REPORT 161

The Geology of the Auvergne 1:250 000 Sheet Area, Northern Territory

(EXCLUDING BONAPARTE GULF BASIN)

I. P. SWEET, I. R. PONTIFEX,
AND C. M. MORGAN

DEPARTMENT FOR MINERALS AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

REPORT 161

The Geology of the Auvergne 1:250 000 Sheet Area, Northern Territory

(EXCLUDING BONAPARTE GULF BASIN)

I. P. SWEET, I. R. PONTIFEX,
AND C. M. MORGAN

AUSTRALIAN GOVERNMENT PUBLISHING SERVICE
CANBERRA 1974

DEPARTMENT OF MINERALS AND ENERGY

MINISTER: THE HON. R. F. X. CONNOR, M.P.

SECRETARY: SIR LENOX HEWITT, O.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

DIRECTOR: N. H. FISHER

ASSISTANT DIRECTOR, GEOLOGICAL BRANCH: J. N. CASEY

Published for the Bureau of Mineral Resources, Geology and Geophysics by the Australian Government Publishing Service

ISBN 0 642 00762 4

MANUSCRIPT RECEIVED: JULY 1971

REVISED MANUSCRIPT RECEIVED: DECEMBER 1972

ISSUED: SEPTEMBER 1974

Printed by Graphic Services Pty Ltd, 60 Wyatt Street, Adelaide 5000

CONTENTS

Page

PLATES

TABLES

ILLUSTRATIONS

Figures

SUMMARY

The Auvergne 1:250 000 Sheet area is part of a large area of Precambrian rocks which crop out over about 100 000 km² in the northwest of the Northern Territory. The northwestern part of the Sheet area is occupied by Palaeozoic rocks (Bonaparte Gulf Basin) which are described in detail in other Bureau of Mineral Resources publications.

Basement rocks of Archaean (or Lower Proterozoic) and Carpentarian age in the southwest corner of the Sheet area are extensions of units previously recognized in the Halls Creek Mobile Zone.

Younger Proterozoic rocks occupy two distinct tectonic provinces, the Sturt Block and the Fitzmaurice Mobile Zone. The Sturt Block is a stable shelf or platform on which there is a relatively undisturbed sequence of sandstone, siltstone, dolomite, and glacial sediments. The Fitzmaurice Mobile Zone, between the shelf and the Bonaparte Gulf Basin, contains a thick monotonous sequence of highly faulted and moderately folded sandstone and siltstone. The two provinces are separated by a major thrust-fault, the Victoria River Fault.

The mobile zone contains four formations known collectively as the Fitzmaurice Group, consisting of massive, coarse, and commonly texturally immature sandstone, siltstone, and subordinate conglomerate and pebble beds. The Legune and Goobaieri Formations of the Fitzmaurice Group consist mostly of siltstone with interbedded quartz sandstone. The rocks in the mobile zone are probably more than 3700 m thick, but lateral facies changes and abundant faulting make accurate determination difficult.

The stratigraphy of the Sturt Block can be summarized:

		Thickness (m)
Duerdin Group	(youngest)	500+
Bullo River Sandstone		300+
Auvergne Group		about 950
Bullita Group		300+
Wattie Group		100+
Limbunya Group	(oldest)	50+

The Limbunya Group consists of massive crystalline dolomite capped by chert. The Wattie Group is not differentiated into formations, and consists of sandstone and siltstone with minor dolomite. The Bullita Group comprises dolomitic siltstone, dolomite, siltstone, sandstone, and chert. Carbonate rocks increase in abundance and purity towards the top of the sequence.

The Auvergne Group, which comprises seven formations, unconformably overlies the Bullita Group and constitutes almost two-thirds of the area of exposed Proterozoic rocks. The lower four formations consist mainly of quartz sandstone and siltstone, with minor dolomite and dolomitic siltstone; the upper three contain mainly dolomite, dolomitic siltstone, and sandstone.

The rocks of both the Bullita and Auvergne Groups show abundant sedimentary features characteristic of shallow-water and subaerial conditions of deposition, which indicate a stable environment. The Duerdin Group, unconformably overlying the Bullo River Sandstone and the Auvergne Group, contains sandstone, siltstone, and sediments of glacial and fluvioglacial origin.

The contact between rocks of the two tectonic provinces forming the basin is represented by the Victoria River Fault, of which surface traces are sparse. Sediments of the Fitzmaurice Mobile Zone are probably older than those of the Sturt Block, although there is some indirect evidence that deposition in both areas could have taken place simultaneously. Tentative correlations with units in the East Kimberley region indicate that the mobile zone sediments are early or middle Adelaidean, and that the stable shelf sequence spans much of the Adelaidean (with several major breaks).

Except for minor ochre production, no minerals have been mined in the Sheet area, and BMR mapping in 1967 revealed no indications of potentially economic mineralization. Exploration for oil and coal is being carried out in the Bonaparte Gulf Basin. Oil seeps reported from Precambrian rocks in the area have not been substantiated. Water is mostly obtained from permanent waterholes and dams, but some groundwater is used.

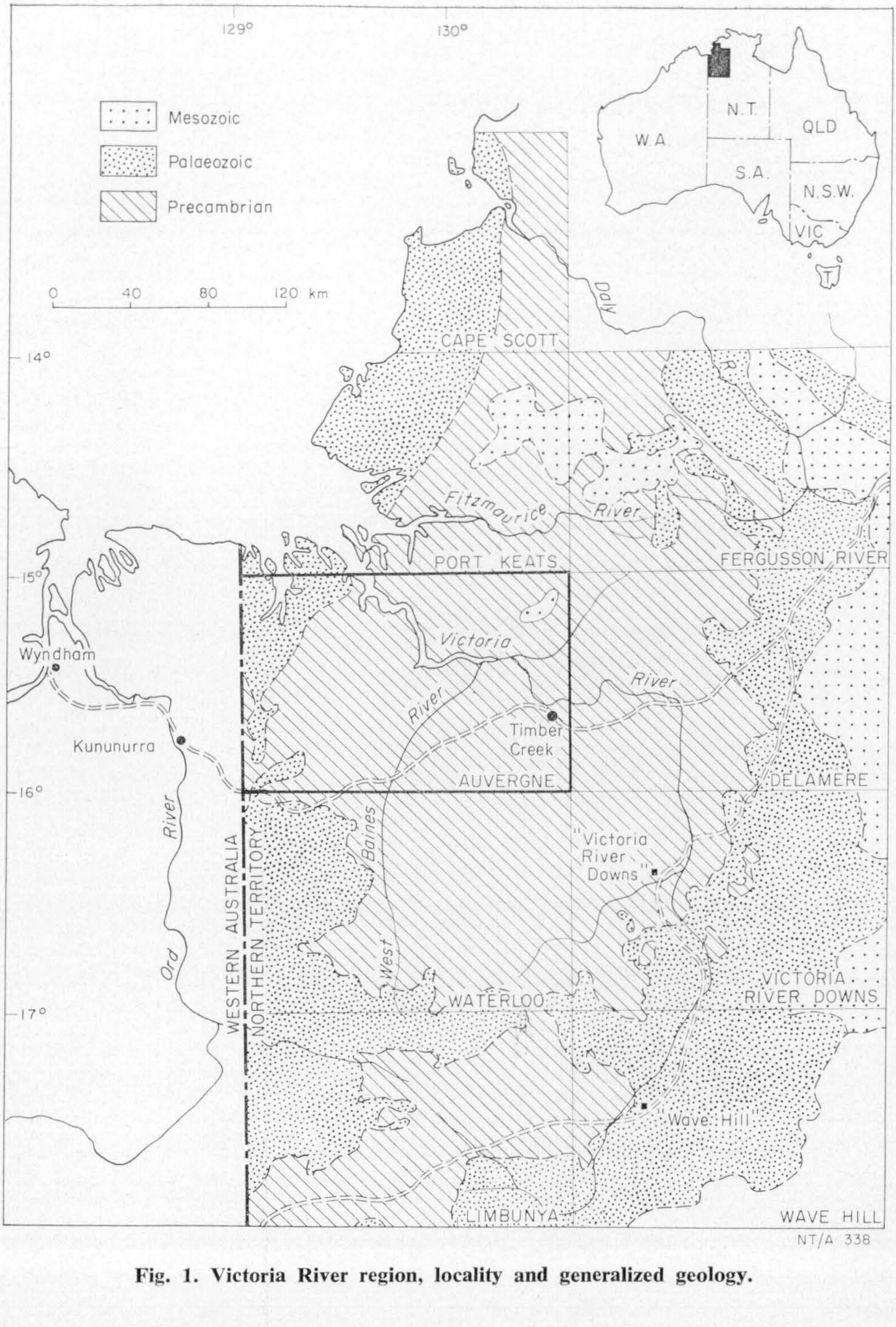


Fig. 1. Victoria River region, locality and generalized geology.

INTRODUCTION

The Auvergne Sheet area lies between longitudes 129° and 130° 30′E, and latitudes 15° and 16°S; it is bounded on the west by the Northern Territory/ Western Australia border, and on the north (in part) by the Joseph Bonaparte Gulf. This Report describes the results of 1:250 000 scale mapping of the geology of the Sheet area, except the Bonaparte Gulf Basin (Fig. 1) and updates a progress report by Pontifex, Morgan, Sweet, & Reid (1968). The geology of the Palaeozoic rocks in the Bonaparte Gulf Basin has been described by Veevers & Roberts (1968).

Mapping was carried out between May and October 1967 by I. R. Pontifex (party leader), C. M. Morgan, I. P. Sweet, and A. G. Reid, and for a short time P. R. Dunn. The Precambrian geology of part of the Port Keats 1:250 000 Sheet area was also mapped, and reconnaissance traverses were made in the Delamere, Fergusson River, and Cape Scott Sheet areas; mapping of these Sheet areas was completed in 1968.

The main Katherine-Wyndham road is sealed from Katherine to Timber Creek (300 km). Tracks from Kununurra (W.A.) to Legune and Bullo River stations, and minor tracks along the Keep River in the southwest, and through the Bradshaw and Koolendong Valleys to the Fitzmaurice River in the northeast (from Coolibah station in the Delamere Sheet area) provide access to the area, but off the tracks vehicles can generally only traverse valleys. The north and central-western portions of the Sheet area were reached by helicopter.

During the dry season the Victoria River is tidal up to 160 km from its mouth; Timber Creek, near the upper tidal limit, has a maximum tidal range of 2.5 m. The river is navigable by craft with a draft of less than 1.5 m as far as Timber Creek, but strong tidal currents (up to 7 knots), mud banks, and occasional rock bars make navigation hazardous.

There are no towns within the Auvergne Sheet area; the closest town, Kununurra (W.A.), which is 36 km by road west of the Sheet boundary, is linked to Perth and Darwin by regular air services. Wyndham, 112 km west of Kununurra, has both air and shipping services. Katherine, on the Stuart Highway, is 290 km by road east of the Sheet boundary. Apart from a police station, a store, and a road maintenance camp at Timber Creek, the only habitations are Auvergne, Bullo River, Legune, and Bradshaw cattle stations. The total population is probably less than 200, the majority of whom are Aboriginals. Kununurra has a population of about 1000, and Katherine about 3000.

The only industry is cattle raising. Holdings are large: Auvergne and Coolibah about 10 000 km^2, and Legune and Bullo River about 3 000 km^2. Most cattle are moved by road-train to the Wyndham or Katherine meatworks.

The climate is warm, dry, and monsoonal, with a short rainy season in summer and a long dry season in winter. The annual rainfall ranges from almost 1000 mm in the north to less than 750 mm in the south, most rain falling between December and March, and some in November and April; the remainder of the year is almost rainless.

The mean monthly maximum temperatures range from about 29°C in June and July to about 38°C from November to March. Mean minimum temperatures range from about 10°C in July to about 25°C in January and February. Extremes of both maximum and minimum temperatures increase away from the coast.

The Sheet area is characterized by several eucalypt species which grow 6 to 20 m high. Hilly country has a thin cover of very poor soil derived mostly from weathering of sandstone and siltstone, and supports a cover of spinifex. Annual sorghums (including 'cane-grass') grow on slopes with a thicker soil cover. The plains, generally with thicker soil cover, support better pastures, including annual and perennial sorghums and kangaroo and spear grasses. Distinctive trees include the baobab (bottle tree) and a species of *Bauhinia*; watercourses are generally lined with paperbark trees. Along the coast, areas of mangrove and samphire swamp are associated with salt flats. Perry (1970) detailed the vegetation of the area.

The 1967 mapping was carried out mainly using four-wheel-drive vehicles operating from a central base camp near a permanent waterhole in the East Baines River, 1 km south of the Katherine-Kununurra road crossing. A launch was used to map along the Victoria and Fitzmaurice Rivers, upstream to Timber Creek on the Victoria, and to within 5 km of Koolendong Valley on the Fitzmaurice. Otherwise inaccessible areas were visited by helicopter. Much of the field mapping, particularly in the early part of the season, was based on geological photo-interpretation by Perry (1967).

Field information was plotted on airphoto overlays. Aerial photographs covering the area at a scale of 1:50 000 were flown by the RAAF in 1948. New photographs at a scale of 1:85 000 were flown in 1967.

The airphoto overlays were compiled on Division of National Mapping photo-scale planimetric sheets. The resulting geological compilations were photographically reduced to 1:250 000 scale, and the final geological map was compiled at this scale. The area covering the Bonaparte Gulf Basin was copied from the 1:250 000 map accompanying Veevers & Roberts (1968).

Previous investigations

Geological work before 1955 was summarized by Traves (1955). One of the first Europeans to explore the Victoria River Basin area was Stokes (1846), who in 1839 navigated the Victoria River to about Timber Creek, continued on foot to about the present Katherine road crossing of the river, and made some general geological observations.

Brown (1895) referred to sandstone and shale which crop out in scarps along the lower tracts of the Victoria River as the 'Victoria River Sandstone' and 'Victoria River Shale'; these names have been discarded. Several geologists, including Wells (1907), Woolnough (1912), and Wade (1924), reconnoitred the area and made broad correlations of the stratigraphy.

Traves (1955) produced a map covering the area of present investigations at a scale of 16 miles to one inch, and named the entire Proterozoic sequence in the Victoria River Basin the Victoria River Group.

Laing & Allen (1956) mapped that part of the Victoria River area covered by Associated Freney Oil Fields N.L. Permit No. 1, N.T., and subdivided the Victoria River Group of Traves into six stratigraphic units (Table 2).

Harms (1959) produced a generalized map of part of the Victoria River area. He called rocks on the Sturt Block 'Victoria River Formation', and those in the Fitzmaurice Mobile Zone 'Macadam Range Beds'. Randal (1962) mapped part of the Precambrian sequence in the Fergusson River Sheet area, and Dunn (1965) made reconnaissance traverses in the Auvergne Sheet area.

The recent BMR investigation is the first systematic geological survey of the Precambrian rocks.

The Palaeozoic rocks of the Bonaparte Gulf Basin are described by Veevers & Roberts (1968) and Kaulback & Veevers (1969).

PHYSIOGRAPHY

Drainage

The southeastern three-quarters of the Sheet area is drained by tributaries of the Victoria River, notably the East and West Baines, Angalarri, and Bullo Rivers, and Paperbark and Lalngang Creeks; their lower reaches are tidal during the dry season. The northwest portion of the area is drained by the Keep River system.

Most major streams have a superimposed pattern; the Victoria River in particular traverses across the strike of almost all rock units. Lalngang and Paperbark Creeks are essentially subsequent streams developed along the trace of the Victoria River Fault; other minor streams, and to a large extent the Angalarri River, are also subsequent.

Physiographic divisions

The main physiographic units, illustrated in Figure 2, have been largely controlled by variations in bedrock and follow the broad structural trends; they reflect quite clearly the three basic tectonic units.

The Sheet area contains two physiographic subdivisions of the Ord-Victoria region used by Traves (1955) and Paterson (1970): the *Cambridge Gulf Lowlands* in the northwest, and the *Victoria River Plateau* over the remainder of the area. The Cambridge Gulf Lowlands include the erosional remnants of Palaeozoic and Precambrian rocks and extend into the adjacent Cambridge Gulf Sheet area. They include a sub-unit, the tidal flats. The Victoria River Plateau has been subdivided into five unnamed physiographic units.

The *low rounded hills* are restricted to areas of exposure of dolomite and dolomitic siltstone in the far southeast. Low, rounded, and minor conical-shaped hills, commonly with terraced slopes, are typical; some are capped by sandstone or chert. The drainage is characteristically dendritic, but is controlled in places by lineaments caused by faulting and, to a lesser extent, folding.

The *gently sloping plateau,* which includes the Newcastle Ranges, lies immediately northwest of the low rounded hills and is formed by outcrops of resistant Jasper Gorge Sandstone. Its surface slopes at about 5° to the northwest and the trend follows the regional strike of the Jasper Gorge Sandstone.

The southern margin of the plateau is an irregularly dissected scarp whose northern boundary merges with the plains to the north. Deep gorges are incised into the plateau by the Victoria and Baines Rivers. Jointing is prominent and controls the courses of minor tributaries.

The *inland plains* form a northeast-trending belt about 30 km wide, extending from the southern-central margin to the eastern-central margin of the Sheet area. Part of Koolendong Valley to the north is included in the unit. Adjacent to the Victoria River the belt is called the Whirlwind Plain. The inland plains have developed on, and are essentially restricted to, areas underlain by the Angalarri Siltstone and have a maximum elevation of 45 m above sea level.

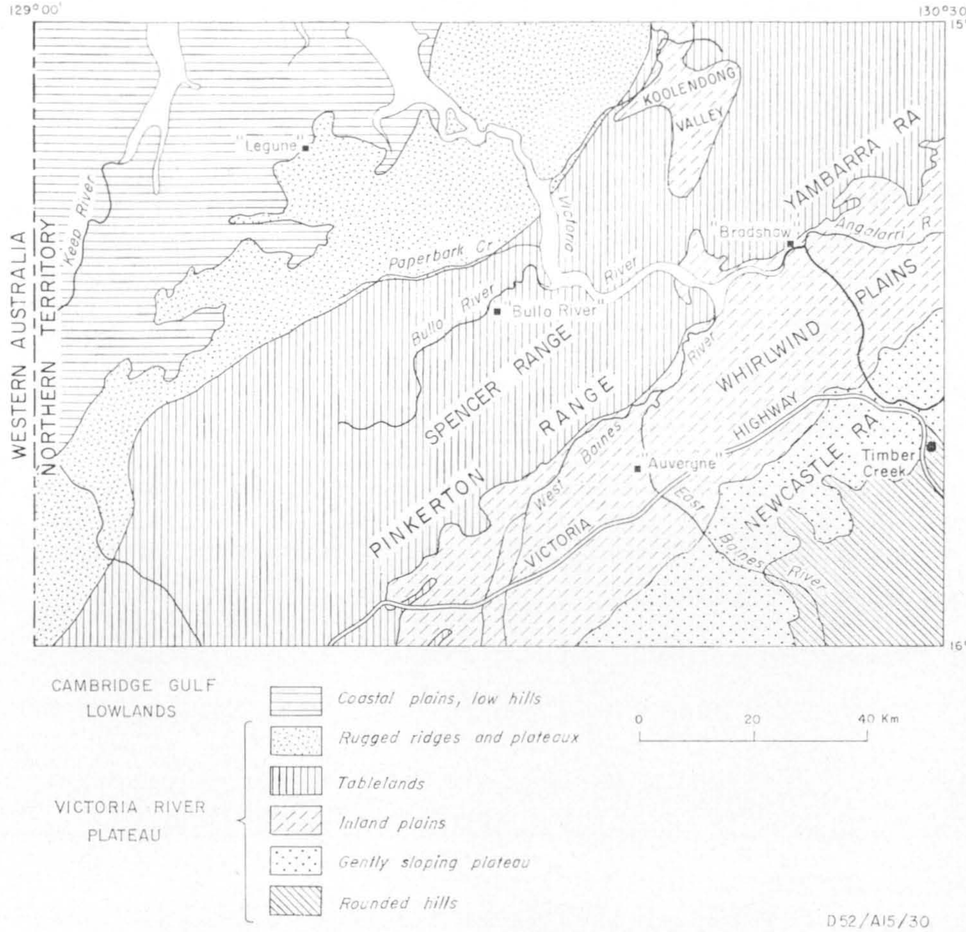


Fig. 2. Physiographic sketch map of Auvergne Sheet area.

The Victoria, Angalarri, and East and West Baines Rivers cut through the plains and form large alluvium-covered flats; terraces have formed along the Victoria River. Most of the remainder of the plain is covered by predominantly clayey residual soil developed on the underlying siltstone. In several areas between the East Baines and Victoria Rivers thin sheets of Cainozoic gravels, possibly river gravels or piedmont sediments are relatively resistant to erosion and give the plains a local relief of up to 20 m.

The *tablelands* are the most extensive physiographic unit and include the Pinkerton, Yambarra, and Spencer Ranges, plus a large area in the central west occupied by the Bullo River Sandstone. They are a continuation of the 'Tablelands' of the Fergusson River Sheet area (Randal, 1962). Relief is moderate and ranges to 275 m in the Pinkerton Range; the highest point, near Skinner Point, is 349 m above sea level.

The tablelands consist mainly of dissected plateaux, mesas, and cuestas; commonly they are structural benches bounded by scarps up to 75 m high. Benches are controlled by gently dipping resistant sandstone beds from which the overlying soft beds are being, or have been, removed. Major consequent streams are deeply incised into the sandstone; minor tributaries are largely controlled by joints and faults. The tablelands are extensively dissected, particularly in the northeast. Much of the tableland surface consists of massive Pinkerton Sandstone, although the central-western area consists of extremely rugged topography formed on Bullo River Sandstone.

