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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

REPORT 166

The Geology of the Northern Victoria River Region, Northern Territory

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and I. R. PONTIFEX

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SUMMARY

The oldest rocks in the northern Victoria River region, the Hermit Creek Metamorphics of probable Archaean age, are poorly exposed in the north. Unconformable on basement is the Finniss River Group, a sequence of turbidites and acid volcanics of Lower Proterozoic age deposited in the Pine Creek Geosyncline. The Chilling Sandstone probably 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 north-northeasterly belt of intensely faulted sandstone, the Fitzmaurice Group, overlies the Carpentarian and Lower Proterozoic rocks with pronounced unconformity. This faulted belt, the Fitzmaurice Mobile Zone, is separated from the tectonically more stable Sturt Block by a major lineament, the Victoria River Fault.

The oldest rocks cropping out within the Sturt Block are the Bullita Group of carbonate rocks and siltstone, which are overlain unconformably by glauconitic sandstone and shale (Wondoan Hill and Stubb Formations). These rocks were gently folded and eroded before the Auvergne Group, a sequence of shallow-water siltstone, sandstone, and dolomite, was laid down. It too is only gently folded, and faulted.

Another sedimentary sequence, the Tolmer Group, which crops out only in the Fergusson River Sheet area, lies 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, Wattie, Bullita, and Auvergne Groups, and its age relation with these groups is unknown; it is tentatively correlated with the Wattie and Bullita Groups.

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

An area of 650 km^2 in the Fergusson River Sheet area, previously mapped as Waterbag Creek Formation (Tolmer Group), is now regarded as Jinduckin Formation of Cambrian or Ordovician age. This re-interpretation results from recognition of the Dorisvale Fault, which forms the western margin of the Daly Basin.

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

Gold and tin are associated with the Carpentarian granites, and production has been recorded from a number of localities in the north. Barite reefs in Antrim Plateau Volcanics, and Tertiary laterites (for their iron content) may have economic potential.

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

INTRODUCTION

This Report includes a description of the geology of the Precambrian rocks and of the Antrim Plateau Volcanics in the Cape Scott, Port Keats, Fergusson River, and Delamere 1:250 000 Sheet areas, and updates a report by Morgan, Sweet, Mendum, & Pontifex (1970). A previously unrecognized exposure of Ordovician Jinduckin Formation is also described. The area surveyed lies within latitudes 13° and 16°S and between longitudes 129° and 131°E, in the Northern Territory (Fig. 1).

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

Main access is from the Stuart Highway to the east, by way of roads to the Daly River Police Station and the Victoria Highway. The Stuart Highway provides access to areas south and north of the Daly River, including the Moyle River area.

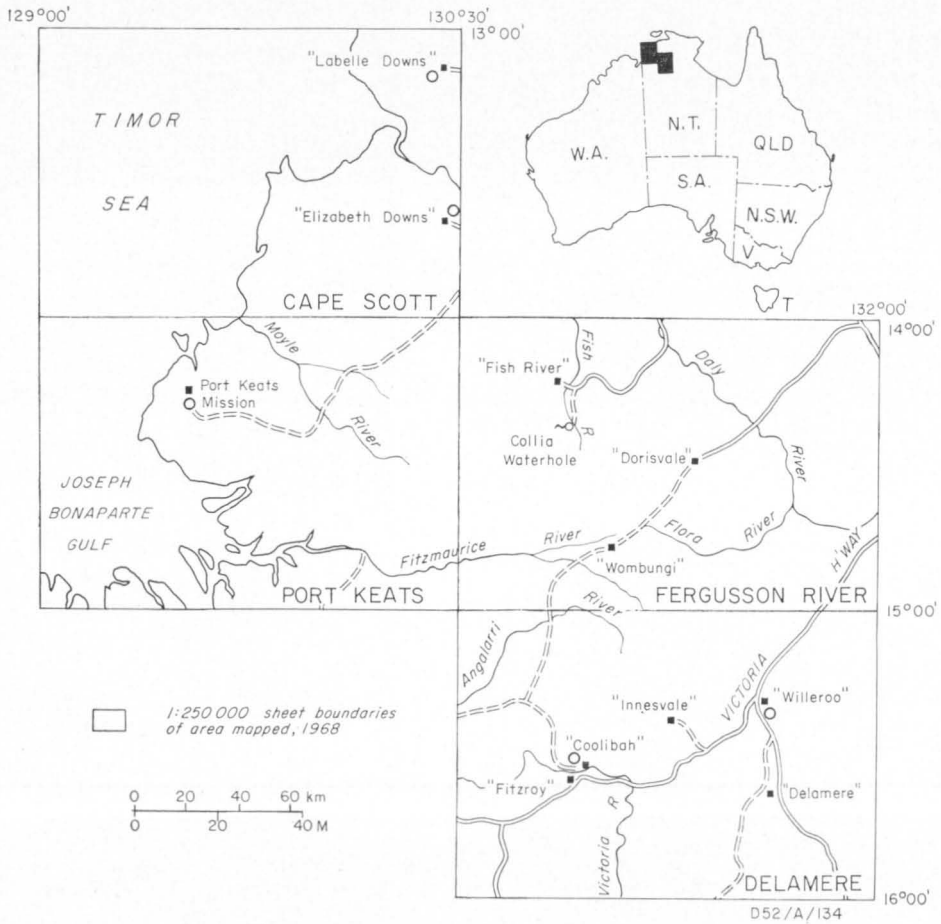


Fig. 1. Location and access in northern Victoria River area.

The Victoria Highway is the main road through the southern part of the area and is sealed to Timber Creek. A sealed branch road extends from Willeroo southwards to Top Springs.

Using these roads and minor station tracks, combined with cross-country work, it was possible to cover about half the area by vehicle. Most of the large escarpments surrounding plateaux are 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., 1968), but boats were not used on the survey.

The area is sparsely inhabited. Apart from a number of pastoral properties, the only centres of permanent population are Daly River Mission and settlement, and Port Keats Mission. The population of the Daly River Police District in 1966 was 1022, of whom 783 were Aboriginals. Temporary population is significant as it includes road and bridge construction gangs, and fencing and boring contractors. By far the largest centre of population is Port Keats Mission, with over 500 Aboriginal and about 20 European residents. Most stations shown in Figure 1 have a European population of less than 10, but may have a larger number of Aboriginal stockmen and their families. Coolibah station, including Bradshaw and Wombungi outstations, had at the time of the survey about 30 Europeans and about 60 Aboriginals.

The only industry is beef-cattle raising. Properties are large—between 2500 and 10 000 km^2—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 was found for their cattle. Cultivation of crops, notably grain sorghum, is being attempted on several properties. The Daly River Aboriginal Reserve of 13 300 km^2 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 area. Tin is still being recovered at Collia Tinfield, where up to 10 men have been working for part of each year for the last few years.

The climate is monsoonal: a long dry season from about April to November with prevailing southeasterly winds is followed by a short wet season with northwesterly winds. Moisture is brought in from the northwest spasmodically from October, with resulting thunderstorm activity (Table 1). The true monsoonal influence in January and February brings heavy falls. Cyclones occasionally result in heavy falls as late as April. The rainfall is greatest in the northwest, and decreases from an average of 140 cm at Port Keats to about 64 cm in the southeast.

Table 1 shows that the coolest months are June and July, and the hottest October to March. The highest maxima are in November, before the heavier cloud and higher humidity of the wet season cause reduced insolation. At the end of the wet season, as cloud lessens and the sun is again directly overhead, daily maximum temperatures rise slightly in most 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 free of frost, although inland there have been recorded minimum temperatures below 4.5°C in June and July.

Vegetation changes noticeably from northwest to southeast owing to the reduction in annual rainfall. The well drained sandy plains southeast of Port Keats support open forest, comprising eucalypts between 15 and 30 m high. The under-

TABLE 1. CLIMATIC DATA FOR PORT KEATS AND KATHERINE*

		Jan.	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Year*
PORT KEATS														
Temperature (°C)	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
	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	20.2
	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	1406.2
KATHERINE														
Temperature (°C)	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	34.5
	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	20.2
	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	27.3
Rainfall (mm)	Mean monthly	232.1	201.5	156.2	34.2	5.6	2.0	0.8	0.5	5.8	29.8	83.8	199.6	951.9

* Source: Bureau of Meteorology, Darwin.

storey includes cycads, palm trees, and grasses. The black soil areas support pandanus palms and tall grasses, and the swamps contain varieties of paperbark tree and reeds.

Most of the sandstone ranges in the north are thickly clothed by 'cane grass', an annual sorghum which grows rapidly in the wet season up to 2 m, 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. Farther 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 & Stewart (1953) described the vegetation of the northern part of the area, and Perry (1970) that of the south.

The BMR survey was carried out in 1968 from May to September. Five geologists were engaged in mapping for the first half of the season, and three in the second. Most of the time was spent in ground surveys, using four-wheel-drive vehicles. Areas inaccessible to motor vehicles were studied during a six-week helicopter program of 130 hours flying time. The aircraft used was a Bell G3-B1 helicopter capable of carrying two passengers and equipment.

Photographs available were:

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

The earlier photographs are of poor to moderate quality, the latest ones excellent.

Previous investigations

Stokes (1846) first commented on the geology of the area. Tenison Woods (1886) noted the 'fluviatile sandstones and conglomerates' near the mouth of the Victoria River, and the '. . . good volcanic country . . . higher up. . . .'

Brown (1895), who made the first accurate observations on the geology of the area, traversed the tidal reaches of the Victoria and Fitzmaurice Rivers and sampled a quartz reef near the mouth of the latter; assays revealed traces of gold; one sample yielded 58 g of silver to the tonne. Brown called the country rocks of the area 'Fitzmaurice River Rocks', which are referred to in this Report as the Fitzmaurice Group. He collected fossils from the locality named Fossil Head by Stokes, traversed the country from Fountain Head to Victoria River Downs, and described the country and rocks of his route across the Fergusson River and Delamere Sheet areas.

Wells (1907) gave 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, were produced by Noakes (1949) and Traves (1955); they have provided the main background knowledge for more recent geological mapping.

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 7-mile grid spacing was carried out over the whole area (Whitworth, 1970); and all except the eastern part of the Fergusson River Sheet area has been covered by an airborne magnetometer survey (page 90).

PHYSIOGRAPHY

The four Sheet areas have been divided into seven physiographic units (Fig. 2). Three, the Cambridge Gulf Lowlands, the Victoria River Plateau, and the Victoria River Plains and Benches, were originally delineated by Paterson (1970) and are subregions of his Ord-Victoria Region; the laterite-capped plateaux and mesas include the Sturt Plateau of Paterson. The Daly River Basin and Northern Uplands were described by Walpole et al. (1968); and the Litchfield and Cullen Plains, which have been delineated and named by us, are part of the Western Plains of Walpole et al.

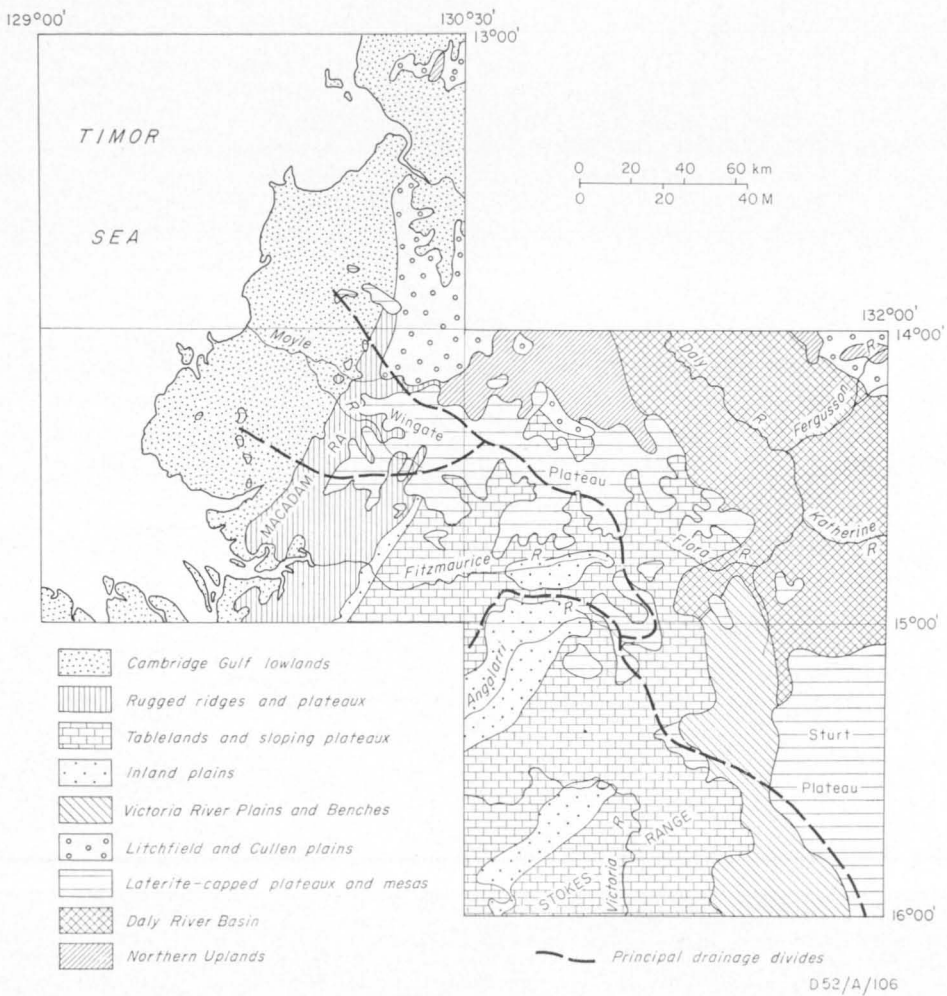


Fig. 2. Physiographic sketch map.

The *Cambridge Gulf Lowlands* form a coastal strip up to 60 km wide in the northwestern part of the survey area and are underlain almost entirely by Palaeozoic rocks of the Bonaparte Gulf Basin. The lowlands include a few small hills and elevated plains, but mostly consist of flat, low-lying soil plains 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 low sand dunes which support considerable vegetation. The hills and soil plains are quite heavily vegetated, but the alluvial plains are marshy and open.

The *Victoria River Plateau* includes three sub-units. The *rugged ridges and plateaux* form a northeast-trending belt up to 40 km wide through the Port Keats and Cape Scott Sheet areas. The ranges are formed of the deformed sediments of the Fitzmaurice Mobile Zone and consist of rugged ridges, cuestas, hogbacks, and small plateaux predominantly of sandstone, with contrasting narrow alluvium-floored valleys where softer rocks such as siltstone have been preferentially weathered out. The ruggedness is enhanced by extensive faulting and the lack of vegetation or soil on many of the hills. Maximum local relief is about 150 m.

The *tablelands and sloping plateaux* occupy a large part of the southern half of the survey area, and are underlain by the Auvergne, Bullita, and Tolmer Groups, which are flat-lying and gently dipping sequences of Proterozoic sandstone, siltstone, and carbonate rocks. Landforms include structural plateaux, benches, mesas, buttes, cuestas, hogbacks, and karst areas. The plateau rises to 300 m above surrounding areas. The Newcastle and Bynoe Ranges in the western part of the Delamere Sheet area comprise a large northwest-dipping cuesta capped by Jasper Gorge Sandstone. Large areas are capped by sandstones which produce a rough inaccessible surface.

The *inland plains* comprise three large northeast-trending valleys within the Victoria River Plateau. They are formed in siltstone units of the Proterozoic rocks and consist of flat, soil-floored valleys, which in most places are separated from the tablelands and plateaux by steep scarps.

The *Victoria River 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 common, and relief does not exceed 100 m. The interbedded sandstone units form northwest-trending rocky outcrops, some of which have sharp cliffs up to 6 m high.

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

The *Daly River Basin,* a wide northwest-trending valley in the Fergusson River Sheet area, is a fairly flat soil plain with scattered outcrops of carbonate rock giving rise to a karst topography. It coincides approximately with the extent of the carbonate rocks of the Daly River Group. All outcrops are of low relief except for the few scattered laterite-capped mesas.

The *laterite-capped plateaux and mesas* of the Wingate Plateau in the north and the Sturt Plateau in the southeast form a northwest-trending belt developed on an almost flat laterite surface capping the Cretaceous Mullaman Beds. The unit

consists of extensive flat-topped plateaux and small mesas edged by vertical breakaways and steep slopes, and represents an uplifted Tertiary 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 rugged, with relief up to 250 m. Strike ridges and valleys are developed in the northeast corner of the Port Keats Sheet area on rocks of the Finniss River Group.

Drainage

Two large rivers, the Victoria and the Daly, flow through the survey area. The Fergusson, Katherine, and Flora Rivers, which are tributaries of the Daly, and the Fitzmaurice and Moyle Rivers are also sizable. The Daly and its tributaries flow for most or all of the dry season, and the others often do so, as do several small rivers fed by springs at the base of the Wingate Plateau; but most watercourses flow only after heavy rain.

The divides between the main river systems are shown in Figure 2. The courses of the major rivers are only locally structurally controlled. Thus, although the Daly River follows the axis of the Daly Basin, the Fitzmaurice and Victoria Rivers cut across the strike of the Fitzmaurice Mobile Zone. Paterson (1970) considered that the present river system is due both to a system which existed on an early Neogene surface (now the surface of the laterite-capped mesas and plateaux) and to drainage consequent on new slopes. Both the revival of drainage and the formation of new slopes have resulted from the epeirogenic uplift of the Neogene surface as a whole. In some places the river systems are unrelated to the structure below the cover (mostly Mullaman Beds) of the Neogene surface and have now been superimposed on it; in others the rivers follow structures which were already reflected in the Neogene surface before uplift.

Many secondary streams in the rugged ridges and plateaux are subsequent and follow the northeasterly strike. Within the tablelands and sloping plateaux, strata are virtually flat-lying and there is, therefore, little structural control on river courses. However, in the northwest Delamere Sheet area the secondary streams run parallel to the northwesterly dip.

STRATIGRAPHY (Fig. 3)

Tables summarizing stratigraphy are at the beginning of the detailed descriptions of the major rock groups.

The Precambrian rocks mapped range in age from probable Archaean to mid-Adelaidean. The southern part of the area has not been previously mapped, and several new rock units have been defined and described. Adelaidean rocks (Fitzmaurice Group) in the Port Keats Sheet area were previously mapped as Lower Proterozoic Chilling Sandstone (Walpole et al., 1968). The Auvergne and Bullita Groups, which crop out extensively in the Auvergne Sheet area, extend northeastwards into the western half of the Fergusson River Sheet area. Much of the nomenclature of Randal (1962) has therefore been discarded; the terms Yambarra and Laurie Creek Beds are replaced by the Auvergne Group, and the Palm Creek Beds by the Bullita Group and the lowermost unit of the Auvergne Group.

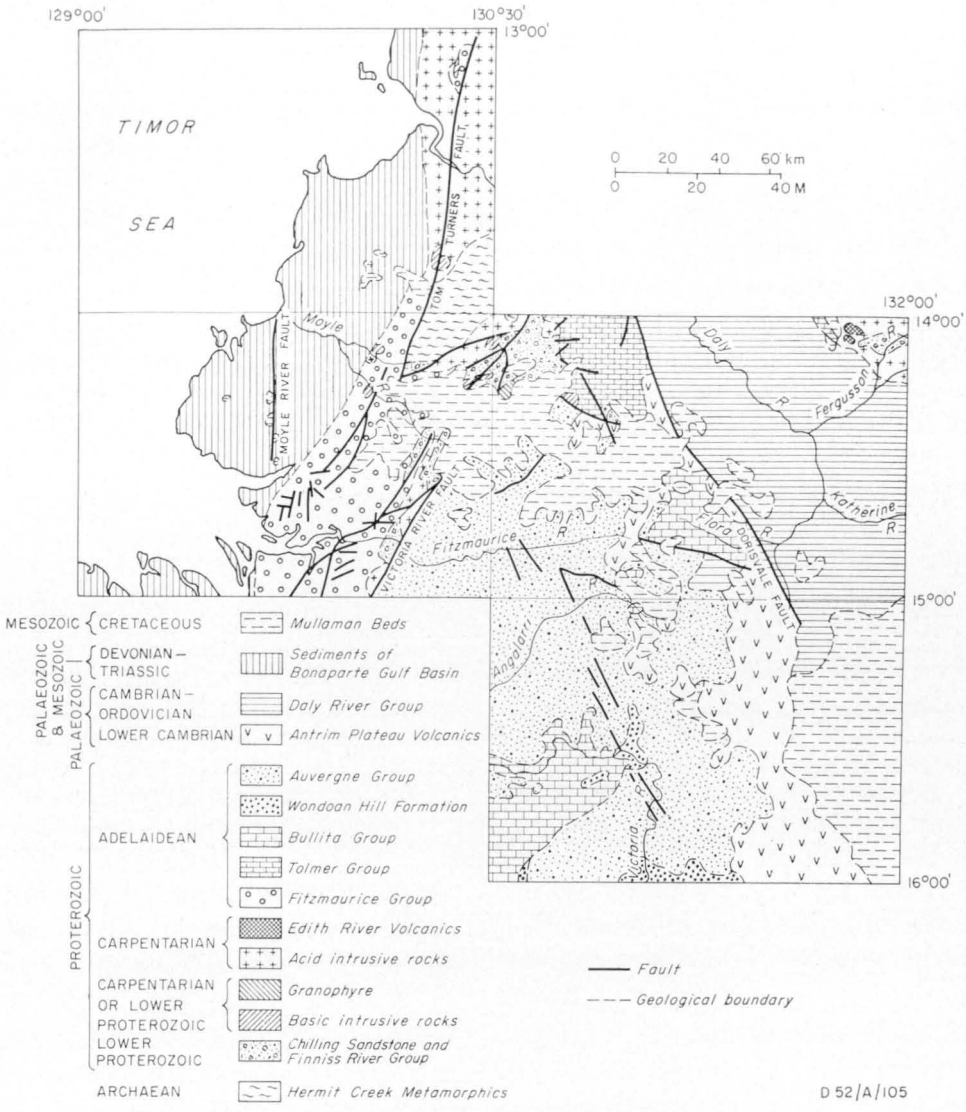


Fig. 3. Geological sketch map—northern Victoria River area.

ARCHAEAN (Table 2)

Hermit Creek Metamorphics

The Hermit Creek Metamorphics, which form the Archaean basement west of the Pine Creek Geosyncline, 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 their unconformable relation with the overlying Noltenius Formation.

Derivation of name: From Hermit Creek, a north-flowing tributary of the Daly River in the Cape Scott Sheet area. Malone and Randal first used the term on the Muldiva Creek 1-mile Sheet, and a brief account was included in the Fergusson

River and Pine Creek Explanatory Notes (Randal, 1962; Malone, 1962). The unit was mentioned briefly by Walpole et al. (1968).

Distribution and topographic expression: The metamorphics are limited to an area of about 310 km^2 at the junction of the Cape Scott, Port Keats, Fergusson River, and Pine Creek Sheet areas. They crop out sparsely as low rounded hills with subdued relief, except where there is a protective, more resistant capping (e.g. Mullaman Beds in the Dilke Range) and near the massive Litchfield Complex rocks.

Stratigraphic Relations: An Archaean age for the Hermit Creek Metamorphics was inferred on metamorphic and structural grounds by Walpole et al. (1968). R. N. Walker (pers. comm.) has since observed that the Noltenius Formation unconformably overlies the Hermit Creek Metamorphics 29 km east of Tom Turners Crossing in the Port Keats Sheet area. Elsewhere the metamorphics are intruded by the Carpentarian Litchfield Complex, and faulted against still younger rocks.

Description: The unit consists of schist, granulite, and basic igneous rocks, similar lithologically to the Tickalara Metamorphics and the Lamboo Complex in the Halls Creek Mobile Zone, Western Australia (Dow et al., 1964). The predominant rock type, ferruginous quartz-muscovite schist, is extensively exposed in the Cape Scott Sheet area, and a more phyllitic variant is widespread in the Port Keats Sheet area. Foliated mica schist overlies younger migmatites of the Litchfield Complex at the eastern end of the Dilke Range (Cape Scott Sheet area), where the contact dips about 10°S and is parallel to the foliation of the schist. Contact metamorphic effects are limited to the presence of minor granitic lenses in the schist. The Archaean rocks appear to have been overthrust onto the Litchfield Complex by a Carpentarian or younger orogenic movement.

In the northwest Dilke Range, weathered tourmalinized quartz-muscovite schist cropping out close to the Litchfield Complex is overlain by a 10-m band of cordierite-sillimanite-garnet gneiss, which dips steeply west. The gneiss contains porphyroblasts of garnet, small needles of sillimanite, and prisms of corundum, in a matrix composed mainly of cordierite; biotite, after sillimanite, and chlorite are present. Rocks of the northwest Dilke Range are intruded by granite and pegmatites.

The basic rocks of the Hermit Creek Metamorphics include plagioclase amphibolite, tremolite schist, and altered serpentinite. They are considered to be metamorphosed ultrabasic and basic rocks unrelated to the early Carpentarian intrusives. Plagioclase amphibolite, believed to be a metamorphosed gabbro, 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, and is weakly foliated. In the northwest Dilke Range, a serpentinized peridotite consists of corroded olivine crystals and picotite in a matrix of serpentine replacing olivine and enstatite, and tremolite replacing enstatite.

The Tom Turners 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 are strongly sheared.

LOWER PROTEROZOIC (Table 2)

FINNISS RIVER GROUP

Burrell Creek Formation

A small exposure of Burrell Creek Formation in the northeast Fergusson River Sheet area was mapped and described by Rattigan & Clarke (1955). It con-

TABLE 2. ARCHAEAN AND LOWER PROTEROZOIC STRATIGRAPHY

Age Group	*Rock Unit*	*Map Symbol*	*Thickness (m)*	*Lithology*	*Physiographic Expression*	*Distribution**	*Stratigraphic Relations*
LOWER PROTEROZOIC — FINNISS RIVER GROUP	Henschke Breccia	Plg	1000	Coarse ferruginous sedimentary breccia and conglomerate with quartz fragments. Some sandstone interbeds	Massive rugged hills and ridges	Around Henschke Falls in N *Port Keats*	Unconformable below Moyle River Formation. May intertongue with Chilling Sandstone or Noltenius Formation
	Chilling Sandstone	Plh	4800	White blocky and massive medium quartz sandstone	High rugged ridges and plateaux	N margin of *Port Keats* and *Fergusson River* and NW of Meeway Plain	Conformable on Noltenius Formation (intertonguing). Intruded by Koolendong and Soldiers Creek Granites, basic sills, and granophyre.
	Meeway Volcanics	Pla	1700	Porphyritic rhyolite and dacite, tuff, sandy tuff; some outcrops intensely sheared	Lava forms high rounded tors. Tuff forms rugged angular hills and steep slopes below sandstone units	W and NW of Meeway Plain and W of Koolendong Valley	Probably intertongues with Chilling Sandstone. Unconformable below Moyle River Formation
	Berinka Volcanics	Pli	840 min	Porphyritic grey rhyolite and dacite and minor acid intrusives in *Port Keats*. Tuff, agglomerate, rhyolite, altered spherulitic acid volcanics and amygdaloidal intermediate flows in *Fergusson River*	Very rugged hills and ridges in *Fergusson River*. Forms valley with gently undulating floor in *Port Keats*	NE *Port Keats* and NW corner *Fergusson River*	Intertongues with Noltenius Formation
	Noltenius Formation	Pln	4200	Low-grade metamorphosed siltstone, greywacke, sandstone, conglomerate. Contact metamorphism where in contact with granite	Extremely rough country. Ridges, angular hills. Some low-lying rough country	N between *Port Keats* and *Fergusson River*. N of Collia Waterhole. In valleys W of Meeway Plain	Unconformable on Hermit Creek Metamorphics. Conformable below Chilling Sandstone. Intruded by granophyre, basic sills, Berinka Volcanics, granites
	Burrell Creek Formation	Plb		Massive grey-brown medium-grained quartz greywacke, siltstone, and phyllite	Rugged hills	NE *Fergusson River*	Lateral equivalent of lower part of Noltenius Formation
				UNCONFORMITY			
ARCHAEAN	Hermit Creek Metamorphics	Ah		Ferruginous quartz-muscovite schist and phyllite. Rare tremolite schist, amphibolite, and serpentinite	Plains of low relief with little outcrop. Few low hills	NE *Port Keats* and SE *Cape Scott*	Intruded by Litchfield Complex and basic sills and dykes. Unconformably overlain by Noltenius Formation

* Sheet areas in Italics.

sists mainly of massive, cleaved, grey-brown, medium-grained quartz greywacke, siltstone, and phyllite. The Burrell Creek Formation 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 formation of the western part of the Pine Creek Geosyncline. It is exposed from the northwest Fergusson River Sheet area southwards to Collia Waterhole; in the northeast Port Keats Sheet area; as small outliers near Tom Turners crossing; and as a large inlier northwest 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: From Noltenius Billabong, north of Daly River Police Station in the Pine Creek Sheet area (Walpole et al., 1968). Hossfeld (1937a, b) mapped the formation in the Fletchers Gully, Buldiva, and Collia areas and included it in the 'Muldiva Stage' of the 'Mosquito Creek Series'. White et al. (1962) distinguished between the Noltenius Formation and the Chilling Sandstone in the Muldiva Creek and surrounding 1-mile Sheet areas.

Stratigraphic relations: The Noltenius Formation is overlain conformably by the Chilling Sandstone and grades eastwards into the more argillaceous Burrell Creek Formation. It was thought by Walpole et al. (1968) to be transitional between the sandstone to the west and shale to the east. However, later mapping showed that typical Noltenius Formation extends westwards into the Port Keats Sheet area, and does not grade into a coarser rock as previously thought, but intertongues with the Berinka Volcanics. It unconformably overlies the Hermit Creek Metamorphics in the Port Keats Sheet area. The Noltenius Formation is intruded by early Carpentarian granites and by several basic igneous bodies.

Description: The Noltenius Formation consists of metamorphosed siltstone and greywacke estimated by air-photograph interpretation to be as much as 4100 m thick in the northwestern Fergusson River Sheet area. However, if surface exposures of rock are repeated by folding and faulting this estimate may be too high, and the formation may only be about 1500 m thick.

Northwest of Meeway Plain in the Port Keats Sheet area the formation, which is intruded by Koolendong Granite, is represented by uniformly red-purple, poorly bedded siltstone with bands of grey slate and sheared pebbly sandstone. A marked regional cleavage strikes 030° and dips 85°E. The range of the bedding dip from 10°E to about 70°E suggests 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 km north and south of the Fitzmaurice River, a sequence of highly deformed rocks comprises spotted schist and grey-green phyllite interbedded with sheared volcanics. Chevron folds and B lineations are common. North of the Fitzmaurice River several bands of conglomerate up to 6 m thick contain stretched pebbles (Fig. 4), whose shapes are prolate ellipsoid with the long axes normally 8 to 10 cm long, but exceptionally up to 30 cm; the plane of elongation of the pebbles is parallel to the regional cleavage and schistosity. The pebbles are mostly quartzitic and are contained in a poorly sorted sand-silt matrix.

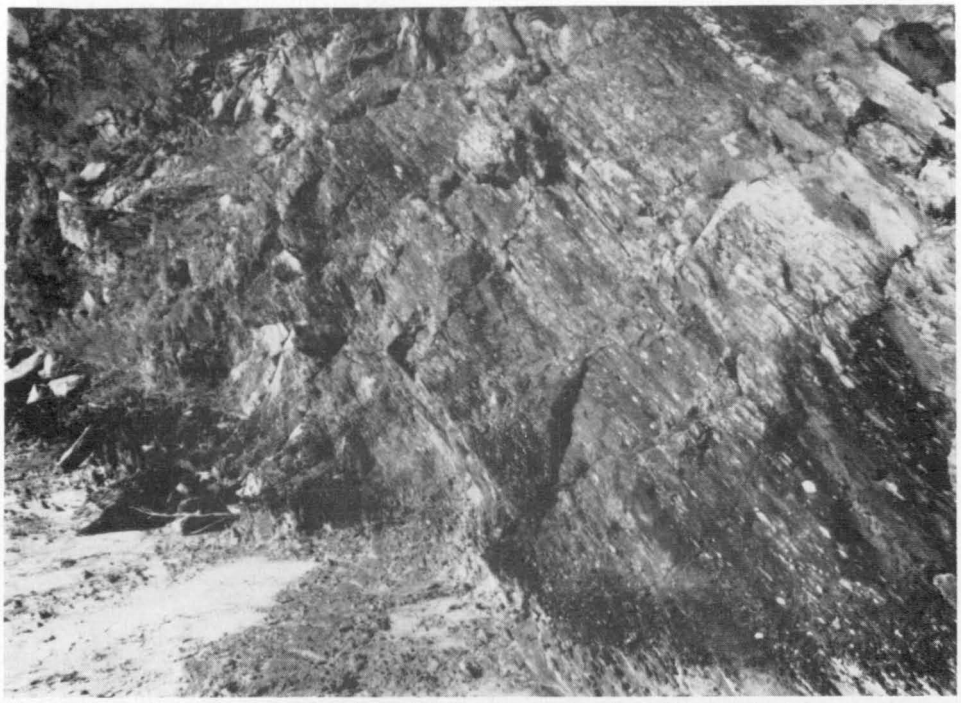


Fig. 4. Sheared conglomerate in Noltenius Formation. Bank of Fitzmaurice River at western margin of Koolendong Valley, Port Keats Sheet area.

Near the Muldiva and Buldiva mines, grey-green phyllites with thin interbeds of fine-grained sandstone have a regional cleavage strike of about 110°, dipping at about 80°N.

Around the northern margin of the Soldiers Creek Granite is a broad halo of hornfelsed Noltenius Formation; the granite contains large xenoliths. At 14°29′S, 130°48′E, a large outcrop of quartz-sericite schist contains andalusite (chiastolite) and garnet partly replaced by sericite and pyrophyllite. Farther north, at 14°15′S, 130°47′E, there is evidence of retrograde metamorphism in quartz-muscovite-garnet schist, which is composed of a matrix of unstrained quartz and oriented muscovite flakes with syntectonically rotated garnet porphyroblasts; in thin section, sericite replacement of the garnet can be recognized.

Massive graded greywacke (Fig. 5) with thin bands of interbedded phyllite and quartz-greywacke conglomerate crop out along Allia Creek about 10 km southeast of Fletchers Gully. The greywacke consists of angular unsorted grains of quartz and feldspar in a matrix of clay minerals, sericite, quartz, and biotite; the larger biotite flakes are probably of metamorphic origin, and some quartz is recrystallized. The greywacke falls into the feldspathic greywacke class of Pettijohn (1957).

A sequence of poorly sorted hematitic clayey sandstone exposed in the north-east Port Keats Sheet area is massive to flaggy, and may be transitional between the Noltenius Formation and the Chilling Sandstone.

Distinguishing features: Although similar to the Hermit Creek Metamorphics in places, the Noltenius Formation is less folded and metamorphosed, more phyllitic,

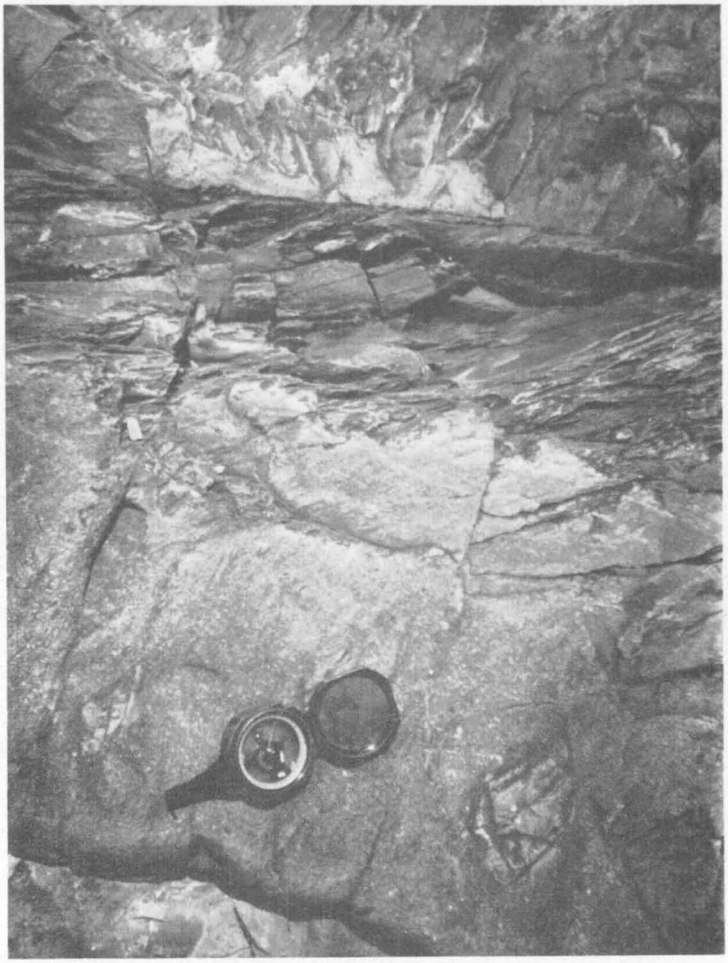


Fig. 5. Turbidite unit within Noltenius Formation showing graded bedding, uneven base, included boulders, and a cleaved fine-grained shaly top. Allia Creek 10 km southeast of Fletchers Gully mine, Fergusson River Sheet area.

less weathered, and more consistently cleaved. Andalusite is virtually restricted to the Noltenius Formation.

Palaeogeographic significance: The Noltenius Formation was deposited in a deep-water, probably reducing, environment close to the continental slope. Walpole et al. (1968) suggested that the unit was deposited largely by turbidity currents in an environment intermediate between shelf and deep-water facies, but no evidence of a westward transition to shelf facies was discovered during this survey.

Berinka Volcanics

The term Berinka Volcanics was first used by Randal (1962) to describe acid lavas and pyroclastics which crop out over an area of about 12 km^2 in the north-west Fergusson River Sheet area. Randal considered that they overlie the Noltenius

Formation, but that their relation to the Chilling Sandstone is unknown. Walpole et al. (1968) suggested that they may be interbedded with the Noltenius Formation, and included in them a granophyre found at the contact with a gabbro. We have included the granophyre in another unit, the Ti-Tree Granophyre, and regard it as a possible late-stage differentiate of the basic intrusives. Volcanic rocks and high-level intrusives in the northeast Port Keats Sheet area have been assigned to the Berinka Volcanics.

Distribution and stratigraphic relations: Outcrop is confined to the northeast-trending belt of Lower Proterozoic rocks between 30 and 40 km east of Tom Turners Crossing in the Port Keats Sheet area. The extrusives form a belt about 10 km long and 1 km wide within the Noltenius Formation and Chilling Sandstone. Outcrop is poor and the unit forms a deep valley between hills of sandstone and greywacke. The volcanics are separated by a fault from sandstone of the Noltenius Formation to the northwest, and are overlain to the southeast by siltstone, sandstone, and greywacke of the Noltenius Formation. It appears that the Berinka Volcanics are interbedded with, or intertongue with, the Noltenius Formation as suggested by Walpole et al. (op. cit.).

The sandstone of the Noltenius Formation northwest of, and stratigraphically below, the extrusives contains at least three separate acid sills considered to be high-level intrusive equivalents of the volcanics; their appearance is very different from that of the Ti-Tree Granophyre. The sills, which are up to 75 m thick and 5 km long, are generally conformable with the bedding, but are transgressive in places. The intrusive rocks become noticeably finer towards the contact with the sandstone, which is partly recrystallized at the contact.

