet area. Neg. M/796).

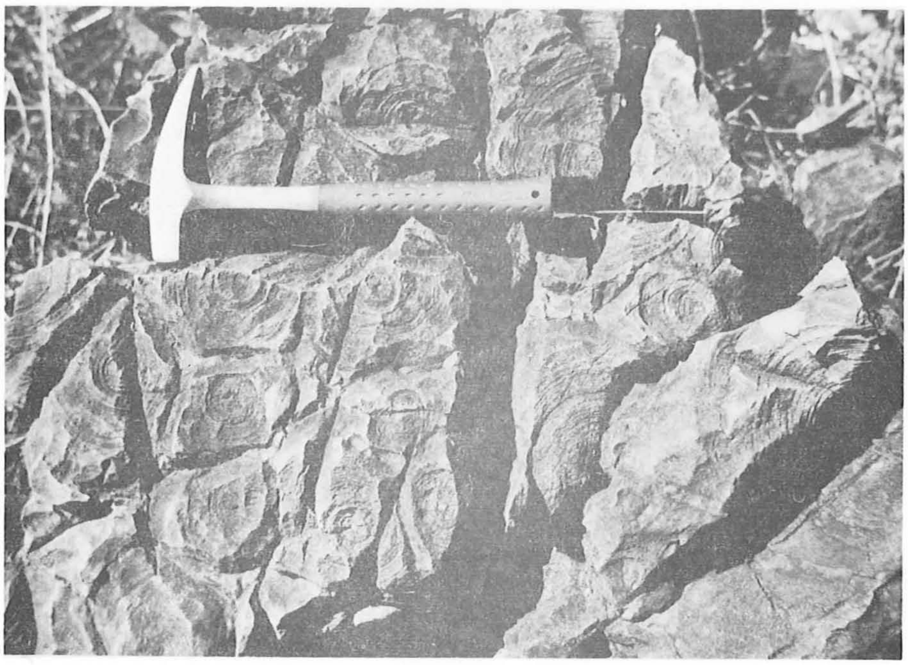


Fig.16. "Upper marker" of Skull Creek Formation. View of top of bed showing stromatolites. 15 km west of Fitzroy Homestead, Delamere Sheet area. Neg. M/796.

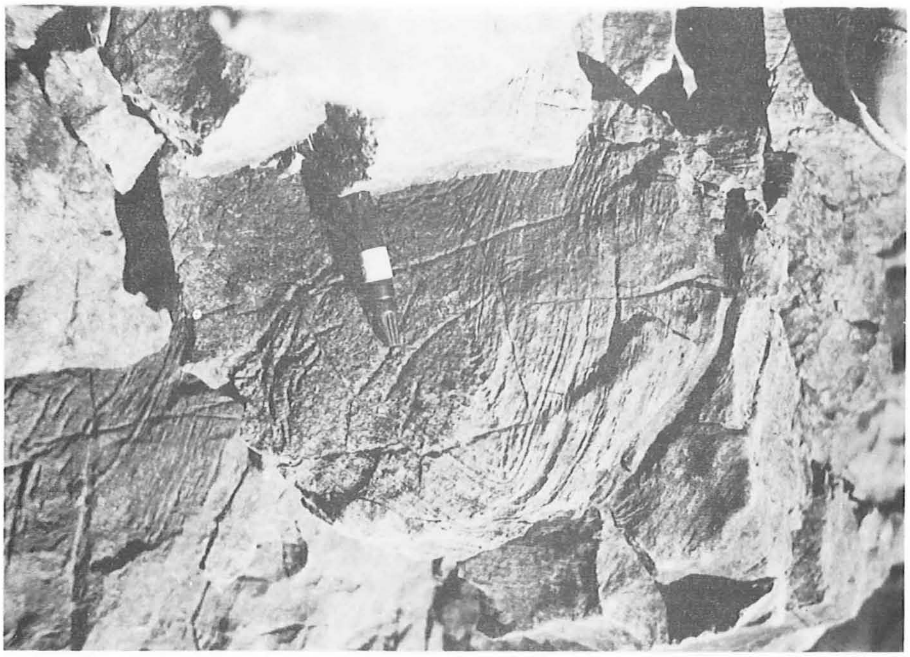


Fig.17. Side view of a stromatolite showing conical form of laminae. Same locality as Fig.16. Neg.M/796.

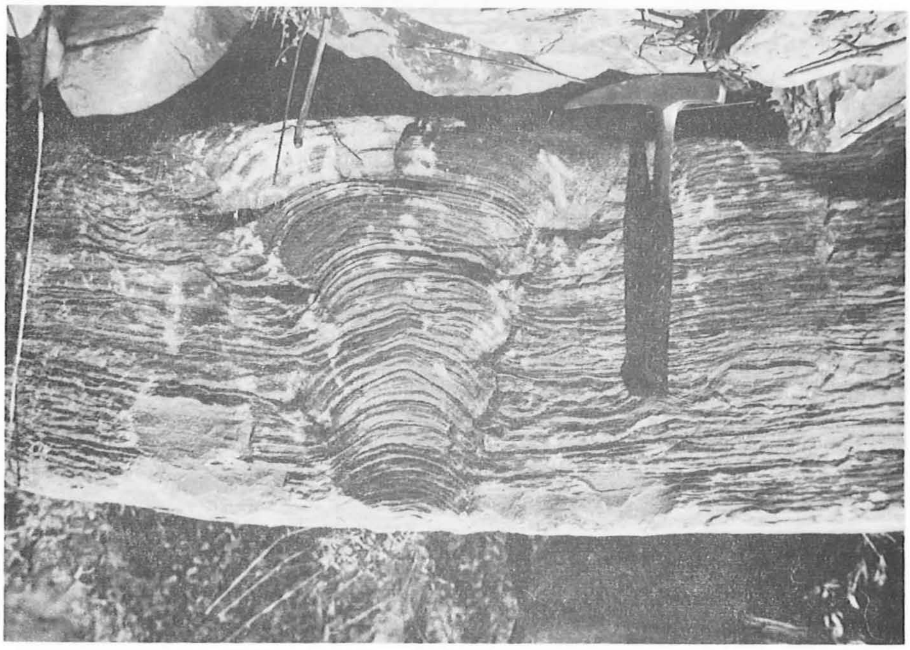


Fig.18. Hemispherical stromatolite from Skull Creek Formation "upper marker". Large loose block by roadside at Timber Creek - Victoria River Downs road junction 29 km east of Timber Creek. Photo has been inverted to show stromatolite the right way up. Neg. M/796.

Table 3 (cont.)

Field No.	Reg. No.	Mg%	Ca%	Ca/Mg (molar)	Residue %
W46	6877218	10.7	22.5	1.28	8.7
W56	" 219	10.7	22.0	1.25	9.7
W68	" 220	11.7	3.5	0.18	21.9
W69B	67770073	9.3	19.7	1.29	17.4
W69D	" 0073	11.1	5.8	0.32	20.6
W92	68770221	6.2	12.2	1.19	48.2
W96	" 0222	11.05	17.9	1.32	3.1
Y209	" 0223	10.7	22.0	1.24	24.9
Y210	" 0224	11.2	23.3	1.26	5.0
Y213	" 0225	11.2	21.5	1.16	7.5

Bardia Chert Member of Skull Creek Formation

Distribution: The Bardia Chert Member covers an area of about 325 square kilometres in the southwestern part of the Delamere Sheet area, with minor occurrences westwards on the Auvergne Sheet area.

Derivation of name: The name is derived from Bardia Yard, which is a stock yard near the Victoria River Downs road crossing of Skull Creek.

Type area: The main Katherine-Wyndham highway crosses Skull Creek about 18 km northeast of Bardia Yard, and passes over excellent outcrops of chert in the creek bed. Low hills in this locality are the best reference area for the member, and the type locality is in a small cliff 1 km west-south-west of the old road crossing of Skull Creek (Grid ref. 370012).

Stratigraphic relationships, lithology and thickness: The Bardia Chert Member is at the top of the Skull Creek Formation. There are other prominent lenses and beds of chert in the formation, but they are not as widespread as the Bardia Chert Member.

The chert occurs as a flat-lying capping on low hills in the west of the Delamere Sheet area. However, about 12 km to the east, it dips gently southeast, and can be seen below the Bynoe Formation (Fig. 38).

It is between 6 and 15 metres thick near Skull Creek.

The chert varies from red-brown to pink on the weathered surface, and generally forms massive, resistant outcrops. The rock is predominantly micro-crystalline quartz, with some veins and vughs of coarser grained quartz and calcite crystals. The internal structure of the rock is variable; in many areas, including that near the Skull Creek road crossing, it is finely laminated. It contains concentric, domed laminations which may be replacements of stromatolitic dolomite. In many areas the chert has been brecciated and re-cemented by chert or coarser-grained quartz.

Origin of chert: The chert is part of the Skull Creek Formation but the exact time of its formation is not known. Possible origins are:

(1) that it formed by chemical precipitation immediately following the deposition of the remainder of the Skull Creek Formation, and was then overlain by the Byone Formation;

(2) that it replaced a series of dolomite beds. This would explain the apparent stromatolite structures in the chert. It would also provide an explanation of the occurrence of breccia chert. It has been suggested by M. Brown (pers. comm.) that the breccia could have formed by collapse of laminated chert into cavities formed in the dolomite by circulating waters.

Either of these mechanisms suggest that the interval between the end of Skull Creek deposition and the beginning of Bynoe deposition could be quite long, and that the surrounding land was of very low relief. This would provide little or no detritus, but may provide silica-rich waters. Alternatively, the chert may actually represent a hiatus at the end of Skull Creek time, with the chert actually being a form of fossil duricrust.

Another possibility is that the chert replaced the dolomite at some later date; that is, after deposition of the Bynoe, and perhaps even subsequent formations. This could involve disturbance of Bynoe Formation. There is no evidence of such distrubance.

Bynoe Formation

Distribution: The Bynoe Formation crops out extensively on the southwest quarter of the Delamere Sheet area. Two minor exposures occur near the northern margin of this sheet area. The formation crops out extensively in southwestern part of the Fergusson River Sheet area.

Derivation of name: The formation was originally called, informally, the Coolibah Formation (Laing and Allen, 1956), but this has been changed to Bynoe Formation which is taken from the Bynoe Range, an elongate mesa 1.6 km north of the Victoria River, and between 3 and 13 km west of Coolibah homestead.

Reference area: The Bynoe and Fitzroy Ranges provide good exposures of the formation. The type section is on the southeastern slope of Wondoan Hill, a prominent butte 3 km west of Coolibah homestead.

Stratigraphic relationships: The Bynoe Formation overlies the Skull Creek Formation, probably conformably. The contact is marked by the Bardia Chert Member of the Skull Creek Formation in the area about 32 km south-southwest of Coolibah Homestead.

The contact between the two formations is easily traced on the aerial photos, and on the ground it is defined as the change from predominantly dolomite or chert (Skull Creek Formation) to siltstone (Bynoe Formation). The contact may be gradational over a few feet, but it is not generally exposed.

The Bynoe Formation is overlain unconformably by Jasper Gorge Sandstone in some areas, but in the Fitzroy and Bynoe Ranges it is overlain, also unconformably, by Wondoan Hill Formation.

Lithology and thickness: The formation comprises a monotonous series of massive green, purple and red-brown siltstone, with interbeds of fine-grained sandstone, marl, and dolomite.

The best exposed section is the type section at Wondoan Hill, and is as follows:

TOP

Thickness in metres	Base of sandstone cliffs	Wondoan Hill Formation
16.2	Poor outcrop - mostly siltstone (see text below)	
0.6	Grey silty dolomite	
9.0	Siltstone	
0.9	Dolomitic sandstone, thin to medium-bedded, fine to very coarse-grained sand; crossbedded and ripple marked.	
7.5	Siltstone	
0.3	Grey dolomite	
18.0	Siltstone with occasional greyish, thin (8-15 cm) dolomite interbeds.	
0.3	Grey dolomite	
14.4	Siltstone	
0.6	Slightly silty grey dolomite	
4.5	Siltstone	
0.6	Flaggy, grey laminated silty dolomite. Ripple marks.	
10.5	Siltstone	
0.3	Finely laminated dolomitic sandstone	
25.5	Siltstone	
0.3	Slightly dolomitic sandstone, ripple marked, some green mud flakes and possibly halite casts.	
9.0	Siltstone	
0.3	Dark brown-weathering dolomitic sandstone. Has thick leached crust on outcrops.	
9.3	Siltstone	
0.6	Fine-grained sandstone, laminated to thin-bedded, ripple marked.	
19.8	Siltstone	
0.3	Dolomitic sandstone, laminated, blocky, with leached crust.	
16.5	Siltstone	
0.6	Hard grey sandstone	
3.9	Siltstone	

TOP

Thickness in metres	
0.3	Hard grey sandstone
0.6	Grey-green siltstone
0.6	Massive, indurated siltstone
1.5	Purple siltstone
0.3	Grey-green siltstone
3.3	Purple siltstone
0.3	Light grey, fine-grained sandstone
10.5	Siltstone
Base of section	River level

TOTAL: 187.2

This is the best exposed, and probably the most complete section known of the Bynoe Formation. The base of the section, at river level is probably within a few metres of the top of the Skull Creek Formation, which crops out about 6 km downstream. The Bynoe Formation is overlain by extremely thick-bedded, massive sandstone of the Wondoan Hill Formation.

The most characteristic rock type is the massive siltstone, which is seen in most outcrops (see Fig. 19). It is thick-bedded, in beds from 15 cm to a metre or so thick, and is red-brown to purple. When weathered the siltstone breaks into small angular fragments. The siltstone has a high proportion of quartz (of the order of 60 percent), carbonate (dolomite), and muscovite. The red-brown siltstone contains iron as limonite, and green and grey green siltstone probably in clay minerals, or as siderite. Beds of both colours occur, but most red-brown beds contain spherical patches from 1 mm to (rarely) 5 cm across of grey green colour. It appears that these are places in which the iron has been reduced from the ferric to the ferrous state. However, this is not conclusive, and the reaction could have proceeded the other way. Such reactions are not related to recent weathering, since these features have been seen in very recently exposed, unweathered outcrops.

The green siltstone and spots contain a much higher proportion of carbonate, probably dolomite, as well as clay minerals. It seems likely that the red-brown siltstone formed when carbonate was leached from the rocks, and iron-bearing clays weathered to give limonite as one of the residues, with accompanying colour changes from grey-green to red-brown.

The rock types interbedded with the siltstone are dolomite and dolomitic sandstone. The dolomite and dolomitic sandstone are generally light grey or fawn on fresh surfaces, but when weathered they develop a crust (generally between 1 and 5 cm thick) consisting of a porous, limonite-rich rock, devoid of carbonate. This is quite soft, in contrast to the highly indurated nature of the fresh rock, which has both dolomite and silica (quartz) cement.

The type section at Wondoan Hill contains several sandstone beds in the lower and middle parts of the sequence and becomes more dolomitic near the top. In the Fitzroy Range, south of Wondoan Hill a similar trend is noticeable and shale is associated with the dolomite.

Another section, measured on a hill near Bob's Grave Spring in the southwest of the Delamere Sheet area, totalled 112 metres. This also is overlain by Wondoan Hill Formation. The base is not present, but is seen about 1.5 km further west. Dips are low ($1-3^{\circ}$ east), and probably between 30 and 60 metres of formation exist below the part which was measured. The first 22.5 metres of the section contains interbedded siltstone and flaggy sandstone. The sandstone forms small ledges, giving the lower slopes of the hill a terraced appearance. It is a white to faint grey-green sandstone, with some ripple marks. The siltstone and sandstone is overlain by about 64 metres of typical Bynoe Formation siltstone (i.e. red-brown to purple and grey-green micaceous siltstone, probably also dolomitic). In the top 30 metres of the section there is flaggy and blocky, fine-grained siliceous sandstone with minor dolomite in the matrix. Halite casts and ripple marks occur. There are not dolomite beds in this locality.

Bynoe Formation crops out extensively east and northeast of Wombungi outstation in Fergusson River Sheet area. The rocks are of typical "Bynoe Siltstone" lithology, and include interbedded sandstone.

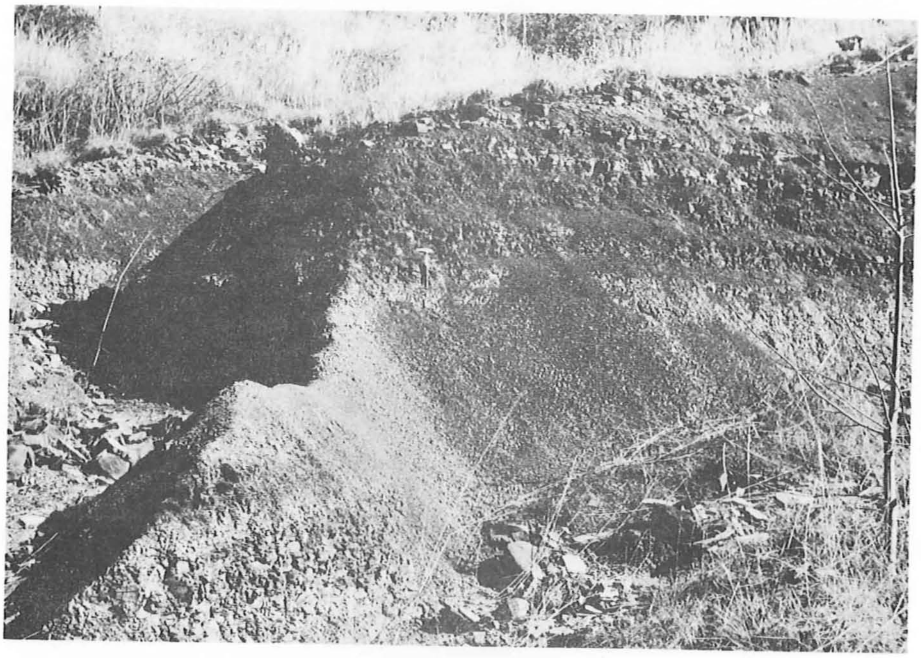


Fig. 19. Bynoe Formation. Massive grey-green (light tone) and red-brown to purple (dark tone) siltstone, with a thin sandstone interbed near top of photo 1.6 km north of Bob's Grave Spring. Neg. M/796.

On the southern side of the Wombungi-Dorisvale track up to 3 metre thick bands of grey to light brown, massive, fine-grained sandstone are interbedded with the siltstone. The siltstone is friable, thin-bedded, cross-bedded and ripple marked.

In the same area silty dolomites up to 1.2 metres thick are interbedded with grey-green dolomitic siltstone with halite casts. Medium to coarse-grained, poorly sorted, pebbly sandstone also crops out in layers up to 1.5 metres thick. Grains are subrounded, and mostly of quartz, with some chert, and possibly a little silicified siltstone. Some mudflakes or shale fragments are also present.

In this northern area the Bynoe Formation has been lateritized in several places. This is not a Cainozoic laterite, but a Precambrian one, developed on an old land surface before the Auvergne Group sediments were laid down. Fresh siltstone has been observed to grade up into a structureless, mottled or leached ferruginous laterite, which is overlain by fresh Jasper Gorge Sandstone.

In some areas, notably along the foot of Stokes Range, travertine or calcrete has developed on the Bynoe Formation. This is generally a grey, pink or purple deposit, between a few centimetres and 1.5 metres thick, and is presumably a result of leaching of the dolomitic siltstone.

<u>Distinguishing features</u>: On aerial photographs the Bynoe Formation shows as smooth slopes where it is capped by a harder rock type. Where the capping has been removed, it crops out as low, rounded hills, or commonly as spurs, with a prominent terraced effect due to hard beds within the formation. The latter feature is well developed in the southwest corner of the Delamere Sheet area.

Lithologically, the Bynoe Formation is distinguished by the red-brown to purple and grey-green siltstone. Although similar rock types do occur in the Timber Creek Formation, they are interbedded with a variety of other rocks. Where there is doubt in this regard the stratigraphic position relative to the Skull Creek Formation is the best criterion for distinction.

Palaeogeographic significance: The minor rock-types in the Bynoe Formation display sedimentary structures such as ripple marks, small-scale cross-bedding and halite casts which are indicative of deposition in very shallow water with periods of exposure. The presence of dolomite supports this suggestion. A paralic or lagoonal environment with hypersaline conditions would result in halite and dolomite precipitation.

The depositional environment of the siltstone is unknown. It is generally medium to thick-bedded, and the absence of other structures indicates that there was little or no modification by currents either during or after deposition. As this rock-type is very wide spread, it could represent a marine facies, with the interbeds of other rock-types representing minor periods of paralic sedimentation.

Banyan Formation

The Banyan Formation is a new name for a predominantly limestone/dolomite unit which overlies the Bynoe Formation in the southern-central part of the Fergusson River Sheet area. It is considered to be part of the Bullita Group.

Distribution: The unit crops out over an area of about 500 square kilometres on the Fergusson River Sheet area, around the Flora River and Hayward Creek. It extends as far west as Scissors Creek, and it is cut-off to the east by the Dorisvale Fault. Its northerly extent is the watershed of the Flora Valley and in the south it reaches almost to the sheet margin in the Hayward Creek area. The formation occupies the flanks of a large basin structure, the central part of which is filled with Lower Cambrian basalts. A small inlier of the formation is exposed in a structural window in the Jasper Gorge Sandstone on the northern margin of the Delamere Sheet area.

Derivation of name: The name is derived from Banyan Creek, a southern tributary of the Flora River. This creek cuts across a large thickness of the formation, but outcrop is poor.

Type area: No type section has been established, but the type area is in the Flora River valley, between Haywood and Scissors Creeks.

Previous nomenclature: The Banyan Formation was originally included in the "Palm Creek Beds" and Waterbag Formation, by Randal (1962).

Stratigraphic relationships: The lower contacts of this formation are not exposed. In the Flora River section, dips appear to be consistently eastwards. The Banyan Formation in most places appears to lie conformably on the Bynoe Formation. Both the Banyan and Bynoe Formations are truncated by a weathering profile of pre-Auvergne Group age. At the western margin of outcrop 13 km east-northeast of Wombungee, however, horizontally bedded limestone of the Banyan Formation overlies siltstone of the Bynoe Formation dipping 3°E. Similar unconformable relationships of this magnitude occur locally in other areas around the margin of the Banyan Formation.

The formation is unconformably overlain by the Stubb Formation or where this is absent, the Jasper Gorge Sandstone. The Antrim Plateau Volcanics and the Mullaman Beds also overlie the formation unconformably.

The relationship of this unit to the Tolmer Group is discussed later.

Lithology and thickness: The Banyan Formation is basically a thick limestone and dolomite unit with sandstone near the base and siltstone near the top.

The sandstone near the base is interbedded with minor flaggy to blocky dolomite and fissile siltstone. The sandstone is red-brown, calcareous, and flaggy, and commonly contains halite casts. It has a weathered, iron-oxide stained "crust" around the hard unweathered rock. Small-scale cross-bedding is common within the sandstone and becomes very abundant in the grey, crystalline dolomite. The siltstone is purple to cream and light brown, fissile and dolomitic. This basal sandstone is only exposed in the cores of two gentle easterly plunging anticlines about 6 km south of the Flora River in the Hayward Creek area. It is estimated to have a minimum thickness of 45 metres.

Above the sandstone the Banyan Formation is composed almost entirely of dolomite and limestone (except for the siltstone near the top).

In the Hayward Creek Valley the sandstone is overlain by a chertified limestone-breccia. The angular fragments of chert are all sizes and commonly are white to grey. The bed is massive and contains rare small crystals of pyrite. It has a maximum thickness of 30 metres.

Overlying the chert-breccia is a sequence of grey to pink, fine-grained, crystalline, stromatolitic limestone and dolomite with some shaly limestone bands. The "Collenia"-type stromatolites are generally closely grouped in specific horizons. Columnar stromatolites also occur in association with the "Collenia"-type. Fig. 20 shows typical exposures of the columnar stromatolites. The larger single stromatolite colonies reach one metre in diameter.

Oolitic limestone and fragmental limestone and dolomite with a few bands of crystalline limestone make up the remainder of the sequence below the upper siltstone. The oolites are macroscopic and show evidence of recrystallization in part. Brecciation and re-cementation are widespread throughout. The grey to buff, fragmental limestone and dolomite contains numerous angular to rounded fragments (1 mm to 5 cm) of limestone, dolomite and chert and is the most distinctive lithology in the whole formation. Small rounded quartz grains and larger shale fragments occur in a commonly glauconitic, limestone matrix. Stromatolites also occur in forms similar to those described above. Halite casts were noted in places. Sulphide minerals have been found in the more crystalline masses within the fragmental rock; these are assumed to have been introduced during recrystallization. Galena occurs in small euhedral crystals up to 8 mm across at a point on the north side of the Flora River opposite Banyan Creek (14°46'S, 131°18'E). Pyrite crystals up to 5 mm across occur in a similar stratigraphic horizon at 14°58'S, 131°19'E.

The carbonates between the bottom sandstone and top siltstone are estimated from air photos to be 210 metres thick near the centre of the basin but thin considerably towards the margins. In the structural window on the northern margin of the Delamere Sheet area, a single band, 2.4 metres thick, of fragmental limestone appears to conformably overlie the Bynoe Formation. The lithology of this limestone and its stratigraphic position almost certainly verify the band to be Banyan

Formation. Stubb Formation unconformably overlies the bed. This is the southwestern limit of the formation and may represent the edge of its depositional basin.

The siltstone at the top of the formation has a thin sandstone capping.

Hayward Creek, in its upper course has cut through a small scarp and exposed about 15 metres of the siltstone. The sequence consists of pale purple to cream, fissile, laminated, fine-grained siltstone and shale. These are capped by a dark purple, massive, thick-bedded, friable sandstone. The siltstone may be recognised by its colour, lack of dolomite and mica, and by its regular bedding.

The siltstone is thickest towards the centre of the basin where about 60 metres occurs near the confluence of the Flora River and Piker Pocket Creek. The sequence here consists of leached light-brown, yellowish mudstones and fissile siltstones with small nodular concretions in places. It is doubtful if these beds abelong to the Banyan Formation or to the unconformably overlying Stubb Formation. They appear conformable with the carbonate sequence however, and are grouped with the Banyan Formation.

The carbonates have been replaced by chert south of the Flora Valley. The replacement appears to be related to the present topography and is assumed to have developed during Cretaceous time. Claystone, sandstone and laterite, all of Cretaceous age, overlie the chert. The chert varies from white to yellow, red and brown and is only rarely brecciated. Stromatolites are found in the chert indicating that the chert has replaced pre-existing carbonate rocks of this unit.

Distinguishing features: The Banyan Formation generally is poorly exposed and forms areas of low relief. Outcrops on areas of higher relief are chertified. The carbonate part of the sequence gives a distinctive finely-banded, bedded pattern on aerial photographs. It is generally light toned in contrast to the chert which is medium toned, unbedded and shows a higher relief pattern. The lower siltstone is light toned, exhibits low relief and appears to be unbedded. The upper siltstone can be recognized by its soft, medium-toned appearance with a capping of light to medium-toned, bedded, unjointed sandstone.

The carbonate rocks are characterized by pink fine-grained crystalline dolomite and fragmental, grey to buff limestone. Lithologically they are almost identical to the Hinde Dolomite of the Tolmer Group. The photo-pattern and topographic expression of both units are similar. Correlations between the two units however, are difficult to substantiate. The Banyan Formation is notable for its abundance of stromatolites.

The upper siltstone part of the unit may be distinguished by its purple to cream and yellowish brown, fissile, compact siltstone and shale. These contain no mica, and are rarely nodular. The lower sandstone is similar to part of the Jindackin Formation, and where they crop out in adjacent areas it is difficult to positively identify the formation on a lithological basis only.

Palaeogeographic significance: This formation represents the last sedimentation prior to an erosional break and deposition of the Auvergne Group in this area. The character of the limestone suggests it is a shallow-water deposit formed in an active environment, probably intermittently lagoonal and sub-aerial. Stromatolite colonies, are abundant in some horizons and tend to confirm the interpretation as a shallow-water environment. Brecciation, re-cementation, and cross-bedding, are all common and together with the abundance of derived fragmental limestone-dolomite, suggests considerable preconsolidation disturbance.

The distribution of this unit is restricted and it appears to have formed in an isolated basin, roughly co-extensive with its present known position.

Wondoan Hill Formation (new name)

The Wondoan Hill Formation crops out in the vicinity of Coolibah homestead and in the Stokes and Fitzroy Ranges on the Delamere Sheet area. It lies unconformably upon the Bullita Group and is absent from the sequence in many place, having been eroded prior to the deposition of the Auvergne Group. The formation consists of a series of alternating sandstones, shales and siltstones of marine origin.

Distribution: The Wondoan Hill Formation crops out over about 125 square kilometres in the central and southwestern parts of the Delamere Sheet Area. It forms the capping of the Fitzroy Range and of the hills south of Coolibah homestead. It is also exposed in the scarps west of the Victoria River crossing. The unit also crops out near Bob's Grave Spring in the southwest corner of the Delamere Sheet area. It extends southwards onto the Victoria River Downs Sheet area.

Derivation of name: The name is derived from Wondoan Hill, a prominent mesa approx. 1 km north of Fitzroy homestead on the Delamere Sheet area. The basal sandstone of the formation is well exposed there although the upper parts of the formation are absent. The type section for the formation is at the eastern end of the Fitzroy Range (Long. 130°55'E, Lat. 15°38'S).

Stratigraphic relationships: The Wondoan Hill Formation unconformably overlies the Bynoe Formation and is also the last evidence of sedimentation before a further erosional break. The unit is commonly absent from the succession and the Stubb or Jasper Gorge Formations lie unconformably on the older Bynoe Formation. The Wondoan Hill Formation is unconformably overlain by the Stubb Formation and the Jasper Gorge Sandstone.

Lithology and thickness: The formation consists of a sequence of interbedded sandstone, siltstone and shale. The lower parts of the formation are extremely glauconitic and are represented by a very friable green sandstone. The unit has a maximum thickness of about 110 metres on the Delamere Sheet area. The type section is as follows:

Thickness in metres	TOP OF HILL
6	White to brown, flaggy, thin-bedded medium-grained sandstone.
8.8	Fissile, laminated sandstone and brown siltstone. Some coarser sandstone bands.
4.9	No outcrop. Flaggy to blocky thin sandstone boulders.
10	No outcrop. Boulders of blocky, coarse to medium sandstone, with pebbly bands.
9.7	No outcrop. Blocky to massive boulders of hard, white, medium sandstone. Some haematite bands.
7.6	Fissile, pale yellow to cream dolomitic siltstone and shale.
14.3	No outcrop. Boulders of blocky to flaggy sandstone, commonly haematitic.
5.5	Blocky to flaggy, medium-bedded, coarse to medium-grained sandstone with some pebbly bands.
4.0	No outcrop. Pebbles of red micaceous haematitic shale.
1.5	Red, fissile, haematitic, micaceous shale. Overlain by 30 cm of pale-brown, fissile, thin-bedded micaceous sandstone.
8.8	No outcrop. Blocky to flaggy, pebbly, sandstone boulders.
0.6	Blocky to pebbly, coarse sandstone. Rounded chert pebbles common in sandstone.
5.5	No outcrop. Boulders of cross-bedded, flaggy to blocky sandstone.
7.9	No outcrop. In upper part hæmatite shale fragments abundant. Some flaggy cross-bedded sandstone boulders in lower part.
6.4	No outcrop. Green glauconitic sandstone and shale fragments in places.
4.0	Blocky to flaggy cross-bedded sandstone.
2.4	Massive, white to brown, medium-grained, thick-bedded sandstone.