The *rugged ridges and plateaux,* which coincide with the Fitzmaurice Mobile Zone, are an extension of the Carr Boyd Ranges of the adjacent Cambridge Gulf Sheet area (Plumb & Veevers, 1971). They continue across the Port Keats Sheet area to join the 'Uplands' of Randal (1962) in the Fergusson River Sheet area. This is some of the most rugged country in the Auvergne Sheet area; local relief is up to 200 m, though maximum elevation above sea level is only about 220 m. The bedrock is mainly faulted and jointed sandstone and siltstone.

Except for the superimposed Victoria River, drainage is largely subsequent; the bedrock structure, particularly faulting, produces an irregular dendritic pattern. Springs are common, particularly along large fault scarps. Massive sandstone forms either wide areas of rugged topography or individual prominent ridges. Siltstone forms relatively low rounded hills. Basement rocks in the far southwest form low rounded hills and prominent dissected ridges.

The *Cambridge Gulf Lowlands,* in the northwest, overlie Bonaparte Gulf Basin sediments. They consist of low-lying plains, gradually increasing in elevation from sea level to about 15 m where they meet the foothills of the rugged ridges and plateaux. Erosional remnants of Palaeozoic rocks, between Cockatoo Creek and the Legune track near the western margin of the Sheet area, are continuations of the Burt Range and the Weaber Range in the adjacent Cambridge Gulf Sheet area. The plains are generally covered by Cainozoic sand and soil. Alluvial plains, apparently younger than the sand, have developed along the main streams. The Keep River has cut into its own alluvium to a depth of 10 m or more, and between the Keep River and Legune extensive alluvial black soil has been deposited.

The *tidal flats* are low-lying areas surrounding the estuaries of the Keep and Victoria Rivers and of minor coastal streams. In the lower reaches they are covered by mud and salt and are subject to tidal seasonal inundation. Inland they grade into emerged salt and mud flats subject only to seasonal flooding.

Correlation of land surfaces

Within the Sheet area two surfaces can be recognized and equated with the mature weathering surfaces defined in the Northern Territory by Hays (1967); a third surface described by Hays is only tentatively identified.

North of Mount Golla Golla in the far northeast, residuals of lateritized Cretaceous rocks form the general plateau surface of the tablelands. These are remnants of the Tennant Creek Surface of Hays (1967), of which the Bradshaw Surface of Wright (1963) is part. Hays identified a surface commonly capped by ferruginous conglomerate ('detrital laterites'). He believed it formed from the Tennant Creek Surface by erosion and redeposition of laterite, and called it the Wave Hill Surface. According to Hays, remnants of it survive as dissected tablelands and accordant hill summits which can be traced, sloping gently, into the Joseph Bonaparte Gulf and the Daly River Basin. It could not be positively identified in the Auvergne Sheet area, but it is possible that parts of the surface of the Pinkerton, Spencer, and Yambarra Ranges are remnants of the Wave Hill Surface.

The inland plains and the Cambridge Gulf Lowlands are part of the Koolpinyah Surface (Hays, 1967). It is the surface representing present-day baselevel, and is not yet fully developed.

STRATIGRAPHY

The Precambrian rocks of the Auvergne Sheet area are divided by a northeast-trending lineament, the Victoria River Fault, and the sequences on opposite sides of the fault cannot be directly correlated. The sequence northwest of the fault occupies the Fitzmaurice Mobile Zone, and that southeast of the fault occupies the Sturt Block; the northwest sequence is described first.

Table 1 summarizes the Precambrian stratigraphy of the Sheet area. The accompanying Auvergne Sheet (Plate 1) was prepared before isotopic dates became available, and some of the ages shown on the Sheet have since been modified (as shown in Table 1).

In the Fitzmaurice Mobile Zone a sequence of at least 3700 m of sandstone and siltstone (the Fitzmaurice Group) rests unconformably on a basement of metasediments, acid volcanics, and granite. About 2400 m of sandstone, siltstone, dolomite, and glacial sediments is exposed in the Sturt Block. Basement is not exposed in the Sturt Block within the Auvergne Sheet area, but it has been observed about 160 km to the south in the Limbunya Sheet area.

A. FITZMAURICE MOBILE ZONE

The Halls Creek Group and Lamboo Complex form the basement rocks of the Fitzmaurice Mobile Zone, and their lithology is summarized in Table 2; basement does not crop out in the Sturt Block.

Basement rocks crop out in an arcuate belt which extends for 800 km from the coast near Derby in Western Australia to 35 km inside the Northern Territory in the Auvergne Sheet area.

ARCHAEAN OR LOWER PROTEROZOIC

HALLS CREEK GROUP

The type area for the Halls Creek Group is in the Gordon Downs Sheet area, where Dow & Gemuts (1969) recognized four subdivisions. Rocks of the Halls Creek Group, cropping out in the southwest of the Auvergne Sheet area, form a north-northeast-trending discontinuous belt 32 km long and up to 8 km wide. They are poorly exposed, forming dissected ridges with a maximum relief of about 30 m. The Halls Creek Group is overlain by the Devonian Cockatoo Formation; 8 km north-northeast of Ernie Lagoon it is faulted against, or overlain by, what is thought to be Legune Formation. All other contacts are either faulted or not exposed. The photo-pattern is uniform and medium-toned.

In the adjoining Cambridge Gulf Sheet area the metamorphics of the Halls Creek Group are intruded by the Bow River Granite and overlain with strong angular unconformity by the Whitewater Volcanics (Plumb & Veevers, 1971).

Lithology: Most rocks are green fine-grained phyllite with varying quantities of small (1 mm) quartz grains. Euhedral andalusite prisms up to 5 mm long are common on the eastern side of the belt. Quartz veins are not abundant, but in places contorted veins and segregations of quartz range in size from less than 1 mm to about 10 cm. There is no indication of bedding.

The most common rock type is chlorite-quartz-sericite phyllite of the greenschist facies. Quartz ranges from zero to 60 percent, and the grains are ragged and up to 2 mm long. The chlorite replaces biotite, which is unaltered in only a few places. The sericite and the little muscovite present are extensively altered to a fine brown product. Andalusite is pseudomorphed by sericite. Accessory minerals are tourmaline and (?) apatite. Foliation produced by the alignment of elongated quartz grains and sericite flakes is marked, but chlorite flakes lie across the foliation, suggesting that biotite was formed during a period of later metamorphism.

Farther west, in the Cambridge Gulf Sheet area, the rocks consist mainly of quartz greywacke and slate, regionally metamorphosed to the low greenschist facies with later contact metamorphism adjacent to the granite.

CARPENTARIAN

Whitewater Volcanics

The Whitewater Volcanics, which crop out in the southwest of the Sheet area, were named by Dow & Gemuts (1969). About 20 km northeast of this outcrop, a belt of porphyry which extends for some 5 km is probably the intrusive equivalent of the Whitewater Volcanics as it contains abundant micropegmatite and is similar to intrusives in the lower part of the volcanic sequence in the adjacent Cambridge Gulf Sheet area. To the north the volcanics are faulted against the Burt Range and Cockatoo Formations, and to the south against the Halls Creek Group. In the east they are overlain by the Cockatoo Formation. There are no exposed contacts between the volcanics and the intrusives, which both form low rounded hills with little outcrop; fresh outcrop is restricted to creek channels. The photo-pattern is uniformly medium-toned.

In the adjacent Lissadell and Cambridge Gulf Sheet areas (Plumb & Veevers, 1971), the Whitewater Volcanics overlie the Halls Creek Group with marked angular unconformity and are overlain by the Hensman Sandstone (possible equivalent of the lower part of the Fitzmaurice Group). The intrusive porphyries in the lower part of the sequence 'are similar to the Castlereagh Hill Porphyry of the Lamboo Complex which is considered to be comagmatic with the volcanics. In Cambridge Gulf the Castlereagh Hill Porphyry intrudes the volcanics'.

Lithology of extrusive porphyries: In hand specimen one can recognize phenocrysts of euhedral and subhedral white feldspar up to 5 mm long, and subhedral or anhedral light blue and brown quartz up to 2 mm long set in a grey-green cryptocrystalline groundmass. Fine dark green chlorite which forms aggregates up to 5 mm long could be pseudomorphs of a mafic mineral, possibly biotite. A slight foliation is defined by partial alignment of phenocrysts and chlorite blebs.

In thin section the proportion of andesine to microcline phenocrysts is about 10:1. Andesine phenocrysts are partly or completely altered to sericite and epidote, and some are partly replaced by aggregates of calcite. Some contain small rectangular and rounded inclusions of fine chlorite, and others are composed of a mosaic of smaller grains. Most quartz phenocrysts are heavily embayed, but the pyramidal form is recognizable in some. Microcline microperthite phenocrysts up to 1 mm long are euhedral or subhedral and little altered. Subhedral grains of (?)ilmenite are extensively altered to (?)leucoxene. The groundmass is formed of interlocking grains of feldspar and lesser amounts of quartz, chlorite, and sericite.

Lithology of intrusive porphyries: In hand specimen the rock has a cryptocrystalline red-brown groundmass. White, light pink, or clear quartz phenocrysts are anhedral

TABLE 1. PRECAMBRIAN STRATIGRAPHY OF THE AUVERGNE SHEET AREA

Age	*Unit Name*	*Map Symbol*	*Lithology*	*Maximum Thickness (m)*
A. *STURT BLOCK* ADELAIDEAN		UNCONFORMITY		
	DUERDIN GROUP			
	Ranford Formation			
	Ernie Lagoon Member	Ᵽor	Quartz sandstone, minor grit and conglomerate interbeds	10
	Beasly Knob Member	Ᵽob	Quartz sandstone, siltstone, minor grit and conglomerate	130
	Bucket Spring Member	Ᵽou	Siltstone, micaceous sandstone	55
	Moonlight Valley Tillite	Ᵽom	Tillite; pink laminated dolomite at top	130+
	Blackfellow Creek Sandstone	Ᵽol	Massive quartz sandstone; minor micaceous and conglomeratic sandstone	30+
	Fargoo Tillite	Ᵽof	Tillite, conglomerate containing dolomite clasts	160
	Skinner Sandstone	Ᵽoi	Sandstone, pebbly sandstone, conglomerate, minor mudstone and tillite	60
		UNCONFORMITY		
	Big Knob Beds	Ᵽn	Reddish brown ferruginous sandstone, grit, and conglomerate	20
		UNCONFORMITY		
	Bullo River Sandstone	Ᵽb	Reddish brown ferruginous sandstone, grit, and conglomerate	320
	Black Point Sandstone Member	Ᵽk	Reddish brown feldspathic quartz sandstone, minor conglomerate	60
		UNCONFORMITY		
	AUVERGNE GROUP			
	Shoal Reach Formation	Ᵽah	Dolomite, sandstone, sandy and silty dolomite, minor siltstone and shale	110
	Spencer Sandstone	Ᵽae	Quartz sandstone, silty sandstone, dolomitic sandstone	170
	Lloyd Creek Formation	Ᵽal	Oolitic, stromatolitic, sandy, and silty dolomite; dolomitic siltstone	75
	Pinkerton Sandstone	Ᵽap	Massive quartz sandstone, minor siltstone and mudstone	90

TABLE 1. PRECAMBRIAN STRATIGRAPHY OF THE AUVERGNE SHEET AREA—(*cont.*)

Age	*Unit Name*	*Map Symbol*	*Lithology*	*Maximum Thickness (m)*
	Saddle Creek Formation	Ᵽad	Sandstone, siltstone, minor dolomite	160
	Angalarri Siltstone	Ᵽaa	Greyish green siltstone and shale, minor dolomite and limestone	300+
	Jasper Gorge Sandstone	Ᵽaj	Quartz sandstone, siltstone, minor conglomerate	130
		UNCONFORMITY		
	BULLITA GROUP			
	Skull Creek Formation	Ᵽbs	Dolomite, some silty and sandy; dolomitic siltstone and sandstone; chert	130
	Bardia Chert Member	Ᵽbm	Laminated and brecciated chert	30
	Supplejack Dolomite Member	Ᵽbu	Massive dolomite	20
	Timber Creek Formation	Ᵽbt	Siltstone, dolomitic siltstone, sandstone, dolomite	115+
	WATTIE GROUP	Ᵽiu	Sandstone and siltstone, minor dolomite	100+
		UNCONFORMITY		
CARPENTARIAN OR ADELAIDEAN				
	LIMBUNYA GROUP	Ᵽhu	Dolomite, chert	50+
B. *FITZMAURICE MOBILE ZONE*				
ADELAIDEAN				
	FITZMAURICE GROUP			
	Legune Formation	Ᵽfe	Siltstone and quartz sandstone	600+
	Lalngang Sandstone	Ᵽfl	Quartz sandstone, grit, and conglomerate; minor siltstone	1400+
	Goobaieri Formation	Ᵽfg	Shale, siltstone, and sandstone	615+
	Moyle River Formation	Ᵽfm	Quartz sandstone; minor siltstone and conglomerate	1050+
		UNCONFORMITY		
CARPENTARIAN				
	Bow River Granite	Ᵽbo	Coarse biotite granite and adamellite	—
	Whitewater Volcanics	Ᵽw	Quartz feldspar porphyry	—
		UNCONFORMITY		
ARCHAEAN OR LOWER PROTEROZOIC				
	Halls Creek Group	Ah	Phyllite, minor mica-andalusite schist	—

TABLE 2. SUMMARY OF LITHOLOGY OF BASEMENT ROCKS

Age	*Rock Unit*	*Map Symbol*	*Lithology*	*Physiographic Expression*	*Relations*
CARPENTARIAN	Bow River Granite	Ᵽbo	Coarse biotite granite and adamellite	Boulders or piles of boulders on soil plain	Contacts rarely exposed. Intrudes Whitewater Volcanics and Halls Creek Group in adjacent Sheet areas. Overlain unconformably by Moyle River Formation
	Whitewater Volcanics	Ᵽw	Quartz-feldspar porphyry: lavas, tuffs, intrusives	Low rounded hillocks, little outcrop	Overlain by probable Legune Formation. Other contacts not exposed in Sheet area. Overlies Halls Creek Group unconformably in adjacent Sheet areas
ARCHAEAN OR LOWER PROTEROZOIC	Halls Creek Group	Ah	Phyllite, minor mica-andalusite schist	Dissected ridges, little outcrop	Overlain unconformably by probable Legune Formation

to euhedral and up to 5 mm long. Subhedral dark grey plagioclase phenocrysts are up to 5 mm long. Dark green chlorite appears as vaguely defined blebs and streaks.

In thin section quartz phenocrysts are seen to be embayed and corroded, but some retain a bipyramidal form. Most plagioclase phenocrysts are completely sericitized; a few are subhedral alkali feldspar up to 2 mm long and only slightly sericitized. Anhedral grains of (?)leucoxene are up to 0.5 mm long. Small flakes of chloritized biotite form irregular grains and lenticular aggregates up to 2 mm long; zircon is included in the biotite flakes. The groundmass is formed of ragged grains of quartz, feldspar, granophyric intergrowths of them, and flakes of biotite and sericite. The grainsize ranges from fine to nearly the size of the phenocrysts.

LAMBOO COMPLEX

Bow River Granite

The Bow River Granite, extensive in the East Kimberley region and defined by Dow & Gemuts (1969), is exposed over an area of about 12 km^2 in the southwest corner of the Sheet area. It crops out as sporadic boulders or piles of boulders up to 8 m high on the soil plain. Three isolated areas of granite lie 67 to 75 km to the northeast. Outcrop is restricted to steep slopes capped by Moyle River Formation.

In the northeast the granite is unconformably overlain by the Moyle River Formation. In the southwest it is flanked to the north and south by metamorphics of the Halls Creek Group, but the relation between the granite and the metamorphics was not established in the Sheet area. In the adjacent Cambridge Gulf and Lissadell Sheet areas, the granite intrudes the metamorphics (Plumb & Veevers, 1971).

Lithology: The composition ranges from biotite granite to biotite adamellite. Textures range from coarse even-grained to coarse porphyritic.

Rounded grains of blue opalescent quartz, subhedral green plagioclase grains, and anhedral white or pink microcline grains up to 0.5 cm long can be identified in hand specimen. In the porphyritic variety, ovoid tabular microcline phenocrysts are up to 2 cm in diameter. Biotite forms segregations of similar size.

The plagioclase ranges from oligoclase to andesine, and is extensively altered to sericite and epidote. Microcline microperthite forms ragged anhedral grains with inclusions of plagioclase. The feldspars are surrounded by mosaics of quartz grains of widely varying size. Graphic intergrowth between quartz and alkali feldspar is common. Green and brown biotite is associated with muscovite, zircon, and magnetite.

In the northeast the granite is highly weathered and cut by a number of no more than 20 cm thick quartz veins. The weathering probably developed on a land surface before the Moyle River Formation was laid down.

ADELAIDEAN

FITZMAURICE GROUP

The stratigraphy of the Fitzmaurice Group is summarized in Table 3. It is the only Precambrian unit within the Fitzmaurice Mobile Belt, apart from the small area of Halls Creek Group and Carpentarian igneous rocks in the southwest. It consists of a thick monotonous succession of sandstone with interbeds of conglomerate, grit, siltstone, and shale. Units of the Fitzmaurice Group were first

TABLE 3. SUMMARY OF STRATIGRAPHY, FITZMAURICE GROUP
(FITZMAURICE MOBILE ZONE SEDIMENTS)

Rock Unit	*Symbol*	*Lithology*	*Maximum Thickness (m)*	*Physiographic Expression*	*Stratigraphic Relations*
Legune Formation	Ꝑfe	Uniform sequence of interbedded siltstone and quartz sandstone	600+	Rugged hills with sandstone scarps varying to moderately low hills with stepped and rounded slopes	Conformable on Lalngang Sandstone. Contact with Palaeozoic sediments in adjacent Bonaparte Gulf Basin not exposed
Lalngang Sandstone	Ꝑf1	Quartz sandstone, grit, conglomerate; minor siltstone	1400+	Varies from rugged topography, much jointed and with prominent sandstone scarps, to undulating ranges in west	Conformable between Legune and Goobaieri Formations
Goobaieri Formation	Ꝑfg	Basal quartz sandstone overlain by shale, siltstone and sandstone	615+	Areas of no outcrop. Forms valleys between ridges of Moyle River Formation and Lalngang Sandstone	Conformable between Lalngang Sandstone and Moyle River Formation
Moyle River Formation	Ꝑfm	Interbedded massive and bedded quartz sandstone, minor siltstone and conglomerate	1050+	Alternating hard and soft bands and severe faulting produce rugged inaccessible benches, scarps, and ridges	Unconformable on Bow River Granite

recognized as photogeological units, and are difficult to distinguish in the field. Their differentiation is further complicated by severe faulting and apparent facies changes. The geological boundaries as mapped in this belt are therefore questionable in some areas. In particular, the geology of Entrance Island and the area immediately southwest of it is uncertain, and more rocks of the Goobaieri and Moyle River Formations very probably crop out adjacent to the Victoria River Fault west of the Victoria River. The total thickness of the group is difficult to measure, but more than 3500 m is exposed in the north, where all four units crop out.

Moyle River Formation (New name)

Distribution: The Moyle River Formation crops out extensively in the north-central part of the Sheet area and extends, within the Fitzmaurice Mobile Belt, into the adjoining Port Keats Sheet area.

Type Section: In the Port Keats Sheet area, about 1 km south of the Fitzmaurice River. The top of the section is at 14°48′20″S, 130°06′15″E.

Stratigraphic relations: The formation unconformably overlies Bow River Granite and is overlain conformably by the Goobaieri Formation; it is faulted against rocks of the Auvergne Group along the Victoria River Fault.

Lithology and thickness: The Moyle River Formation consists of interbedded massive and bedded, fine to coarse, poorly to moderately sorted quartz sandstone, with minor fissile siltstone, grit, and pebble conglomerate. Mud flakes, rock fragments, and yellow, green, and white clay are present both in fragments and interstitially, but are not abundant. The sandstone consists of subangular to rounded quartz grains, many of which have secondary siliceous overgrowths. Sericite occurs both as a matrix (5%) and pseudomorphing rock fragments (or possibly feldspar). Zircon and tourmaline are accessories.

Thicknesses are difficult to determine accurately owing to extensive faulting. A minimum thickness of 1050 m, estimated from aerial photographs, is exposed 9.5 km north of Goobaieri Bay. Alternating hard and soft beds and severe faulting produce rugged inaccessible benches, scarps, and ridges. On aerial photographs the different lithological types show up as different tones, producing a banded pattern, contrasting with the Lalngang Formation, which has a uniform tone.

Goobaieri Formation (New name)

Distribution: The Goobaieri Formation crops out predominantly in the north-central part of the Sheet area, and there are small areas of suspected Goobaieri Formation in the central west. It may be present immediately south of Entrance Island, but some, if not all, has been removed by faulting. Minor outcrops adjacent to the Victoria River Fault, 35 to 40 km west of the Victoria River, may extend farther west and include some rocks mapped as Legune Formation.

Type section: In the nose of a syncline 13 km north of Goobaieri Bay. The base of the section is at 15°05′40″S, 129°47′20″E and the top at 15°03′15″S, 129°48′45″E.

Stratigraphic relations: The formation is overlain by the Lalngang Sandstone and underlain by the Moyle River Formation; both contacts are conformable.