Lithology: The extrusive rocks are typically dark grey or grey-green and cryptocrystalline, with subhedral phenocrysts of quartz and feldspar and dark plates of chlorite. Towards the southwest end of the outcrop some of the rocks are marked with polygonal ridges on weathered surfaces, a few millimetres high and up to 15 cm across; they have curved sides and rounded corners (Fig. 6), and are probably shrinkage cracks formed while the lava was cooling. In thin section, specimens from the ridges are not noticeably different from other parts of the rock except that they are fractured and tend to be pink, presumably from a slightly greater weathering rate.

The volcanics contain interbeds of sandstone up to 3 m thick, as well as several beds of hematite up to 15 cm thick. Most thin sections were of porphyritic acid lava, probably dacite, without shard structures. The groundmass is light brown and cryptocrystalline, and is composed of very small radiating aggregates of devitrified glass; phenocrysts are of quartz, plagioclase, alkali feldspar, augite, and chlorite. Quartz phenocrysts up to 2 mm across are either anhedral or bipyramidal with embayed margins. The plagioclase grains are subhedral, up to 2 mm across, and are heavily sericitized; in some sections the twin lamellae are poorly developed. The alkali feldspar is somewhat sericitized euhedral and subhedral microperthitic orthoclase. Phenocrysts of plagioclase to alkali feldspar are in the ratio of about 10:1. In some sections augite accounts for up to 10 percent of the phenocrysts. Irregular aggregates of chlorite are also common. One section consists of angular chunks of brown volcanic glass with perlitic cracks, and ragged and anhedral grains of feldspar, chlorite, quartz, and augite, set in a fine groundmass.

The intrusive rocks are medium to fine, grey with red-brown patches, and severely altered. The groundmass consists of fine sericite replacing a medium-

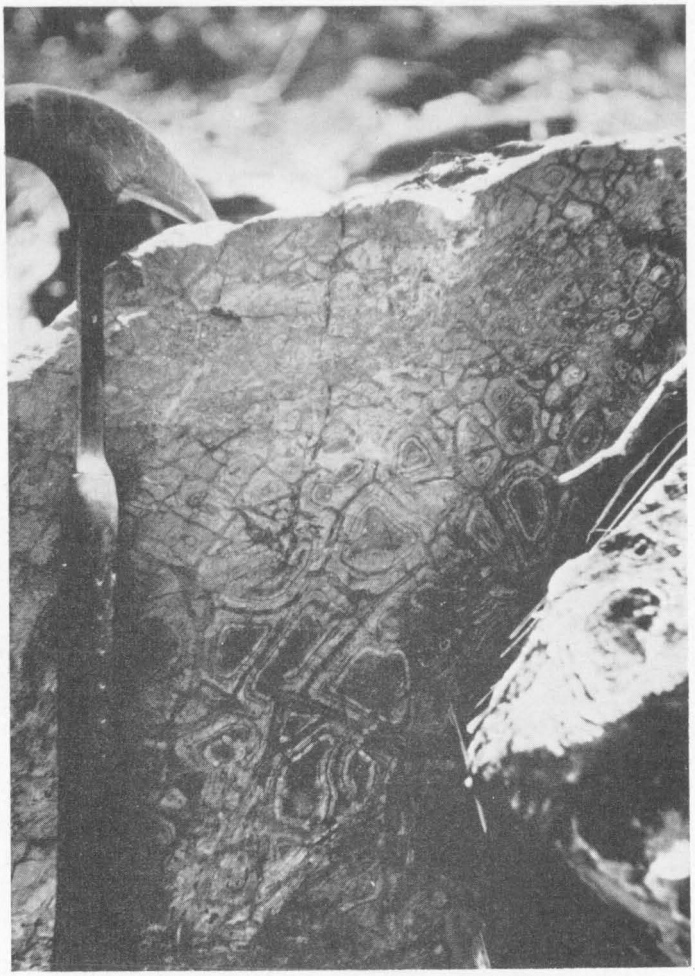


Fig. 6. Polygonal (?shrinkage crack) structures in acid lavas of the Berinka Volcanics 30 km east of Tom Turners Crossing, Port Keats Sheet area.

grained mosaic of quartz and feldspar. Phenocrysts of feldspar are subhedral, up to 2 mm long, and considerably sericitized. The most common type of phenocryst is mainly iron oxide with a little quartz, and its shape suggests that it may replace feldspar.

Meeway Volcanics (new name)

Meeway Volcanics is the name given to Lower Proterozoic acid volcanics and tuffs which crop out near the Fitzmaurice River in the Port Keats Sheet area. They are not included with the Berinka Volcanics because they overlie, and probably intertongue with, Chilling Sandstone at one outcrop. Nevertheless, they are probably part of the same phase of volcanic activity as the Berinka Volcanics, and are included in the Finniss River Group.

Derivation of name: From Meeway Plain, which extends from the north bank of the Fitzmaurice River at 14°38′S, 130°11′E, in a north-northeasterly direction for about 30 km.

Distribution: The volcanics are restricted to the Port Keats Sheet area and crop out along the northwestern margin of Meeway Plain. South of the Fitzmaurice River sheared outcrops form the western margin of the Koolendong Valley. Several small outcrops west of Meeway Plain have also been assigned to the formation. *Type section:* Measured along a creek which drains the northwestern corner of the Meeway Plain; the section, whose base is at the edge of the plain at 14°35′15″S, 130°19′E, extends northwestwards for 3.5 km along the creek.

Stratigraphic relations: The Meeway Volcanics probably intertongue with the Chilling Sandstone, but their precise relation has not been established. The boundary between them has been drawn where white quartz sandstone gives way to softer, blue-grey tuffaceous sandstone. The top of the volcanics is cut off by the Victoria River Fault: the Meeway Volcanics are therefore the youngest bedded Lower Proterozoic unit in the Port Keats Sheet area.

Lithology and thickness: At the type section 1000 m of massive acid lava and minor tuff overlie 650 m of flaggy and massive grey-brown tuff. The tuff grades downwards into blue-grey sandstone which overlies white quartz sandstone mapped as Chilling Sandstone.

Description: In the northwest Meeway Plain the volcanics cover about 10 km^2. The eastern part consists of acid lava; to the west, the lava is underlain by 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 (Chilling Sandstone) from the rugged hills of tuff to the east. The lava is bounded to the east by the Victoria River Fault, which separates it from rocks of the Auvergne Group.

The lava forms high massive tors with good but deeply weathered outcrop. The tuff forms rugged, more angular hills with less outcrop. The dip of the lava flows is not apparent, but if the dip of 60° in the tuff continues to the east, the lava would be about 1000 m thick.

The lava is composed of phenocrysts of anhedral to euhedral quartz, and pink and green feldspar up to 3 mm long set in a fine red-brown matrix. Quartz phenocrysts are generally subhedral, bipyramidal, and embayed. Most of the feldspar phenocrysts are sericitized plagioclase; alkali feldspar phenocrysts are rare; the fine groundmass consists of quartz, feldspar, and a little chlorite. Immediately west of the lava, fine to medium, brown or speckled grey-brown rock believed to be tuff has a flaggy to massive parting. It consists of rounded and angular fragments up to 3 mm long of quartz, feldspar, opaque minerals, and sericite, set in a ground mass composed mainly of quartz and feldspar. The tuff grades westwards into tuffaceous sandstone and siltstone. At the boundary with the underlying Chilling Sandstone it is blue-grey, blocky, and fine-grained, and contains a high proportion of soft clay material. It consists of scattered angular quartz grains (0.1 mm), opaque minerals, tourmaline, and muscovite, in a matrix of fine sericite.

Along the western side of Koolendong Valley and extending 10 km south of the Fitzmaurice River, volcanics form low rugged outcrops. They are difficult to distinguish from other rocks in this area (mainly gritty sandstone or greywacke probably belonging to the Noltenius Formation) as they have been heavily sheared and altered. The volcanics are fine-grained, red-brown or green-grey, and small

quartz phenocrysts are visible in hand specimen. The quartz occurs as aggregates of grains separated by fine sericite, but is in optical continuity. The aggregates are surrounded by a groundmass of fine quartz, opaque minerals, green chlorite, and possibly feldspar. Overall, the aggregates have bipyramidal shape and embayed margins. Other specimens are too sheared to retain evidence of their volcanic nature, but in hand specimen are similar in appearance to the rock just described.

In an area 11 km west of the northwestern corner of the Meeway Plain, a belt of Chilling Sandstone about 1.5 km wide strikes north-northeast. Rocks which resemble tuff crop out at the base of the scarp that flanks the western edge of the belt. Another small outcrop of rock resembling tuff was found at the southeast corner of the belt close to its contact with the Moyle River Formation. The western outcrop has a stratigraphic thickness of about 60 m and lies between the Noltenius Formation and Chilling Sandstone; the eastern outcrop appears to be interbedded with the Chilling Sandstone. The rocks are fine to medium, hard, purple-grey, and flaggy or massive. In places thin bedding is well defined by alternating purple-brown and grey bands. The main constituents are fine-grained angular quartz, an opaque mineral, and ragged muscovite flakes up to 0.2 mm long. Patches of sericite appear to be pseudomorphs after feldspar. These rocks resemble the tuff at the northern end of the Meeway Plain, but there is no proof that they are of volcanic origin.

Severely sheared and altered rock crops out over about 8 km^2 of rugged ground 4 km north of the Fitzmaurice River. The rock is dark grey-green and contains euhedral phenocrysts of green feldspar (probably plagioclase) up to 2 mm long, and anhedral phenocrysts of quartz. The feldspar is largely replaced by sericite; potash feldspar forms smaller rounded and unaltered phenocrysts. The groundmass is fine to medium and composed of quartz, sericite, muscovite, and chlorite. The rock is overlain to the east by the Moyle River Formation.

Chilling Sandstone

The name Chilling Sandstone was first used by Randal (1962) and Malone (1962), who stated that it overlies the Noltenius Formation and represents the last phase of deposition along the western margin of the Pine Creek Geosyncline. Walpole et al. (1968) retained the name, and included in the unit sandstone extending southwards and westwards into the East Kimberley region of Western Australia. Much of this area is now known to consist of much younger rocks, probably of Adelaidean age, and called by us the Fitzmaurice Group. Our limits of the Chilling Sandstone extend little beyond those of Randal (1962) and Malone (1962).

Derivation of name The formation is named from Chilling Creek in the northwest Fergusson River Sheet area.

Distribution: The Chilling Sandstone crops out over an area of about 500 km^2 in the Fergusson River and Port Keats Sheet areas. Rocks in an area south of Chilling Creek, previously designated by Randal (1962) as Depot Creek Sandstone, are now mapped as Chilling Sandstone. The largest single area of outcrop is northwest of the Meeway Plain in the central Port Keats Sheet area. Outcrops at Murrenja Hill are now regarded as Fitzmaurice Group; those at Fog Bay were not examined, but are likely to be Fitzmaurice Group.

Type section: In the syncline between Fletchers Gully Goldmine and Chilling Creek, Fergusson River Sheet area (Walpole et al., 1968).

Stratigraphic relations: The unit overlies Noltenius Formation conformably in the type area. It probably intertongues with the Meeway Volcanics in the Fitzmaurice River area. No evidence was seen of the intertonguing relation with the Noltenius Formation suggested by Walpole et al. (1968). The Chilling Sandstone is intruded by early Carpentarian acid and basic rocks.

Lithology and thickness: The Chilling Sandstone is mainly white, blocky to massive, silicified, medium-grained orthoquartzite. Some feldspathic sandstone crops out in the Port Keats Sheet area. About 4800 m of the formation crops out immediately south of the type area, a much greater thickness than that reported by Walpole et al. It is difficult to assess thicknesses in other areas as faulting and erosion have complicated the general picture.

Grains are moderately to well sorted and feldspar content is usually low. Shallow-water structures such as interference ripples, cross-bedding, and, more rarely, pebble bands are present. Silicification has transformed most of the rock into a quartzite in the more southerly outcrops, where traces of original structures have been observed. Owing to its brittleness, the sandstone is commonly brecciated and extensively jointed. However, compression has caused some large-scale open folds such as the southerly-plunging syncline in the type area. Near intrusive bodies, the sandstone has been completely recrystallized to a simple equigranular mosaic of quartz grains (annealed texture), and feldspar and biotite have formed within a metre or so of the contacts.

Palaeogeographic significance: The Chilling Sandstone represents the last known clastic sedimentation in the Pine Creek Geosyncline. Walpole et al. (1968) considered that it formed on an extensive platform adjacent to the newly-filled main trough of the Pine Creek Geosyncline. Although the platform is not as extensive as they envisaged, the basic hypothesis still holds.

The Chilling Sandstone reflects more stable conditions in and near the Pine Creek Geosyncline. The maturity of the sediments indicates a lower, perhaps more distant, source area. Erosion of predominantly acid basement rocks could account for the preponderance of quartz. The sandstone was probably the source of much of the mature sandstone in the younger Fitzmaurice Group.

Henschke Breccia (new name)

Distribution and derivation of name: The Henschke Breccia is known only from an area of about 20 km^2 near Henschke Falls in the northern Port Keats Sheet area. *Type section locality:* From the top of Henschke Falls due west-southwest for 2.5 km to the east bank of the unnamed creek at 14°11′40″S, 130°10′30″E.

Stratigraphic relations: The formation is best exposed between Henschke Falls and a south-trending fault 2.5 km west of the falls, where it dips steeply and is overlain with marked angular unconformity by basal conglomerate of the Moyle River Formation (Fig. 7). Such basal conglomerates have been seen only near the Henschke Breccia, and have obviously been derived from it; the two look very alike and it is almost impossible to distinguish between them farther east, where the unconformable relation is not apparent and the mapped limits may not be entirely correct.

The relations between the Henschke Breccia and other formations older than the Moyle River Formation are unknown. Phyllite and granite to the north and



Fig. 7. Strongly jointed Henschke Breccia overlain unconformably by basal conglomerate of the Moyle River Formation; 3 km west of Henschke Falls, Port Keats Sheet area.

east appear to be faulted against the breccia; the phyllite is tentatively regarded as Noltenius Formation.

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

In the east, the breccia, interbedded with white quartz sandstone not unlike Chilling Sandstone, may be 1000 m thick. The type section is of uniformly massive breccia, and about the same thickness. The breccia contains at least one interbed of slate and phyllite, and is probably related in age to the Noltenius Formation and Chilling Sandstone. It could be a tongue or lens within either or possibly a wedge of coarse clastics along a fault zone active during sedimentation. 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.

The breccia is medium to thick-bedded, and its parting varies from blocky to massive; in some localities bedding cannot be distinguished. Prominent joints give a false impression of bedding. Bedding appears to be vaguely graded in the west, but cross-bedding is common in the east (Fig. 8). The Henschke Breccia is composed mainly of dark purple or red-brown breccia with white clasts of quartz and other rocks, and includes minor, well sorted, white, medium-grained quartz sandstone. The breccia is 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 subrounded clasts.

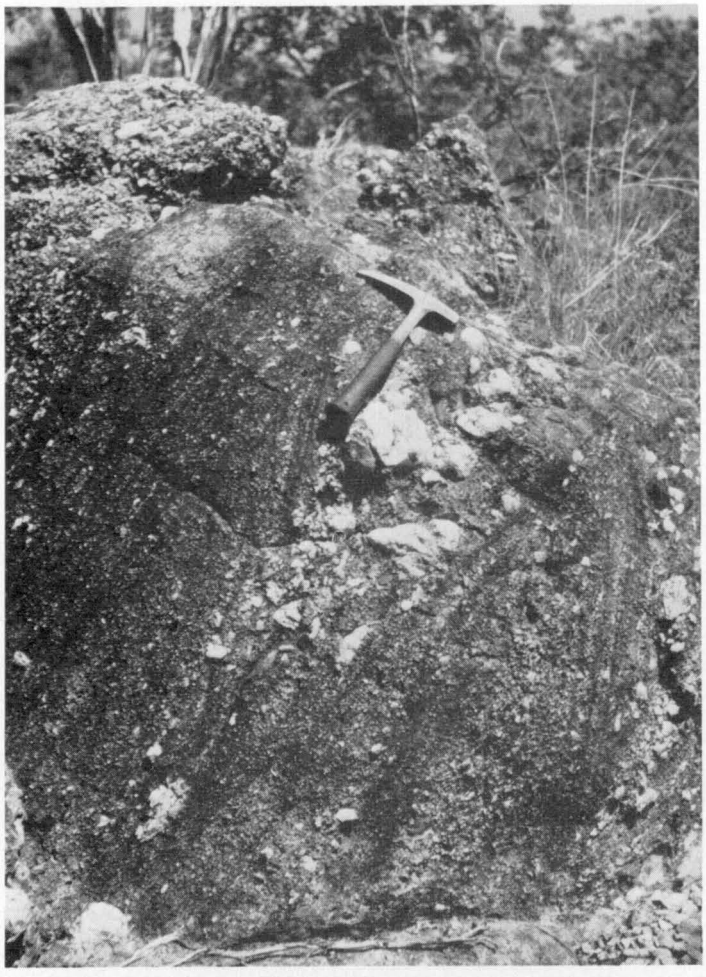


Fig. 8. Steeply dipping, cross-bedded Henschke Breccia. Large and small white clasts are quartz; 6.5 km east of Henschke Falls, Port Keats Sheet area.

Quartz, by far the most common detrital component of the breccia, is white and typically displays strained extinction in thin section. Rock fragments include muscovite schist, quartzite, and what may be acid volcanics. The matrix is composed of quartz, sericite, hematite, and limonite. The sericite appears authigenic, and is presumably the product of diagenetic or metamorphic processes on a clay matrix. Very finely divided hematite, weathered to limonite in most specimens, throughout the rock gives its characteristic colour.

Distinguishing features: The formation was at first considered to be easily distinguishable because of its massive nature and unusual lithology. However, similar rock types in the basal Moyle River Formation make the two formations difficult to distinguish except where their stratigraphic relations are apparent.

Palaeogeographic significance: The unit was laid down rapidly by strong currents, and the predominance of quartz clasts indicates that the eroded terrain was similar

to that occupied by the Hermit Creek Metamorphics to the north. Because the stratigraphic relations are poorly known, little is known about the geological and structural setting of the depositional environment.

CARPENTARIAN

Basic and Intermediate Intrusive Rocks (Table 3)

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 are probably older than the early Carpentarian granites; they are possibly late Lower Proterozoic. An age of 1393 to 1525 m.y. obtained on a sample of gabbro from Moyle No. 1 well west of Tom Turners Crossing (Page, 1968) must be regarded as a minimum; it probably represents a metamorphic event.

Basic and intermediate intrusive rocks are exposed in six main areas:

(1) West of Tom Turners Crossing, bordering coastal plains, four outcrops of dolerite form cobble-strewn rises. The dolerite is in contact with sandstone of the Moyle River Formation and granite of the Litchfield Complex. Most of the sandstone contacts are faulted, and others very poorly exposed, but the sandstone apparently overlies the dolerite. The contact with the granite is also poorly exposed, but the granite becomes finer-grained towards the contact and probably intrudes the dolerite; a 1.2-m quartz vein in the dolerite supports this conclusion.

The dolerite is medium-grained, melanocratic, and has a subophitic texture. Laths of andesine (An_{45}) range from fresh to quite severely saussuritized; some are enclosed in anhedral and subhedral grains of pigeonite which are partly altered to iron oxide and bright green hornblende; these in turn have been partly altered to chlorite. Microcline and quartz form about 5 percent of the rock and are commonly graphically intergrown. Biotite and skeletal or subhedral grains of opaque mineral are accessories.

(2) About 20 km^2 of basic intrusives crops out near the northern margin of the Port Keats and Fergusson River Sheet areas, and a smaller body crops out a few kilometres to the southwest; both bodies are surrounded by granite which becomes finer-grained near boundaries with the dolerites, but the contacts are not exposed. The rocks form low boulder-strewn hills with limited outcrop.

The most common rock type is a melanocratic medium-grained quartz dolerite with small quantities of opalescent quartz. Coarse quartz gabbro contains mafic minerals up to 2.5 cm long and feldspar and quartz up to 0.5 cm long. Owing to the sparseness of exposures, it is difficult to see its relation with the dolerite, in which it appears to form irregular and vaguely defined bodies. Another feature of the dolerite is the presence of straight cross-cutting ridges about 2 mm wide on the weathered surfaces; on fresh surfaces they are slightly darker than the rest of the rock. They appear to have formed along joints.

The plagioclase is labradorite (An_{50} to An_{60}), forming stumpy anhedral or subhedral grains. Alkali feldspar and micropegmatite 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 occur near biotite grains. The plagioclase is considerably altered in the cross-cutting bands. The pyroxene has been

TABLE 3. CARPENTARIAN IGNEOUS ROCKS

Rock Unit	*Map Symbol*	*Lithology*	*Physiographic Expression*	*Distribution**	*Stratigraphic Relations*
Edith River Volcanics	Pue	Coarse porphyritic dacite and rhyodacite	Rugged hills and ridges	NE *Fergusson River*	Dykes in Cullen Granite and overlying flows; 105 m thick
Allia Creek Granite	Pga	Medium to coarse porphyritic biotite-muscovite adamellite, granodiorite, and tonalite	Soil plain with sporadic piles of boulders. Rough slopes below sandstone capping	NW *Fergusson River*	Intrudes Noltenius Formation. Unconformably overlain by Depot Creek Sandstone
Cullen Granite	Pgc	Medium and even-grained biotite granite; coarse porphyritic biotite-hornblende granite and adamellite	Soil plain with sporadic outcrops	NE *Fergusson River*	Intrudes Burrell Creek Formation. Intruded by Edith River Volcanics
Koolendong Granite	Pgk	Even-grained and minor porphyritic coarse biotite and biotite-hornblende granite, adamellite, and granodiorite	Pavements and boulder piles in soil plains. Rough slopes below sandstone cappings	W of Koolendong Valley and Meeway Plain, and in valleys NW of Meeway Plain	Intrudes Noltenius Formation and Chilling Sandstone. Unconformably overlain by Moyle River Formation. Adamellite intrudes granodiorite in south
Soldiers Creek Granite	Pga	Porphyritic even-grained coarse muscovite-biotite granite and adamellite. Numerous greisen and pegmatite veins. Cassiterite and tourmaline in greisen	Rugged hills up to 100 m high separated by soil plains	N of Collia Waterhole in *Fergusson River*	Intrudes Chilling Sandstone and Noltenius Formation and contains Noltenius roof pendants. Unconformably overlain by Depot Creek Sandstone and Antrim Plateau Volcanics
Litchfield Complex	Pgl	Coarse even-grained biotite granite, adamellite, granodiorite, tonalite. More acid towards W of *Port Keats*. Garnetiferous in *Fergusson River*. Mafic xenoliths abundant. Migmatic zones at contacts with Hermit Creek Metamorphics	Boulder piles on flat soil plains. Few rough hills up to 100 m high	NW *Fergusson River*, NE *Port Keats*, E *Cape Scott*	Intrudes Hermit Creek Metamorphics and probably Basic Sills. Unconformably overlain by Moyle River Formation
Ti-Tree Granophyre	Pgi	Pink or grey medium mesocratic granophyre	Forms valleys in sequences it intrudes. Outcrop restricted to few small piles of boulders	32 km E of Tom Turners Crossing, 24 km SW of Fletchers Gully mine	Sills up to 300 m thick in Noltenius Formation and between Noltenius and Chilling Sandstone. Most relations concordant
Basic and intermediate Sills and Dykes	Pdo	Medium and coarse quartz diorite and gabbro. Some chalcopyrite traces	Low boulder-strewn hills	NE *Port Keats* and NW *Fergusson River*. 8 km NW and SW of Tom Turners Crossing, 19 km SW of Hermit Hill	Intrudes Hermit Creek Metamorphics, Noltenius Formation, and Chilling Sandstone. Unconformably overlain by Moyle River Formation. Probably intruded by Litchfield Complex

* Sheet areas in Italics.

completely altered either to hornblende or to a mixture of chlorite, biotite, and a pleochroic blue-green mineral. In some bands the quartz content is as much as 40 percent, which is twice as high as in the main body of the rock. The higher quartz content suggests that the veins have been formed by the migration along joint planes in the dolerite of siliceous fluids probably originating in the nearby granite of the Litchfield Complex.

(3) Diorite intrudes Noltenius Formation (and Chilling Sandstone?) in the northeastern Port Keats Sheet area. At least two small sills (up to 30 m wide and 1.5 km long) of medium-grained diorite intrude Noltenius Formation greywacke and siltstone, which 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 be underlain by a similar intrusive body. The sill rock is a medium-grained mesocratic diorite, in which laths of andesine are heavily saussuritized and the pyroxene is completely converted to green-brown hornblende and minor chlorite; interstitial quartz and skeletal crystals of iron oxide are abundant, and calcite is patchily distributed.

(4) About 12 km^2 of gabbro crops out 20 km northwest of Collia Waterhole and forms low hummocky ground strewn with boulders. The gabbro probably intrudes the Noltenius Formation and is faulted against the Angalarri Siltstone. It is grey or grey-green, medium to coarse, and consists mainly of plagioclase and amphibole, with accessory iron oxide. The plagioclase is fresh andesine or labradorite and forms anhedral and subhedral grains 0.1 to 2 mm long. In one section the fine grains 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 1 mm long, but aggregates of amphibole and its alteration products are up to 3 mm.

(5) Diorite or gabbro crops out sporadically over several square kilometres on either side of Tom Turners Fault about 20 km west-southwest of Hermit Hill. East of the fault a small body of gabbro crops out between Hermit Creek Metamorphics and granite of the Litchfield Complex; its relation to the Litchfield Complex is not known. The rock is medium to coarse, melanocratic, and virtually all the pyroxene has been converted to amphibole.

Gabbro also crops out west of the fault in a narrow strip about 8 km long. It is coarse-grained and consists of light brown amphibole (75 to 80 percent), and laths of feldspar which are almost completely sericitized. There are a few small outcrops of deeply weathered schist of the Hermit Creek Metamorphics along the western edge of the gabbro. Granite and granodiorite of the Litchfield Complex also crop out west of the gabbro, but contacts are not exposed; a fine-grained gabbro which crops out near one of the exposures of Hermit Creek Metamorphics may be a chilled margin. Both the gabbro and its fine-grained equivalent are cut by leucocratic aplite veins up to 1 m wide, probably offshoots from the granite of the Litchfield Complex.

(6) Medium-grained mesocratic dolerite forms a northerly-trending sill about 400 m wide and 3 km long on the western side of Murrenja Hill in the northern Cape Scott Sheet area. As it appears to intrude Adelaidean Fitzmaurice Group rocks forming the hill, the dolerite may be much younger than those already discussed. Alternatively, the dolerite may be faulted on its western margin, and overlain unconformably to the east.

Ti-Tree Granophyre (new name)

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

Distribution: One outcrop of 40 km^2 lies 24 km southwest of Fletchers Gully in the Fergusson River Sheet area, and several small outcrops exist near Hermit Creek, 35 km east of Tom Turners Crossing in the Port Keats Sheet area.

Type Area: The type area is in the northeast Port Keats Sheet area, where granophyre forms a number of sills in the Noltenius Formation at 14°13′E, 130°25′E.
Stratigraphic relations: In the type area the Ti-Tree Granophyre forms sills in the Noltenius Formation. At other exposures it forms a discordant intrusive body in the Chilling Sandstone and the Noltenius Formation.

Lithology: The granophyre in 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. The plagioclase is zoned and almost completely altered to sericite and epidote, and the quartz is granophyrically intergrown with the feldspar. Green-yellow pleochroic hornblende is considerably altered to chlorite. Small grains of iron oxide are common, and an outcrop of fresh rock having the composition of adamellite at grid ref. 418667 contains about 2 percent pyrrhotite.

In the Port Keats Sheet area, the granophyre is grey, mesocratic, and medium-grained, with phenocrysts of green plagioclase and black aggregates of biotite, both up to 0.5 cm long. It consists of quartz, microcline, plagioclase, chlorite, relict amphibole, calcite, and iron oxide. The microcline forms anhedral to euhedral grains up to 0.2 cm long and is mostly quite fresh. The poorly twinned subhedral to euhedral grains of sericitized plagioclase are up to 0.5 cm long, and quartz is in anhedral pods up to about 0.5 cm across. Graphic intergrowths of quartz and microcline 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 mineralogy or texture is apparent in thin sections from various points across one of the sills.

Granophyre also crops out between the Berinka Volcanics and gabbro 14 km west of Fletchers Gully mine. Walpole et al. (1968) tentatively included the granophyre in the Berinka Volcanics despite some evidence that it intrudes the gabbro. We have included it in the Ti-Tree Granophyre which may be a late-stage differentiate from the basic rocks.

Litchfield Complex

The Litchfield Complex is a body of acid and minor intermediate plutonic igneous rocks and associated migmatites cropping out along the eastern edge of the Cape Scott Sheet area and in the northeast Port Keats and northwest Fergusson River Sheet areas. Walpole et al. (1968) described in detail the area north of Litchfield homestead.

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

of the diversity in lithology, the name was later revised by Malone (1962) and Randal (1962) to Litchfield Complex.

Topographic expression: The granite crops out as rare isolated hills or tors with large rounded exfoliated boulders up to 12 m across. The hills have a maximum relief of 180 m. 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 ridges or low, irregularly rounded hills.

Contact relations: The aureole of metamorphism at the contact between the Litchfield Complex and the Hermit Creek Metamorphics is up to 1 km wide. Garnet is well developed in the granite and associated pegmatites invade parts of the metamorphic rocks. Tourmaline occurs in the pegmatite and schist 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 the gabbro is thought to be older than the granite. Near the contact, garnetiferous granodiorite is considered to be a product of hybridization of granite and gabbro. Basic and ultrabasic rocks in the Hermit Creek Metamorphics are intruded by the Litchfield Complex which is unconformably overlain by the Moyle River Formation and by Permian conglomerate and sandstone.

Lithology: Granite, which forms a large part of the exposed outcrop of the Litchfield Complex, ranges from leucocratic biotite granite to melanocratic garnetiferous granodiorite and tonalite.

In the Port Keats and Fergusson River Sheet areas the Litchfield Complex consists of leucocratic and mesocratic, coarse, generally even-grained granitic rocks; mafic xenoliths are ubiquitous. The rock becomes noticeably more leucocratic towards the southwest. A porphyritic granite exposed 16 km east of Tom Turners Crossing and 24 km east-northeast of the crossing contains euhedral or subhedral microcline microperthite phenocrysts generally about 1 cm long. Pink garnet (most crystals converted partly to biotite) appears to be restricted to the more basic granitic rocks which crop out in the Fergusson River Sheet area.

In the northwestern Fergusson River Sheet area and along the eastern margin of the Port Keats Sheet area, the rocks are granodiorite and tonalite with about 25 percent of biotite; farther southwest, adamellite with 10 to 20 percent of biotite is more common. This trend continues towards the west, and a leucocratic granite is exposed around Dawson Hill northwest of Tom Turners Crossing. Walpole et al. (1968) reported an increase in garnet content towards the Hermit Creek Metamorphics and the presence of sillimanite and cordierite near the contact; they suggested that these features indicated possible hybridization with the metamorphics.

The granite in the Hermit Hill area contains distinctive quartz-biotite bands striking 110° and dipping between 60°S and vertically. Quartz and biotite, and rarely feldspar, are concentrated in the bands. The quartz is commonly aggregated into clots, averaging 5 cm across, in zones within the granite. Small rounded biotite xenolith aggregates are common; in places the xenoliths are large and show various stages of assimilation by the granite. 'Ghost' fold structures from the original schist are preserved as biotite-quartz bands in the granite.

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

Hybridized granite cropping out 25 km west of Hermit Hill commonly contains amphibolitic and biotitic xenoliths, averaging 12 cm across, with 1-cm reaction rims. To the east, near Tom Turners Fault, garnetiferous granodiorite crops out near gabbro and Archaean schist.

At Woolbannah and Billawock Hills in the Cape Scott Sheet area, metamorphosed, slightly gneissic, mesocratic biotite granite and adamellite both include biotite-quartz xenoliths. Some of the smaller biotite-rich 'xenoliths' are probably garnet phenocrysts which have undergone retrograde metamorphism; the garnet growth was a late event of granite crystallization. Tourmaline-bearing quartz veins are common.

Pegmatites of quartz, feldspar, muscovite, and garnet are common throughout the Litchfield Complex, and the veins are 15 cm to 12 m wide. Feldspar crystals commonly reach 75 cm in length, mica crystals 18 cm, and tourmaline crystals 60 cm. Three sets may be distinguished: a gently-dipping (10°-15°NW) northeasterly set; a conjugate set dipping southeast; and a vertical set with variable strike. Pegmatites are concentrated along the margins of the granite and the Archaean schists.

Pegmatites on the southern slopes of the Dilke Range contain large and small 'rafts' of highly folded reconstituted Archaean schist. They grade into more normal quartz-feldspar pegmatite towards the granite, and into a coarse schist towards the Archaean rocks. In the recrystallized schist the original structure is still recognizable despite the introduction of quartz, feldspar, and biotite.

In the northeastern Dilke Range, a fine to medium granite intrudes a layered migmatite complex containing bands composed of euhedral feldspar crystals up to 15 cm long. Archaean schist appears to be thrust over the top of the migmatite, and the plane of discontinuity dips about 10°S. Intrusive granite forms lenticular bodies in the schist. In the south Nacoolya Hills area, migmatization has not been sufficiently intense to erase the original foliation preserved in xenoliths of altered biotite schist in the migmatite.

A leucocratic adamellite is extensively exposed west of Murrenja Hill in the Cape Scott Sheet area, forming tor-like outcrops 6 to 9 m high. It contains large euhedral phenocrysts of microcline in a matrix of zoned albite, quartz, biotite, and hornblende.

Xenoliths, ranging from granite to tonalite, are abundant throughout the Litchfield Complex. The most common type is mesocratic to melanocratic, fine to medium, and spotty owing to small flakes of biotite. They are up to 1 m in diameter and form up to about 10 percent of the rock. The formation of xenoliths by stoping 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. Rb/Sr whole-rock isochron determinations by Leggo gave an age of 1760 m.y. (Walpole et al., 1968). Compston & Arriens (1968) reassessed the age as a little over 1800 m.y., and K/Ar determinations on biotite and muscovite gave younger ages. The complex is generally considered to be early Carpentarian. C. P. Cameron (pers. comm.) has observed an unconformable contact between the Litchfield Complex and probable Noltenius Formation 33 km east of Tom Turners Crossing. This suggests that part of the Litchfield Complex is basement to the Pine Creek Geosyncline, and that it was only partly remobilized during the early Carpentarian.

Soldiers Creek Granite

Derivation of name: The Soldiers Creek Granite was named by Hossfeld (1937a) from Soldiers Creek, which flows through the northwestern Fergusson River Sheet area.

Distribution: The granite occupies an area 24 km long and up to 8 km wide between the Buldiva and Collia tin mines in the northwest Fergusson River Sheet area. A separate body of granite covering about 2.5 km^2 lies immediately north of the Buldiva mine, and another of similar size lies 13 km west-southwest of the mine. The granite forms pavements, ridges, and tors up to 30 m high, separated by an uneven, dissected gravel plain. On aerial photographs the granite areas have a typical dendritic drainage pattern.

Contact relations: The granite intrudes rocks of the Noltenius Formation, bodies (mostly roof pendants) of which are scattered throughout the main area of outcrop. Near its contacts with the granite, it has been metamorphosed to muscovite schist and andalusite-muscovite schist. The southern and eastern margins of the granite are defined largely by faults. The oldest known to overlie the granite unconformably is the Depot Creek Sandstone Member. Granite intrudes the Chilling Sandstone west-southwest of Buldiva.

No isotopic dates have been obtained from the granite but its contact relations are the same as the Allia Creek Granite which is dated at 1820 m.y. (Compston & Arriens, 1968).

Lithology: Most of the rock is coarse-grained, leucocratic, muscovite-biotite granite or adamellite, and much is porphyritic with phenocrysts of microcline up to 1.5 cm long. In places porphyritic and even-grained varieties intertongue. Coarse, even-grained granite, veins of which intrude Chilling Sandstone, is exposed 3 km west of Buldiva.

At several localities the granite is brecciated. In some breccias, rounded granite fragments up to 1 m across give the appearance of granite xenoliths in granite, but thin section examination confirmed that the matrix is intensely sheared and brecciated, and the inclusions are tectonically rounded. The groundmass consists of anhedral to subhedral grains of microcline, plagioclase (An_{28} to An_{34}) locally myrmekitically intergrown with the alkali feldspar, quartz, and biotite. The plagioclase is generally heavily altered to sericite and kaolin. The quartz shows severe strain 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 and each forms up to about 5 percent of the rock, though near the greisen zones the muscovite is more abundant and forms larger flakes. The biotite is partly replaced by chlorite and an opaque mineral (probably iron oxide); apatite and iron oxide are accessories. The cleavage traces of the micas are commonly distorted. The rock has apparently been heavily sheared in most places.

The granite is cut by numerous intersecting greisen veins which range from a few centimetres to 60 cm in width and are generally straight. They stand out as they are harder and less weathered than the remainder of the granite. Where several veins are close together in a swarm, they form prominent ridges up to 30 m high. The veins are formed of fine, white or light grey quartz and muscovite, and commonly contain larger muscovite flakes and, in places, quartz grains, and anhedral pink altered feldspar up to 0.5 cm long. There are a few veins of coarse white quartz up to 15 m wide. Quartz-feldspar-muscovite-tourmaline pegmatites with

grainsize up to 15 cm are common at the contacts with the Noltenius Formation and the Chilling Sandstone.

Small (1 to 3 mm) grains of black cassiterite occur in areas where the greisen veins are abundant, such as at the tin mines at Buldiva, Muldiva, and Collia, and tin has been reported at other positions in the granite. At Collia the tin is in greisen within the granite, but at Muldiva and Buldiva it is in greisen in the Noltenius Formation. Flaky specularite forms pods up to 30 mm long in the greisen veins and in the granite near them. Tourmaline is found in the greisen veins in the northern part of the granite. Flakes of muscovite up to 3 mm long are abundant in most veins; relict grains of biotite and somewhat altered alkali feldspar are less common. The plagioclase in the granite in the vicinity of the veins is pseudomorphed by sericite and kaolin, and contact zones between the greisen and granite are gradational. In the northeast corner of the exposed granite, the greisen veins contain prisms of green tourmaline up to 3 mm long.

The abundance of greisen and pegmatite, and the numerous roof pendants of Noltenius Formation show that the Soldiers Creek Granite is the top of an acid pluton.

Koolendong Granite (new name)

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

Type area: The type area is the granite outcrop at 14°58′S, 130°05′E, 16 km south of the Fitzmaurice River.

Stratigraphic relations: The Koolendong Granite intrudes the Lower Proterozoic Noltenius Formation. Xenoliths of sandstone are included in the granite, and the texture becomes noticeably finer-grained towards the contact. Its relation to the Auvergne Group, from which it is separated by the Victoria River Fault, is unknown. It is overlain unconformably by the Moyle River Formation of Adelaidean age.

Lithology: In the type area, granite and adamellite crop out in an area of about 10 km^2. 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 the rest of the plain. Weathered sheared granite is exposed to the west on hillslopes capped by the Moyle River Formation.

Most or all of the pavements are composed of a mesocratic biotite granodiorite, but individual boulders up to 1 m in diameter and piles of boulders up to 3 m across are composed of leucocratic adamellite. In some boulders the two types are interbanded, and several large boulders of granodiorite contain single sharply defined veins of adamellite up to 0.5 m thick, suggesting that the adamellite has intruded the granodiorite. The presence of euhedral epidote in both rocks suggests that they were derived from the same source.

The granodiorite is laced by a network of quartz and pegmatite veins a few millimetres to at least 0.5 m thick. They vary from straight to contorted forms, and from well defined to vaguely defined and discontinuous varieties. Some quartz and

pegmatite segregations up to 0.5 m long contain muscovite-rich centres. The pegmatites consist of quartz, plagioclase, biotite, and muscovite. Some are even-grained, but others contain euhedral feldspar phenocrysts up to 2 mm long and muscovite books of similar size.