Total 107.9 metres

Bynoe Formation

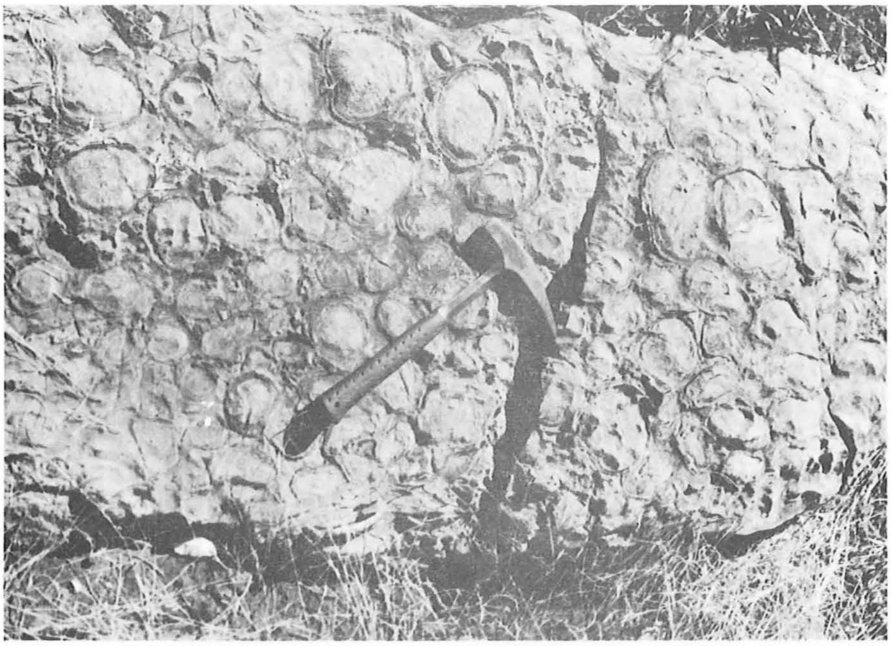


Fig.20. Colonial columnar stromatolites in the middle dolomite member of the Banyan Formation. 14 km south-west of Mount Freda - Fergusson River Sheet area. Neg. M/857.

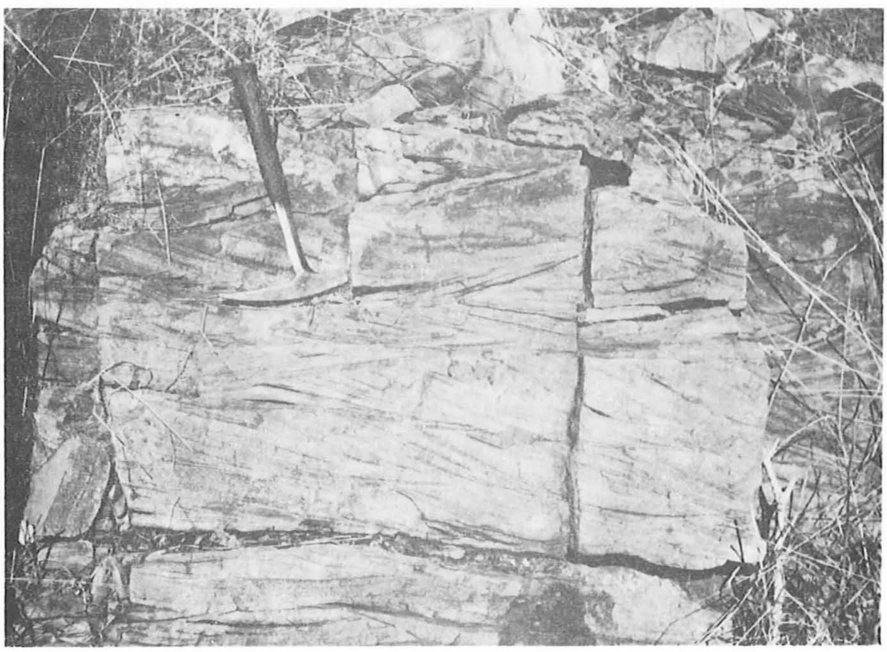


Fig.21. Cross-bedding in the basal sandstone member of the Wondoan Formation. 10 km south-west of Coolibah homestead, in the Fitzroy Range, Delamere Sheet area. Neg. GA/1466.

The basal, massive, sandstone of the Wondoan Hill Formation forms a very prominent band along the Fitzroy Range and also forms the capping of Wondoan Hill and the hills directly south of Coolibah homestead. Cross-bedding is well developed in the sandstone (Fig. 21).

It is about 30 metres thick at Wondoan Hill and consists of a thick-bedded, massive to blocky, medium-grained quartz sandstone which contains some very thin restricted micaceous lenses. The cross-bedded units are 60 to 150 cm thick.

The formation exhibits several east-facing monoclinal flexures, the most marked of these being exposed on the western side of Ryan Creek. Here a "window" of Wondoan Hill Formation is exposed in the Stubb Formation. The Wondoan Hill Formation dips beneath this younger formation and is last seen in the old Victoria River crossing where a resistant sandstone forms a natural causeway. The sequence is faulted down east of Coolibah homestead and forms the floor of the main valley.

In the southwest area of the Delamere Sheet about 3 km ENE of Bob's Grave Spring, green micaceous shale and fissile friable sandstone crop out above the purple siltstone of the Bynoe Formation. They are overlain by brown to red and pale yellow shale with interbedded blocky sandstone.

Distinguishing features: The formation is a soft to medium-toned photogeological unit, the basal bed being a light to medium toned, bedded, sandstone unit, indistinguishable from the Jasper Gorge Sandstone. The formation invariably crops out in scarps and commonly forms the soft, poorly exposed unit in the Stokes Range. The unit may be recognized by its distinctive lithology of green glauconitic sandstone and shales. The red haematitic shale and yellow dolomitic siltstone are also distinctive.

Palaeogeorgaphic significance: The Wondoan Hill Formation consists of a marine sequence possibly formed in shallow water. The presence of glauconite suggests that the lower part of the formation was formed by slow deposition in a marine environment between 20 and 750 metres in depth. The formation is assumed to be deposited in shallowing water since sandstones become more abundant upwards. The erosion which occurred following the deposition of this unit has commonly removed much of it.

AUVERGNE GROUP

The Auvergne Group comprises a shallow water sequence of siltstone, sandstone, and dolomite, totalling some 600 metres in thickness. (Pontifex et al, 1968). Its outcrop is continuous from the northeastern part of the Auvergne Sheet area, to the Port Keats, Fergusson River, and Delamere Sheet areas. Outcrop extends south beyond the area dealt with this report.

The Auvergne Group is older than the Adelaidean tillites, of the Duerdin Group (Pontifex, op.cit), and is thought to be of Adelaidean age. Its relationships to the Tolmer and Fitzmaurice Groups are not known.

Stubb Formation

The Stubb Formation is a new name and it applies to the basal unit of the Auvergne Group. The formation consists of shale, siltstone and sandstone and conformably underlies the Jasper Gorge Sandstone. In contrast to the Jasper Gorge Sandstone which is very widespread, the Stubb Formation is restricted in both outcrop and occurrence

Distribution: The Stubb Formation is a relatively soft unit and crops out sparsely, mainly in scarps. An area of about 1200 square kilometres, extending west of Delamere homestead to the Victoria River is composed of this unit. It extends as far north as Innesvale homestead but is not present west and north of Coolibah homestead. The formation also occurs extensively in scarp outcrops between the Victoria River gorge and the Timber Creek - Victoria River Downs road. In the northern-central part of the Delamere Sheet area a small inlier of the unit crops out. There are also several small outcrops in the south-central part of the Fergusson River Sheet area. The formation extends southwards onto the Victoria River Downs Sheet area.

Derivation of name: The name is derived from Stubb Yard (Long. 131°10', Lat. 15°36'S) on the Delamere Sheet area.

Type area: The formation is well exposed in Sullivans Creek valley which is followed by the Willeroo - Timber Creek road.

Stratigraphic relationships: The Stubb Formation conformably underlies the Jasper Gorge Sandstone and is the basal unit of the Auvergne Group. It is commonly absent from the sequence, the basal rock type then being the massive Jasper Gorge Sandstone. The Stubb formation, where present, grades upwards into the Jasper Gorge Sandstone, and the boundary is defined at the bottom of the lowest prominent massive sandstone. The Stubb Formation unconformably overlies the Wondoan Hill Formation, the Bynoe Formation, and the Banyan Formation. It is itself unconformably overlain on its eastern margin of outcrop by the Antrim Plateau Volcanics.

Lithology

The formation ranges in lithology from fissile dark grey shale at the base through red-brown micaceous quartz siltstone to blocky white friable sandstone at the top. The upper sandstone beds commonly form hill cappings which on aerial photographs are indistinguishable from Jasper Gorge Sandstone. The unit has a maximum thickness of about 210 metres which is best exposed in the type area. A large thickness of poorly exposed Stubb Formation occurs in the Victoria River Gorge, south of the main road crossing.

In the Sullivan Creek valley the lower silty parts of the unit are well exposed in road cuttings and small cliffs. A composite section measured in this area is as follows:-

Thickness in metres	Jasper Gorge Sandstone
13.7	Blocky to massive friable creamy-white to brown sandstone; little cementation; rounded quartz grains; medium to thick-bedded, medium to coarse-grained; iron oxide staining present. Some cross-bedding.
11.3	Blocky to flaggy quartz sandstone, medium-bedded.
15.2	Flaggy, grey, fine-grained sandstone.
15.2	No outcrop. Grey to white flaggy fine-grained sandstone boulders.
7.6	Grey siltstone with some sandy beds. Little outcrop.
4.6	Flaggy to blocky, white to brown cross-bedded sandstone.
13.4	White to brown flaggy sandstone; cross-bedded with some interbedded siltstone. Some small pebbly bands. Mud flakes common.
6.1	White to brown flaggy sandstone, cross-bedded with interbedded siltstone 60 cm band of grey to brown shale.

9.1	Grey to purple fine-grained sandstone and interbedded siltstone.
18.3	Micaceous purple to grey and brown siltstone. Some harder sandy bands of iron rich, nodular, fine-grained grey to red-brown and purple sandstone.
79.2	30 metres of brown shale above a 15 cm band of sandstone. Then 48 metres of iron-stained, grey and purple, friable siltstone and shale. Some fine sandstone bands.

Total 193.7 metres   Base not seen

Several kilometres further east on a small hill, 100 metres south of the main road, 36 metres of grey, purple and yellow-brown friable shale and siltstone crop out. They are very micaceous and weather purple. Mud cracks are common. The shale and siltstone contain several hard, white to grey and purple siliceous sandstone lenses ranging from 2.5 cm to 60 cm thick. The fine-grained, indurated, quartz sandstone is composed of well sorted, well rounded white, quartz grains.

The formation thins sharply near the westward limit of the scarp of the Stokes Range and is absent near the Victoria River Downs - Timber Creek road. This is assumed to be due to an uneven surface of deposition but some evidence points to an erosional phase during the period of deposition of the unit.

At Long. 130°41'E, Lat. 15°54'S a section of the whole sequence was measured as follows:

Thickness in metres	Jasper Gorge Sandstone
7.3	Laminated, fissile, cream and pale-purple siltstone. Shaly in purple zones. No obvious structures apart from depositonal disconformities.
6.7	Flaggy to massive sandstone, medium-grained, predominantly thin-bedded; white to brown and purple. Some brown very fine-grained laminated sandstone bands.
18.9	Brown to white, blocky to flaggy sandstone with some silty bands. Sandstone medium to fine-grained, well sorted, grains sub-rounded; thin to medium-bedded, with abundant cross-bedding. Origin of foresets - 340°.
6.7	Flaggy to blocky, medium-bedded sandstone. Darker bands about 0.6 cm thick, with well rounded grains. Outcrop poor.

7.9	Cream to brown, laminated, fissile to flaggy very micaceous siltstone.
13.7	Grey shale weathering to iron-stained beds. Some silty micaceous bands (0.6 to 15 cm thick). Friable and fissile.
38	Laminated, fissile, friable grey shale with thin fine-grained siltstone and sandstone lenses.
76	No outcrop - probably shale.
Total 175.2	Bynoe Formation

Cross-bedding and slump structures suggest a west to south-west provenance in this area.

Good outcrop is rare but at one locality in the Stokes Range 25 km SSW of Coolibah homestead, fissile, laminated, micaceous, brown siltstone and shale crops out well. It contains a 1-metre band of hæmatitic sandstone breccia and some large lenses of blocky to massive, friable, medium-grained sandstone.

The Stubb Formation displays abundant sedimentary structures in the Stokes Range - Victoria River area. Figure 22 shows a typical slump structure in the western part of the range. Flute casts, skip casts, load structures, ripples marks and cross-bedding are all common.

In an inlier within the Jasper Gorge Sandstone 3 km east of Mount Hogarth near the northern margin of the Delamere Sheet area the Stubb Formation consists of blocky to flaggy, medium-bedded, white to red-brown quartz sandstone, overlain by poorly bedded flaggy to fissile, grey micaceous siltstone.

On the Fergusson River Sheet area 30 km east-southeast of Wombungi outstation an unusual rock-type crops out interbedded with grey to purple micaceous shale and siltstone of the Stubb Formation. It consists of a massive hæmatitic siltstone with cone-in-cone structures defined by calcite.

Further north at a point about 28 km ENE of Wombungi outstation 2-metre thick layer of laterite underlies the Jasper Gorge Sandstone. It consists of quartz and shale fragments in a ferruginous matrix, and unconformably overlies dolomite of the Banyan Formation. It is possible that this ferruginization occurred during the period of deposition of the Stubb Formation.

6 km NE of Wombungi outstation the Bynoe Formation below the Jasper Gorge Sandstone is also ferruginized and silicified. This period of ferruginization, possibly a laterite-forming phase, is thought to be represented by the hæmatitic sandstone and breccia which is widespread within the Stubb Formation.

Distinguishing features: The Stubb Formation forms a soft, medium-toned, photogeological unit with some outstanding hard bands near the top. It generally has a restricted outcrop in scarps and is only well exposed in steep gullies, truncated spurs or road cuttings. It is at the base of the Auvergne Group and lithologically it can be distinguished by its micaceous nature and its dark grey basal shale where present. The ferruginous bands are unique to this unit and it also contains abundant sedimentary structures.

Palaeogeographic significance: The unit represents the first deposition after a period of erosion and forms the base of the Auvergne Group in many places. Sedimentation began with mud and silt which appear possibly as a function of outcrop, to be thicker in the west. Deposition became progressively more arenaceous with time and in places graded imperceptibly into the Jasper Gorge Sandstone. It seems to have been deposited "patchily" in basin areas on the eroded surface.

The formation is probably marine in origin. The rate of deposition was rapid as shown by the lensing of beds, and by the abundant sedimentary structures.

Jasper Gorge Sandstone

The Jasper Gorge Sandstone covers a very large area on the Delamere and Fergusson River Sheet areas. It consists of a massive to flaggy, medium-grained, white to brown sandstone with a very uniform lithology throughout. The unit truncates the Bullita Group, with strong unconformity in places. It forms the base of the Auvergne Group where the underlying Stubb Formation is absent. The unit has been

Fig.22. Slump folding in the upper part of the Stubb Formation.
22 km east-north-east of Bardia Yard, Delamere Sheet area.
Neg.M/797.

defined and described by Pontifex et al (1968) on the Auvergne Sheet Area. Part of the "Palm Creek Beds" on the Fergusson River Sheet area (Randal, 1962) have been found to belong to this unit, and hence have been allocated to it.

Distribution: The formation crops out over 4500 sq km in the western part of the Delamere Sheet area. It also covers 500 sq km in the south-central part of the Fergusson River Sheet area. The sandstone mostly forms a scarp - plateau topography since it is resistant to weathering.

Stratigraphic relationships: The formation unconformably overlies all members of the Bullita Group (Wondoan Hill Formation, Bynoe Formation, Banyan Formation, Bardia Chert Member, Skull Creek Formation and Timber Creek Formation). In places it overlies them with marked discordance but in the central part of the Delamere Sheet area there is little angular discordance between the Jasper Gorge Sandstone and the Wondoan Hill and Bynoe Formations. It conformably overlies the Stubb Formation.

The Jasper Gorge Sandstone is conformably overlain to the north and west by the Angalarri Siltstone; the contact is well exposed near the Ikymbon River on the Delamere Sheet area as shown in Figure 23. In some areas especially in the northeast of the Delamere Sheet area the Jasper Gorge Sandstone is unconformably overlain both by Antrim Plateau Volcanics and Mullaman Beds. The volcanics and their associated sediments commonly lie within old valleys and channels in the Jasper Gorge Sandstone.

Lithology: The Jasper Gorge Sandstone is a white to brown, flaggy to massive, medium-grained sandstone. It is very uniform in lithology throughout its outcrop area. Commonly it has a thin basal conglomerate in the western area of outcrop and also contains a considerable thickness of green and purple shale and siltstone. The sandstone consists of well sorted, well rounded grains of quartz with very few accessory minerals. It was probably derived from a pre-existing sandstone since the grains show high sphericity and the rock is very mature. The quartz grains are 0.1 mm to 2 mm in diameter and have some minor syntaxial growth. The matrix is composed of more angular quartz crystals. Accessory minerals which make up about 3% of the total volume consist of rounded grains of tourmaline, volcanic glass and rarely zircon with minor muscovite. One sample showed poor sorting with a possible bimodal distribution but generally, sorting is very good.

The formation is generally less than 30 metres thick, although it does appear to attain 105 metres in the Victoria River Gorge area.

A section through the Jasper Gorge Sandstone was measured about 6 km SSW of Trinity Reach on the northwest side of the Victoria River:-

Thickness in metres	Top of Hill
42.6	Flaggy to blocky, medium-grained sandstone; white to brown.
4.6	Indurated, massive thick-bedded medium-grained sandstone.
6.1	No outcrop - possibly flaggy fine-grained sandstone and coarse siltstone.
17.1	Laminated, micaceous quartz siltstone and lenticular mudstone and sandstone. Cross-bedding and ripple marks abundant. Fig. 24 shows probable sandstone dykes.. Beds fissile to flaggy, rarely blocky.
5.5	No outcrop - probably soft beds.
10.7	Massive and blocky, medium to thick-bedded, medium-grained sandstone with a 30 cm basal conglomerate.
Total 86.6	Skull Creek Formation

In the western part of the Stokes Range there is a thinner ~~though somewhat~~ similar sequence of beds:-

Thickness in metres	Top of Hill
7.6	Massive, thick-bedded, red-brown to white sandstone. Indurated in lower part.
6.1	Purple and green-grey, coarse-grained, spotted siltstone; abundant cross-bedding; blocky, laminated beds.
22.9	Flaggy, thin-bedded, friable sandstone; indurated near top.
7.6	Blocky, medium to thin-bedded sandstone white to grey with dark bands. Some local discontinuities lensing, washouts, cross-bedding, ripples and mud cracks; beds become flaggy to fissile near top with thin interbed of purple siltstone.

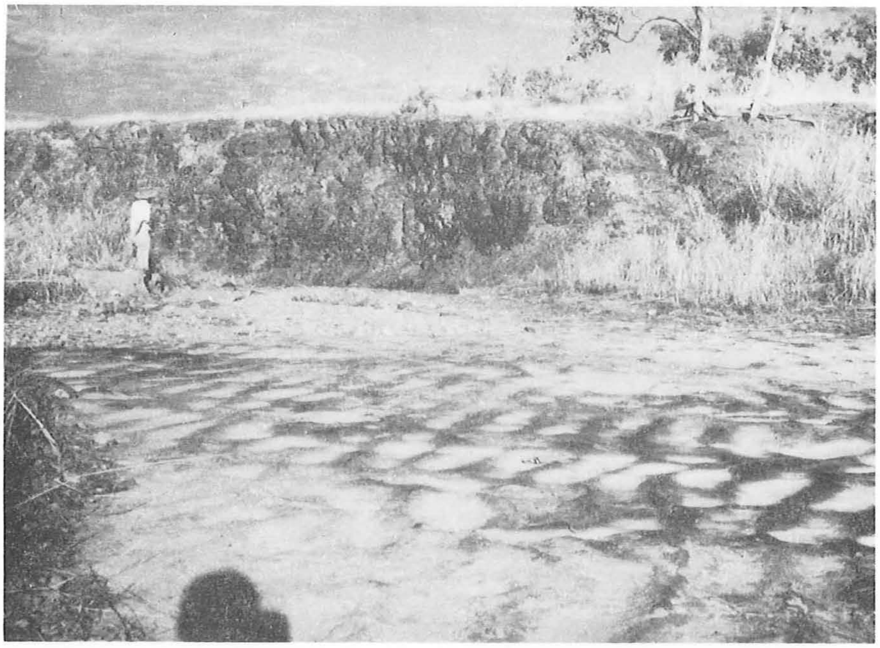


Fig.23. Uppermost surface of Jasper Gorge Sandstone exposed in creek, overlain by Angalarri Siltstone. 8 km south of Mount Thymann, Delamere Sheet area. Neg.GA/1176.

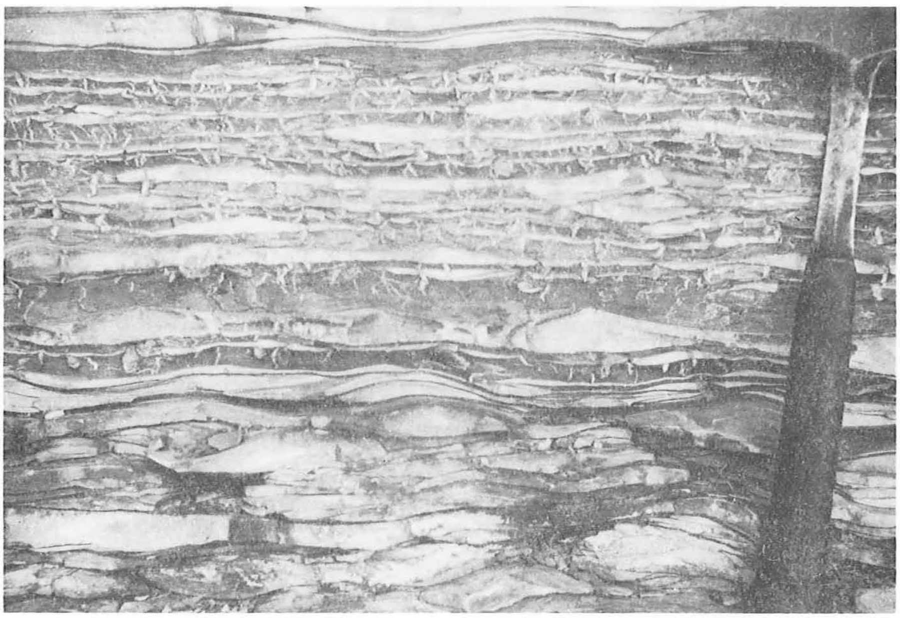


Fig.24. Vertical section of Jasper Gorge Sandstone showing small sandstone dykes and lenticular thin sand beds produced by ripple structure. 6 km south-south-west of Trinity Reach, Delamere Sheet areas.

6.1	Massive, brown to white, medium to thick-bedded sandstone. Widely spaced jointing.

Total 50.3 Stubb Formation

Further east along the scarp of the Stokes Range the basal sandstone becomes reduced to about 4 metres in thickness, overlain by 25-30 metres of flaggy sandstone and siltstone which is capped by 7.5 metres of blocky friable sandstone. The siltstone beds lense out southeastwards.

In the Stokes Range near the Victoria River crossing the basal massive to blocky, ferruginous sandstone, forms a very prominent scarp about 36 metres high.

A section 6 km ENE of Stubb Yard in the Sullivan Creek valley shows the following sequence:-

Thickness in metres	Top of Hill
7.9	Flaggy, white to cream and brown, friable, thin-bedded sandstone. Indurated near top.
6.7	Blocky, medium-bedded, medium-grained, white to cream, brown and purple sandstone.
9.4	Flaggy to blocky, medium-bedded, white to brown and purple sandstone. Near the top is a 1.5 metre band of limonite-spotted, purple and white, friable sandstone.
8.5	Blocky sandstone, becoming flaggy near the top; friable, medium-grained, white to purple and brown, mud flakes present, also cross-bedding.
14.6	Massive, thick-bedded, white to red-brown, cross-bedded, coarse-grained sandstone. Nodular weathering in upper part.

Total 47.1 metres Stubb Formation

The Jasper Gorge Sandstone shows some interesting features north of Ingaladdi Waterhole. Six kilometres north of the waterhole Antrim Plateau Volcanics and associated sediments lie in a channel within the Jasper Gorge Sandstone. The volcanics appear to crop out in partly sand infilled river channels. The Jasper Gorge Sandstone in this region is grey, blocky, thin-bedded and friable.

Ten kilometres north of Ingaladdi Waterhole large-scale cross-bedding is developed (Fig. 25). The rock is a massive, white to purple, medium-grained, medium-bedded, friable sandstone, composed of well rounded quartz grains which rapidly weather t o white sand. Some pebble bands are present. Coarser-grained bands commonly define the cross-beds which indicate a provenance direction from the east north-east.

In the Crocodile Yard - Mount Thymanan region of the Delamere Sheet area, the topmost beds of the Jasper Gorge Sandstone are exposed. They consist of up to 6-metre thick bands of medium to coarse-grained sandstone interbedded with up to 2.5 metre thick bands of siltstone. The sandstone varies from thick to thin-bedded with abundant cross-bedding, the individual foresets measureing up to 3 metres thick and 9 metres long. The sandstone is poorly sorted and contains some pebbly inclusions; mud flakes are common. Minor barytes is scattered through the sandstone.

On the Fergusson River Sheet area, the Jasper Gorge Sandstone is largely sand covered and shows less surface jointing than further south. The rock in hand specimen is identical to that on the Delamere Sheet area but the unit commonly weathers to a grey colour.

Nineteen kilometres northwest of Collia Waterhole a small outcrop of brown to white, medium to thick-bedded, blocky to massive sandstone probably belongs to the Jasper Gorge Sandstone. It underlies the Angalarri Siltstone and contains abundant small-scale cross-beds.

On the Port Keats Sheets area a similar small outcrop of Jasper Gorge Sandstone occurs in the North Meeway Plain. It is cut off to the west by part of the Victoria River Fault system.

Nineteen kilometres south of Timber Creek, on the Auvergne Sheet area, a basal chert-sandstone breccia which was not noted by Pontifex et al (1968) crops out. The rock consists of poorly rounded and sorted clasts of chert and, more rarely, quartzite and sandstone, in a poorly sorted fawn sandstone matrix. The clasts are generally 2-3 mm in diameter but do reach 10 cms in places. (Fig. 26). This basal conglomerate occurs locally around Timber Creek, but is not developed elsewhere in the area mapped.

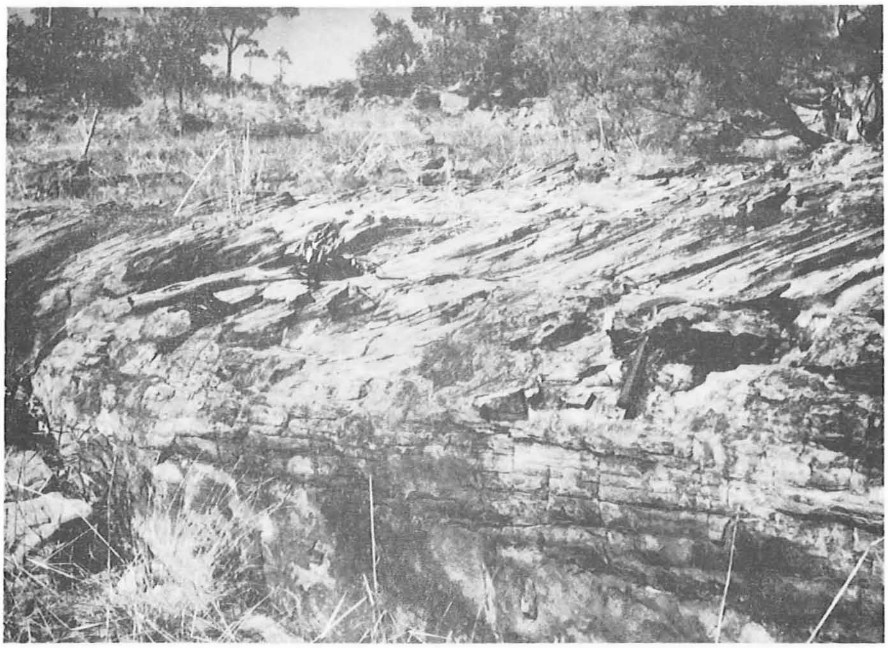


Fig.25. Cross-bedding in Jasper Gorge Sandstone. 10 km north of Ingaladdi Waterhole. Delamere Sheet area.
Neg. GA/1464.

Fig.26. Poorly sorted basal sedimentary breccia of the Jasper Gorge Sandstone. Angular clasts of chert and quartzite lie in a sandstone matrix. 19 km south of Timber Creek, Auvergne Sheet area. Neg.M/796.

Distinguishing features: The Jasper Gorge Sandstone is a light to medium-toned photogeological unit and is easily distinguished by its bedded and very jointed nature. It is lithologically a monotonous sandstone unit with some interbedded green and purple siltstone. The siltstone is well developed in the western part of the region, but is absent east of the Victoria River Gorge. The unit forms most of the scarps and plateaux present on the Delamere Sheet area. Cross-bedding and mud flakes are commonly present but there are no widespread load casts, flute casts or slump structures in this unit as in the underlying Stubb Formation

Palaeogeographic significance: The surface of deposition of the Jasper Gorge Sandstone was very regular and since lithology and thickness are very uniform over a large area, a progressive marine transgression over a peneplained area is suggested. The sandstone is a shallow-water deposit and the abundance of cross-bedding indicates considerable current movement. Lack of other sedimentary structures however, suggests that no high gradients were present on the depositional surface. The presence of shale and siltstone in the west indicates that a deeper-water environment prevailed in that area at least during part of the deposition of this unit.