Lithology and thickness: The Goobaieri Formation crops out poorly and consists of dark grey, green, and purple fissile siltstone and shale interbedded with fine and medium-grained grey sandstone. A friable, white, blocky, thin-bedded, medium-grained sandstone is prominent in the middle of the sequence. The type section contains at least 615 m of interbedded sandstone and siltstone (Section 1, Appendix).

In the central west the Goobaieri Formation consists of dark grey or green, fissile, laminated shale and siltstone, with minor sandstone beds (up to 1 m) which are grey or purple, blocky to massive, thin-bedded, and fine to medium-grained.

Lalngang Sandstone (New name)

Distribution: The Lalngang Sandstone crops out extensively in the central north, both north and south of the Victoria River. The name is derived from Lalngang Creek, a tributary of the Victoria River.

Type section: In the ridge northwest of Lalngang Creek. Its base is at the northwest foot of the ridge at 15°11′00″S, 129°52′30″E, and its top is on top of the ridge 2 km to the southeast at 15°11′40″S, 129°53′40″E.

Stratigraphic relations: The formation overlies the Goobaieri Formation conformably. About 20 km south of Entrance Island it grades up into probable Legune Formation. It is faulted against rocks of the Auvergne Group along part of the Victoria River Fault.

Lithology and thickness: The Lalngang Sandstone consists of interbedded sandstone, grit, conglomerate, and minor siltstone and fine sandstone (Fig. 3). Near Indian Hill it contains more siltstone than elsewhere, and little or no grit or conglomerate. The sandstone is pink, light brown, or grey, massive but flaggy at the base of the formation, medium to thick-bedded, medium to coarse, moderately sorted, and highly ferruginous in places. Mud flakes and shale fragments are common, and cross-bedding is well developed.

The grit and conglomerate beds are up to 30 cm thick; the conglomerate contains rounded or angular pebbles up to 2 cm across. Grit and conglomerate also occur as small (15 cm) lenses in the foreset beds of the sandstone, which consists of subangular to well rounded quartz grains with siliceous overgrowths and contains accessory tourmaline and zircon.

All thicknesses were measured from aerial photographs, and include 460 m near the northern margin of the Sheet area, 600 m 6 km northeast of Bucket Spring, and about 1400 m 11 km west of Bucket Spring. These are minimum values as the whole unit is not readily measurable. At the type section the formation is 1400 m thick.

The abundance of pebble conglomerate and grit beds, the scarcity of siltstone beds, and the well developed cross-bedding (Fig. 4) are distinctive. The fine jointing (produced by the abundant cross-bedding), the small amount of soil cover, and the sparseness of vegetation are characteristic of the northern outcrops. The western outcrops have more soil cover and form more undulating ranges. North of the Victoria River the bedding planes form steps which are conspicuous on the aerial photographs.

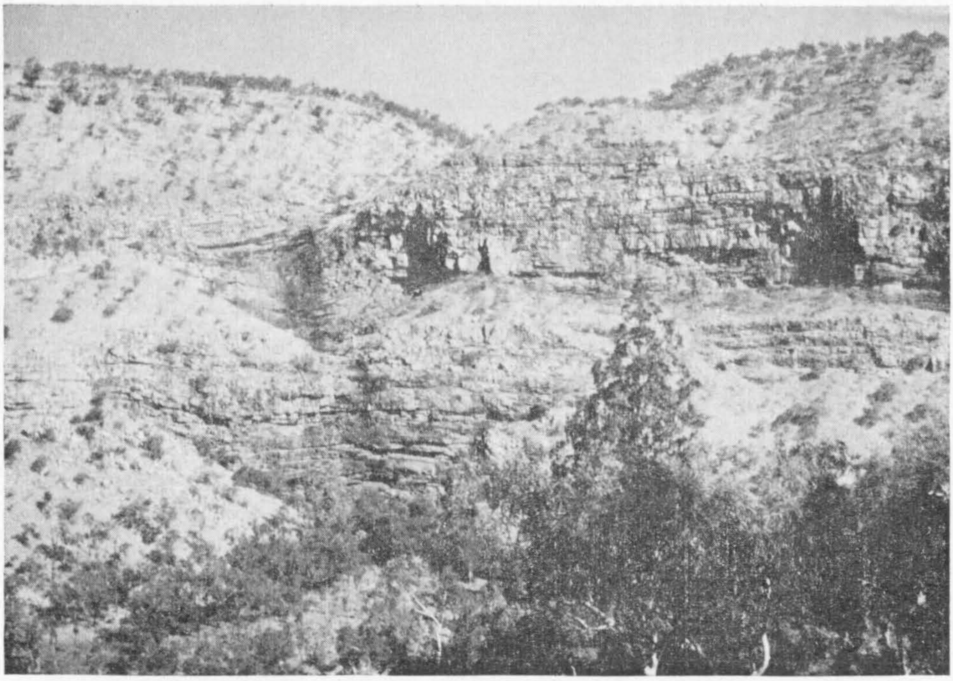


Fig. 3. Lalngang Sandstone: massive, thick-bedded, coarse-grained sandstone at Nap Springs. (GA/514)

Legune Formation (New name)

Distribution: The Legune Formation extends along the entire length of the Fitzmaurice Mobile Zone, mostly along its northern margin adjacent to the Bonaparte Gulf Basin. The name is derived from the Legune pastoral lease. The formation is best exposed, and most readily examined, in rugged hills about 16 km southeast of Legune homestead.

Type section: 6.5 km east of Alligator Springs at 15°18′S, 129°26′E. About 16 km southwest of Alligator Springs, and also 16 km southeast of Nap Springs, the Legune Formation conformably overlies the Lalngang Formation. No Proterozoic rocks were found overlying the Legune Formation. For most of its extent along the northern margin of the mobile zone it has a general north-northwesterly dip below sandy and black soil plains which mostly overlie Phanerozoic sediments of the Bonaparte Gulf Basin. Contact between the Legune Formation and Phanerozoic sediments is not exposed, but must be unconformable. Sandstone unconformably overlying the Whitewater Volcanics near Ernie Lagoon is tentatively mapped as Legune Formation.

Lithology and thickness: The Legune Formation consists of a monotonous sequence of interbedded quartz sandstone and siltstone (Fig. 5), and exposed sections up to 600 m thick are common south and southeast of Legune homestead. Typically the sandstone forms hard bands (commonly cliffs) 0.5 to 8 m thick. In the Transit Hill and Alligator Springs areas, individual sandstone bands can be traced for up to 20 km. However, in the central part of the outcrop area south of Legune home-

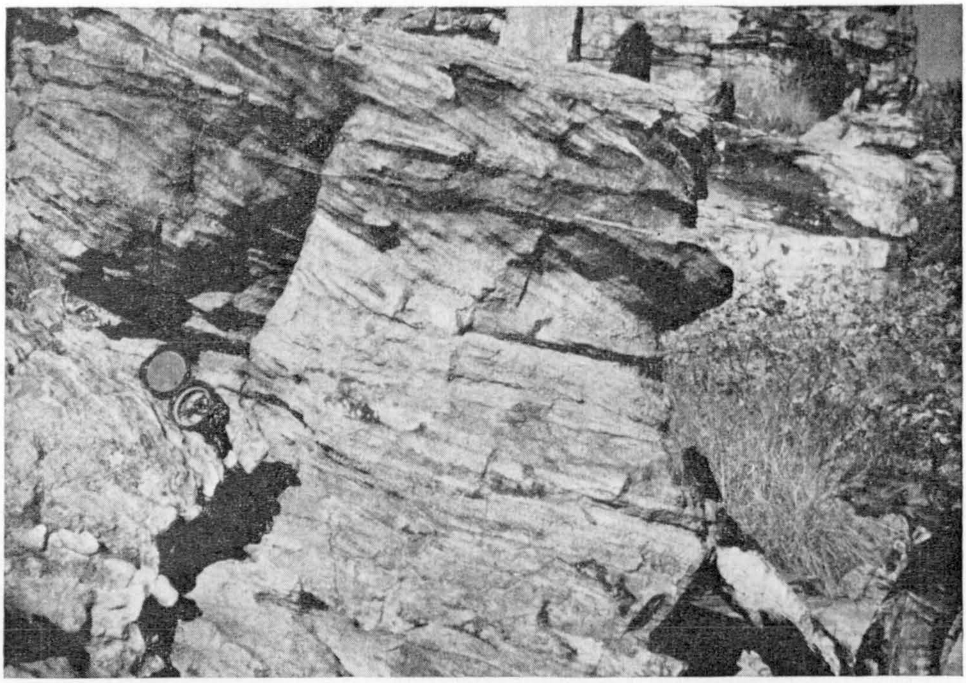


Fig. 4. Lalngang Sandstone: coarse, gritty, cross-bedded sandstone with minor pebble beds; 12 km southwest of Indian Hill. (GA/511)

stead, massive sandstone bands are few and the rocks are mainly siltstone and fine sandstone.

The sandstone is reddish or very dark grey on the weathered surface, and light grey or white when fresh. It is medium-grained, variably flaggy, blocky, and massive. Thin laminae and lenses of siltstone and mudstone, mud flakes, and minor sericite are common in the sandstone, which also contains a few discontinuous grit and small pebble bands.

The interbedded finer sediments range from very fine siltstone to fine sandstone and probably form up to 70% of the formation. They are generally fissile and occur as bands up to 60 m thick between sandstone bands. The siltstone is generally chocolate brown, less commonly dark grey-green, and in places ferruginous and sericitic.

Ripple marks, mud cracks, current lineations, and cross-bedding are common in some areas. Irregular tubular structures on some bedding planes appear to be infillings in mud cracks rather than organic structures.

In some sections a vertical gradation from relatively poorly sorted, thick-bedded medium to coarse sandstone through to well sorted, thin-bedded fine sandstone and siltstone can be recognized over thicknesses of 4 to 8 m. Section 2 (Appendix), measured 6.5 km east of Alligator Springs on the Legune track, is typical of the Legune Formation in the Auvergne Sheet area.

Twenty thin sections of sandstone from different beds south of Legune homestead were examined. Almost without exception the sandstone is orthoquartzite (terminology of Pettijohn, 1957). The quartz content is generally greater than

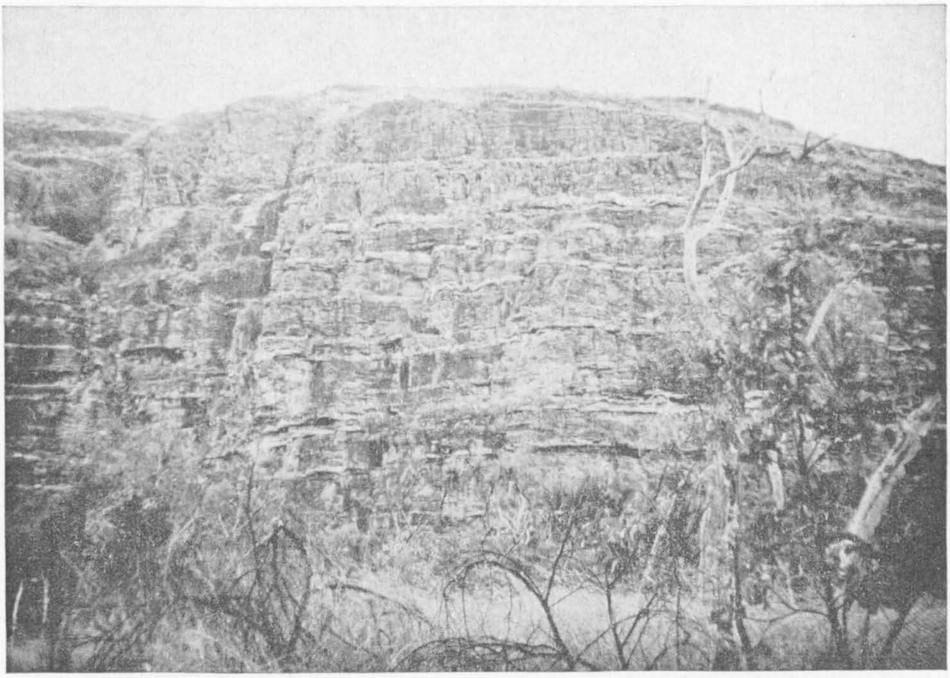


Fig. 5. Legune Formation: monotonous sequence of siltstone with sandstone interbeds; 17 km southwest of Alligator Springs. (GA/603)

95% in the detrital fraction; accessory minerals in order of abundance are tourmaline, zircon, rutile, and muscovite. The proportion of cement in the rocks ranges from nil to 20 percent, and is ferruginous and/or clayey. Secondary quartz overgrowths commonly surround the quartz grains. Most rocks are fine to medium, well sorted, and commonly grade into siltstone. Their composition and textures indicate that they are mature sediments, normally with low porosity. Most contain interlocking quartz grains associated with recrystallization and strain effects in the form of striations, fracturing of grains, and distortion of muscovite around quartz grains.

North of Legune homestead the Legune Formation generally contains more siltstone, and in the Madjellindi Valley area north of the Fitzmaurice River (Port Keats Sheet area) it is almost entirely siltstone.

In the southwest of the mobile belt, the Legune Formation contains a greater proportion of sandstone. The sediments are more gritty, and some are poorly sorted and generally less mature than those described above. Section 3 (Appendix), measured through the Legune Formation 20 km north-northeast of Ernie Lagoon, contains many gritty beds.

The character of the siltstone and the gross lithology differ from any unit of the stable shelf succession. The Legune Formation also differs from other formations in the mobile zone, which consist mainly of generally coarser-grained, relatively poorly sorted sandstone and show greater lateral facies variations. Faulting, although fairly common in the Legune Formation, is generally less marked than in the other formations. Although some sandstone bands form cliffs (e.g. Transit

TABLE 4. NOMENCLATURE USED FOR PROTEROZOIC UNITS IN THE VICTORIA RIVER BASIN

Brown *1895*	*Traves* *1955*	*Laing & Allen* *1956*	*Randal* *1962*	*Pontifex, Morgan, Sweet, & Reid* *1968*
				Duerdin Group
				Bullo River Sandstone Black Point Sandstone Member
		Pinkerton Beds	Yambarra Beds	Auvergne Group Shoal Reach Formation Spencer Sandstone Lloyd Creek Formation Pinkerton Sandstone Saddle Creek Formation
	Victoria River Group	Auvergne Shale	Angalarri Siltstone	Angalarri Siltstone
Victoria River Sandstone		Jasper Gorge Sandstone		Jasper Gorge Sandstone
Victoria River Shale		Coolibah Formation	Palm Creek Beds	Bullita Group Bynoe Formation
		Skull Creek Limestone / Timber Creek Formation		Skull Creek Formation Timber Creek Formation
				Wattie Group
				Limbunya Group

Hill), the unit as a whole forms less rugged country than other formations in the mobile zone.

Palaeogeographic significance: Legune Formation sediments are more mature than those in the underlying formations, indicating relatively more stable conditions during the later period of deposition in the mobile zone. Mud cracks and other sedimentary features indicate that the environment was fairly shallow water with periods of exposure. Less mature sediments at the southwest end of the mobile zone suggest relative instability in this area during deposition of the Legune Formation.

B. STURT BLOCK

CARPENTARIAN OR ADELAIDEAN

LIMBUNYA GROUP

The type area of the Limbunya Group is in the Limbunya Sheet area, where it has been subdivided into eleven formations as outlined by Mendum (1972) and described by Sweet, Mendum, Bultitude, & Morgan (in press).

In the Auvergne Sheet area the Limbunya Group crops out only as about 50 m of medium to coarse crystalline dolomite, capped by 18 m of pinkish brown chert. The dolomite, which weathers to dark grey, probably belongs to the Campbell Springs Dolomite; the chert replaces the underlying dolomite and has not been formally named.

About 24 km southeast of Auvergne homestead the chert is banded and brecciated and forms a ridge 8 km long adjacent to a prominent faulted monocline. The sequence forming the ridge dips steeply to the north, but within 100 m either side of the ridge the rocks have a maximum dip of 10°. Section 4 (Appendix), measured on the southern side of the ridge, contained 18 m of chert and minor sandstone. Well bedded chert, in flaggy beds, weathers into blocks 4 to 5 cm thick, in which banding is defined by variation in colour from white, light grey, and cream to pale brown. In places the chert is folded; the sequence of folding ranges from gentle undulations to almost isoclinal folds (Fig. 6). In some beds the bedding is completely disrupted. Blocks of chert are randomly oriented or maintain some degree of position and orientation, giving an indication of the original banding or bedding. The matrix between the chert fragments is white or purple-stained chert, and in some bands is a fine-grained silicified sandstone.

The contact between the Limbunya Group and the overlying Wattie Group was not observed, but it is probably an unconformity as seen in areas farther south (Mendum, 1972). The Limbunya Group is overlain unconformably by Jasper Gorge Sandstone, and sinkholes have developed by collapse of the sandstone into cavities in the dolomite.

ADELAIDEAN

WATTIE GROUP

The Wattie Group was first recognized and named in the Waterloo and Wave Hill Sheet areas (Sweet, Mendum, Bultitude, & Morgan, in press), where it has been sub-divided into seven formations; it has not been differentiated in the Auvergne Sheet area because the outcrop area is small and only the two youngest formations have been definitely recognized. The *Seale Sandstone*, conformably overlain by the Timber Creek Formation, consists of about 5 m of medium and

Fig. 6. Folded and brecciated chert in the Limbunya Group, 24 km southeast of Auvergne homestead. (GA/545)

coarse quartz sandstone. The *Gibbie Formation*, underlying the Seale Sandstone, consists of about 100 m of interbedded siltstone, sandstone, and dolomite. Fresh outcrop in the bank of the East Baines River near the southern margin of the Sheet area is typically flaggy to fissile with some blocky beds. The sandstone is fine-grained, siliceous, and well indurated; the siltstone is chocolate or greyish-green, and thin to medium-bedded. The dolomite beds, rarely more than 5 m thick, are fine-grained and grey.

BULLITA GROUP (New name)

The stratigraphy of the Bullita Group is summarized in Table 5. The group occupies a triangular area in the southeast of the Sheet area, bordered on the northwest by the Newcastle Range. It crops out extensively farther south and east in the Waterloo, Delamere, and Victoria River Downs Sheet areas.

TABLE 5. SUMMARY OF STRATIGRAPHY, BULLITA GROUP
(AUVERGNE SHEET AREA)

Rock Unit	*Symbol*	*Lithology*	*Maximum Thickness (m)*	*Physiographic Expression*	*Stratigraphic Relations*
Skull Creek Formation	P̲bs	Dolomite: stromatolitic, silty, and sandy; dolomitic siltstone and fine-grained sandstone; thin chert lenses	130 (excluding Bardia Chert Member)	Low rounded hills where not capped by Jasper Gorge Sandstone. Dendritic drainage pattern, but where bedding steeply inclined, drainage controlled by faults and folds	Overlies and may partly intertongue with Timber Creek Formation. Overlain unconformably by Jasper Gorge Sandstone
Bardia Chert Member	P̲bm	Chert: laminated, massive; brecciated; white, grey, pinkish brown	30	Flat cappings on many hills, commonly edged by a small cliff	At top of Skull Creek Formation. Overlain unconformably by Jasper Gorge Sandstone
Supplejack Dolomite Member	P̲bu	Massive, coarsely crystalline dolomite, weathers to dark grey	20	Bench in hillslopes with karren structure	Conformable member within formation
Timber Creek Formation	P̲bt	Siltstone, dolomitic siltstone, fine-grained sandstone, dolomite	115+	Terraced low rounded and conical hills reflect alternation of hard and soft layers	Conformable with, and underlies Skull Creek Formation

The Bullita Group comprises six formations, of which only the Timber Creek and Skull Creek Formations crop out in the Auvergne Sheet area. It is overlain unconformably by basal Auvergne Group (Jasper Gorge Sandstone). Total thickness of the group is unknown as its top is eroded, but at least 300 m are exposed in the Sheet area.

Timber Creek Formation (New name)

The name Timber Creek Formation was originally given to what was considered to be a lateral facies variant of the Skull Creek Formation (Laing & Allen, 1956). The extent of the unit as defined by Laing & Allen is slightly greater than mapped in 1967, but the general reference area is the same.

Distribution: The Timber Creek Formation crops out in an area of about 500 km^2 south and southwest of Timber Creek store. It also crops out to the east in the Delamere, and to the south in the Waterloo, Sheet areas.

Type Section: The type section, at 15°40′S, 130°28′E, is in the scarp about 1.5 km west-northwest of the Timber Creek store.

Stratigraphic relations: Evidence of the stratigraphic relations of the Timber Creek Formation is mainly derived from adjacent Sheet areas (Sweet, Mendum, Morgan, & Pontifex, 1974; Sweet, Mendum, Bultitude, & Morgan, in press), where it conformably overlies Seale Sandstone (Wattie Group) and is conformably overlain by Skull Creek Formation in the Auvergne Sheet area, as suggested by Laing & Allen (1956).

Lithology and thickness: The Timber Creek Formation is well exposed in a 150-m scarp formed by a waterfall about 1.5 km west-northwest of the Timber Creek store. The sediments are almost flat-lying and are capped by Jasper Gorge Sandstone. Timber Creek Formation is exposed in the lower 75 m, and for 6 m below the Jasper Gorge Sandstone.