Granite crops out in hill-slopes bordering the western side of the Koolendong Valley 8 km south of the Fitzmaurice River. As in all other outcrops, the granite immediately below the Moyle River Formation is extremely altered, but fresh granite occurs farther below the contact. The granite is leucocratic and of coarse even-grained texture, its composition approaching adamellite; biotite accounts for about 2 percent of the rock.

The northernmost outcrops border the western side of the Meeway Plain, where the granite is well exposed but deeply weathered. Farther west it is 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 0.5 mm, 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.

The texture is hypidiomorphic-granular with grains up to 5 mm long, and some signs of shearing are generally evident. The plagioclase ranges from oligoclase to andesine and is partly altered to sericite and epidote. The alkali feldspar is microcline microperthite and has formed myrmekitic intergrowths 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. Some of the epidote not included in grains of plagioclase contains a well defined but altered hexagonal centre, possibly composed of zoisite. The outer epidote zone is rarely the same shape as the centre, and small biotite flakes are commonly included between the two zones.

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

The adamellite is medium-grained and equigranular. Unlike the granodiorite, it contains no sphene or hornblende; most of, if not all, the epidote lacks centres of secondary zoisite (?); the biotite is a minor constituent.

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

The rocks in the Meeway Plain locality range from granite to adamellite. Modal analyses for two thin sections are:

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 intensely sericitized, and the biotite is altered to chlorite. The groundmass consists

mainly of quartz and microcline microperthite, which commonly are graphically intergrown. The absence of migmatites or wide contact aureoles suggests that this is a high-level granite.

Cullen Granite

The Cullen Granite, described by Walpole et al. (1968), forms a large batholith in the centre of the Pine Creek Geosyncline. About 500 km^2 are exposed in the northeast Fergusson River Sheet area, where it intrudes rocks of the Burrell Creek Formation and is intruded by the Edith River Volcanics. The two main rock types are a medium even-grained leucocratic biotite granite, and a coarse porphyritic biotite-hornblende granite or adamellite. The phenocrysts are of pink potash feldspar up to 5 cm 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, one from near the Edith River and the other from near Pine Creek, were dated (Hurley et al., 1961) at 1695 m.y. using the K/Ar method; a check determination by the Rb/Sr method on the Edith River sample gave an age of 1765 $\pm$ 90 m.y. Later work by the Rb/Sr method on total rock indicated 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 et al.

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 the only one in the area covered by this Report crops out 3 km northwest of Fletchers Gully in the Fergusson River Sheet area and covers about 50 km^2. The granite forms massive exfoliated pavements; boulders and minor ridges up to 5 m high are scattered throughout the soil plain. It also crops out in a scarp capped by the Depot Creek Sandstone Member.

Contact relations: The granite intrudes schist of the Noltenius Formation. At the contact, 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 a little iron oxide and tourmaline. Garnet-mica schist, cordierite schist, and mica schist have also been found in the contact zone. The granite is unconformably overlain by the Depot Creek Sandstone Member.

Lithology: The granite consists of medium to coarse, grey, porphyritic biotite-muscovite adamellite, granodiorite, and tonalite, with a pronounced platy 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, and the biotite and muscovite are intergrown. In the granodiorite and tonalite, the plagioclase is andesine-labradorite, biotite is more abundant, and 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 up to 50 cm long (Fig. 9). The foliation is parallel to the margins of the granite and dips steeply towards the centre.

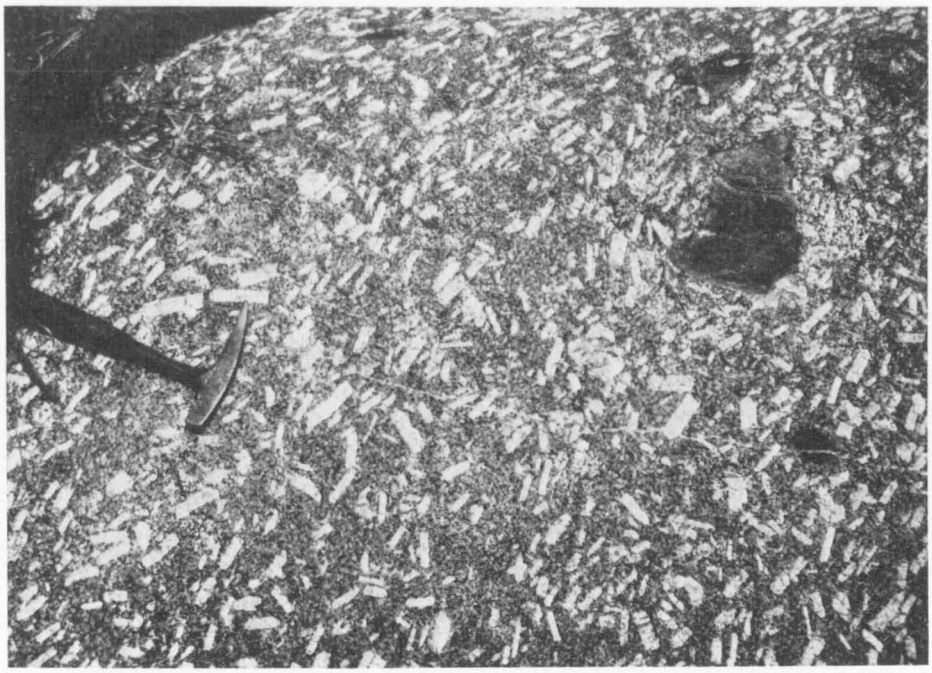


Fig. 9. Allia Creek Granite containing xenoliths and large microcline phenocrysts. Near centre of granite body—northwest corner of Fergusson River Sheet area.

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

Edith River Volcanics

The Edith River Volcanics crop out in several places in the northeast Fergusson River Sheet area, where the outcrops cover about 40 km^2. The formation was described by Walpole et al. (1968):

'Dykes and sills of Edith River Volcanics occur in the Fergusson River area, where the Edith River Volcanics 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 m); 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 & Clark, 1955).'

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

FITZMAURICE GROUP (Table 4)

The Fitzmaurice Group is a thick sequence of interbedded sandstone, siltstone, shale, and minor pebble conglomerate cropping out in a belt 8 to 40 km wide and extending from the southwest Auvergne Sheet area northeastwards to the southwest Cape Scott Sheet area.

The group consists of four formations: Moyle River Formation (base), Goobaieri Formation, Lalngang Sandstone, and Legune Formation. Initially the Legune Formation was not included in the group (Pontifex et al., 1968), but its similarity to the other units was later recognized (Morgan et al., 1970; Sweet et al., in press, b).

Stratigraphic relations: The basal unit of the Fitzmaurice Group, the Moyle River Formation, unconformably overlies Carpentarian and Lower Proterozoic rocks in several localities in the Port Keats Sheet area (Fig. 7). A deeply weathered erosion surface of Koolendong Granite is overlain unconformably by Moyle River Formation west of the Meeway Plain. Contacts between units of the group are conformable except in Macadam Range, where the Lalngang Sandstone may be unconformable on the Moyle River Formation.

Tectonic setting: Outcrop of the Fitzmaurice Group, confined to the linear belt described above, is bounded on the southeastern side by a major fault, and on the northwest by Palaeozoic rocks of the Bonaparte Gulf Basin. The belt has been called the Fitzmaurice Mobile Zone (Pontifex et al., 1968), and is a continuation of the Halls Creek Mobile Zone in the East Kimberley region of Western Australia (Dow & Gemuts, 1969).

Lithology and thickness: The mobile zone in the Port Keats Sheet area appears to be a synclinorium of faulted Fitzmaurice Group. The rocks on the eastern limb are readily identified as Fitzmaurice Group, and are about 3000 m thick. The sequence in the west limb appears to be over 12 000 m thick and contains a great thickness of sandstone and two major siltstone members which do not occur in the east. The sequence has, however, been tentatively divided into the four formations recognized elsewhere. Because of their similarity to the sequence farther south, the sandstone north of Tom Turners Crossing in the Port Keats and Cape Scott Sheet areas are also mapped as Fitzmaurice Group.

Moyle River Formation

Derivation of name: The formation was named after the Moyle River in the Port Keats Sheet area (Pontifex et al., 1968; Sweet et al., in press, a).

Distribution: The Moyle River Formation crops out in the ranges west of the Koolendong Valley and Meeway Plain in the Port Keats Sheet area. The Macadam Range and the area to the north are composed almost wholly of Moyle River Formation. Outcrops of sandstone extending north-northeast from Tom Turners Crossing in the Port Keats Sheet area as far as the Docherty Hills in the southern Cape Scott Sheet area have been assigned to the Moyle River Formation, as have the sandstone and conglomerate forming Murrenja Hill in the northern Cape Scott Sheet area.

Stratigraphic relations: The formation lies unconformably on Lower Proterozoic and Carpentarian igneous and sedimentary rocks in most eastern and northern

TABLE 4. STRATIGRAPHY OF THE FITZMAURICE GROUP

Rock Unit	*Map Symbol*	*Thickness (m)*	*Lithology*	*Physiographic Expression*	*Distribution**	*Stratigraphic Relations*
Legune Formation	Pfe	2100	Interbedded grey, white, green, or brown fissile laminated siltstone; white, grey, or green poorly sorted sandstone	Gently undulating plains, finely dissected slopes, rounded hills	*Port Keats*	Conformable on Lalngang Sandstone
Lalngang Sandstone	Pfl	1800	Interbedded fine, medium, and coarse grey feldspathic sandstone, grit, minor pebble beds and siltstone. One 120-m bed of grey-green siltstone S *Port Keats*	Rugged steep ridges up to 150 m high. Lower and less rugged hills W of Madjellindi Valley	S and central *Port Keats*	Conformable with Legune Formation; may be unconformable on Moyle River and Goobaieri Formations in Macadam Range, but elsewhere conformable on Goobaieri Formation.
Goobaieri Formation	Pfg	600	Interbedded grey and green siltstone and fine sandstone. Interbeds of medium and coarse white sandstone in upper part	Valleys with gently undulating floors. Coarser sandstone beds form ridges and cliffs in scarp sides	Central *Port Keats*	Conformable on Moyle River Formation.
Moyle River Formation	Pfm	1050 in SE *Port Keats*. ?10 000 in NW	White, fine or medium sandstone; few thin interbeds of siltstone and coarse sandstone. Several beds up to 450 m NW of Madjellindi Valley	Rugged steep-sided ridges. Truncated by Mesozoic peneplain surface in Macadam Range	Central and N *Port Keats*	Unconformable on Carpentarian and Lower Proterozoic rocks. Overlain conformably by Goobaieri Formation and possibly unconformably by Lalngang Sandstone.

* Sheet areas in Italics.

outcrops in the Port Keats Sheet area. In some places near the Victoria River Fault, particularly in the Koolendong Valley, movement along the unconformity has resulted in shearing and brecciation of the base of the Moyle River Formation as well as the underlying rocks. The formation is conformably overlain by the Goobaieri Formation, and probably unconformably by Lalngang Sandstone.

Lithology and thickness: In the east the formation is 450 to 1000 m thick and consists of a monotonous succession of fine and medium sandstone with a few interbeds of siltstone and coarse sandstone and grit; thin pebble beds occur at its base. In the west, however, it contains several thick siltstone units, and a thickness of 10 000 m was estimated from aerial photographs and measured dips. The many faults and false dips owing to foreset bedding may lead to an erroneously high estimate. An estimate of about 10 000 m was also obtained for the sandstone sequence in the ranges north of Tom Turners Crossing. Generalized stratigraphic sections are shown in the Appendix, Sections 1 and 2.

In the eastern part of the Fitzmaurice Mobile Zone, the formation consists almost entirely of white, grey, purple-grey, and pink sandstone which is blocky or massive with a few flaggy interbeds, thin to thick-bedded, and fine to medium-grained with a few coarser beds; sorting is moderate or poor. A matrix of slightly friable soft white clay accounts for up to 5 percent of the sandstone composition. A few thin interbeds consist of grey and purple micaceous siltstone and coarse sandstone. Cross-bedding is common and consists of planar units 2 to about 25 cm thick; ripple marks are also present. The orientation of cross-bedding suggests that the sediment was supplied from the northwest.

In places a conglomerate at the base of the formation contains subrounded quartzite and shale pebbles in beds up to 30 cm thick. In the northern Koolendong Valley isolated patches of sedimentary breccia immediately overlie the granite.

From 10 to 27 km east of Tom Turners Crossing, granites of the Litchfield Complex are overlain by sandstone believed to be part of 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. The basal beds comprise conglomerate about 2 m thick, overlain by an equally thick band of coarse sandstone. The conglomerate consists of rounded and angular cobbles of quartzite in a poorly sorted sandstone matrix. The coarse sandstone is similar to the conglomerate, but the maximum size of the pebbles is only about 0.5 cm.

About 8 km east of Tom Turners Crossing, the basal Moyle River Formation is a massive conglomerate containing quartz clasts set in a ferruginous sandy matrix. It is at least 10 m thick and is derived directly from the Henschke Breccia, which it overlies with pronounced angular unconformity (Fig. 7).

Close to the Fitzmaurice River the sandstone is at least 400 m thick, but some may have been removed by strike faulting. In the gorge 30 km north-northwest of the mouth of the Little Fitzmaurice River it is 1000 m thick, and 34 km north-northwest of the mouth it is at least 700 m thick.

Goobaieri Formation

The Goobaieri Formation was first recognized in the Auvergne Sheet area (Pontifex et al., 1968), where it consists of a thick sequence predominantly of siltstone and fine sandstone. Its outcrops continue north into the Port Keats Sheet

area as far as the Fitzmaurice River. Farther north, along the eastern side of the Madjellindi Valley, a thick sequence predominantly of siltstone has been mapped as Goobaieri Formation. On the western side of the Madjellindi Valley, the Fitzmaurice Group is considerably thicker and different from that on the eastern side in that it contains thick siltstone units, one of which consists predominantly of dark grey siltstone typical of the Goobaieri Formation in the type area and is therefore tentatively mapped as such.

Stratigraphic relations: As in the Auvergne Sheet area, the Goobaieri Formation overlies the Moyle River Formation and is overlain by the Lalngang Sandstone. Both contacts appear conformable in most outcrops, but the Lalngang Sandstone may overlie Goobaieri Formation unconformably west of Madjellindi Valley.

Lithology and thickness: The formation consists of interbedded siltstone and fine sandstone with several bands of medium and coarse sandstone in the upper part. The siltstone and fine sandstone are grey and crop out poorly, whereas the coarser sandstone is white and forms prominent ridges with good outcrop.

South of the Fitzmaurice River, most of the lower part of the formation consists of siltstone with thin interbeds (3 to 5 cm thick) 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 alternating bands of poorly outcropping siltstone and fine sandstone with prominently outcropping coarse sandstone. The siltstone is white or light greenish 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 coarse sandstone generally contains some clay matrix, and is coarser toward the top of the formation. A section of the top 170 m of the formation measured 13 km northwest of Koolendong yard is presented in the Appendix, Section 3. At least two prominent sandstone bands below this section do not crop out at the point where the section was measured. About 18 km west of Koolendong yard, the upper part of the formation (from the lowest prominent sandstone band) was estimated to be about 420 m thick, and the lower part 120 m thick; estimates were made from aerial photographs and measured dips.

North of the Fitzmaurice River, on the eastern side of the Madjellindi Valley, the formation is similar to that south of the Fitzmaurice River. However, the siltstone and fine sandstone are green rather than grey, and the bands of coarser sandstone are less abundant and not so prominent. The formation is estimated to be at least 700 m thick, and appears to have been affected by reverse faulting.

On the western side of the Madjellindi Valley, outcrops mapped as Goobaieri Formation are separated by the Chalanyi Creek Fault. West of the fault is a sequence of 630 m (estimated) of grey siltstone and interbedded sandstone (Appendix, Section 4). The top of the Moyle River Formation does not crop out where the section was measured, but the photo-pattern suggests that it consists of interbedded sandstone and siltstone.

East of the Chalanyi Creek Fault, the Goobaieri Formation crops out in a north-northeasterly belt about 27 km long. In the southern part it consists of an estimated 480 m of interbedded grey siltstone and fine sandstone beds with interference ripple marks. The sandstone is poorly sorted and contains randomly distributed coarse sand grains. In the north, near the Moyle River, the sequence is only about 240 m thick and consists of dark grey-green fissile and laminated siltstone with a prominent band of coarse sandstone in the centre; the sandstone contains subrounded quartz grains in a dark green argillaceous matrix.

Distinguishing features: The formation invariably underlies well defined valleys. Outcrop of the siltstone and fine sandstone is scarce and generally restricted to scarps below exposures of sandstone bands which form prominent ridges in the valleys. 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 central Port Keats Sheet area.

Derivation of name: The formation was named from Lalngang Creek in the Auvergne Sheet area (Pontifex et al., 1968; Sweet et al., in press, b).

Stratigraphic relations: In most places where it crops out, the Lalngang Sandstone lies conformably between the Legune Formation and the Goobaieri Formation; both contacts are gradational. In the southern part of the Macadam Range, however, the Goobaieri Formation is apparently absent and the Lalngang Sandstone lies directly on the Moyle River Formation.

Lithology and thickness: In the Fitzmaurice River valley 40 km southeast of Table Hill, the formation consists of an estimated 500 m of interbedded fine, medium, and coarse sandstone with minor pebble beds (up to 25 cm thick) and siltstone beds. Cross-beds and ripple marks are common. In the syncline a few kilometres east of this exposure, the lithology of the formation is similar but it contains bands up to 3 m thick of thin-bedded and laminated sandstone and siltstone which constitute about 5 percent of the formation.

The formation grades into the underlying Goobaieri Formation through a sequence of interbedded siltstone and sandstone. The sandstone is white, blocky, thin-bedded, medium-grained, and is interbedded with white siliceous siltstone and fine sandstone. The boundary between the two formations is taken as the top of the uppermost thick siltstone band, identifiable on aerial photographs. The top of the Lalngang Sandstone consists of interbedded white medium sandstone and coarse sandstone which grade up into the Legune Formation, the boundary being arbitrarily drawn from aerial photograph interpretation.

About 12 km south of the Fitzmaurice River, a 120-m siltstone band 450 m above the base of the formation is soft and is easily recognized in the field and on aerial photographs. It is grey, green, or red-brown, fissile or flaggy, laminated, slightly micaceous, and is interbedded with fine-grained flaggy sandstone and white or brown, coarse, poorly sorted sandstone with a soft silty matrix.

In the north-northeasterly band between the Madjellindi Valley and Meeway Plain, a section 1200 m thick comprises two sandstone members separated by 200 m of siltstone (Appendix, Section 5). The siltstone appears to grade southward into sandstone 13 km north of the Fitzmaurice River, but it may be cut off by a fault.

West of the Madjellindi Valley, rocks of the Fitzmaurice Group are unlike the group elsewhere. Rocks mapped as Lalngang Sandstone comprise a sequence of interbedded sandstone and siltstone between the extrapolated upper part of the Moyle River Formation and the inferred lower boundary of the Legune Formation. An estimated thickness of the Lalngang Sandstone is 1800 m. Its upper part consists

of interbedded fine flaggy sandstone and fissile siltstone, both of which are grey-brown, laminated, and micaceous; the lower beds range from flaggy to blocky, thin to medium-bedded, and fine to coarse, poorly sorted sandstones.

Distinguishing features: The terraced hillslopes produced by the bedding give a characteristic photo-pattern. The coarse gritty beds are characteristic and help to distinguish the Lalngang Sandstone from the Moyle River Formation.

Legune Formation

Distribution: The Legune Formation crops out in a belt extending from the south-west Auvergne Sheet area to the northern end of the Madjellindi Valley in the Port Keats Sheet area. It occupies the core of a large syncline in the Port Keats Sheet area.

Derivation of name: The formation was named from Legune station in the Auvergne Sheet area (Pontifex et al., 1968; Sweet et al., in press, b).

Stratigraphic relations: The Legune Formation is the youngest Precambrian unit cropping out in the Fitzmaurice Mobile Zone. South of, and immediately north of, the Fitzmaurice River, the Legune Formation is faulted against older rocks of the Fitzmaurice Group. On the eastern 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. On the western side of the Madjellindi Valley, on the other hand, a thick sequence of interbedded siltstone and sandstone interposes between the two. The boundary has been taken as the point at which the siltstone and shale become subordinate to siltstone and sandstone.

Lithology and thickness: In the Auvergne Sheet area and southern Port Keats Sheet area, the Legune Formation consists of a monotonous succession of interbedded sandstone and siltstone, but farther south, in the Madjellindi Valley, it consists of interbedded siltstone and shale.

Outcrops in the Fitzmaurice River valley are highly lenticular interbeds of fine, medium, and coarse sandstone in siltstone. The siltstone is grey, white, green, or reddish brown; it is fissile, thin-bedded or laminated, and indurated. 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 matrix, which constitutes as much as 80 percent of some beds. Iron oxide and tourmaline are accessory minerals.

Two types of sandstone are usually present: one is fine or medium, and the other coarse or pebbly, with most grains 3 mm across and a few up to 10 mm. Both are grey, white, or light green, flaggy, blocky or massive, thin to thick-bedded, generally poorly sorted, and commonly contain up to 10 percent of white or light green grains of clay which may be derived from weathered feldspar grains. The coarser sandstone is distinctly bimodal, having moderately well sorted grains of quartz and quartzite set in a matrix of clay, limonite, and angular silt grains. The larger grains are rounded or subrounded and 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.

On the east side of the Madjellindi Valley, 24 km north of the Fitzmaurice River, the formation consists of interbedded hard white siliceous siltstone and shale. White fine-grained sandstone interbeds are common near the contact with the

Lalngang Sandstone. The siltstone is white or light grey, flaggy or fissile, and thin-bedded or laminated, composed predominantly of coarse quartz silt with sericite and limonite matrix. The shale contains widely scattered angular quartz grains surrounded by a matrix of limonite and clay forming up to 50 percent of the rock.

In the extreme north and northwest of the Madjellindi Valley, the Legune Formation consists predominantly of greyish-brown or purple-brown fissile siltstone, which grades into the underlying Lalngang Formation through a series of shale, siltstone, and fine sandstone interbeds. The siltstone is pale blue, green, or grey, hard, laminated, and flaggy. The shale is white and soft and has indefinite fissile partings. Interbeds range from about 2.5 cm to 15 cm thick. Fine flaggy sandstone is more abundant towards the base of the formation.

Thickness: Only a minimum thickness can be estimated because the formation is the youngest Precambrian unit in the mobile belt and occupies the core of a syncline. Minimum thicknesses, estimated from aerial photographs and measured dips, are: at the head of the Madjellindi Valley 675 m; in the Fitzmaurice valley, 2100 m.

Distinguishing features: Because it contains more fine-grained rocks, the Legune Formation is eroded into more rounded hills, with more closely spaced drainage than the underlying sandstones. These characteristics allow the unit to be identified on aerial photographs.

Discussion of the Fitzmaurice Group

The sediments of the Fitzmaurice Group were deposited in a trough or unstable shelf bordering a stable block. The trough subsided fairly rapidly, but except for limited periods supply of sediment kept pace with deposition.

Sedimentation appears to have taken place in two major cycles. The first cycle began with deposition of sand on a surface of Lower Proterozoic and Carpentarian basement rocks. This was followed by reduced sediment supply and consequent deposition of finer-grained sediments (Goobaieri Formation).

The second cycle, resulting in deposition of the Lalngang Sandstone and Legune Formation, may have followed the first cycle without a break in the east, where the Lalngang Sandstone appears to conformably overlie Goobaieri Formation. Uplift and erosion probably occurred in the west, where Lalngang Sandstone appears to overlie Moyle River Formation.

Dow & Gemuts (1969) correlated the Helicopter Siltstone with part of the Carr Boyd Group in the East Kimberley; Sweet et al. (in press, b) correlated these units with the Angalarri Siltstone (Auvergne Group) and Fitzmaurice Group, respectively. The source of sediment therefore seems likely to have been in the northwest, because the Auvergne Group was probably laid down at the same time as the Fitzmaurice Group.

Insufficient work has been done to enable us to reach definite conclusions about the environments of deposition of the Fitzmaurice Group.

TOLMER GROUP (Table 5)

The Tolmer Group, a sequence of shallow-water sandstone, siltstone, and dolomite which crops out in the northern Fergusson River Sheet area, is up to 1000 m thick, and overlies Lower Proterozoic sediments and early Carpentarian granites with marked unconformity. It is overlain unconformably by Palaeozoic

TABLE 5. STRATIGRAPHY OF THE TOLMER GROUP

Rock Unit	*Map Symbol*	*Thickness (m)*	*Lithology*	*Physiographic Expression*	*Distribution*	*Stratigraphic Relations*
Waterbag Creek Formation	Ptg	150-300+	Thin to medium-bedded, chocolate and red-brown friable sandstone and siltstone. Dolomitic sandstone and dolomite, rare in lower part becoming abundant in upper part. Halite casts	Low rounded hills and areas of low relief. Soft beds commonly covered by Cainozoic units	Zone about 10 km wide N from about 22 km NW of Dorisvale homestead	Conformable on Hinde Dolomite. Unconformably overlain by Antrim Plateau Volcanics
Hinde Dolomite	Pth	120	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	Belt up to 5 km wide N from 16 km E of Collia Waterhole	Conformable between Waterbag Formation and Stray Creek Sandstone Member
Buldiva Sandstone						
Stray Creek Sandstone Member	Pty	180	Green and purple, flaggy and fissile, thin-bedded coarse siltstone and fine-grained sandstone, commonly glauconitic and micaceous; coarser sandstone near base. Current lineations and skip casts	Softer beds: gentle slopes and low rises. Harder beds: cuestas	Belt 5-13 km wide N from 10 km NW of Collia Waterhole	Conformable between Hinde Dolomite and Depot Creek Sandstone Member
Depot Creek Sandstone Member	Pto	300-600	White and red-brown, flaggy to massive, thin and medium-bedded poorly sorted quartz sandstone. Pebble beds. Indurated	Cliffs, plateaux, and cuestas	NNW zone N of Collia Fault in *Fergusson River*. Small outcrop in NE	Conformably overlain by Stray Creek Sandstone Member. Unconformable on granite and Noltenius Formation

* Sheet areas in Italics.

rocks in the Daly Basin and is considered to be Adelaidean. It is moderately faulted and only gently folded.

Mapping in 1968 indicated that the Tolmer Group, as mapped previously in the Pine Creek Sheet area (Malone, 1962), does not extend nearly as far south or west as was envisaged by Randal (1962) and Walpole et al. (1968). The most important changes in distribution are as follows (and are shown on the Fergusson River Sheet—Pontifex & Mendum, 1972):

(1) The Wingate Plateau is not capped by Buldiva Sandstone and the rocks mapped as such have been assigned to four different units: (a) the western part of the Wingate Plateau is underlain by Fitzmaurice Group; (b) the central and northeastern portions of the plateau are largely Chilling Sandstone; (c) much of the eastern portion consists of Auvergne Group, particularly Saddle Creek Formation; (d) a large proportion of the Wingate Plateau has a thin veneer of Mullaman Beds.

(2) The area west and south of Dorisvale is no longer regarded as Waterbag Creek Formation; it is now mapped as: (a) Jinduckin Formation in the area between Dorisvale and Kathleen Falls; (b) Bynoe Formation and Banyan Formation between Dorisvale and Wombungi outstation.

The age relation between the Tolmer Group and the lithologically similar Bullita and Auvergne Groups is discussed at the end of the section describing the Waterbag Creek Formation; relations described by Walpole et al. (1968) have been amended.

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 main outcrop of the Depot Creek Sandstone Member in the Fergusson River Sheet area is in a northwesterly belt north of Collia Waterhole. There is also a small outcrop about 10 km east of Jindare homestead in the northeastern corner of the Sheet area. The unit extends south from the Pine Creek Sheet area, where it was originally recognized and defined by Malone (1962).

Stratigraphic relations: 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 and Saddle Creek Formation, and separated from the Bullita Group farther south by a veneer of Cretaceous Mullaman Beds. The upper contact, with the Stray Creek Sandstone Member, is conformable.

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

At its southerly limit, 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 in which the pebbles are up to 2 cm across. The rock contains about 1 percent 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 and consists of white and red, blocky and massive, medium-bedded, friable, medium-grained sandstone; the grains are of subrounded well sorted quartz stained by iron oxide.

The member is well exposed in the Fish River Gorge, where it consists of white, pink and brown, blocky, indurated medium-grained sandstone, though the induration may be only a near-surface effect (Walpole et al., 1968). About 5 km west of the gorge, ripple marks near the pebbly base of the unit have a wavelength of 4 cm and an amplitude of 1 cm.

About 13 km north of Fletchers Gully, the sandstone is white, massive, thin-bedded, medium-grained, and moderately to well sorted, with poorly sorted pebbly beds.

Lithology is comparatively uniform over a large area. Prominent vertical jointing is characteristic, and the sandstone is extensively silicified along fault zones, in which the fault fillings include a little specular hematite.

Palaeogeographic significance: The Depot Creek Sandstone Member marks the beginning of a widespread marine transgression.

Stray Creek Sandstone Member

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

Reference area: Although the type area is on the eastern side of the Daly River Basin, good exposures occur on its western side, east of Collia Waterhole. A complete section is exposed about 10 km northeast of the waterhole.

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

Lithology and thickness: The member is probably about 180 m thick, and consists of fine-grained silty quartz sandstone, commonly glauconitic, with minor flaggy medium-grained sandstone interbeds in the lower part, and siltstone beds in the upper part.

A section of the lower half of the member measured northeast of Collia Waterhole is 96 m thick. Nearly all the section measured consisted of fissile, micaceous, chloritic, grey-green, coarse-grained siltstone or fine-grained sandstone. At least three flaggy, white to pink, medium-grained quartz sandstone beds in the lower part of the sequence are lithologically identical with the Depot Creek Sandstone Member.

The typical fine-grained sandstone, which is thin-bedded to laminated, is glauconitic or chloritic, and in places is bright green where fresh; the weathered rock is usually purple. The surfaces of beds contain prominent current lineations and some skip or prod casts; these features are widespread, and are useful in identifying the member in patchily exposed areas.

Near the top of the lower half of the member are several flaggy hematitic carbonate beds between 15 cm and 1.5 m thick. The most prominent bed is 60 to 150 cm thick and quite massive. It is reddish purple owing to the high hematite

content, 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 hematite and glauconite are scattered.

The upper half of the Stray Creek Sandstone Member consists of rarely exposed fissile fine-textured sandstone or siltstone.

Palaeogeographic significance: The fine grain and occurrence of glauconite show that the Stray Creek Sandstone Member was deposited in a marine environment, probably in deeper, quieter water than the Depot Creek Sandstone Member. Tidal currents probably caused the lenticular bedding and current lineation. The occurrence of skip and prod moulds supports the recording by Walpole et al. (1968) of jellyfish remains in the member. The origin of the carbonate-hematite-glauconite beds is unknown.

Hinde Dolomite

The Hinde Dolomite crops out prominently between 11 and 13 km northeast of Collia Waterhole. It probably underlies the superficial cover farther north, west of the Fish River, and it has been observed in the limbs of an anticline about 35 km north of Collia Waterhole. The Hinde Dolomite was mapped by Randal (1962) and Malone (1962) and is described by Walpole et al. (1968, p. 94).

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., op. cit.), but a complete section was measured 13 km northeast of Collia Waterhole on the western side of the basin (Appendix, Section 7).

Stratigraphic relations: The Hinde Dolomite appears to be conformable with the underlying and overlying formations. There is an abrupt change from clastic to carbonate rock at its base, which is therefore easy to define. Its upper limit is marked by a chert bed, which is overlain by brown siltstone and fine-grained sandstone of the Waterbag Creek Formation.

Lithology and thickness: Near the northern margin of the Fergusson River Sheet area, a section of 64 m was measured through the Hinde Dolomite (Appendix, Section 6). Although chert caps the hill in which the section was measured, the upper contact is not exposed. Stromatolitic dolomite is common in the basal 37 m of the section.

The reference section 13 km northeast of Collia Waterhole contains about 120 m of dolomite and siltstone, overlain by chert. The chert at the top of the formation appears to be in the sequence, between the Hinde Dolomite and the Waterbag Creek Formation. It may, however, be a stratum of silicification which formed during a period of lateritization. It is massive pink to brown chert with patches of more coarsely crystalline quartz. It is brecciated and recemented in some areas.

Palaeogeographic significance: The presence of stromatolites is generally taken to indicate a very shallow water environment (Logan, Rezak, & Ginsburg, 1964). This and the occurrence of dolomite show that the basin of deposition shallowed considerably after deposition of the Stray Creek Sandstone Member.

Waterbag Creek Formation

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

Of the area originally mapped by Randal (1962) as Waterbag Creek Formation, the area east of the Dorisvale Fault near Dorisvale homestead is now considered to be underlain by Jinduckin Formation. The rocks to the west of the fault are now mapped as Bynoe Formation.

Derivation of name: Randal derived the name from Waterbag Creek, a tributary of the Flora River. The area through which the creek runs is now considered to be occupied by Bynoe Formation.

Type area: Although not in the literature, good outcrops northeast of Collia Waterhole are regarded as the type area for the formation (M. A. Randal, pers. comm.).
Stratigraphic relations: The Waterbag Creek Formation overlies the Hinde Dolomite, probably conformably, and is overlain unconformably by basalt and sandstone of the Antrim Plateau Volcanics.

Lithology and thickness: The total preserved thickness is probably more than 300 m, though the low northeast dip makes it difficult to measure because of the width of outcrop. The lower part of the formation is more than 150 m thick. The formation contains a variety of rock types: thin to medium beds of siltstone, sandstone, dolomitic sandstone, and dolomite.

The best exposure of the basal 60 m is 13 km northeast of Collia Waterhole. At the base of the hill are grey-green sericitic siltstone and fine to medium quartz sandstone. The surface of the sandstone is marked by numerous pits 2 to 3 mm across, caused by the leaching out of patches of coarse-grained carbonate. The sandstone weathers light red-brown, and generally contains specks of limonite and mud flakes. Most of the hill is made up of chocolate and red-brown, fissile dolomitic siltstone interbedded with sandstone similar to that lower in the sequence. Mud flakes are common. Flaggy white dolomitic quartz siltstone and grey fine-grained dolomite with halite casts are interbedded with siltstone in places.

Farther northeast, flaggy and blocky dolomite predominates in the upper part of the formation and is grey, fine-grained, and cherty. The chert lenses, which stand out from the weathered surface of the dolomite, are generally sub-parallel to the bedding, but their boundaries are irregular, and cut across laminations; they may have arisen by replacement. Dolomite exposed near a track 20 km northeast of Collia Waterhole is interbedded with red-brown dolomitic siltstone. Most of the Waterbag Creek Formation occurs in low hills with limited outcrop of siltstone, but covered with fine-grained sandstone rubble. 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.

Palaeogeographic significance: Sedimentary structures indicate that at least some of the Waterbag Creek Formation was deposited in shallow water with periods of subaerial exposure. Little is known of lateral changes in the environment of deposition.

Randal (1962) and Walpole et al. (1968) considered that the Tolmer Group was younger than the Victoria River Group, based on stratigraphic relations inter-

preted by Randal (op. cit.). The relations observed, however, were between units now placed within the Auvergne Group. The only contacts between Tolmer Group and Auvergne Group are faulted.

It is most unlikely that the Tolmer Group is younger than the Auvergne Group because movement on the Collia Fault has brought Depot Creek Sandstone up to the same level as the Angalarri Siltstone. It is also unlikely that they are contemporary; the lower formations—the Buldiva Sandstone and the Jasper Gorge and Angalarri formations—have a certain lithological similarity, but the upper parts of the two groups are quite different.

A more probable correlation is Tolmer Group with Bullita Group. The Bynoe and Waterbag Creek Formations are virtually identical—Randal was correct at the time in assigning the rocks southwest of Dorisvale homestead to the Waterbag Creek Formation: they are now included in the Bynoe Formation because they are identical with the Bullita Group farther south. The Skull Creek Formation and Hinde Dolomite also have marked similarities, and further study of the stromatolites in both units could lead to a positive correlation.

Cloud & Semikhatov (1969) described stromatolites from the Hinde Dolomite as *Inzeria tjomusi Krylov,* and infer an age of less than 950 m.y. This conflicts with our conclusions, and points to the need for further studies.

The Buldiva Sandstone bears no similarity to the Timber Creek Formation, and is perhaps equivalent to part or all of the Wattie Group. This must remain a matter for speculation as the most northerly outcropping Wattie Group is at the southern margin of the Auvergne Sheet area.

BULLITA GROUP (Table 6)

The Bullita Group comprises a sequence of dolomite, dolomitic siltstone, and minor sandstone and chert. Although the base of the group is not exposed in the area, a thickness of about 540 m has been measured in the southwestern Delamere Sheet area, and it may be even thicker in the north. Rocks of the group crop out west of Dorisvale homestead in the Fergusson River Sheet area and in the southwest Delamere Sheet area, as well as south of the area under discussion.

The age of the Bullita Group is now regarded as lower Adelaidean. This is tentative because it lies unconformably below the Wondoan Hill Formation which contains glauconites dated by the Rb/Sr method as 1120 m.y. (R. Page, pers. comm.).

Timber Creek Formation

The Timber Creek Formation crops out at the western margin of the Delamere Sheet area in scarps adjacent to the Victoria River. It is also exposed in the adjacent Auvergne Sheet area (Sweet et al., in press, b), and extends south into the Victoria River Downs and Waterloo Sheet areas. The unit was named informally by Laing & Allen (1956), and has been defined by Sweet et al. (in press, b).

Stratigraphic relations: The base of the Timber Creek Formation is not exposed in the Delamere Sheet area, but farther south, in the Victoria River Downs Sheet area, it conformably overlies a sequence of interbedded sandstone and siltstone (Sweet et al., in press, a).

Laing & Allen (1956) believed that the Timber Creek Formation was a lateral equivalent of the Skull Creek Formation, but mapping in 1968 has shown

TABLE 6. STRATIGRAPHY OF THE BULLITA GROUP AND WONDOAN HILL FORMATION

Rock Unit	*Map Symbol*	*Thickness (m)*	*Lithology*	*Physiographic Expression*	*Distribution**	*Stratigraphic Relations*
Wondoan Hill Formation	Pwo	Up to 105	Green glauconitic shale and sandstone, quartz sandstone, dolomitic siltstone	Smooth scarps, some cliffs	Central and S *Delamere*	Unconformable on Bullita Group. Overlain conformably by Stubb Formation and unconformably by Jasper Gorge Sandstone
			UNCONFORMITY			
Bullita Group						
Banyan Formation	Pbb	Probably 210 max.	Stromatolitic and oolitic dolomite and limestone, minor siltstone and sandstone	Flat to undulating plains, some low, rounded hills	Central S *Fergusson River*	Conformable on Bynoe Formation. Overlain unconformably by Stubb Formation and Jasper Gorge Sandstone
Bynoe Formation	Pby	Up to 200	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	SW *Delamere* and central S *Fergusson River*	Probably conformable on Skull Creek Formation
Skull Creek Formation	Pbs	About 180	Grey fine to coarsely crystalline dolomite with interbedded siltstone and minor sandstone. Some stromatolitic dolomite	Banded and terraced scarps, undulating country of low and moderate relief, latter with closely spaced streams	SW *Delamere*. Minor outcrop in N, extending into *Fergusson River*	Overlain by Bynoe Formation. Gradational from Timber Creek Formation
Bardia Chert Member	Pbm	Up to 15	Pink to pink-brown laminated chert, some brecciated and recemented by coarser silica	Flat or gently dipping surfaces, rough and uneven in detail	SW *Delamere*	Top of Skull Creek Formation. Overlain by Bynoe Formation
Supplejack Dolomite Member	Pbu	25-30	Massive dark grey, coarsely crystalline dolomite; stromatolitic near top	Prominent terrace in hillslopes; karren and karst developed	SW *Delamere*	Conformable member
Timber Creek Formation	Pbt	75+	Interbedded purple and grey-green quartz siltstone, fine sandstone and finely crystalline dolomite	Smooth scarps or, if no hard caprock, terraced slopes	W *Delamere* along Victoria River	Older formations not seen. Grades into Skull Creek Formation

* Sheet areas in Italics.

that it underlies the Skull Creek Formation. This relation is best shown near Mount Sellars, 8 km south-southeast of Timber Creek (Fig. 10), and is also apparent along the Victoria River valley upstream from Timber Creek for a distance of about 19 km.