Angalarri Siltstone

Distribution: The Angalarri Siltstone was previously defined and described for the Auvergne Sheet area by Pontifex et al. (1968). On the Delamere Sheet area it forms the Angalarri River valley and extends northwards to the headwaters of the Angalarri and Fitzmaurice Rivers on the Fergusson River Sheet area. It also occurs between the Collia Fault and the Wingate Plateau. On the Port Keats Sheet area it crops out along the eastern margin and the Koolendong Valley and Meeway Plain and in isolated outcrops in the Meeway Plain.

Reference area: The reference area is the Baines River-Yambarra Range area, 19 km north-northeast of Auvergne homestead in the Auvergne Sheet area. (Pontifex et al., 1968).

Derivation of name: The unit was named by Randal (1962) after the Angalarri River in the southwest corner of the Fergusson River Sheet area.

Stratigraphic relationships: The Angalarri Siltstone is a constituent formation of the Auvergne Group.

It conformably overlies the Jasper Gorge Sandstone, a relationship which may be seen between the Ikymbon and Angalarri Rivers and near The Twins. About 8 km south of Mount Thymanan, highly fissile grey-green siltstone of the Angalarri Siltstone rests on an upper exposed surface of Jasper Gorge Sandstone which shows large interference ripple marks (Fig. 28). Similar relationships and similar structures in the Jasper Gorge Sandstone are exposed in the northernmost margins of the Meeway Plain.

The unit is conformably overlain by the Saddle Creek Formation, a relationship which is shown in the scarp slopes of the ranges forming the western margin of the Angalarri River valley and along the eastern margin of the Koolendong Valley and Meeway Plain. The Antrim Plateau Volcanics and associated interbedded sandstone unconformably overlie the Angalarri Siltstone near The Twins. The Jarong Conglomerate overlies the unit southwest of the Collia Fault and the Mullaman Beds unconformably overlie it in the northern part of the Delamere Sheet area and south of Collia Waterhole.

Lithology and thickness: The Angalarri Siltstone has much the same lithology, thickness, and physiographic expression as previously described for the Auvergne Sheet area (Pontifex et al., 1968). Notable exceptions are the inclusion of sandstone interbeds in some areas, and relatively more dolomite interbeds in others.

The sandstone interbeds occur in an area extending from The Twins, along the east of J41 Yard, between and to the south of the Ikymbon and Angalarri Rivers, in isolated remnants sitting on the Jasper Gorge Sandstone plateau; the southernmost of which is Valley Hill. These interbeds are in the lower part of the unit, and consist of fine-grained silty, sericitic sandstone and form bands up to 4.5 metres thick. One or two in particular form prominent benches in otherwise soft-weathering slopes. They form marker-horizons which are easily followed on the air photos for up to 64 km.

The following three sections are from this area. They are the most complete sections measured from the Angalarri Siltstone, but they only provide a minimum thickness since the Saddle Creek Formation does not overlie the unit at any one of these localities. The base of the unit at the contact with Jasper Gorge Sandstone is clearly defined in each, the rocks overlying each section are Mullaman Beds and/or Cainozoic laterite.

I : Section through Angalarri Siltstone at Valley Hill, a prominent isolated hill of flat-lying sediments, conformably lying on the Jasper Gorge Sandstone, 32 km northwest of Coolibah homestead, Delamere Sheet area.

Thickness in metres	
	Capping of laterite. Base is irregularly nodular and lumpy, passes up into regularly pisolitic laterite.
7.5	Siltstone: white, massive and completely structureless, somewhat porcellinized. Irregular patches of mottled, and ferruginized rather clayey rock. (Believed to be a leached zone of a laterite profile within Angalarri Siltstone).
12.2	Poor exposure. Siltstone: light-grey, white, laminated, fissile. Apparently leached Angalarri Siltstone.
0.6	Sandstone: mottled, variegated, yellowish brown to red.
4.6	No exposure
0.9	Siltstone bands: light-grey to white, apparently leached.
7.6	No outcrop, scree-covered.
0.9	Sandstone: greyish-red, silty, fine-grained, massive; flaggy towards top. Forms a distinct platform.
0.9	Siltstone: grey-green to reddish, fissile.
3.0	Sandstone: fine-grained, silty, grey, sericite, limonite-spotted, flaggy to thin-bedded towards the top.
4.0	Poor exposure; mainly fissile siltstone.

2.1	Bench-forming band of sandstone: massive, grey, fine-grained, laminated and thin-bedded towards top where it grades into fissile siltstone above it.
34.1	Largely scree-covered. Mainly fissile siltstone, slightly coarser and more sericitic than the lower 48.8 metres, and may grade to fissile fine-grained sandstone. Grey-green, laminated, mud cracks, sole markings, ripple marks and minor halite casts. Sericitic lamellae of mudstone. This siltstone contains minor interbeds of massive fine-grained sericitic sandstone (as in the lower bench), in bands up to 61 cm thick.
2.4	Minor bench-forming band of siltstone: grey to greenish grey, fine-grained, sericitic. Overall massive, but laminated to thin bedded. Some mud flakes, fine-scale cross bedding, minor limonite spottings.
48.8	Slope, mostly scree-covered. Minor outcrop of reddish brown fissile siltstone, grey-green and shaley in places.

Total 129.7 metres — Base of hill formed by top of Jasper Gorge Sandstone

II : Section through Angalarri Siltstone; forming an isolated laterite capped hill lying on Jasper Gorge Sandstone, 8 km south of Mount Thymanan, Delamere Sheet area.

Thickness in metres	
47.2	Poor exposure. Siltstone with up to 5% interbeds of fine-grained sandstone. Siltstone is green-grey, weathers reddish, fissile, laminated; complete scree cover near top.
39.6	Siltstone, to fine-grained sandstone. Poor exposure and much weathered. Generally brownish red, fissile, breaking into thin plates rather than flakes as in basal 150 ft. Apparently fairly homogeneous; interbeds of sandy siltstone rare.
18.3	Siltstone: grey-green weathers reddish, generally fissile, slightly coarser than in basal 47.2 metres. Minor thin (46 cm) interbands of sericitic silty sandstone.
1.8	Sandstone: fine-grained, silty matrix, grey-green, limonite-spotted and slightly sericitic; weathers flaggy to rounded, bench and platform-forming.
47.2	Poor exposures. Siltstone: grey-green, fissile to platey.

4.6	Sandstone: grey, fine-grained with silty sericitic matrix, generally massive but fine bedding seen on weathered surface. Forms fairly prominant bench around lower part of hill.
25.9	Generally scree-covered. Siltstone in creeks: grey-green, highly fissile to shaley, weathering to flakes, laminated, mud cracks.

Total 184.6 metres   Base of hill, top of Jasper Gorge Sandstone.

III : Section through Angalarri Siltstone, 10 km south-east of J41 Yard, Delamere Sheet area.

Thickness in metres	Mullaman Beds
17.1	Siltstone: fissile to platey, laminated to thin-bedded, grey, weathers reddish; immediately under Cretaceous sandstone it is leached with patches of ochreous powder.
1.2	Minor bench of fine-grained silty sandstone as in lower benches
9.1	Scree cover of fissile, shaley siltstone and fine-grained sandstone.
3.0	Upper main bench and platform. Sandstone: fine-grained, silty matrix, laminated, massive, sericitic, limonite-spotted.
30.5	Poor exposure of siltstone: fissile, grey-green to reddish.
41.2	Minor bench-forming band of fine-grained sandstone: massive, grey, sericitic silty matrix.
4.6	Poor outcrop. Minor exposure of grey-green shaley siltstone. Much scree cover of fine-grained sandstone.
1.8	Lower bench and platform. Sandstone: grey to khaki, silty matrix, limonite-spotted, locally sericitic; massive, but thin-bedded.
45.7	Poor exposure, mainly siltstone: grey-green to khaki, fissile, weathers to plates and scales, laminated, some sericitic, locally flaggy
9.1	No outcrop, scree of fissile and platey siltstone.

Total 123.3 metres   Base of hill, top of Jasper Gorge Sandstone.

Where the Angalarri Siltstone is not capped by Cretaceous sandstone or by laterite it forms low rounded hills, generally covered by scree of fissile and platey siltstone.

It forms the slopes below the scarp formed by the Saddle Creek Formation and Pinkerton Sandstone, along the northwestern side of the Angalarri River, and along the Fitzmaurice River. It is generally covered by scree from the overlying sandstone units, but it is well exposed 8 km north of Mount Kukpalli where it consists of typical grey-green, extremely fissile siltstone, varying locally to platey, and flaggy. The rock is glauconitic and reddish brown (weathered) bands are common. Thin-bedded to flaggy limestone bands occur at plain level near Mount Woolonjang and also 10 km northwest of Wombungee.

Along the southern side of The Twins Fault (or Monocline) the Angalarri Siltstone dips steeply to the south. One of the silty sandstone interbeds about 4 metres thick is at the base, and lies directly on Jasper Gorge Sandstone. The fissile siltstone found elsewhere below the silty sandstone has apparemtly been removed by faulting. In places, this silty sandstone band has obviously been affected by the faulting, and has a crude metamorphic foliation or cleavage (parallel to the fault), is sericitic and is extensively ferruginized. It was probably this foliated rock which erroneously led Randal (1962) to map the rocks of this area as Noltenious Formation.

The foliated, sandstone is overlain by about 5 metres of fissile, ferruginized siltstone, and then by a 3-metre bed of silty sandstone which is relatively uneffected by the fault and can be followed, for about 12 km.

This silty sandstone band is overlain by about 100 metres of chocolate, (and lesser grey-green), fissile, shaley siltstone which weathers to fine plates and scale-like fragments.

The chocolate siltstone is overlain by 30 metres of grey-green shaley siltstone which contains up to 30 beds of flaggy dolomite and some flaggy, hard dolomitic grey siltstone. The dolomite beds are up to 25 cm thick. Above the dolomite bands the formation consists entirely of grey-green shaley siltstone.

Between the Wingate Plateau and the Collia Fault, the Angalarri Siltstone generally occurs in scree-covered slopes capped by Mullaman ~~Beds~~. About 16 km west-southwest of Collia Waterhole where it is overlain by the Saddle Creek Formation it consists of red-brown fissile siltstone with interbeds 1 cm thick of grey limestone and calcareous siltstone, from 1 cm to 30 cm apart. The base is not exposed in this area. About 8 km east-southeast of Collia Waterhole up to 42 metres of grey-green, shaley and fissile, slightly sericitic siltstone, forms slopes below Cretaceous sandstone and Cainozoic laterite capping. In some slopes it has a homogeneous composition. In others, slightly higher in the sequence, the unit consists of pinkish grey dolomitic siltstone as flaggy bands up to 8 cm thick, which are intercalated with red-brown and grey-green fissile siltstone, in bands up to 25 cm thick.

The Angalarri Siltstone in the Collia area is similar to the unit further south but thin interbedded carbonate rocks are more abundant near Collia and the siltstone is commonly more highly weathered, which produces a greater proportion of the red-brown coloured siltstone.

In the northern part of the Meeway Plain the Angalarri Siltstone occurs in isolated outcrops composed of laminated to thin-bedded, grey-green and red-brown, and fissile siltstone with some interbedded thin (2 cm) sandy bands.

The upper contact in the Angalarri and Fitzmaurice Rivers area is distinct, with a very marked change from fissile siltstone to the medium to coarse-grained, poorly sorted, basal sandstone of the Saddle Creek Formation. However on the east side of the Koolendong Valley, near the southern margin of the Port Keats Sheet area, the contact between Angalarri Siltstone and Saddle Creek Formation is gradational: over a vertical distance of 6 metres fissile siltstone of the lower unit grades up into sandstone of the upper unit.

Thickness: Pontifex et al. (1968) calculated a minimum thickness of 300 metres for the Angalarri Siltstone in the Auvergne Sheet area. However more recently a bore located 3 km northeast of Bradshaw homestead penetrated 275 metres of the unit without entering the underlying Jasper Gorge Sandstone and at least 120 metres of the unit forms the cliff slope immediately above the plain on which the bore was sunk. A minimum thickness of 395 metres can therefore be assumed near Bradshaw.

In 1968 the maximum thickness measured, from the base up to its contact with overlying Mullaman Beds, was 185 metres near Mount Thymanan. A total thickness calculated from an assumed dip of 1° is about 500 metres in the Mount Thymanan area.

Distinguishing features: The relatively uniform lithology of the Angalarri Siltstone over wide areas is characteristic. The exceptions described above, particularly the inclusion of prominent bench-forming silty sandstone bands in the J41-Mount Thymanan area are local (in terms of the extent of this unit throughout the Victoria River Basin). The highly characteristic basal sandstone of the overlying Saddle Creek Formation is diagnostic of its upper contact.

Palaeogeographic significance: The Angalarri Siltstone is widespread, and is believed to have been deposited in marine water of moderate depth (Pontifex et al, 1968).

Saddle Creek Formation and Pinkerton Sandstone

The Saddle Creek Formation and Pinkerton Sandstone have previously been defined and described for the Auvergne Sheet area by Pontifex et al. (1968). They are discussed together here because of their close association in the field.

Distribution: The main outcrop of the formations is along the margin of a dissected plateau or tableland which extends from the northwest corner of the Delamere Sheet area to the southwest and central-west of the Fergusson River Sheet area. Outcrops also occur between the Collia Fault and Wingate Plateau in the Fergusson River Sheet area and along the eastern margin os the Koolondong Valley and Meeway Plain in the Port Keats Sheet area.

Reference area: The reference locality for both formations is in the Pinkerton and Yambarra Ranges in the Auvergne Sheet area (Pontifex et al, 1968).

Derivation of name: See Pontifex et al (1968).

Stratigraphic relationships: Both units are constituent formations of the Auvergne Group. The Saddle Creek Formation conformably overlies the Angalarri Siltstone and is conformably overlain by the Pinkerton Sandstone. The Pinkerton Sandstone is conformably overlain by Lloyd Creek Dolomite.

Seven sections have been measured through these formations in the area and these are diagrammatically represented in Fig. 27.

The Saddle Creek Formation in section No. 1 is lithologically similar to the unit as previously defined for the northeastern part of the Auvergne Sheet area. The formation is thicker in Section No. 2 on the eastern margin of the north Koolendong Valley. Along the margin of this valley, the unit is photogeologically distinct from the overlying Pinkerton Sandstone. The lower boundary cannot always be traced positively since flaggy sandstones in some places occupy scarps which give a similar photo pattern to Angalarri Siltstone. The lower contact in this area is gradational over 5 to 10 m. Typical Angalarri-type siltstones give way to siltstone with thin (2 to 10 cm) beds of fine-grained quartz sandstone. The proportion of such interbeds increases upwards until they predominate, with subordinate siltstone. The siltstones then disappear completely, and thicker, flaggy sandstone crops out.

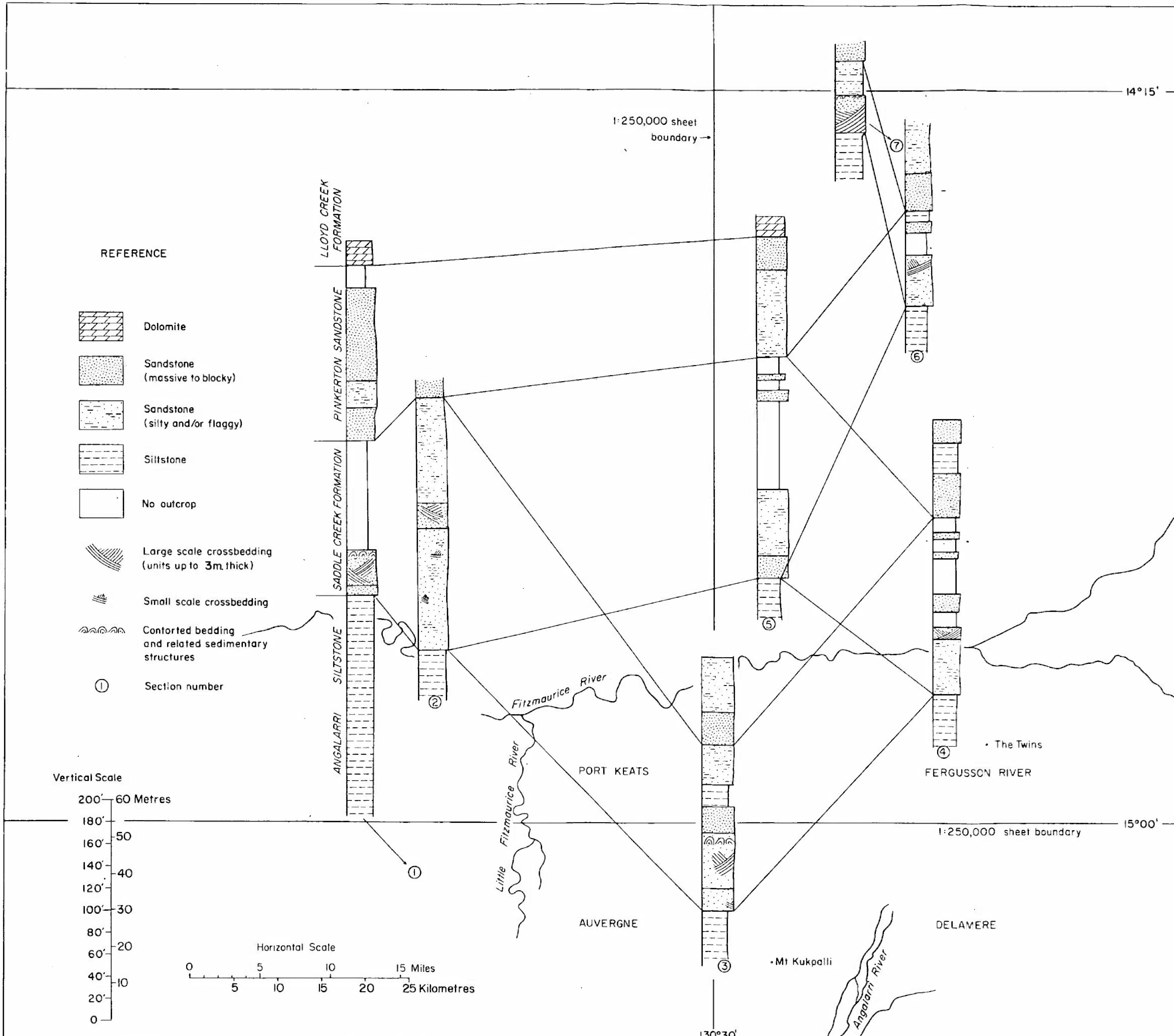
There is considerable facies change within the Saddle Creek Formation along the margin of the northern Koolendong Valley and the Meeway Plain. Near the Fitzmaurice River the formation consists predominantly of fine to medium-grained, blocky to massive, cross-bedded and ripple-marked sandstone. Some mudcracks and contorted beds occur. There is no siltstone overlying these sandstones, but the white, hard basal Pinkerton Sandstone does overlie them.

Five km further north, bordering the Meeway Plain, the lower part of the unit continues as a massive, cross-bedded, reddish sandstone. Several feet of blocky white sandstone overlies this, and is in turn overlain by up to 15 m of poorly outcropping, sandy siltstone. This is typical of the unit much further south, suggesting that the sandstone near the Fitzmaurice River is a local development only.

The basal sandstone of the Saddle Creek formation is exposed in a valley 16 km north of the Meeway Plain. It is a continuation of the margin of the Plain but separated from it by the cover of the Mullaman Beds. Large scale cross bedding is typical of this exposure.

Similar facies variations in the upper part of the Saddle Creek Formation appear to exist in the area between Mount Kukpalli, The Twins, and northwest of The Twins in the scarps immediately north and south of the Fitzmaurice River. Considerable siltstone is shown in sections 3, 4, and 5. By flying along the scarp in a helicopter, variations in the thickness of the sandstone bands, and the resultant thinning of the siltstone can be recognized. In places the basal sandstone of the Pinkerton Sandstone, and sandstones of the Saddle Creek Formation, are in contact and it is difficult to positively determine the boundary between the two units. This difficulty is emphasized on air photos, because whereas the contact may be seen in section in the scarp cliff, it is not always visible from vertically above.

The basal sandstone persists throughout the area but it is generally thicker than previously defined (up to 30 m as compared with 10 m in most of the Auvergne Sheet area), and in places it can be subdivided. In the scarp between Mount Kukpalli and the northern margin of the Delamere Sheet area an upper, indurated, thin-bedded sandstone caps the more friable cross-bedded sandstone. The latter varies from 3 m to 12 m thick and directly overlies the Angalarri Siltstone. Primary sedimentary structures generally occur throughout the basal sandstone, but north and northwest of The Twins these are far more pronounced in the upper part. Bands up to 2 m thick which contain flame and load structures, and distorted bedding tend to be restricted to the upper part of the basal sandstone. Ball and pillow type structures of the type described by Potter and Pettijohn (1963) are also common.



To accompany Record 1970/3

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Fig 27 Stratigraphic Sections of Saddle Creek Formation and Pinkerton Sandstone within the area mapped in 1968. (Lithology generalised, positions of sections approximate)

The upper siltstone of the Saddle Creek Formation is rarely exposed but it is generally represented by a slope of a soft weathering unit above the basal sandstone. In places it is found to consist predominantly of massive, fine-grained, sericitic, sandstone; intercalated with fissile to flaggy siltstone. Twelve km north of Mount Kukpalli these interbeds are locally contorted by primary sedimentary structures. The slumped fissile siltstones which "wrap around" massive fine sericitic sandstone seen in Fig. 28 are identical to the structures in the same stratigraphic position in the unit near The Tombs on the Auvergne Sheet area.

Within 1 km west of The Twins the upper siltstone is absent. The Saddle Creek Formation there consists entirely of an estimated 20 m thick sandstone. It is overlain by about 13 m of massive, clean, medium-grained sandstone, which is almost certainly the basal sandstone of the Pinkerton Sandstone.

This massive sandstone may, however, be a band in the upper part of Saddle Creek Formation. Certainly to the northwest of this locality massive sandstone up to 7 m thick are common in a poorly outcropping sequence, representing the upper part of the Saddle Creek Formation. In the vicinity of section No. 4 the thin bedding of the basal sandstone is highly characteristic. Also the sandstone is blocky to flaggy, medium-grained, friable and in the lower part current-bedded units measure up to 0.5 m thick. A massive sandstone with large-scale cross-bed units overlying this is commonly limonitic.

The Saddle Creek Formation is exposed in several pockets in the Coolamon area, generally in the vicinity of the Coolamon Fault which has locally disrupted the flatlying sequence, up-throwing and giving relatively steep dips to the lower units of the Auvergne Group.

The basal sandstone of Saddle Creek Formation is seen overlying Angalarri Siltstone, 10 km northeast of Coolamon homestead, (section No. 6 in Fig. 27). Sedimentary structures of the type described above characterize this sandstone but they are more pronounced towards its top.

In some places overlying this is a very thin-bedded sequence of intercalated fine-grained sandstone and siltstone, part of which appears to be calcareous. The formation in this area is generally thinner than to the south and southwest.

At the head of Soldiers Creek a massive unit of sandstone is cream-white and brown, thick bedded, medium-grained and has a blackish weathering surface; it is flaggy to massive and typically friable. It contains large scale cross bedded units (up to 10 m long by 3 m thick); their typical altitude is 125° strike 45° dip to the northeast. Ripple marks and small scale slumping are also common. Near the top of the outcrop a bed 1 m thick contains contorted bedding and flame structures.

Above this basal 11 m of sandstone is a 10 m band of no outcrop, interpreted as being the upper siltstone part of the formation. This is overlain by massive white Pinkerton Sandstone.

No Angalarri Siltstone was actually seen below the basal sandstone at this locality but interpretation from surrounding areas and the swampy nature of the valley floor suggests an impermeable underlying bedrock and suggests the presence of this siltstone formation.

The Saddle Creek Formation in this area is thus 21 m thick, which confirms the indications in the Coolamon area that the unit becomes much thinner in its northern and north eastern extent, relative to its occurrence on the Auvergne and Delamere Sheet areas.

Characteristic of the Pinkerton Sandstone is the ubiquitous basal quartz sandstone which is white and weathers brownish-red, massive, fine to medium-grained and commonly ripple-marked and contains mud-flake clasts. Sandstone containing varying amounts of silt and is either massive, blocky or flaggy, and more or less resistant to erosion, occur above this massive basal band. Lithologically the unit is similar to that described on the Auvergne Sheet area, although generally it was not differentiated into relatively distinctive sandy and silty layers as in this Sheet area. Its thickness of 50 m in section 1 (Fig. 27) is less than the maximum of 100 m of this unit in the Auvergne Sheet area, but it is consistent with the 55 m of the unit measured near Bradshaw. Section No. 5 (Fig. 27) revealed 24 m of almost continuous sandstone (of varying properties), between the Saddle Creek and Lloyd Creek Formations.

Fig.28. Structures in siltstone and sandstone in upper part of Saddle Creek Formation. 13 km north of Mount Kukpalli, Delamere Sheet area. Neg.GA/1192.

In the Collia area no complete section of Pinkerton Sandstone is exposed but the general impression from isolated observations of the sequence suggests that it is of the order of 30 m thick. Halite casts were noted in the beds in this region. It therefore seems likely that the Pinkerton Sandstone is thinning in a general northeasterly direction.

Distinguishing Features

A distinctive property of the Saddle Creek Formation is the abundance of primary sedimentary structures in the basal sandstone. The character of the upper siltstone part of the formation has proved to be variable. Its position under the ubiquitous, massive, thick, sandstone band which characterizes the base of the Pinkerton Formation, in most cases aids in its recognition.

The sandstone forming the Pinkerton Sandstone is not in itself diagnostic. Only the stratigraphic position of this unit and its topographic expression within the Auvergne Group, allows it to be recognized on the ground and on air-photos.

Upper Auvergne Group - Lloyd Creek Formation, Spencer Sandstone and Shoal Reach Formation

Distribution: Lloyd Creek Formation, Spencer Sandstone and Shoal Reach Formation, which will be referred to as the upper Auvergne Group, crop out over about 1000 sq km on the Auvergne, Port Keats, and Fergusson River Sheet areas. The formations are now recognized on over 400 square miles of the Port Keats Sheet area east of the Koolendong Valley and Meeway Plain. They extend onto the Fergusson River Sheet area where they crop out north of the Fitzmaurice River for several kilometres along the length of Laurie Creek.

The northernmost outcrop of the upper Auvergne Group is about 16 km west of Collia Waterhole, and is a very poor exposure of Lloyd Creek Formation.

Derivation of names: The three formations have been formally defined and named by Pontifex et al (1968), from features on the Auvergne Sheet area.

Reference areas: The type localities for all three formations are in the area between the Pinkerton and Spencer Ranges on the Auvergne Sheet area (Pontifex et al, 1968).

Stratigraphic relationships: In all localities the Lloyd Creek Formation conformably overlies the Pinkerton Sandstone, and is overlain conformably by Spencer Sandstone, which is overlain in like manner by Shoal Reach Formation. No younger Precambrian units were observed to overlie the Shoal Reach Formation as they do on the Auvergne Sheet area (e.g. the Bullo Sandstone), but it is masked in some areas by the Mullaman Beds (Cretaceous).

Lithology and thickness: The lithology and thickness are essentially the same as those described by Pontifex *et al.* (1968).

The general relief of the area is fairly low (from 30 to 120 metres) and as a result outcrop is poor. Rare good outcrop occurs on the outer bank of meandering streams, which have cut deeply into the surrounding hills.

The following sections were measured through the Lloyd Creek Formation and the Spencer Sandstone.

(1) Eight Kilometres northeast of Mussel Hole Yard, where a sequence of the Auvergne Group dips at about 20° to the east on the limb of a monocline, and is crossed by a major creek.

	Thickness in metres	Top of Section
Spencer Sandstone	32	Light brown to pink, thin-bedded to laminated sandstone. Halite casts, mud flakes, sole markings common.
Lloyd Creek Formation	1.2	Oolitic dolomite, replaced by chert.
	12.8	Poor exposure, scree indicates fine-grained sandstone with bands of dolomite and dolomitic siltstone. Some oolites.
	19.2	Dolomitic siltstone: minor oolitic dolomite replaced by chert.
	7.6	Basal cliff: includes thick beds of partly silicified stromatolitic dolomite, intercalated with reddish, fine-grained sandstone, and grey, hard, dolomitic sandstone. Minor bands of fine-grained, clean dolomitic occur. Some silicified intramicrite. Small lenses of silicified oolitic dolomite.
	Total 40.8	

Pinkerton Sandstone

(2) <u>Sixteen kilometres northwest of Bradshaw outstation</u>. This is the southernmost outcrop of Lloyd Creek formation north of the Yambarra Range and is about 75 m thick. It is capped by 6 m of Spencer Sandstone. It comprises dolomitic siltstone in the lower portion, overlain by very silty, thin bedded stromatolitic dolomites. Above this is a sequence of about 15 m of blocky, yellow-brown weathering, grey dolomites. Oolite is common, as are intraclasts in some beds. The overlying Spencer Sandstone is fine-grained, quartz rich, and is ripple marked, thin bedded, flaggy weathering, and contains halite casts and mud flakes.

(3) <u>East Bank of Little Fitzmaurice River, 19 miles north of Bradshaw Outstation</u>

	Thickness in metres	Top of hill
Spencer Sandstone	100+	Fine grained sandstone.
	96	Thin bedded quartz sandstone. Minor interbeds of purple sandstone.
Lloyd Creek Formation	100	Limonitic coarse-grained siltstone and very fine-grained sandstone, some dolomitic. Medium-bedded, blocky to flaggy, some convolute bedding.
	150	Fissile green siltstone and flaggy to blocky green-brown and grey-green siltstone. Most are medium-bedded, but some current and convolute laminations.
	3	Dolomitic siltstone with a few laminae of silty dolomite. Blocky parting.
	Total 253 (Lloyd Creek)	Base of hill

Other sections on the Auvergne and Port Keats Sheet areas show that the Lloyd Creek Formation is predominantly dolomitic siltstone with interbedded oolitic and stromatolitic dolomites. The Spencer Sandstone is a fine-grained sandstone, and shows no major change from the area mapped in 1967 (Pontifex <u>et al</u>., 1968). The northernmost outcrop of Lloyd Creek Formation is about 8 miles west of Collia Waterhole.

The Shoal Reach Formation does not crop out at all between Lalngang Creek and the upper reaches of Alligator Creek, some 64 km north. In its northernmost outcrops around Alligator Creek, and east to Coolamon homestead, it is of similar lithology to its type area on the Auvergne Sheet. It consists of fissile to thin-bedded, flaggy, chocolate and green siltstone. There are some hard, quartz-rich flaggy beds, 5-10 cm thick, with ripple marks and laminae caused by concentrations of chloritic flakes.

Above these rocks white (leached?) and purple siltstone with minor dolomite, are overlain by flaggy dolomite and white dolomite-quartz siltstone.

PALAEOZOIC AND YOUNGER

Palaeogeographic significance

The Lloyd Creek Formation probably resulted from deposition of carbonates and siltstone in a restricted marine or lagoonal environment, or both. Such conditions are known to favour dolomite precipitation and growth of stromatolites.