The lower 75 m of the sequence consists of thin-bedded intercalated bands of the following rock types, in order of abundance:

(a) Silty dolomite and dolomitic siltstone

(b) Fine to very fine quartz sandstone

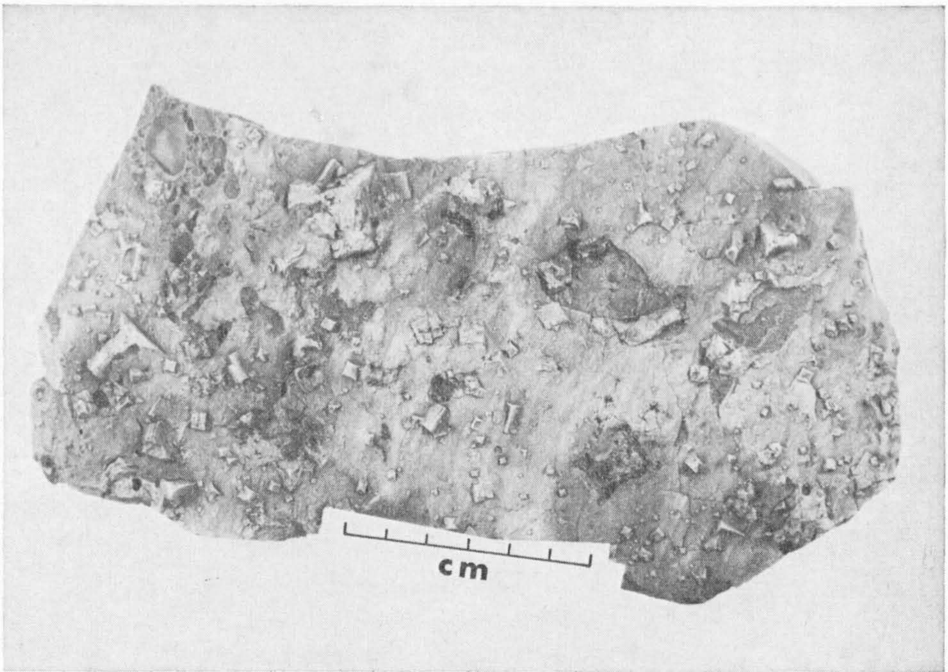
(c) Fissile siltstone and mudstone

(d) Dolomite

These rock types, and combinations of them, form thin-bedded to laminated bands up to 25 cm thick which can be traced unchanged along the strike for up to 75 m.

The silty dolomite is laminated to medium-bedded, fine-grained (micrite), and greenish grey or reddish brown. Commonly it contains chocolate mud flakes up to 1 mm across, and except for the mud flakes is fairly well sorted and homogeneous. In thin section it consists of silt-size quartz grains cemented by a fine-grained dolomitic matrix. In some bands subhedral crystals of dolomite up to 0.2 mm long form small aggregates, and in places form trains along bedding planes. One section contained up to 5 percent barite in small lenses localized along bedding planes. Common accessory minerals are tourmaline, zircon, sericite, chlorite, and feldspar.

The fine sandstone is thin-bedded, laminated, and only contains minor dolomite. It commonly shows ripple marks and fine-scale cross-bedding. Fine sand



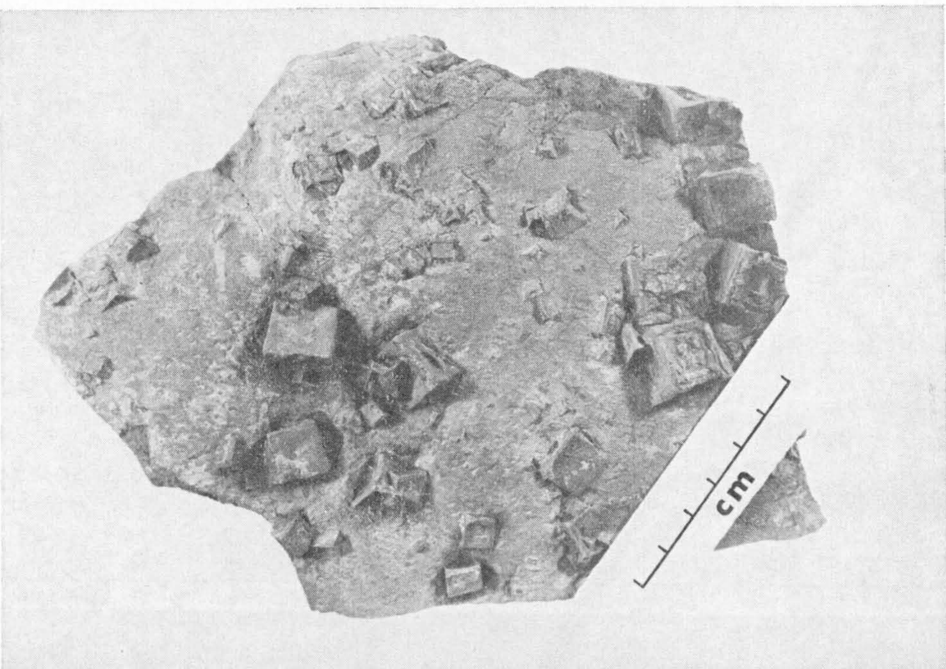


Fig. 7. Halite casts and mud-flake moulds in very fine sandstone in Timber Creek Formation. (GA/845, GA/843)

lamellae within dolomite bands are common, and show fine sets of migrating foreset beds and small cut-and-fill structures.

The siltstone and mudstone are fissile, and chocolate, greyish-green, or green; mud flakes are common; pseudomorphs after halite (Fig. 7), and mud cracks are also present.

The dolomite consists of micrite and contains minor disseminated and broken trails of silt-size quartz grains. Some dolomite beds contain thin lenses of chert up to 12 mm thick.

The 6 m of Timber Creek Formation exposed below the Jasper Gorge Sandstone consists of siltstone and mudstone which are reddish brown, grey, and laminated at the top, grading down into thin-bedded reddish brown dolomite in beds up to 0.5 m thick.

Elsewhere, exposure below the Jasper Gorge Sandstone is generally poor. One exception is a cliff on the south side of the Victoria River 5 km north-northeast of the Timber Creek store, with a similar sequence to the lower part of the exposure described above.

A rock bench in the bed of the Victoria River adjacent to its junction with Timber Creek consists of a greyish buff dolomite containing lenses of black chalcedonic chert up to 5 cm thick.

About 1 km southeast of Timber Creek police station, on the east bank of Timber Creek, about 12 m of predominantly greyish green and purple laminated and thin-bedded siltstone is overlain by about 5 m of dolomite. The dolomite forms bands up to about 1.5 m thick, which are thin-bedded, silty, and pock-marked, and contain fairly abundant chert as lenses and nodules. Funnel-shaped structures of finely laminated chert, which are concave upwards and cut across the bedding of the enclosing dolomite, may be stromatolites which have been replaced by chert or possibly chert-filled solution cavities.

Section 5 (Appendix), measured through the Timber Creek Formation on a hill 6.5 km south-southeast of the store, comprises 80 m of dolomite, siltstone, and minor sandstone. About 9 km south-southwest of the store, Section 6 (Appendix) has a basal sandstone which may belong to the Wattie Group, and because the Skull Creek Formation crops out 2 km farther southeast the measured thickness of 98 m is probably that of the whole Timber Creek Formation.

About 35 km southwest of Section 6, Section 7 (Appendix) was measured at 15°58′S, 130°18′E. The base of the section is probably within 10 m stratigraphically from the base of the formation. Overlying the Timber Creek Formation is 8 m of chert and sandstone overlain by 15 m of Jasper Gorge Sandstone.

Sections 5 and 6 are typical of the Timber Creek Formation south of Timber Creek. The beds dip to the southeast at between 0.5° and 5°, and exposures in shallow creeks indicate that the general plain level coincides with a distinctive, tough, dark brown dolomitic, feldspathic sandstone which is medium-bedded and massive. It comprises about 50 percent fine sand grains cemented by a fine-grained aggregate of dolomite. Dolomite also forms discrete crystals and small aggregates up to 3 mm long, which weather out to give the rock a pitted surface. The rock may contain up to 10 percent feldspar, and accessory tourmaline, sericite, and secondary iron oxides. Mapping of areas to the south (Sweet, Mendum, Bultitude, & Morgan, in press) indicated that the sandstone is widespread; it is now included in the Wattie Group, although it is not differentiated as such in the Auvergne Sheet area.

Dolomite layers and, less commonly, quartz sandstone beds form the hard bands imparting the terraced topography to the otherwise smooth slopes of the Timber Creek Formation. Generally the lower part of the sequence is predominantly silty, and the upper part, about 45 m thick, is carbonate-rich.

Samples of carbonate rock from the Timber Creek Formation were analysed to determine their CaO/MgO ratios:

Field No.	*Location* *Latitude*	*Longitude*	*Insol. Residue* (*wt%*)	*CaO* (*wt%*)	*MgO* (*wt%*)	*CaO/MgO*
P156H	15°37′	130°27′	34.8	19.5	14.9	1.31
P156D	15°37′	130°27′	22.1	24.6	16.5	1.49
P382E	15°44′	130°29′	10.2	23.5	19.0	1.23
S155A	15°40′	130°27′	20.5	24.0	16.5	1.45
S155B	15°40′	130°27′	34.8	19.5	14.9	1.30

The CaO/MgO ratios indicate that these rocks are essentially dolomite (the CaO/MgO ratio in pure dolomite is 1.40). P382E and S155A probably contain some magnesite. A comparison, in hand specimen and thin section, of other carbonate rocks from the formation with the five analysed samples indicated that all the carbonate rocks are dolomitic and contain varying amounts of clastic impurities.

Skull Creek Formation (New name)

The Skull Creek Formation was included in the Victoria River Group by Traves (1955), but was not named separately by him. Laing & Allen (1956) named it the 'Skull Creek Limestone'. In the Auvergne Sheet area the unit comprises dolomite and siltstone, and accordingly the name has been modified to Skull Creek Formation.

Distribution: The Skull Creek Formation is exposed within an area of about 750 km^2 in the extreme southeast of the Sheet area. This is only a small part of the total outcrop of the unit, which covers a large portion of the centre of the Victoria River area.

Type section: The type section nominated by Laing & Allen (1956) has been retained; it is in the central dome near the Timber Creek/Jasper Gorge road, 30 km from the Timber Creek police station in the Delamere Sheet area. The formation takes its name from Skull Creek which passes between two of the domes near the type section. Masses of laminated and brecciated chert at the top of the Skull Creek Formation in some areas have been mapped as the Bardia Chert Member. A prominent massive dolomite band has been mapped as Supplejack Dolomite Member in Sheet areas south of Auvergne. Outcrops near the southern margin are the only ones shown on the Auvergne map Sheet.

Stratigraphic relations: Laing & Allen (1956) considered that the Timber Creek Formation was a silt-dolomite facies variant of the 'Skull Creek Limestone'. They stated that the boundary is gradational, but defined it as the horizon where more than 10 percent siltstone enters into a predominantly limestone (now known to be dolomite) section.

In the Auvergne Sheet area the boundary between the two units, or the differentiation between them using Laing & Allen's definitions, could not be substantiated. There is undoubtedly a considerable facies change within the area from mainly carbonate in the extreme southeast to predominantly silt in areas underlying Jasper Gorge Sandstone to the northwest, but the change appears to be one of normal vertical, and not lateral, facies change.

There is no markedly different photo-pattern between the two formations, and in most places in the Auvergne Sheet area the Skull Creek Formation contains more than 10 percent silt or sand fraction. A boundary has been tentatively mapped on the Auvergne map Sheet. For the present, the name Timber Creek Formation has been retained for the unit north and west of the boundary, and Skull Creek Formation for the unit southeast of it.

The Skull Creek Formation contains a large amount of chert. Up to 30 m of chert overlies dolomite in the western part of the Delamere Sheet area, and smaller bodies likewise occur in the Auvergne Sheet area. The chert has a distinctive lithology and pattern on aerial photographs, enabling it to be mapped as a member of the Skull Creek Formation. However, the Skull Creek Formation also contains chert interbeds at several other stratigraphic horizons and these are not included in the Bardia Chert Member.

Lithology and thickness: In the Auvergne Sheet area the Skull Creek Formation was examined mainly near the eastern margin, where access is obtained with some difficulty from the Bullita track. A maximum of about 130 m was measured, but between Coolibah station and Timber Creek in the Delamere Sheet area it measures up to 200 m thick.

Exposure in the Auvergne Sheet area is generally poor: much of the country is flat or moderately undulating and the surface consists of large, scattered, remnant, flaggy blocks or broken flat-lying beds of dolomite. The maximum vertical section exposed in these areas is about 10 m. Where the unit is preserved by overlying sandstone and chert, and in rare areas of steeply dipping beds, a vertical section of 100 m or more may be seen.

The Skull Creek Formation consists essentially of grey, thin-bedded, flaggy and massive, silty and sandy dolomite, minor dolomitic fine-grained sandstone, and flaggy and blocky relatively pure dolomite. On its weathered surface the sandy dolomite is dark-coloured and shows fine-scale sedimentary structures, rare mud cracks, and pseudomorphs after halite. The pure dolomite has a smooth weathered surface which in places shows incipient development of fluting.

Section 8 (Appendix), measured through the Skull Creek Formation south of Barrabarrac Creek at 15°56′S, 130°26′E, comprises 112 m of dolomite and siltstone overlain by 20 m of banded and brecciated chert.

Section 9 (Appendix) is a composite of a lower carbonate sequence which forms a low banded hill, and a sequence about 3 km farther north which is almost certainly continuous with and stratigraphically higher than that in the banded hill. Both component sections are in the Delamere Sheet area within 1 km of the eastern margin of the Auvergne Sheet area.

In the Waterloo Sheet area, about 2 km south of its boundary with the Auvergne Sheet area, the Bullita track crosses a steeply dipping sequence of mainly carbonate rocks. A light brown friable thin-bedded sandstone about 2 m thick is overlain by about 60 m of thin-bedded dolomite, silty dolomite, and dolomitic siltstone. These rocks show small-scale sedimentary structures and chert is associated with the carbonates. Overlying them is a fairly distinctive 6-m bed of purplish grey cherty dolomite which is overlain by about 6 m of massive, irregularly nodular, and bedded chert. These steeply dipping beds form the elbow of a monocline which runs in a long sinuous line about 40 km long and 0.5 km wide; such structures are common in the Skull Creek and Timber Creek Formations. The flat-lying beds adjacent to the monocline consist of grey to buff, thin-bedded, cryptocrystalline dolomite in bands up to 1 m thick, intercalated with thinner-bedded dolomite and silty dolomite bands. The dolomite contains irregular bodies and bands of chert. The sequence imperceptibly grades in places into predominantly thin-bedded siltstone, most of it dolomitic. The total carbonate content in the formation in this area is apparently greater than in the same formation to the north in the Auvergne Sheet area.

Samples of carbonate rock from the Skull Creek Formation were analysed, and their CaO/MgO ratios indicate that they are essentially dolomites:

Field No.	*Location* Latitude	Longitude	*Insol. Residue* (*wt%*)	*CaO* (*wt%*)	*MgO* (*wt%*)	*CaO/MgO*
P355A	15°47′	130°31′	23.1	23.9	16.5	1.45
P355C	15°47′	130°31′	57.0	12.3	9.80	1.26
P356	15°47′	130°31′	3.5	31.3	19.45	1.61
P390D	15°55′	130°10′	21.1	24.0	16.5	1.45

Specimen P356 was described in hand specimen as 'pure' dolomite because it contained no apparent sand or silt. The insoluble residue in P355A is mainly chert. P355C is a dolomitic fine-grained sandstone. P390D is dolomite and interbedded silty dolomite.

Supplejack Dolomite Member (New name)

The Supplejack Dolomite Member crops out in the extreme southeastern corner of the Auvergne Sheet area. It is much more extensive in the Waterloo and Victoria River Downs Sheet areas, and a more complete description appears in Sweet, Mendum, Bultitude, & Morgan (in press). The name is derived from Supplejack yard, approximately 16 km northwest of Bullita homestead. Laing & Allen (1956) first observed it and designated it the 'upper marker' of the Skull Creek Formation. It stands out as prominent dark-toned areas on aerial photographs, and is therefore easily mapped.

Type section: Adjacent to the track connecting Supplejack yard and Bullita homestead, 9 km west-northwest of the homestead at 16°6′S, 130°21′E. The upper and lower boundaries are conformable with the remainder of the Skull Creek Formation (Sweet, Mendum, Bultitude, & Morgan, in press).

Lithology and thickness: The Supplejack Dolomite Member consists of medium to coarsely crystalline dolomite, weathering dark grey to almost black. In outcrops near the southern margin of the Auvergne Sheet area, it consists of massive grey laminated dolomite which may contain some stromatolites. The member has not been differentiated everywhere it crops out in the Auvergne Sheet area. It has not been measured, but is estimated to be 1 to 20 m thick.

Bardia Chert Member (New name)

Distribution: In the Auvergne Sheet area the Bardia Chert Member forms several elongate isolated hills within the Skull Creek Formation. It has a distinctive photo-pattern and its presence has been photo-interpreted near the inaccessible southern margin of the Sheet area where it forms cappings on some hills (Jasper Gorge Sandstone caps other hills in the same area). Mount Dempsey consists of up to 30 m of Bardia Chert and associated sandstone.

Massive chert is far more extensive in the western part of the Delamere Sheet area (Sweet et al., 1974), and in the northern part of the Victoria River Downs Sheet area (Sweet, Mendum, Bultitude, & Morgan, in press).

Derivation of name: The Bardia Chert Member is named after Bardia yard in the southwestern corner of the Delamere Sheet area.

Type section: In the Burt Range in the Victoria River Downs Sheet area at 16°11′40″S, 130°55′30″E.

Lithology: The Bardia Chert Member consists of white, grey, and pinkish brown, extremely fine-grained chert which is generally banded. The banding is distorted in places by folding; more commonly the chert is brecciated and angular, and rectangular fragments of banded chert have been displaced and cemented by chalcedonic silica. All processes apparently have taken place *in situ.* Voids and drusy cavities lined with chalcedony and fine quartz crystals are common. In the section at 15°56′S, 130°26′E, cavities and interbeds of ochreous clay are common. Also in this area, a remnant hill in an equivalent stratigraphic position to the nearby chert member consists almost entirely of brown and yellowish banded 'mudstone' containing minor siliceous patches. The mudstone may have been the original rock type which the chert has replaced in other areas; or it may be an alteration product of the chert.

Mount Dempsey is formed by highly brecciated chert and light brown, silty, sericitic chert which is interbedded with silicified sandstone. The sequence is in a faulted anticline adjacent to four intersecting photolinear features and is surrounded by lower-lying, essentially flat dolomite of the Skull Creek Formation. The chert is massive, lacks banding, and consists of a microcrystalline aggregate of silica which contains about 15 percent detrital(?) silt-size quartz, sericite grains, and diffuse lenses of clay. It is likely that the rock is a silty dolomite which has been replaced by chert. Well preserved pseudomorphs after halite up to 1 cm across are common on weathered surfaces. The sandstone is a silicified heterogeneous labile sandstone which contains minor amounts of altered feldspar. Some beds of sandstone contain abundant elongate or globular mud pellets and pseudomorphs after halite. It is difficult to estimate the thickness of the member at Mount Dempsey because of its structural situation and the vagueness of the boundaries between the chert and silicified sandstone. Although the dolomite of the Skull Creek Formation which underlines the chert member contains bands and lenses of chert, there is no apparent increase in the abundance of chert towards the base of the chert member.

In two of the sections measured, Jasper Gorge Sandstone directly overlies the chert member. In the section at 15°58′S, 130°18′E, a 3-m band of reddish thin-bedded silty sandstone within the chert member contains fine-scale cross-bedding, ripple marks, pseudomorphs after halite, and moulds of possible fossil jellyfish and of a peculiar spiral animal form (Fig. 8). The spiral mould is almost certainly the same type as previously described by Öpik (1957).

Several elongate hills about 10 km south of Twelve Mile Waterhole (western margin of Delamere Sheet area) consist of up to 30 m of chert. The chert forms the upper three-quarters of each hill, resting on Skull Creek Formation which makes up the lower quarter and the surrounding plains. The chert is massive, but forms crude bands up to 3 m thick which tend to strike parallel to the axis of the hill they form, and also dip fairly steeply towards the centre of the hill. The chert at the ends of each ridge also dip towards the centre of the hill, forming an elongate basin structure. Along the spines of some ridges the chert bands (some of which are laminated) are nearly vertical. These attitudes are not reflected in the underlying Skull Creek Formation sediments which are flat-lying or dip very gently.

Although the chert has been named and mapped as a formal unit, its validity as a member of the Skull Creek Formation is in doubt. It overlies different parts of the formation in different areas, and in Section 7 (Appendix) it overlies Timber Creek Formation. It is thus apparent that chert forms a stratigraphic unit which developed after the Timber Creek and Skull Creek Formations were folded and eroded. In the Delamere Sheet area the chert antedates the Bynoe Formation, which overlies the Skull Creek Formation conformably in areas where the chert is not present (Morgan et al., 1970). The Bardia Chert Member appears to be a unit of silicification which developed after deposition of the Skull Creek Formation, but before the Bynoe Formation was laid down.

Palaeogeographic significance of Timber Creek and Skull Creek Formations: Both formations were deposited in a placid shallow water which extended over a slowly subsiding stable shelf. The carbonate rocks are mainly chemical deposits. The contribution of carbonate in the form of algal beds or reefs is small.