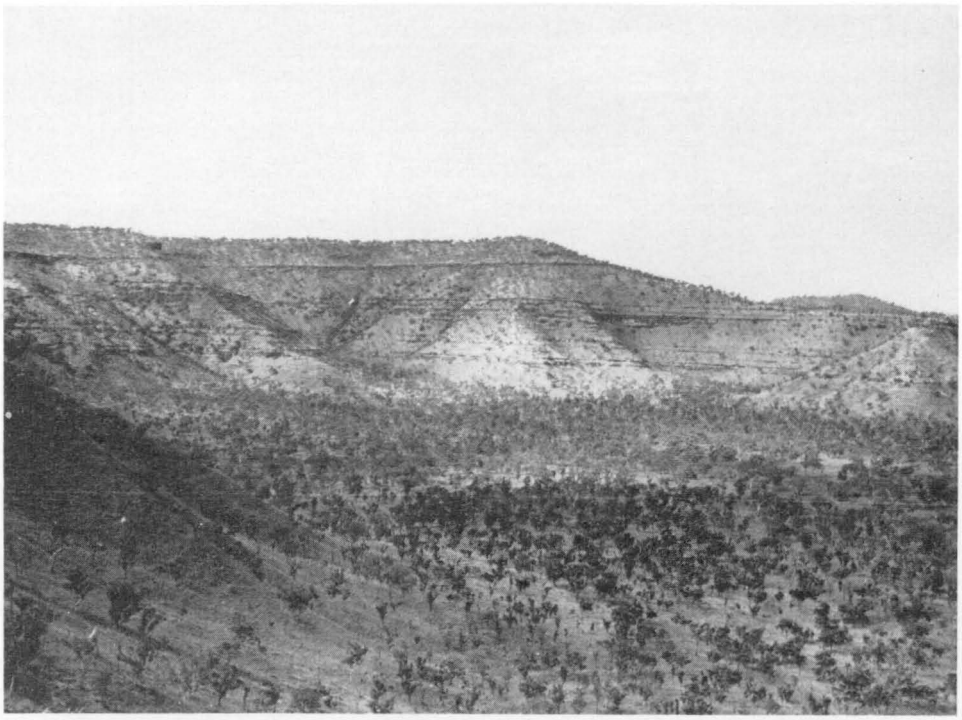


Fig. 10. View from slope of Mount Sellars, 8 km south-southeast of Timber Creek. Timber Creek Formation forms valley floor, and is overlain by dolomite (well bedded rocks) of the Skull Creek Formation. The capping of Jasper Gorge Sandstone lies with angular unconformity on Skull Creek Formation.

Around Timber Creek, the formation is overlain unconformably by Jasper Gorge Sandstone. Figure 10 shows the slight angular discordance between Jasper Gorge Sandstone and Skull Creek Formation. About 1 km west of the photograph locality, the Skull Creek Formation has been completely eroded, and Timber Creek Formation underlies the sandstone.

Lithology and thickness: The lithology is described in detail by Sweet et al. (in press, a) and Sweet et al. (in press, b).

In the Delamere Sheet area, the formation is predominantly siltstone, dolomitic in places, with interbeds of fine-grained sandstone, shale, and dolomite. The siltstone is generally rich in quartz, coarse-textured, and red-brown, chocolate or light grey-green, with green patches or spots in places; it is usually thin to medium-bedded, with flaggy and blocky partings. Most of the sandstone is fine-grained and silty, but immediately west of Timber Creek several interbeds of clean medium-grained quartz sandstone were observed. Shale and mudstone bands ranging from fissile to flaggy, and laminated to thin-bedded, are normally grey-green, but ferric iron colours such as purple and chocolate are not uncommon. Sedimentary structures observed include halite casts, mud cracks, and small-scale ripple marks.

The thickness of the formation is more than the 80 m observed in the type section (Sweet et al., in press, b), where the lower part is unexposed and the upper part is eroded and overlain unconformably by Jasper Gorge Sandstone.

In the area mapped, the Timber Creek Formation underlies the Skull Creek Formation. However, it is possible that elsewhere the two formations have an intertonguing or laterally gradational contact, as suggested by Laing & Allen (1956).

Palaeogeographic significance: Laing & Allen (op. cit.) suggested that the Timber Creek Formation is a near-shore facies composed mainly of fine detrital material; lime, magnesia, and silica were precipitated from solution. The halite casts and mud cracks show that the sediments were deposited from bodies of hypersaline water which periodically evaporated. The environment is thus probably paralic, with both lagoonal and shallow marine sediments.

Skull Creek Formation

The Skull Creek Formation crops out in the southwest Delamere Sheet area. Outcrops in Sheet areas west and south have been described by Sweet et al. (in press, b) and Sweet et al. (in press, a).

Derivation of name: The formation was designated 'Skull Creek Limestone' in an unpublished report by Laing & Allen (1956), but was modified to Skull Creek Formation and formally defined by Sweet et al. (in press, b).

Type area: The central anticline of a group of three 1 km west of the Timber Creek/Victoria River Downs road in the southwest corner of the Delamere Sheet area.

Stratigraphic relations: The formation overlies the Timber Creek Formation in the Delamere Sheet area (Fig. 10). It is overlain conformably by the Bynoe Formation—which in some areas lies directly on dolomite, and in others on the Bardia Chert Member—and with angular unconformity by the Jasper Gorge Sandstone.

Lithology and thickness: The Skull Creek Formation is composed of dolomite, dolomitic siltstone, sandstone, and chert. In the Delamere Sheet area, a prominent dolomite member that weathers to dark grey (Supplejack Dolomite Member), and a chert member at the top of the formation (Bardia Chert Member) have been delineated.

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 Supplejack Dolomite Member and a lower dolomite bed (informally called the 'lower marker') as points of reference, it has been possible to build up a composite section of the formation.

Pontifex et al. (1968) recorded a section 10 km south-southwest of Timber Creek which they referred to as Timber Creek Formation, but later mapping has shown that only the basal 3 m is Timber Creek Formation. The overlying Skull Creek Formation was recognized as such by the presence of the 'lower marker'. The section measured by Pontifex et al. appears as Section 8 in the Appendix; there is about 54 m 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 Section 8, near Mount Sellars, was measured through the same part of the formation. The parts not exposed are believed to be occupied by siltstone (Appendix, Section 9). 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 13.5 m of flaggy dolomite near the top of the section.

The sequence between the Supplejack Dolomite Member and the 'lower marker' is well exposed on both sides of the Victoria River from near its confluence with Skull Creek to the region near Trinity Reach and Wickham Heights. A section 68 m thick measured on the east bank of the river about 1.5 km west of Wickham Heights does not crop out very well, and may be largely dolomitic siltstone, but several beds 30 to 150 cm thick of grey, flaggy, fine-grained dolomite in this interval crop out. The Supplejack Dolomite Member is about 27 m thick.

A section measured by barometer from the top of the Supplejack Dolomite Member to the base of the Bynoe Formation about 5 km southeast of Wickham Heights is 70 m thick. 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.

The type section was first measured across the limb of an anticline in the southwestern corner of the Delamere Sheet area by Laing & Allen (1956). The uppermost outcrop is a massive grey dolomite in the 'upper marker' of Laing & Allen, which we have called the Supplejack Dolomite Member. The section measured is 150 m thick; the upper half is predominantly dolomite, but the lower half contains much siltstone (Appendix, Section 10).

The 'lower marker' crops out near the Victoria River between Trinity Reach and The Brothers, a distance of 32 km. It is not as prominent on aerial photographs as the Supplejack Dolomite Member, perhaps because of its regular jointing which causes it to be eroded more easily. Both are, however, lithologically similar and are composed of thick beds of fine to medium crystalline dolomite with blocky to massive partings; laminations are absent or very faint on most fresh surfaces. Weathered surfaces of the Supplejack Dolomite Member, etched by solution, reveal the presence of stromatolites (Fig. 12), and 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, found in the purer dolomite beds throughout the formation, 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, it occurs as extensive resistant beds several centimetres thick. It is laminated in the same manner as the surrounding dolomite, which it is considered to have replaced. In the same area, chert occurs as brecciated silica-cemented masses, also parallel to bedding. The most notable chert occurrence is a band at least 15 m thick at the top of the Skull Creek Formation, the Bardia Chert Member. It has been recognized only in the southwestern Delamere Sheet area.

Most of the purer carbonate rocks are micrites. The carbonate is finely crystalline, and most specimens examined do not contain 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 rock forms the top of the formation on the northern side of the Victoria River. Its grainsize ranges from 0.5 to about 5 mm. It is quite dense, and some beds are limonitic or hematitic. Specimens W68 (68770220) and W69D (68770073) are very coarsely crystalline, and both have low Ca/Mg ratios (Table 7). X-ray diffraction shows that they contain magnesite. They also contain appreciable quantities of manganese and iron, but the X-rays did not reveal the presence of siderite or ankerite.

TABLE 7. CHEMICAL ANALYSES OF SKULL CREEK FORMATION

Field No.	*Reg. No.*	*Mg %*	*Ca %*	*Ca/Mg* (molar)	*Residue %*
W4	68770 213	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	67770 067	5.8	10.6	1.26	55.6
W40B	070	8.9	20.9	1.50	5.2
W46	68770 218	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	67770 073	9.3	19.7	1.29	17.4
W69D	073	11.1	5.8	0.32	20.6
W92	68770 221	6.2	12.2	1.19	48.2
W96	222	11.05	17.9	1.32	3.1
Y209	223	10.7	22.0	1.24	24.9
Y210	223	11.2	23.3	1.26	5.0
Y213	225	11.2	21.5	1.16	7.5

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 about 13 km farther north in the Fergusson River Sheet area. At the first locality, the Supplejack Dolomite Member comprises several massive beds totalling about 7.5 m; a pink-grey bed near the top contains abundant stromatolites. Three rock samples from this area are apparently all calcitic dolomites (Y209, 210, 213, Table 7). The member at this locality also includes chert lenses and a concordant barite vein up to 1.5 m wide and about 4 m long. At the second locality, the member was not recognized; about 100 m of grey flaggy dolomitic siltstone (containing small barite veins) interbedded with thick beds of grey to pink finely crystalline dolomite was intersected; limonite pseudomorphs are considered to be replacement of pyrite.

Supplejack Dolomite Member

Distribution: The member crops out most extensively in the southwestern Delamere Sheet area. Only outcrops southwest of the Timber Creek/Victoria River Downs road have been shown on the geological map accompanying this Report; in most other areas, the member occupies steep-sided mesas and cannot be plotted on maps.

Derivation of name: From Supplejack yard in the Waterloo Sheet area (at grid ref. 641 228).

Type section: Along the track between Supplejack yard and Bullita homestead in the Waterloo Sheet area.

Description: The Supplejack Dolomite Member is easily recognized on aerial photographs by its dark mottled texture, owing partly to rugged outcrops on hillsides almost devoid of soil and vegetation. These rocks weather to dark grey, and result in an almost black tone on photographs. The member also supports a small tree with dark green, very dense foliage which gives a dark texture on the photographs and is commonly the distinguishing feature of the member even where it is not exposed as large bare outcrops. The appearance of the member is shown in Figure 11.

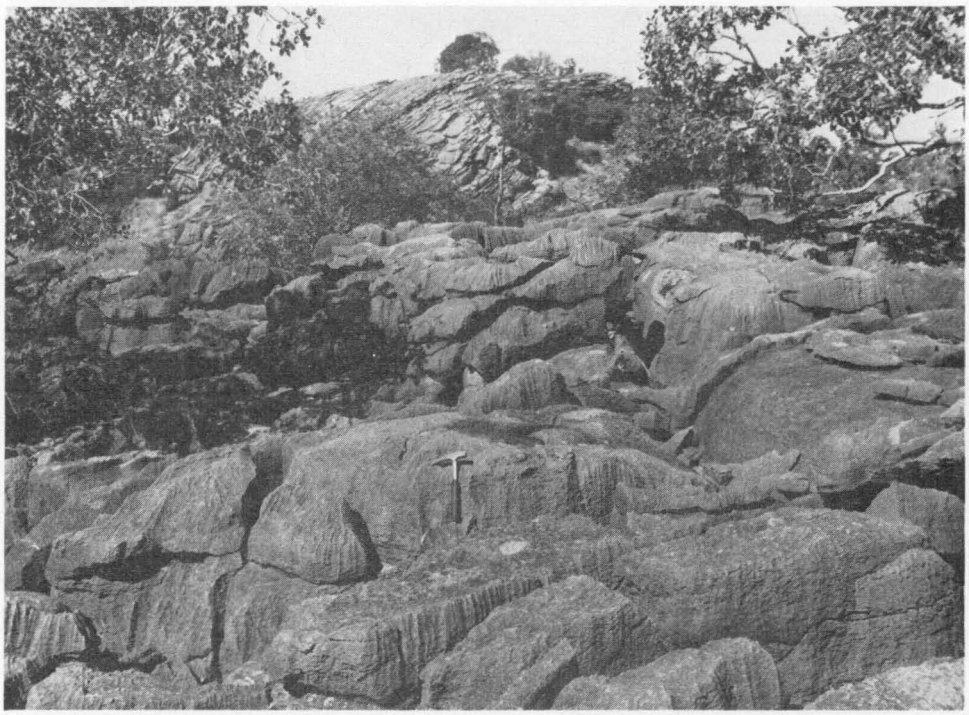


Fig. 11. Supplejack Dolomite Member of Skull Creek Formation showing clints and grikes; near southern margin of Delamere Sheet area.

The member consists of massive, dark grey, coarsely crystalline carbonate beds, mostly dolomite, which are almost certainly recrystallized micrite. Several thick beds at the top of the member are stromatolitic, and the uppermost of these beds contains high-spired conical forms similar to *Conophyton* spp. (Fig. 12).

Bardia Chert Member

Distribution: The Bardia Chert Member covers an area of about 325 km^2 in the southwestern Delamere Sheet area, with minor outcrops in the Auvergne Sheet area (Pontifex et al., 1968; Sweet et al., in press, b).

Derivation of name: The name is derived from Bardia yard, a stockyard near the Victoria River Downs road crossing of Skull Creek in the southwestern Delamere Sheet area.

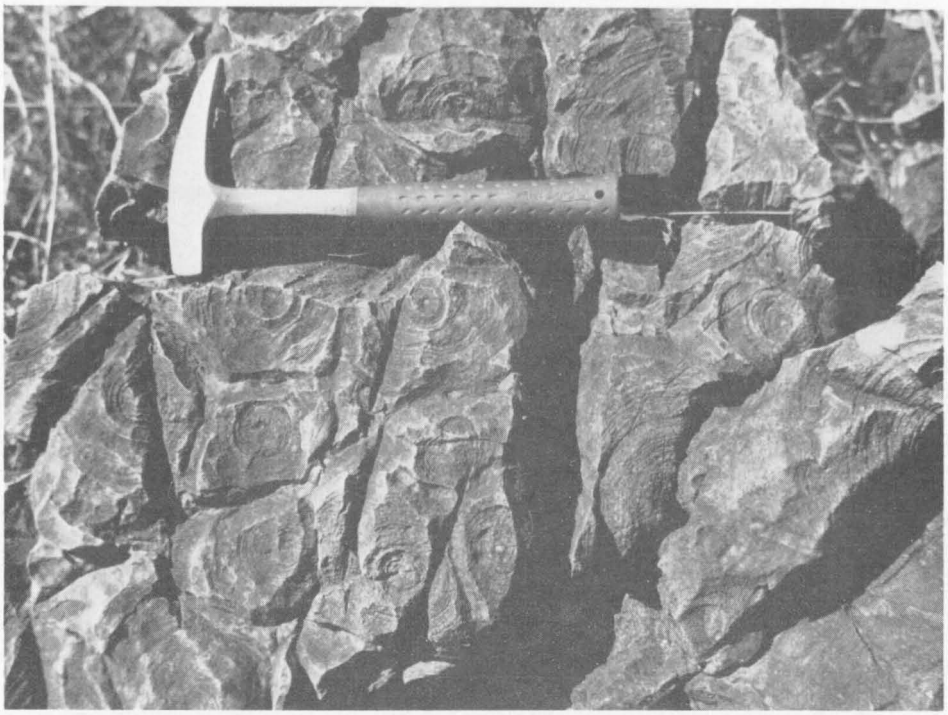


Fig. 12. Supplejack Dolomite Member of Skull Creek Formation. View of top of bed showing stromatolites; 15 km west of Fitzroy homestead, Delamere Sheet area.

Type section: In the Victoria River Downs Sheet area, at 16°11′40″S, 130°55′30″E. The section is in a scarp 0.5 km west of the Victoria River Downs/Timber Creek road.

Stratigraphic relations, lithology and thickness: The Bardia Chert Member is at the top of the Skull Creek Formation. Other prominent lenses and beds of chert in the formation are not as widespread as the Bardia Chert Member. The Bardia Chert Member is a flat-lying capping on low hills in the west of the Delamere Sheet area, but about 12 km to the east it dips gently southeast and can be seen below the Bynoe Formation (Fig. 13). It is between 6 and 15 m thick near Skull Creek, and at the type locality.

The chert is red-brown to pink on weathered surfaces, and generally forms massive resistant outcrops. It is predominantly microcrystalline quartz, with some veins and vugs of coarser-grained quartz and calcite crystals. The internal structure of the rock is variable; in many cases, 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 recemented by chert or coarser-grained quartz.

Origin of chert: The chert may have been chemically precipitated as the last stage of Skull Creek deposition and then overlain by the Bynoe Formation. Alternatively, it may have replaced a series of dolomite beds, which would explain both the apparent stromatolite structures in the chert and the occurrence of brecciated chert. It has been suggested by M. C. Brown (pers. comm.) that the breccia could have

formed by collapse of laminated chert into cavities formed in the dolomite by circulating waters.

The latter mechanism suggests that there may be a hiatus between the Skull Creek and Bynoe Formations, during which time silica-rich solutions were supplied from a surrounding landmass of low relief. Alternatively, the chert may be a fossil duricrust representing a hiatus at the end of Skull Creek time. It is also possible that the chert was a late diagenetic phenomenon after deposition of the Bynoe and perhaps even subsequent formations, but there is no evidence to support this.

Bynoe Formation (new name)

Derivation of name: The formation was named from Bynoe Range, 8 km west of Coolibah homestead in the central Delamere Sheet area.

Distribution: The Bynoe Formation crops out in the southern Fergusson River, western Delamere and Victoria River Downs, and eastern Waterloo Sheet areas.

Lithology: Reddish brown and grey-green micaceous dolomitic siltstone with thin interbeds of dolomite and dolomitic sandstone.

Type section: On the southern side of Wondoan Hill, a prominent mesa 5 km west of Coolibah homestead. The base of the section is the northern bank of the Victoria River (15°34′S, 130°55′E).

Thickness: 189 m at the type section (Appendix, Section 11). A measured section comprised predominant siltstone with several dolomite and dolomitic sandstone beds 0.5 to 1.0 m thick.

Age: Proterozoic, probably Adelaidean.

Fossils: None known.

Stratigraphic relations: The Bynoe Formation is a constituent formation of the Bullita Group. Its upper and lower contacts are conformable with the Weaner Sandstone and the Skull Creek Formation, respectively. It is overlain unconformably by Jasper Gorge Sandstone in some localities.

Modification of previous nomenclature: The Bynoe Formation was previously included in the Victoria River Group of Traves (1955). It was informally named Coolibah Formation (a previously used name) in an unpublished company report by Laing & Allen (1956). Laing & Allen's Coolibah Formation also included units now mapped as Stubb and Wondoan Hill Formations.

Description: The type section is the best exposed and the most complete section known of the Bynoe Formation (Appendix, Section 11). 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 thick-bedded massive sandstone of the Wondoan Hill Formation.

The most characteristic rock type is the massive siltstone seen in most outcrops (Fig. 13), including the type section. The beds, 15 cm to 1 m thick, are red-brown to purple, and green to grey-green; locally the colour boundaries transgress bedding planes, so at least some of the colour changes are secondary. When weathered, the siltstone breaks into small angular fragments. The siltstone contains quartz (about 60%), carbonate (up to 30% dolomite), and muscovite. Iron occurs as limonite in the red-brown siltstone, and as clay minerals and siderite in

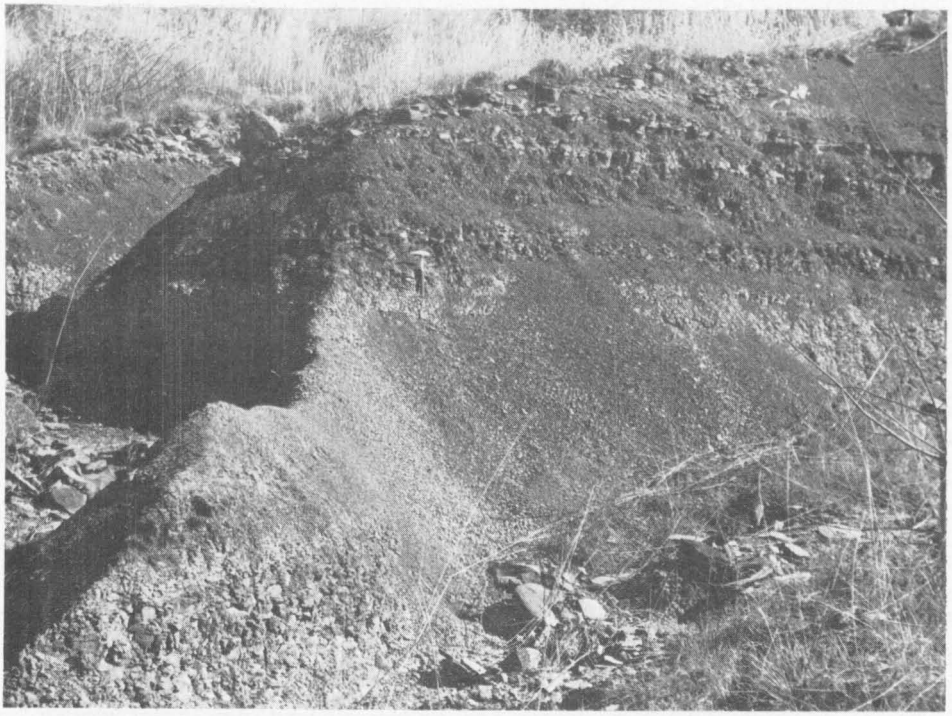


Fig. 13. Bynoe Formation: massive grey-green (light tone) and red-brown to purple (dark tone) siltstone, with a thin sandstone interbed near top of photo; 1.6 km north of Bob's Grave Spring, Delamere Sheet area.

the green and grey-green siltstone. Most red-brown beds contain grey-green spherical patches 1 mm to (rarely) 5 cm across. 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. Such a reaction is not related to recent weathering because beds of both colours have been observed in recently exposed fresh outcrop.

The interbedded dolomite and dolomitic sandstone are generally light grey or fawn on fresh surfaces, but when weathered they develop a crust (generally 1 to 5 cm thick) of porous rock containing much limonite but no carbonate. The crust is quite soft, in contrast to the highly indurated 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 south-west Delamere Sheet area, totalled 112 m and is overlain by Wondoan Hill Formation. The base is not present, but is seen about 1.5 km farther west. Dips are low (1-3°E), and probably 30 to 60 m of formation exists below the measured section.

The first 22.5 m of the section contains interbedded siltstone and flaggy sandstone. The sandstone, which forms small ledges and gives the lower slopes of the hill a terraced appearance, is white to faint grey-green, and ripple-marked. The siltstone and sandstone are overlain by 64 m of typical Bynoe Formation red-brown to purple and grey-green micaceous siltstone, probably dolomitic. The upper 30 m of the section is composed of flaggy and blocky, fine-grained, siliceous to calcareous sandstone. Halite casts and ripple marks are present but there are no dolomite beds in this locality.

Typical siltstone and interbedded sandstone of the Bynoe Formation crop out extensively east and northeast of Wombungi outstation in the Fergusson River Sheet area. On the southern side of the Wombungi-Dorisvale track, 3-m bands of grey and light brown, massive fine-grained sandstone are interbedded with friable, thin-bedded, cross-bedded and ripple-marked siltstone. In the same area silty dolomite beds up to 1 m thick are interbedded with grey-green dolomitic siltstone with halite casts. Medium to coarse, poorly sorted pebbly sandstone also crops out in layers up to 1.5 m thick. Grains are subrounded and consist mostly of quartz, with some chert and possibly some silicified siltstone; some mud flakes or shale fragments are also present. In this area, the Bynoe Formation has been lateritized in several places. The laterite is believed to be Precambrian, developed on an old land surface before the Auvergne Group sediments were laid down. In a few places, fresh siltstone grades 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 developed on the Bynoe Formation is generally grey, pink, or purple, between a few centimetres and 1.5 m thick, and is presumably the result of leaching of the dolomitic siltstone.

Distinguishing features: On aerial photographs the Bynoe Formation appears 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 as spurs, with a prominent terraced effect owing to hard beds within the formation. Such terraces are well developed in the southwest Delamere Sheet area.

Lithologically, the Bynoe Formation is distinguished by the massive red-brown to purple and grey-green siltstone. Although a similar rock type is found in the Timber Creek Formation, it is interbedded with much dolomite and sandstone. *Palaeogeographic significance:* The minor rock types in the Bynoe Formation display sedimentary structures such as ripple marks, small-scale cross-bedding, and halite casts, 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 siltstone 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. It seems most likely that the dominant siltstone was laid down in the sea and that the smaller interbeds signify paralic interludes.

Banyan Formation (new name)

Derivation of name: The formation is named from Banyan Creek, a tributary of the Flora River in the southern Fergusson River Sheet area.
Distribution: The Banyan Formation occupies about 500 km^2 in the central-southern Fergusson Sheet area.

Lithology: Grey, pink, and fawn dolomite, and minor limestone; some beds are stromatolitic and oolitic; the formation also comprises minor sandstone, chert, and calcareous and quartz-rich siltstone.

Type section: 2.5 km west of Hayward Creek, within 4 km of the southern margin of the Fergusson River Sheet area. A section was not taped because of unsuitable terrain. The base of the section is at 14°58′S, 131°18′40″E; the top is 2 km to the south, at 14°59′S, 131°19′E. The generalized sequence is:

(Top) 15 m siltstone
80 m dolomite and limestone
30 m silicified dolomite
45 m sandstone

Thickness: The thickness of the Banyan Formation, estimated from aerial photographs and measured dips, is about 170 m at the type section. Farther north, near the Flora River, it was estimated to be about 210 m.

Age: Proterozoic, probably Adelaidean.

Fossils: Columnar stromatolites are abundant.

Stratigraphic relations: The Banyan Formation is a constituent formation of the Bullita Group. It conformably overlies the Bynoe Formation, and is unconformably overlain by the Stubb Formation and the Antrim Plateau Volcanics.

Modification of previous nomenclature: The formation was previously included in the Victoria River Group of Traves (1955). Parts of the unit were included in the Palm Creek Beds and Waterbag Creek Formation of Randal (1962); the former name has been discarded because it contains at least two units separated by an unconformity, but the latter is retained for rocks farther north in the Fergusson River Sheet area.

Description

Lithology and thickness: The Banyan Formation is basically a 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 dolomitic siltstone. It is red-brown, calcareous, and flaggy, and commonly contains halite casts. A weathered 'crust' stained with iron oxide surrounds the hard unweathered rock. Small-scale cross-bedding is common within the sandstone and becomes abundant in the grey crystalline dolomite. The basal sandstone, estimated to be at least 45 m thick, is only exposed in the cores of two easterly-plunging anticlines about 6 km south of the Flora River in the Hayward Creek area (type locality), where it is overlain by silicified limestone breccia up to 30 m thick. The breccia contains white and grey angular fragments of varying sizes, and rare small crystals of pyrite. Overlying the breccia is a sequence of grey to pink, fine-grained, crystalline stromatolitic limestone and dolomite with some shaly limestone bands. Hemispheroidal stromatolites (terminology of Logan et al., 1964) are generally closely grouped in specific layers, and with them are associated columnar stromatolites up to 1 m across (Fig. 14). 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 which is purple, cream, and light brown. The oolites are macroscopic and partly recrystallized. Brecciation and recementation are widespread throughout the sequence. The grey and buff

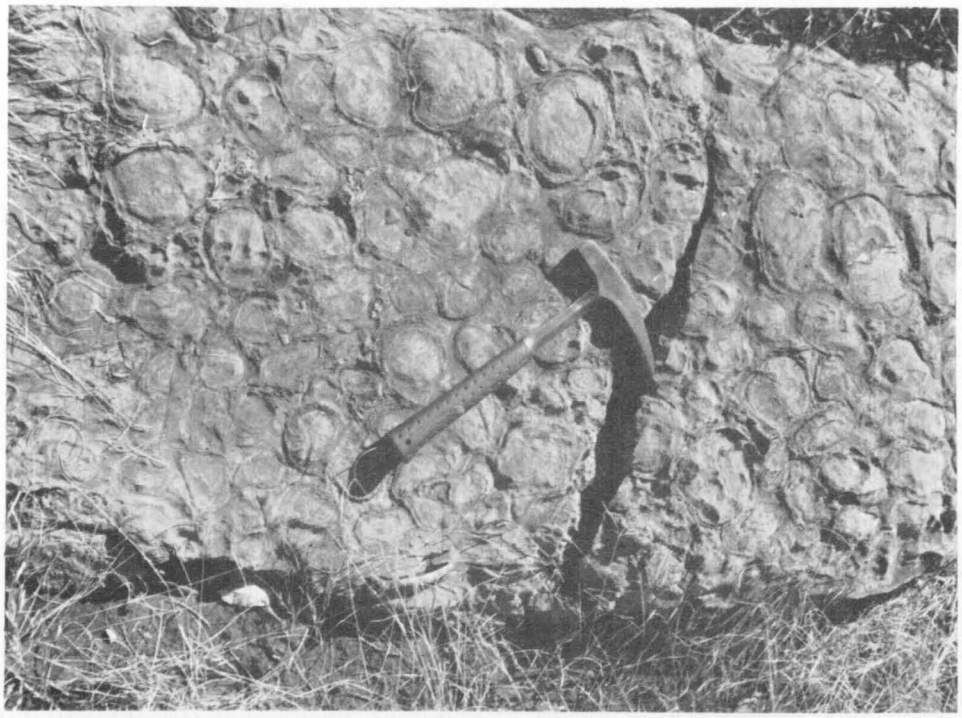


Fig. 14. Columnar stromatolites in the middle dolomite member of the Banyan Formation; 14 km southwest of Mount Freda in the Fergusson River Sheet area.

fragmental limestone and dolomite are distinctive, and contain numerous angular to rounded fragments (1 mm to 5 cm) of limestone, dolomite, and chert. Small rounded quartz grains and larger shale fragments are in a glauconitic limestone matrix, and stromatolites and halite casts also occur in this bed of the formation.

Sulphide minerals, assumed to have been introduced during recrystallization, occur in the more crystalline masses of the fragmental rock: small euhedral crystals of galena are 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); and pyrite crystals are up to 5 mm across in a similar stratigraphic position at 14°58′S, 131°19′E.

The carbonate rocks are estimated from aerial photographs to be 210 m thick near the centre of the basin, but become considerably thinner towards the margins; they are estimated to be 80 m thick in the type section. In the structural window on the northern margin of the Delamere Sheet area, a single 2.5-m band of fragmental limestone appears to overlie the Bynoe Formation conformably. Its lithology and stratigraphic position indicate that it belongs to the Banyan Formation. Rocks of the Stubb Formation unconformably overlie the bed.

The headwaters of Hayward Creek have cut through a low hill, exposing about 15 m of clastic sediments overlying the dolomite-limestone beds. The sequence consists of pale purple to cream, fissile, laminated fine-grained siltstone and shale, capped by dark purple, massive, thick-bedded friable sandstone.

In the centre of the basin near the confluence of the Flora River and Piker Pocket Creek, the clastics are about 60 m thick and consist of leached yellowish

mudstone and fissile siltstone with small nodular concretions in places. Although the beds are lithologically similar to the overlying Stubb Formation, they are conformable with the Banyan Formation and therefore included in it.

The limestone-dolomite sequence has been partly replaced by chert south of the Flora valley, presumably during Tertiary lateritization. The chert is white, yellow, red, and brown, is rarely brecciated, and contains stromatolites.

Distinguishing features: The carbonate part of the sequence gives a distinctive finely-banded, light-toned pattern on aerial photographs. The sandstone near the base is light-toned and of low relief; bedding does not show. The upper siltstone can be recognized by its soft, medium-toned appearance with a capping of light to medium-toned, bedded, upjointed sandstone.

Palaeogeographic significance: The Banyan Formation represents the last known sedimentation before the erosional break that preceded deposition of the Auvergne Group. The character of the limestone suggests that it was laid down in shallow water mostly of fairly high energy, and interrupted by lagoonal and subaerial episodes. Stromatolite colonies are abundant in some beds that were probably intertidal. Brecciation, recementation, and cross-bedding are all common and, together with the abundance of derived fragmental limestone-dolomite, suggest considerable current activity.

WONDOAN HILL AND STUBB FORMATIONS

Wondoan Hill Formation (new name)

Derivation of name: The formation is named from Wondoan Hill (at 15°34′S, 130°55′E), a prominent mesa 1 km north of Fitzroy homestead in the Delamere Sheet area.

Distribution: The Wondoan Hill Formation crops out in the central and southwestern parts of the Delamere Sheet area, and the northwestern and central parts of the Victoria River Downs Sheet area; there is an isolated outcrop near the centre of the Wave Hill Sheet area.

Lithology: The formation comprises interbedded sandstone, siltstone, shale, and claystone. The lower sandstone beds are highly glauconitic.

Type locality: At the eastern end of the Fitzroy Range, at 15°38′S, 13°55′E. The section was measured up the southern side of the range 9 km due south of Wondoan Hill (Appendix, Section 12).

Thickness: The thickness of the Wondoan Hill Formation is 108 m in the type section, 145 m in Jasper Gorge in the Victoria River Downs Sheet area, and less than 100 m in most other areas.

Age: Proterozoic, probably Adelaidean.

Fossils: None known.

Stratigraphic relations: The Wondoan Hill Formation unconformably overlies the Bynoe Formation. It is conformably overlain by the Stubb Formation and unconformably by the Jasper Gorge Sandstone.

Modification of previous nomenclature: The formation was previously included in the Victoria River Group of Traves (1955). It was included in the Coolibah For-

mation of Laing & Allen (1956), but has been shown by our mapping to be a separate mappable unit.

Detailed description: The thickest section of Wondoan Hill Formation in the Delamere Sheet area is in the type section (Appendix, Section 12).

The massive basal cross-bedded sandstone (Fig. 15) of the Wondoan Hill



Fig. 15. Cross-bedding in the basal sandstone of the Wondoan Hill Formation; 10 km southwest of Coolibah homestead in the Fitzroy Range, Delamere Sheet area.

Formation forms a prominent band along the Fitzroy Range and also forms the capping of Wondoan Hill and the hills directly south of Coolibah homestead. It is about 30 m thick at Wondoan Hill and consists of a thick-bedded, massive to blocky, medium-grained quartz sandstone which contains several thin micaceous lenses; the cross-bedded units are 60 to 150 cm thick.

In the southwest Delamere Sheet area, about 3 km east-northeast of Bob's Grave Spring, green micaceous shale and fissile friable sandstone cropping out above purple Bynoe Formation siltstone are overlain by brown to red and pale yellow shale with interbedded blocky sandstone; these beds are assigned to the Wondoan Hill Formation, which crops out extensively farther south (Sweet et al., in press, a).

Distinguishing features: The green glauconitic sandstone and shale and the red hematitic shale and yellow dolomitic siltstone are distinctive.

Palaeogeographic significance: The presence of glauconite suggests that the lower part of the formation was formed by slow deposition in a marine environment of

moderate depth. The progressively higher arenaceous content of the sediments indicates shallower water during the later depositional phases.

Stubb Formation (new name)

Derivation of name: The formation is named from Stubb yard, at 15°37′S, 131°10′E, in the Delamere Sheet area. The yard is immediately south of the Victoria Highway, 5 km east-southeast of the Victoria River road bridge in the Delamere Sheet area.

Distribution: The Stubb Formation crops out extensively westwards from Delamere homestead to the Victoria River, in the Delamere Sheet area. Minor outcrops occur in adjacent Sheet areas to the north and south.

Lithology: Brown, white, and purple micaceous quartz siltstone, grading upwards into white and brown sandstone with siltstone interbeds. Black and dark grey shale forms the lower part of the sequence in some areas.

Type locality: In the valleys of Sullivan Creek and the Victoria River. The base is at 15°35′S, 131°05′E (in scarp south of Victoria River) and the top is at 15°30′S, 131°21′E (near Sullivan yard).

Thickness: The Stubb Formation is 190 m thick at the type section (Appendix, Section 14).

Age: Proterozoic, probably Adelaidean.

Fossils: None known.

Stratigraphic Relations: The Stubb Formation lies conformably on the Wondoan Hill Formation and unconformably on the Bullita Group. It is overlain unconformably by Jasper Gorge Sandstone.

Modification of previous nomenclature: The Stubb Formation was previously included in the Victoria River Group of Traves (1955). It was included in the Coolibah Formation of Laing & Allen (1956), but has been shown by our mapping to be a separate mappable unit. In initial reports of our field work (Morgan et al., 1970; Pontifex & Mendum, 1972; Sweet, 1972) the Stubb Formation was included in the Auvergne Group and was thought to be conformable with the Jasper Gorge Sandstone. The contact is now believed to be unconformable, and the Stubb Formation is excluded from the Auvergne Group.

Detailed description: The formation ranges 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 indistinguishable on aerial photographs from Jasper Gorge Sandstone. The unit has a maximum thickness of about 210 m and is best exposed in the type area. A large thickness of poorly exposed Stubb Formation occurs in the Victoria River gorge south of the Victoria Highway.

In the Sullivan Creek valley, the lower silty parts of the unit are well exposed in road cuttings and small cliffs. The composite type section measured in this area consists of more than 150 m of grey siltstone and shale, with minor sandstone interbeds, overlain by 40 m of flaggy and blocky quartz sandstone. The sandstone is included in the Stubb Formation because it crops out below the cliff-forming sandstone defined as the base of the Jasper Gorge Sandstone (Appendix, Section 13).

Farther east, in a small hill 100 m south of the Victoria Highway, 36 m of grey, purple, and yellow-brown, friable micaceous shale and siltstone crops out. Mud cracks are common, and the shale and siltstone contain several hard white to grey and purple siliceous sandstone lenses 2.5 cm to 60 cm thick. The sandstone is fine-grained and indurated, and is composed of well sorted, well rounded, white quartz grains.

The formation is truncated near the westward limit of the scarp of the Stokes Range and is absent near the Victoria River Downs/Timber Creek road. A section measured in the Stokes Range (Appendix, Section 14) totals 175 m of shale and siltstone, including about 30 m of cross-bedded sandstone. The cross-bedding and slump structures suggest a west to southwest provenance.

Good outcrop is rare in the Stokes Range, but at one locality 25 km south-southwest of Coolibah homestead fissile, laminated, micaceous brown siltstone and shale are exposed. At this locality the unit includes a 1-m band of hematitic sandstone breccia and large lenses of blocky to massive friable medium-grained sandstone.