More sand and silt was deposited during the time represented by the Spencer Sandstone, although conditions may still have been suitable for dolomite precipitation.

The Shoal Reach Formation may result from an environment similar to that for the Lloyd Creek Formation. Although it contains no oolites or stromatolites, the dolomite contains many halite casts, which suggest that it formed in evaporitic conditions.

No conclusions as to the shape of the basin of deposition can be drawn from the lithology of these formations.

Antrim Plateau Volcanics

Distribution: In the area covered by this record the Antrim Plateau Volcanics crop out on the Delamere and Fergusson River Sheet areas.

On the Fergusson River Sheet area they crop out over an area of about 320 sq km round Collia Waterhole, over a similar area just to the west of Wombungie Outstation, and in a belt up to 24 km wide which runs roughly south west across the centre of the sheet area from the north to the south margin. This belt forms the south-western margin of the Daly Basin; the area in it which is mapped as volcanics is about 500 sq km.

On the Delamere Sheet area the volcanics crop out in a belt up to 48 km wide in the eastern half of the sheet area; a few scattered outcrops also occur as far west as a line running north-south through Coolibah Station. In all, the volcanics cover about 3000 sq km on the Delamere Sheet area.

Topographic Expression

The volcanics are not well exposed. On the west of the belt which runs across both sheet areas and in the valleys round Collia Waterhole they crop out sporadically in scarps below the Cretaceous. In the main part of the belt however, they form rounded and terraced hills strewn with cobbles of basalt, and flat black soil plains on which outcrop is found only in creek beds. In the area to the west of Wombungee they form hills up to 45 metres high on which outcrop is once again mainly restricted to scattered boulders. Vesicular and amygdaloidal varieties form the most prominant outcrops.

Stratigraphic relationships

The volcanics lie with angular unconformity on the Precambrian rocks. To the north of Collia Waterhole they rest on Carpentarian Soldiers Creek Granite; north of Muldiva tin mine they rest on rocks of the Tolmer Group. Elsewhere they lie on rocks of the Auvergne Group with a low-angle unconformity. The surface on which the volcanics rest is very uneven and in some places such as to the east of Ingaladdi Waterhole the volcanics rest in [illegible] cut in the Jasper Gorge Sandstone.

The volcanics are disconformably overlain by Middle Cambrian Tindall Limestone and Cretaceous Mullaman Beds.

Lithology and thickness (Figs. 29, 30)

The volcanics are mainly grey, grey-purple or grey-green coarse-grained basalt. The top and bottom of flows are fine grained and vesicular and amygdaloidal. Vesicles are filled with quartz, prehnite, banded agate or green clays.

Sandstone, conglomerate and limestone are commonly interbedded with the volcanics.

A tuffaceous rock crops out along the eastern side of Bamboo Creek on the northern border of the Fergusson River Sheet area. It consists of a fine grained weathered red-brown groundmass which contains rounded and subangular fragments of quartz and quartzite, up to about 30 cm diameter. Small lenses of sandstone are interbedded with the tuff. The groundmass consists of rounded and angular grains of quartz, ortho-quartzite feldspar and sericitised pseudomorphs (possibly after feldspar) in a matrix of iron oxide, sericite and angular elongated grains of quartz. The texture of the groundmass "flows" round the coarser fragments.

The basalt consists of anhedral to subhedral laths and small phenocrysts of plagioclase, anhedral or subhedral grains of augite, small grains of iron oxide and minor interstitial quartz and chlorite. The grain size of the laths varies from 0.1 to 0.5 mm, the phenocrysts are up to 1 mm long. The augite grains vary in size from 0.1 to 1 mm. The plagioclase is andesine or labradorite and varies from quite fresh to completely sericitised. Augite is mostly fresh but some is converted to fibrous mats of chlorite which constitutes between 10 and 25 percent of the rock.

Thickness: Up to about 90 metres of volcanics are exposed in the scarps on the highway near Fig Tree Yard (Delamere Sheet area). This is lying on Stubb Formation and is overlain by Cretaceous sandstone. The maximum proved thickness of the volcanics in the area covered by this record is 150 metres in a bore hole about 24 km east of Delamere homestead.

Geochemistry: Geochemical analyses were made of 65 samples of Antrim Plateau Volcanics. The results are recorded in the Appendix. Most of the trace elements are within the normal range for the basalts, although the Fe (iron) content for weathered samples is high. The single sample with high Cu value (No. 69-34) came from basalt adjacent to a sandstone interbed about 6 km northeast of Delamere homestead.

Fig.29. Hard fine-grained basalt in creek bed 6 km south of Innisvale homestead - Delamere Sheet area. Neg.GA/1746.

Fig.30. Basalt north of main highway near Sullivan yard - Delamere Sheet area. Neg.GA/1778.

Sediments interbedded with the Antrim Plateau Volcanics

Sandstone, conglomerate, chert and limestone have been found interbedded with the Antrim Plateau Volcanics (Barclay and Hays (1965), Randal and Brown (1967)). In the area covered by this record, sandstone, conglomerate, and limestone have been found, of which the sandstone is by far the most common type/ Fig. 32. None of the sediments have been named except for the Jarong Conglomerate.

Outcrops of the sandstone offer good sites for roads and homesteads in country which is otherwise covered by black soil developed on basalt. Aborigines have used overhangs on several outcrops for camp sites and rock paintings; and they have used it for the manufacture of tools where it has been baked and indurated.

Sandstone: ~~On the Delamere and~~ the ~~very~~ south of the Fergusson River sheet areas sandstone forms sporadic elongated outcrops within two major belts each of which is up to 16 km wide and trends at about 300°. Delamere and Innisvale homesteads lie on one of these and Ingaladdi Waterhole on the other. The sandstone also crops out quite extensively between Wombungee and Dorisvale homesteads along the western margin of the Daly Basin and in the valleys around Collia Waterhole on the Fergusson River Sheet area. The sandstone is difficult to distinguish from the volcanics on air photos and for this reason there is possibly considerably more outcrop of it than shown on the map.

The sandstone is interbedded with the lower flows of Plateau Volcanics and also underlies them. Apart from the volcanics it lies on rocks ranging from Lower Proterozoic Noltenius Formation to the Adelaidean Angalarri Siltstone. On the Delamere and southern part of the Fergusson River Sheet areas it commonly forms elongated lenses within the volcanics up to 30 metres thick, 3 km wide and several kilometers long. They generally strike about 300°.

The deposits of sandstone between Wombungee and Dorisvale homesteads and near Collia Waterhole are somewhat different in form from those to the south. The sandstone generally occurs as numerous, thin (0.6 to 15 metres) and rather extensive sheets interbedded with the volcanics. In these areas conglomerates are only found below the volcanics whereas on the Delamere Sheet area they are interbedded with them.

Along the western edge of the Daly Basin on the Fergusson River Sheet area the sandstone occurs as scattered thin deposits lying on the Waterbag Formation.

The majority of the sandstone is light grey or cream and weathers to red-brown. It is generally blocky or massive but tends to have a parting along the foreset beds; it is thin to medium bedded, medium to coarse grained, and well (or moderately) sorted. Up to 20 percent of soft, white, brown, and black grains are visible. Many outcrops are very friable with honeycomb weathering and case hardening; whereas others are hard and indurated possibly due to metamorphism by overlying basalt flows. Cross-bedding is ubiquitous in the outcrops on the Delamete Sheet area; units are up to 6 metres thick and are generally of the planar-grouped type although trough cross-beds also occur. The dip directions of the foreset beds are mostly between about 240° and 340°. On the Fergusson River Sheet area the bedding is indistinct and cross-bedding is uncommon or entirely absent.

In thin section the rock contains grains of quartz (60 to 70 percent), plagioclase and microcline (up to 5 percent), coarse and fine siltstone (up to 15 percent) fine chert (less than 5 percent) a brown semiopaque mineral possibly limonite (one or two percent) and accessory tourmaline. The grains are rounded, from about 0.1 to 1 mm in diameter and well sorted. The quartz has wide syntaxial rims separated from the original grain by a sheath of brown mineral (possibly limonite) and clay. The feldspar is either fresh or severely altered. The coarser siltstone consists of angular grains of quartz and feldspar up to 0.05 mm long in a matrix of clay, sericite and limonite. The finer siltstone consists of sericite, limonite and fine quartz. Both the siltstones are typical of types found in the Angalarri Siltstone. The grains are widely separated and the matrix or cement forms up to 20 percent of the rock. The harder rocks are cemented by quartz whereas the softer ones have a matrix of clay (most of which is removed in the section making process). One specimen taken from a sandstone dyke in the basalt had a cement of fine chert.

Fig.31. Sandstone "dyke" in basalt of the Antrim Plateau Volcanics. About 100 m. north of main road 4 km east-north-east of Sullivan Yard, Delamere Sheet area. Neg.GA/1776.

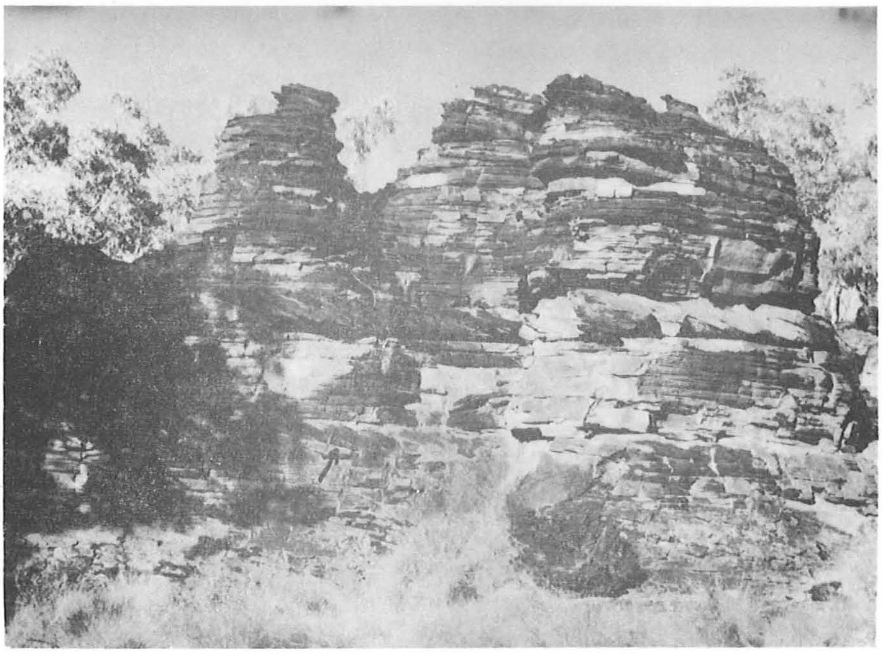


Fig.32. Typical outcrop of aeolian(?) sandstone interbed of Antrim Plateau Volcanics. 16 km north-east of J41 Yard, Delamere Sheet area. The outcrop is about 6 m.high. Neg. GA/1189.

Randal and Brown (1967) describe a thin section of an indurated sandstone at the base of a basalt flow in which the quartz cement contains abundant needles and short prisms of an orthorhombic mineral probably mullite.

The high content of feldspar, clay, silt and opaque grains distinguish the sandstone from almost all other sandstones in the district. In many places the sandstone and its associated conglomerate form low vertical cliffs and quite commonly crop out as well defined small mesas and stacks. On the Delamere Sheet area the ubiquitous cross-bedding and the discordant relationships between the sediments and the volcanics are very distinctive.

On air photos the small mesas, stacks and cliffs are distinctive where they are big enough to show up, also the ground underlain by sandstone tends to be slightly darker than that underlain by the volcanics. However, in some places, especially on the Fergusson River Sheet area it is only possible to differentiate the sediments from the volcanics (and other underlying formations) by field investigation.

The elongated lenticular deposits of sandstone may either be infilled channels or ridges which have been surrounded and overlain by basalt. In support of the first theory both volcanics and sandstone lie in a channel cut in the Jasper Gorge Sandstone 6 km north of Ingaladdi Waterhole showing that some form of channel cutting agency (presumably rivers) was active not long before and so possibly during the diffusion of the volcanics. Most of the evidence however, supports the view that the sandstone was deposited as ridges and mounds. Randal and Brown (1967) describe deposits of the sandstone in the vicinity of Delamere homestead in which the sandstone - basalt interface dips under the basalt and in which the basalt lies on the bedding surface of the sandstone. They support the view of Barclay and Hays (1965) that the sandstone is aeolian and suggest that the deposits are longitudinal dunes. They cite the following evidence for the aeolian nature of the sandstone: the large-scale cross-beds, the good sorting, the lack of pebbles, the occurrence as mounds and ridges, the sharp and little disturbed contact between the sandstone and the overlying basalt and the partial melting of a narrow zone of the sandstone at the contact indicating that the sediment was dry. They also report shallow elongated ridges and furrows on the surface of the sandstone below the volcanics apparently caused by the viscous drag of the lava moving over the surface.

The remarkable parallelism of all the deposits is strong evidence of the dune origin theory, since only the wind direction is likely to be such a uniform influence over such a large area. However, the high percentage of clay grains is not typical of aeolian deposits.

Twenty nine kilometres southwest of Willeroo homestead an elongated lenticular sandstone is overlain by a thinner but more extensive sheet of basalt conglomerate. For many miles past the south-west limit of this conglomerate the horizon at which it occurs is a very prominent bench and the basalt forming this bench contains sandstone dykes. It is probable that the bench is an old land surface and since it lies above the sandstone lens it is possible that the latter was an infilled channel in the land surface.

Sandstone dykes: In several places the basalt beneath deposits of sandstone contains dykes of sandstone. These are generally straight, more or less vertical and from a few mm to a metre or more wide. The sandstone in them is similar to that in the overlying deposit. However, instead of having syntaxial rims, the grains are separated by fine quartzite. The sandstone probably filled cracks in the basalt.

In several places the dykes are severely contorted into tight folds. It seems probable that this sand, probably wind blown, was incorporated in the basalt while the latter was still at least semi-liquid. (Fig. 31).

Conglomerate: In several places conglomerate is associated with the sandstone or is in a similar stratigraphic position. One of these conglomerates crops out in the vicinity of Collia Waterhole and has been differentiated as a separate formation, the Jarong Conglomerate. Three other types of conglomerate have been found: chert conglomerate; basalt conglomerate; sedimentary breccia.

A small amount of chert conglomerate crops out near Pandanus Springs (29 km south-west of Willeroo Homestead on the Delamere Sheet area) and underlies the typical sandstone. It consists of fragments of chert and highly altered basalt, in a matrix of indurated sandstone. The chert is red, yellow and white and is in subangular to subrounded fragments ranging in size from 1 cm to 30 cm. The matrix is a fine cherty material containing 40 to 50 percent of subrounded grains of quartz with minor feldspar and limonite. Randal and Brown (1967) report a barite or celestite cement in places. The basalt fragments consist of a ferruginized alteration product, possibly of glass, with laths of feldspar partially or wholly replaced by calcite. The large lumps of chert are similar to the cherty matrix and appear to grade into it. Several of them contain lath-like structures only visible in plane light suggesting that they are lumps of basalt completely replaced by chert.

Basalt conglomerate consists of lumps of basalt, mostly vesicular, in a sandstone or clay matrix. It has been found in two areas, one is around the main highway 29 km south west of Willeroo homestead and the other extends from 1.5 to 13 km east of Delamere homestead.

In the former area the conglomerate overlies interbedded sandstone. About 7.5 metres of the conglomerate is exposed. It consists of rounded lumps of vesicular basalt from a few centimetres to at least 60 cm in diameter set in a matrix similar to the sandstone. The basalt forms up to 80 or more percent of the rock. In places there is so little sandstone that it is difficult to tell whether the sandstone is the matrix of a conglomerate or is a sandstone dyke. A similar rock crops out 1.5 km east of Delamere homestead. Thirteen kilometres east of the homestead the basalt is overlain by 6 metres of a conglomerate consisting of lumps of basalt up to a metre in diameter, rounded to angular and of wide variety of types including vesicular and non-vesicular. The matrix is soft and clayey. Overlying this conglomerate there is 12 metres of a similar rock with a hard matrix similar to the sandstone. The sandstone also forms lenses from 5 to 60 cm thick in the conglomerate and overlies the whole deposit.

A <u>sedimentary breccia</u> associated with the sandstone crops out in the areas between the Twins and Wombungee, between Wombungee and Dorisvale and 5 km north west of Collia Waterhole on the Fergusson River Sheet area. At all the outcrops investigated the breccia underlies the Antrim Plateau Volcanics. It is probably an extension of the Jarong Conglomerate. It consists of angular slabs of sandstone and minor siltstone, from a 0.6 to 25 cm long. The matrix is identical to the sandstone. Where the breccia or sandstone overlies the Angalarri Siltstone it contains numerous small fragments of the latter. The thickness of the breccia ranges up to about 4.5 metres.

Limestone: Six kilometres south-west of Mount Freda on the Fergusson River Sheet area flaggy to blocky purple and grey limestone crops out interbedded with weathered basalt. The limestone is finely-oolitic and crystalline. Stromatolites are abundant in the beds which total about 7.5 metres in thickness. Near the top of the sequence the limestone becomes flaggy and even fissile, and thin shale bands appear. Limestone pebbles were seen enclosed in the overlying basalt. The limestone is restricted to this area only.

Jarong Conglomerate

The Jarong Conglomerate is a new name; it refers to a locally distributed boulder conglomerate at the base of the Antrim Plateau Volcanics.

Distribution: The Jarong Conglomerate crops out to the south and west of Collia Waterhole on the Fergusson River Sheet area. Its areal distribution is very limited; it covers only 20 square kilometres. Further small outcrops of the conglomerate occur 16 km south-west of Collia Waterhole and 5 km north-east of Wombungie.

Derivation of name: The name is taken from Jarong Spring, which lies 10 km west of Collia Tinfield. The type area is a hill 5 km south-east of Collia Tinfield (Lat. 14°24'S, Long. 130°55'E). No sections were measured as the unit is very variable in both thickness and lithology.

Stratigraphic relationships: The Jarong Conglomerate unconformably overlies the Angalarri Siltstone over much of its area of outcrop. It also overlies the Soldiers Creek Granite. The conglomerate is overlain conformably by Antrim Plateau Volcanics and unconformably by the Mullaman Beds of Cretaceous age.

The relationships of the unit to the sandstone interbedded with the volcanics are obscure. It appears in places to overlie the sandstone but nowhere is the reverse true. It is probably a local, lateral equivalent to part of the sandstone. The Jarong Conglomerate is probably equivalent to the Witch Wai Conglomerate as defined by Walpole et al. (1968) on the Pine Creek Sheet area.

Lithology and thickness: This unit may be lithologically termed a petromict conglomerate (Pettijohn 1957). Although it has a restricted extent and thickness, many of its features are similar to the larger, better known conglomerates of this type.

In the type area 3 km south east of Collia Tinfield, the conglomerate forms the lower scarp of the hill, in which about 15 metres are exposed. The conglomerate grades downwards into sandstone with pebbly and conglomeratic interbeds. The sandstone is a light-brown, flaggy to massive, medium-grained rock containing up to 5% feldspar. It shows poor sorting, has sub-angular grains and is cross-bedded in parts. As shown in Figure 33 pebbles are randomly distributed in an otherwise uniformly-grained, cross-bedded sandstone with very little disruption of bedding.

The conglomerate itself consists of poorly sorted clasts, which range from pebble size up to boulders 60 cm in diameter, in a medium-grained sandstone matrix. The clasts are commonly rounded to sub-rounded, only the shaly or schistose inclusions being angular. Quartzite and sandstone form about 90% of the clasts with schist, dolomite, granite and chert making up the remainder. The conglomerate is very massive and widely jointed. These joints cut across large clasts as shown in Figure 34. When found as isolated boulders, these roughly hemispherical clast resemble facetted glacial erratics. The sequence in the type area is about 60 metres thick.

Directly east of the type area at the scarp edge of the valley, the Jarong Conglomerate crops out at a higher topographic level and is only about 3 metres thick.

A thick sequence of sandstone and conglomerate (about 75 metres) crops out 24 km northeast of Jarong Spring. The boulders in the conglomerate are more varied in lithology than in the type area; Berinka volcanics, possible Bullo Sandstone (as found on the Auvergne Sheet area), and granite are commonly found as large round boulders. Quartzite and sandstone, both commonly cross-bedded, form about 80% of the clasts. Minor pink to grey crystalline dolomite boulders with chert nodules and large stromatolites are also found. The matrix and underlying sediment are a red-brown, feldspathic, medium to fine-grained, poorly-sorted sandstone. The sandstone is interbedded with better sorted, friable quartz sandstone which contains 10-15 cm pebble bands in places. The sandstone is ripple marked and contains haematite-rich spots. It may be laterally equivalent to the sandstone which is extensively interbedded with the volcanics in the Wombungi-Dorisvale part of the Sheet area.

About 0.8 km further east from this locality, a small knob of Jarong Conglomerate rests unconformably on Soldiers Creek Granite. The rock consists of numerous rounded to sub-rounded clasts in a poorly sorted matrix of angular fragments of quartz, mica, feldspar and clay minerals. At this locality about 75% of the clasts are quartzite and sandstone, some 10% granite, the remainder are chert, shale, pebbly sandstone and chlorite and mica schist.

Sixteen kilometres south-west of Collia Waterhole the conglomerate is conformably overlain by Antrim Plateau Volcanics. The conglomerate consists of rounded to sub-angular sandstone pebbles, up to 3 mm in diameter, in a matrix of medium-grained, poorly sorted sandstone with up to 5% feldspar. An isolated granite boulder was found in the conglomerate.

Five kilometres northeast of Wombungee a similar conglomerate, interbedded with sandstone, crops out. Angular slabs of sandstone rest in a white to light-grey, blocky, medium-grained sandstone matrix. This moderately sorted sandstone matrix, which contains 2-3% feldspar, is composed of sub-angular sub-rounded quartz grains. The interbeds average about 0.5 metres in thickness.

The general attitude of the beds is not easily determined. Generally they appear to be flat-bedded except in the small knob 3 km north-east of Jarong Spring where elongate pebbles are alinged into bands which dip 25° to the SSW. This is presumed to be a local depositional dip since the lower contact of the unit with the granite is horizontal.

Distinguishing features: This unit is best recognized by its stratigraphic position and lithology. It underlies the Antrim Plateau Volcanics and overlies Precambrian rocks, and may possibly be termed a basal Cambrian conglomerate. Its clasts are well rounded (c.f. Henschke Breccia) and show a wide range of origin. Its matrix shows similarities to the sandstone interbedded with the volcanics in places.

On aerial photographs the unit is represented by a soft, medium-toned pattern giving well rounded topography. The pattern is similar to that of a siltstone.

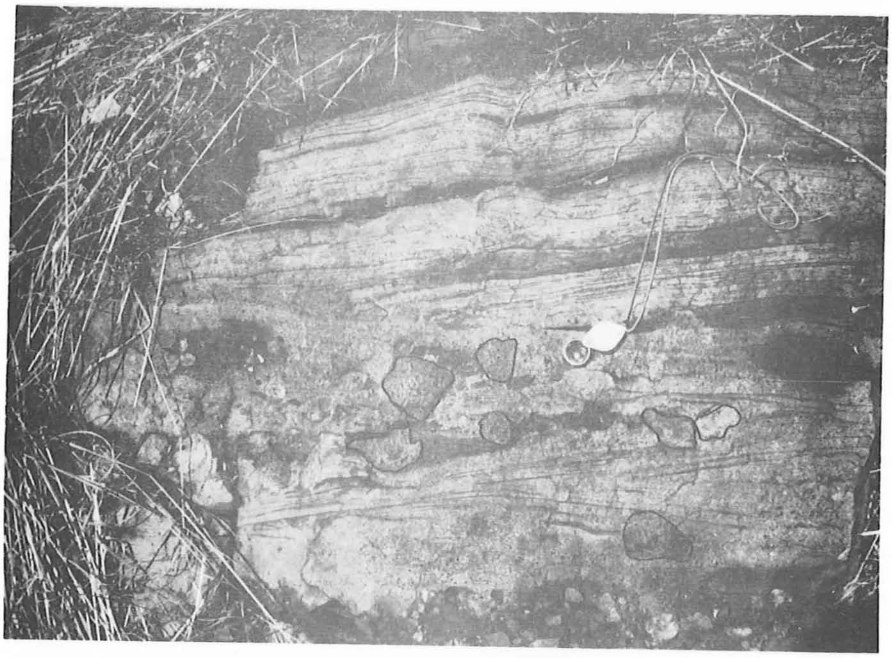


Fig.33. Rounded quartzite and sandstone boulders erratically distributed in cross-bedded sandstone of Jarong Conglomerate, 3 km southeast of Collia Waterhole.
Neg. GA/1458.

Fig.34. Joint Plane in the Jarong Conglomerate cutting across clasts. Locality as for Fig.33. Neg.GA/1463.

Palaeogeographic significance: The Jarong Conglomerate lies at the base of the Antrim Plateau Volcanics which are unconformable on the Precambrian sequence. This factor together with the poor sorting, steep depositional dip and general distribution of the lithology, suggests that the conglomerate had a continental origin. Its location around the Collia Fault strongly implies that the fault was a scarp at the time of deposition of this unit. The sediments would have been derived from high areas to the north and east of the fault. Some features of the deposit, e.g. pebbles in cross-bedded sandstone, point to a flash flood origin in part at least.

DALY RIVER GROUP

This group includes two formations, namely, the Tindal Limestone and the Jinduckin Formation. They were not studied in detail during this survey, but it became apparent that an area previously regarded as Precambrian is in fact Lower Palaeozoic Jinduckin Formation. The evidence for this is presented below.

Jinduckin Formation (Olj)

The Jinduckin Formation was originally named by Randal (1962), as a constituent formation of the Daly River Group, overlying Middle Cambrian limestone in the Daly River Basin. In 1968 rocks previously mapped as Waterbag Formation (Randal, 1962) in an area of about 650 sq km, south-east of Dorisvale, and in a strip between the Dorisvale Fault and established Jinduckin Formation 24 km north-west of Dorisvale, were remapped as Jinduckin Formation.

The following comments refer only to this remapped area since the rest of the formation was not examined by us. For further information about the unit and its distribution, reference should be made to Randal and Brown (1967) and Walpole et al (1968).

The redefinition of the rocks in this area was made on the basis of:

(a) their lithological affinities with established Jinduckin Formation,

(b) their tectonic setting and stratigraphic relationships

(a) Lithology of the Jinduckin Formation

In the area under discussion the Jinduckin Formation is exposed in a hill slope below a capping of Cretaceous sandstone and Cainozoic laterite. Its base was not seen. The lower 36 metres consists of thin dolomite interbeds in a predominantly purple-red dolomitic siltstone. This is overlain by about 18 metres of brown friable blocky sandstone, and about 45 metres of interbedded blocky to massive dolomite and shale and thin sandstone. The shale typically weathers to a grey "rotten" appearance, possibly partly due to its calcareous tufa covering. The shale becomes more arenaceous upwards and over about 15 metres is finally replaced by a brown very fine to medium-grained well sorted, flaggy ferruginous sandstone. The ferruginous sandstone has thin interbeds in some areas consisting of ochreous yellow-brown fine siltstone. This siltstone reaches about 70 metres in thickness.

At least 30 metres of interbedded medium to fine-grained sandstone and blocky dolomite overlie this sequence and are the youngest beds seen.

The following section was measured on a prominent spur formed by Jinduckin Formation 6 km due south of Dorisvale homestead.

Thickness in metres	Mullaman Beds
45.7	Slope largely covered by scree of laterite and overlying sandstone, also by blocks of ferruginous sandstone of the type exposed below. Along strike from the section line khaki, light-yellow-brown fine siltstone to mudstone interbedded with bands 0.6 to 1.2 metres thick of friable pinkish-brown, sericitic, massive fine-grained sandstone. Minor halite casts
4.6	A series of benches, 0.6 to 1.2 metres thick of sandstone bands of the type described in the underlying bench. Between benches 0.9 to 1.2 metres of probable siltstone poorly exposed
3.0	Bench of sandstone friable, reddish-brown, ferruginous, fine to medium-grained, well sorted. Varies to light brown siltstone, pockmarked and sericitic, and containing some muddy patches.
19.8	Slope largely scree covered with ferruginous sandstone. Minor dolomitic, grey, fine-grained sandstone. Interbeds of dolomitic siltstone and bands up to 1.2 metres of sandstone: reddish and brown, massive, fine-grained, well sorted, ferruginous and commonly leached, suggesting that possibly a carbonate matrix has been removed.

7.6	Grey dolomitic siltstone intercalated with thin to massive brown siltstone. Thin dolomite interbeds
1.2	Dolomitic sandstone: grey-purplish, thin-bedded to massive, fine-grained
0.6	Thin-bedded flaggy dolomite
6.1	Massive reddish-brown dolomitic siltstone. Minor grey spotted, and grey dolomite interbeds.
9.1	Numerous grey-buff flaggy dolomite bands up to 0.6 metres thick, intercalated with fine-grained dolomitic sandstone and dolomitic siltstone. Minor small chert lenses and nodules in the dolomite.

Total 97.7 m minimum   Base of hill

Sequences in the Jinduckin Formation similar to this section were noted in two other areas south of Dorisvale.

About 11 km west of Kathleen Falls 24 metres of thin-bedded grey and grey-pink flaggy dolomite is interbedded with chocolate-brown dolomitic siltstone. This is overlain by up to 18 metres of a reddish-brown, ferruginous, fine to medium-grained, well sorted, pock-marked and apparently leached sandstone.

Apparently higher in the sequence, only 3 km west of Kathleen Falls interbedded thin bands of laminated dolomite and flaggy dolomite (both associated with chert), dolomitic siltstone and beds up to 1.5 metres thick of the light-brown, fine-grained, ferruginous sandstone crop out.

Just east of the Dorisvale Fault 19 km south-south-east of Dorisvale the sequence consists of about 30 metres of bands of dolomite (7.5 to 20 cm thick) which contain chert, intercalated with reddish and grey dolomite siltstone. This predominantly carbonate sequence grades upwards over about 36 metres into a fine-grained, reddish sandstone, which is notably massive, friable and seemingly leached. This sandstone is interbedded with ochreous yellow and reddish brown silty mudstone for topmost 18 metres of the section. The Dorisvale Fault is marked by a 5 metre wide reef of silicified fault breccia in this locality and the beds immediately adjacent to the fault dip at up to 70°.

North-west of Dorisvale homestead the basal siltstone member is not exposed. The middle carbonate section is however well exposed in the valleys of Homestead and Whiskey Spring Creeks. A large strike fault repeats the section eastwards in Homestead Creek valley. The carbonate sequence is capped by 70 metres of red-brown flaggy, thin to medium-bedded, sandstone which is composed mainly of sub-rounded quartz and chert fragments and exhibits good sorting.