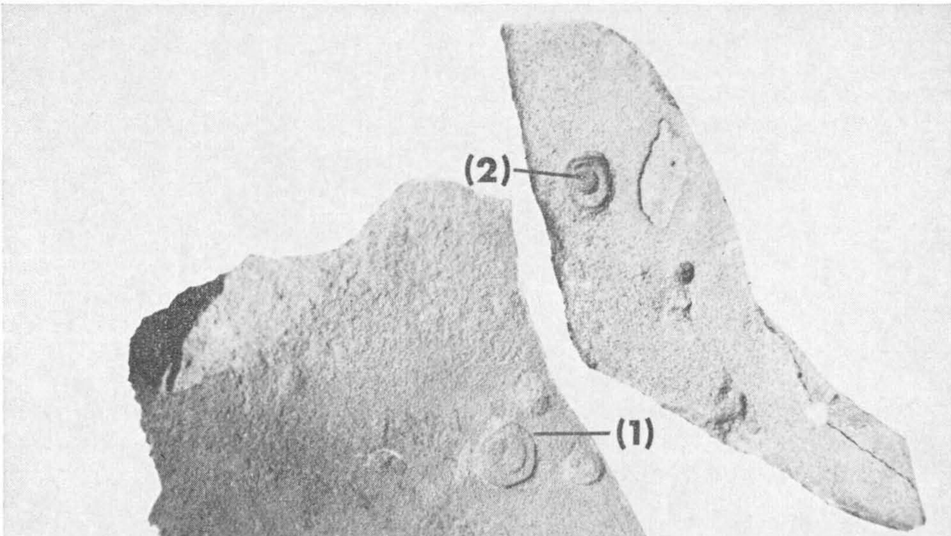


Fig. 8. Moulds of primitive organisms or chert plates (1) and spiral shaped fossil (2) in a thin sandstone bed associated with chert in the Bardia Chert Member at 15°58′S, 130°18′E. (GA/842)

The predominance of silt and very fine sand intimately associated with dolomite in the Timber Creek Formation, and the sedimentary structures found in these rocks, suggest deposition under lagoonal conditions possibly alternating with an intertidal mudflat-type environment. The surrounding areas were probably almost at base level, providing fine detritus. Some areas were free of mud and silt contamination long enough to allow relatively pure dolomite and chert to form, some with stromatolites.

The rocks forming the Skull Creek Formation contain generally less clay and silt, indicating conditions favourable for a predominantly chemical deposition and the formation of more 'pure' dolomite and more abundant chert. Mud and silt were minimal in the Skull Creek Formation sediments, but the presence of stromatolites and the sedimentary structures indicate deposition in intertidal waters. The Bardia Chert Member is a unit of silicification and postdates deposition of the Skull Creek Formation (confirmation of this is given in Sweet, Mendum, Bultitude, & Morgan, in press).

AUVERGNE GROUP (New name)

Derivation of name: Auvergne Group is a new name derived from the Auvergne pastoral lease which occupies most of the Whirlwind Plain. The stratigraphy is summarized in Table 6.

Distribution: The group forms most of the Pinkerton and Yambarra Ranges and extends north and east into the Port Keats, Delamere, and Fergusson River Sheet areas, and south into the Waterloo and Victoria River Downs Sheet areas.

Stratigraphic relations: The Auvergne Group forms the upper part of the sedimentary rock succession within the Victoria River area. It comprises seven conformable formations, consisting of shale, siltstone, sandstone, and dolomite, and has a total thickness of about 950 m. It unconformably overlies the Bullita Group and is unconformably overlain in part by the Bullo River Sandstone, and in some areas by the Duerdin Group and Antrim Plateau Volcanics.

The northwestern limit of outcrop of the Auvergne Group is the Victoria River Fault.

Jasper Gorge Sandstone (New name)

Distribution: The Jasper Gorge Sandstone forms flat or gently sloping hilltops and prominent scarps in the Newcastle Range, a belt up to 35 km wide across the southeastern corner of the Sheet area and extending into the central parts of the Waterloo and Delamere Sheet areas and the northwestern part of the Victoria River Downs Sheet area.

Derivation of name: The name is derived from Jasper Gorge in the Victoria River Downs Sheet area, on the road between Timber Creek and Victoria River Downs. The term Jasper Gorge Sandstone was first used by Laing & Allen (1956), and the formation is equivalent to the Victoria River Sandstone of Brown (1895). Traves (1955) also called it the Victoria River Sandstone, and included it in his Victoria River Group. The name Jasper Gorge Sandstone is retained rather than Victoria River Sandstone because of the previous multiple usage of the latter name.

Type section: The type section chosen by Laing & Allen for the Jasper Gorge Sandstone is at the eastern end of Jasper Gorge, where about 185 m of red and

TABLE 6. SUMMARY OF STRATIGRAPHY, AUVERGNE GROUP
(AUVERGNE SHEET AREA)

Rock Unit	*Map Symbol*	*Lithology (in order of abundance)*	*Maximum Thickness (m)*	*Physiographic Expression*	*Stratigraphic Relations*	*Remarks*
Shoal Reach Formation	Ꝑah	Dolomite, sandstone, sandy and silty dolomite, minor siltstone and shale	110	Easily eroded unit, poorly exposed except where protected in scarps by overlying Bullo River Sandstone	Conformable on Spencer Sandstone; probably unconformably overlain by Black Point Member of Bullo River Sandstone	Thins in NE where rarely preserved
Spencer Sandstone	Pae	Quartz sandstone, silty sandstone, dolomitic sandstone	170	Fairly prominent basal sandstone band, poorly exposed sub-outcrop and minor ledge-forming for rest	Conformable between Lloyd Creek Formation and Shoal Reach Formation	
Lloyd Creek Formation	Ꝑal	Dolomite (oolitic and stromatolitic), sandy and silty dolomite; dolomitic siltstone	75	Soft weathering, most common in scarps below Spencer Sandstone; dolomite bands form layer-cake structure	Conformable between Pinkerton Sandstone and Spencer Sandstone	Stromatolite content diagnostic
Pinkerton Sandstone	Ꝑap	Massive quartz sandstone, minor siltstone and mudstone	120	Forms scarps and plateaux in Pinkerton and Yambarra Ras. Commonly deeply incised	Conformable between Saddle Creek Formation and Lloyd Creek Formation	Generally forms barrier tableland country, poor vegetation cover, good surface water
Saddle Creek Formation	Ꝑad	Basal cross-bedded sandstone, upper siltstone, minor oolitic dolomite	160	Mainly in scarp below Pinkerton Sandstone, basal band usually prominant, upper siltstone poorly exposed	Conformable between Angalarri Siltstone and Pinkerton Sandstone	Thin dolomite bands in upper silt in SW. Basal band has abundant sedimentary structures. Upper siltstone thins in NE
Angalarri Siltstone	Ꝑaa	Greyish green siltstone and shale; minor dolomite and limestone	300+	Soft weathering. Mainly as lower part of scarps and plains country, cut and exposed by some major streams	Conformable between Jasper Gorge Sandstone and Saddle Creek Formation	Good grazing country in Whirlwind Plain. Green colour distinctive. Rare thin flaggy limestone beds
Jasper Gorge Sandstone	Ꝑaj	Massive quartz sandstone, siltstone, minor basal conglomerate	130	Resistant, plateau and scarp-forming. Deep gorges	Unconformable on Timber Creek and Skull Creek Formations	Aquifer under Ꝑaa in some areas. Jointing prominent

white quartz sandstone is exposed. However, since no exact locality was nominated, we have designated a section north of Jasper Gorge at 15°58′S, 130°43′E, as the type section (Sweet, Mendum, Bultitude, & Morgan, in press).

In the Auvergne Sheet area the Jasper Gorge Sandstone overlies the Timber Creek and Skull Creek Formations. Locally the contact is not obviously unconformable, but on a regional scale there is an angular unconformity between them. The contact is sharp, but even at localities where it is exposed evidence of erosion is not easily found.

The Jasper Gorge Sandstone has a fairly consistent shallow dip to the northwest, where it dips below the Angalarri Siltstone that forms the Whirlwind Plain. The actual contact between the Angalarri Siltstone and Jasper Gorge Sandstone was not seen, but the attitude of both units indicate that they are conformable.

Lithology and thickness: In the Auvergne Sheet area the Jasper Gorge Sandstone has a maximum thickness of about 130 m on the sandstone plateau adjacent to the East Baines River.

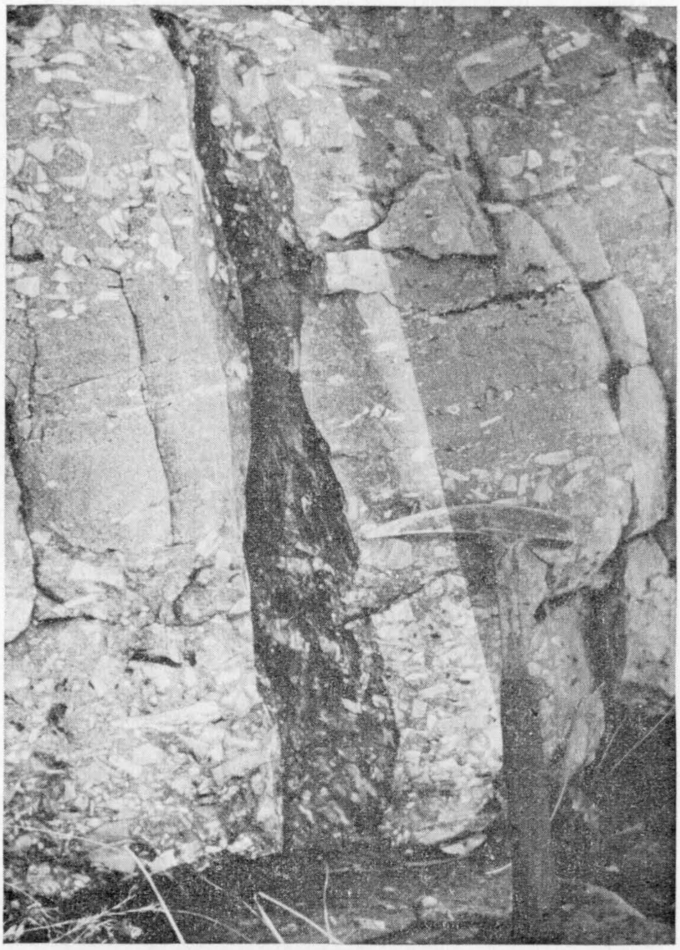


Fig. 9. Basal conglomerate of Jasper Gorge Sandstone: bands of predominantly angular chert clasts intercalated with bands of fine-grained sandstone; matrix between chert fragments is also sandstone; 24 km southeast of Auvergne homestead. (GA/546)

Fig. 10. Basal conglomerate of Jasper Gorge Sandstone: much poorer sorting than rocks in Fig. 9; clasts are angular to subangular; matrix is poorly sorted sandstone. About 18 km south of Timber Creek police station. (M/796)

In the scarps near Timber Creek, the Jasper Gorge Sandstone is at least 30 m thick. Section 10 (Appendix), measured 1 km north-northwest of Timber Creek store, is 31.5 m thick, although the top of the formation is absent.

Section 11 (Appendix), measured through the Jasper Gorge Sandstone in the headwaters of Little Horse Creek, revealed more than 50 m of the formation. Again the upper part is absent, and it seems likely that the formation totals at least 60 m around Timber Creek.

The sequence along the strike-fault 24 km southeast of Auvergne homestead contains a massive conglomerate bed at the base of the Jasper Gorge Sandstone immediately overlying Limbunya Group chert. Including the basal conglomerate, the formation is up to 130 m thick (Section 12, Appendix). The conglomerate varies in thickness to a maximum of 6 m and forms a prominent bench which shows clearly on aerial photographs.

Clasts make up to 50 percent by volume of the conglomerate and are heterogeneous in shape, size, composition, and distribution. They are angular to subrounded (Fig. 9); many larger fragments tend to be tabular and range from coarse sand-size to pebbles 5 cm across. The tabular clasts are aligned roughly parallel to the bedding. The clasts consist of (in estimated order of abundance):

(a) white and grey chert and fine-grained siliceous metaquartzite;

(b) soft white claystone (?mudstone or lumps of completely decomposed feldspar);

(c) glassy bluish opalescent quartz;

(d) sandstone of similar composition to matrix;

(e) accessory small subrounded granules of pink feldspar.

The rock commonly contains voids which are lined by crystals of drusy quartz. The matrix consists of dark brown, well rounded, clear quartz grains which average 0.8 mm in diameter, are poorly sorted, and all have secondary overgrowths of quartz which almost fill spaces between grains; cryptocrystalline silica cements the matrix between the overgrowths. In some places the conglomerate passes down into mixed conglomerate, chert, and breccia which have a maximum thickness of 3 m; the matrix is coarser and the fragments are more angular and cherty than in the overlying conglomerate. The total thickness of the formation here is apparently greater than near Timber Creek; it may be a local thickening, or the formation may be thickening to the southwest.

Near Timber Creek police station, several thin pebble bands near the base of the Jasper Gorge Sandstone are similar in composition to the conglomerate farther west, but are finer-grained and better sorted. A basal red sandstone band is continuous along most scarps in the Timber Creek area. In other areas it is not continuous, and as one sandstone bed lenses out another appears under or over it.

Most sandstone samples from the Timber Creek area are orthoquartzite (Pettijohn, 1957). The basal band contains about 10 percent clouded composite grains probably derived from volcanic rock or metaquartzites, and accessory limonite. In more poorly sorted, gritty, and pebbly sandstone the coarser fragments are poorly rounded and sorted and commonly consist of chert, bluish opalescent quartz, and rock fragments. Comparatively, the finer sandstone matrix is fairly mature.

The topography underlain by the Jasper Gorge Sandstone is distinctive and is readily distinguished on aerial photographs. It forms mesa and plateau-type topography and dip-slopes with large areas of bare rock commonly strewn with blocky boulders up to 2 m across. It typically forms the top of scarps, and is dissected by steep gorges. Joint lineaments are abundant and form a clearly defined pattern; some joints are up to 10 km long.

The distribution and lithology of the Jasper Gorge Sandstone indicate that it is a mature to very mature sandstone laid down on a stable, broad continental shelf. The structures indicate shallow water, probably a near-shore marine environment.

In most places the lower part of the formation probably represents deposition during a very slowly advancing marine transgression across an erosion surface, with adequate time for reworking and sorting of the sand. The sporadic distribution of local lenses of silt through the sequence indicates fluctuation in water depth, although an apparent general increase in the proportion of silt toward the top of the unit indicates that deposition probably accompanied a general deepening of the Victoria River Basin.

Angalarri Siltstone (New name)

Distribution: The Angalarri Siltstone underlies the Whirlwind Plain and forms a northeast-trending belt, averaging 25 km wide, across the southeastern half of the Sheet area. It also crops out in the scarp slopes of the Yambarra and Pinkerton Ranges and in the slopes bordering the eastern side of Koolendong Valley. Adjacent to the Victoria River Fault near Holdfast Reach, its characteristic lithology aided the identification of massive overlying sandstone units. Isolated outcrops occur in the Spencer Range, near the Keep River, and in the far northeast of the Sheet area.

It continues north and east into the Fergusson River, Delamere, and Port Keats Sheet areas, and south into the Waterloo Sheet area.

Derivation of name: The unit was formally named by Randal (1962) after the Angalarri River in the southwest corner of the Fergusson River Sheet area. Laing & Allen (1956) informally named it the Auvergne Shale from exposure in the East Baines River, and previously it had been included in Traves' (1955) undifferentiated Victoria River Group.

Type section: No complete section of the Angalarri Siltstone is exposed in the Auvergne Sheet area, and no type section has been measured. It is generally exposed only where overlying sandstone formations protect it from weathering, and where rivers cut into it in the Whirlwind Plain.

The lower part crops out along the East Baines River at, and south of, the main road crossing. The upper part forms the slopes of scarps in the Pinkerton and Yambarra Ranges, where it is well exposed at Mount Razorback and Curiosity Peak. Accordingly, the type section nominated is along the East Baines River from the East Baines Gorge to the Pinkerton Range escarpment.

Stratigraphic relations: The Angalarri Siltstone lies apparently conformably on the Jasper Gorge Sandstone. The actual contact was not found, and the relationship is inferred largely from photo-interpretation which indicates that the Jasper Gorge Sandstone dips gently below the siltstone that has the same gentle regional dip to the northwest. This lower contact is gradational in places as the lower part of the Angalarri Siltstone contains a number of sandstone interbeds.

The upper contact, which is apparently conformable, is generally well defined by the marked change in lithology from green fissile siltstone to flaggy sandstone at the base of the overlying Saddle Creek Formation. An exposure of the contact 3 km west-northwest of Skinner Point showed truncation of beds by the Saddle Creek Formation, but this is thought to be a local unconformity.

Lithology and thickness: Although no complete stratigraphic section has been observed, in most of the Sheet area it is possible to divide the Angalarri Siltstone into a lower, flaggy, coarse-grained siltstone and an upper, fissile, finer-grained siltstone or silty shale. Dolomitic siltstone and flaggy dolomite have been observed east of Bradshaw homestead near the Angalarri River, and 11 km east of Skinner Point in the southwest. The rocks in the latter locality are probably in the lower or middle part of the formation.

The lower siltstone is best exposed along the East Baines River, south of Auvergne homestead. It includes grey or greyish green coarse-grained quartz siltstone. Finer-grained quartz silt and clay probably form less than 20 percent of the total rock, and accessory pyrite and barite are present in some areas. Beds vary from vaguely laminated to thin-bedded, and the partings from fissile to flaggy. Partings are commonly due to concentrations of micaceous minerals on bedding planes. Well defined flaggy to blocky interbeds of coarse silt-size to fine sand-size grains occur in the first 10 m above the Jasper Gorge Sandstone. The contact is defined by a marked change in resistance to weathering, corresponding to the change from sandstone (Jasper Gorge Sandstone) to interbedded siltstone and sandstone (Angalarri Siltstone). Intraformational breccia of sandstone blocks within the normal bedded siltstone matrix was observed at one locality in the East Baines valley.

Large areas of the Whirlwind Plain display a prominent joint pattern on aerial photographs. Although well weathered, the underlying rocks are very similar to the coarse siltstone and fine sandstone mentioned above. The joint pattern may be a reflection of major joints in the underlying Jasper Gorge Sandstone, indicating that the cover of Angalarri Siltstone is relatively thin.

Interference and oscillation ripple marks and, to a lesser extent, current ripple marks are very common (Fig. 11). The first two structures reach amplitudes of 15 cm wavelengths up to 2 m, although they are generally of the order of 1 to 2 cm and 5 to 15 cm, respectively. There is no obvious preferred orientation of structures, and ripple axes on consecutive beds, each 5 to 10 cm thick, show different orientations (Fig. 18).

The upper beds of the Angalarri Siltstone crop out along the entire length of the Pinkerton and Yambarra Ranges, and consist of very finely interlaminated siltstone and shale (Fig. 12). Individual laminae are commonly only about 0.2 mm thick, the finer consisting of extremely fine-grained clay minerals, and the coarser of angular quartz silt, with minor muscovite, clay, and feldspar. The clay minerals impart a green colouration to the rock, and some thin laminae contain light green silt-size pellets of glauconite.

Within the siltstone in the upper 15 m of the formation, discontinuous sandstone lenses are 15 cm to 1 m thick, rarely up to 3 m. Current-bedding, ripple marks, and sole markings are developed in the lenses, particularly in Koolendong Valley where the Angalarri Siltstone is at least 185 m thick (Section 13, Appendix).

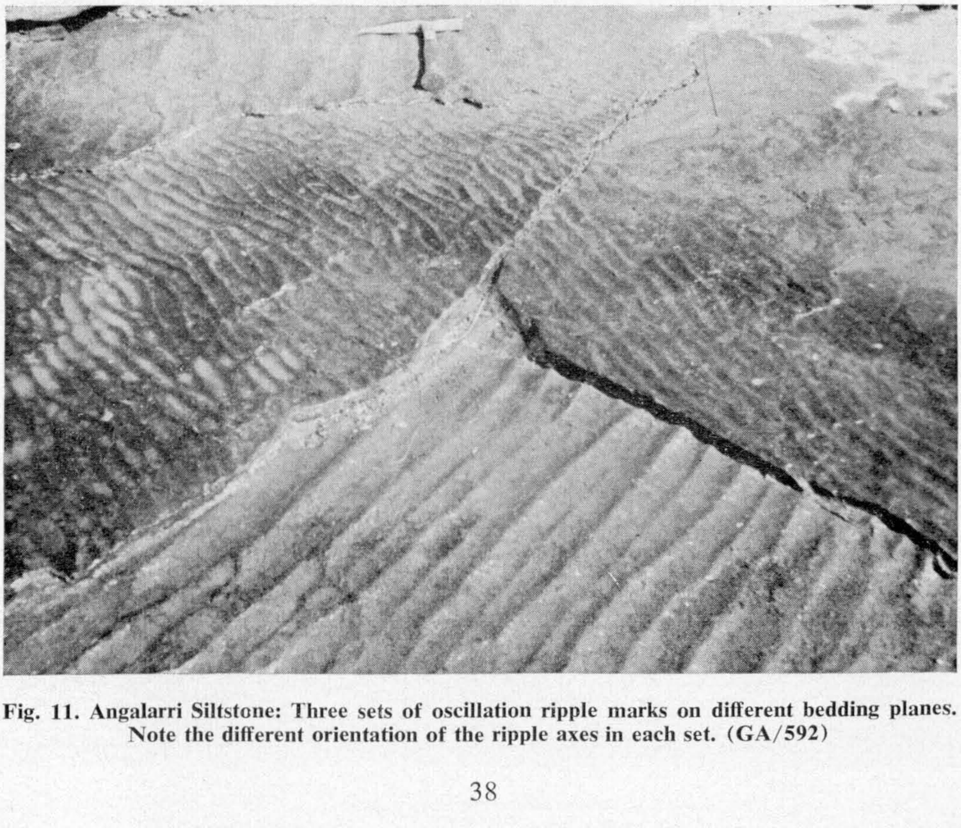


Fig. 11. Angalarri Siltstone: Three sets of oscillation ripple marks on different bedding planes. Note the different orientation of the ripple axes in each set. (GA/592)

Fig. 12. Upper beds of Angalarri Siltstone: fissile siltstone and shale on side of gully, capped by the basal sandstone of the Saddle Creek Formation. (GA/621)

The thickness of the formation in most places can only be estimated. The unit has a general regional dip between 0 and 5° to the northwest in the Whirlwind Plain, although there are minor reversals of dip. Assuming only a 1° dip to the northwest, the thickness of the unit is computed to be about 460 m. The Argument Camp (Auvergne Sheet) and Amanda (Waterloo Sheet) bores penetrated about 150 m of shale and siltstone, but since they are sited well below the top of the formation, 300 m is a conservative estimate of its thickness. A water-bore east of Bradshaw outstation penetrated 214 m of Angalarri Siltstone, and there is at least 100 m of the formation above the bore site.