Sedimentary structures of the Stubb Formation in the Stokes Range escarpment include flute casts, skip casts, load structures, ripple marks, and cross-bedding (Fig. 16 shows a typical slump structure in the western part of the range).



Fig. 16. Slump folding in the upper part of the Stubb Formation; 22 km east-northeast of Bardia yard, Delamere Sheet area.

In an inlier in 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.

About 30 km east-southeast of Wombungi outstation in the Fergusson River Sheet area, a massive hematitic siltstone interbedded with grey to purple micaceous shale and siltstone includes calcite-lined cone-in-cone structures.

About 28 km east-northeast of Wombungi, Jasper Gorge Sandstone directly overlies the Banyan Formation. However, a ferruginous erosion surface at the contact is thought to be laterite formed during the deposition of the Stubb Formation farther south. A laterite surface separating the Bynoe Formation and Jasper Gorge Sandstone is considered to be the source of the hematitic breccias and siltstone of the Stubb Formation.

Palaeogeographic significance: The Stubb Formation is probably of marine origin. The earlier sediments, such as dark shale, were deposited in moderate to deep water, which rapidly shallowed as the abundant supply of sediment continued. Current activity and rapid sedimentation are indicated by the numerous sedimentary structures.

AUVERGNE GROUP

The nomenclature previously applied to rocks now mapped as Auvergne Group is shown in Table 8. Walpole et al. (1968, p. 85) noted that the Victoria River Group of Traves and Laing & Allen would 'almost certainly require revision when the . . . region has been mapped in detail', and for that reason declared all their nomenclature informal (including the group name). The Auvergne Group comprises a shallow-water sequence of siltstone, sandstone, and dolomite about 600 m thick (Table 9). It is divided into seven formations (Sweet et al., in press, b).

TABLE 8. NOMENCLATURE OF THE AUVERGNE GROUP AND STUBB FORMATION

Traves (1955)	*Laing & Allen (1956)*	*Randal (1962); Walpole et al. (1968)*	*Sweet et al. (in press, b) and this Report*
'Victoria River Group' (also included rocks now mapped as Bullita and Fitzmaurice Groups)	'Pinkerton Beds'	'Laurie Creek Beds'	Shoal Reach Formation
			Spencer Sandstone
			Lloyd Creek Formation
		'Yambarra Beds'	Pinkerton Sandstone
			Saddle Creek Formation
	'Auvergne Shale'	Angalarri Siltstone	Angalarri Siltstone
	Jasper Gorge Sandstone	'Palm Creek Beds' (part)	Jasper Gorge Sandstone
	'Coolibah Formation' (part)		Stubb Formation

Jasper Gorge Sandstone

The Jasper Gorge Sandstone, a massive to flaggy, medium-grained, white to brown sandstone, covers a large area in both the Delamere and Fergusson River Sheet areas. It was described and defined by Sweet et al. (in press, b), in the

TABLE 9. STRATIGRAPHY OF THE AUVERGNE GROUP AND STUBB FORMATION

Rock Unit	*Map Symbol*	*Thickness (m)*	*Lithology*	*Physiographic Expression*	*Distribution**	*Stratigraphic Relations*
Shoal Reach Formation	Pah	up to 60	Brown and grey-green siltstone; minor dolomite and sandstone	Steep slopes bordering plateaux capped by Mullaman Beds or laterite	Between Alligator Creek (*Port Keats*) and old Coolamon H.S. (*Fergusson River*)	Conformable sequence. Shoal Reach Formation unconformable below Mullaman Beds; Jasper Gorge Sandstone unconformable on Stubb Formation and older units
Spencer Sandstone	Pae	up to 60	Fine sandstone, some dolomite; thin-bedded with ripple marks and halite casts; some silty sandstone	Moderate smooth slopes bordering plateaux, low banded hills	SE *Port Keats* and SW *Fergusson River*	
Lloyd Creek Formation	Pal	up to 75	Grey-green siltstone, algal oolitic dolomite and dolarenite; sandy and silty dolomite	Low hills, smooth to vaguely terraced	As for Spencer Sandstone	
Pinkerton Sandstone	Pap	up to 50	Fine and medium, well sorted, white quartz sandstone; cross-bedded and ripple-marked; minor siltstone and shale	Cliffs, scarp cappings, plateaux, cuestas, and hogbacks	From Victoria River Fault to near Wombungi and Collia Waterhole in *Port Keats* and *Fergusson River*; small occurrence in *Delamere*	
Saddle Creek Formation	Pad	20-90	Fine and medium sandstone; reddish, clayey or 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	
Angalarri Siltstone	Paa	More than 300	Grey-green fissile sericitic siltstone, minor fine sandstone and dolomite	Undulating plains and steep smooth scarps	E and SE of Victoria River Fault as far as Ikymbon River; N to Collia Waterhole	Conformable on Wondoan Hill Formation
Jasper Gorge Sandstone	Paj	45-105	Medium-grained well sorted quartz sandstone; basal conglomerate and siltstone interbeds at some localities	Prominent cliffs, mesa cappings, and plateaux	Central and W *Delamere* and into S *Fergusson River*	
Stubb Formation	Pat	0-200	Grey and purple micaceous siltstone and shale; flaggy fine-grained sandstone	Scarps capped by cliffs of Jasper Gorge Sandstone or upper Stubb Formation	Central *Delamere* and S central *Fergusson River*	

* Sheet areas in Italics.

Auvergne Sheet area. Part of the 'Palm Creek Beds' in the Fergusson River Sheet area (Randal, 1962) have been assigned to the Jasper Gorge Sandstone. It is also extensively exposed in the Victoria River Downs and Waterloo Sheet areas (Sweet et al., in press, a).

The formation crops out over 4500 km^2 in the western Delamere Sheet area, and over 500 km^2 in the south-central Fergusson River Sheet area. The sandstone forms cliff-capped mesas and plateaux.

Stratigraphic relations: The formation overlies the Bullita Group and the Wondoan Hill and Stubb Formations unconformably. It is conformably overlain by the Angalarri Siltstone; the contact is well exposed near the Ikymbon River in the Delamere Sheet area (Fig. 17). In some areas, the Jasper Gorge Sandstone is unconformably overlain by Antrim Plateau Volcanics.



Fig. 17. Uppermost surface of Jasper Gorge Sandstone overlain by Angalarri Siltstone; 8 km south of Mount Thymanan, Delamere Sheet area.



Fig. 18. Vertical section of Jasper Gorge Sandstone showing small sandstone dykes and lenticular thin sand beds produced by ripple structure; 6 km south-southwest of Trinity Reach, Delamere Sheet area.

Lithology: The Jasper Gorge Sandstone is a uniform sandstone, white to brown, flaggy to massive, and medium-grained. At the base of outcrops in the west there is generally a thin conglomerate, and in all outcrops the lowermost sandstone is indurated and strongly outcropping. Interbeds of green and purple shale and siltstone are found higher in the sequence. The sandstone consists of well sorted, well rounded grains of quartz, with few accessory minerals. It was probably derived from an older sandstone since the grains are well rounded and the rock is texturally and mineralogically mature. The quartz grains are 0.1 to 2 mm in diameter and some have syntaxial rims; the matrix is composed of more angular quartz grains. Accessory minerals, which make up about 3 percent of the total volume, consist of rounded grains of tourmaline, volcanic glass, zircon, and muscovite.

In the Stokes Range near the Victoria River, 105 m of sandstone is preserved, but in most other areas less than 50 m remains. A section of 86 m of sandstone, with some siltstone and mudstone, was measured 6 km south-southwest of Trinity Reach, on the northwestern side of the Victoria River (Fig. 18, and Appendix, Section 15). A similar sequence, only 50 m thick, was measured near the western end of Stokes Range (Appendix, Section 16).

Farther east along the scarp of the Stokes Range, the indurated basal sandstone thins to about 4 m, and is overlain by 25 to 30 m of flaggy sandstone and siltstone capped by 7.5 m of blocky friable sandstone. The siltstone beds lens out southeastwards. In the Stokes Range near the Victoria River crossing, massive to blocky ferruginous sandstone at the base of the formation forms a prominent cliff

about 36 m high. A section 6 km east-northeast of Stubb yard in the Sullivan Creek valley contains 47 m of flaggy and blocky, medium-grained quartz sandstone (Appendix, Section 17).

Large-scale cross-bedding can be seen 10 km north of Ingaladdi Waterhole (Fig. 19). The sandstone is massive, white to purple, medium-grained, medium-



Fig. 19. Cross-bedding in Jasper Gorge Sandstone—10 km north of Ingaladdi Waterhole, Delamere Sheet area.

bedded, and is composed of well rounded quartz grains; pebble bands are present; it is extremely friable and weathers to white sand. The orientation of the cross-beds indicates that the source lay to the east-northeast.

The topmost beds of the Jasper Gorge Sandstone exposed in the Crocodile yard/Mount Thymanan region of the Delamere Sheet area consist of bands of medium to coarse, poorly sorted sandstone up to 6 m thick interbedded with bands of siltstone up to 2.5 m thick. The sandstone varies from thick to thin-bedded, and is cross-bedded; individual foresets are up to 3 m thick and 9 m long. In places the sandstone contains pebbles and mud flakes, and small amounts of barite are scattered throughout.

In the Fergusson River Sheet area, the Jasper Gorge Sandstone is largely covered by sand and shows less surface jointing than farther south. It is similar to the sandstone exposed in the Delamere Sheet area, but some weathers to a grey colour rather than to the more common red.

A small outcrop of brown to white, medium to thick-bedded, blocky to massive sandstone 19 km northwest of Collia Waterhole probably belongs to the Jasper Gorge Sandstone. It underlies the Angalarri Siltstone and contains abundant small-

scale cross-beds. A similar small outcrop, truncated to the west by the Victoria River Fault, is in the northwestern Meeway Plain in the Port Keats Sheet area.

A basal chert-sandstone breccia 19 km south of Timber Creek, in the Auvergne Sheet area, consists of poorly sorted angular clasts of chert and, more rarely, quartzite and sandstone, in a fawn sandstone matrix. Most clasts are 2 to 3 cm in diameter and a few exceed 10 cm (Fig. 20). The breccia has not been found elsewhere in the area mapped.



Fig. 20. 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.

Distinguishing features: The Jasper Gorge Sandstone is a light to medium-toned photogeological unit easily distinguished by its bedding and heavy jointing. It forms several major escarpments and plateaux in the Delamere Sheet area.

Palaeogeographic significance: The Jasper Gorge Sandstone was deposited at the close of the marine transgression that started with the deposition of the underlying Stubb Formation. Most of it was laid down in shallow water.

Angalarri Siltstone

The Angalarri Siltstone was named by Randal (1962) from the Fergusson River Sheet area. He, and later Walpole et al. (1968), included it in the Victoria River Group. Sweet et al. (in press, b) nominated a type section and formally defined the unit after mapping the Auvergne Sheet area.

Stratigraphic relations: The Angalarri Siltstone conformably overlies the Jasper Gorge Sandstone. The contact is exposed between the Ikymbon and Angalarri Rivers, and near The Twins, in the Delamere and Fergusson River Sheet areas. About 8 km south of Mount Thymanan, and in the northernmost margins of the Meeway Plain, highly fissile grey-green siltstone rests on a surface of Jasper Gorge Sandstone showing large interference ripple marks (Fig. 17).

The Angalarri Siltstone is conformably overlain by the Saddle Creek Formation. A gradational boundary is exposed in an outcrop in the scarp bordering the eastern side of the Koolendong Valley in the Port Keats Sheet area.

Lithology and thickness: Sweet et al. (in press, b) described the Angalarri Siltstone in the Auvergne Sheet area, where Pontifex et al. (1968) calculated a minimum thickness of 300 m. However, a more recent bore drilled 3 km northeast of Bradshaw homestead bottomed in the unit after penetrating 275 m, and was spudded in at least 120 m below the top; so at this place the Angalarri Siltstone is at least 395 m thick. Only 185 m is preserved below Mullaman Beds near Mount Thymanan; the total thickness calculated from an assumed dip of 1° is about 500 m in the Mount Thymanan area.

Several bench-forming sandstone interbeds occur in the Angalarri Siltstone between The Twins, in the Fergusson River Sheet area, and the Ikymbon and Angalarri Rivers, in the Delamere Sheet area. They are in the lower part of the formation, and consist of bands up to 4.5 m thick of fine-grained silty sericitic sandstone. Two beds in particular form prominent benches in otherwise soft-weathering slopes, and form marker-horizons which can be traced for long distances on aerial photographs. In Sections 18, 19, and 20 (Appendix), which were measured through the lower part of the Angalarri Siltstone, the sandstones form prominent outcrops.

Where the Angalarri Siltstone is not capped by harder rocks, it forms low rounded hills generally covered by talus of fissile and platy siltstone. It forms the slopes below the scarp capped by 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 is well exposed 8 km north of Mount Kukpalli, where it consists of grey-green, extremely fissile glauconitic siltstone, with some platy and flaggy interbeds; the rocks weather to reddish brown. Thin-bedded to flaggy limestone beds occur at plain level near Mount Wollonjang and also 10 km northwest of Wombungi.

Along the southern side of The Twins Fault, the Angalarri Siltstone dips steeply to the south. One of the silty sandstone interbeds about 4 m thick, faulted against Jasper Gorge Sandstone, has obviously been affected by the faulting: metamorphic foliation or cleavage (parallel to the fault) has developed, and the rock is sericitic and extensively ferruginized. The appearance of this foliated rock probably led Randal (1962) to assign the rocks of this area to the Noltenius Formation. The foliated sandstone is overlain by about 5 m of fissile ferruginized siltstone, which is in turn overlain by a 3-m bed of silty sandstone that is relatively unaffected by the fault and can be followed for about 12 km. The silty sandstone is overlain by about 100 m of chocolate (and less abundant grey-green), fissile shaly siltstone, which weathers to fine plates and scale-like fragments. The chocolate siltstone is overlain by 30 m of grey-green shaly siltstone which includes numerous beds of flaggy dolomite up to 25 cm thick and some flaggy, hard,

dolomitic grey siltstone. Above them the formation consists entirely of grey-green shaly siltstone.

The Angalarri Siltstone in the Collia area is generally similar, but thinly interbedded carbonate rocks are more abundant near Collia and the siltstone is more highly weathered to red-brown. The carbonate rocks, probably limestone and calcareous siltstone, are in beds 1 to 20 cm thick and interbedded with grey-green siltstone.

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

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, and fissile siltstone grades into sandstone over a vertical distance of 6 m.

Distinguishing features: The characteristic feature of the Angalarri Siltstone is its uniformity over wide areas.

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

Saddle Creek Formation and Pinkerton Sandstone

The Saddle Creek Formation and Pinkerton Sandstone have previously been defined and described from the Auvergne Sheet area by Sweet et al. (in press, b). They are discussed together because of their close spatial association.

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

Stratigraphic relations: 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 Formation.

Lithology and thickness: Seven sections diagrammatically represented in Figure 21 have been measured through the formations. The Saddle Creek Formation thickens northwards along the eastern margin of the Koolendong Valley, as shown in Sections 1 and 2. The lower contact in this area is gradational over 5 to 10 m. The proportion of sandstone interbeds in the Angalarri Siltstone increases, and sandstone becomes predominant. The Saddle Creek Formation is characterized by massive, cross-bedded, and friable sandstone overlain by siltstone.

Near the Fitzmaurice River, the Saddle Creek Formation consists of fine to medium, blocky to massive, cross-bedded and ripple-marked sandstone, with rare mud cracks and contorted beds. The siltstone is not developed, and the massive basal bed of the Pinkerton Sandstone directly overlies the sandstone. About 5 km

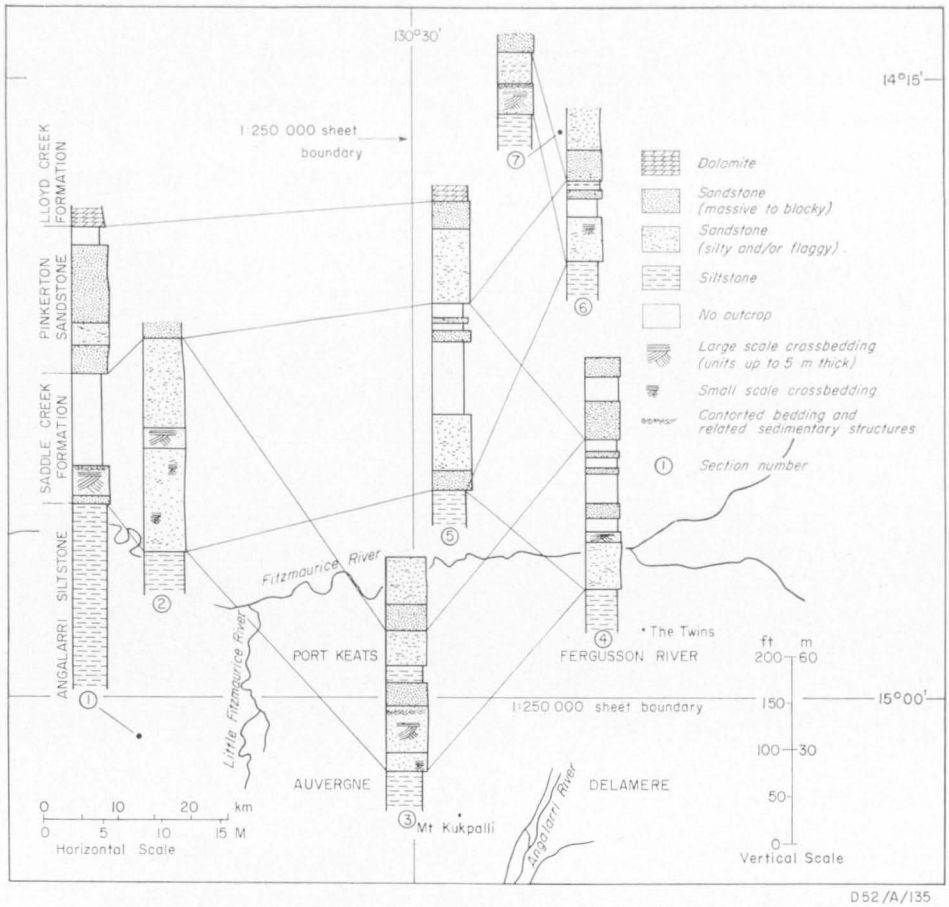


Fig. 21. Sections through Saddle Creek Formation and Pinkerton Sandstone.

farther north, bordering the Meeway Plain, siltstone occurs in the sequence above the lower massive cross-bedded sandstone.

Facies variations are apparent in the upper part of the Saddle Creek Formation between Mount Kukpalli, The Twins, and northwest of The Twins in scarps immediately north and south of the Fitzmaurice River. A considerable thickness of siltstone shown in Sections 3, 4, and 5 is accounted for by local thickening of beds. It is difficult to distinguish the boundary between the basal sandstone of the Pinkerton Sandstone and sandstone of the Saddle Creek Formation from aerial photographs.

The lower sandstone is 15 to 30 m thick throughout the area, compared to a thickness of less than 10 m in most of the Auvergne Sheet area (Sweet et al., in press, b). In the scarp between Mount Kukpalli and the northern margin of the Delamere Sheet area, friable cross-bedded sandstone 3 m to 12 m thick directly overlies the Angalarri Siltstone and is capped by an indurated thin-bedded sandstone. Primary sedimentary structures generally occur near the base of the lower sandstone, but north and northwest of The Twins, bands up to 2 m thick, containing flame and load structures and distorted bedding, tend to be restricted to the upper

part of the lower sandstone. Ball and pillow type structures of the kind described by Pettijohn & Potter (1963, pls. 100-108) are also common.

The rarely exposed upper part of the Saddle Creek Formation consists of fissile to flaggy siltstone with interbeds of massive fine-grained sericitic sandstone; some sandstone interbeds 12 km north of Mount Kukpalli are contorted by primary sedimentary structures. The slumped fissile siltstones, which wrap around massive fine sericitic sandstone, are identical with structures in the same stratigraphic position near The Tombs in the Auvergne Sheet area.

About 1 km west of The Twins, the Saddle Creek Formation consists of 20 m of sandstone which is overlain by about 13 m of massive, clean, medium-grained sandstone mapped as the base of the Pinkerton Sandstone.

The sandstone of the Saddle Creek Formation is seen overlying Angalarri Siltstone 10 km northeast of Coolamon homestead (Section 6, Fig. 21). Overlying the sandstone 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.

About 18 km west of Collia Waterhole is 11 m of massive sandstone of the Saddle Creek Formation, earlier mapped by Randal (1962) as the Depot Creek Sandstone Member of the Buldiva Sandstone. The sandstone is thick-bedded and medium-grained, and contains large-scale cross-bedded lenses (up to 10 m long and 3 m thick) whose foresets dip to the northeast. Ripple marks and small-scale slump structures are also common. Near the top of the outcrop a bed 1 m thick contains contorted bedding and flame structures.

Pinkerton Sandstone is characterized by a massive quartz sandstone at the base; it is white, weathering to light brownish red, fine to medium, and ripple-marked, and commonly contains mud flakes. It is overlain by a siltier, less massive sandstone. Lithologically the formation is similar to that described in the Auvergne Sheet area (Sweet et al., in press, b). Its thickness of 50 m in Section 1 (Fig. 21) is less than the maximum of 100 m in the Auvergne Sheet area, but similar to the 55 m measured near Bradshaw. Section 5 (Fig. 21) revealed 24 m, almost all sandstone, between the Saddle Creek and Lloyd Creek Formations.

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 about 30 m thick. The formation here consists of massive sandstone, and one bedding plane contained halite casts.

Distinguishing features: A distinctive feature of the Saddle Creek Formation is the abundance of cross-bedding and contorted bedding in the basal sandstone.

Palaeogeographic significance: The base of the Saddle Creek Formation is a shallow-water facies, deposited rapidly, probably on a sloping sea floor, as indicated by slumping and contortion. The upper part of the formation and the Pinkerton Sandstone are also regarded as shallow marine facies. The thinning of the Pinkerton Sandstone, and the occurrence of halite casts in the northeast, indicate deposition near the basin margin.

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

The three formations referred to (for convenience) as upper Auvergne Group have been described and defined by Sweet et al. (in press, b) from the Auvergne

Sheet area. They have been traced northeastwards into the Port Keats and Fergusson River Sheet areas, where they had been previously named Laurie Creek Beds by Randal (1962). This name has now been discarded. The northernmost outcrop of the upper Auvergne Group, about 16 km west of Collia Waterhole, is a highly weathered oolitic dolomite assigned to the Lloyd Creek Formation.

Stratigraphic relations: In all localities, the Lloyd Creek Formation conformably overlies the Pinkerton Sandstone and is overlain conformably by Spencer Sandstone, which is overlain in turn by Shoal Reach Formation. No younger Precambrian units were observed overlying the Shoal Reach Formation as they do in the Auvergne Sheet area (e.g. The Bullo River Sandstone).

Lithology and thickness: The lithology and thickness are essentially the same as those in the Auvergne Sheet area, and described by Sweet et al. (in press, b). The general relief of areas occupied by upper Auvergne Group is fairly low (30 to 120 m) and outcrop is poor, the best exposures being in bluffs on the outside of meanders.

The southernmost outcrop of Lloyd Creek Formation north of the Yambarra Range is 16 km northwest of Bradshaw outstation. It is about 75 m thick and is capped by 6 m of Spencer Sandstone. It comprises dolomitic siltstone in the lower portion, overlain by very silty thin-bedded stromatolitic dolomite, above which is about 15 m of blocky grey dolomite weathering yellowish brown; both intramicrite and oomicrite beds are present (Folk, 1959). The overlying Spencer Sandstone is flaggy, thin-bedded, fine-grained, quartzose, and ripple-marked, and contains halite casts and mud flakes.

Outcrops in the Port Keats and Fergusson River Sheet areas are similar to the section described; the Lloyd Creek Formation is predominantly dolomitic siltstone with interbedded oolitic and stromatolitic dolomites, and the Spencer Sandstone is a fine-grained sandstone. The northernmost outcrop of Lloyd Creek Formation is about 12 km west of Collia Waterhole.

The Shoal Reach Formation does not crop out between Lalngang Creek (Auvergne Sheet area) and the upper reaches of Alligator Creek, some 64 km farther north in the Port Keats Sheet area. In its northernmost outcrops around Alligator Creek, and east to Coolamon homestead, it is of similar lithology to its type area in the Auvergne Sheet area and consists mainly of fissile to thin-bedded, flaggy, chocolate and green siltstone. Hard flaggy interbeds richer in quartz and 5 to 10 cm thick contain ripple marks, and laminae caused by concentration of chloritic flakes. The upper part of the sequence consists of white (leached?) and purple siltstone with minor dolomite, overlain by flaggy dolomite and white dolomite-quartz siltstone.

Palaeogeographic significance: The association of dolomite, siltstone, and fine sandstone, and the occurrence of stromatolites, oolites, ripple marks, and halite casts, all point to a paralic environment of deposition for the upper Auvergne Group. The environment was probably a complex of shallow marine intertidal and lagoonal environments with a variable, but generally fairly poor, sediment supply.

PALAEOZOIC (Table 10)

Jarong Conglomerate (new name)

Derivation of name: The formation is named from Jarong Spring at 14°22′45″S, 130°49′E, 9.5 km west of Collia Waterhole in the Fergusson River Sheet area.
Distribution: The Jarong Conglomerate has a limited outcrop of about 50 km^2

between Collia Waterhole and Wombungi outstation, Fergusson River Sheet area. *Lithology:* Petromict conglomerate grading down into sandstone with conglomeratic interbeds. It contains boulders of quartzite, sandstone, schist, dolomite, granite, and chert, up to 0.6 m across.

Type locality: The northern slope of a small mesa 3 km southeast of Collia Waterhole, at 14°23′40″S, 130°55′30″E. The formation consists of 60 m of massive conglomerate; the lower half contains more sandstone matrix than the upper half. *Thickness:* The Jarong Conglomerate is up to 75 m thick near Jarong Spring. It is absent south of Wombungi outstation, 50 km south-southeast of the type section. *Age:* Probably lowermost Cambrian.

Fossils: None known.

Stratigraphic relations: The unit lies unconformably on the Soldiers Creek Granite and the Angalarri Siltstone. It is overlain, probably conformably, by the Antrim Plateau Volcanics.

Modification of previous nomenclature: None.

Description: The Jarong Conglomerate is polymict at the type locality, where the total thickness is about 60 m. The lower scarp of the hill is composed of about 15 m of conglomerate, which 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 percent feldspar. It is poorly sorted, composed of subangular grains, and locally cross-bedded. Pebbles are randomly distributed in an otherwise even-grained cross-bedded sandstone with little disruption of bedding (Fig. 22). The conglomerate consists of poorly sorted clasts which range from pebble size to boulders 60 cm in diameter, set in a medium-grained sandstone matrix. The clasts are rounded or subrounded; only the shaly or schistose inclusions are angular. Quartzite and sandstone form about 90 percent of the clasts; schist, dolomite, granite, and chert make up the remainder. The conglomerate is massive and is cut by widely spaced joints which cut across large clasts (Fig. 22). When found as isolated boulders, the hemispherical clasts resemble faceted glacial erratics. Directly east of the type locality at the scarp bordering the valley, the Jarong Conglomerate is only about 3 m thick.

A thick sequence of sandstone and conglomerate (about 75 m) crops out 24 km northeast of Jarong Spring. The large boulders are derived from Berinka Volcanics, coarse gritty sandstone, and granite. Cross-bedded quartzite and sandstone form about 80 percent of the clasts. A few pink to grey crystalline dolomite boulders with chert nodules and large stromatolites were also found. The matrix and underlying sediment are of similar composition: red-brown, feldspathic, medium to fine, poorly-sorted sandstone. The sandstone is interbedded with well sorted friable quartz sandstone which contains pebble bands 10 to 15 cm thick. It is ripple-marked and contains spotty concentrations of hematite. It may be laterally equivalent to the sandstone extensively interbedded with the volcanics in the Wombungi-Dorisvale part of the Sheet area.

About 0.8 km east of this locality, a small knob of Jarong Conglomerate rests unconformably on Soldiers Creek Granite; it consists of numerous rounded to subrounded clasts in a poorly sorted matrix of angular fragments of quartz, mica, feldspar, and clay minerals. About 75 percent of the clasts are quartzite and sandstone, about 10 percent granite, and the remainder are chert, shale, pebbly sandstone, and chlorite and mica schist.

TABLE 10. PALAEOZOIC AND MESOZOIC STRATIGRAPHY

Age	Group	Rock Unit	Map Symbol	Thickness (m)	Lithology	Physiographic Expression	Distribution*	Stratigraphic Relations
LOWER CRETACEOUS		Mullaman Beds	Klm	Up to 30	Freshwater and marine sandstone and siltstone	Flat capping on plateaux and mesas	Same as laterite (see Table 11)	Unconformable on all older rocks; invariably lateritized
		UNCONFORMITY						
TRIASSIC			R		Micaceous sandy siltstone, sandstone, shale	Low hills	SE of Port Keats Mission	Conformable on Permian
PERMIAN			P	About 2000	Conglomerate sandstone, siltstone, limestone	Low hills	Along coastline and SE of Port Keats Mission	Unconformable on Precambrian
		UNCONFORMITY						
CAMBRIAN TO LOWER ORDOVICIAN	DALY RIVER	Oolloo Limestone	Olo	60	Silicified limestone, cherty in places	Karst topography	Along Daly River in *Fergusson River*	Conformable on Jinduckin Formation
		Jinduckin Formation	Colj	60-135	Ferruginous fine to medium quartz sandstone and siltstone with halite pseudomorphs. Some marl; dolomitic and silicified limestone, conglomerate	Mesas and rocky hills to 60 m high	E half *Fergusson River* and NE *Delamere*	Conformable on Tindall Limestone
		Manbulloo Limestone Member	COlu	60	Silicified flaggy limestone	Karst topography	W edge of Daly Basin in *Fergusson River*	Limestone lenses within Jinduckin Formation
		Tindall Limestone	Cmt	150	Fossiliferous calcilutite and crystalline limestone with chert nodules and bands; some sandstone	Karst topography	Along margins of Daly Basin in *Fergusson River;* and NE *Delamere*	Unconformable on Antrim Plateau Volcanics, Tolmer Group and Cullen Granite
		Montejinni Limestone	Cmm	78	Limestone, dolomite, calcareous siltstone, mudstone	Karst topography or savannah woodlands	E *Delamere*	Unconformable on Antrim Plateau Volcanics. Equivalent in part to Tindall Limestone

UNCONFORMITY

Age	*Group*	*Rock Unit*	*Map Symbol*	*Thickness (m)*	*Lithology*	*Physiographic Expression*	*Distribution**	*Stratigraphic Relations*
LOWER CAMBRIAN		Antrim Plateau Volcanics	Cla	150	Fine and medium-grained basalt. Some vesicular layers. Interbedded sandstone, conglomerate, chert	Undulating plains, rounded and terraced hills. Sandstone forms small rocky hills	Belt from near central *Fergusson River* to SE *Delamere*	Unconformable on Precambrian units
		Jarong Conglomerate	Clj	3-75	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 N and S of Collia Waterhole	Unconformable on Precambrian units

UNCOMFORMITY

* Sheet areas in Italics.



Fig. 22. Joint plane in the Jarong Conglomerate cutting across clasts; 3 km southeast of Collia Waterhole, Fergusson River Sheet area.

About 16 km southwest of Collia Waterhole, the conglomerate, which is conformably overlain by Antrim Plateau Volcanics, consists of rounded to subangular sandstone pebbles up to 3 cm in diameter in a matrix of medium-grained poorly sorted quartz with up to 5 percent of feldspar grains; one granite boulder was found in the conglomerate.

About 5 km northeast of Wombungi, a similar conglomerate is interbedded with sandstone. Angular slabs of sandstone up to 50 cm thick are contained in a white to light grey, medium-grained sandstone matrix composed of subangular and subrounded quartz grains and 2 to 3 percent feldspar.

The general attitude of the beds is not easily determined, but they appear to be flat-lying. In a small knob 3 km northeast of Jarong Spring, elongate pebbles are aligned into bands which dip 25° south-southwest. This is assumed to be a local depositional dip since the lower contact of the unit with the granite is horizontal.

Distinguishing features: On aerial photographs the unit is represented by a soft medium-toned pattern, and the land surface is well rounded, similar to that over a siltstone.

Palaeogeographic significance: The Jarong Conglomerate lies at the base of the Antrim Plateau Volcanics and is unconformable on the Precambrian sequence. The poor sorting, steep depositional dip, and restricted occurrence suggest that the conglomerate is continental. It is everywhere close to the Collia Fault, and may well be an outwash unit from streams cutting through the scarp that the fault formed at that time. The sediments were probably derived from high areas north and east of the fault, and transported by flooding streams.

Antrim Plateau Volcanics

Distribution: In the Fergusson River Sheet area, the Antrim Plateau Volcanics crop out over an area of about 320 km^2 around Collia Waterhole, a similar area west of Wombungi outstation, and a belt up to 25 km wide and 500 km^2 in extent along the southwestern margin of the Daly Basin.

The volcanics form a belt up to 48 km wide in an area of over 3000 km^2 in the eastern half of the Delamere Sheet area; a few scattered outcrops also occur as far west as a line running north-south through Coolibah station. More extensive outcrops farther south are described by Bultitude (1971).

Topographic expression: The volcanics are not well exposed. In the western part of the belt and in the valleys round Collia Waterhole, they are exposed patchily in scarps below caps of the Mullaman Beds. The remainder of the belt consists of rounded and terraced hills strewn with cobbles of basalt, and flat black-soil plains. West of Wombungi, they underlie boulder-strewn hills up to 45 m high. The most prominent outcrops are of vesicular and amygdaloidal basalt.

Stratigraphic relations: The volcanics overlie the Precambrian rocks with angular unconformity. North of Collia Waterhole, they rest on Soldiers Creek Granite; north of Muldiva tin mine, on rocks of the Tolmer Group; and elsewhere, on rocks of the Auvergne Group. The surface on which the volcanics rest is uneven and in some places, such as east of Ingaladdi Waterhole, they occupy valleys cut in the Jasper Gorge Sandstone. The Antrim Plateau Volcanics are disconformably overlain by Middle Cambrian Tindall Limestone.

Lithology: The volcanics are mainly grey, grey-purple, or grey-green coarse-grained basalt (Fig. 23). The tops and bottoms of flows are marked by vesicles and amygdales; vesicles are filled with quartz, prehnite, banded agate, or a green mineral, probably chlorite. Sandstone, conglomerate, and limestone are interbedded with the volcanics.

Tuff exposed along the eastern side of Bamboo Creek on the northern border of the Fergusson River Sheet area consists of a fine-grained groundmass, weathered to red-brown, containing rounded and subangular fragments of quartz and quartzite up to about 30 cm across. The groundmass consists of rounded and angular grains of quartz, orthoquartzite, feldspar, and sericitized pseudomorphs (possibly after feldspar) in a matrix of iron oxide, sericite, and angular elongated grains of quartz. Several small sandstone lenses are interbedded with the tuff.

The basalt consists of anhedral to subhedral laths (0.1 to 0.5 mm) and microphenocrysts (up to 1 mm long) of labradorite, some of which is sericitized; anhedral



Fig. 23. Hard fine-grained basalt in creek bed 6 km south of Innesvale homestead, Delamere Sheet area.

to subhedral grains of augite (0.1 to 1 mm), mostly fresh but some converted to fibrous mats of chlorite; small grains of iron oxide; and a little interstitial quartz and chlorite.

Thickness: About 90 m of volcanics is exposed in scarps near the Victoria Highway at Fig Tree yard in the Delamere Sheet area. The maximum proven thickness of the volcanics in the area is 150 m, intersected in BMR Delamere No. 1 stratigraphic hole about 24 km east of Delamere homestead (Bultitude, 1971).

Geochemistry: Sixty samples of Antrim Plateau Volcanics were analysed (Morgan et al., 1970). Most of the trace element values are within the normal range for basalt, although the iron content of weathered samples is high. Copper values are generally low, although many minor occurrences of copper minerals have been recorded.

Sediments interbedded with the Antrim Plateau Volcanics

Sandstone, conglomerate, chert, and limestone are interbedded with the Antrim Plateau Volcanics (Barclay & Hays, 1965; Randal & Brown, 1967). In the area described in this Report, sandstone, conglomerate, and limestone have been found, sandstone being by far the most common (Fig. 24). The interbeds have not been given stratigraphic names.

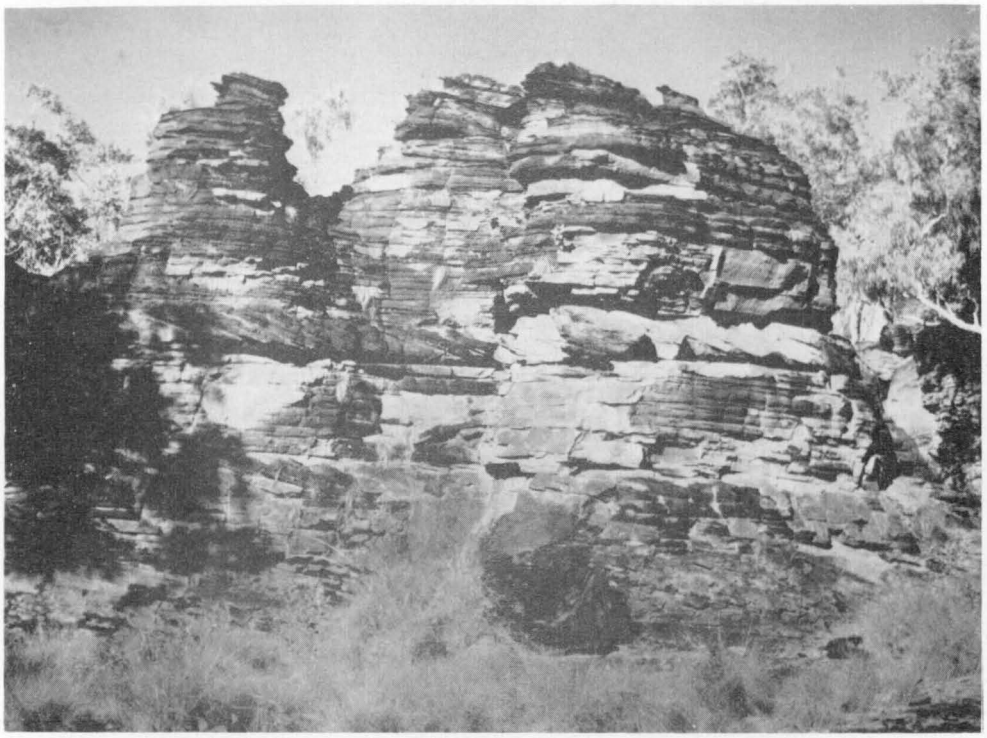


Fig. 24. Typical outcrop of sandstone interbed of Antrim Plateau Volcanics. The outcrop is about 6 m high—16 km northeast of J41 yard, Delamere Sheet area.

Outcrops of the sandstone offer good sites for roads and homesteads in country otherwise covered by black soil derived from basalt. Aboriginals have used overhangs on outcrops for camp sites and rock paintings, and have used baked indurated sandstone to make tools.

Sandstone: Elongate outcrops of sandstone occur within two belts, each up to 16 km wide and trending at about 300°. Delamere and Innesvale homesteads lie in one of these belts, and Ingaladdi Waterhole in the other. Sandstone also crops out extensively between Wombungi and Dorisvale homesteads along the western margin of the Daly Basin and in the valleys around Collia Waterhole in the Fergusson River Sheet area. The sandstone is difficult to distinguish from the volcanics on aerial photographs and there may be many more outcrops than shown on the map. Lenses occur both within, and at the base of, the volcanics.