Above the sandstone there is about 30 metres in which pale-grey blocky, medium-bedded crystalline dolomite is interbedded with the sandstone. The d olomite contains a few collenia-type stromatolites and isolated bands of columnar stromatolites. Some calcareous siltstone is also present.

These sequences near Dorisvale compare favourably with the log of a bore 51 km south of Katherine (BMR Scout Hole, Katherine No. 1) which passes through the Jinduckin Formation (Randal & Brown, 1968). It is described as having an upper 24 metres of red-chocolate brown siltstone with interbeds of well sorted very fine to fine-grained sandstone. This grades downwards into grey silty dolomite and dolomitic siltstone containing interbeds of dolomite with associated chert. The sandstone content decreases to nothing in the lower most part of the unit.

Spotted dolomitic siltstone with interbedded dolomites also occur in the Bynoe Formation west of the Dorisvale Fault - where they were previously mapped as Waterbag Formation. However the interbedded sandstone which dominates the upper part of the sequences described above, is characteristic only of the Jinduckin Formation in this area. The sequences south-east and north west of Dorisvale are apparently non-fossiliferous, but fossils of Lower Ordovician age have been identified 24 km north-east of Dorisvale (Opik, 1968). They occur in the sandstone in the upper part of the formation, possibly higher than is represented near Dorisvale. M.C. Brown (B.M.R. pers. comm.) considers that the lower carbonate part of the Jinduckin Formation, which conformably overlies the Middle Cambrian Tindall Limestone, is of Cambrian age, and that only the uppermost part of the formation is of Lower Ordovician age.

(b) Tectonic setting and stratigraphic relationships

In 1968 the Dorisvale Fault was recognized. This is a major fault, whose southern and northern portions on the Fergusson River Sheet area divide the Precambrian rocks to the west from the Palaeozoic rocks forming the Daly River Basin to the east. It therefore effectively forms the western margin of the Daly River Basin and may have been active during its sedimentation. The occurrence of Waterbag Formation to the east of the fault as mapped by Randal (1962) did not appear to fit the general relationships. A re-examination of the rocks of the so-called Waterbag Formation showed that they had a similar attitude and lithology to rocks mapped as Jinduckin Formation to the north and south. Furthermore although no actual contact between the so-called Waterbag Formation and the Tindall Limestone was seen, hitherto unmapped nearly horizontal Tindall Limestone crops out near the track 3 km south-west of Dorisvale homestead, and lies at a lower topographic level than the surrounding slopes of nearly horizontal so-called Waterbag Formation. The conclusion of this mapping is that the so-called Waterbag Formation is younger than the Tindall Limestone and is part of the Jinduckin Formation.

MULLAMAN BEDS

Extensive outcrops of flat-lying Lower Cretaceous rocks first described by Brown (1895), were named the "Mullaman Group" by Noakes (1949), subsequently, modified to Mullaman Beds by Skwarko (1966).

The Mullaman Beds crop out extensively on the eastern part of the Delamere Sheet, and are described by Skwarko (op. cit.) and Randal and Brown (1967). Further extensive outcrop of the beds occurs in the central west of Fergusson River, and central east of the Port Keats, Sheet areas (viz. the Wingate Plateau). Scattered mesas capped by Mullaman Beds occur throughout much of the remainder.

The Mullaman Beds directly overlie the Pinkerton Sandstone along the scarp near Mount Kukpalli, in the Coolamon area, and also in the Collia area. Along the Mount Kukpalli scarp they are exposed in the cliff as a massive reddish sandstone, flat-lying and generally capped by laterite. Where the underlying Pinkerton sandstone is also flat-lying, and occurs as similar cliff forming sandstone, it is extremely difficult to distinguish between the sandstone of the two units. Figure 35 shows Mullaman Beds unconformably overlying gently dipping Saddle Creek Formation.

On the Wingate Plateau, and in most of the scattered outcrops, the Mullaman Beds are only a thin capping, generally between 10 and 30 metres thick, overlying a variety of Precambrian formations. Capping a mesa 10 km. southeast of J41 Yard, on the Delamere Sheet area, is 35.4 m of Mullaman Beds. This consists of a basal medium to coarse-grained friable quartz sandstone 19.2 m thick. Above this is 16.2 m of friable, mottled, clayey sandstone with a silicified capping. The whole sequence has been affected by deep weathering processes associated with laterite formation. In almost all instances the Cretaceous rocks were found to be affected in this manner, and some showed almost complete lateritic profiles, with several feet of nodular or pisolitic laterite capping a mottled and leached horizon at least 30 m thick.

12 km north of Tom Turner's Crossing, near Flood Hill, on the Port Keats Sheet area, is about 5 m of white sandstone, overlain by 1 m of ferruginous sandstone. The sandstone is fine to medium grained, with some coarse grains and is an orthoquartzite. It is probably basal Mullaman Beds.

In nearly every outcrop, the Mullaman Beds comprise leached ferruginous, or silicified kaolinitic siltstone and claystone as well as sandstone.

Laterite

Laterite crops out extensively on the Port Keats, Cape Scott/Fergusson River and Delamere Sheet areas. Most plateaux, and many mesas and buttes throughout the area are capped by laterite.

Lithology and thickness: The laterite profile is in nearly every case developed on shale or claystone, and argillaceous sandstone and siltstone of the Cretaceous Mullaman Beds. In most cases these rock types are probably within the pallid zone of the laterite, and originally may have been more arenaceous. The ferruginous zone of the laterite profile is generally only 1.5 to 3 metres thick. Few observations were made of mottled and pallid zones, but the profile is probably over 30 metres thick in places. Where the laterite passes into a mottled zone the original nature of the sediments is still recognizable, as their structure has not been entirely destroyed. In a number of localities it is not clear whether Cretaceous or older beds have been lateritized. On the Delamere Sheet area the Antrim Plateau Volcanics and the Angalarri Siltstone may both have been subjected to lateritization.

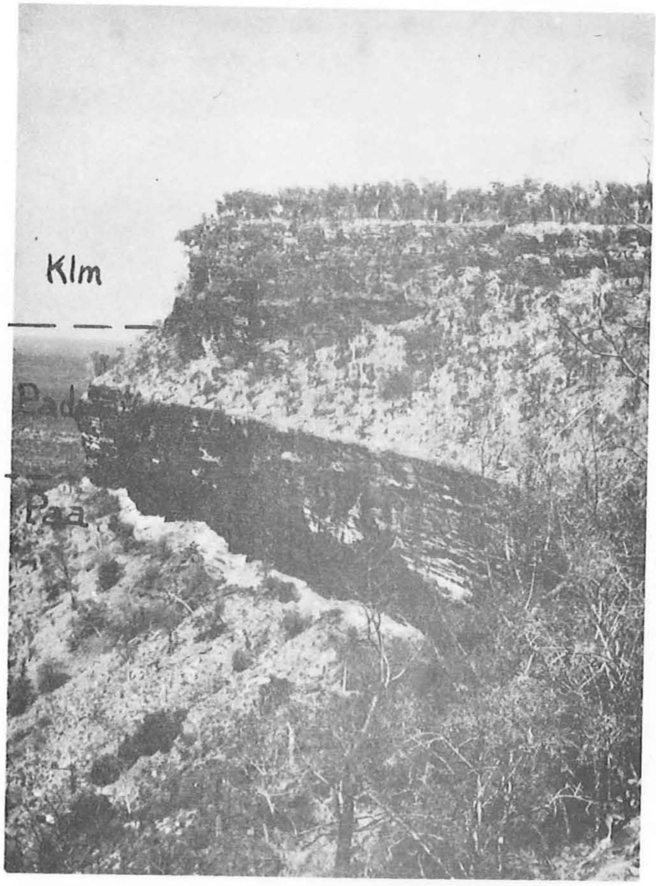


Fig.35. Mullaman Beds overlying Saddle Creek Formation, 13 km north of Mount Kukpalli, Delamere Sheet area.
Neg.GA/1183.

Throughout the area the plateaux have accordant summits, up to 300 metres above sea level near Bradshaw, and 180 to 240 metres over much of the rest of the area. These plateaux are the remnants of an ancient land surface, called the Tennant Creek Surface by Hays (1967). The same surface has been called the Bradshaw Surface by Wright (1963). Another surface, between 15 and 30 metres below the Tennant Creek Surface, is known as the Wave Hill Surface (Hays, op. cit.). This is characteristized by detrital laterite. Remnants of this surface occur in the area mapped.

No laterite occurs on the Precambrian sandstone which are truncated by this the Wave Hill surface. However, in many cases the sandstone is very friable, and enriched in iron, especially along joints. Hays (op. cit.) considers that these rock types were not suitable for a true ferruginous laterite to develop.

Table 4 contains analyses of laterites from several localities. In general, they are low in iron and aluminium, and high in silica, and therefore are not highly regarded prospects for Alumina.

Superficial Deposits

Czs: This includes a variety of residual soils, as well as some alluvial and most colluvial deposits. Soils developed on the Proterozoic sandstones are generally skeletal very sandy or loamy soils. The Angalarri Siltstone is in places masked by relatively thick (2-5 metres) residual soils, which are generally of fine silty texture.

Scree and very low angle slope deposits are developed at the base of scarps, and these include gravels and some sand and silt deposits, cut by numerous small gullies.

Czb: Black soil is developed in many places as a residual soil on basalt on the Delamere Sheet area; it also occurs as alluvium near the southern margin of this sheet. Some areas of black soil occur within swampy areas on the Port Keats and Cape Scott sheet areas, but have been included with the Qa.

TABLE 4. LATERITE ANALYSES

Registered Number	Field Number	Fe_2O_3 %	Al_2O_3 %	SiO_2 %	TiO_2 %	Cu	Pb	Zn	parts per million Co	Ni	Cd	Cr	Mn	Fe %
Amdel: Report No. ANZ2559/69														
68.77.194	X100	42.0	6.6	40.7	0.61	40	35	45	30	35	5	80	25	
" 195	X222	41.0	17.1	32.1	0.67	10	50	10	15	15	5	300	25	
" 196	X331	54.7	8.3	25.5	0.37	10	45	130	70	60	10	45	140	
" 200	E161	85.0	1.0	3.2	0.03	5	95	1600	320	250	15	30	5300	
" 201	E2968	48.3	14.9	24.6	0.61	5	70	15	20	30	10	220	20	
" 202	E158	40.9	9.5	39.4	0.58	10	50	15	20	20	10	150	50	
" 203	E318	51.0	13.8	20.7	0.78	10	60	15	25	15	10	160	100	
" 204	E296C	57.6	13.1	15.9	0.61	5	80	15	20	15	10	410	10	
" 205	Y130	43.8	10.0	35.9	0.63	15	60	20	25	10	10	140	25	
" 206	Y 78	44.1	14.1	27.5	0.84	5	40	20	25	10	10	240	20	
" 207	Y 83	36.7	4.7	50.6	0.44	10	45	15	20	10	10	120	10	
" 208	E37B	50.1	9.3	27.1	0.44	5	60	10	25	5	10	220	10	
" 209	Y46	59.9	10.5	16.3	0.50	5	65	15	25	10	10	570	25	
" 210	Y168B	34.1	15.4	39.6	0.68	5	55	15	20	5	5	250	80	
" 211	Y223	36.4	10.2	41.0	0.34	30	70	15	30	15	10	350	170	
" 335	W118	46.3	15.9	25.1	0.52	5	70	70	35	10	10	270	150	
" 336	W119	47.2	15.6	24.2	0.58	5	60	10	25	15	10	360	5	
" 337	W121	41.9	10.0	36.3	0.41	5	65	10	25	15	10	400	5	
" 338	W282	38.4	20.2	26.2	0.75	5	65	10	25	20	5	310	5	
" 339	X165F	13.4	16.7	56.8	0.94	10	25	15	10	15	5	35	55	
B.M.R.: Lab. Report No. 105, 1969.														
68.77.200	E161	79	6.6	11.6		15	108	640	8.8	193	1.8	100	5000	55
"	W282	30	9.3	52.2		2.5	10	9.8	6.8	3	0.5	350	12.5	21

No. 68.77.200 (E161) is a breccia containing probable Cretaceous sandstone, silcrete and Antrim Plateau Volcanics. This is either a laterite or a gossan.

Qt: River terrace deposits, believed to be of Quaternary age, occur marginal to the Victoria River on the Delamere Sheet area. They are about 10 metres above the present low river level, and in some areas are being actively eroded by small streams. They consist of laminated fine sand and silt.

Qcs: Light toned areas along the coast are probably the remnants of Pleistocene strand lines and have been delineated on the maps of Port Keats and Cape Scott.

Qac: This unit includes coastal mud and silt flats.

Qa: Present day alluvial deposits include the swampy country on the Port Keats and Cape Scott areas. Such areas are predominantly of black alluvium with some silt and sand.

GEOPHYSICAL WORK

Gravity

A regional reconnaissance gravity survey was carried out over a large part of north-west Australia in 1967. The information obtained was compiled and interpreted by the Geophysical Branch of the Bureau of Mineral Resources, (Whitworth 1970). We have adapted relevant parts of Whitworth's interpretation and his gravity map (Fig. 36).

The area has been divided into a number of geophysical provinces.

a. The Wangites Regional Gravity Ridge roughly corresponds with the Pine Creek Geosyncline and Fitzmaurice Mobile Belt. On the Port Keats Sheet area the south-east boundary of the gravity ridge corresponds closely with the Victoria River Fault; and the western boundary corresponds with the north-trending Moyle River Fault which is the eastern boundary of the Bonaparte Gulf Basin. Although the crest of the gravity lies over Palaeozoic rocks, these only constitute a thin layer of sediments overlying the Proterozoic basement. It is suggested that the gravity high has been produced by densification of crustal rock by intense metamorphism, although it may be significant that sills of basic rocks are quite common in the area covered by the gravity ridge. The feature dies out to the south west at the boundary between the Port Keats and Auvergne Sheet areas; this may be due to a decreasing degree of metamorphism in this direction.

b. The Bonaparte Regional Gravity Depression corresponds quite closely with the Bonaparte Gulf Basin. However it is not known what causes the intense gravity high in the centre of the depression. The centre of the gravity low a few kilometres from Port Keats mission corresponds closely to the centre of a structural basin which was delineated by seismic work.

c. The Tipperary Regional Gravity Low is a fairly small amplitude feature which roughly corresponds to the Daly River Basin. It has indistinct boundaries with the Victoria Regional Gravity Shelf, and the Dunmarra Regional Gravity Low which is the south eastwards extension of the Tipperary Low. The axis of the gravity low is to the west of the axis of the basin and appears to have been influenced by the presence of the Soldiers Creek Granite. The gravity survey results suggest that the Proterozoic, as well as the Palaeozoic, sediments become thicker southward across the basin thus showing that the basin may have been in existence during the Precambrian.

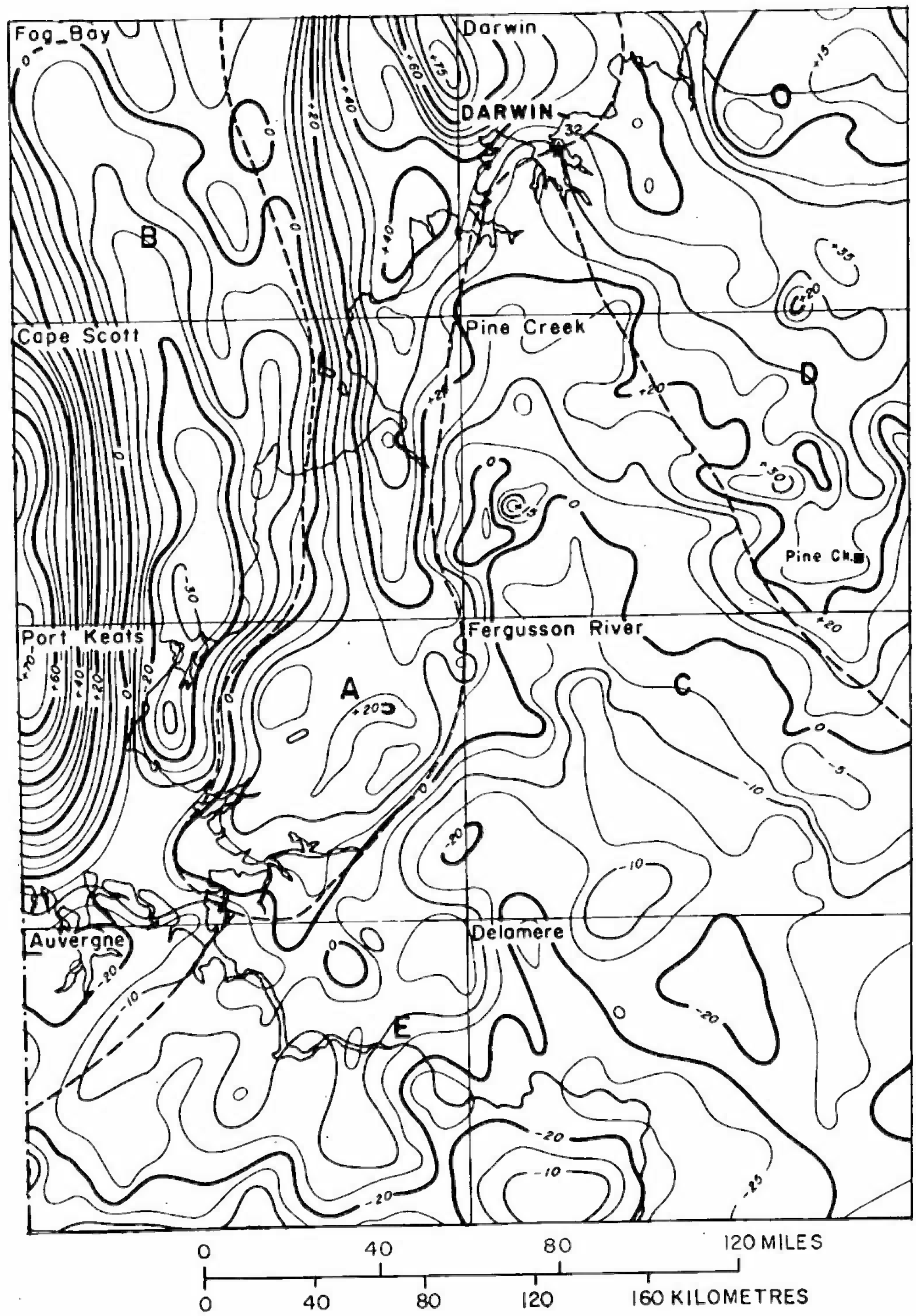
d. The Marrakai Gravity Plateau to the north east of the Daly River Basin, is a relatively simple province particularly considering that it overlies a Geosynclinal area. It is of much lower intensity than the Wangites Ridge to the west. Its geological significance is uncertain. However it does suggest that density contrasts within the area are small.

e. The Victoria Regional Gravity Shelf is a vaguely defined province with small gravity variations and few structural trends. It corresponds with the Sturt Stable Block. It may be relevant that there is a relatively high gravity value in the vicinity of the abrupt structural domes in the south-west corner of the Delamere Sheet area; and also that there is a linear gravity feature which coincides with a north-north-west-trending system of faults in the west of the same sheet area.

A more detailed gravity survey of the areas underlain by the Bonaparte Gulf Basin on the Port Keats and Cape Scott Sheet areas was undertaken in 1966. It was carried out in conjunction with a seismic programme by the Compagne Generale de Geophysique (Australian Aquitaine Petroleum, 1966) and the results correspond closely with those of the regional survey.

Fig. 36. PRELIMINARY BOUGER ANOMALIES AND GRAVITY FEATURES

(1967 Helicopter Gravity Survey)



A : *Wangites Regional Gravity Ridge*
B : *Bonaparte Regional Gravity Depression*
C : *Tipperary Regional Gravity Low*
D : *Marrakai Gravity Plateau*
E : *Victoria Regional Gravity Shelf*

To accompany Record NT/A 298

Aeromagnetic surveys

Several aeromagnetic surveys have been flown over the region by the Bureau of Mineral Resources. The western part of Port Keats Sheet area was covered in 1958. The eastern half of the same sheet area and the western half of the Fergusson River Sheet area were covered in 1956 at the same time as the radiometric surveys. The whole of the Delamere 1:250,000 Sheet area was covered in 1966-67. All the surveys were flown on lines one mile apart.

Over most of the area the contour pattern is very simple. The few anomalies that do exist do not appear to be produced by the Carpentarian-Adelaidean sediments, but by the Lower Proterozoic - Archaean basement below them. The Antrim Plateau Volcanics, on the other hand, do produce some small variations. On the Port Keats Sheet area the Moyle River Fault produces an obvious discontinuity in the contour pattern. Some of the outcrops of gabbro produce small anomalies. One linear positive anomaly in the centre of the eastern part of the sheet area is located over a thin sill-like intrusion of granite in the Chilling Sandstone.

Seismic work

In 1966 a seismic survey was carried out over the Palaeozoic rocks to the east of Port Keats Mission for Australian Aquitaine Petroleum Pty. Ltd. by Compagnie Generale de Geophysique (A.A.P., 1966). This confirmed the position and size of the Moyle River Fault and also detected several major and minor branches of the fault. Also produced a contour map of four horizons within the Palaeozoic sequence showing a structural low near Port Keats Mission which corresponds with the centre of the negative Bouguer anomaly.

Radiometric Survey

A reconnaissance airborne scintillometer survey was made over the eastern half of the Port Keats and western half of the Fergusson River Sheet areas. The results of the survey are referred to in the section on Economic Geology.

STRUCTURE

Tectonic Units

The four sheets mapped in 1968 included a wide range of tectonic environments. A number of basic tectonic units can be distinguished in the area (Fig. 37). They are:- Archaean basement; Pine Creek "Geosyncline"; Intrusive Igneous Rocks; Fitzmaurice Mobile Zone; Sturt Block; Tolmer Group; Palaeozoic and Mesozoic Basins. The units approximately correspond to regional geophysical gravity anomalies. Generalized structures within these regions is shown in Fig. 39.

Archaean Basement

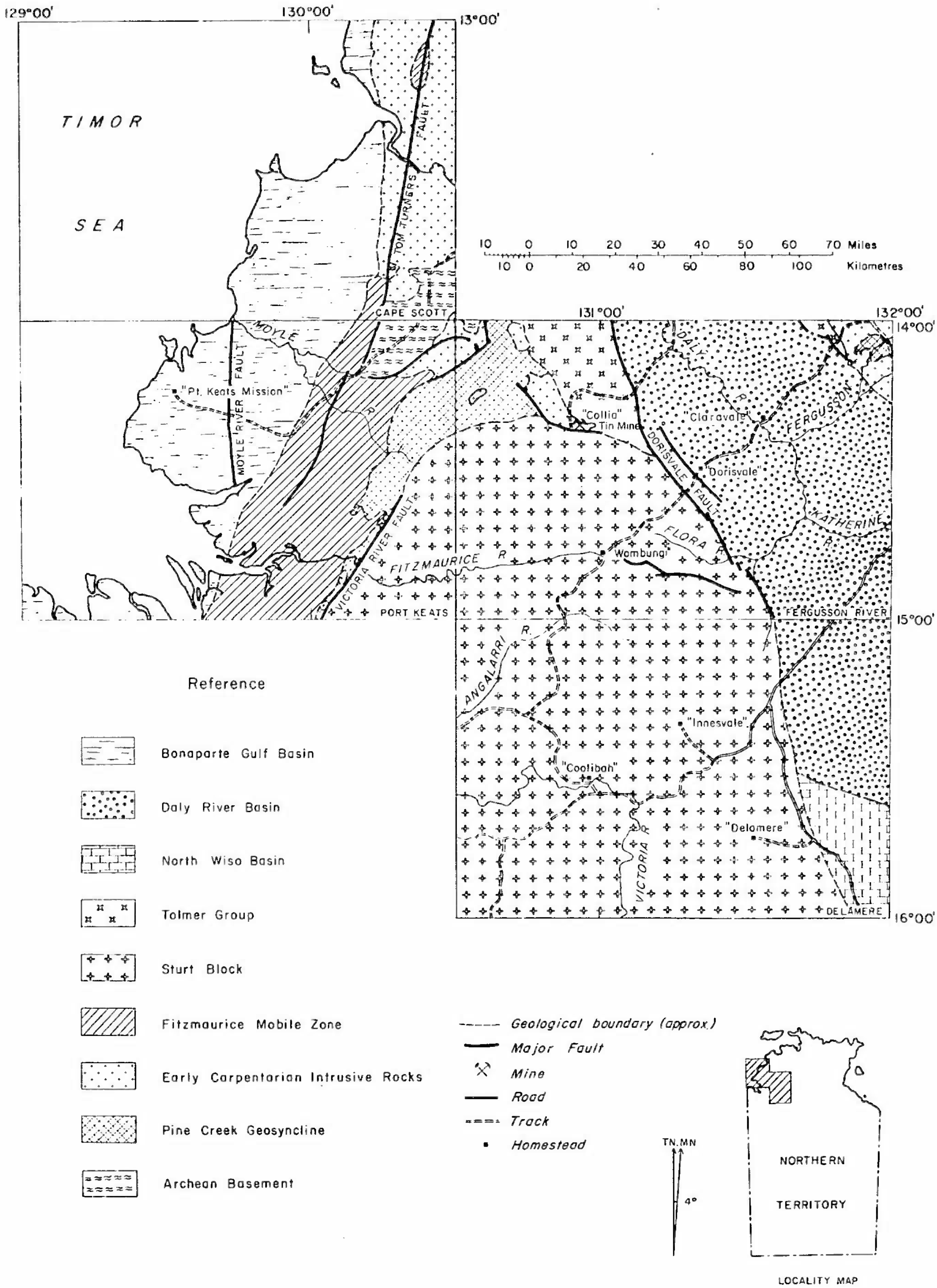
The Archaean Basement lies to the north-west of the Pine Creek "Geosyncline" but is only exposed in close association with early Carpentarian "granite" and gabbro. It may underlie parts of the Sturt Block but this remains unproven. Folding is very intense and metamorphism varies from upper greenschist facies to local almandine-amphibolite and even granulite facies very close to the intrusives.

Pine Creek "Geosyncline"

The Pine Creek "Geosyncline" forms an inverted Y shape in the region mapped. The two arms of the Y form the major structural trends in the region. (Fig. 37). The arms encircle the Sturt Block which presumably formed a stable craton during the period of formation of the Lower Proterozoic orogenic belts. Almost all of the younger tectonic units unconformably overlie the Pine Creek "Geosyncline" at its eastern and western limits.

The western arm of the "geosyncline", which contains a large proportion of sheared sandstone and volcanics, extends south-southwest to the southern margin of the Port Keats Sheet area. The geophysical work (regional gravity survey) indicates that this arm extends south at depth as far as the Victoria River, although the western part of the geophysical anomaly may be due to the former Archaean Basement.

FIG. 37 TECTONIC UNITS
OF CAPE SCOTT, PORT KEATS, FERGUSSON RIVER AND DELAMERE 1:250,000 SHEET AREAS



To accompany Record 1970 / 3

The eastern arm of the Pine Creek "Geosyncline" contains a thick sequence of greywacke, siltstone and sandstone which are strongly folded and metamorphosed to upper greenschist facies. The unit is terminated to the south by the Collia Fault where it is intruded by the Soldier's Creek Granite.

In the northeast part of the Fergusson River Sheet area siltstone and greywacke of the Pine Creek "Geosyncline" are intruded by granite which forms the major unit in this region. The nature of the boundary of this granite with the Daly River Basin is not known in this area.

The Pine Creek Geosyncline displays several features characteristic of a true geosyncline such as granite and basic intrusives, greywacke etc. (De Sitter, 1956). It is not, however, large enough, nor does it contain ophiolites, thrust faulting or high-grade metamorphism and hence may best be considered as a parageosyncline or intra-cratonic basin (Walpole et al., 1968).

Intrusive Igneous Rocks

The Intrusive Igneous Rocks are composed basically of granitic rocks with minor gabbro, diorite and granophyre intrusions. The igneous rocks are restricted in outcrop to the Archaean Basement and Pine Creek "Geosyncline". There has been no intrusive igneous activity in this area since the early Carpentarian. The igneous bodies have commonly caused only local contact metamorphism of the sediments they intrude, which suggests that the intrusions have near vertical contacts with the country rock. The contacts are commonly faulted or aligned along linear features.

The granitic rocks are intimately mixed with the Archaean sediments and may possibly have resulted from granitization of the sediments. This is particularly likely in the case of the Litchfield Complex on the Cape Scott Sheet area where migmatites, consisting of partly granitized schists and pegmatitic materials are widespread. Most of the granites, however, have well developed intrusive relationships and the Soldier's Creek Granite has all the characteristics of a high-level intrusion.

Apparent foliation in the Soldier's Creek and Allia Granites is due to the platy alignment of large feldspar crystals and tabular xenoliths and is probably the result of flow movement during infusion. Banding of quartz, feldspar and more rarely, biotite is common in the granitic rocks.

Fitzmaurice Mobile Zone

The Fitzmaurice Mobile Zone lies unconformably on the west of the Pine Creek "Geosyncline" and consists of a moderately folded and highly faulted, thick sequence of quartz sandstone and siltstone. The rocks which are between 3,000 and 12000 metres thick form a large synclinal structure which has a thin steeply dipping eastern limb and a thicker more gently dipping western limb. Several phases of faulting appear to be present in this zone which is considered equivalent to the Carr Boyd Succession in the East Kimberley area of Western Australia (Dow et al., 1964). The unit is thought to have formed in a very active environment in fault-bounded, subsiding troughs.

Sturt Block

The Sturt Block is the major tectonic unit in the Victoria River District. It is bounded to the east by the Dorisvale Fault and to the west by the Victoria River Fault. Its northern limits are concealed beneath a Mesozoic cover. The block appears to have acted as a stable craton since, at least, Lower Proterozoic time. It undoubtedly formed a "foreland" during the Lower Proterozoic "geosynclinal" activity since the trends of the orogenic zone bend around the block. The block is covered by a series of predominantly flat-lying and gently folded Carpentarian(?) and Adelaidean (Fig. 38) sediments. Minor structures such as normal faults, monoclines and small domes are common within the block but the area has been an essentially stable one for a long period. The beds dip gently away from the centre of the block; dips near the western margin of the block commonly reach 30°.

There are two known unconformities in the Proterozoic sequence; they lie above and below the Wondoan Hill Formation. Where this formation is missing in the north and west of the Sturt Block the angular unconformity between the Bullita and Auvergne Groups is more apparent. There is good evidence for folding, peneplanation and lateritization during this stratigraphic break.

Fig. 38 (A): Panoramic view of part of Delamere 1:250,000 sheet area, looking towards the west and southwest margins of the area. Stokes Range is in left background. Tower Hill on the right.