Uniform lithology over a large area is the most important feature of the Angalarri Siltstone. The almost ubiquitous greyish green fissile siltstone, which weathers to scree of fine flakes and scales, below the fairly distinctive basal sandstone of the Saddle Creek Formation is diagnostic. Because of its soft nature it has been easily eroded to form extensive plains surrounding the East and West Baines and Angalarri Rivers.

The prevalence of oscillation ripples and the lack of current-bedding suggest that the formation was deposited offshore away from littoral currents, but still well above wave base. The size of some ripples may indicate an environment exposed to long-wavelength ocean waves. Glauconite in the upper part of the formation is an environment indicator as it has been found only in marine environments (Cloud, 1955). Cloud stated that 'the formation of glauconite requires marine water near normal salinity, reducing conditions, and appropriate source materials. It is favoured by high organic content of the bottom sediments in which it forms, and by slow or negative sedimentation. It may form under a fairly wide but not unlimited range of temperature and depths'. Chilingar (1955) considered that weakly oxidising conditions are required. The presence of pyrite and glauconite in the Angalarri Siltstone indicates that reducing conditions probably prevailed.

In summary, the formation was probably deposited at moderate depth on a marine shelf with reducing bottom conditions.

Saddle Creek Formation (New name)

Distribution and derivation of name: The Saddle Creek Formation, named after Saddle Creek at the southwestern end of the Pinkerton Range, crops out along the length of the Pinkerton and Yambarra Range, a distance of about 190 km. It also crops out in scarps in the Spencer Range, in the folded zone between No. 7 Bore and Ernie Lagoon, and along the eastern margin of Koolendong Valley. It extends northeast and east-northeast of the Auvergne Sheet area into the Port Keats, Fergusson River, and Delamere Sheet areas.

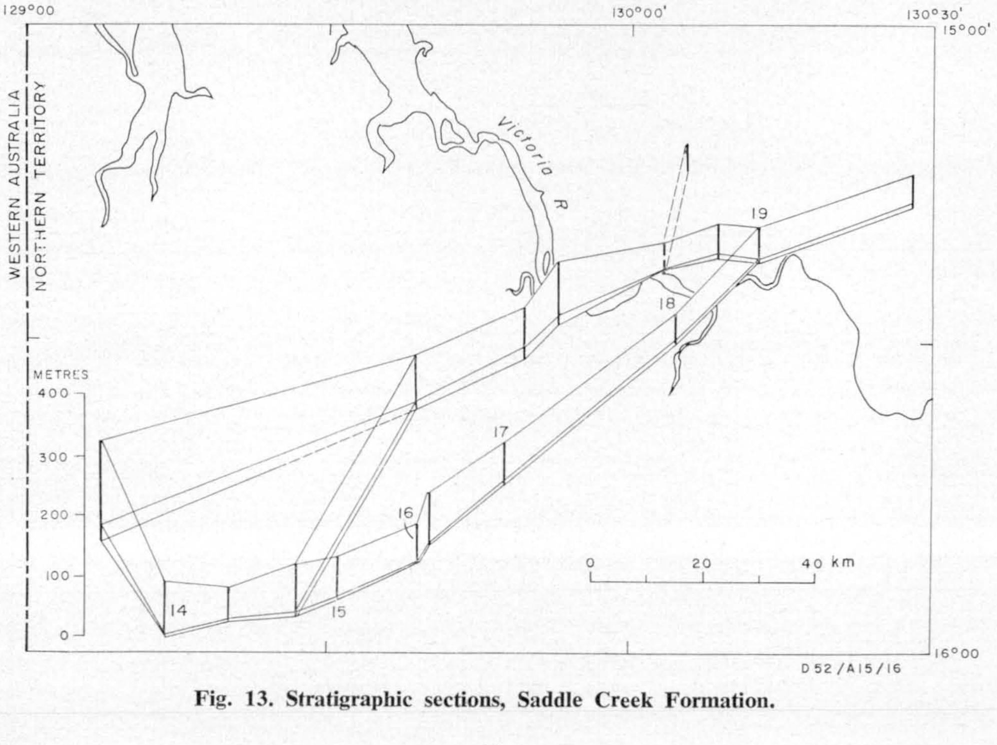


Fig. 13. Stratigraphic sections, Saddle Creek Formation.

Type section: At 15°48′S, 129°39′E, about 1.5 km west of the place where the road to Bullo River homestead traverses the Pinkerton Range scarp.

Stratigraphic relations: The Saddle Creek Formation conformably overlies the Angalarri Siltstone and is conformably overlain by the Pinkerton Sandstone (Fig. 25). In the southwest the lower contact is not everywhere clearly defined owing to the presence of minor sandstone bands at the top of the Angalarri Siltstone. However, the lower contact in other places and the upper contact in all places is sharp and distinct.

Lithology and thickness: The Saddle Creek Formation along most of the Pinkerton-Yambarra Ranges scarp consists of a basal sandstone band about 7 m thick, overlain by up to 90 m of dolomitic siltstone. In the southwest part of the Pinkerton Range, the upper siltstone contains several bands of sandy oolitic dolomite. Near the Victoria River the upper siltstone contains glauconitic bands of massive, friable, fine-grained sandstone.

In the Nutwood Creek area (near Bullo River) and adjacent to the Halls Creek Fault in the southwest, the basal sandstone dominates the formation and measures up to 30 m. The thickness of the upper siltstone varies; in the southwest part of the Pinkerton Range it is up to 105 m, at Karracumby Peak 50 m; to the north and northeast it is generally thinner, but along the eastern margin of Koolendong Valley it varies between about 15 and 65 m (Section 19, Appendix).

Seven measured sections through the formation are summarized in the form of a fence diagram (Fig. 13; for descriptions see Sections 14-20, Appendix). Section 20 is not shown in the figure as it is in the Port Keats Sheet area.

Only the upper part of the Saddle Creek Formation is exposed between 3 and 6 km north of Bullo Gorge on both sides of the Bullo River. It consists of greyish green siltstone, fissile dolomitic siltstone, and one thin bed of a ferruginous carbonate rock. Five kilometres north-northeast of Bullo Gorge, 76 m of the upper Saddle Creek Formation are exposed. Here, and in the Nutwood Creek area the basal sandstone is 15 m and 20 m thick, respectively.

The *basal sandstone* of the Saddle Creek Formation is generally white to light grey-brown, commonly greenish, and weathers to red-brown and dark grey. It is poorly sorted, fine to medium-grained with thin coarse-grained beds (commonly foreset beds), and minor pebbles and pebble beds. The development of undercaving at the base of the unit is caused by its friable nature (high clay content) and its flaggy ragged partings. Parting (or bedding) planes show abundant ripple marks and mud cracks.

The grains are subrounded and subspherical. Siltstone bands, commonly thin and discontinuous, are interbedded with the sandstone and typically contain glauconite. With decreasing grainsize, the roundness and sphericity of the grains become less well developed until the fine grains (0.05 mm) are commonly sliver-like.

Quartz is the main constituent, and many grains contain fine inclusions. Chert, and quartz of metamorphic origin together form up to 10 percent of the grains. Feldspar, both plagioclase and microcline, forms up to 7 percent in some sections. Accessory detrital minerals include zircon, tourmaline, and magnetite. Glauconite is present in subordinate amounts in places.

Sedimentary structures are characteristic of the basal sandstone band. Cross-bedding is the most common, and sets of foreset beds are up to 25 m thick. Con-

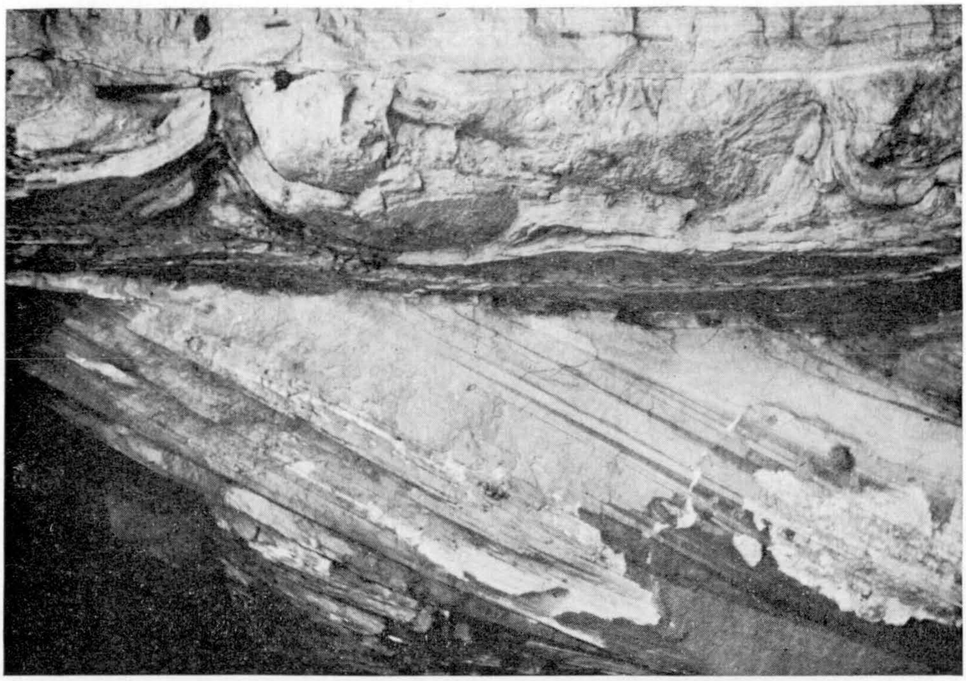


Fig. 14. Basal sandstone of Saddle Creek Formation: typical sedimentary structures are cross-bedding, convolute bedding, and associated flame structures (disrupted bed is about 1.5 m thick). Fergusson River 1:250 000 Sheet area, 25 km east of Coolamon homestead ruins. (GA/518)

volute bedding and flame structures are also typical, and commonly about 0.5 to 1 m high. Such a band may cut off a series of foreset beds, or simply be part of a normal thin-bedded horizontal sequence (Fig. 14). Other common structures are several varieties of ripple marks, mud cracks, halite pseudomorphs, sole markings, and current lineations.

The *upper siltstone* is generally greyish green, commonly fissile, but varies to massive and friable. Many grains of fine sand are scattered through the silt, and some beds are fine silty sandstone. Subordinate chert, plagioclase, and microcline are common. Interstitial clay, chlorite, sericite, and glauconite have been identified. The glauconite content is as high as 15 percent and is generally most abundant near the base and top of the siltstone.

Much of the siltstone is carbonate-rich. The carbonate is erratic in distribution but generally is present as an interstitial component; it appears to be dolomite. Minor carbonate cement also occurs in the basal sandstone.

In the southwest half of the Pinkerton Range, bands of dolomite up to 1 m thick are interbedded with the siltstone and form low cliffs up to 3 m high. As many as four cliffs occur in the section of the Saddle Creek Formation west of the Bullo River track (Fig. 15); two are more prominent, but in places no dolomite bands are exposed.

Several of the dolomite bands are oolitic, iron-rich, and commonly glauconitic. The oolites have an average diameter of 0.4 mm and a quartz (or rarely microcline) nucleus. The dolomite in the oolites has commonly been replaced by cryptocrystalline silica, the silicified parts forming discontinuous lenses up to 25 cm long and 5 cm wide. There is very little detrital interstitial material in the oolitic dolomite, and secondary very finely crystalline quartz cements the oolites in places. The fine-grained non-oolitic dolomite is invariably silty, with up to 25 percent of coarse silt-size quartz grains disseminated through the dolomite.

The Saddle Creek Formation is recognised, particularly in the scarp slope of the Pinkerton and Yambarra Ranges, by its stratigraphic position below the widespread, prominent Pinkerton Sandstone. The most characteristic single feature is the basal silty sandstone band, generally about 9 m thick and invariably displaying abundant primary sedimentary structures.

The sedimentary structures in the basal sandstone indicate a predominantly shallow-water environment of deposition. The cross-bedding, asymmetrical ripple marks, current lineations, and isolated pebbles up to 20 mm in diameter, indicate intermittently high current-velocities. The foreset beds and ripple marks lack a strongly preferred orientation, suggesting varying current directions typical of a very shallow-water environment.

The convolute bedding and flame structures are believed to have formed by hydraulic rupturing of overlying beds by fluid trapped in lower, more permeable, beds. Some of these structures are 'quicksand structures' resulting from the disturbance of water-saturated sedimentary layers. The palaeogeographic significance of these structures may be simply due to slumping, owing to rapid deposition on a sloping sea-floor.

The deposition of the siltstone was also apparently in shallow water and in a stable shelf environment. Glauconite and oolites indicate conditions of agitation in a shallow-water marine environment. Dolomite occurs only in the southwest, and the siltstone thins towards the northeast. The large-scale cross-bedding in the basal sandstone could have been formed by strong tidal currents.

Pinkerton Sandstone (New name)

Distribution: The Pinkerton Sandstone forms the resistant cappings of the main escarpments and dissected plateaux of the Pinkerton and Yambarra Ranges (Figs. 15, 18); it also crops out in the Spencer Range, and as a prominent hogback ridge along the southeastern side of the Victoria River Fault. It extends east and north into the Delamere, Fergusson River, and Port Keats Sheet areas, and southwest into the Waterloo Sheet area.

Derivation of name: The name is derived from the Pinkerton Range, a prominent escarpment up to 280 m high, which extends from the Keep River to the Victoria River, a distance of 105 km.

Type section: In the Spencer Range, 10 km east of Bullo Gorge; good sections of the lower part of the formation are exposed in the Pinkerton and Yambarra Ranges.

Stratigraphic relations: The formation conformably overlies the Saddle Creek Formation and is overlain conformably by the Lloyd Creek Formation. The base is defined in most places by a white massive cross-bedded quartz sandstone; its upper limit is marked by the first appearance of dolomite beds, some with stromatolites and some with intraformational breccia, and is usually marked by a ledge or break in slope.

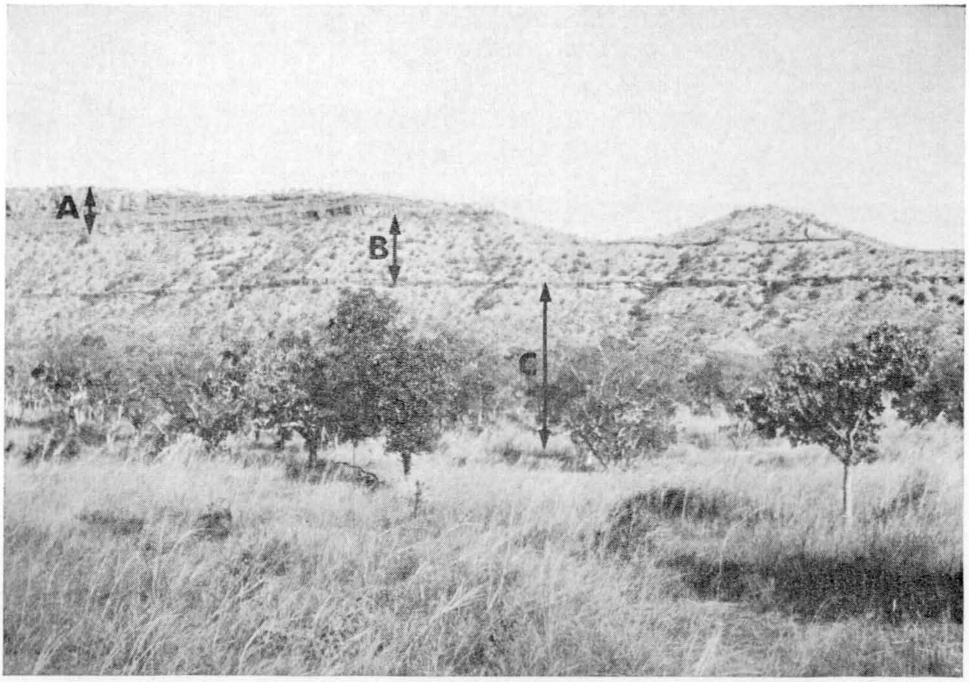


Fig. 15. A = Angalarri Siltstone; B = Saddle Creek Formation, showing basal sandstone and thin dolomite beds above; C = Pinkerton Sandstone. Scarp of Pinkerton Range near Bullo River track. (GA/1194)

Lithology and thickness: The Pinkerton Sandstone characteristically forms stepped slopes which result from differential erosion of hard and soft bands (Fig. 17). The base of the formation is marked by massive to blocky, cross-bedded, and thin to medium-bedded quartz sandstone. Beds 0.5 to 1 m thick are commonly interbedded with silty fine sandstone beds 1 to 20 cm thick. The basal unit is prominent and forms the hard capping on most of the Pinkerton and Yambarra Ranges. It is only about 1.5 m thick west of the Keep River, but is 15 to 20 m thick in most of the Pinkerton Range. Where it caps the Yambarra Range north of Bradshaw homestead it forms cliffs over 30 m high (Fig. 18).

Sections measured through the Pinkerton Sandstone are summarized in the fence diagram (Fig. 16). They show a gradually increasing thickness of the basal member of the formation from southwest to northeast (Sections 21, 22, and 23, Appendix).

The basal band commonly consists of a moderately well sorted quartz sandstone. Generally quartz constitutes more than 95 percent of the rock, and subordinate components are rock fragments (mostly siliceous), microcline, limonite, and accessory heavy minerals, mainly tourmaline and zircon. The grains are generally of fine to medium sand-size (about 0.05 to 1 mm) and subrounded to well rounded. Syntaxial growths have in most places partly or wholly obliterated original grain boundaries. The sandstone contains spots comprising aggregates of grains up to 5 mm across and loosely cemented by limonite; silica cement is absent within the spots.

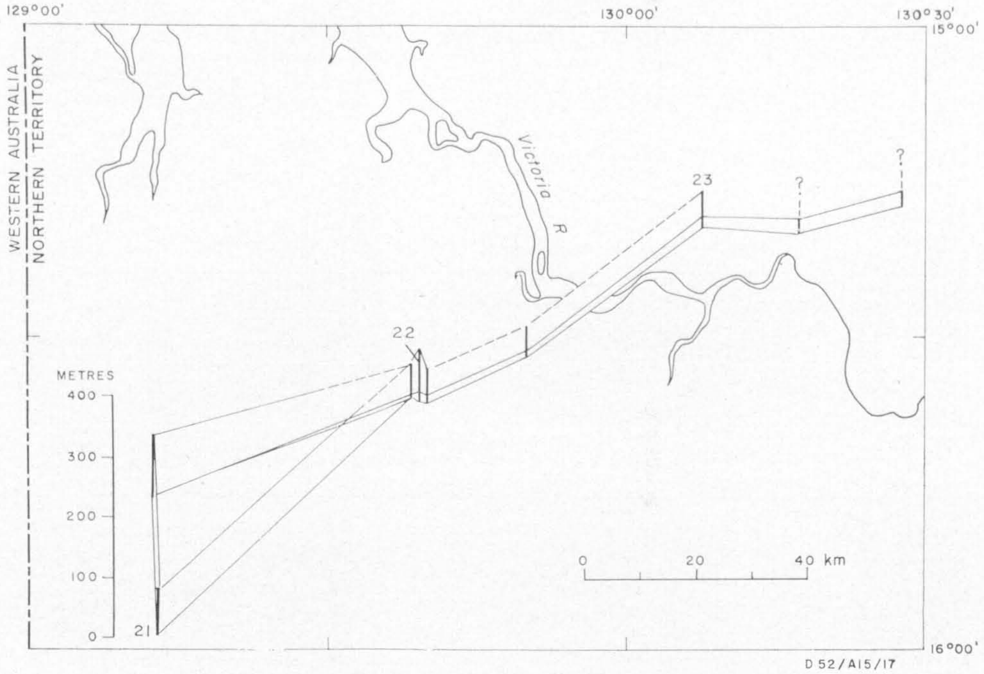


Fig. 16. Stratigraphic sections, Pinkerton Sandstone.