The sandstone between Wombungi and Dorisvale homesteads and near Collia Waterhole is somewhat different from that farther south. It occurs as numerous thin (0.6 to 15 m) rather extensive sheets interbedded with the volcanics.

Along the western edge of the Daly Basin in the Fergusson River Sheet area, scattered thin beds of sandstone lie unconformably on Waterbag Creek Formation. The sandstone, light grey or cream and weathering to red-brown, is generaliy blocky or massive, but tends to have a thinner parting along the foreset beds. It is thin to medium-bedded, medium to coarse-grained, and well or moderately sorted. Exposures include friable varieties typified by honeycomb weathering and only a veneer of induration, and hard indurated rock possibly owing to baking by overlying basalt flows. Cross-bedding is ubiquitous in the Delamere Sheet area outcrops; cross-bedded units are up to 6 m 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°. In the Fergusson River Sheet area, the bedding is indistinct and cross-bedding rare or absent.

The sandstone is composed of quartz (60 to 70%), plagioclase and microcline (up to 5%), coarse and fine silt (up to 15%), fine chert (less than 5%), brown limonite (1-2%), and accessory tourmaline. The grains are rounded, 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 limonite and clay. Both fresh and highly altered feldspar are visible. The coarser silt consists of angular grains of quartz and feldspar up to 0.05 mm long in a matrix of clay, sericite, and limonite; the finer silt consists of sericite, limonite, and fine quartz. In both types 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 rocks have a clay matrix. One specimen from a sandstone dyke in the basalt had a chert cement.

Randal & Brown (1967) described a thin section of an indurated sandstone at the base of a basalt flow in which siliceous cement contains abundant needles and short prisms of an orthorhombic mineral tentatively identified as mullite.

The high content of feldspar, clay, silt, and opaque grains distinguishes the sandstone from almost all other sandstone in the district. In many places the sandstone and associated conglomerates form low vertical cliffs and crop out as well defined small mesas and stacks. In the Delamere Sheet area, the ubiquitous cross-bedding and the discordant relations between the sediments and the volcanics are distinctive. The ground underlain by sandstone tends to be slightly darker than that underlain by the volcanics. However, in some places, especially in the Fergusson River Sheet area, the sediments can only be distinguished from the volcanics (and other formations) by field investigation.

The lenses of sandstone are believed to be channel or ridge sediments which have been surrounded and overlain by basalt. Both volcanics and sandstone lie in a fluvial(?) channel cut in the Jasper Gorge Sandstone 6 km north of Ingaladdi Waterhole. Most of the evidence elsewhere supports the view that the sediment was deposited as ridges and mounds. Randal & Brown (1967) described beds near Delamere homestead, where the sandstone-basalt interface dips under the basalt and the basalt lies on the bedding surface of the sandstone. They supported the view of Barclay & Hays (1965) that the sandstone is aeolian and suggested that the sediments are longitudinal dunes, citing the large-scale cross-beds, the good sorting, the lack of pebbles, the occurrence as mounds and ridges, the sharp 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 described low elongated ridges and shallow furrows on the surface of the sandstone at the base of the volcanics, apparently caused by the viscous drag of the lava moving over the surface.

The remarkable parallelism of all the sandstone lenses is evidence in support of an aeolian origin, since only wind direction is likely to have such a uniform influence over such a large area. However, the high percentage of clay grains is not typical of aeolian units.

About 29 km southwest of Willeroo homestead, a lenticular sandstone is overlain by a thinner more extensive sheet of basalt conglomerate. For many kilometres beyond the known southwestern limits of this conglomerate, the stratigraphic interval in which it occurs is a prominent bench; the basalt forming this bench contains sandstone dykes, and it is believed that the sandstone was an infilled channel in the land surface.

Sandstone dykes: In several places the basalt beneath the sandstone contains dykes of sandstone more or less vertical and 3 mm to 1 m or more wide. In several places the dykes are severely contorted into tight folds. It seems probable that wind-blown sand was incorporated in the basalt before it solidified (Fig. 25). The sandstone,



Fig. 25. Sandstone dyke in basalt of the Antrim Plateau Volcanics. About 100 m north of main road 4 km east-northeast of Sullivan yard, Delamere Sheet area.

which probably filled cracks in the basalt, is similar to that in the overlying bed, but instead of having syntaxial rims, the grains are separated by fine quartzite.

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

A small outcrop of chert conglomerate near Pandanus Springs (29 km southwest of Willeroo homestead in the Delamere Sheet area) underlies sandstone, and consists of clasts 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 clasts 1 cm to 30 cm across. The matrix is of fine cherty material containing 40 to 50 percent of subrounded quartz grains with minor feldspar and limonite. Randal & Brown (1967) reported a barite or celestite cement in places. The basalt clasts consist of a ferruginized alteration product, possibly of glass, with laths of feldspar partly or wholly replaced by calcite. The large clasts of chert are similar to the cherty matrix and appear to grade into it; several contain lath-like structures only visible in plane polarized light, probably lumps of basalt completely replaced by chert.

Basalt conglomerate has been found in two areas, one near the main highway 29 km southwest of Willeroo homestead, and the other between 1.5 and 13 km east of Delamere homestead. On the main highway 7.5 m of conglomerate, overlying and interbedded with sandstone, consists of rounded lumps of vesicular basalt, ranging from 5 to at least 60 cm in diameter, set in a matrix similar to the sandstone. The basalt forms up to 80 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 a sandstone dyke. A similar rock crops out 1.5 km east of Delamere homestead. About 13 km east of the homestead basalt is overlain by 6 m of a conglomerate containing lumps of basalt up to 1 m across; the lumps are rounded to angular and of a wide variety of basalt types, including both vesicular and nonvesicular rock. The matrix is soft and clayey. Overlying the conglomerate is 12 m of a similar rock with a hard matrix similar to that of the sandstone, which occurs as lenses 5 to 60 cm thick in the conglomerate and also overlies it.

A sedimentary breccia, considered to be a facies variant of the Jarong Conglomerate and exposed between The Twins and Wombungi, between Wombungi and Dorisvale, and 5 km northwest of Collia Waterhole in the Fergusson River Sheet area, underlies the Antrim Plateau Volcanics. It is up to 4.5 m thick and consists of angular slabs of sandstone and minor siltstone 0.6 to 25 cm long in a matrix identical with the sandstone. Where the breccia or sandstone overlies the Angalarri Siltstone it contains numerous small fragments of shale and siltstone.

Limestone: Flaggy to blocky, purple and grey limestone is interbedded with weathered basalt 6 km southwest of Mount Freda in the Fergusson River Sheet area. The limestone is restricted to this area and contains very small ooliths, and stromatolites are abundant in beds which total about 7.5 m in thickness. Near the top of the sequence the limestone is flaggy and even fissile, and contains thin shale bands. Limestone pebbles are enclosed in the overlying basalt.

The Jinduckin Formation, a formation of the Daly River Group, was not studied in detail during this survey, but it became apparent that one sequence previously regarded as Precambrian is in fact Jinduckin Formation. Evidence for this is presented below.

Jinduckin Formation (COlj)

The Jinduckin Formation was originally named by Randal (1962) as the upper formation of the Daly River Group. In 1968, rocks previously mapped as Waterbag Creek Formation (Randal, 1962) in an area of about 650 km^2 southeast of Dorisvale, and in a strip between the Dorisvale Fault and known Jinduckin Formation 24 km northwest of Dorisvale, were remapped as Jinduckin Formation.

The following comments refer only to the remapped area as we did not examine the rest of the formation. Further information about the unit and its distribution is in Randal & Brown (1967) and Walpole et al. (1968).

The rocks were re-assigned because of their lithological affinities with established Jinduckin Formation rocks, and their tectonic setting and stratigraphic relations. The differences between our interpretation and that of Randal & Brown is shown in Figure 26.

A section measured on a prominent spur formed by Jinduckin Formation 6 km due south of Dorisvale homestead contained 44 m of dolomitic beds overlain by 53 m of siltstone and sandstone (Appendix, Section 21). A stratigraphic bore (DDH 1) drilled near Dorisvale homestead penetrated at least 256 m of Jinduckin Formation and 165 m of Tindall Limestone before entering Antrim Plateau Volcanics at a depth of 424 m (E. Lau, pers. comm.).

Similar sequences were noted in three other areas south of Dorisvale. One is about 11 km west of Kathleen Falls, where 24 m of thin-bedded grey and grey-pink flaggy dolomite are interbedded with chocolate-brown dolomitic siltstone, and overlain by 18 m of a reddish brown, ferruginous, fine to medium, well sorted, pock-marked and apparently leached sandstone. About 3 km west of Kathleen Falls, and probably higher in the sequence, interbedded thin bands of laminated dolomite and flaggy dolomite (both containing chert nodules), dolomitic siltstone and beds up to 1.5 m thick of the light-brown, fine-grained, ferruginous sandstone are exposed. It is probable that the limestone at Kathleen Falls is Manbulloo Limestone Member of the Jinduckin Formation, and not Tindall Limestone as shown on the accompanying Fergusson River Sheet.

East of the Dorisvale Fault, 19 km south-southeast of Dorisvale homestead, the sequence consists of about 30 m of cherty dolomite (in beds 7.5 to 20 cm thick), intercalated with reddish and grey dolomitic siltstone. This predominantly carbonate sequence grades upwards over about 36 m into a fine-grained, massive, friable reddish sandstone. The sandstone is interbedded with ochreous yellow and reddish brown silty mudstone for the upper 18 m of the section. The Dorisvale Fault is marked by a reef 5 m wide of silicified fault breccia in this locality and dips up to 70° have been imposed owing to drag.

Northwest of Dorisvale homestead, carbonates are 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 m of red-brown, flaggy, thin to medium-bedded sandstone composed mainly of well

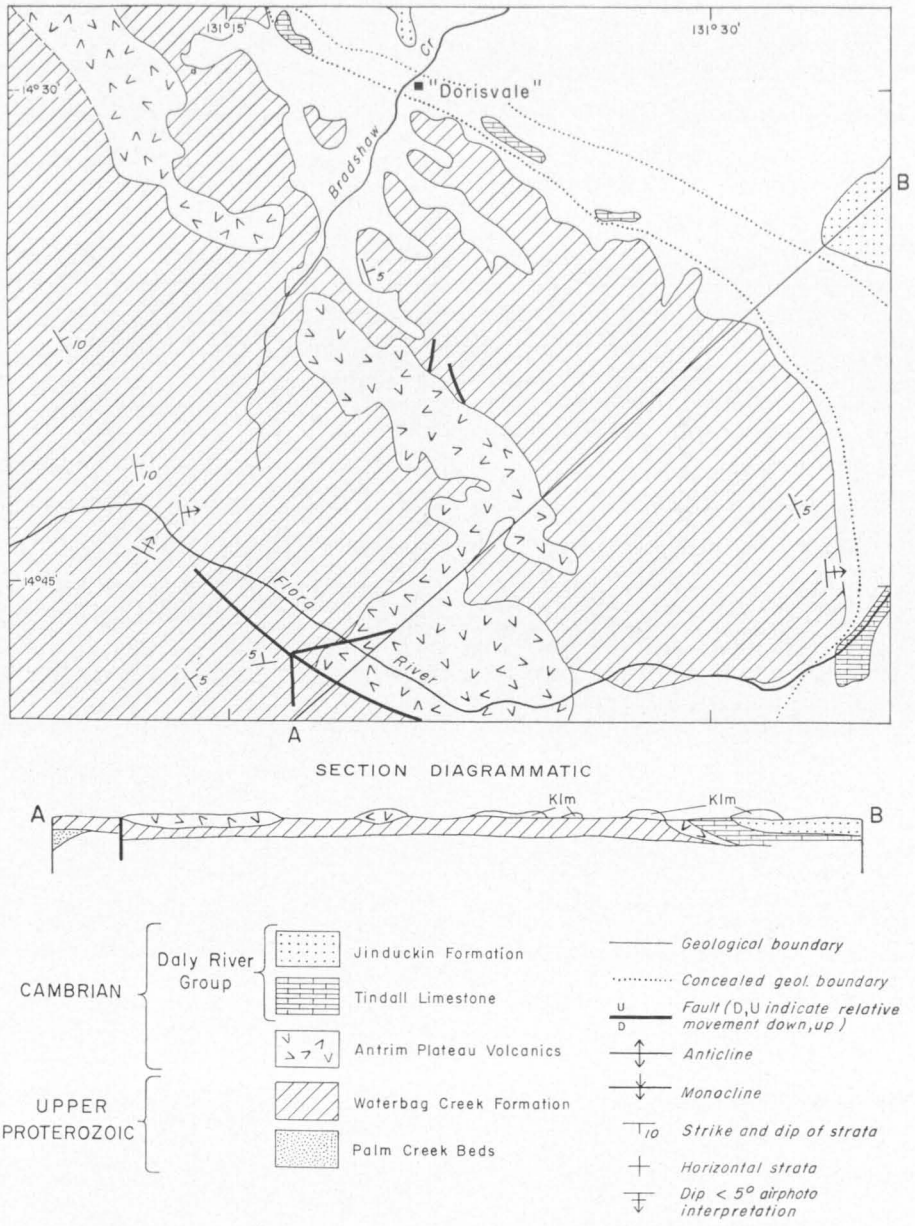


Fig. 26a. Old interpretation of geology south of Dorisvale homestead.

sorted subrounded quartz and chert fragments. The sandstone is overlain by about 30 m of pale grey, blocky, medium-bedded crystalline dolomite interbedded with sandstone and calcareous siltstone. The dolomite contains a few hemispheroidal stromatolites and isolated bands of columnar stromatolites.

The Jinduckin Formation near Dorisvale is similar to that intersected in a bore 51 km south of Katherine, BMR Scout Hole Katherine No. 1 (Randal & Brown, 1967), in which 24 m of red-chocolate brown siltstone with interbeds of

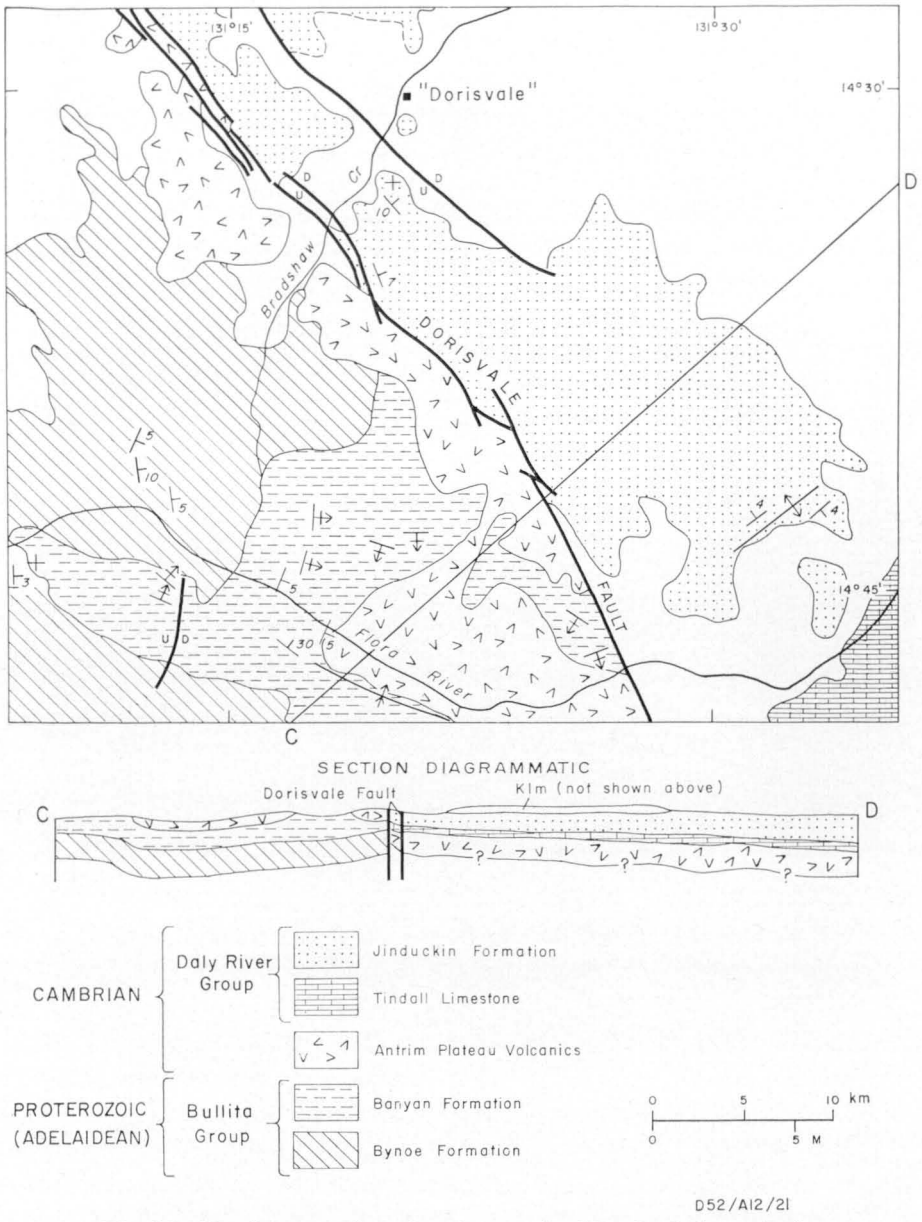


Fig. 26b. New interpretation of geology south of Dorisvale homestead.

well sorted very fine to fine sandstone grades downwards into grey silty dolomite and dolomitic siltstone containing interbeds of dolomite with associated chert. The lowermost part of the unit does not include sandstone.

Spotted dolomitic siltstone with interbedded dolomite also occurs in the Bynoe Formation west of the Dorisvale Fault, where it was previously mapped as Waterbag Creek Formation. However, the interbedded sandstone that dominates the upper part of the sequence is characteristic only of the Jinduckin Formation in this area. The sequences southeast and northwest of Dorisvale are apparently

non-fossiliferous, but fossils of Lower Ordovician age have been identified 24 km northeast of Dorisvale (Öpik, 1968) in known Jinduckin Formation. The fossils occur in the sandstone in the upper part of the formation, possibly higher than is represented near Dorisvale. M. C. Brown (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 is Lower Ordovician.

MESOZOIC (Table 10)

Mullaman Beds

Extensive outcrops of flat-lying Lower Cretaceous rocks, first described by Brown (1895), were named the Mullaman Group by Noakes (1949) and subsequently modified to Mullaman Beds by Skwarko (1966). The Mullaman Beds, described by Skwarko (op. cit.) and Randal & Brown (1967), crop out over wide areas in the eastern Delamere Sheet area, and in the central western Fergusson River and the central eastern Port Keats Sheet areas. Scattered mesas are capped by Mullaman Beds throughout much of the remainder of the area. In nearly every outcrop, the Mullaman Beds include leached, ferruginous or silicified, kaolinitic siltstone and claystone as well as sandstone.

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 composed of massive flat-lying reddish sandstone, generally capped by laterite. Where the underlying Pinkerton Sandstone is also flat-lying, and occurs as similar cliff-forming sandstone, it is difficult to distinguish between the two. Figure 27 shows Mullaman Beds unconformably overlying gently dipping Saddle Creek Formation. On the Wingate Plateau, and in most of the scattered outcrops, the Mullaman Beds consist of a thin veneer 10 to 30 m thick.

About 10 km southeast of J41 yard in the Delamere Sheet area, 35.5 m of Mullaman Beds cap a mesa. The sequence consists of medium to coarse, friable quartz sandstone 19 m thick, overlain by 16 m of friable mottled clayey sandstone with a silicified capping. The whole sequence has been affected by deep weathering and lateritization. Some almost complete laterite profiles are exposed: 1 to 3 m of nodular or pisolitic laterite cap a mottled and leached stratum at least 30 m thick.

About 12 km north of Tom Turners Crossing, near Flood Hill in the Port Keats Sheet area, about 5 m of white orthoquartzite is overlain by 1 m of ferruginous sandstone. The orthoquartzite is fine to medium grained, with some coarse grains; the sandstone is believed to be basal Mullaman Beds.

CAINOZOIC (Table 11)

Laterite

Most plateaux, and many mesas and buttes, are capped by laterite in the Port Keats, Cape Scott, Fergusson River, and Delamere Sheet areas. The laterite profile is always present on shale or claystone and on argillaceous sandstone and siltstone of the Mullaman Beds, but some older rocks may have been lateritized in areas where Mullaman Beds are absent. The ferruginous zone is generally only 1.5 to 3 m thick. Few observations were made of mottled and pallid zones, but they are probably over 30 m thick in places. Bedding is still recognizable in the mottled zone.

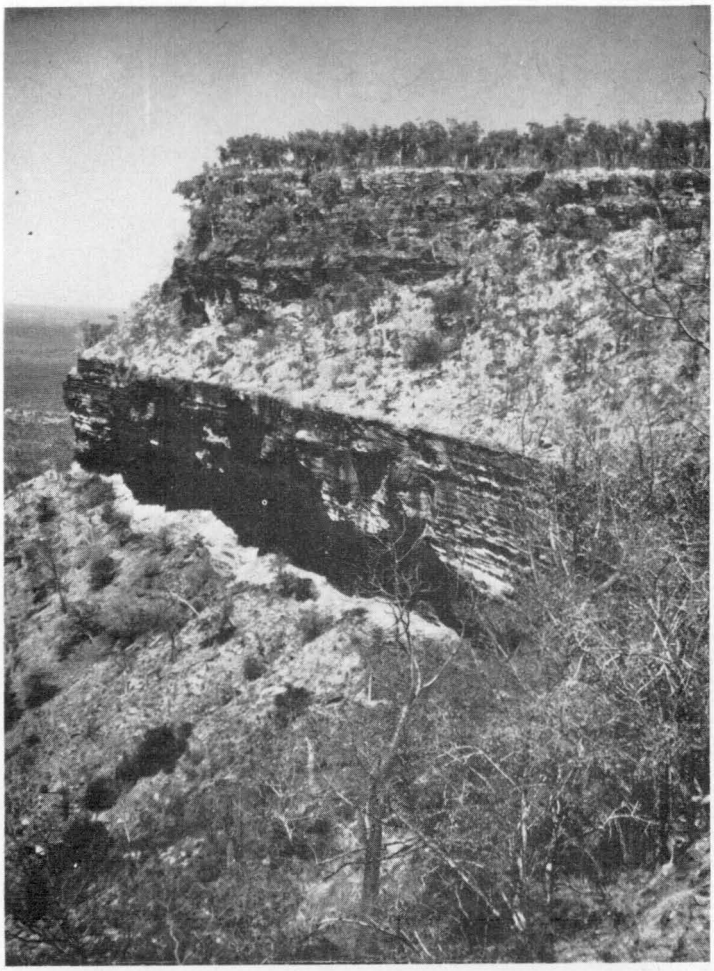


Fig. 27. Mullaman Beds overlying Saddle Creek Formation; 13 km north of Mount Kukpalli, Delamere Sheet area.

The plateaux are remnants of a landsurface named by Hays (1967) the Wave Hill Surface, and characterized by ferruginous conglomerate reworked from laterite ('detrital laterite'). It is 15 to 30 m lower than the Tennant Creek Surface of Hays, which contains a complete laterite profile. As complete profiles were observed in many places, the Tennant Creek Surface appears to be more extensive than envisaged by Hays.

No laterite occurs on the Precambrian sandstone truncated by the Wave Hill Surface, though much of the sandstone is friable and ferruginous, especially along joints. Hays considered that the sandstone was not a suitable source for a true ferruginous laterite.

The ages of the land surfaces and their associated laterites are not known accurately. The youngest rocks known to be affected are Lower Cretaceous, and although the laterite is generally regarded as of Lower Tertiary age, it could be as old as Cretaceous in some areas (Hays, 1967).

TABLE 11. CAINOZOIC STRATIGRAPHY

Rock Unit	*Map Symbol*	*Thickness (m)*	*Lithology*	*Physiographic Expression*	*Distribution**	*Stratigraphic Relations*
Coastal sediments	Qc		Mud, silt, evaporites	Salt flats, generally free of vegetation but with mangroves along coast, rivers, and inlets	Belts of varying width along coast	Superficial
Coastal sand dunes	Qs		Sand, partly stabilized vegetation	Dunes of very low relief	Along coast	Superficial
Alluvium	Qa		River silt, sand, gravel	River banks, flood plains	Along creeks. Abundant on coastal plain	Superficial
Terraces	Qt	up to 15	Sand, silt	Flat terraces	Either side of Victoria River in *Delamere*	Superficial
Soil	Czs		Residual sandy soils, travertine, colluvium. Small patches of black soil	Scrub-covered plains with low relief	Extensive in coastal plains, over granite and metamorphics in N, in Daly River Basin, and on plateau in E *Delamere*	Superficial
Black soil	Czb		Dark grey clayey soil	Grassy plains with few or no trees. Clumps of grass produce uneven surface	Along Fitzmaurice River in W *Fergusson River*, and in patches over Antrim Plateau Volcanics	Superficial
Laterite	Czl	Up to 6	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	E *Delamere*, central W *Fergusson River* and E *Port Keats*	All outcrops of Mullaman Beds are lateritized; may have formed on some older rocks
UNCONFORMITY						

* Sheet areas in Italics.

Table 12 contains analyses of laterites from several localities; in general, they are low in iron and aluminium, and high in silica, and therefore are not likely prospects for alumina.

Superficial Sediments

Czs: This includes a variety of residual soils as well as some alluvial and most colluvial sediments. 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 to 5 m) residual soils, which are generally of fine silty texture.

Scree and low-angle slope sediments at the base of scarps include gravel and some sand and silt; they are cut by numerous small gullies.

Czb: Black soil is developed in many places as a residual soil on basalt in the Delamere Sheet area, and as alluvium near the southern margin of that area. Black soil occurs within swamps in the Port Keats and Cape Scott Sheet areas, but has been included with Qa.

Qt: River terrace beds of laminated and cross-bedded fine sand and silt, believed to be of Quaternary age, occur along the Victoria River in the Delamere Sheet area. They are about 10 m above the present low river level, and in some areas are being eroded by small streams.

Qs: Along the coast, areas of light tone on aerial photographs are probably the remnants of Pleistocene strandlines, and have been delineated on the Port Keats and Cape Scott Sheets.

Qc: Includes coastal salt, mud and silt flats.

Qa: Present-day alluvium along most major and minor streams, including the swampy country in the Port Keats and Cape Scott areas, is predominantly of black alluvium with some silt and sand.

GEOPHYSICAL SURVEYS

Gravity

A regional reconnaissance gravity survey was carried out over a large part of northwestern Australia in 1967 (Whitworth, 1970). The area has been divided into a number of geophysical provinces. The *Wangites Regional Gravity Ridge* roughly corresponds with the Pine Creek Geosyncline and Fitzmaurice Mobile Belt. In the Port Keats Sheet area, the southeastern boundary of the gravity ridge corresponds closely to the Victoria River Fault, and the western boundary to the north-trending Moyle River Fault, which is the eastern boundary of the Bonaparte Gulf Basin. The crest of the gravity anomaly lies over Palaeozoic rocks, which form only a thin layer over 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 southwest at the boundary between the Port Keats and Auvergne Sheet areas, perhaps owing to a decreasing degree of metamorphism in this direction.

The *Bonaparte Regional Gravity Depression* corresponds closely to the Bonaparte Gulf Basin. The cause of the intense gravity high in the centre of the depression is unknown. The centre of the gravity low, a few kilometres from Port Keats

TABLE 12. LATERITE ANALYSES

Registered Number	*Field Number*	*Fe_2O_3 %*	*Al_2O_3 %*	*SiO_2 %*	*TiO_2 %*	*Cu*	*Pb*	*Zn*	*Co*	*Ni*	*Cd*	*Cr*	*Mn*	*Fe %*
								All values in ppm						
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	
68.77.195	X222	41.0	17.1	32.1	0.67	10	50	10	15	15	5	300	25	
68.77.196	X331	54.7	8.3	25.5	0.37	10	45	130	70	60	10	45	140	
68.77.200	E161	85.0	1.0	3.2	0.03	5	95	1600	320	250	15	30	5300	
68.77.201	E296B	48.3	14.9	24.6	0.61	5	70	15	20	30	10	220	20	
68.77.202	E158	40.9	9.5	39.4	0.58	10	50	15	20	20	10	150	50	
68.77.203	E318	51.0	13.8	20.7	0.78	10	60	15	25	15	10	160	100	
68.77.204	E296C	57.6	13.1	15.9	0.61	5	80	15	20	15	10	410	10	
68.77.205	Y130	43.8	10.0	35.9	0.63	15	60	20	25	10	10	140	25	
68.77.206	Y78	44.1	14.1	27.5	0.84	5	40	20	25	10	10	240	20	
68.77.207	Y83	36.7	4.7	50.6	0.44	10	45	15	20	10	10	120	10	
68.77.208	Y37B	50.1	9.3	27.1	0.44	5	60	10	25	5	10	220	10	
68.77.209	Y46	59.9	10.5	16.3	0.50	5	65	15	25	10	10	570	25	
68.77.210	Y168B	34.1	15.4	39.6	0.68	5	55	15	20	5	5	250	80	
68.77.211	Y223	36.4	10.2	41.0	0.34	30	70	15	30	15	10	350	170	
68.77.335	W118	46.3	15.9	25.1	0.52	5	70	70	35	10	10	270	150	
68.77.336	W119	47.2	15.6	24.2	0.58	5	60	10	25	15	10	360	5	
68.77.337	W121	41.9	10.0	36.3	0.41	5	65	10	25	15	10	400	5	
68.77.338	W282	38.4	20.2	26.2	0.75	5	65	10	25	20	5	310	5	
68.77.339	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	79.0	6.6	11.6		15	108	640	8.8	193	1.8	100	5000	55
68.77.338	W282	30.0	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. It is either a laterite or a gossan (from approx. grid. ref. 775344 in the Fergusson River Sheet area).

Mission, corresponds closely to the centre of a structural basin delineated by seismic work.

The *Tipperary Regional Gravity Low* is a feature of fairly small amplitude which roughly corresponds to the Daly Basin. It has indistinct boundaries with the Victoria Regional Gravity Shelf and the Dunmarra Regional Gravity Low which is the southeastern extension of the Tipperary Low. The axis of the gravity low lies to the west of the axis of the basin, perhaps corresponding to the extent of underlying Soldiers Creek Granite. The gravity survey results suggests that the Proterozoic, as well as the Palaeozoic, sediments become thicker southward across the basin, indicating that the basin may have been in existence during the Precambrian.

The *Marrakai Gravity Plateau* to the northeast of the Daly Basin is a relatively simple province considering that it overlies a geosyncline. It is of much lower intensity than the Wangites Ridge to the west.

The *Victoria Regional Gravity Shelf* is a vaguely defined province with small gravity variations and few structural trends. It corresponds to the Sturt Block. It may be relevant that there is a relatively high gravity value near the structural domes in the southwest Delamere Sheet area; and also that a linear gravity feature coincides with a north-northwest 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 in the Port Keats and Cape Scott Sheet areas was undertaken in 1966. It was carried out in conjunction with a seismic program by the Compagnie Générale de Géophysique (AAP, 1966) and the results correspond closely with those of the regional survey.

Aeromagnetic Surveys

Several aeromagnetic surveys have been flown over the region by the Bureau of Mineral Resources. The western part of the Port Keats Sheet area was covered in 1958, and the eastern half of Port Keats and the western half of Fergusson River Sheet area in 1956 as a joint aeromagnetic/radiometric survey. The whole of the Delamere Sheet area was covered in 1966/67. All surveys were flown on lines one mile (1.6 km) apart.

Over most of the area the contour pattern is simple, and the few anomalies appear to be produced not by the Carpentarian-Adelaidean sediments, but by Lower Proterozoic Archaean basement. The Antrim Plateau Volcanics produce some small variations of magnetic intensity. In the Port Keats Sheet area, a discontinuity in the contour pattern corresponds to the Moyle River Fault. Some of the outcrops of gabbro produce small anomalies. One linear positive anomaly in the central-eastern Sheet area is located over a thin sill-like intrusion of granite in the Chilling Sandstone.

Seismic Survey

In 1966 a seismic survey carried out over the Palaeozoic rocks east of Port Keats Mission for Australian Aquitaine Petroleum Pty Ltd by Compagnie Générale de Géophysique (AAP, 1966) confirmed the position and size of the Moyle River Fault and detected several major and minor branches of the fault. A contour map of four horizons within the Palaeozoic sequence shows a structural low near Port Keats Mission corresponding to 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

A number of basic tectonic units can be distinguished in the area (Fig. 28), including Archaean basement, Pine Creek Geosyncline, Fitzmaurice Mobile Zone, Sturt Block, and Palaeozoic and Mesozoic basins. The units approximately correspond to regional geophysical gravity anomalies. Generalized structures within these regions are shown in Figure 30.

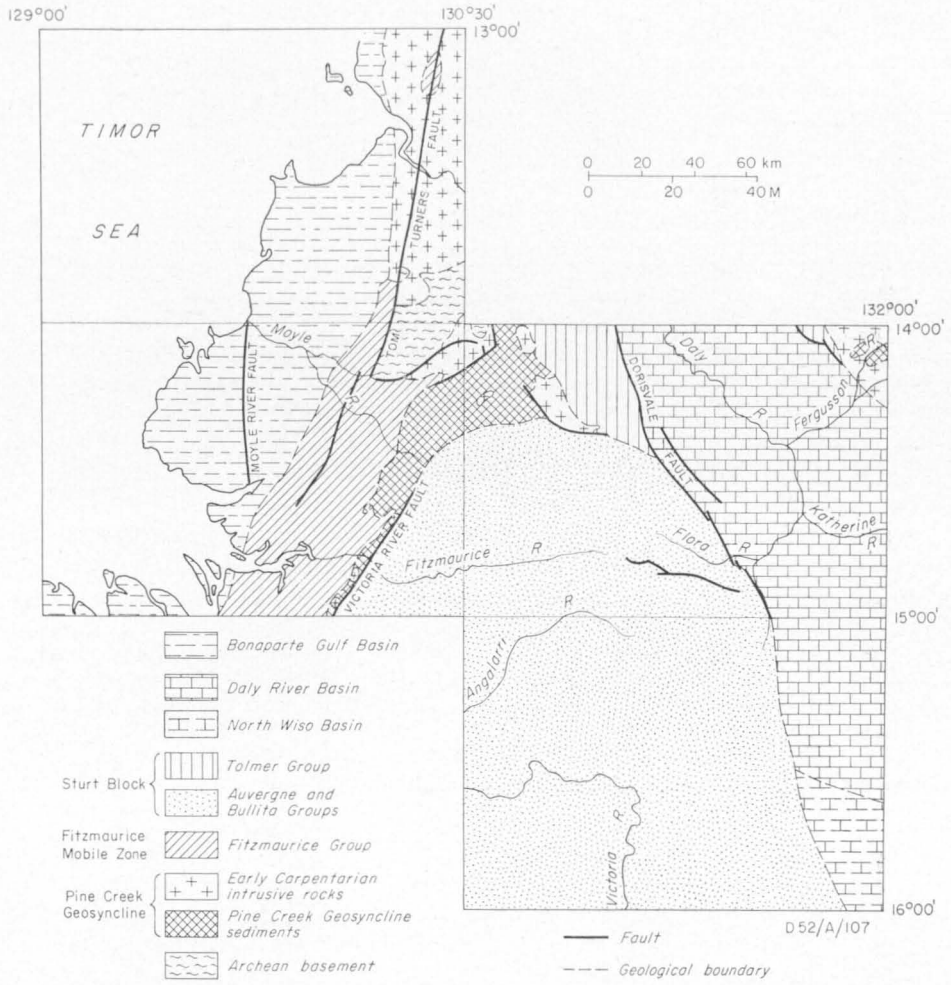


Fig. 28. Map of tectonic units in northern Victoria River region.

Archaean Basement

The Archaean Basement lies northwest of the Pine Creek Geosyncline, but is only exposed in close association with early Carpentarian granite and gabbro. The occurrence of younger intrusive rocks indicates that the Pine Creek Geosyncline extended over the presently exposed basement. Folding is intense and metamorphism ranges from upper greenschist facies to almandine-amphibolite and even granulite facies close to the intrusives.

Pine Creek Geosyncline

Only the southwestern extremity of the Pine Creek Geosyncline was mapped in this survey. The structure and tectonic history of the geosyncline were discussed by Walpole et al. (1968). It is apparent that the whole of the area became a relatively stable craton before deposition of Adelaidean rocks.

The Pine Creek Geosyncline is a thick, strongly folded sequence of greywacke, siltstone, and sandstone, metamorphosed to upper greenschist facies. The unit is terminated to the south by the Collia Fault, where it is intruded by the Soldiers Creek Granite.

In the northeast 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 Pine Creek Geosyncline displays several features characteristic of a true geosyncline such as granite and basic intrusives, greywacke, etc. but it does not contain ophiolites, thrust-faulting, or high-grade metamorphism; and hence it may best be considered as a parageosyncline or intracratonic basin (Walpole et al., 1968).

Intrusive Igneous Rocks

The intrusive igneous rocks are basically granitic, with minor gabbro, diorite, and granophyre. They are restricted in outcrop to the Archaean Basement and Pine Creek Geosyncline. There has been no intrusive igneous activity in the area since the early Carpentarian. The igneous bodies have caused only local contact metamorphism of the sediments they intruded, which suggests that contacts are steep. The contacts are commonly faulted or aligned along linear features.

The granitic rocks are intimately mixed with the Archaean sediments and some may be the product of granitization of the sediments, particularly the Litchfield Complex in 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 relations, and the Soldiers Creek Granite has all the characteristics of a high-level intrusion.

Foliations in the Soldiers Creek and Allia Creek Granites are due to the platy alignment of large feldspar crystals, and tabular xenoliths may be the result of flow movement during intrusion. Banding of quartz, feldspar, and, more rarely, biotite is common in the granitic rocks.

Fitzmaurice Mobile Zone

The Fitzmaurice Mobile Zone merges structurally with the southwestern Pine Creek Geosyncline, but the rocks in it are of Adelaidean age. They consist of a moderately folded and highly faulted sequence of quartz sandstone and siltstone. The sequence is 3000 to 12 000 m thick and forms a large synclinal structure which has a thin, steeply-dipping eastern limb and a thicker, more gently-dipping western limb. The Fitzmaurice Mobile Zone is considered to be the northerly extension of the Halls Creek Mobile Zone in the East Kimberley region of Western Australia. It appears to have been an unstable shelf area during the Adelaidean, and bordered the stable Sturt Block.

Sturt Block

The Sturt Block, part of the Sturtian Block of Noakes (1949), is the major tectonic unit in the Victoria River District. It is bounded to the west by the Victoria River Fault, and its northern limits are concealed beneath a Mesozoic cover. The



Fig. 29 (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.

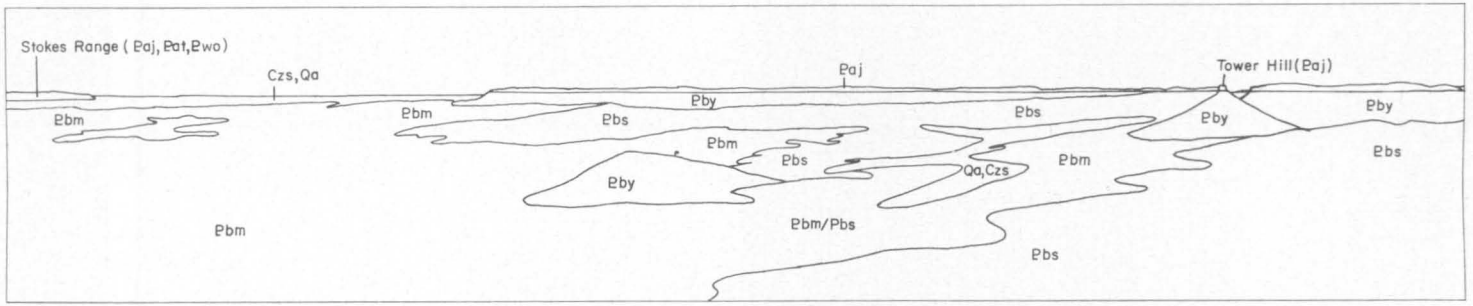


Fig. 29 (B): Well-bedded Skull Creek Formation (Pbs) with a thin capping of Bardia Chert Member (Pbm), overlain by Bynoe Formation (Pby). These rocks dip at 2° to the southeast (to the left of the photo), and are overlain with angular unconformity by flat-lying Jasper Gorge Sandstone (Paj).