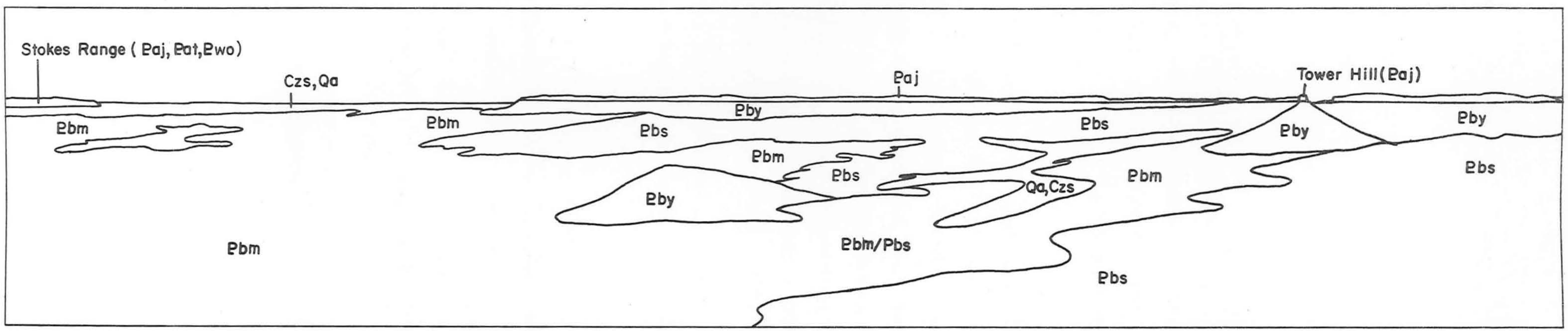


Fig. 38 (B): Well bedded Skull Creek Formation (Ᵽbs) with a thin capping of Bardia Chert Member (Ᵽbm), overlain by Bynoe Formation (Ᵽby). These rocks dip at 2° to the southeast (to the left of the photo), and are overlain with angular unconformity by flat-lying Jasper Gorge Sandstone (Ᵽaj).

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The Banyan Formation was deposited in a local basin in the Flora Valley region and its thickness ranges from 3 to 300 metres in 30 km. This sequence is unique and crops out adjacent to the faulted margin of the Sturt Block.

Tolmer Group

The relationships of the Tolmer Group sediments to those on the Sturt Block and Fitzmaurice Mobile Zone are not clear. The contact is faulted or obscured by Cretaceous beds. Opinions are divided as to the probable age of the group.

The outcrops of Tolmer Group conform to the outline of the northern part of the Daly River Basin and the sedimentation may have been restricted to that basin. However if the Tolmer Group is a direct correlate of sediments on the Sturt Block it is possible that the area of the Daly River Basin was part of Sturt Block in Tolmer Group time and that the Daly River Basin was developed later in Palaeozoic times on the margin of the Sturt Block. In the absence of evidence either way the Tolmer Group is included in a separate structural unit. The

The unit is moderately faulted but only gently folded. It dips between 5° and 30° in its western outcrop and about 5° in the east.

Palaeozoic and Mesozoic Basins

The Precambrian rocks of the Victoria River District are bounded to the east and west by younger sedimentary basins.

The Daly River Basin lies to the east of the Dorisvale Fault which downthrows the Palaeozoic rocks of the Daly River Group to the east. The basin is a north-west-trending synclinal structure containing a total of about 400 metres of Palaeozoic sediments. The beds are rarely faulted and show only slight warping. A concealed basement ridge divides the Daly River Basin from the Wiso Basin which lies to the south of it (Randal & Brown, 1967). The tectonic arrangement of the Wiso Basin is very similar to that of the Daly River Basin. No boundary fault has been recognized between the Wiso Basin and the Sturt Block, and the contact may be an unconformity.

The Bonaparte Gulf Basin lies to the west of the Fitzmaurice Mobile Zone and the Litchfield Complex. On the Cape Scott Sheet Area the Litchfield Complex is known to extend westwards beneath a thin veneer of sediments of the Bonaparte Gulf Basin. A similar situation exists farther south where drilling has proved that gabbro extends west as far as the concealed Moyle River Fault. Here, however, there is a distinct step in the underlying topography with a large thickening of Palaeozoic sediments west of the lineament. Detailed geophysical work (seismic, gravity & magnetic) has accurately positioned this fault. At Kulshill No. 1 well, 13 km ESE of Port Keats Mission, drilling was halted in Devonian sediments at 4,440 metres. (Duchemin et al., 1966). Folding and faulting in the Bonaparte Gulf Basin are weak, large-scale depositional dips being the only major structural influence.

FOLDING

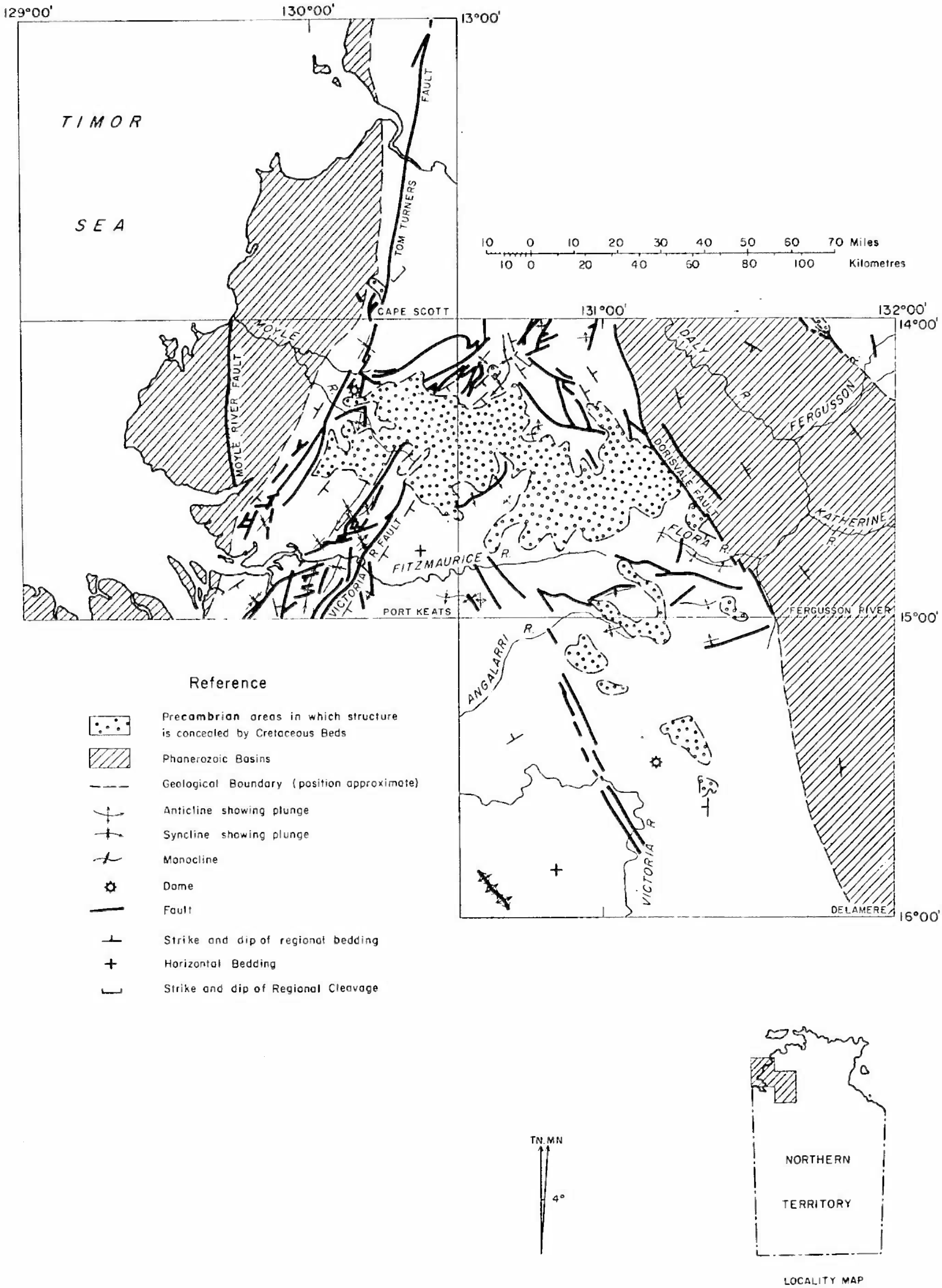
Folding is widespread in the Victoria River district and varies from gentle warping to intense polyphase deformation. Fig. 39 shows the main fold axes and their plunge directions.

The Archaean Basement has been affected by several phases of deformation. Walpole et al. (1968) report that the unit has a primary east-west foliation. The 1968 mapping has shown that a secondary foliation occurs.

This appears to be an axial plane schistosity or in places, merely a cleavage, which has a regional significance. It ranges in orientation from 045/vertical to 010/80°W, averaging 025/85°W. The associated minor folds show a very variable style ranging from small cherton folds, to larger similar and even concentric folds.

The folds vary in wavelength from 60 cm to 8 cm and in amplitude from 90 cm to 5 cm Chevton folds generally are small whereas similar and concentric folds are larger. The folds and associated foliation probably formed during the Pine Creek orogeny and they effectively obscure features formed by the primary folding. Lineations on the limbs of minor folds indicate that the primary trend has been refolded and cleaved along new axes. This secondary foliation is an axial plane cleavage and is associated with several different types of folds. The secondary folding was produced at the same time as the major fold movements in the Pine Creek "Geosyncline".

FIG. 39 STRUCTURE MAP
OF CAPE SCOTT, PORT KEATS, FERGUSSON RIVER AND DELAMERE 1:250,000 SHEET AREAS



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The Pine Creek "Geosyncline" shows moderate to tight folding. The regional cleavage, which is very well developed in the finer-grained rocks, ranges in orientation from a strike of 030° and a dip of 85°E in the Port Keats Sheet area to a strike of 115° and a dip of 85°N in the Muldiva Creek region. The fold axes exhibit a very similar variation.

In the Muldiva Creek region the major syncline has a variable southerly plunging axis. The more incompetent siltstone and shale beds show local isoclinal and disharmonic folding in this area, whereas the more competent sandstone and greywacke are folded in regular concentric folds.

The Fitzmaurice Mobile Zone is a weakly to moderately folded synclinorium. Anticlinal hinges are generally faulted out. The folds have axes aligned parallel to the trend of the mobile zone. Their plunges are not variable like some of those in the older units. Folding is thought to have occurred at a very high level since no metamorphism has taken place.

The Sturt Block exhibits a variety of fold styles. Monoclines which reflect basement steps are common. The trend of the monoclines is very variable but many are aligned east-west. The monoclines are caused by renewed movements along older fault lines in the basement. There are several east-northeast-trending anticlines on the southern part of the Fergusson River Sheet area. These, and a series of north-northwest-trending normal faults on the Sturt Block, are probably a result of a late Adelaidean or Early Phanerozoic stress system. Several domes crop out in otherwise flat-bedded rocks in the Sturt Block. The mode of origin of these domes is not known. Laing and Allen (1956) suggest that they are formed by transcurrent movement between basement blocks.

Very local minor kink folds occur near the major faults. [redacted] with horizontal axes in the Goobaieri Formation, a few hundred yards from the Victoria River Fault. A larger drag fold crops out immediately northwest of the Chalanyi Creek Fault in the Macadam Range on the Port Keats Sheet area. This fold suggests that dextural transcurrent movement has taken place along the fault.

Metamorphism

Metamorphic effects are restricted to the older tectonic units of the Victoria River district.

The Archaean Basement has been regional metamorphosed and this event post-dates the second fold phase and may obscure an earlier metamorphism which pre-dates the folding. The later metamorphism is well documented by mineralogical changes, which are observable in thin section. Biotite and chlorite show a syntectonic origin but garnet formation was a post-orogenic event. The rocks grade from upper greenschist facies to locally almandine-amphibolite facies (Turner & Verhoogen, 1960). Diapthoresis has occurred throughout the unit with garnet porphyroblasts being retrograded to chlorite, biotite and quartz with only a few remnants of original garnet remaining.

Later contact metamorphism by the Litchfield Complex has locally produced very high-grade metamorphic rocks. A garnet-sillimanite-corundum-cordierite rock crops out in the Dilke Range on the Cape Scott Sheet area. Tourmalinization is a widespread effect in the contact zone. Some retrograding of garnets has occurred within the Litchfield Complex itself possibly indicating slow cooling of the igneous mass at deeper levels of the crust. The partial digestion of some of the Archaean rocks by migmatitic fluids also indicates reaction at deep crustal levels.

In the Pine Creek "Geosyncline" there is evidence of one regional metamorphic phase with overprinted, local, contact metamorphic effects near the intrusive igneous rocks. Andalusite and garnet are widespread in the finer-grained clastic rocks, the latter mineral commonly showing a syntectonic origin by virtue of its rotated porphyroblasts. Subsequent retrograde metamorphism has caused these minerals to be almost completely replaced however. Tourmalinization and local high-grade contact metamorphism occurs around the margins of the igneous intrusives. In the more westerly areas quartzite is commonly formed from the clean sandstones.

FAULTING

Perhaps the most significant faults in the Victoria River District are the Victoria River and Dorisvale Faults. These control the areal extent of the Sturt Block. The former is a high-angle reverse fault on the Port Keats Sheet area although it becomes a low-angle thrust fault further south. The Dorisvale Fault however, appears to be a normal fault which shows evidence of several periods of movement, the latest of which occurred in the Tertiary Period.

Few major faults were mapped in the Archaean Basement, the notable exception being the Tom Turners Fault which cuts the unit in part, downthrowing beds to the west. This fault is probably a very high-angle reverse fault and was initiated early in the tectonic history of the area. Its southerly continuation in the Fitzmaurice Mobile Zone, the Chalanyi Creek Fault, shows evidence of sinistral transcurrent movement.

The major faults of the area strike parallel to the Pine Creek "Geosyncline" and were presumably initiated by the same stress system that caused the Lower Proterozoic orogeny. Renewed movements along these faults at various times since their inception has obscured the true relationship of the fault types.

The Fitzmaurice Mobile Zone admirably demonstrates the relationships of a primary northeast-trending system of faults with a later cross-cutting east-west set (Fig. 39).

On the Sturt Block east-west-trending faults appear to be of an early age whereas the north-northwest-trending faults are Late-Adelaidean or Phanerozoic.

Faulting has played an important part not only in determining the structural history of the area but also in influencing deposition especially in the Fitzmaurice Mobile Zone.

GEOLOGICAL HISTORY

The rocks exposed in the Victoria River District range in age from Tertiary to Archaean and here represent a period of about 2,500 million years or more. The geological history of the region within this time can be partly reconstructed, but many of the sediments deposited, particularly in the Archaean and Lower Proterozoic, have been removed by subsequent erosion or are concealed by younger beds.

The Archaean sediments, which consisted of coarse-grained quartz siltstone and silty sandstone, are assumed to have formed in a basin area which was subsequently folded along east-west axes and metamorphosed. Synorogenic ultra-basic and basic rocks were intruded into the sediments. This orogenic belt was then uplifted and gradually peneplained, much of the derived sediments being redeposited in the Pine Creek "Geosyncline". The Henschke Breccia, which consists of about a thousand metres of petromict conglomerate, may represent rapid deposition on the western margin of the geosyncline. Conglomerate and grit also crop out further south in the Meeway Plain area.

The Sturt Block may well be composed at depth of Archaean rocks since it acted as a "foreland" during the formation of the Pine Creek "Geosyncline".

Hills (1956) and Walpole (1960) suggest that the formation of the Pine Creek "Geosyncline" was due to segmentation of the Archaean "shield" by subcrustal convection currents. Walpole et al. (1968) postulate alternating tensional and compressional stresses directed roughly east-west, producing north-north-east and west-north-west zones of transcurrent movement. Subsidence then occurred, causing sedimentation to begin in the "Geosyncline". The Noltenius Formation consists of flysch deposits; fine-grained siltstone and greywacke being the predominant rock types. In contrast, the clean quartz sandstone of the Chilling Sandstone was deposited later in a shallow-water active environment close to the western margin of the basin. Acid and minor intermediate volcanics, the Berinka and Meeway Volcanics, were extruded into the sedimentary sequence along this margin. During and after orogenesis this western margin continued to be an active zone as shown by the many faults and basic and acid intrusives along its length.

The late Lower Proterozoic folding and metamorphism which affected the Pine Creek Geosyncline also refolded and remetamorphosed the Archaean rocks along NNE axes. The fold axes in the Pine Creek Geosyncline trend parallel to its margins and hence are locally variable. Folding was not very intense and metamorphism reached only to upper greenschist and locally to almandine - amphibolite facies. No thrust faults or ultra-basic intrusives have been recognized in the "Geosyncline". Retrograde metamorphism to lower greenschist facies followed the folding episode.

Most basic rocks were intruded along the western margin of the Pine Creek Geosyncline; medium-grained diorites and associated granophyres are common. In the Archaean basement to the west more extensive gabbro, dolerite and diorite were intruded.

In early Carpentarian times several granitic masses were emplaced within the Pine Creek "Geosyncline". The granitic suite has caused local contact metamorphism to hornblende hornfels facies and tourmalization of the Pine Creek "Geosyncline" sediments but has had more widespread effects on the Archaean basement. Here migmatites are abundant, derived partly from Archaean schists and partly from pegmatitic material. The metamorphic aureoles are also wider and reach up to pyroxene hornfels facies. Pegmatites are particularly abundant within the Litchfield Granite and the Soldiers Creek Granite.

The Edith River Volcanics were extruded immediately following the emplacement of the "granites"; these acidic lavas cropping out in close association with the Cullen Granite.

A considerable period of slight metamorphism, uplift and erosion followed this intrusive activity in the Carpentarian. The Lower Proterozoic sediments and early Carpentarian intrusives were peneplained prior to the deposition of Adelaidean sediments

In the west, however, the thick arenite sequence of the Fitzmaurice Group was deposited in a faulted trough. Probably some of the faults in the Fitzmaurice Mobile Zone were active during deposition. The age of this deposition is not known but it post-dates the peneplanation of early Carpentarian rocks. The rock types present indicate moderately fast deposition in the trough close to a sediment source. Very few sedimentary structures are present in the sequence.

Moderate folding associated with further faulting probably occurred soon after lithification. Fault movement in this zone continued until late Palaeozoic times.

Possibly contemporaneously, a thick sequence of sediments, the Bullita and Auvergne Groups, was deposited on the Sturt Block. Evidence of early sedimentation on the Sturt Block is not exposed; the oldest exposed sediments are in a siltstone-dolomite-sandstone sequence overlain by a thick dolomite unit with abundant stromatolite colonies. A chert horizon developed on the dolomite, probably indicating a small time break in deposition. A thick siltstone unit (Bynoe Formation) overlies the chert. A period of uplift with associated warping and the development of local monoclines and anticlines was followed by erosion. The warping was strongest in the west of the Delamere Sheet area where the Bullita Group has an average dip of 5° beneath flat-lying Auvergne Group sediments. Further east only slight tilting has occurred and siltstone, sandstone and shale (Wondoan Hill Formation) was deposited. In the Fergusson River Sheet area a laterite (?) horizon is widespread beneath the Jasper Gorge Sandstone indicating that sub-aerial conditions with a seasonal wet climate prevailed.

Following this period of erosion a rapid marine transgression resulted in the deposition of a siltstone-sandstone sequence (Stubb Formation) in the eastern part of the Sturt Block. The subsequent deposition of sandstone (Jasper Gorge Sandstone) was uniform over the whole Sturt Block. It represents a progressive shallow-water marine transgression over a low relief platform. The subsequent deposition of the siltstone, sandstone and dolomite of the Auvergne Group took place in an active, shallow-water, marine environment with intermittent sub-aerial and lagoonal conditions.

The Tolmer Group was deposited in a quiet, shallow-water, marine environment which became progressively deeper at first but later shallowed to intermittently lagoonal conditions. A dolomite sequence with abundant stronatolites was deposited in this latter phase. Deposition took place in the region of the Daly River Basin. The age relationships of this group and its original areal distribution are not known. A period of erosion followed the deposition of these sediments.

Lower Cambrian times saw the extensive outpouring of tholeiitic flood basalts over much of the eastern margin of the Sturt Block. The basalts were probably extruded for the most part in sub-aerial conditions as evidenced by the interbedded dune sands. Small exposures of interbedded limestone and conglomerate on the Fergusson River Sheet area suggest that areas of shallow water did exist in the north.

Subsequent to the basalt outpouring in the Middle Canbrian, the Tindall Limestone was laid down in a quiet shallow-water marine environment. The limestone is conformably overlain by a dolomite-sandstone-siltstone unit which was deposited in littoral and at times sub-aerial conditions. The upper parts of this unit, the Jinduckin Formation, and the overlying Oolloo Limestone are Lower Ordovician in age.

In the Daly River and Wiso Basins no further sedimentation occurred until Lower Cretaceous times. Further west, however, in the Bonaparte Gulf Basin, a thick sequence of Devonian and Carboniferous marine sediments was deposited, followed by Permian and Triassic sandstone, siltstone and diamictites. Slight folding and faulting occurred between Cambrian and Cretaceous times.

During the Lower Cretaceous non-marine sandstone and marine claystone were deposited over a wide area. Plant remains are common in the sandstone. Skwarko (1966) has described the palaeogeography and depositional history of these beds.

Extensive development of laterite occurred in Tertiary times and in many places this deposit, together with the underlying Cretaceous Mullaman Beds, obscures the Precambrian geology. Later warping and uplift have caused marked changes in the physiography and drainage patterns in the region.

ECONOMIC GEOLOGY

The Woolngi and Fletchers Gully gold mines and the Buldiva, Muldiva and Collia tin mines are the sites of the main known mineralization. They are all small workings and, with the exception of Collia, are now abandoned. No minerals apart from tin, gold and a small quantity of copper have been mined in the area although there are small uneconomic occurrences of uranium minerals, wolfram, galena, iron ore and barytes. Metals Exploration N.L. is currently (1969) exploring the Antrim Plateau Volcanics for copper. Traces of oil and gas have been found in a well drilled in the Palaeozoic sediments of the Bonaparte Gulf Basin south of Port Keats Mission, and thin seams of coal have been found in bores in the same area.

Gold

(a) Woolngi goldfield - north-east corner of the Fergusson River Sheet area.

The Woolngi gooldfield was first mentioned in mining reports in 1897 and was abandoned in 1908. The gold occurs in quartz reefs about 1 metre thick which intrude an overfolded anticline in the Burrell Creek Formation. About 125 kg of gold are known to have been won from the field.

(b) Fletchers Gully goldfield - north-west corner of Fergusson River Sheet area.

Alluvial gold was reported at Fletchers Gully in 1905; since then the history of the field has been one of repeated closing and re-opening. Lode gold occurs in quartz reefs filling fissures and tension cracks associated with an anticline in the Noltenius Formation. Both alluvial and lode gold were worked until the 1940's. About 84 [illegible] of gold are known to have been won from the field.

In 1895 H.Y.L. Brown assayed a quartz reef in the sediments of the Fitzmaurice Group near the mouth of the Fitzmaurice River. One sample showed 56.6 grammes of silver to the metric ton. Another showed traces of gold.

Tin (Production Figures given in Table5)

Tin was first discovered at Fletchers Gully in 1905, shortly after the end of the first gold rush to that area. The tin occurs as cassiterite in minor pegmatite dykes associated with the Allia Granite.

The tin deposits at Buldiva, Muldiva, and Collia were first seriously worked in 1922. At Buldiva, tin has been won from numercus small tourmaline-muscovite pegmatite lenses intruded into the Soldiers Creek Granite and Noltenius Formation; from a basal conglomerate in the overlying Cretaceous Mullaman Beds; and more recently from eluvial and alluvial deposits. The bulk of the production has come from the latter.

TABLE 5 : TIN PRODUCTION

Period	Area	Tin conc. (kilogrammes)	
1910	Fletchers Gully	2,040	
1922-23	Fletchers Gully	4,270	
	Collia	1,020	
1923-24	Collia and Muldiva	26,800	
1924-25	Collia	5,560	
	Muldiva	3,770	
1925-26	Collia and Buldiva	5,110	
1926-27	Collia and Buldiva	554	
1927-28	Collia	1,385	
1928-29	Collia	1,490	
1935-36	Buldiva and Fletchers Gully	N/A	
1937-38	Fletchers Gully	N/A	
1940-41	Fletchers Gully	0.035	35.6
1943-44	Fletchers Gully	0.220	224
1948-49	Collia	0.100	102
1949-50	Collia	0.200	204
1950-51	Collia	0.390	397
1951-52	Collia	0.350	356
1952-53	Collia	0.480	489
1953-61	Collia	N/A	
1961	Collia	0.22	224
		(163 kg tin mineral)	
1962-65	Collia	N/A	
1966	Collia	7,580	
		(4,680 kg tin mineral)	
1967	Collia	34,000	
		(24,300 kg tin mineral)	

N/A : figures not available, (probably because production was nil during these periods).

Where less than 1 kg figures also quoted as grains.

At Muldiva, some production has come from quartz-mica-tourmaline-cassiterite lodes intruded into schist of the Noltenius Formation. The largest lode ranged from 0.3 to 0.6 metres wide and was traced for 45 metres, but the bulk of the production was from alluvial deposits.

The Collia area has been worked intermittently since 1922. Most production has come from shallow pockets in small streams, and more recently (1966-67) from selective mining of eluvial deposits bordering quartz-tourmaline-cassiterite dykes.

Uranium: Uranium-bearing minerals were found in 1950, immediately to the east of the Sturt Highway crossing of the Fergusson River. At this occurrence torbernite and autunite, with copper and cobalt minerals, occur in a sheared zone of the Cullen Granite, near the contact of the granite with the Burrell Creek Formation (Crohn, 1968). Four other radioactive occurrences were located in the Cullen Granite, where the mineral, probably autunite or meta-autunite, is associated with quartz reefs. All these shows were examined in detail by Commonwealth geologists, who recommended that no further work be done (Fisher, 1952; Gardner, 1953 a, b).

Copper: Copper shows to the west of the Woolngi goldfield are shown on Jensen's map (1919), and copper was recovered from Woolngi before 1896, but in neither case are production figures available. Copper minerals occur as traces in shafts and costeans near the Fergusson River Siding, and traces of native copper occur in the Antrim Plateau Volcanics near Collia.

It is possible that copper will be found at the contact between the Antrim Plateau Volcanics and the overlying Cambrian limestone on the Delamere and Fergusson River Sheet areas as malachite and azurite have been found at the contact elsewhere.

Barytes

Reefs and aggregates of barytes, with traces of galena, occur in Thompsons Pocket, southwest of Dorisvale homestead (Fergusson River Sheet). They are probably associated with sandstone interbedded with Antrim Plateau Volcanics although contacts with the country rock are not exposed. Minor barytes also occurs in the Soldier's Creek Granite 8 km north-west of Collia Waterhole.

Small aggregates of barytes are also found in the Bynoe Formation about 6 km west of Coolibah homestead on the Delamere Sheet area.

Wolfram

Small crystals of wolfram are sparsely scattered in quartz veins and stringers in the Burrell Creek Formation, in the Woolngi goldfield area.

Galena

Crystals of galena up to 5 mm across, and small aggregates of galena were found locally in recrystallized limestone in the Banyan Formation, north of the Flora River-Banyan Creek junction. The limestone is stromatolitic, and contains halite casts.

IRON

Laterite of probable Tertiary age is extensive over the Mullaman Beds throughout the area. The ferruginous zone is either irregularly nodular and contaminated with porcellanite, quartz sand and various clays, or it is regularly pisolitic, and consists almost entirely of hydrated iron-oxide. A maximum thickness of 6 metres was seen north of Dorisvale but it is generally thinner. At present (1969) leases are held for potential iron-ore reserves of this type southeast of Kathleen Falls. Table 5 contains analyses for several laterite samples from the area.

Pyrrhotite

Small amounts of disseminated pyrrhotite were found in one small outcrop of granophyre on the Fergusson River Sheet area. This was about 40 km west northwest of Collia Waterhole (Grid reference 348186) (see section on Ti Tree Granophyre).

Phosphate

In recent years exploration for phosphate has been carried out unsuccessfully in Middle Cambrian rocks of the Daly River Group. The Daly River Group was considered attractive because it is similar in age and lithology to phosphate-bearing rocks in north-western Queensland.

Radioactive Anomalies

A reconnaissance airborne radiometric survey was made over the eastern half of the Port Keats and western half of the Fergusson River Sheet areas by the Bureau of Mineral Resources in 1956. A number of radioactive anomalies were discovered. The position of these is shown in Fig. A more detailed airborne radiometric and geological survey was made in the area by Planet Gold N.L. in 1968.

Eighty-five percent of the anomalies found by the Bureau of Mineral Resources are situated on laterite overlying the Mullaman Beds. The other 15 percent are near outcrops of laterite. Most but not all of the anomalies are in the area covered by the mobile belt.

Oil

Three exploratory oil wells, (Kulshill No. 1, Kulshill No. 2 and Moyle No. 1) were drilled for Australian Aquitaine Petroleum in 1965-1966. They were sited in the Palaeozoic rocks of the Bonaparte Gulf Basin to the south and east of Port Keats Mission. No commercial reserves were proved although traces of oil, gas, bitumen and fluoroscence were encountered in both the Kulshill wells. The hydrocarbons occur in the Lower Permian (Microconglomeratic Shale Member and Basal Silicified Sandstone Member of the Kulshill Formation) and in the upper part of the Lower Carboniferous (Tanmurra Formation and Milligan Beds 1 and 3). All shows were in impermeable rocks.

Coal

Coal seams have been intersected in bore holes in Permian rocks between the mouths of the Fitzmaurice and Daly Rivers on the Port Keats and Cape Scott Sheet areas. They were originally found in bores drilled by the government between 1905 and 1909. In 1965-66 coal seams were intersected by the Kulshill No. 2 oil well at 390 metres. In 1967 five shallow bores (Kuriyippi 1-5) were drilled for Theiss Bros. Ltd. in an attempt to find commercial quantities of coal; these are situated between Table Hill and Kulshill Creek on the Port Keats Sheet area. Carbonaceous material was intersected in four of the holes but no thick coal seams of wide lateral extent were found within 915 metres of the surface. Furthermore the coal was of poor quality.

The coal occurs in two horizons in the Lower Permian "Sugarloaf Formation", viz the "Sugarloaf Shale" (upper coal measures) and "Sugarloaf Sandstone" (lower coal measures). In the upper measures the coal is interbedded with black clay, shale or fine to coarse-grained grey sandstone. In the lower measures the coal was mostly in medium to coarse-grained friable porous sandstone. The coal occurs as small fragments, interspaced grains, thin lenses and seams. The only seam of any lateral extent was 0.6 metres thick. All other seams were less than 23 cm thick.

Water resources

Surface water resources have been used for stock-raising purposes since the area was first stocked. Although most rivers and creeks stop flowing after the wet season, numerous waterholes occur throughout the country and many are permanent.

The Katherine and Flora Rivers are spring fed, and flow all the year. Although the Victoria virtually stops flowing by about August, long reaches of the river still contain abundant water.