A poorly outcropping softer rock overlies the basal sandstone (Fig. 17). In rare fresh outcrops it is composed of thinly interbedded green mudstone, quartz siltstone, and fine sandstone. The green colour commonly merges into purple zones, indicating a change from ferrous to ferric state in the iron-containing minerals. Bright green mud flakes and glauconite pellets are present in the basal sandstone and overlying soft layer in the Spencer Range area.

The soft layer is generally obscured by scree from a second cliff-forming fine-grained sandstone which is 15 to 30 m thick and has a blocky to massive parting, but is thin-bedded or laminated. Small-scale cross-bedding and ripple marks are common; mud cracks are rare. Abundant mud flakes occur on most bedding planes, and in some beds constitute half the rock; they are generally discoidal, a feature best seen where the flake has weathered out leaving a mould.

Although the rock is best described as a fine-grained sandstone, a significant proportion of the grains is in the coarse silt range. Size sorting varies from moderate to good, and the grains are subrounded to rounded. Most specimens contain 90 percent or more quartz and generally less than 5 percent rock fragments which are mainly composite quartz grains with many inclusions, and chert. Many specimens contain 2 or 3 percent of larger well rounded grains. Secondary overgrowths obliterate some of the original sedimentary textures. Minor minerals include hematite, limonite, feldspar (mostly microcline), and well rounded tourmaline and zircon.

Overlying the second hard sandstone unit is a third scarp-forming unit, but because it is not massive it rarely forms cliffs. It is generally a flaggy, fine to medium quartz sandstone. In some areas it has an irregular parting and does not

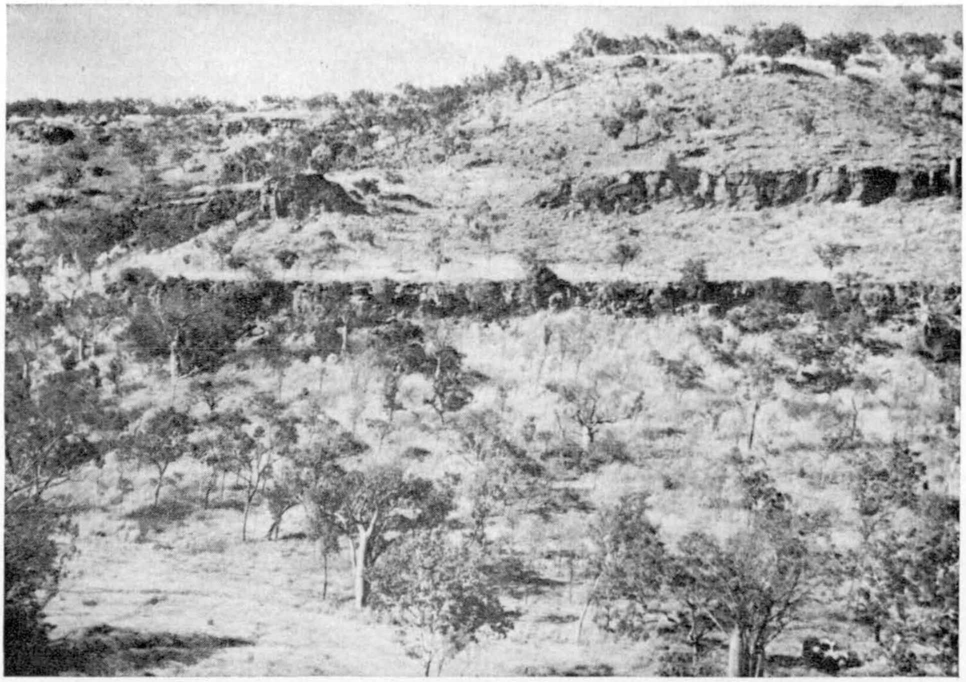


Fig. 17. Alternating hard and soft beds in the Pinkerton Sandstone. Base of lowest cliff is the base of the formation. Lower and middle sandstone units are prominent; the third hard bed forms top of hill; 6 km northeast of Bullo Gorge. (GA/580)

break into rectangular or tabular blocks as do the lower and middle members. The irregular surface on some blocks is suggestive of bioturbation structures produced by burrowing organisms.

In the steeply dipping overturned sequence of rocks along the southern margin of the Victoria River Fault, the Pinkerton Sandstone forms a strike ridge of resistant sandstone in which individual units cannot be recognized. The sandstone is well indurated, light-coloured, fine to medium, and siliceous.

The thickness could not be determined accurately where the beds are vertical as the geological boundaries are covered by scree, but it is probably not less than 100 m and may be considerably more. East of Holdfast Reach the Pinkerton Sandstone forms massive cliffs and may be 120 m thick; the Saddle Creek Formation is very thin here, and possibly there is a lateral facies change with Saddle Creek Formation grading into Pinkerton Sandstone.

Pinkerton Sandstone forms resistant capping on hills bordering Koolendong Valley, where it comprises a basal prominent white massive quartz sandstone overlain by a blocky, thin-bedded, ripple-marked and mudflaked, brown to pink fine sandstone similar to that in the Auvergne area.

Palaeogeographic significance: The high quartz content and general lack of unstable rock fragments and minerals such as feldspar and mica show that the rocks of the Pinkerton Sandstone are generally mature. The maturity and the presence of chert fragments suggest derivation from a pre-existing sedimentary rock.

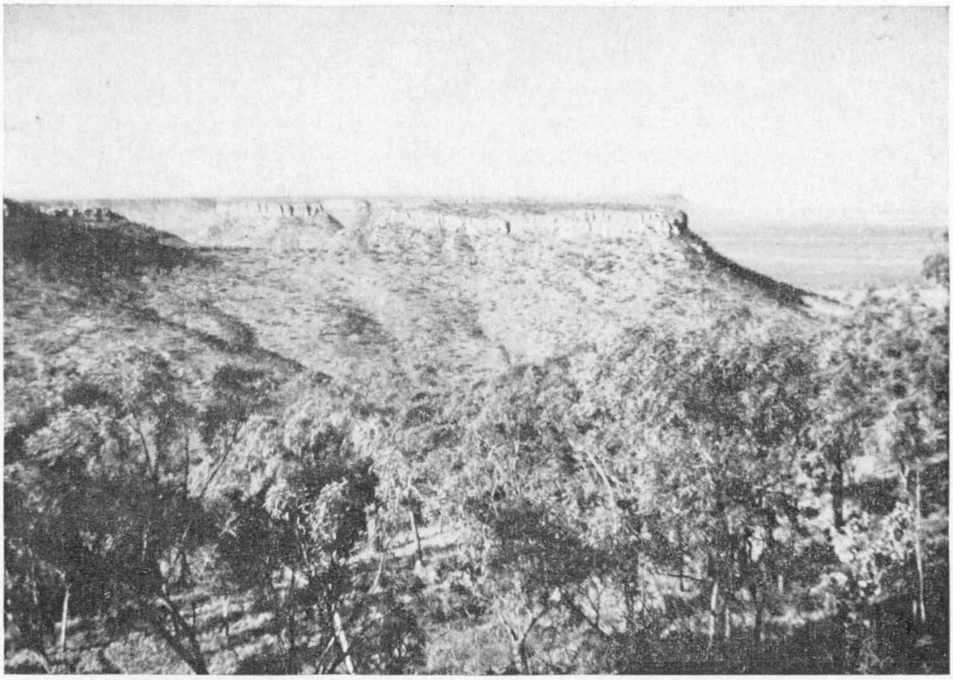


Fig. 18. View from top of Yambarra Range near Bradshaw. Pinkerton Sandstone forms prominent cliffs up to 35 m high. Below the cliff is a thin layer of Saddle Creek Formation; its base is defined by the thin sandstone bed visible in the saddle near the centre of the photograph. (GA/1002)

The extent and thickness of the sandstone are consistent with deposition during a marine transgression with minor shoreline oscillation, giving rise to thicker sequences in the northeast and a number of siltstone interbeds throughout. The widespread occurrence of mud flakes suggests that many thin laminae of mud were deposited and later broken up. This probably indicates alternating turbulent and quiet-water conditions or subaerial exposure.

Lloyd Creek Formation (New name)

Distribution: The Lloyd Creek Formation crops out generally in scarp slopes in the Pinkerton, Spencer, and Yambarra Ranges from the southwest corner of the Sheet area through to the northeast. It extends farther north and east into the Port Keats and Fergusson River Sheet areas.

Derivation of name: The name is derived from Lloyd Creek, a tributary of the Bullo River.

Type section: The most complete sections were seen near the Bullo River station track about 5 km north of the main Pinkerton Range escarpment. The type section is at 15°46′S, 129°39′E.

Stratigraphic relations: The Lloyd Creek Formation is apparently conformable with both the underlying Pinkerton Sandstone and the overlying Spencer Sandstone, although the contacts are poorly exposed.

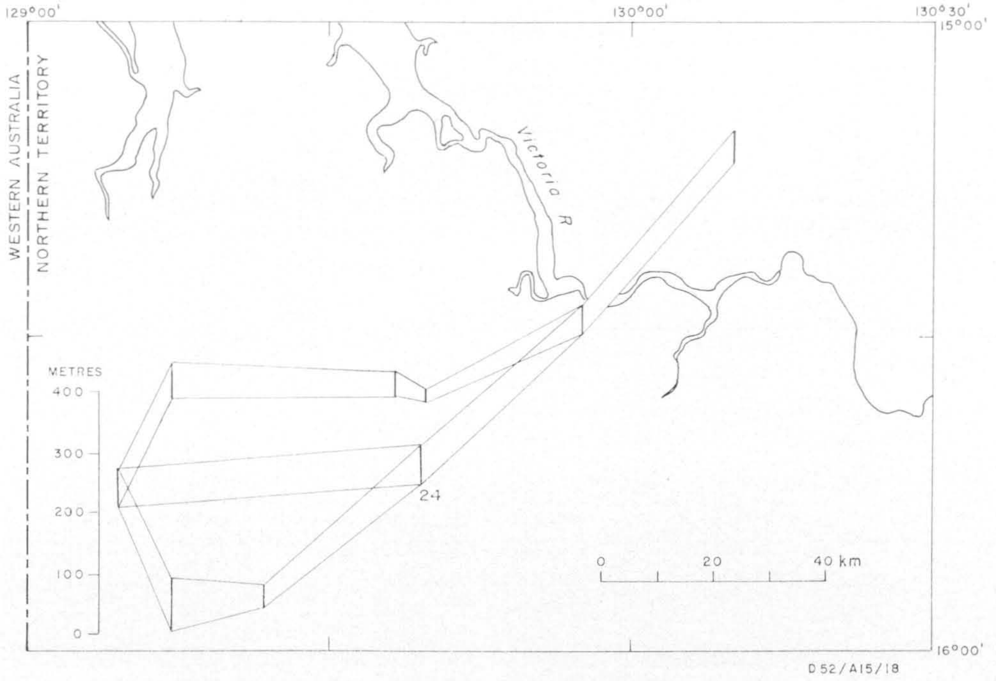


Fig. 19. Stratigraphic sections, Lloyd Creek Formation.

Lithology and thickness: The Lloyd Creek Formation is characterized by oolitic and stromatolitic dolomite. The dolomite is interbedded with sandy dolomite, fine-grained laminated dolomite, dolomitic siltstone, and minor sandstone. Because of the hard capping of basal Spencer Sandstone and the easily weathered rock types, the formation crops out poorly and is generally covered by scree.

The Lloyd Creek Formation is nowhere greater than about 75 m thick. Nine sections were measured in the field, and the thinnest, near the centre of the area, was 29 m; the sections gave satisfactory thickness data, but little information on lithology as the formation is generally poorly exposed. The type section was measured near the Bullo River track and is 74 m thick (Section 24, Appendix). The distribution of the sections and their variations in thickness are shown in the fence diagram (Fig. 19).

Samples of the carbonate rocks have been analysed:

Registered No.	*Insoluble Residue (wt%)*	*CaO (wt%)*	*MgO (wt%)*	*CaO/MgO*	*CaO/MgO (molar ratio)*
67770322	15.9	23.5	18.3	1.39	0.83
67770087A	3.7	32.1	19.0	1.69	1.03
67770087B	14.3	33.7	11.8	2.87	1.73
67770117C	19.3	25.55	16.5	1.55	0.93
67770327	16.7	26.45	16.5	1.60	0.96

Sample 67770087B is more calcitic than the others and is one of the more oolitic rocks sampled; this may mean that the oolites are richer in calcite than in dolomite.

Sandy and oolitic dolomites are commonest in outcrop; they are in beds up to 75 cm thick and contain 10 to 20 percent quartz sand and various proportions of oolites. The rocks weather to greyish brown and both oolites and quartz grains are conspicuous on weathered surfaces, whereas they are difficult to see on freshly broken, light grey surfaces. Some sand grains are concentrated in thin laminae, outlining small cross-beds and ripple marks, but the majority occur as nuclei of oolites. In other localities dark grey dolomitic siltstone is interbedded with fine-grained well sorted quartz sandstone. Sandy dolomite generally predominates.

The quartz grains are subangular to subrounded and 0.05 to 0.2 mm across. Most oolites are within the range 0.3 to 0.5 mm, and almost spherical. On some rock surfaces they weather away leaving a pockmarked surface, but in others the outer shell has been silicified and the oolites stand out as cream-coloured spheres. A small percentage of oolites are non-spherical, but still have smooth surfaces. The carbonate has been recrystallized and only remnants of concentric structure remain. Although quartz is the most common detrital mineral, small quantities of feldspar (microcline), tourmaline, zircon, chert, chalcedony, some metamorphic rock fragments, and minor opaque minerals (weathering to limonite) are present.

Stromatolites were observed in most outcrops. In vertical section they appear as laminations of various shapes, weathering alternately to pale and dark greyish brown. Based on Donaldson (1963), they may be classified according to the shape of the laminations into one or more of six groups. On this basis most forms are 'columnar stromatolites', and some 'hemispherical stromatolites'. In the Bullo Gorge region a bed of partly silicified dolomite contains small 'digitate stromatolites' and possibly some other types; the top of the bed is uneven because of the numerous small hemispherical projections at the top of each column (Fig. 20).

In several outcrops the stromatolite beds are closely associated with sandy and oolitic dolomite and with intraformational breccia and conglomerate. Near No. 7 Bore small hemispherical forms encrust a block of sandstone within fine-grained dolomite. The laminae of columnar stromatolite from the area northwest of No. 7 Bore have depressions, which contain lenses of coarse detritus, and the laminae become thin and pinch out. This is typical of stromatolites formed by trapping of detritus by algal mats as described by Logan (1961) from the Shark Bay area of Western Australia. Figure 21 shows unevenly laminated dolomite; the laminae were probably formed by the sediment-trapping algal mats.

The Lloyd Creek Dolomite is the only formation in the Auvergne Group in which both oolites and stromatolites are extensively developed, although oolites have been observed within the Saddle Creek Formation. The presence of sand-sized particles, oolites, stromatolites, and some intraformational breccia indicate that the formation was deposited in a shallow-water, fairly high-energy environment. Oolites are generally considered to form in agitated water (Eardley, 1938; Rusnak, 1960), although some non-spherical oolites may form in quiet water (Freeman, 1962). Because of their ubiquitous association with current-bedded sand in the Lloyd Creek Formation, a wave and current-swept environment is most likely.

From the available evidence (Logan, 1961), stromatolitic beds appear to be near-shore strata, either marine or saline lake. Other fine-grained dolomite in the formation, in association with sand and silt, suggests a shallow-water, stable-shelf environment.

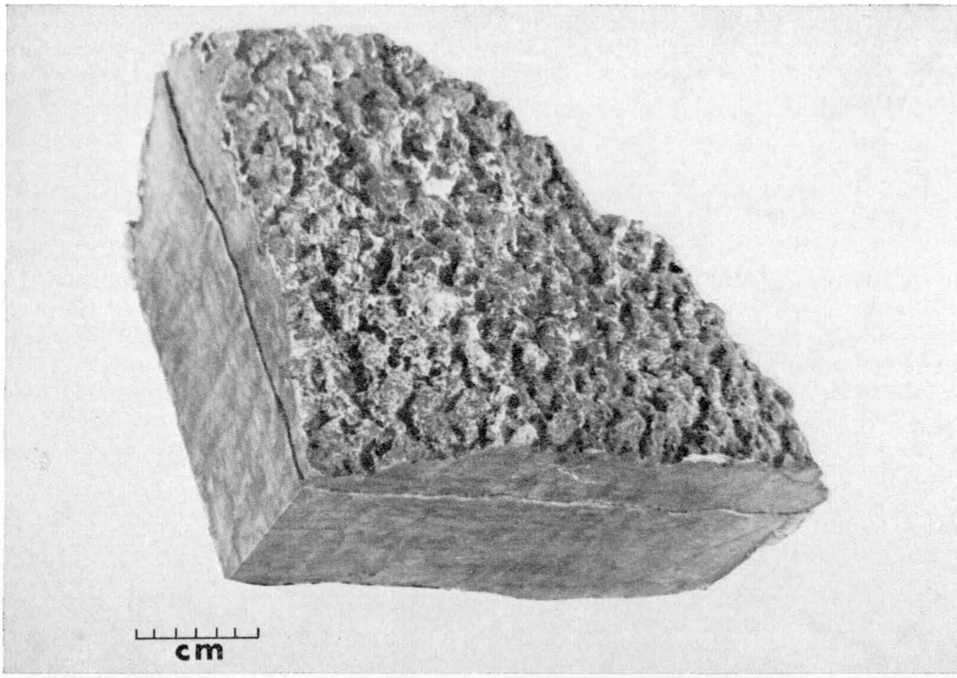


Fig. 20. Smaller columnar or digitate stromatolites from Lloyd Creek Formation 5 km north-northwest of Bullo Gorge. Some branching of columns is evident in the parent outcrop. (GA/852)

Spencer Sandstone (New name)

Distribution: The Spencer Sandstone crops out mainly in the centre of the Sheet area, and in a belt up to 10 km wide along the central part of the Spencer Range where it forms slopes which dip gently to the northwest. Between the Bullo River track and the Victoria River Fault, the sandstone follows around the nose and along the limbs of regional fold structures. From this area it can be followed to the southwest along the southern side of the Victoria River Fault.

Derivation of name: After Spencer Range in the central part of the Auvergne Sheet area.

Type section: The unit is best exposed and most readily examined in areas adjacent to the Bullo River homestead track where it crosses the Spencer and Pinkerton Ranges. The type section is adjacent to the track 10 km south of Bullo Gorge at 15°44′S, 129°38′E.

Stratigraphic relations: The Spencer Sandstone is the middle formation of three which constitute a predominantly dolomitic upper part of the Auvergne Group. The Spencer Sandstone is conformably underlain by the Lloyd Creek Formation and conformably overlain by the Shoal Reach Formation.

The contact with the Shoal Reach Formation is poorly exposed, but there is some evidence that it is transitional. The contact is defined at the first outcrop of dolomitic sandstone above the underlying quartz sandstone, and is generally marked by a change in slope.

Fig. 21. Irregular algally laminated dolomite of the Lloyd Creek Formation. Same locality as Fig. 20. (GA/851)

In some places Spencer Sandstone is dolomitic, suggesting no significant facies difference from the overlying Shoal Reach Formation. However, the considerable areas of distinctive topography formed by the sandstone, notably the basal bed and the characteristic change of slope forming its upper contact, make it readily identifiable on aerial photographs and warrants it being mapped as a distinct formation.

Lithology and thickness: The Spencer Sandstone is generally poorly exposed; over large areas it forms low rounded hills with shallow-dipping slopes.

The poor exposure and the fact that the upper part of the formation is eroded make it difficult to obtain the thickness of the Spencer Sandstone. Measured thicknesses vary from 142 m at the type section (Section 25, Appendix) to at least 165 m (Section 26, Appendix) 3 km to the north of the type section.

In most areas the Spencer Sandstone has a basal brown thin-bedded, flaggy and blocky, fine or medium sandstone bed up to 15 m thick (Fig. 22). It contains abundant small-scale cross-laminations and ripple marks; reddish purple and green mud flakes are common, and pseudomorphs after halite occur in some places. Typically the mud flakes weather out, leaving pits in the exposed surfaces.

The upper part of the unit is generally more poorly exposed than the lower part, and consists of generally white sandstone (weathering to reddish brown) which is blocky to flaggy, medium to fine, thin-bedded to laminated, and commonly friable. It is interbedded with thin-bedded, fissile silty sandstone. Ripple marks and cross-bedding are common.