Fig. 29a & b. Panoramic view of rocks in Delamere Sheet area.

block formed a craton during the Lower Proterozoic geosynclinal activity as the trends of the orogenic zone bend around the block, and appears to have remained stable ever since, though minor structures such as normal faults, monoclines, and small domes are common within it. The block is covered by a series of predominantly flat-lying and gently folded Carpentarian(?) and Adelaidean (Fig. 29) sediments. The beds dip gently away from the centre of the block, and are only folded close to the Victoria River Fault where several synclines and anticlines developed.

Tolmer Group

The Tolmer Group was deposited in an intracratonic basin within the Sturt Block. The present-day outcrop of Tolmer Group is restricted to the margins of the Daly Basin, and it has been suggested (Walpole et al., 1968) that the basin began to develop during the Adelaidean. However, because the Tolmer Group is a probable correlative of the Bullita Group, it seems likely that the present outcrops of Tolmer Group were preserved beneath the Daly Basin which developed during the Cambrian.

Palaeozoic and Mesozoic Basins

The Precambrian rocks of the Victoria River District are bounded to the east by the intracratonic Daly and Wiso Basins, and to the west by the Bonaparte Gulf Basin.

The *Daly Basin* lies 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 about 400 m of Palaeozoic sediments. The beds are rarely faulted and are only slightly warped. A concealed basement ridge divides the Daly Basin from the *Wiso Basin* to the south (Randal & Brown, 1967). The tectonic arrangement of the two basins is very similar although there is no bounding fault on the western side of the Wiso Basin.

The *Bonaparte Gulf Basin* lies west of the Fitzmaurice Mobile Zone and the Litchfield Complex in the north. In the Cape Scott Sheet area the Litchfield Complex is known to extend westwards beneath a thin veneer of sediments of the Bonaparte Gulf Basin. Farther south, drilling has proved that gabbro of the Litchfield Complex extends west as far as the concealed Moyle River Fault. The Moyle River Fault is a major structure, and probably formed the eastern margin of the Bonaparte Gulf Basin for much of the Palaeozoic Era. Detailed geophysical work (seismic, gravity, and magnetic) has accurately positioned this fault. At Kulshill No. 1 well, 13 km east-southeast of Port Keats Mission, drilling was halted in Devonian sediments at 4440 m (Duchemin et al., 1966).

FOLDING

Folding is widespread in the Victoria River district and varies from gentle warping to intense polyphase deformation. Figure 30 shows the main fold axes and their plunge directions.

The Archaean Basement has been affected by several phases of deformation. Walpole et al. (1968) reported a primary east-west foliation, and the 1968 mapping revealed a secondary foliation which appears to be an axial plane schistosity, or in places merely a cleavage; the secondary foliation has a regional significance; its average strike is 025° and dip 85°W, ranging from 045°, vertical, to 010°, 80° W. The associated minor folds range from small chevron folds to larger similar, and even concentric, folds.

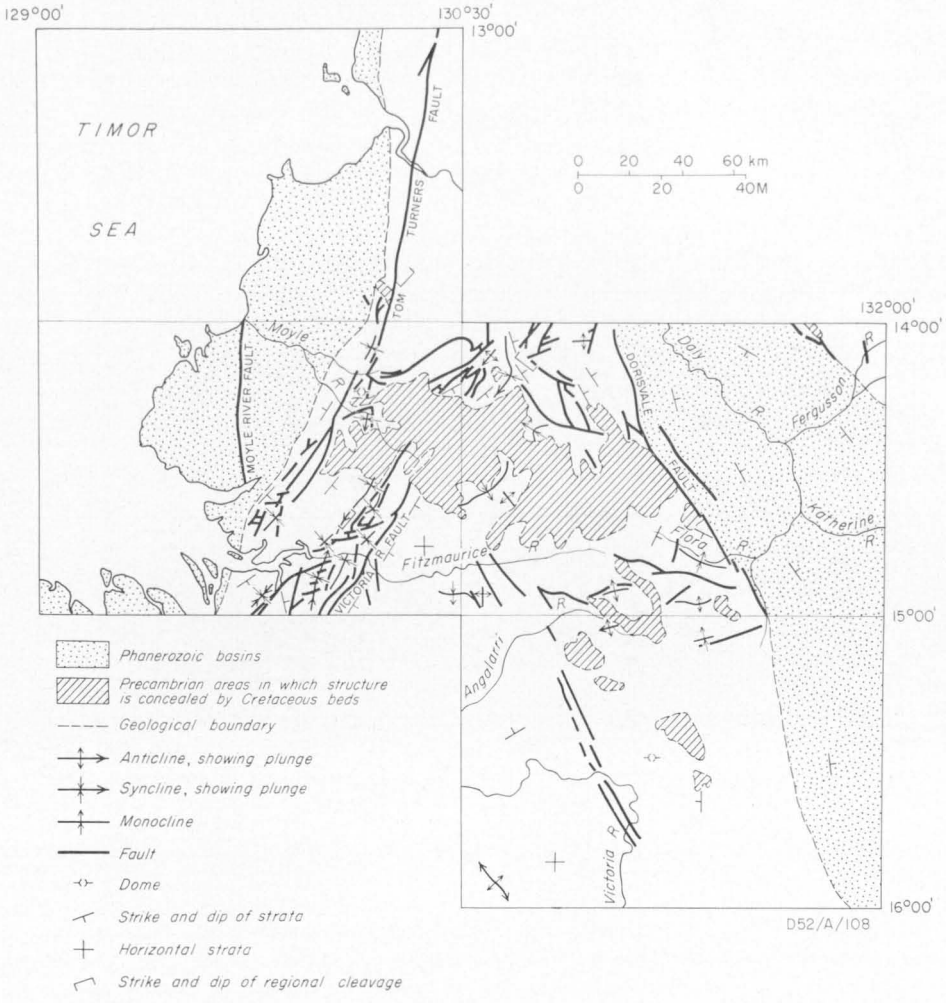


Fig. 30. Map of structural elements in northern Victoria River region.

The folds vary in wavelength from 8 to 60 cm and in amplitude from 5 to 90 cm. Chevron folds are generally small and similar and concentric folds larger. The folds and associated foliation probably formed during the Pine Creek Orogeny and 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.

The Pine Creek Geosyncline is moderately to tightly folded (Walpole et al., 1968). The regional cleavage, which is very well developed in the finer-grained rocks, ranges from 030°, dip 85°E, in the Port Keats Sheet area, to 115°, 85°N, in the Muldiva Creek region. The fold axes have a similar range.

In the Muldiva Creek region, a large syncline has a variable southerly plunging axis. The more incompetent siltstone and shale beds show local isoclinal and disharmonic folding, whereas the more competent sandstone and greywacke are in regular concentric folds.

The Fitzmaurice Mobile Zone is a moderately folded and strongly faulted synclinorium. The axes of the folds are aligned parallel to the trend of the mobile zone, and their plunges are not variable like some of those in the older units.

The Sturt Block exhibits a variety of fold styles. The trend of the monoclines is variable, but many are aligned east-west. Monoclinal folds are thought to be caused by renewed movements along older fault lines in the basement. There are several east-northeasterly anticlines in the southern Fergusson River Sheet area. These, and a series of north-northwesterly normal faults on the Sturt Block are probably a result of a late Adelaidean or early Palaeozoic stress system. Several domes crop out in otherwise flat-bedded rocks in the Sturt Block; their origin is not known: Laing & Allen (1956) suggested that they were formed by transcurrent movement between basement blocks.

Local small kink folds are associated with the major faults. Small-scale folds with horizontal axes occur in the Goobaieri Formation within 0.5 km of the Victoria River Fault. A larger drag-fold immediately northwest of the Chalanyi Creek Fault in the Macadam Range in the Port Keats Sheet area suggests that sinistral transcurrent movement took place along the fault.

Metamorphism

The effects of metamorphism are identifiable in the Archaean Basement and the sedimentary and igneous rocks of the Pine Creek Geosyncline.

Regional metamorphism of the Archaean Basement postdates the second fold phase, perhaps obscuring an earlier metamorphism. The later metamorphism is recognizable by mineralogical changes; biotite and chlorite show a syntectonic origin, but garnet formation was post-orogenic. The rocks grade from upper greenschist facies to locally almandine-amphibolite facies. Identifiable retrograde metamorphic effects are garnet replacement by chlorite, biotite, and quartz.

Later contact metamorphism caused by intrusion of the Litchfield Complex produced high-grade metamorphic rocks such as garnet-sillimanite-corundum-cordierite rock in the Dilke Range in the Cape Scott Sheet area. Tourmalinization is widespread in the contact zone. Some retrograding of garnets has occurred within the Litchfield Complex, possibly through slow cooling of the igneous mass at depth. Migmatization of some of the Archaean rocks indicates reaction at deep crustal levels.

Rocks of the Pine Creek Geosyncline have undergone regional metamorphism and local contact metamorphism along the margins of intrusive igneous rocks. The contact metamorphism is typified by tourmalinization. Andalusite and garnet are widespread in the finer-grained clastic rocks, garnet commonly showing a syntectonic origin by virtue of its rotated porphyroblasts. Retrograde metamorphsim has resulted in almost complete replacement of the garnet by sericite. The Chilling Sandstone has been converted to a metaquartzite.

Faulting

The most outstanding faults in the Victoria River District are the Victoria River and Dorisvale Faults. The former is a high-angle reverse fault in the Port Keats Sheet area, though the angle decreases farther south (Sweet et al., in press, b). The Dorisvale Fault appears to be a normal fault which shows evidence of several periods of movement, the latest of which occurred during the Tertiary.

Of the few major faults mapped in the Archaean Basement, the Tom Turners Fault, probably an early high-angle reverse fault, depresses the western block.

Its southerly continuation in the Fitzmaurice Mobile Zone, the Chalanyi Creek Fault, shows evidence of sinistral transcurrent movement. The major faults of the area are parallel to the Pine Creek Geosyncline and were presumably caused by the Lower Proterozoic orogeny. Renewed movements at various times since their inception has obscured the true relation of the faults. The relation of a primary northeast-trending system of faults with a later cross-cutting east-west set of folding (Fig. 30) is admirably shown in the Fitzmaurice Mobile Zone. In the Sturt Block, east-west faults appear to be the older; the north-northwest faults are Late Adelaidean or Palaeozoic.

GEOLOGICAL HISTORY

The rocks exposed in the Victoria River District range in age from Tertiary to Archaean and span a period of 2500 m.y. or more. The geological history 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.

In the Archaean, coarse-grained quartz siltstone and silty sandstone are assumed to have been deposited in a basin and subsequently folded along east-west axes and metamorphosed. Synorogenic ultrabasic and basic rocks were intruded into the sediments. This orogenic belt was then uplifted and gradually eroded, most of the derived sediments being redeposited in the Pine Creek Geosyncline. The Henschke Breccia, which consists of about 1000 m of polymict conglomerate, may represent rapid deposition on the western margin of the geosyncline; conglomerate and grit also crop out farther south in the Meeway Plain area. The Sturt Block probably has a basement of Archaean rocks, and acted as a foreland during the formation of the Pine Creek Geosyncline.

Hills (1956) and Walpole (1960) suggested that the Pine Creek Geosyncline was formed by segmentation of the Archaean 'shield' by subcrustal convection currents. Walpole et al. (1968) postulated alternating tensional and compressional stresses directed roughly east-west, producing north-northeast and west-northwest zones of transcurrent movement, and followed by subsidence that initiated sedimentation. The Noltenius Formation consists of flysch beds: fine-grained siltstone and greywacke are the predominant rock types. In contrast, the clean quartz sandstone of the Chilling Sandstone was deposited later in a shallow-water current-swept environment at 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, the western margin continued to be an active zone, as is shown by the many faults and basic and acid intrusives along its length.

The late Lower Proterozoic folding and metamorphism that affected the Pine Creek Geosyncline also refolded and remetamorphosed the Archaean rocks along north-northeasterly axes. Folding was not intense; metamorphism reached a grade of upper greenschist, and locally almandine-amphibolite facies. No thrust-faults or ultrabasic intrusives have been recognized in the geosyncline. Retrograde metamorphism to lower greenschist facies took place after the folding episode. Basic rocks are concentrated along the western margin of the Pine Creek Geosyncline. Diorites and granophyre were also intruded into the Lower Proterozoic rocks.

During the early Carpentarian, several granitic masses were emplaced within the Pine Creek Geosyncline. The granites locally contact-metamorphosed to horn-

blende hornfels facies and tourmalinized the geosynclinal sediments, and formed migmatites from Archaean schists and pegmatitic material. The metamorphic aureoles in Archaean basement are wider and reach pyroxene hornfels facies. Pegmatites are particularly abundant within the Litchfield Granite and the Soldiers Creek Granite. The Edith River Volcanics were extruded after the emplacement of the granites; present-day exposures are concentrated near the Cullen Granite.

The Archaean, Lower Proterozoic, and Carpentarian rocks were deeply eroded before a thick early or middle Adelaidean arenite sequence (the Fitzmaurice Group) was deposited in a fault trough, fairly rapidly and close to the source of sediment, and folding associated with further faulting probably occurred soon after lithification. Fault movement continued until late Palaeozoic time.

A much thinner sequence was deposited on the Sturt Block during the Adelaidean; some of the sedimentation may have been contemporaneous with that of the Fitzmaurice Mobile Zone, but correlations across the Victoria River Fault are impossible. The early sedimentation in the area was mostly shallow marine and paralic, with carbonate sediments predominating, but with some periods of mainly clastic sedimentation. After consolidation, a period of uplift and erosion took place. The rocks (Bullita Group) were gently folded, and several monoclines and small dome structures formed. Warping was strongest in the western Delamere Sheet area, where the Bullita Group dips at 5° to 10° beneath flat-lying Auvergne Group sediments. Farther east, only slight tilting occurred, and silt, sand, and mud were deposited (Wondoan Hill and Stubb Formations) in a shallow marine environment. In the Fergusson River Sheet area, a probable laterite bed is widespread beneath the Jasper Gorge Sandstone, indicating subaerial conditions with a seasonal wet climate.

The Tolmer Group was deposited in a quiet shallow sea which became progressively deeper at first, but later shallowed, intermittently to lagoons in which a dolomite sequence with abundant stromatolites was deposited, and finally regressed completely, so that the sediments were eroded.

Auvergne Group deposition began when a marine transgression deposited shallow-water sands throughout the area (Jasper Gorge Sandstone). As the sea deepened, finer sediments were laid down (Angalarri Siltstone). Shoaling or uplift preceded a long period of shallow marine and paralic sedimentation (upper Auvergne Group).

During the Lower Cambrian, extensive tholeiitic flood basalts poured over at least the eastern half of the mapped area. The basalts were probably extruded mainly in subaerial conditions as is shown by interbedded dune sands, but some were subaqueous and contain beds of limestone and conglomerate in the Fergusson River Sheet area.

Later, the Tindall Limestone was laid down in a quiet shallow sea during the Middle Cambrian. The limestone is conformably overlain by a dolomite-sandstone-siltstone unit, the Jinduckin Formation, which was deposited under littoral and at times subaerial conditions. The upper parts of this unit and the overlying Oolloo Limestone are Lower Ordovician.

In the Daly and Wiso Basins, there is no evidence of further sedimentation until Lower Cretaceous time. Farther 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 diamictite. Slight folding and faulting occurred between Cambrian and Cretaceous times.

During the Lower Cretaceous, non-marine fossiliferous sandstone and marine claystone were deposited over a wide area. Skwarko (1966) described the palaeogeography and depositional history of these beds.

Laterite was formed extensively during the Tertiary, mostly on Cretaceous rocks, and in many places obscures the underlying Precambrian rocks. Later Tertiary and Quaternary warping, uplift, and erosion have influenced the development of the present-day landscape.

ECONOMIC GEOLOGY

The Woolngi and Fletchers Gully goldmines and the Buldiva, Muldiva, and Collia tin mines are the main sites of known mineralization (Crohn, 1968). All are 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 barite. 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 (Geotechnics, 1968; Morgan, 1972).

Gold

Woolngi Goldfield. The Woolngi Goldfield in the northeast Fergusson River Sheet area was first mentioned in mining reports in 1897 and was abandoned in 1908. The gold occurs in quartz reefs about 1 m 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.

Fletchers Gully Goldfield. Alluvial gold was reported at Fletchers Gully in the northwest Fergusson River Sheet area in 1905; since then, the history of the field has been one of repeated closing and re-opening. Lode gold occurs in quartz reefs that fill fissures and tension cracks associated with an anticline in the Noltenius Formation. Both alluvial and lode gold were worked until the 1940s. About 84 kg of gold are known to have been won from the field.

Brown (1895) assayed a quartz reef in the sediments of the Fitzmaurice Group near the mouth of the Fitzmaurice River. One sample showed 56.6 g of silver per tonne; another yielded traces of gold.

Tin (Table 13)

Tin was first discovered at Fletchers Gully in 1905, shortly after the end of the first gold rush to that area. It occurs as cassiterite in small pegmatite dykes associated with the Allia Creek Granite.

The tin deposits at Buldiva, Muldiva, and Collia were first seriously worked in 1922. At Buldiva, tin was won from numerous 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 came from the latter.

At Muldiva, some production came from quartz-mica-tourmaline-cassiterite lodes intruded into schist of the Noltenius Formation. The largest lode ranged from 30 to 60 cm wide and was traced for 45 m, but most production was from alluvial deposits.

TABLE 13. TIN PRODUCTION

Period	*Locality*	*Tin concentrate (kg)*
1910	Fletchers Gully	2036
1922-23	Fletchers Gully	4276
	Collia	1018
1923-24	Collia and Muldiva	26758
1924-25	Collia	5560
	Muldiva	3767
1925-26	Collia and Buldiva	5114
1926-27	Collia and Buldiva	554
1927-28	Collia	138
1928-29	Collia	1488
1935-36	Buldiva and Fletchers Gully	N.A.
1937-38	Fletchers Gully	N.A.
1940-41	Fletchers Gully	35.6
1943-44	Fletchers Gully	223.4
1948-49	Collia	101.8
1950-51	Collia	203.6
1951-52	Collia	397.0
1952-53	Collia	356.3
1953-61	Collia	N.A.
1961	Collia	224 (163)
1962-65	Collia	N.A.
1966	Collia	7573 (4683)
1967	Collia	33787 (24259)
1968-70	Collia	N.A.
1971	Collia	— (162.3)

N.A.—Figures not available (probably no production).
Figures in brackets show kilograms of contained metal.

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 east of the Sturt Highway crossing of the Fergusson River, where torbernite and autunite, with copper and cobalt minerals, occur in sheared Cullen Granite near the contact of the granite with the Burrell Creek Formation (Crohn, 1968). Four other radioactive mineral occurrences were located in the Cullen Granite; in these the mineral, probably autunite or meta-autunite, is associated with quartz reefs. All prospects were examined in detail by Commonwealth geologists, who recommended that no further work be done (Fisher, 1952; Gardner, 1953 a, b).

Copper

Copper prospects west of the Woolngi Goldfield are shown on Jensen's map (1915). Copper was recovered from Woolngi before 1896, but production figures are not 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.

Copper may occur at the contact between the Antrim Plateau Volcanics and the overlying Cambrian limestone in the Delamere and Fergusson River Sheet areas, as secondary copper minerals have been found at the contact elsewhere.

Barite

Reefs and aggregates of barite, with traces of galena, occur at Thompsons Pocket, southwest of Dorisvale homestead (Fergusson River Sheet area). They are probably associated with sandstone interbedded with Antrim Plateau Volcanics, although contacts with the country rock are not exposed. A little barite also occurs in the Soldiers Creek Granite 8 km northwest of Collia Waterhole.

Small aggregates of barite are also found in the Bynoe Formation about 6 km west of Coolibah homestead in the Delamere Sheet area. A vein up to 1.5 m wide and 4 m long was seen in the Skull Creek Formation in an anticline in the southern Fergusson River 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

Galena occurs as crystals up to 5 mm across and as small aggregates in recrystallized limestone in the Banyan Formation north of the junction of Flora River and Banyan Creek. The limestone is stromatolitic, and contains halite casts.

Iron

Laterite of probable Tertiary age covers much of the Mullaman Beds. The ferruginous zone is either irregularly nodular and contaminated with porcellanite, quartz sand, and various clays, or pisolitic, and consists almost entirely of hydrated iron oxide. A maximum thickness of 6 m was measured 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 12 contains analyses of several laterite samples from the area.

Phosphate

In recent years, phosphate has been sought 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 northwestern 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 in 1956 (BMR, 1956). A number of minor radioactive anomalies were discovered, of which 85 percent are located in laterite overlying the Mullaman Beds, and the other 15 percent are near outcrops of laterite. Most, but not all, of the anomalies are in the area covered by the Fitzmaurice Mobile Zone.

A more detailed airborne radiometric and geological survey was made in the area by Planet Gold N.L. in 1968, but no discoveries were announced.

Oil

Three exploratory oil wells (Kulshill Nos. 1 and 2 and Moyle No. 1) drilled for Australian Aquitaine Petroleum in 1965-66 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 fluorescence were encountered in both 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 were intersected in boreholes in Permian rocks between the mouths of the Fitzmaurice and Daly Rivers in the Port Keats and Cape Scott Sheet areas. They were originally found in Government bores drilled between 1905 and 1909 (Brown, 1908). In 1965-66 coal seams were intersected in Kulshill No. 2 oil well at 390 m. In 1967, five shallow bores (Kuriyippi 1-5) were drilled for Theiss Bros Ltd in an attempt to find commercial quantities of coal (Geotechnics, 1968) between Table Hill and Kulshill Creek in the Port Keats Sheet area. Carbonaceous material was intersected in four holes, but no thick coal seams of wide lateral extent were found within 915 m of the surface. The coal occurs in the Lower Permian 'Sugarloaf Formation', in 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 is 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 m thick; all others were less than 23 cm thick.

Water Resources

Surface water resources have been used for stock since cattle were first introduced. 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 throughout the year. Although the Victoria River virtually stops flowing by about August, long reaches of the river still contain abundant water.

Annual discharges of the Victoria and Daly Rivers are large; the figures available show that each probably has a total discharge in excess of that of the Ord River (AWRC, 1965). Practically none of this water is used for agricultural purposes at present.

Freshwater springs are found in several localities at the base of the Pinkerton Sandstone which acts as an aquifer, and the siltstone at the top of the Saddle Creek Formation provides the impervious layer which causes the water to move laterally and eventually seep out where the contact is exposed by a scarp. Such springs are found in pockets along the southern side 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.

Groundwater resources are being increasingly exploited for pastoral purposes. Table 14 shows the number of bores drilled to date in the Sheet areas investigated, most in the Delamere Sheet area, and within the last 10 years. Further details of bores drilled to date are included in Mendum (1971), Morgan (1972), Pontifex & Mendum (1972), and Sweet (1972).

Adequate water for stock can almost certainly be found in the Cape Scott, Port Keats, and Fergusson River Sheet areas. Most of the bores drilled have satisfactory yields.

In 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/hour), but dry

TABLE 14. WATER-BORES

Sheet Area	*Number of bores drilled*	*Comments*
Cape Scott	14	On eastern margin, on Elizabeth Downs and Litchfield stations
Port Keats	8	Mostly shallow holes at Port Keats Mission
Fergusson River	11	Mostly near Dorisvale homestead
Delamere	65	Most on Delamere and Fitzroy stations

holes are common. The most likely places to drill are in areas in which photolinear features are apparent, or where interbeds of sandstone or chert are known.

(2) The southwestern sector, comprising 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 enhanced by drilling down into chert or dolomite of the Skull Creek Formation. The success rate has so far been low.

(3) The northwestern sector, underlain by Angalarri Siltstone. Because this formation forms plains, surface water is inadequate for stock. Unfortunately, the Angalarri Siltstone is impermeable, and yields very little water. Boreholes intersecting either the alluvium above the siltstone in some areas, or sandstone near the base of the siltstone or underlying the Jasper Gorge Sandstone, may be successful. To penetrate the Jasper Gorge Sandstone, holes up to 300 m deep will be required; the potential of the Jasper Gorge Sandstone as an aquifer is unknown.

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APPENDIX—STRATIGRAPHIC SECTIONS

This appendix contains descriptions of most sections measured in the field and a few estimated in the office with the aid of aerial photographs and measured dips.

Most sections were measured using a 100-ft tape and Brunton compass; appropriate corrections were made for slope of land, dip, and deviation from the ideal cross-strike direction. Some sections were measured with an aneroid barometer, and these were corrected for errors caused by diurnal pressure variations. Measurements of field sections were made in feet (to the nearest foot) and subsequently converted to the nearest 0.5 metre.

Lithological descriptions have been set out, as far as possible in the following manner: nature of parting (massive more than 100 cm, blocky 15-100 cm, flaggy 1-15 cm, fissile less than 1 cm), nature of bedding (thick-bedded more than 30 cm, medium-bedded 10-30 cm, thin-bedded 1-10 cm, laminated less than 1 cm, after Dunbar & Rodgers (1957, p. 57). Colour, texture, rock type, sedimentary structures, and additional information are given in addition to the parting and bedding terms.

The grade-scale used for sandstone descriptions is that of Wentworth (1922), as it appears in Pettijohn (1957). Calcareous rocks have been classified using the system of Folk (1962). Finely crystalline carbonate rocks have generally been called dolomites or limestones rather than micrites.

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SECTION 1: Moyle River Formation southwest of Tom Turners Crossing, Port Keats Sheet area. Thickness estimated from aerial photographs using measured dips.

Thickness (m)	
	Overlain by Goobaieri Formation
1300	*Sandstone*: white or red-brown, massive or blocky, thin-bedded, medium and fine, 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,* fissile or flaggy and micaceous
3200	*Sandstone*: grey and white, blocky and massive, fine to coarse (mostly fine and medium), friable, with small and large-scale cross-beds. Interbeds of *siltstone* and fine *sandstone*
450	*Siltstone*: grey and purple, fissile and flaggy
1350	*Sandstone*: grey, massive, thin-bedded, fine and medium, some gritty, poorly sorted interbeds; some thin cross-bedded units
400	*Siltstone*
3350	*Sandstone*: grey or light brown, massive, fine or medium, friable. Some thin lenticular interbeds of coarse sandstone and pebble conglomerate
100	*Sandstone*: pink and red-grey, massive, thin or thick-bedded, medium or coarse; 1 to 2% of clay matrix; somewhat friable; thin cross-bedded units. Silty interbeds common. Friable poorly sorted coarse sandstone at base
Total 10600	*Underlain by granite*

SECTION 2: Moyle River Formation between Tom Turners Crossing and Docherty Hills (estimated only).

Thickness (m)	
	Overlain unconformably by Permian rocks
2450	*Sandstone*: white or grey-purple, blocky, medium-grained with minor coarse interbeds. Mud flakes and ripple marks
1550	Very little outcrop. Probably predominantly *siltstone;* one prominent band of sandstone in centre of unit
6000	*Sandstone*
Total 10000	

SECTION 3: Top 173 m of Goobaieri Formation measured 13 km northwest of Koolendong yard, at grid ref. 609352, Port Keats Sheet area.

Thickness (m)	
	Overlain by Lalngang Formation
9	*Siltstone*: interbedded with sandstone. *Sandstone* white or light blue-green, flaggy, laminated, very fine; mud cracks common
3	*Sandstone*: white, blocky to flaggy, medium-grained, well sorted; about 2% kaolinized 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; and *sandstone*: white, very fine, micaceous
6	*Sandstone*: white, blocky, thin-bedded, medium-grained, poorly sorted, about 2% white clay grains, possibly kaolinized feldspar. Also interbeds of coarse sandstone, poorly sorted, with subangular to subrounded grains
5	No outcrop
3	*Sandstone*: white, blocky, thin-bedded, fine, well sorted, slightly friable, with about 1% muscovite
Total 173	*Soil plain at base—no outcrop*

SECTION 4: Goobaieri Formation (estimated) west of Madjellindi Valley, Port Keats Sheet area (adjacent to Chalanyi Creek Fault).

	Thickness (*m*)	
		Faulted against Lalngang Formation
	100	Grey *siltstone*
	30	*Sandstone*: white, blocky, fine
	100	*Siltstone*: grey, fissile and flaggy, laminated
	150	Interbedded *siltstone* and *sandstone*. Siltstone: grey or brown, flaggy to fissile, laminated, micaceous; some dark grey and slaty. Sandstone: green and grey, blocky, fine to medium, poorly sorted, muscovitic
	250	*Siltstone*: very dark grey, fissile to flaggy, laminated
Total	630	*Underlain by Moyle River Formation*

SECTION 5: Lalngang Sandstone (estimated) between Madjellindi Valley and Meeway Plain, Port Keats Sheet area.

Thickness (*m*)	
	Overlain by Legune Formation
500	*Sandstone*: white, blocky to massive, thin-bedded with alternate beds of medium and coarse grains, poorly sorted, friable in places, with 2 to 5% soft white clay matrix. Towards base the sandstone is moderately sorted and medium-grained
200	*Siltstone*: purple, fissile to flaggy, laminated, with interbeds of blocky, medium to coarse *sandstone*
500	*Sandstone*: white, blocky to massive, thin-bedded, medium-grained, very poorly sorted, some grains 5 mm across, contains soft clay matrix
Total 1200	*Underlain by Goobaieri Formation*

SECTION 6: Hinde Dolomite (measured with tape) at the northern margin of the Fergusson River Sheet area.

Thickness (*m*)	
	Top of hill
15	*Dolomite*: flaggy and blocky, medium-bedded, pink and purple, crystalline
12	*Dolomite*: flaggy to blocky, medium-bedded, pink, finely crystalline
37	*Dolomite*: pink, blocky, top overlying stromatolitic grey crystalline *dolomite* with some intraclasts. Large colonial stromatolites interbedded with fawn silty dolomite bands and many thin siltstone bands
Total 64	*Bottom of hill*

SECTION 7: Hinde Dolomite (measured with tape) 13 km northeast of Collia Waterhole.

Thickness (m)	
	Overlain by chert and sandstone
63	Poor outcrop. Some *dolomite,* but probably mostly *dolomitic siltstone.* Some scree of almost black shale
10	*Dolomite*: grey and yellow-brown, flaggy, blocky and massive, finely crystalline
6	Poor outcrop. Some *dolomitic siltstone* in scree
3.5	*Dolomite*: blocky and flaggy, some yellowish fissile *siltstone*
4.5	*Dolomite*: flaggy, poor outcrop. Probably some interbedded *siltstone*
3.5	*Dolomite*: flaggy and blocky, grey. Some beds contain intraclasts or pellets which appear to be finely crystalline dolomite
28	No outcrop
0.5	*Dolomite*: weathers to yellow-brown, medium-grained, crystalline carbonate; some minor black specks of iron oxides
Total	
about 120	*Underlain by Stray Creek Sandstone Member*

SECTION 8: Timber Creek and Skull Creek Formations measured 10 km south-southwest of Timber Creek.

SKULL CREEK FORMATION

Thickness (m)	
	Top of hill
15	*Dolomite*: flaggy, alternates with bands of light purple, fissile *siltstone* and *shale*
24	*Dolomite*: massive and blocky, contains minor siltstone and sandstone. Ripple marks and halite casts. 'Lower Marker'
1.5	*Sandstone*: fine-grained purple-brown, indurated. Fine-scale cross-bedding and contorted laminae (slumped foresets)
6	*Dolomite*: massive, silty, minor interbeds of white friable *siltstone.* Halite casts and minor small chert lenses
40.5	*Dolomitic siltstone*: some fissile or flaggy, fine-grained *dolomite*
1.5	*Sandstone*: flaggy, fine-grained. quartz-rich
4.5	*Dolomite*: massive, laminated, partly recrystallized. 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	*Skull Creek Formation*
TIMBER CREEK FORMATION 3+	*Sandstone*: fine-grained, light brown, contains mud flakes and pellets
	Base of hill

SECTION 9: Skull Creek Formation 8 km north-northeast of Section 8.

Thickness (*m*)	
	Overlain by Jasper Gorge Sandstone
45	Very little outcrop. Minor *dolomite* beds
1.5	*Dolomite*: very dark grey-weathering, medium-crystalline
13.5	Flaggy grey *dolomite* and flaggy, fine-grained *dolomitic sandstone;* finely laminated and ripple-marked ('Lower marker'?)
9	No outcrop
9	*Dolomite*: flaggy and blocky, grey
3	No outcrop
1	Flaggy *dolomite*
9	No outcrop
12	*Dolomite*: flaggy and blocky, fine-crystalline
5	Fissile *dolomite* or *dolomitic siltstone*
8.5	*Dolomite*: flaggy to massive, fine-crystalline
13.5	No outcrop
1	Massive *dolomite*
Total about 130	*Base of outcrop*

SECTION 10: Type section of the Skull Creek Formation, 1 km west of Timber Creek/Victoria River Downs road, at 15°56′S, 130°37′E, Delamere Sheet area.

Thickness (*m*)	
	Top of exposure
30	*Dolomite*: massive, grey, karst developed (Supplejack Dolomite Member)
15	*Dolomite*: soft, flaggy, forms rounded outcrops
15	*Dolomite*: massive, dark grey, karst-weathering, fine to medium crystalline, some hemispherical stromatolites
23	*Dolomite*: light grey, flaggy, finely crystalline, some irregular chert lenses
41	Interbedded flaggy grey *dolomite* (30 to 60 cm interbeds) and more fissile *dolomitic siltstone; dolomite* finely crystalline
18	Flaggy, ripple-marked, fine-grained *dolomitic sandstone* and *sandy dolomite*. A few 30-cm interbeds of pure *dolomite*
1.5	*Dolomite*: massive, laminated, fine and medium, crystalline; *chert* bodies abundant and parallel to bedding
6	*Dolomitic siltstone*
3	*Dolomite*: blocky, smooth, finely crystalline, grey or pink, weathers to buff colour
Total 152.5	*Bottom of exposure—core of anticline*

SECTION 11: Type section of Bynoe Formation (measured by barometer) at Wondoan Hill, Delamere Sheet area.

Thickness (m)	
	Overlain by Wondoan Hill Formation
16	Poor outcrop—mostly *siltstone*
0.5	Grey *silty dolomite*
9	*Siltstone**
1	*Dolomitic sandstone*: thin to medium-bedded, fine to very coarse sand; cross-bedded and ripple-marked
7.5	*Siltstone**
0.5	Grey *dolomite*
18	*Siltstone** with occasional greyish, thin (8-15 cm) *dolomite* interbeds
0.5	Grey *dolomite*
14.5	*Siltstone**
0.5	Slightly silty, grey *dolomite*
4.5	*Siltstone**
0.5	Flaggy, grey, laminated *silty dolomite*. Ripple marks
10.5	*Siltstone**
0.5	Finely laminated *dolomitic sandstone*
25.5	*Siltstone**
0.5	Slightly *dolomitic sandstone*, ripple-marked, some green mud flakes and possibly halite casts
9	*Siltstone**
0.5	*Dolomitic sandstone*, with thick leached crust on outcrops, weathers dark brown
9.5	*Siltstone**
0.5	Fine-grained *sandstone*, laminated to thin-bedded, ripple-marked
20	*Siltstone**
0.5	*Dolomitic sandstone*, laminated, blocky, with leached crust
16.5	*Siltstone**
0.5	Hard grey *sandstone*
4	*Siltstone**
0.5	Hard, grey *sandstone*
0.5	Grey-green *siltstone*
0.5	Massive, indurated *siltstone*
1.5	Purple *siltstone*
0.5	Grey-green *siltstone*
3.5	Purple *siltstone*
0.5	Light grey, fine-grained *sandstone*
10.5	*Siltstone**
Total 189	*Base of hill*

* *Siltstone* characteristic of Bynoe Formation consists of interbedded reddish brown to purple, and greyish green, siltstone; colour boundaries commonly transgress bedding planes.

SECTION 12: Type section of Wondoan Hill Formation in the Fitzroy Range 9 km south of Wondoan Hill.

Thickness (*m*)	
	Top of Fitzroy Range
6	*Sandstone*: white to brown, flaggy, thin-bedded, medium-grained
9	*Sandstone and brown siltstone*: fissile, laminated. Some coarser sandstone beds
5	*No outcrop.* Flaggy to blocky, thin *sandstone* boulders
10	*No outcrop.* Boulders of blocky, coarse to medium *sandstone,* with pebbly bands
9.5	*No outcrop.* Blocky to massive boulders of hard, white, medium *sandstone.* Some hematite bands
7.5	*Dolomitic siltstone* and *shale*: fissile, pale yellow to cream
14.5	*No outcrop.* Boulders of blocky to flaggy *sandstone,* commonly hematitic
5.5	*Sandstone*: blocky to flaggy, medium-bedded, coarse to medium, with some pebbly bands
4	*No outcrop.* Pebbles of red micaceous hematitic *shale*
1.5	Red, fissile, hematitic, micaceous *shale.* Overlain by 30 cm of pale brown, fissile, thin-bedded micaceous *sandstone*
9	*No outcrop.* Blocky to flaggy, pebbly, *sandstone* boulders
0.5	*Sandstone*: blocky to pebbly, coarse; rounded chert pebbles common
5.5	*No outcrop.* Boulders of cross-bedded, flaggy to blocky *sandstone*
8	*No outcrop.* In upper part hematite *shale* fragments abundant. Some flaggy cross-bedded *sandstone* boulders in lower part
6.5	*No outcrop.* Green glauconitic *sandstone* and *shale* fragments in places
4	*Sandstone*: blocky to flaggy, cross-bedded
2.5	*Sandstone*: massive, white to brown, medium-grained, thick-bedded
Total about 108	*Underlain by Bynoe Formation*

SECTION 13: Composite type section of Stubb Formation measured along Sullivan Creek, Delamere Sheet area.

Thickness (*m*)	
	Overlain by Jasper Gorge Sandstone
13.5	*Sandstone*: blocky to massive, friable, creamy-white to brown, little cement, rounded quartz grains, medium to thick-bedded, medium to coarse, iron oxide staining present, some cross-bedding
11.5	*Sandstone*: blocky to flaggy, quartz-rich, medium-bedded
15	*Sandstone*: flaggy, grey, fine-grained
15	*No outcrop.* Grey to white, flaggy, fine-grained *sandstone* boulders
7.5	*Siltstone*: grey, some sandy beds. Poor outcrop
4.5	*Sandstone*: flaggy to blocky, white to brown, cross-bedded
13.5	*Sandstone*: white to brown, flaggy, cross-bedded; some interbedded *siltstone,* small pebbly bands and mod flakes
6	*Sandstone*: white to brown, flaggy, cross-bedded; interbeds of *siltstone;* 60 cm band of grey to brown *shale*
9	*Sandstone*: grey to purple, fine-grained; interbeds of *siltstone*
18.5	*Siltstone*: micaceous, purple to grey and brown; some harder sandy bands of iron-rich, nodular, fine-grained, grey to red-brown and purple *sandstone*
48	*Siltstone and shale*: grey and purple, iron-stained, friable, some fine sandstone bands
30	*Shale*: brown, fissile
0.5	*Sandstone*
Total 192.5	*Base not seen*

SECTION 14: Section of Stubb Formation measured in Stokes Range escarpment at 15°54′S, 130°41′E, Delamere Sheet area.