Annual discharges of the Victoria and Daly Rivers are extremely large, and figures available show that each of these rivers probably has a total discharge in excess of that of the Ord River (Review of Australia's Water Resources, 1963). Practicably none of this water is used for agricultural purposes at present.

Fresh water springs are found locally at the base of the Pinkerton Sandstone. This unit acts as the aquifer, and the siltstones at the top of the Saddle Creek Formation provide the impervious layer which causes the water to move laterally and eventually seep out where this contact is intercepted by a scarp. Such springs are found in pockets along the southside of the Coolamon Fault, along the scarp between The Twins and Mount Golla Golla and in the Collia area. Jarong Springs is a notable example of springs at this stratigraphic horizon.

Ground water resources are being increasingly exploited for pastoral purposes. Table shows the number of bores drilled to date on the sheet areas investigated.

The Delamere sheet area is the only one on which a significant number of bores have been drilled. Most have been drilled within the last 10 years.

TABLE

1:250,000 Sheet Area	Number of bores	Comments
Cape Scott	14	On eastern margin of area. Elizabeth Downs and Litchfield Stations.
Port Keats	9	1 is an oil exploration bore. Most of others are shallow holes at Port Keats Mission.
Fergusson River	11	
Delamere	65	Most are on Delamere and Fitzroy stations.

The probability of finding adequate stock water supplies on the Cape Scott, Port Keats and Fergusson River Sheet areas is high. Most of the bores drilled to date have yielded satisfactorily.

On the Delamere Sheet area the main areas in which bores are needed are:-

(1) the eastern sector, underlain by basalt. The Antrim Plateau Volcanics yield large quantities of water from some bores (over 4500 litres per hour), but dry holes are common. The best places to drill are in areas in which photo-linear features are apparent, or where interbeds of sandstone or chert are known to occur.

(2) the southwestern sector, comprising vast plains underlain by Bynoe and Skull Creek Formations. Yields from the rather impermeable Bynoe Formation will generally be low, and chances of striking water will be by drilling down into chert or dolomites of the Skull Creek Formation.

(3) the north-western sector, underlain by Angalarri Siltstone. Because this formation forms plains, surface water is inadequate for stock. Unfortunately, the Angalarri Siltstone is extremely impermeable, and yields very little water. Successful bore holes will have to derive water either from the alluvium above the siltstone in some areas, or from sandstones near the base of the siltstone, or below it in the Jasper Gorge Sandstone. To penetrate the latter formation will require holes up to 300 metres deep, and the potential of the Jasper Gorge Sandstone as an aquifer is unknown.

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APPENDIX

ANALYSIS OF ANTRIM PLATEAU VOLCANICS

by
T.I. Slezak

Sixty-five samples of Antrim Plateau Volcanics were analysed by optical emission spectroscopy on the Hilger and Watts 3 metre Polychromator for the following elements: Cu, Fe, Mg, Mn, Cr, Co, Ni, V, Mo, Ca, Ti, Sr, Ba, Sc, Y, La, and Zr. The values for Fe, Mg. Mn, Ca, and Ti are given in per centum, whereas all others are in parts per million.

The samples were crushed in a 4" jaw crusher and the resulting chips reduced to -120 mesh in a Siebtechnik mill using a Tungsten carbide vessel. This type of vessel introduces W and some Co as metallic contaminants to the sample, and thus it is possible that the Co values obtained for hard rocks are high.

The analytical method used was adapted from Ahrens and Taylor ("Spectrochemical Analysis", 1961, p. 189, Addison-Wesley Publishing Company). One part of sample was mixed with two parts of graphite (National Carbon Company Type L4160 Grade SP-2). The mix was loaded into a preformed graphite electrode (National Carbon Company Type L4260) and arced as the anode in a constant current (8 amps) D.C. arc for 130 seconds. Both internal standard and rock standard control were used. On previous experience with this method for the analysis of similar materials it is estimated that the values given for elements are within 10% of the true values.

The results (Table 4) show that many of the samples are extensively altered from their original compositions, though their basaltic nature is indicated by normal values obtained for V and Sc.

Sample Number	1:250,000 Sheet Area	Grid Co-ordinates E	N	Remarks
1	Delamere	430500	3042100	Fine-grained basalt overlain by laterite
2	Delamere	4158	30419	Fine-grained basalt overlain by laterite
3	Ferg. Riv.	4161	31272	Massive basalt
4	Ferg. Riv.	4437	31176	Vesicular basalt
5	Ferg. Riv.	4437	31176	Massive basalt
6	Ferg. Riv.	3968	31741	Basalt overlying Jarong Conglomerate
7	Ferg. Riv.	3786	31990	Vesicular basalt with sandstone
8	Ferg. Riv.	3797	32006	Vesicular basalt with sandstone
9	Ferg. Riv.	4306	31569	Massive basalt
10	Ferg. Riv.	3987	30561	Basalt overlying Jasper Gorge Sandstone
11	Ferg. Riv.	4120	31426	Vesicular basalt with siltstone inclusions
12	Ferg. Riv.	4014	31454	Coarse basalt
13	Auvergne	1946	29900	Massive basalt
14	Auvergne	1977	29934	Massive basalt
15	Waterlog	1972	29730	Massive basalt
16	Ferg. Riv.	3797	31832	Vesicular basalt overlying granite
17	Ferg. Riv.	3769	31851	Massive basalt
18	Ferg. Riv.	4030	31935	Massive basalt
19	Ferg. Riv.	4100	31900	Massive basalt
20	Ferg. Riv.	4184	31719	Vesicular basalt
21	Delamere	4335	39428	Basalt with platy flow
22	Delamere	4421	30431	Fine-grained massive basalt
23	Delamere			Fine-grained vesicular basalt with platy flow
24	Delamere	4450	30536	Fine-grained basalt with platy flow
25	Delamere	4488	30445	Fine-grained massive basalt
26	Delamere	4505	30448	Fine-medium-grained basalt
27	Delamere	4488	30415	Fine-medium-grained basalt

Sample Number	1:250,000 Sheet Area	Grid Co-ordinates E	N	Remarks
28	Delamere	4488	30405	Porphyritic basalt
29	Delamere	4484	30455	Basalt interbedded with chert
30	Delamere	4618	30536	Medium-grained basalt
31	Delamere	4666	30183	Medium-grained basalt
32	Delamere	4668	30235	Medium-grained basalt
33	Delamere	468500	3025100	Basalt
34	Delamere	4754	30118	Basalt cobbles in a conglomerate
35	Delamere	4754	30119	Interbedded with the basalt
36	Delamere	4462	30430	Interbedded with the basalt
37	Delamere	4328	30525	Fine-medium-grained massive basalt
38	Delamere	4631	30731	Porphyritic medium-grained basalt
39	Delamere	4410	30428	Porphyritic fine-grained basalt
40	Ferg. Riv.	3994	31281	Fine-grained basalt
41	Ferg. Riv.	3994	31281	Fine-grained basalt
42	Ferg. Riv.	4039	31330	Lateritised basalt
43	Delamere	4356	30266	?
44	Ferg. Riv.	3825	31348	Medium-grained basalt
45	Ferg. Riv.	4321	31557	Basalt near a barytes vein
46	Ferg. Riv.	3818	31722	Fine-grained vesicular basalt
47	Delamere	3912	31000	Vesicular basalt
48	Delamere	3924	31000	Nonvesicular massive basalt
49	Ferg. Riv.	3953	31262	Nonvesicular massive basalt
50	Ferg. Riv.	3995	31290	Vesicular basalt
51	Ferg. Riv.	3941	31226	Nonvesicular basalt
52	Ferg. Riv.	3941	31226	Vesicular basalt
53	Ferg. Riv.	3904	31203	Nonvesicular basalt
54	Ferg. Riv.	3851	31164	Massive basalt
55	Ferg. Riv.	3851	31164	Massive basalt

Sample Number	1:250,000 Sheet Area	Grid Co-ordinates E	N	Remarks
56	Ferg. Riv.	39298	31202	Fine-grained basalt
57	Ferg. Riv.	3925	31208	Medium-grained basalt
58	Ferg. Riv.	3988	31269	Fine-grained basalt
59	Ferg. Riv.	4369	31289	Medium-fine-grained basalt
60	Ferg. Riv.	4382	31542	Vesicular basalt
61	Delamere	4010	30735	Non-vesicular basalt
62	Delamere	4010	30735	Vesicular basalt
63	Ferg. Riv.	4467	31175	Basalt body within basalt
64	Ferg. Riv.	4467	31175	Fine-medium-grained basalt
65	Ferg. Riv.	3860	31750	Nonvesicular basalt

ANALYSIS OF ANTRIM PLATEAU VOLCANICS

Laboratory No.	Sample No.	Cu ppm	Fe %	Mg %	Mn %	Cr ppm	Co ppm	Ni ppm	V ppm	Mo ppm	Ca %	Ti %	Sr ppm	Ba ppm	Sc ppm	Y ppm	La ppm	Zr ppm
69-1	E106	26	+10.0	1.6	0.07	26	65	33	200	-10	4.2	0.65	140	380	38	47	110	220
69-2	E133	23	+10.0	0.1	0.38	45	27	30	170	15	0.5	0.38	-40	170	40	88	175	230
69-3	E153/4	17	+10.0	1.9	0.08	68	54	23	180	-10	3.7	0.66	150	475	35	40	84	185
69-4	E160(b)	22	+10.0	3.1	0.28	52	45	36	155	-10	0.7	0.60	40	370	29	29	50	210
69-5	E160(c)	25	3.5	2.7	0.11	72	73	22	300	-10	4.7	0.78	260	400	39	31	50	150
69-6	E176	18	7.0	-0.1	0.01	79	24	-10	170	-10	0.2	0.78	50	520	36	20	-50	200
69-7	E185	23	4.4	1.0	0.07	96	+200	+200	155	-10	0.2	0.49	80	1420	32	50	71	125
69-8	E200	11	6.4	0.9	0.01	96	57	150	320	-10	0.2	0.78	66	560	38	23	-50	145
69-9	E301	33	+10.0	3.3	0.09	130	82	76	220	-10	4.5	0.58	220	600	41	30	50	150
69-10	H4	35	+10.0	2.3	0.10	62	63	44	270	-10	4.3	0.80	135	250	37	32	64	170
69-11	H14	28	+10.0	0.2	0.04	165	35	28	225	-10	0.4	0.80	193	1600	29	35	105	195
69-12	H17	23	+10.0	2.4	0.08	60	50	51	160	-10	2.3	0.64	102	330	30	38	71	195
69-13	S73	58	+10.0	2.7	0.10	54	73	41	280	-10	5.4	0.68	148	255	37	28	-50	145
69-14	S100	25	8.4	3.0	0.12	68	74	46	340	-10	6.6	0.70	174	275	40	26	50	125
69-15	S263A	48	8.2	2.4	0.10	50	89	38	280	-10	5.0	0.66	145	255	37	29	56	150
69-16	W156B	17	6.0	2.8	0.03	70	62	50	130	-10	0.4	0.52	-40	720	26	42	72	180
69-17	W189	57	+10.0	3.0	0.12	134	66	45	205	-10	6.5	0.95	183	96	25	27	58	-100
69-18	W302	29	+10.0	2.8	0.11	56	60	39	230	-10	4.6	0.66	128	330	39	35	80	150
69-19	W305	90	+10.0	3.2	0.10	72	68	54	200	-10	4.7	0.56	255	365	38	25	-50	140
69-20	W315	47	+10.0	3.9	0.07	107	56	61	225	-10	4.7	0.56	220	255	40	30	-50	145
69-21	X2	27	+10.0	1.9	0.10	18	49	28	200	-10	3.0	0.67	120	420	34	34	57	205
69-22	X9	23	+10.0	2.1	0.09	22	54	29	190	-10	3.7	0.64	185	430	33	40	80	200
69-23	X10	35	+10.0	2.2	0.08	22	48	31	145	-10	3.0	0.65	145	480	35	36	94	190
69-24	X18	21	+10.0	2.6	0.10	31	60	38	200	-10	5.0	0.65	180	470	45	51	90	220
69-25	X22	31	+10.0	1.8	0.11	19	49	21	220	-10	3.2	0.65	160	600	36	26	72	170
69-26	X25	31	+10.0	2.6	0.10	50	62	22	230	-10	3.6	0.66	103	370	37	28	-50	160
69-27	X30	23	+10.0	2.6	0.13	17	55	22	200	-10	3.0	0.67	86	470	34	33	66	170
69-28	X31	19	+10.0	1.9	0.11	21	51	26	200	-10	3.7	0.62	135	390	34	33	66	200
69-29	X34	49	+10.0	2.9	0.13	45	62	48	220	-10	4.7	0.54	125	120	37	30	55	150
69-30	X38	20	+10.0	3.1	0.09	80	60	48	220	-10	4.7	0.59	270	260	40	35	55	140
69-31	X39C	42	+10.0	2.4	0.06	45	45	38	260	-10	1.5	0.59	115	480	35	37	76	160
69-32	X52	28	+10.0	2.7	0.11	56	66	44	280	-10	4.4	0.72	150	330	40	32	-50	160
69-33	X74	25	+10.0	3.3	0.11	108	68	70	250	-10	5.3	0.60	145	250	40	30	-50	140
69-34	X96A	470	3.4	+5.0	0.03	67	42	40	330	-10	1.8	0.76	140	260	41	31	96	160
69-35	X96B	27	+10.0	3.1	0.09	52	65	48	250	-10	3.5	0.66	105	260	36	25	-50	150
69-36	X98	23	+10.0	3.1	0.09	45	50	30	290	-10	2.7	0.72	180	370	37	29	50	170
69-37	X102	17	+10.0	2.7	0.11	19	58	21	260	-10	4.7	0.78	150	350	37	28	55	190
69-38	X103	18	7.3	2.5	0.12	68	47	43	190	-10	4.3	0.61	130	350	33	27	69	170
69-39	X117	22	+10.0	1.7	0.09	70	48	30	180	-10	2.8	0.72	140	410	36	40	79	200
69-40	X150	26	+10.0	2.3	0.10	60	52	52	150	-10	3.7	0.59	130	330	35	37	56	190
69-41	X150(b)	47	7.0	2.1	0.10	50	73	37	140	-10	3.7	0.53	115	370	31	36	68	200
69-42	X160	42	+10.0	1.9	0.09	52	45	47	150	-10	4.0	0.58	130	360	31	35	60	210
69-43	X216	20	+10.0	1.9	0.09	21	56	30	210	-10	3.6	0.67	145	300	36	37	61	200
69-44	X258	30	+10.0	2.4	0.09	65	55	51	230	-10	3.8	0.66	130	330	34	28	-50	160
69-45	X265	130	+10.0	3.5	0.10	260	63	120	160	-10	5.0	0.42	125	230	42	27	-50	120
69-46	X275	29	+10.0	2.8	0.08	54	33	50	150	-10	0.9	0.57	105	360	30	40	74	230
69-47	Y27B	19	+10.0	+5.0	0.10	240	64	66	150	-10	3.2	0.46	62	600	31	31	-50	140
69-48	Y29	17	+10.0	3.8	0.07	230	52	80	155	-10	5.1	0.45	110	210	36	25	-50	140
69-49	Y48	18	+10.0	2.5	0.10	66	49	54	160	-10	3.2	0.53	100	350	35	32	55	160
69-50	Y52A	23	+10.0	1.7	0.12	15	29	24	250	-10	2.9	0.98	150	370	39	39	78	220
69-51	Y53A	22	+10.0	2.2	0.10	56	46	41	160	-10	4.1	0.59	140	320	29	32	60	180
69-52	Y53B	30	+10.0	3.0	0.09	270	30	60	155	-10	4.3	0.43	180	290	31	20	-50	115
69-53	Y55	39	+10.0	4.1	0.12	22	24	24	210	-10	2.7	0.95	130	240	34	32	56	200
69-54	Y67A	30	+10.0	1.8	0.09	340	33	40	150	-10	+10.0	0.39	45	90	34	24	64	120

69-55	Y67B	22	+10.0	3.8	0.14	250	45	60	180	-10	5.1	0.49	240	140	34	23	50	120
69-56	Y70	37	+10.0	2.2	0.11	55	54	45	160	-10	4.0	0.58	180	420	32	39	58	205
69-57	Y72	23	+10.0	0.7	0.15	32	31	48	140	-10	2.6	0.68	110	490	35	39	76	220
69-58	Y75	31	+10.0	3.3	0.16	70	57	53	230	-10	5.0	0.61	120	280	37	35	-50	160
69-59	Y116	27	+10.0	2.6	0.08	68	56	50	200	-10	3.8	0.60	170	290	33	32	-50	190
69-60	Y133	25	+10.0	3.0	0.04	50	40	51	140	-10	0.5	0.49	58	460	32	32	54	190
69-61	Y169A	14	+10.0	3.3	0.10	330	50	79	200	-10	4.4	0.49	210	370	34	23	-50	130
69-62	Y169B	66	+10.0	1.3	0.15	18	52	16	260	-10	5.1	+1.00	160	660	30	47	74	280
69-63	Y222A	30	+10.0	1.5	0.02	43	29	23	120	-10	0.6	0.46	44	460	23	27	-50	180
69-64	Y222B	21	+10.0	2.5	0.09	62	62	65	240	-10	4.7	0.62	180	310	39	30	50	150
69-65	Y237	80	+10.0	2.2	0.04	61	35	50	140	-10	1.1	0.54	80	430	28	43	78	200

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

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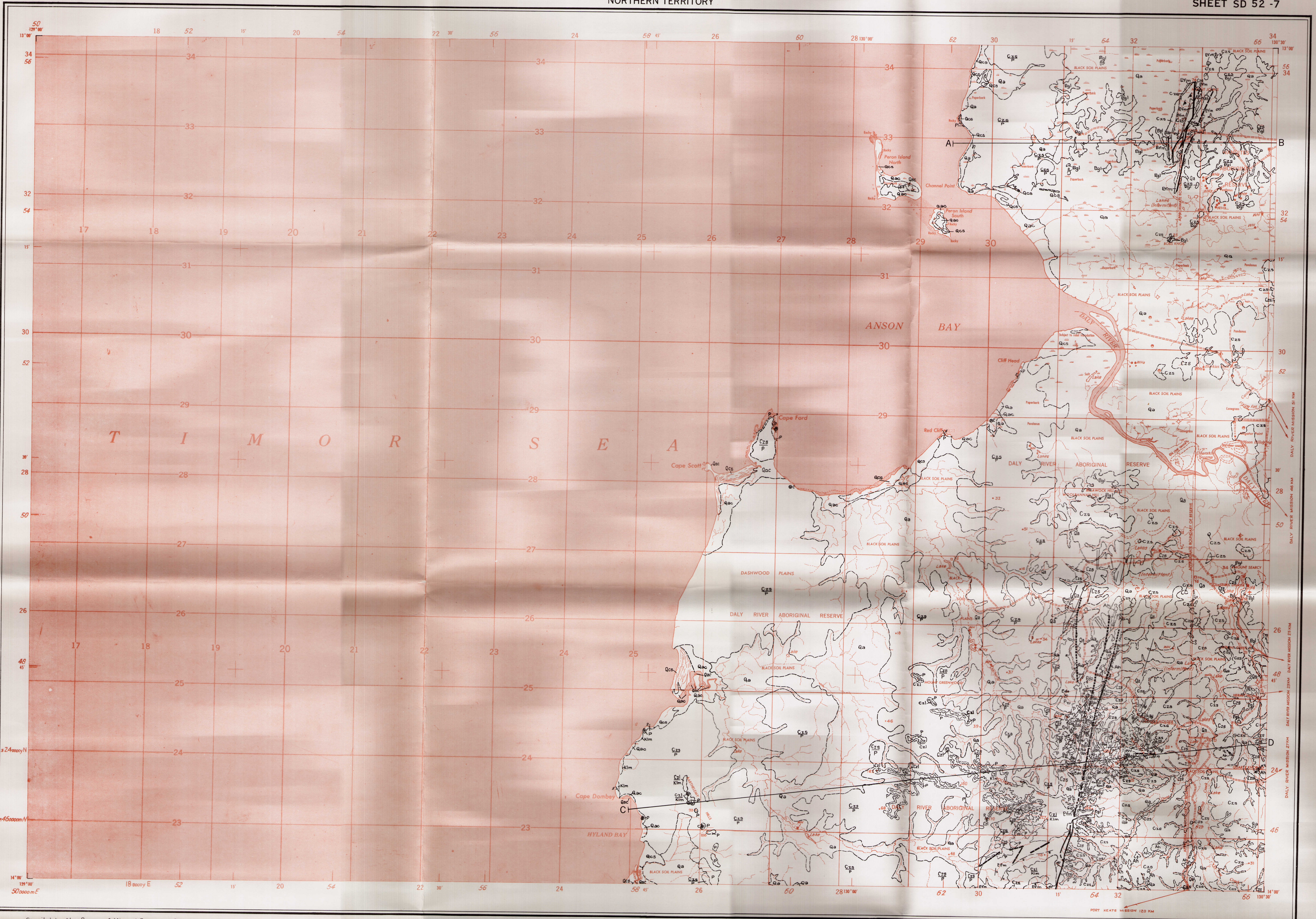
NORTHERN TERRITORY

SHEET SD 52 -7



Reference

CAINOZOIC	QUATERNARY		Qcs	Coastal sand dunes
			Qac	Coastal deposits; mud, silt, evaporites
			Qa	Alluvium
			Czs	Soil, sand, alluvium, some black soil
			Czl	Laterite and ferruginous rubble
MESOZOIC	LOWER CRETACEOUS	Mullaman Beds	Klm	Sandstone, siltstone, claystone
PALAEOZOIC	PERMIAN	Port Keats Group	P	Friable, feldspathic sandstone, siltstone, some diamictite and conglomerate
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Fitzmaurice Group Moyle River Formation	Ēfm	Medium-grained sandstone, some pebble bands
	CARPENTARIAN ?	Litchfield Complex	Ēdo	Gabbro, diorite and minor dolerite
			Ēgl	Granite adamellite, granodiorite, tonalite, migmatite and pegmatite
ARCHAEAN ?			Ah	Quartz-mica schist, phyllite, tremolite schist and amphibolite

Geological boundary
Fault
Lineament

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

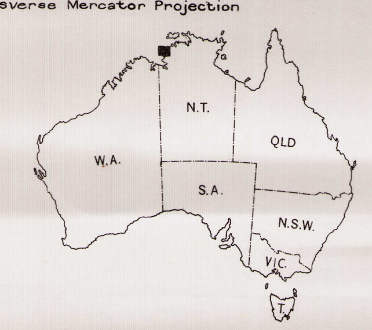
45 Strike and dip of strata
Dip < 15° } Air-photo interpretation
Dip 15° – 45° }
Trend lines
75 Strike and dip of foliation

Macrofossil locality
Vein; q - quartz
c Coal bore

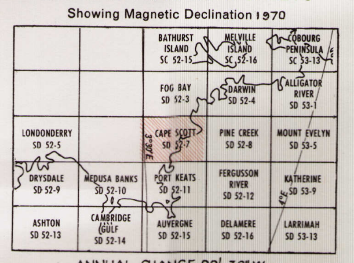
Abandoned bore
Bore - salinity < 2500 ppm
Abandoned saline bore
WH Waterhole
Swamp
Foreshore flat
Rock ledge
Rocks submerged

Sandridges
Cliff
Road
Vehicle track
"Elizabeth Downs" Homestead
Building
Landing ground
Yd Yard
Astronomical station
21 Elevation in metres - approximate

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. R.W. Swartz, M.B.E., E.D., Minister for National Development.
Base map compiled by the Royal Australian Survey Corps from aerial photography at 1:50,000 scale
Transverse Mercator Projection



INDEX TO ADJOINING SHEETS
Showing Magnetic Declination 1970



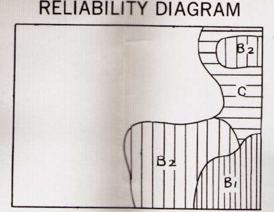
ANNUAL CHANGE 00' 32" W

Scale 1:250,000

5 0 5 10 15 20 25 KILOMETRES

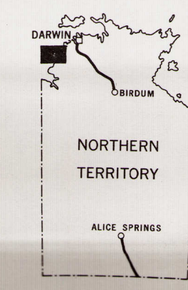
5 0 5 10 MILES

RELIABILITY DIAGRAM

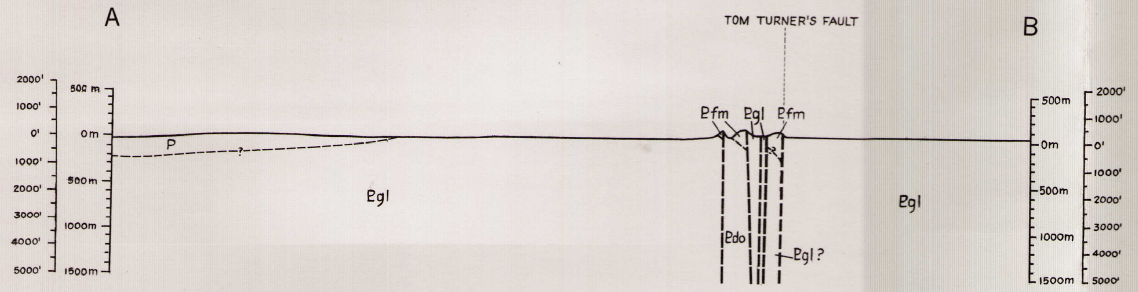


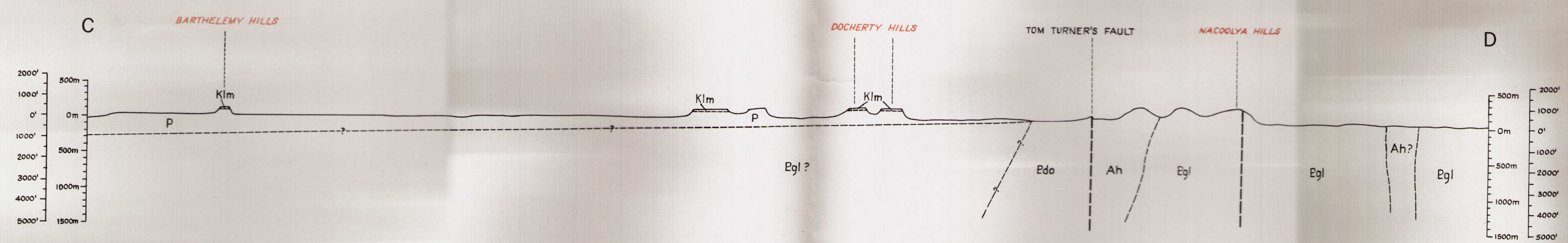
Geology
B1 Detailed reconnaissance: numerous traverses and air-photo interpretation
B2 General reconnaissance: few traverses and air-photo interpretation
C Air-photo interpretation

Geology 1965 by J.J. Veevers, J. Roberts, J.M. Dickins
1968 by C.M. Morgan, I.P. Sweet, J.R. Mendum
Compiled 1969 by C.M. Morgan, I.P. Sweet, J.R. Mendum
Cartography by Geological Branch, B.M.R.
Drawn by L. Kerslake

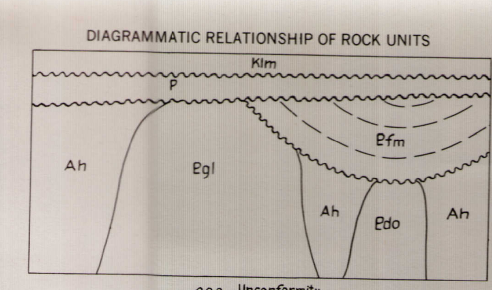


Sections
Cainozoic sediments omitted
Scale: $\frac{V}{H} \simeq 4$





DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



PRELIMINARY EDITION, 1970
SUBJECT TO AMENDMENT

CAPE SCOTT
SHEET SD 52-7

Complimentary

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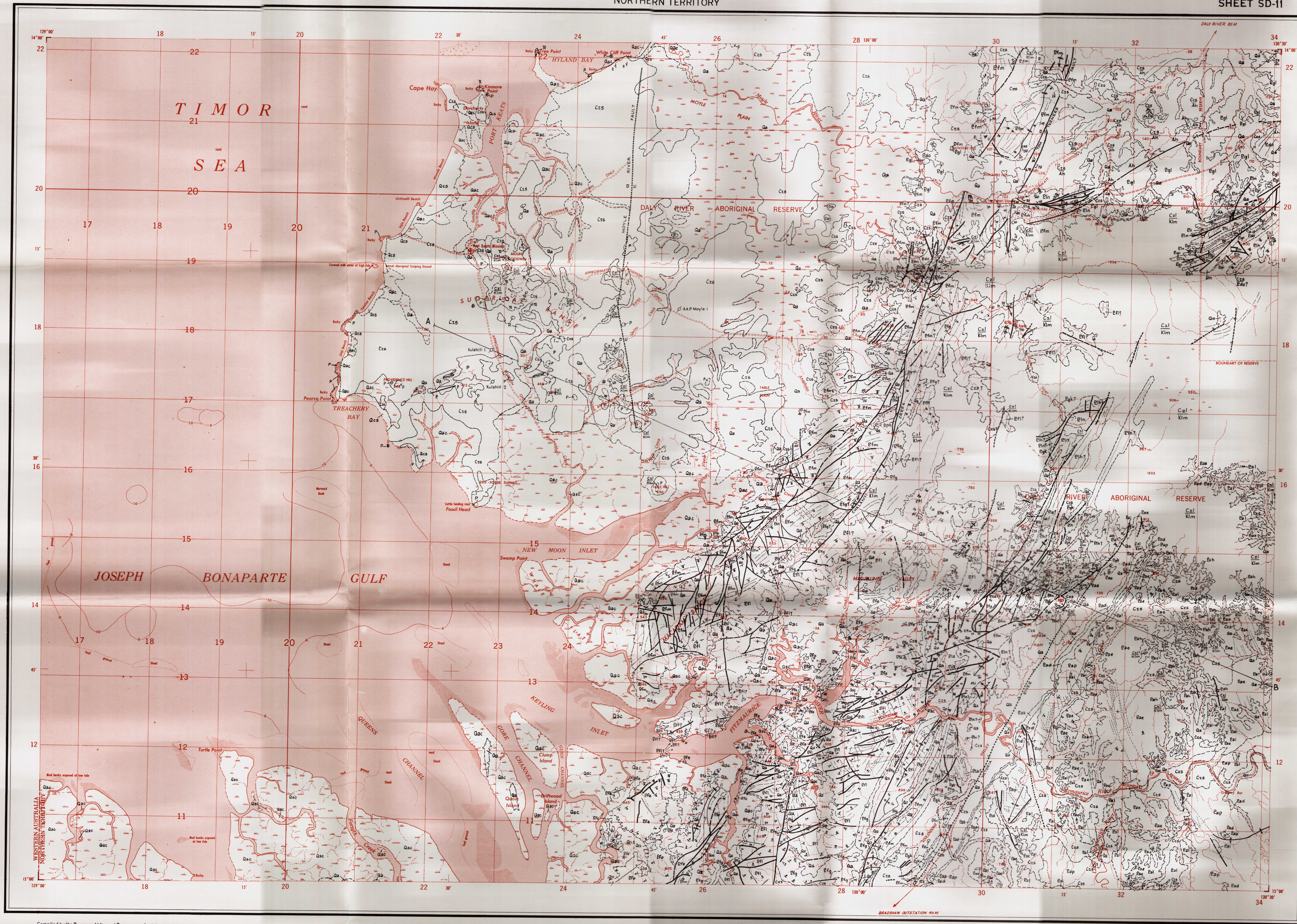
PORT KEATS

NORTHERN TERRITORY

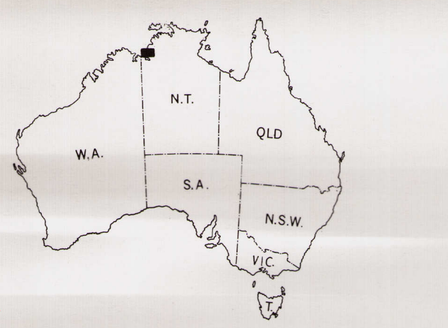
SHEET SD-11

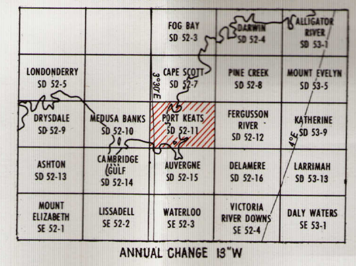


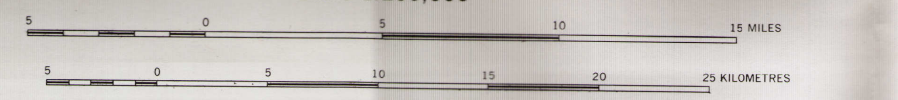
Reference

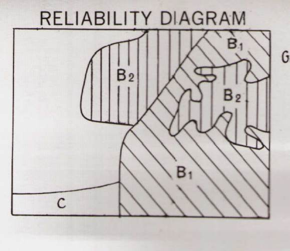
CAINOZOIC	QUATERNARY		Qac	Coastal deposits: mud, silt, evaporites
			Qcs	Coastal sand dunes
			Qa	Alluvium
			Czs	Sand, soil, colluvium
			Czl	Laterite, ferruginous pisolitic soil
MESOZOIC	CRETACEOUS	Mullaman Beds	Klm	Friable and ferruginous sandstone, siltstone, conglomerate
	TRIASSIC	Port Keats Group	R	Sandstone, shale, micaceous sandy siltstone
PALAEOZOIC	PERMIAN	Port Keats Group	P	Sandstone, minor siltstone, limestone, basal conglomerate, diamictites
	CARBONIFEROUS		C	Shale, sandstone, siltstone, minor limestone (Section only)
	DEVONIAN		D	Shale, sandstone, limestone (Section only)
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group: Shoal Reach Formation	Eah	Brown and grey-green siltstone, minor dolomite and sandstone
		Spencer Sandstone	Eae	Sandstone, silty sandstone, minor dolomitic sandstone
		Lloyd Creek Formation	Eal	Dolomite, oolitic and stromatolitic; siltstone, sandy and silty dolomite
		Pinkerton Sandstone	Eap	Massive sandstone, siltstone, minor shale
		Saddle Creek Formation	Ead	Basal cross-bedded sandstone: upper siltstone; minor shale
		Angalarri Siltstone	Eaa	Grey-green siltstone and shale; minor dolomitic siltstone; limestone
		Jasper Gorge Sandstone	Eaj	Sandstone
		Fitzmaurice Group: Legune Formation	Efe	Interbedded sandstone and siltstone and shale: siltstone and shale increases to north
		Laingang Formation	Efl	Sandstone with minor siltstone, grit, conglomerate
		Goobaieri Formation	Efg	Grey and green-grey siltstone and fine sandstone; interbeds of fine white sandstone
		Moyle River Formation	Efm	Fine to medium-grained sandstone: thick siltstone interbeds in north-west: thick basal conglomerate in places
	CARPENTARIAN	Koolendong Granite	Egk	Coarse granite, adamellite, granodiorite: even-grained and porphyritic
		Litchfield Complex	Egl	Granite, adamellite, granodiorite, tonalite: coarse, mostly even grained, xenolithic
	CARPENTARIAN OR LOWER PROTEROZOIC	Ti-Tree Granophyre	Egi	Sills of coarse granophyre
			Edo	Sills of dolerite, quartz diorite, gabbro: mostly amphibolitized
	LOWER PROTEROZOIC	Chilling Sandstone	Elh	White quartz sandstone
		Finniss River Group: Berinka Volcanics	Eli	Acid lavas, minor sandstone interbeds; intrusive acid rocks
		Meeway Volcanics	Ela	Porphyritic acid lavas: tuffs
		Noltenius Formation	Eln	Greywacke, siltstone, sandstone, grit, conglomerate
		Henschke Breccia	Elg	Coarse ferruginous sedimentary breccia and conglomerate with sandstone fragments
	ARCHAEAN	Hermit Creek Metamorphics	Ah	Weathered quartz-mica schists

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. R.W. Swartz, M.B.E., E.D., Minister for National Development. Base map compiled by the Division of National Mapping from aerial photography at 1:50,000 scale Transverse Mercator Projection.



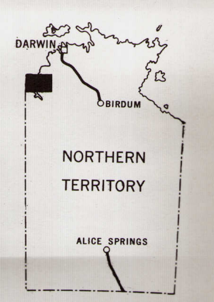






Geology B1 Detailed reconnaissance, numerous traverses, and air-photo interpretation
B2 General reconnaissance, few traverses mainly air-photo interpretation
C Air-photo interpretation

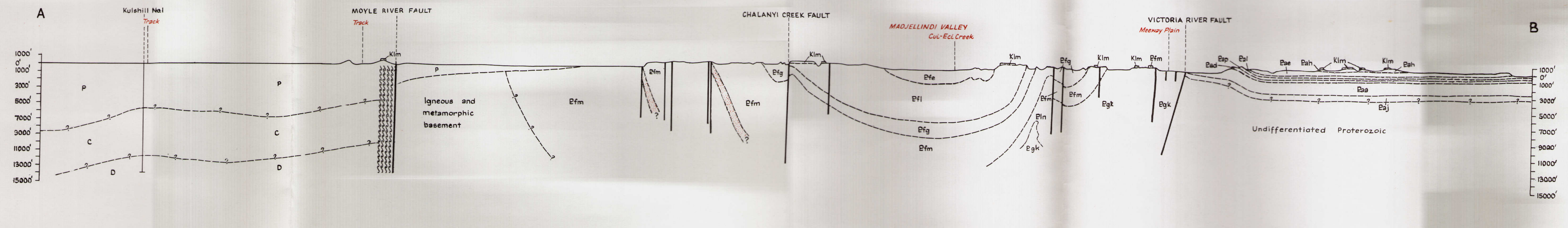
Geology 1965 by J.J. Veevers, J. Roberts, M. Dickens
1967 I.R. Pontifex, C.M. Morgan, I.P. Sweet
1968 I.R. Pontifex, C.M. Morgan, I.P. Sweet, J. Mendum
Compiled 1968 by C.M. Morgan, I.P. Sweet
1969 I.D. Johnston
Cartography by Geological Branch B.M.R.
Drawn by I. Johnston

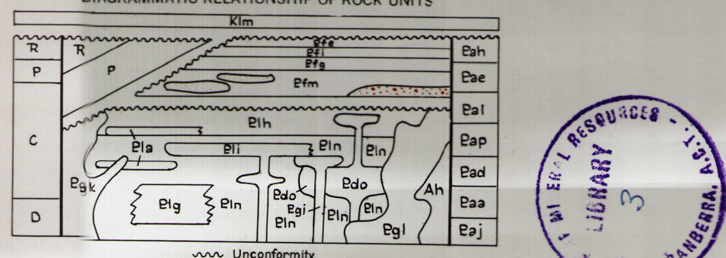


Section

Cainozoic sediments omitted from section

Scale V/H = 2





PRELIMINARY EDITION, 1969

SUBJECT TO AMENDMENT

PORT KEATS

SHEET SD 52-11

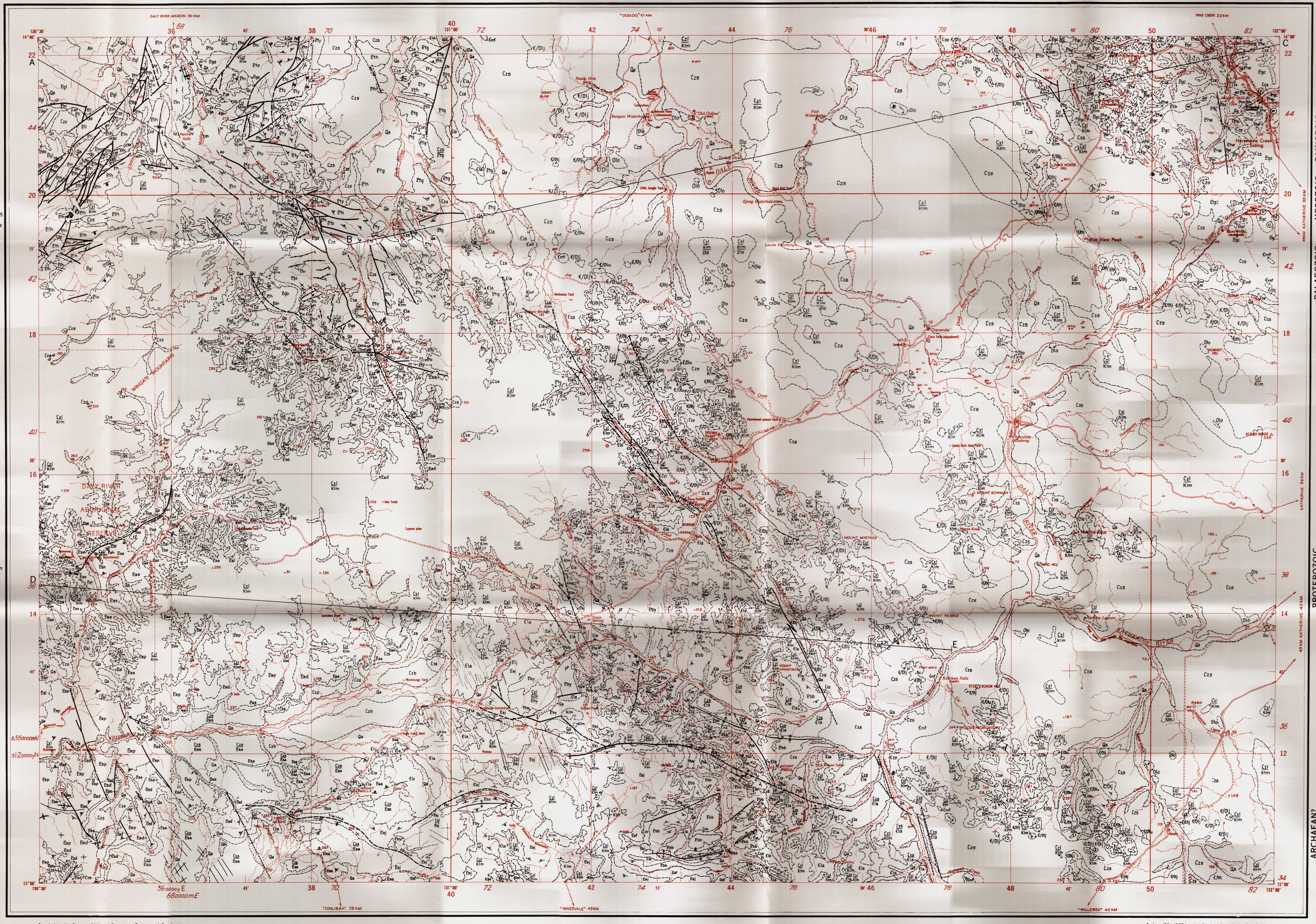
Complimentary

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

FERGUSSON RIVER

NORTHERN TERRITORY

SHEET SD 52-12



Reference

- Geological boundary
- Anticline, showing direction of plunge
- Syncline
- Monocline
- Fault (D, U, indicate relative movement down, up)

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
- Vertical strata
- Horizontal strata
- Overturned strata
- Dip < 5° (Air-photo interpretation)
- Dip 5° – 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)
- Lineament (Air-photo interpretation)
- Strike and dip of vertical joints
- Strike and dip of foliation
- Vertical foliation
- Strike and dip of cleavage
- Vertical cleavage

- Macrofossil locality
- Vein; q - quartz, Ba - barytes

- Unworked deposit
- Mine – minor
- Mine not worked
- Au Gold
- Sn Tin
- U Uranium
- W Tungsten

- OR5007 Bore
- Abandoned bore
- Bore – salinity < 2500 ppm
- Water tank with windpump
- Earth tank
- Waterhole
- Sink hole
- Spring
- Swamp

R5007 refers to bore registration number of Mines and Water Resources Branch, Northern Territory Administration

- Highway
- Road
- Vehicle track
- Railway with siding
- "Dorisvale" Homestead
- Building
- Landing ground
- Yd Yard
- Trigonometrical station
- Astronomical station
- •237 Elevation in metres – approximate
- pa Position approximate

Reference

CAINOZOIC	QUATERNARY			Qa	Alluvial deposits; sand, silt and gravel
CAINOZOIC				Czs	Residual sand and soil, colluvium and minor travertine
CAINOZOIC				Czb	Dark grey clay soil
CAINOZOIC				Czl	Pisolitic laterite and ferruginous rubble
MESOZOIC	LOWER CRETACEOUS		Mullaman Beds	Klm	Sandstone, siltstone and porcellanite
PALAEOZOIC	LOWER ORDOVICIAN	Daly River Group	Oolloo Limestone	Olo	Partly silicified limestone; stromatolites
PALAEOZOIC	MIDDLE CAMBRIAN TO LOWER ORDOVICIAN	Daly River Group	Jinduckin Formation	€/Olj	Ferruginous sandstone and siltstone; minor marl, dolomite and chert; halite pseudomorphs abundant
PALAEOZOIC	MIDDLE CAMBRIAN TO LOWER ORDOVICIAN	Daly River Group	Manbulloo Limestone Member	€/Olu	Partly silicified flaggy limestone
PALAEOZOIC	MIDDLE CAMBRIAN	Daly River Group	Tindall Limestone	€mt	Crystalline limestone with minor lutitic zones; chert nodules
PALAEOZOIC	LOWER CAMBRIAN		Antrim Plateau Volcanics	€la	Massive and vesicular basalt, minor agglomerate; feldspathic sandstone in places, rarely limestone
PALAEOZOIC	LOWER CAMBRIAN		Jarong Conglomerate	€lj	Boulder and pebble conglomerate
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Tolmer Group	Waterbag Formation	Ꞓtg	Ferruginous sandstone and siltstone; minor dolomite and marl; halite pseudomorphs
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Tolmer Group	Hinde Dolomite	Ꞓth	Dolomite and minor limestone, dolomite siltstone
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Tolmer Group	Buldiva Sandstone: Stray Creek Sandstone Member	Ꞓty	Flaggy quartz sandstone; green siltstone and shale
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Tolmer Group	Buldiva Sandstone: Depot Creek Sandstone Member	Ꞓto	Massive, cross-bedded, quartz sandstone; pebble bands
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group	Shoal Reach Formation	Ꞓah	Siltstone, minor dolomite and sandstone
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group	Spencer Sandstone	Ꞓae	Quartz sandstone; minor silty and dolomitic sandstone
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group	Lloyd Creek Formation	Ꞓal	Algal and oolitic dolomite; minor sandy and silty dolomite and grey - green siltstone
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group	Pinkerton Sandstone	Ꞓap	White massive quartz sandstone, minor siltstone and shale
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group	Saddle Creek Formation	Ꞓad	Basal blocky cross-bedded sandstone: upper beds are flaggy quartz sandstone and minor siltstone
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group	Angalarri Siltstone	Ꞓaa	Grey-green siltstone and shale, interbedded minor silty sandstone
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group	Jasper Gorge Sandstone	Ꞓaj	Massive quartz sandstone, minor siltstone
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Auvergne Group	Stubb Formation	Ꞓat	Siltstone and shale, minor flaggy sandstone
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Bullita Group	Banyan Formation	Ꞓbb	Algal and oolitic limestone and dolomite; minor siltstone and sandstone; chert bands
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Bullita Group	Bynoe Formation	Ꞓby	Purple to green siltstone, dolomitic siltstone and minor dolomite
PROTEROZOIC	ADELAIDEAN OR CARPENTARIAN	Bullita Group	Skull Creek Formation	Ꞓbs	Limestone, dolomite and chert; stromatolites
PROTEROZOIC	CARPENTARIAN		Edith River Volcanics	Ꞓhe	Toscanite and dacite flows and porphyritic intrusives
PROTEROZOIC	CARPENTARIAN		Ti-Tree Granophyre	Ꞓgi	Intrusions of granophyre and related acid igneous rocks
PROTEROZOIC	CARPENTARIAN		Allia Granite	Ꞓga	Coarse-grained porphyritic biotite-muscovite adamellite, granodiorite and tonalite
PROTEROZOIC	CARPENTARIAN		Cullen Granite	Ꞓgc	Biotite granite and biotite-hornblende adamellite; syenite differentiates
PROTEROZOIC	CARPENTARIAN		Soldiers Creek Granite	Ꞓgs	Coarse-grained muscovite-biotite granite and adamellite
PROTEROZOIC	CARPENTARIAN		Litchfield Complex	Ꞓgl	Coarse-grained granodiorite and tonalite
PROTEROZOIC	LOWER PROTEROZOIC			Ꞓdo	Intrusions of dolerite, quartz diorite and gabbro; commonly amphibolitized
PROTEROZOIC	LOWER PROTEROZOIC		Chilling Sandstone	Ꞓlh	White, medium-grained quartz sandstone; ripple marks and cross-bedding
PROTEROZOIC	LOWER PROTEROZOIC	Finniss River Group	Berinka Volcanics	Ꞓli	Acid tuff, lavas and agglomerate: minor intermediate lavas
PROTEROZOIC	LOWER PROTEROZOIC	Finniss River Group	Burrell Creek Formation	Ꞓlb	Siltstone, shale, greywacke and greywake-siltstone
PROTEROZOIC	LOWER PROTEROZOIC	Finniss River Group	Noltenius Formation	Ꞓln	Quartz-greywacke, conglomerate, siltstone and shale: quartz-mica schist, phyllite and andalusite schist
ARCHAEAN?			Hermit Creek Metamorphics	Ah	Foliated quartz-mica-schist: some hornfels development near granites

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. R.W. Swartz, M.B.E., E.D., Minister for National Development.
Base map compiled by the Royal Australian Survey Corps from aerial photography at 1:85,000 scale
Transverse Mercator Projection

INDEX TO ADJOINING SHEETS

Showing Magnetic Declination 1970

	FOG BAY SD 52-3	DARWIN SD 52-4	ALLIGATOR RIVER SD 53-1	MILINGIMBI SD 53-2
	CAPE SCOTT SD 52-7	PINE CREEK SD 52-8	MOUNT EVELYN SD 53-5	MOUNT MARUMBA SD 53-6
MEDUSA BANKS SD 52-10	PORT KEATS SD 52-11	FERGUSSON RIVER SD 52-12	KATHERINE SD 53-9	URAPUNGA SD 53-10
CAMBRIDGE GULF SD 52-14	AUVERGNE SD 52-15	DELAMERE SD 52-16	LARRIMAH SD 53-13	HODGSON DOWNS SD 53-14
LISSADELL SE 52-2	WATERLOO SE 52-3	VICTORIA RIVER DOWNS SE 52-4	DALY WATERS SE 53-1	TANUMBIRINI SE 53-2

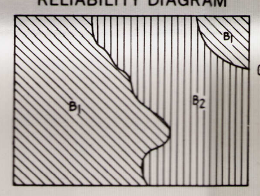
ANNUAL CHANGE 00° 20' W

Scale 1:250,000

5 0 5 10 15 20 25 KILOMETRES

5 0 5 10 MILES

RELIABILITY DIAGRAM

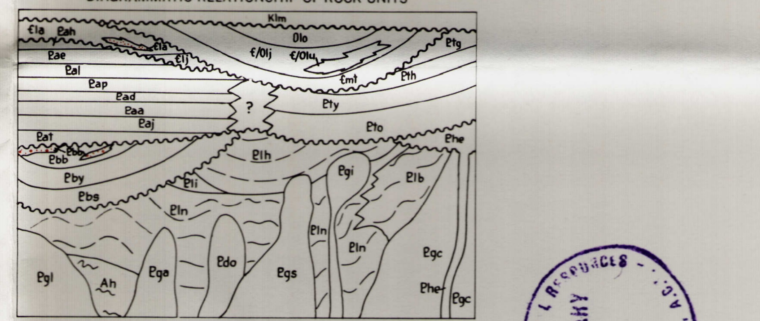


Geology B1 Detailed reconnaissance: numerous traverses, and air-photo interpretation

B2 General reconnaissance: some traverses, and air-photo interpretation

Geology 1951–1957 by M.A. Randal, D.A. White, O.N. Warin, J.H. Rattigan, A.B. Clark, E.K. Carter, J.C. Foweraker, J. Barrie
1968 by C.M. Morgan, I.P. Sweet, J.R. Mendum, I.R. Pontifex
Compiled 1969 by J.R. Mendum
Cartography by Geological Branch BMR
Drawn by Miss D.M. Pillinger

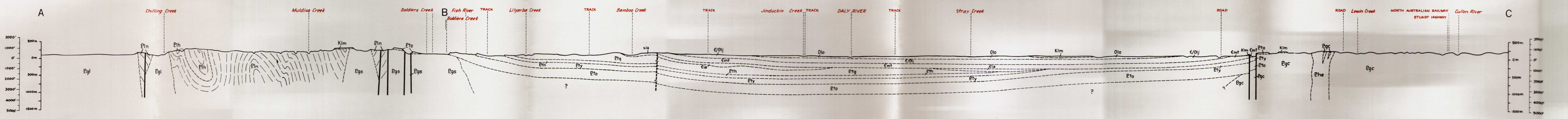
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS

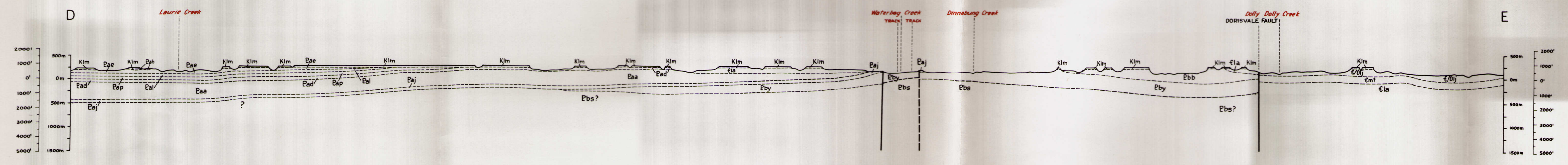


Sections

Cainozoic sediments omitted

Scale: V/H = 4





FERGUSSON RIVER

SHEET SD 52-12

Complimentary

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

DELAMERE

NORTHERN TERRITORY

SHEET SD 52-16

Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium
			Qt	Older alluvium – terrace deposits, mostly silt
			Czb	Black residual soil and alluvium
			Czs	Sand, red and yellow soils, some ferruginous rubble, colluvium
			Czl	Laterite, ferruginous rubble, discontinuous soil cover
MESOZOIC	LOWER CRETACEOUS	Mullaman Beds	Klm	White, buff and pinkish claystone and siltstone quartz sandstone and conglomerate. Plant fossils
PALAEOZOIC	CAMBRIAN & ORDOVICIAN	"Jinduckin Formation"	€/O	Sandstone, siltstone, marl, carbonate beds
	MIDDLE CAMBRIAN	Tindall Limestone	€mt	Fossiliferous limestone and dolomitic limestone
		Montejinni Limestone	€mm	Light grey and brown fossiliferous limestone, some dolomite
			€mm	Red and buff dolomitic mudstone, argillaceous carbonates siliceous breccia at base (Subdivisions not shown in section)
	LOWER CAMBRIAN	Antrim Plateau Volcanics	€la	Massive porphyritic and vesicular basalt. Interbeds of crossbedded quartz sandstone, conglomerate and chert
PROTEROZOIC	ADELAIDEAN ?	Auvergne Group: Pinkerton Sandstone	Ꝑap	Quartz sandstone, minor siltstone
		Saddle Creek Formation	Ꝑad	Basal crossbedded sandstone overlain by siltstone with minor shale and dolomite
		Angalarri Siltstone	Ꝑaa	Grey-green siltstone and shale, minor limestone and sandstone
		Jasper Gorge Sandstone	Ꝑaj	Quartz sandstone, minor conglomerate and grey-green siltstone
		Stubb Formation	Ꝑat	Grey and purple micaceous siltstone and shale; sandstone near top
	ADELAIDEAN OR CARPENTARIAN	Wondoan Hill Formation	Ꝑwo	Massive basal quartz sandstone; green and buff siltstone with minor dolomite
		Bullita Group	Ꝑb	Siltstone, dolomite, minor sandstone and shale (in section only)
		Bynoe Formation	Ꝑby	Purple, red-brown and grey-green micaceous and dolomitic siltstones, silty to pure dolomite and dolomitic sandstone
		Skull Creek Formation	Ꝑbs	Massive grey dolomite and dolarenite, silty dolomite, dolomitic siltstone and sandstone
		Bardia Chert Member	Ꝑbm	Pink and brown finely laminated chert; some brecciated, recemented chert
		Timber Creek Formation	Ꝑbt	Grey dolomitic siltstone, purple and grey-green siltstone and fine-grained sandstone; dolomite

Geological boundary
Anticline showing plunge
Syncline
Fault
Lineament

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

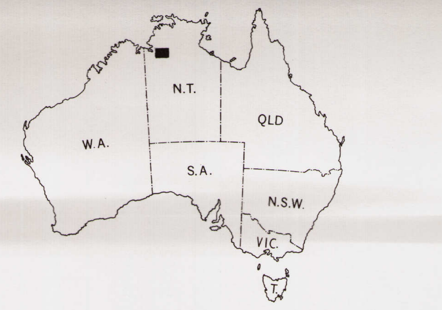
Strike and dip of strata
Horizontal strata
Dip < 5°
Dip 5°-15°
Dip 15°-45°
Trend line with dip of strata
Joint pattern
(air-photo interpretation)
Strike and dip of joints, prevailing or unmeasured
Vertical joints

Macrofossil locality
Plant fossil locality
X DL306 Specimen locality and reference number

R1060 Bore
DWH4 Abandoned bore
R1060 Refers to bore registration number of Mines and Water Resources Branch, Northern Territory Administration. DWH4 Refers to Department of Works Bore (N.T.)
Windpump
T Water tank
WH Water hole
Spring
Marsh
Falls

Highway
Road
Vehicle track
Landing ground
"Delamere" Homestead
Yd Yard
Fence
Astronomical station
530′ Elevation in feet – approximate
PD Position doubtful

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. R. W. Swartz M.B.E., E.D., Minister for National Development. Base map compiled by the Division of National Mapping from aerial photography at 1:50,000 scale. Transverse Mercator Projection.



INDEX TO ADJOINING SHEETS
Showing Magnetic Declination 1970

	CAPE SCOTT SD 52-7	PINE CREEK SD 52-8	MOUNT EVELYN SD 53-5	MOUNT MARUMBA SD 53-6
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DIXON RANGE SE 52-6	LIMBUNYA SE 52-7	WAVE HILL SE 52-8	NEWCASTLE WATERS SE 53-5	BEETALOO SE 53-6

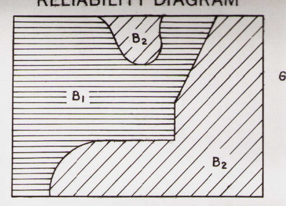
ANNUAL CHANGE 0°15′W

Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

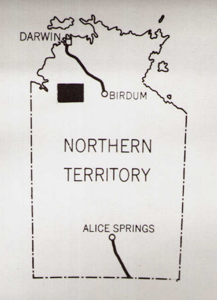
RELIABILITY DIAGRAM



Geology B₁ Detailed reconnaissance, numerous traverses and air-photo interpretation

B₂ General reconnaissance, some traverses and air-photo interpretation

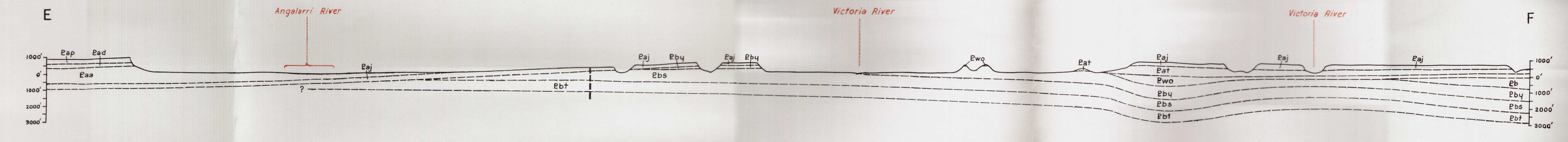
Geology 1966 by M.A. Randal, M.C. Brown, W.J. Perry
1968 by C.M. Morgan, I.P. Sweet, J.R. Mendum, I.R. Pontifex, R.G. Horne
Compiled 1966 by M.A. Randal, M.C. Brown (Cambrian rocks in east)
1968 by C.M. Morgan, I.P. Sweet, J.R. Mendum (Precambrian)
Cartography by Geological Branch B.M.R.
Drawn by J. Kopras, J.M. Wedgbrow



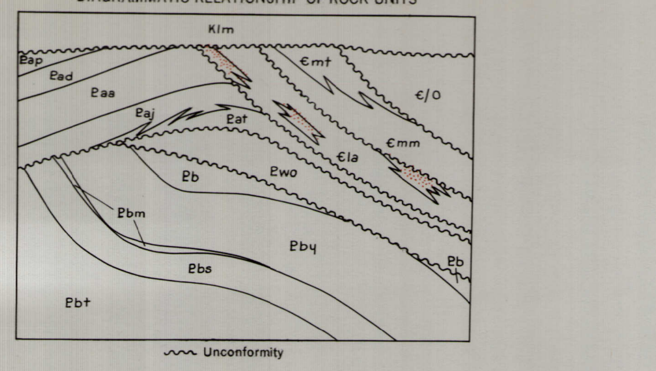
Sections

Cainozoic sediments omitted from section

Scale: $\frac{V}{H} = 4$



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity

PRELIMINARY EDITION, 1970

SUBJECT TO AMENDMENT

DELAMERE

SHEET SD 52-16

Complimentary