Thickness (m)	
	Overlain by Jasper Gorge Sandstone
7.5	*Siltstone*: laminated, fissile, cream and pale purple; shaly in purple zones; no obvious structures apart from depositional disconformities
6.5	*Sandstone*: flaggy to massive, medium-grained, predominantly thin-bedded, white to brown and purple; some brown, fine-grained, laminated *sandstone* bands
19	*Sandstone*: brown to white, blocky to flaggy; medium to fine, well sorted, grains sub-rounded; thin to medium-bedded, with abundant cross-bedding. Origin of foresets—340°; some silty bands
6.5	*Sandstone*: flaggy to blocky, medium-bedded, darker bands about 0.6 cm thick, with well rounded grains. Outcrop poor
8	Cream to brown, laminated, fissile to flaggy micaceous *siltstone*
13.5	*Shale*: grey, weathers to iron-stained beds; some silty micaceous bands (0.6 to 15 cm thick) are friable and fissile
38	*Shale*: laminated, fissile, friable, grey; thin fine-grained *siltstone* and *sandstone* lenses
76	No outcrop—probably *shale*
Total about 175	*Underlain by Bynoe Formation*

SECTION 15: Jasper Gorge Sandstone measured near Victoria River 6 km south-southwest of Trinity Reach, Delamere Sheet area.

Thickness (m)	
	Top of hill
42.5	*Sandstone*: flaggy to blocky, medium-grained, white to brown
4.5	*Sandstone*: indurated, massive, thick-bedded, medium-grained
6	*No outcrop*—possibly flaggy, fine-grained sandstone and coarse *siltstone*
17	*Siltstone*: laminated, micaceous, quartz-rich; and lenticular *mudstone* and *sandstone*. Cross-bedding and ripple marks abundant. Figure 18 shows probable sandstone dykes. Beds fissile to flaggy, rarely blocky
5.5	*No outcrop*—probably soft beds
10.5	*Sandstone*: massive and blocky, medium to thick-bedded, medium-grained, with 30 cm basal conglomerate
Total 86	*Underlain by Skull Creek Formation*

SECTION 16: Jasper Gorge Sandstone in the western Stokes Range, Delamere Sheet area.

Thickness (m)	
	Top of hill
7.5	*Sandstone*: massive, thick-bedded, red-brown to white; lower part indurated
6	*Siltstone*: purple and green-grey, coarse, spotted, abundant cross-bedding; some blocky, laminated beds
23	*Sandstone*: flaggy, thin-bedded, friable, indurated near top
7.5	*Sandstone*: blocky, medium to thin-bedded, white to grey with dark bands; some lenticular bedding, cross-bedding, ripple marks, and mud cracks; beds flaggy to fissile near top with thin interbed of purple *siltstone*
6	*Sandstone*: massive, brown to white, medium to thick-bedded; widely spaced jointing
Total 50	*Underlain by Stubb Formation*

SECTION 17: Jasper Gorge Sandstone measured 6 km east-northeast of Stubb yard in Sullivan Creek valley, Delamere Sheet area.

Thickness (m)	
	Top of hill
8	*Sandstone*: flaggy, white to cream and brown, friable, thin-bedded, indurated near top
6.5	*Sandstone*: blocky, medium-bedded, medium-grained, white to creamish brown and purple
9.5	*Sandstone*: flaggy to blocky, medium-bedded, white to brown and purple; near top is 1.5 m of limonite-spotted, purple and white, friable *sandstone*
8.5	*Sandstone*: blocky, flaggy near top, friable, medium-grained, white to purple and brown, mud flakes present, some cross-bedding
14.5	*Sandstone*: massive, thick-bedded, white to red-brown, cross-bedded, coarse; nodular weathering in upper part
Total 47	*Underlain by Stubb Formation*

SECTION 18: Angalarri Siltstone (lower part only) measured at Valley Hill, 32 km northwest of Coolibah homestead, Delamere Sheet area.

Thickness (m)	
	Top of hill (capped by laterite)
7.5	*Siltstone*: white, massive, structureless, somewhat porcellanized. Irregular mottled, ferruginized, rather clayey patches (believed to be leached zone of laterite profile within Angalarri Siltstone)
12	Poor exposure. *Siltstone*: light grey, white, laminated, fissile. Apparently leached Angalarri Siltstone
0.5	*Sandstone:* mottled, variegated, yellowish brown to red
4.5	No exposure
1	*Siltstone* bands: light grey to white, apparently leached
7.5	No outcrop, scree-covered
1	*Sandstone*: greyish red, silty, fine-grained, massive; flaggy towards top; forms distinct platform
1	*Siltstone*: grey-green to reddish, fissile
3	*Sandstone*: fine-grained, silty, grey, sericitic, limonite-spotted, flaggy to thin-bedded towards top
4	Poor exposure; mainly fissile *siltstone*
2	Bench-forming *sandstone*: massive, grey, fine-grained, laminated and thin-bedded towards top where grades up into fissile *siltstone*
34	Largely scree-covered. Mainly fissile *siltstone,* slightly coarser and more sericitic than lower 49 m, 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*. Minor interbeds of massive, fine-grained sericitic *sandstone* (as in lower bench), in bands up to 61 cm thick
2.5	Minor bench-forming *siltstone* band: grey to greenish grey, fine-grained, sericitic. Overall massive, but laminated to thin-bedded. Some mud flakes, fine-scale cross-bedding, minor limonite spottings
49	Slope, mostly scree-covered. Minor outcrop of reddish brown fissile *siltstone,* grey-green and shaly in places
Total about 130	*Underlain by Jasper Gorge Sandstone*

SECTION 19: Angalarri Siltstone (lower part only) measured 8 km south of Mount Thymanan, Delamere Sheet area.

	Thickness (m)	
		Top of hill (laterite-capped)
	47	Poorly exposed *siltstone* with up to 5% interbeds of fine-grained *sandstone.* Siltstone is green-grey, weathers reddish, fissile, laminated; complete scree cover near top
	39.5	*Siltstone* and fine-grained *sandstone,* poorly exposed, much weathered. Generally brownish red, fissile, breaking into thin plates rather than flakes as in basal 45 m. Apparently fairly homogeneous; few interbeds of *sandy siltstone*
	18.5	*Siltstone*: grey-green, weathers reddish, generally fissile, slightly coarser than in basal 47 m. Minor thin (46 cm) interbands of sericitic *silty sandstone*
	2	*Sandstone*: fine-grained, silty matrix, grey-green, limonite-spotted, and slightly sericitic; weathers flaggy to rounded, bench and platform-forming
	47	Poorly exposed *siltstone*: grey-green, fissile to platy
	4.5	*Sandstone*: grey, fine-grained, silty sericitic matrix; generally massive but vague bedding on weathered surface. Forms fairly prominent bench around lower part of hill
	26	Generally scree-covered. *Siltstone* exposed in creeks: grey-green, laminated, highly fissile, weathering to flakes; mud cracks
Total	184.5	*Underlain by Jasper Gorge Sandstone*

SECTION 20: Angalarri Siltstone (lower part only) measured 10 km southeast of J41 yard, Delamere Sheet area.

	Thickness (m)	
		Overlain by Mullaman Beds
	17	*Siltstone*: fissile to platy, laminated to thin-bedded, grey, weathers reddish; immediately below Mullaman Beds sandstone, it is leached with patches of ochreous powder
	1	Minor bench of fine-grained *silty sandstone* as in lower benches
	9	Scree cover of fissile, *shaly siltstone* and fine-grained *sandstone*
	3	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	Minor bench-forming band of fine-grained *sandstone*: massive, grey, sericitic, silty matrix
	4.5	Poor outcrop. Minor exposure of grey-green *shaly siltstone.* Much scree cover of fine-grained *sandstone*
	2	Lower bench and platform. *Sandstone*: grey to khaki, silty matrix, limonite-spotted, sericitic, massive but thin-bedded
	45.5	Poor exposure, mainly *siltstone*: grey-green to khaki, fissile, weathers to plates and scales, laminated, some sericite, locally flaggy
	9	No outcrop, scree of fissile and platy *siltstone*
Total	162.5	*Base of hill, top of Jasper Gorge Sandstone*

SECTION 21: Jinduckin Formation measured in spur 6 km due south of Dorisvale homestead, Fergusson River Sheet area.

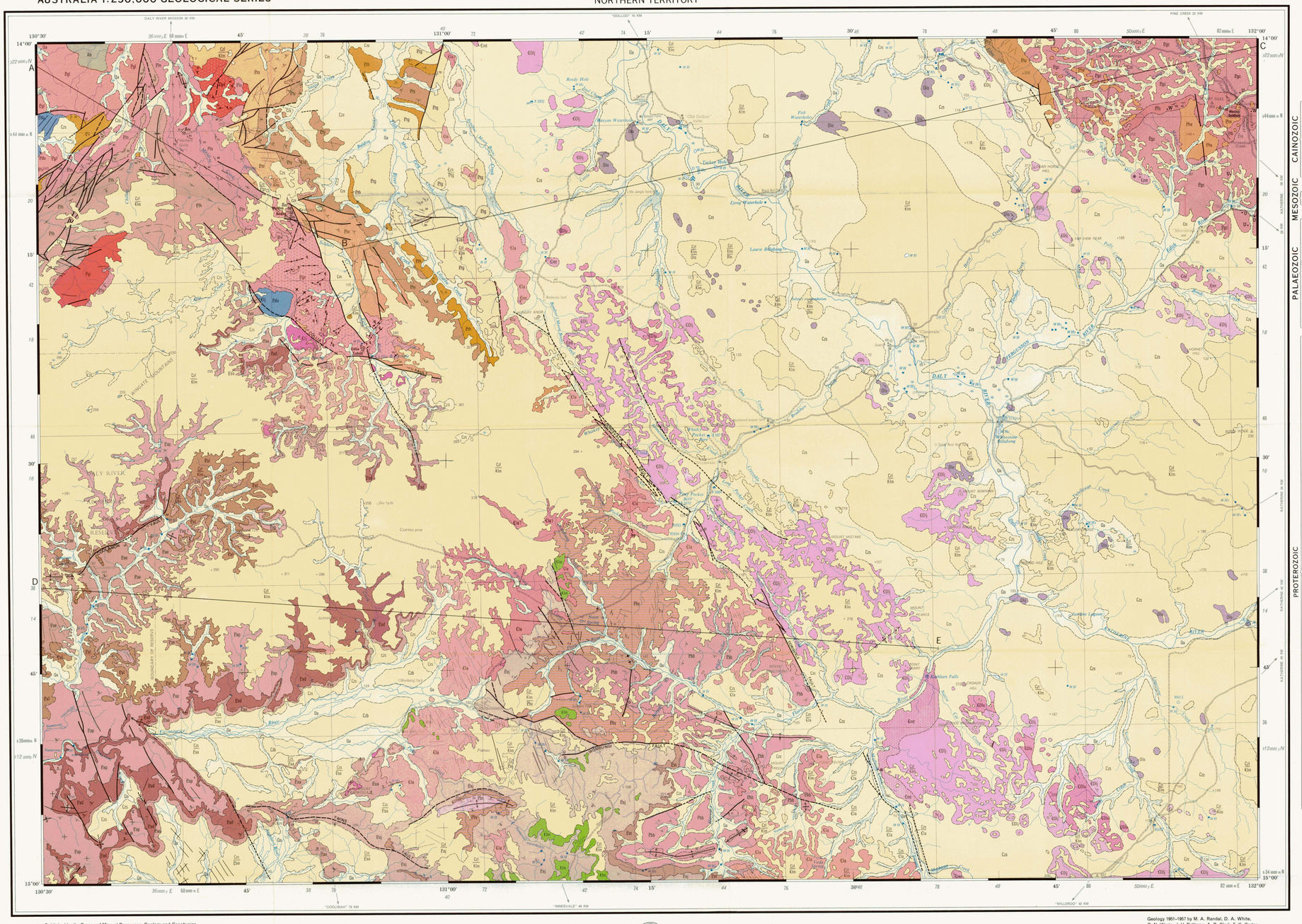
	Thickness (m)	
		Overlain by Mullaman Beds
	45.5	*Siltstone and mudstone*: light yellow-brown, interbedded with fine bands 0.5 to 1 m thick of friable pinkish-brown, sericitic, massive fine-grained *sandstone;* minor halite casts. Slope largely covered by scree of laterite and overlying sandstone, also by blocks of ferruginous sandstone of the type exposed below
	4.5	*Sandstone*: forms a series of benches, 0.5 to 1 m thick, of sandstone bands of the type described in the underlying bench. Between benches about 1 m of poorly exposed *siltstone*
	3	*Sandstone*: friable, reddish-brown, ferruginous, fine to medium, well sorted; forms a bench. Varies to light brown *siltstone,* pockmarked and sericitic, and containing some muddy patches
	20	*Sandstone*: ferruginous, largely scree-covered; minor dolomitic, grey, fine sandstone; interbeds of *dolomitic siltstone* and *sandstone* bands up to 1 m thick: reddish and brown, massive, fine-grained, well sorted, ferruginous and commonly leached, suggesting that possibly a carbonate matrix has been removed
	7.5	*Dolomitic siltstone*: grey, intercalated with thin to massive brown *siltstone;* thin *dolomite* interbeds
	1	*Dolomitic sandstone*: grey-purplish, thin-bedded to massive, fine-grained
	0.5	*Dolomite*: thin-bedded, flaggy
	6	*Dolomitic siltstone*: massive, reddish-brown; minor grey-spotted *siltstone* and grey *dolomite* interbeds
	9	*Dolomite*: numerous grey-buff flaggy bands up to 0.5 m thick intercalated with fine-grained *dolomitic sandstone* and *dolomitic siltstone.* Minor small *chert* lenses and nodules in the dolomite
Total	97	*Base of hill*

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FERGUSSON RIVER

NORTHERN TERRITORY

SHEET SD 52-12

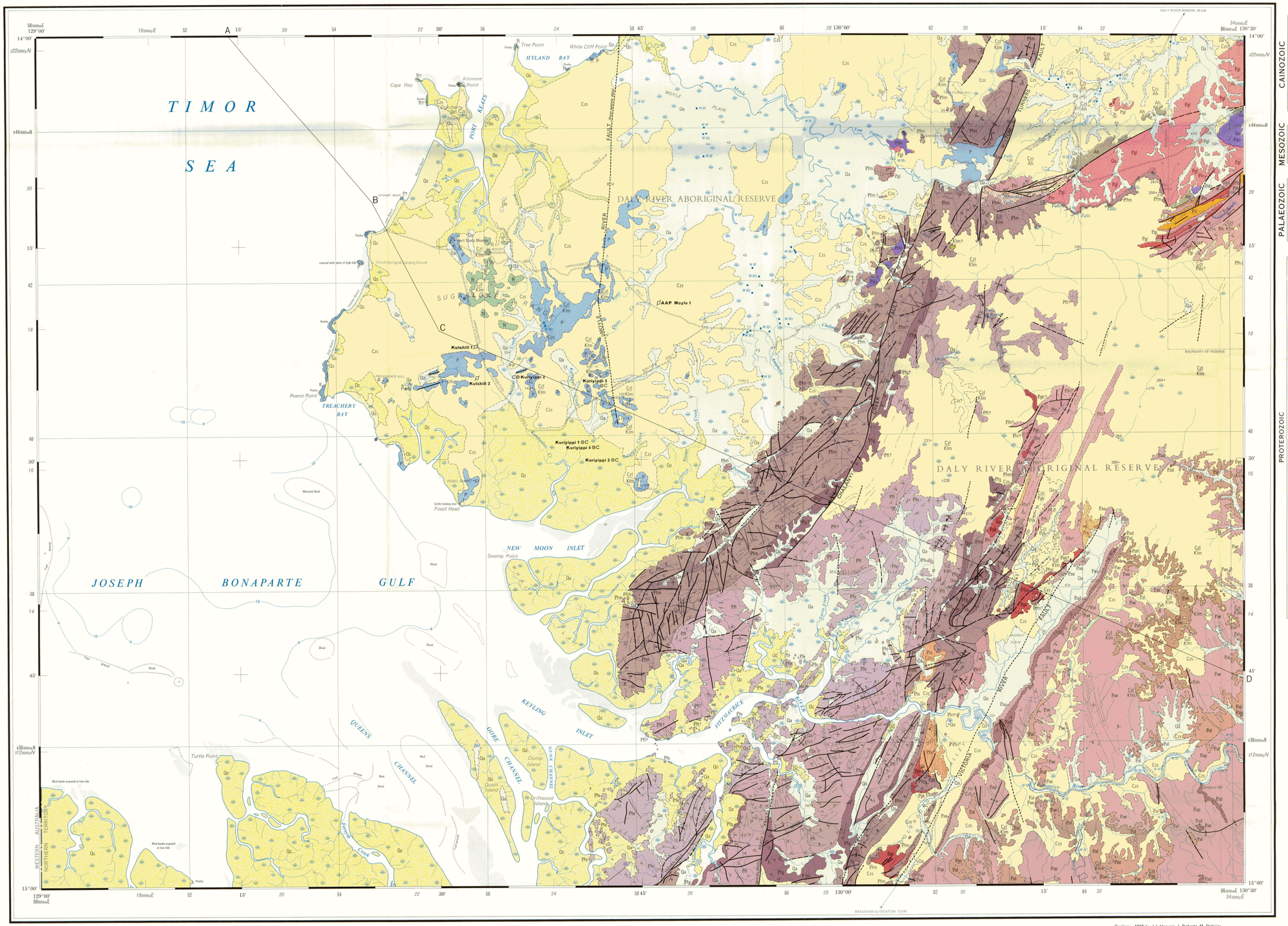

DALY RIVER MISSION 30 KM
"OOLLOO" 16 KM
PINE CREEK 30 KM
"COOLIBAH" 35 KM
"INNESVALE" 48 KM
"WILLEROO" 40 KM
DORISVALE FAULT
WIGNALL MOUNTAINS
DALY RIVER
DALY RIVER RESERVE
BOUNDARY OF RESERVE
Old Oolloo
Mayan Waterhole
Reedy Hole
Fish Waterhole
Lucker Hole
Laurie Billabong
Ferguson Falls
Kathleen Falls
Cypress pine
Spear Grass
Woodland
Open Forest
Open Grassland
Tall Open Forest
Tall Open Woodland
Low Open Forest
Low Open Woodland
Low Woodland
Tall Woodland
Open Scrub
Low Open Scrub
Low Closed Scrub
Tall Open Scrub
Tall Closed Scrub
Mangroves
Cleared land
Cultivation
Settlement
Homestead
Yard
Windmill
Bore
Waterhole
Spring
Swamp
Falls
Rapids
Sink hole
Yards
Trigonometrical station
Road
Track
Vehicle track
Railway with siding
Building
Landing ground
Abandoned
Position doubtful
Cave
Mine
Mine not worked
Gold
Tin
Uranium
Tungsten
Macrofossil locality
Vein; q-quartz, ba-barytes
Minor mineral occurrence
Strike and dip of strata
Prevailing strike and dip of strata
Vertical strata
Horizontal strata
Overturned strata
Dip<5°
Dip 5°–15°
Dip 15°–45°
Dip>45°
Trend line
Joint pattern
Lineament
Strike and dip of vertical joints
Strike and dip of foliation
Vertical foliation
Strike and dip of cleavage
Vertical cleavage
Geological boundary
Anticline showing plunge
Syncline showing plunge
Monocline
Fault (U/D 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
air-photo interpretation
R0001 refers to bore registration number of Mines and Water Resources Branch, Northern Territory Administration
Water tank with windpump
Earth tank with windpump
Highway
Railway
Homestead
Elevation in metres—approximate
Abandoned
Position doubtful
Cave
Au
Sn
U
W
Ah
Ba
Bdo
Bpg
Bpy
Bpz
Cs
Cla
Cld
Cdl
Cdt
Cdu
Cdj
Dbo
Dfb
Dfl
Dfu
Dfy
Dfs
Dfe
Dfm
Dfn
Dfp
Dfd
Dsa
Dsj
Dst
Dsb
Dby
Dbs
Dhe
Dgr
Dgc
Dsb
Dsl
Dsp
Dsd
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Dsj
Dst
Db

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PORT KEATS

NORTHERN TERRITORY

SHEET SD 52-11

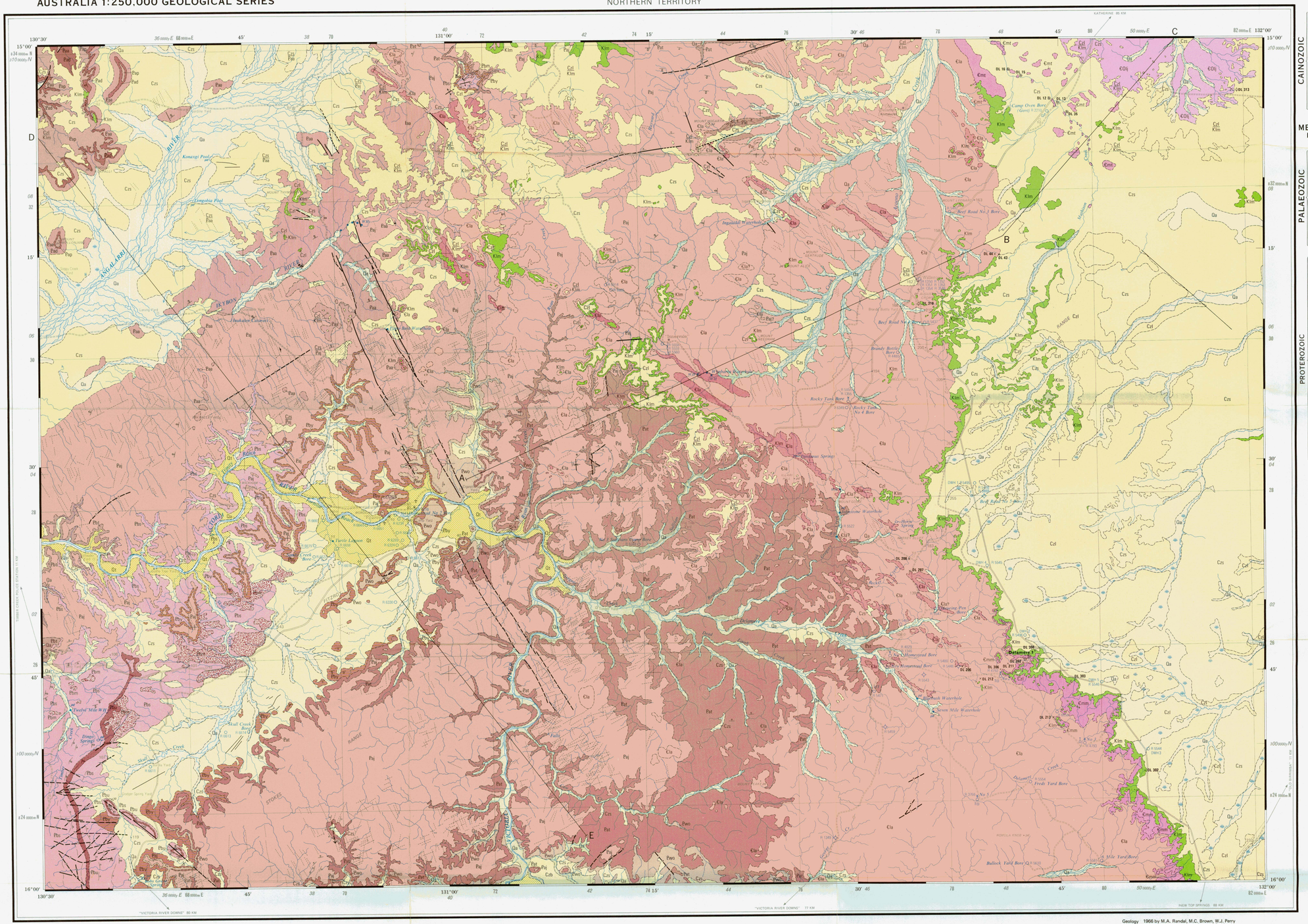

TIMOR SEA
JOSEPH BONAPARTE GULF
DALY RIVER ABORIGINAL RESERVE
DALY RIVER MISSION 18 KM
BRADSHAW OUTSTATION 72 KM
BOUNDARY OF RESERVE
AAP Moyle 1
Kulshill 1
Kulshill 2
Kuriyippi 1
Kuriyippi 2
Kuriyippi 3
Kuriyippi 4
Kuriyippi 5
Port Keats Mission
Tchindi Aboriginal Camping Ground
Cape Hay
Kinmore Point
Tree Point
White Cliff Point
HYLAND BAY
PORT KEATS
Pearce Point
TREACHERY BAY
Fossil Head
NEW MOON INLET
Swamp Point
KEYLING INLET
QUEENS CHANNEL
GORE CHANNEL
GLYDE CHANNEL
Turtle Point
Griffiths Island
Clump Island
Goonii Island
Driftwood Islands
Mud banks exposed at low tide
Cattle loading ramp
Mermaid Bank
Shoal
Reef
Rocky
Wreck
Track
Yard
Tank
Windmill
Bore
Yards
Trigonometrical Station
Spot Height
Contour
Swamp
Mangroves
Sand
Mud
Sand dunes
Coastline
Mean high water
Mean low water
Intermittent Stream
Permanent Stream
Intermittent Lake
Permanent Lake
Aboriginal Reserve
Boundary
Road

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

DELAMERE

NORTHERN TERRITORY

SHEET SD 52-16



Reference

CAINOZOIC

- QUATERNARY
  - Qa — Alluvium
  - Qt — Terrace deposits, mostly silt
  - Czb — Black residual soil and alluvium
  - Czs — Sand, red and yellow soil, 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

- MIDDLE CAMBRIAN TO LOWER ORDOVICIAN — Jinduckin Formation
  - €Oj — Sandstone, siltstone, marl, carbonate beds
- MIDDLE CAMBRIAN — Tindall Limestone
  - €mt — Fossiliferous limestone and dolomitic limestone
- MIDDLE CAMBRIAN — Montejinni Limestone
  - €mm — Light grey and brown fossiliferous limestone, some dolomite
  - €mm — Red and buff dolomitic mudstone, argillaceous carbonates; siliceous breccia at base
- LOWER CAMBRIAN — Antrim Plateau Volcanics
  - €la — Massive porphyritic and vesicular basalt; Crossbedded quartz sandstone, conglomerate and chert

PROTEROZOIC

- ADELAIDEAN — Auvergne Group
  - Pinkerton Sandstone — Psp — Quartz sandstone, minor siltstone
  - Saddle Creek Formation — Psd — Basal crossbedded sandstone overlain by siltstone with minor shale and dolomite
  - Angalarri Siltstone — Psa — Greyish green siltstone and shale, minor limestone and sandstone
  - Jasper Gorge Sandstone — Psj — Quartz sandstone, minor conglomerate and greyish green siltstone
  - Stubb Formation — Pst — Grey and purple micaceous siltstone and shale; sandstone near top
- ADELAIDEAN OR CARPENTARIAN — Bullita Group
  - Wondoan Hill Formation — Pwo — Massive basal quartz sandstone; green and buff siltstone with minor dolomite
  - Pb — Siltstone, dolomite, minor sandstone and shale (section only)
  - Bynoe Formation — Pby — Purple, reddish brown and greyish green micaceous and dolomitic siltstone, silty to pure dolomite and dolomitic sandstone
  - Skull Creek Formation — Pbs — Massive grey dolomite and dolarenite, silty dolomite, dolomitic siltstone and sandstone
  - Bardia Chert Member — Pbc — Pink and brown finely laminated chert; some brecciated recemented chert
  - Supplejack Dolomite Member — Pbu — Massive dark grey dolomite, stromatolitic near top
  - Timber Creek Formation — Pbt — Grey dolomitic siltstone, purple and greyish green siltstone and fine sandstone; dolomite

- Geological boundary
- Anticline showing plunge
- Syncline
- Fault

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

air-photo interpretation:
- Strike and dip of strata
- Horizontal strata
- Dip < 5°
- Dip 5° – 15°
- Dip 15° – 45°
- Trend line showing dip
- Joint pattern
- Lineament

- Strike and dip of joint, prevailing or unmeasured
- Vertical joint

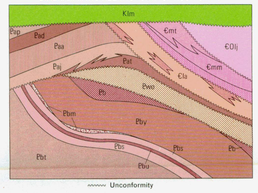
with reference number:
- DL 15 — Macrofossil locality
- DL 318 — Plant fossil locality
- DL 306 — Specimen locality

- St — Stratigraphic hole
- Ba — Minor barytes occurence

- R 1065 — Bore (R 1065: Refers to bore registration number of Mines and Water Resources Branch, Northern Territory Administration;
- DBH 4 — Abandoned bore (DBH 4: Refers to Department of Works Bore (N.T.))
- Windpump
- Tank
- WH — Waterhole
- Spring
- Swamp
- Falls

- Highway
- Road
- Vehicle track
- Landing ground
- "Delamere" — Homestead
- 1765 — Yard
- Fence
- Astronomical station
- ·162 — Elevation in metres
- pt — Position doubtful

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity

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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)
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ARGYLLA DOWNS SD 51-10	POINT KEATS SD 52-11	FERGUSSON RIVER SD 53-12	KATHERINE SD 53-9	GRAPEVINE SD 53-16
CAMBRIDGE GULF SD 51-14	ADMIRALTY SD 52-15	DELAMERE SD 52-16	LARRIMAH SD 53-13	HODGSON DOWNS SD 53-16
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DIXON RANGE SE 52-8	LIMBUNYA SE 52-7	WAVE HILL SE 52-8	NEWCASTLE WATERS SE 53-5	BESTALEL SE 53-6

ANNUAL CHANGE 0°30'W

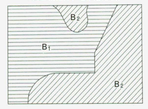
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5 0 5 10 15 20 25 KILOMETRES

5 0 5 10 MILES

GREY NUMBERED LINES ARE 20,000 METRE INTERVALS OF THE AUSTRALIAN MAP GRID, ZONE 52
GREY TICKS WITH ITALIC NUMBERS INDICATE THE 20,000 YARD GRID, ZONE 4 (AUSTRALIA SERIES)
TRANSVERSE MERCATOR PROJECTION

RELIABILITY DIAGRAM



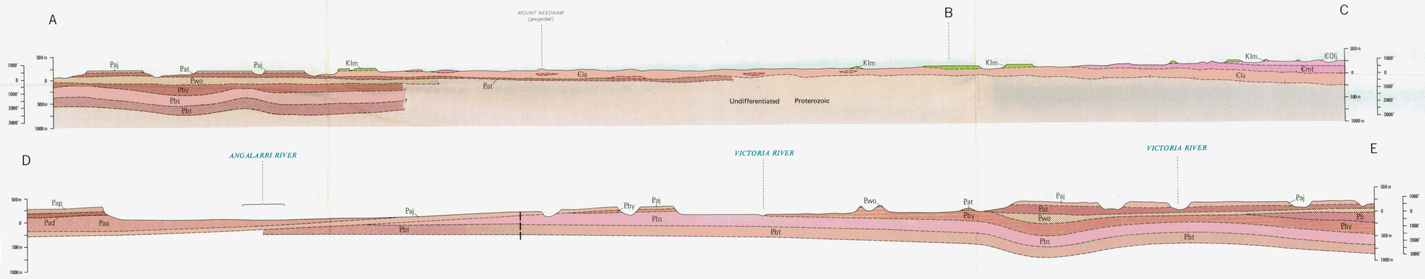
Geology
- B_1 Detailed reconnaissance : numerous traverses, and air-photo interpretation
- B_2 General reconnaissance : some traverses, and air-photo interpretation



Sections

Cainozoic sediments omitted

Scale: $\frac{V}{H} = 4$



FIRST EDITION 1972

DELAMERE

SHEET SD 52-16

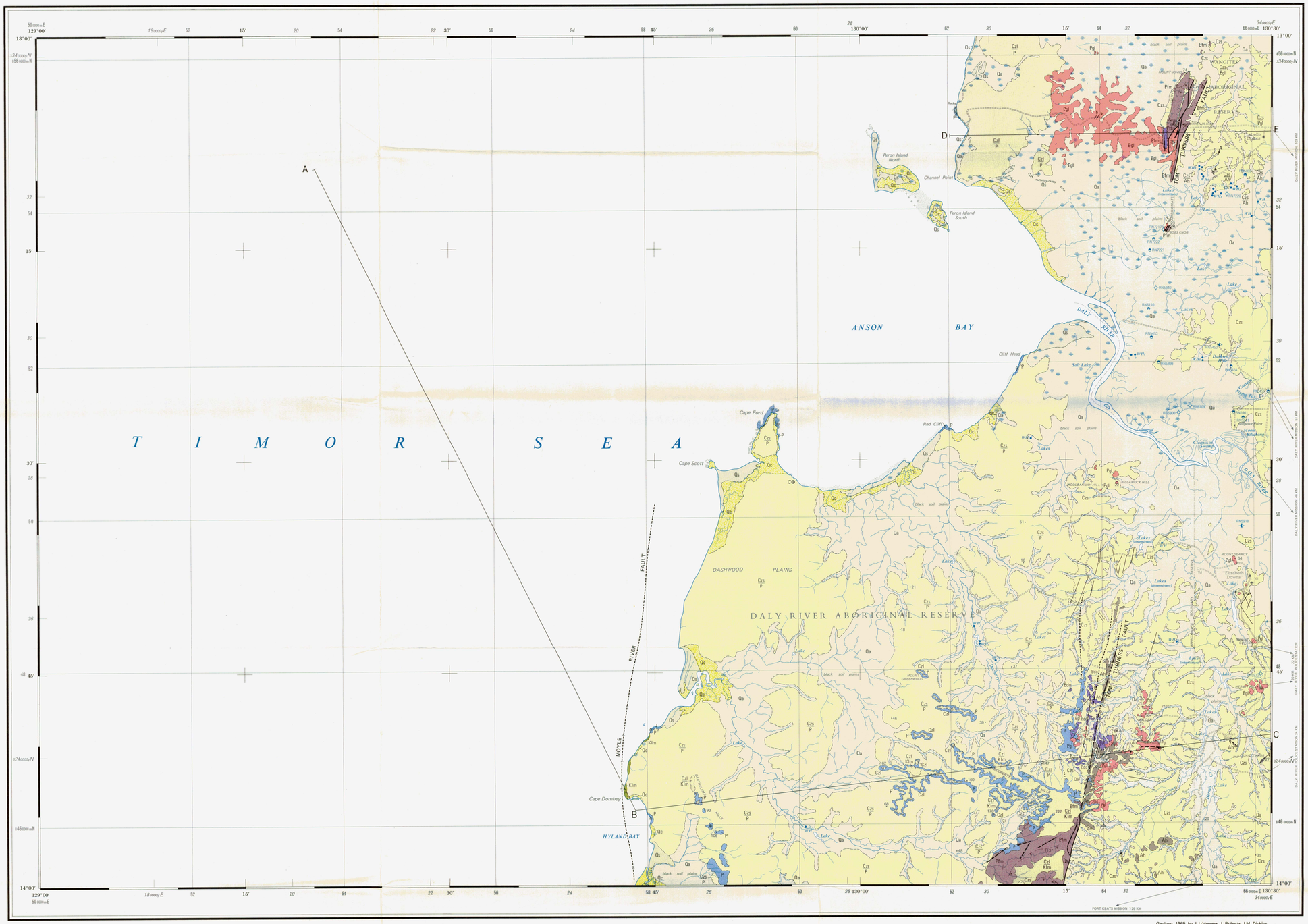
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AUSTRALIA 1:250,000 GEOLOGICAL SERIES

CAPE SCOTT

NORTHERN TERRITORY

SHEET SD 52-7



Reference

CAINOZOIC	QUATERNARY		Qa	*Alluvium*
			Qc	*Coastal deposits; mud, silt, evaporites*
			Qs	*Coastal dune sand*
			Czs	*Soil, sand, alluvium, some black soil*
			Czl	*Laterite and ferruginous rubble*
MESOZOIC	LOWER CRETACEOUS	Mullaman Beds	Klm	*Sandstone, siltstone, claystone*
PALAEOZOIC	PERMIAN		P	*Friable, feldspathic sandstone, siltstone, claystone, some diamictite and conglomerate*
PROTEROZOIC	CARPENTARIAN OR ADELAIDEAN	Fitzmaurice Group Moyle River Formation	Pfm	*Medium sandstone, some pebble bands*
	CARPENTARIAN ?	Litchfield Complex	Pdo	*Gabbro, diorite and minor dolerite*
			Pgl	*Granite, adamellite, granodiorite, tonalite, migmatite and pegmatite*
	ARCHAEAN?	Hermit Creek Metamorphics	Ah	*Quartz-mica schist, phyllite, tremolite schist, amphibolite*

Offshore units are indicated on section and rock relationship diagram only

- *Geological boundary*
- *Fault*
- *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.*
- *Dip < 15°* / *Dip 15°–45°* — *air-photo interpretation*
- *Lineament*
- *Strike and dip of strata*
- *Trend lines*
- *Strike and dip of foliation*
- *Macrofossil locality*
- *Dyke or vein, q—quartz, b—basic.*
- *Coal bore*
- *Abandoned bore*
- *Bore—salinity < 2500 ppm dissolved salts*
- *Abandoned saline bore*
- *RN7222 refers to bore registration number of Mines and Water Resources Branch, Northern Territory Administration*
- *Waterhole*
- *Swamp*
- *Foreshore flat*
- *Rock ledge*
- *Rocks submerged*
- *Road*
- *Vehicle track*
- "Newhaven" *Homestead*
- *Building*
- *Landing ground*
- *Yard*
- *Astronomical station*
- *Elevation in metres — approximate*

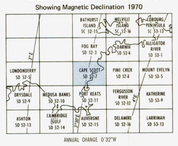
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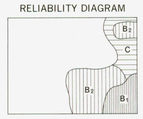
Scale 1:250,000

5 0 5 10 15 20 25 KILOMETRES

5 0 5 10 MILES

GREY NUMBERED LINES ARE 20,000 METRE INTERVALS OF THE AUSTRALIAN MAP GRID, ZONE 52
GREY TICKS WITH ITALIC NUMBERS INDICATE 20,000 YARD GRID, ZONE 4 (AUSTRALIA SERIES)
TRANSVERSE MERCATOR PROJECTION

RELIABILITY DIAGRAM



Geology

B_1 Detailed reconnaissance: numerous traverses and air-photo interpretation

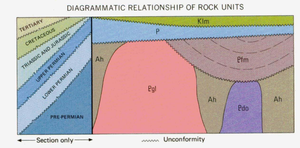
B_2 General reconnaissance: few traverses and air-photo interpretation

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, BMR
Drawn by Mercury Walch Pty Ltd, Hobart, Australia
Printed by Mercury Walch Pty Ltd, Hobart, Australia



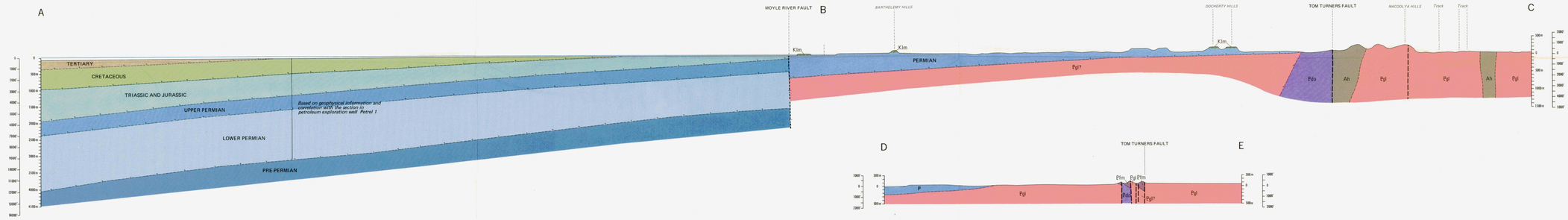
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Sections

Cainozoic sediments omitted

Scale - $\frac{V}{H} = 4$



FIRST EDITION 1971

CAPE SCOTT

SHEET SD 52-7

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