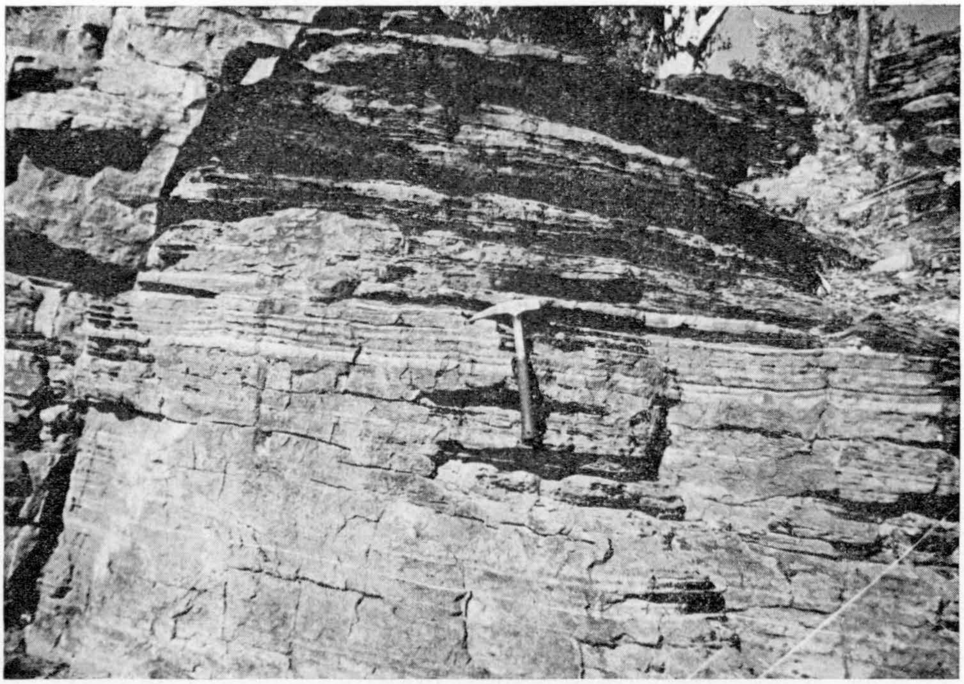


Fig. 22. Basal beds of Spencer Sandstone showing its typical thin-bedded massive to flaggy character; 5 km north-northeast of Bullo Gorge. (GA/586)

The Spencer Sandstone near the Victoria River Fault is similar to that in the Bullo Gorge area. However, near Alligator Waterhole in the southwest corner of the Sheet area, dolomitic sandstone in the middle part of the formation is associated with fine-grained sandstone containing halite casts. A complete section of the Lloyd Creek Formation, Spencer Sandstone, and Shoal Reach Formation was measured 8 km southeast of Ernie Lagoon; the Spencer Sandstone is 145 m thick (Section 27, Appendix).

Palaeogeographic significance: The fact that dolomite persists in some parts of the unit, and that sand is a common component of the formations above and below, indicates that the conditions of deposition of the Spencer Sandstone represent a minor variation from the environment of deposition of the underlying and overlying dolomitic formations.

The Spencer Sandstone was most probably deposited in a shallow sea in a stable environment; there may have been some periods of subaerial exposure.

Shoal Reach Formation (New name)

Distribution: The Shoal Reach Formation crops out extensively in the Spencer Range area, and along the southern margin of the Victoria River Fault for about 130 km from the Ernie Lagoon area to 16 km north of the Victoria River.

Derivation of name: From Shoal Reach near the junction of the Bullo and Victoria Rivers.

Type section: The Shoal Reach Formation and its upper and lower contacts are well exposed adjacent to the Bullo River homestead track between the Pinkerton Range scarp and Bullo Gorge. The type section is at 15°42′S, 129°38′E, 9 km south of the Bullo Gorge.

Stratigraphic relations: The Shoal Reach Formation is the uppermost unit in the Auvergne Group. It conformably overlies the Spencer Sandstone and the contact is probably gradational.

The Shoal Reach Formation is almost certainly unconformably overlain by the Black Point Member of the Bullo River Sandstone. Where exposed, the contact is distinct, and marked by an abrupt change in lithology.

Lithology and thickness: The Shoal Reach Formation consists mostly of dolomite and fine-grained sandstone; intraformational conglomerate is present in places.

Up to 100 m of Shoal Reach Formation was examined both east of Ernie Lagoon and 6.5 km southeast of Bucket Spring. In these areas it is typified by thin lenses and bands of fine grey dolomite within a predominantly sandstone sequence. The sandstone is commonly dolomitic, white to brown, flaggy to blocky, thin-bedded, and medium-grained; mud flakes are common. The dolomite forms lenses up to 30 cm long, and interbedded laminae, in the sandstone.

Near No. 7 Bore and Alligator Waterhole, the upper part of the Shoal Reach Formation consists of grey and pink silty dolomite, weathering to white or grey. Ripple marks and small-scale cross-bedding are delineated by concentrations of sand grains comprising up to 15 percent of the rock in places. Features which show sediment movement before consolidation include intraformational breccia, small-scale slumps, microfaults, and abrupt cut-off of beds. Whitish siltstone and fine sandstone crop out below the dolomite. A thin bed of chocolate shale containing a network of carbonate-filled joints crops out locally in the area.

Between 50 and 70 m of Shoal Reach Formation is poorly exposed within a 13-km radius of Bullo Gorge (Section 28, Appendix). About 8 km west of the gorge the lower 30 m consists of siltstone and fine-grained sandstone; greenish clay laminae and mud flakes are common. The upper 30 m is mainly dolomite interbedded with purple dolomitic siltstone and minor intraformational conglomerate.

Caliche commonly encrusts the fine-grained blocky to flaggy dolomite in the upper part of the unit. Intraformational conglomerate forms part of the upper 6 m of the dolomite 6.5 km south of Bullo Gorge. It consists of fine-grained grey dolomite pebbles in a medium-grained, poorly sorted dolomitic sandstone matrix. The pebbles, up to 4 mm across, are subangular to subrounded. The conglomerate forms beds up to 10 cm thick within a dolomitic and silty sequence.

About 40 m of the Shoal Reach Formation are exposed 3 km east of Black Point. About 30 m of flaggy dolomite and greenish shale are underlain by dolomitic sandstone and dolomite, and overlain by 6 m of partly brecciated dolomitic sandstone and sandy dolomite. Above the latter is 6 m of flaggy dolomite which is overlain by the basal member of the Bullo River sandstone. The dolomite sandstone and sandy dolomite in this area commonly include intraformational breccia in bands up to 20 cm thick and are medium to coarse (and rarely gritty), poorly sorted, and contain fragments and discontinuous bands of dolomite. They are interbedded with fine-grained pinkish grey dolomite bands up to 10 cm thick.

The dolomitic sediments consist mainly of rounded quartz grains of varying size within a fine-grained dolomitic matrix; the approximate proportion of matrix to grains is 3:2. Up to 5 percent of the grains are zircon, and opaque minerals are also present. The quartz grains are mostly clear or dusty single grains; about 10 percent are composite and probably derived from metaquartzite, up to 5 percent appear to have derived from chert, and some from volcanic rocks.

The grains within the sandstone interbeds show graded bedding. Where sandstone beds overlie dolomite the contact is sharp, but upper contacts of sandstones are gradational.

The contact between the Shoal Reach Formation and the overlying Black Point Sandstone Member appears to be transitional 3 km southeast of the mouth of Lalngang Creek, where the dolomitic sandstone near the top of the Shoal Reach Formation contains a bed of sandstone, about 1 m thick, similar to the Black Point Sandstone Member. Overlying this is dolomite, dolomitic intraformational conglomerate, and alternating sandstone and dolomite. The dolomite content decreases upwards, and disappears at the contact with the overlying Black Point Member. In spite of this possible transitional relationship, a disconformable relationship between the Shoal Reach Formation and the Black Point Sandstone Member is indicated in other areas.

Palaeogeographic significance: The composition and distribution of the Shoal Reach Formation indicate that shallow-water marine deposition within a stable platform or shelf environment continued throughout the time of formation of the Auvergne Group. In the Shoal Reach Formation the association of dolomite with sandstone and siltstone which show fine-scale cross-bedding, ripple marks, and graded bedding indicates a shallow rather protected environment, but within the influence of wave action.

Dolomite deposition persisted throughout the development of the formation. The influx of sand was spasmodic, and the nature of some sandy bands and lenses in the dolomite suggests that they may be of aeolian origin.

Intraformational breccia and conglomerate indicate local instability in the sediments before their final consolidation. They are more abundant in the upper part of the unit and may reflect basinal uplift which terminated deposition of the Shoal Reach Formation.

BULLO RIVER SANDSTONE (New name)

Distribution: The Bullo River Sandstone underlies about 620 km^2 of inaccessible country in the central and southwestern Auvergne Sheet area. Several isolated outliers crop out along the Spencer Range and in an area of about 75 km^2 on the east bank of the Victoria River between Holdfast and Shoal Reaches.

Derivation of name: From the Bullo River, the upper reaches of which drain most of the large area of sandstone mentioned above.

Type section: The lower part of the formation is well exposed near Bullo Gorge. In most areas the upper part is removed by erosion, but it is preserved in the core of a large syncline between Bucket Spring and Brolga Swamp. The latter area is therefore nominated as the type area, and a section of 320 m measured 3 km southeast of Bucket Spring is nominated as the type section.

Stratigraphic relations: The Bullo River Sandstone overlies the Shoal Reach Formation with probable disconformity. It is overlain unconformably by the Moonlight Valley Tillite in the south and by the Ranford Formation in the north. The base of the Bullo River Sandstone is formed by the Black Point Sandstone Member, which has a distinctive photo-pattern.

Lithology and thickness: The Bullo River Sandstone is an entirely clastic unit consisting largely of reddish brown to maroon quartz sandstone with some grit and conglomerate. It is strongly cross-bedded and the sandstone is poorly sorted and heterogeneous. The Black Point Sandstone Member of the Bullo River Sandstone is a distinctive ferruginous feldspathic sandstone.

The formation is easily recognized on aerial photographs by its distinctive pattern: the basal member forms a minor scarp and smooth bench, and the remainder is strongly jointed and forms rugged terrain (Fig. 23). On the ground the unit is easily recognized by its blocky to massive nature and its dark red to purple colour.

Above the Black Point Sandstone Member, the remainder of the formation consists mainly of quartz sandstone which is thin to medium-bedded, cross-bedded, and blocky to massive. Laminations in some beds are marked by varying amounts of iron oxides which outline the cross-bedding. Cross-bedding is present in most outcrops and includes festoon, tabular, and, rarely, torrential types. The thickness of individual cross-bedded units varies from about 30 cm to as much as 3 to 4 m. The largest foreset beds are 10 to 20 cm thick and many display primary current lineations.

Most of the sandstone is fine to medium (0.1 to 1.0 mm), but lenses of coarse sand, granules (grit), and small pebbles are present in most areas, commonly as layers within foreset beds. Sorting is generally poor to moderate; some samples

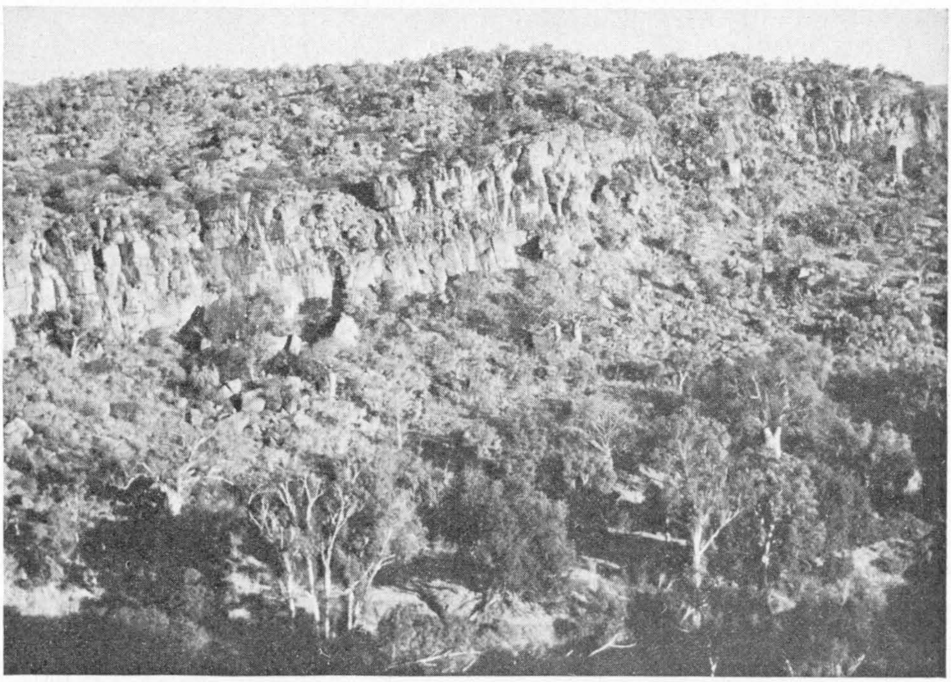


Fig. 23. Typical topography of Bullo River Sandstone; western wall of Bullo River Gorge. (GA/1295)

contain up to 5 percent of recrystallized clay matrix. Most grains are subangular to subrounded. The large fragments are generally more rounded, and pebbles that constitute a high proportion of beds are well rounded.

Quartz forms over 95 percent of fragments in most specimens. Authigenic quartz growths fill most pore spaces and act as cement. Several types of quartz grains are present; (i) no inclusions, clear and unstrained, single crystals; (ii) many inclusions, producing a 'dusty' appearance, single crystals; (iii) grains derived from metamorphic rocks, highly saturated on several grain boundaries, highly strained; (iv) chert, fine-grained, may be chalcedony; (v) other quartz rock fragments, some with much opaque material, which probably have a volcanic origin.

The reddish colour of the Bullo River Sandstone is due mainly to the presence of fine-grained disseminated hematite in the interstices between the quartz grains. Much of it has weathered to limonite which forms irregular masses and red-brown stains throughout the rock. Clay or authigenic minerals derived from clay are present in most rocks, and in a few cases account for 5 to 10 percent of the bulk of the rock. Accessory minerals include well rounded grains of zircon and tourmaline and a few mica flakes.

The total thickness of the formation has been measured in only two places, both in areas near the major fault zone. One section, 3 km southeast of Bucket Spring, is 320 m thick, and the other, 15 km to the northeast, 300 m. These are minimum figures because the Ranford Formation lies unconformably on the Bullo River Sandstone.

Palaeogeographic significance: The Bullo River Sandstone is a redbed facies. The red colour alone is not a criterion of a specific environment of deposition, but the composition of the unit suggests that it is non-marine. The abundance of cross-bedding of all scales and the presence of numerous conglomeratic beds indicate a fluvial environment with streams of sufficient velocity to transport coarse sand and pebbles over wide areas.

The lack of interbedded silt and mud is noteworthy. The sorting and rounding of the sand grains indicate that the sandstone is texturally submature (Pettijohn, 1957). The formation has affinities with previously documented redbeds, particularly the Newark-type described by Pettijohn.

Black Point Sandstone Member (New name)

Distribution: The Black Point Sandstone Member crops out at the margins of the Bullo River Sandstone outcrops.

Derivation of name: From Black Point, a small headland on the east bank of the Victoria River about 19 km upstream from Entrance Island.

Type section: Adjacent to the Bullo River homestead track 5 km north-northwest of Big Knob Waterhole.

Stratigraphic relations: The member is overlain conformably by the rest of the Bullo River Sandstone. The lower contact with the Shoal Reach Formation is probably disconformable because there is an abrupt change in lithology from thin-bedded siltstone and dolomite to the overlying thicker-bedded sandstone.

Lithology: The Black Point Sandstone Member was first differentiated as a photogeological unit by Perry (1967a), its upper boundary being a prominent bench, and its photo-character being much smoother and less jointed than the remainder of the formation.

The rock is similar to the rest of the Bullo River Sandstone, but minor lithological differences are apparent in the field. It contains feldspar—commonly 5 percent and up to 10 percent—which is usually quite fresh and consists mostly of microcline and perthite. In many places the sandstone is better sorted and slightly less ferruginous than the rest of the formation. Conglomeratic sandstone is rare, except for the basal 1 to 2 m.

The base is well exposed at Alligator Waterhole about 16 km northeast of No. 7 Bore, where the contact is sharp and the beds underneath appear to have been truncated. A conglomerate at the base contains a few pebbles of silicified oolitic limestone. The member is massive at this locality and forms very large-scale cross-bedded layers up to 5 m thick.

North and west of Bullo Gorge, 1 to 2 m of red-brown shale form the base of the member. Both east and west of the gorge the contact between the Shoal Reach Formation and the Bullo River sandstone is marked by up to 1 m of massive concretionary limonite which may be the remnants of the weathered surface of the Shoal Reach Formation.

The Black Point Sandstone Member appears generally to be about 45 m thick, but may reach 60 m in the north.

BIG KNOB BEDS (New name)

The Big Knob Beds crop out exclusively as swarms of steep-sided knolls (Fig. 25) in the form of domes or short whalebacks with almost vertical walls on at least two sides. They are up to 20 m high and have a similar diameter, and are formed of bare massive rock and large boulders, most with a steep talus slope. On aerial photographs they appear as small dark-toned spots. Their classification as a formal stratigraphic unit is questionable.

Distribution: There are three separate swarms in the southwest part of the Pinkerton Range (Fig. 24). In the largest, 9 km southwest of Big Knob Waterhole, there are about 110 knobs in an area of 25 km^2. One of the smaller swarms is near No. 7 Bore, and the other is 8 km south of Bullo Gorge around Big Knob Waterhole (Fig. 25). The swarms have sublinear branched forms.

Type locality: At Big Knob Waterhole adjacent to the Bullo track at 15°44′S, 129°40′E.

Stratigraphic relations: The knobs all lie in the stratigraphic level of the Shoal Reach Formation or on the Spencer Sandstone; the bases of a few are in the upper part of the Spencer Sandstone. The upper parts of some knobs lie in the Black Point Sandstone Member of the Bullo River Sandstone. It is possible that all the knobs were lying discordantly within the Shoal Reach Formation before it was preferentially eroded away. The contact between the knobs and adjacent formations was not seen because of scree cover.

Lithology and thickness: The Big Knob Beds consist of ferruginous sandstone, grit, and conglomerate. The most common type is sandstone, which is red-brown, massive, thin-bedded or lacking visible bedding, medium to coarse, and poorly sorted. The subangular quartz grains are up to 0.5 cm across and colourless, white, opalescent blue, or yellow. Both tabular and irregular mudstone clasts are common.

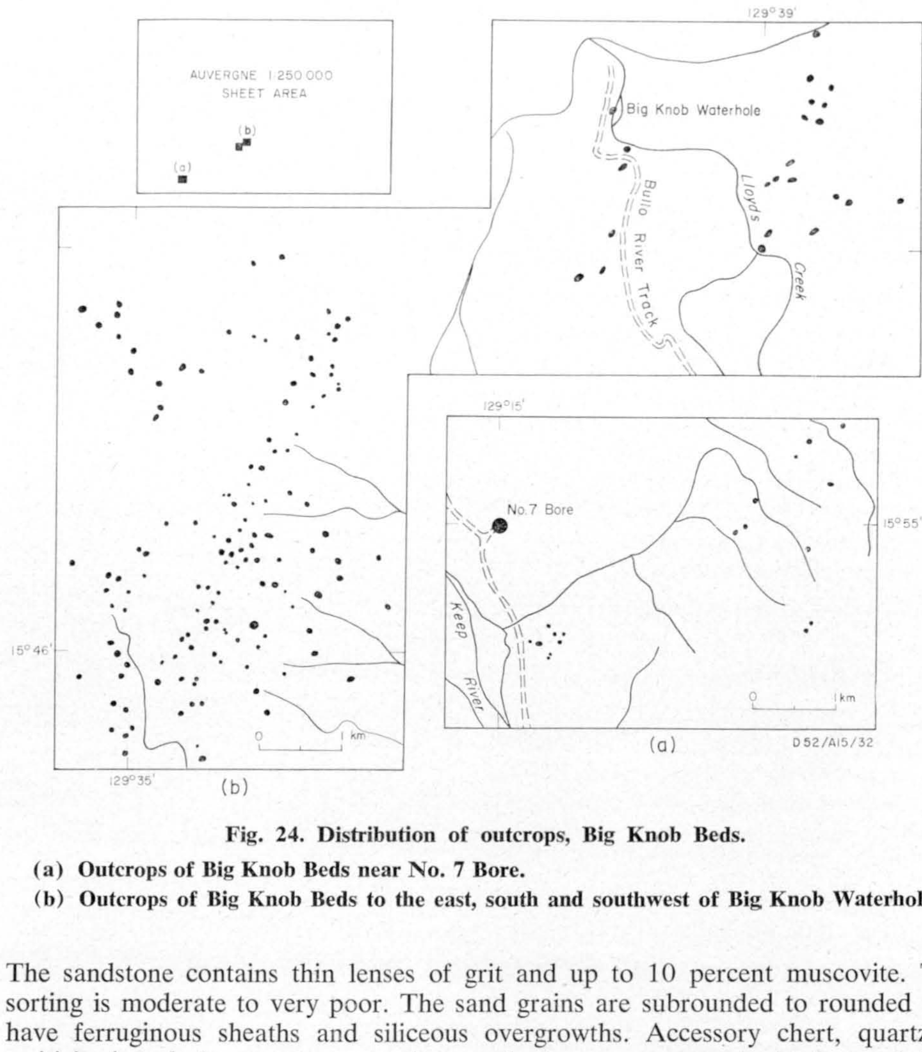


Fig. 24. Distribution of outcrops, Big Knob Beds.

(a) Outcrops of Big Knob Beds near No. 7 Bore.

(b) Outcrops of Big Knob Beds to the east, south and southwest of Big Knob Waterhole.

The sandstone contains thin lenses of grit and up to 10 percent muscovite. The sorting is moderate to very poor. The sand grains are subrounded to rounded and have ferruginous sheaths and siliceous overgrowths. Accessory chert, quartzite, seriticized rock fragments, tourmaline, and zircon are present. A clay and iron oxide matrix forms less than 5 percent of the rock.

The upper parts of some knobs consist of conglomerate. Megaclasts form up to 50 percent of the rock, and their size, shape, and composition vary considerably. They are up to 5 cm long, rounded or angular, and many are tabular. Common rock types are red-brown thin-bedded siltstone; thin-bedded and cross-bedded, medium-grained white sandstone which is poorly sorted and has up to 10 percent feldspar grains; fine to medium, well sorted red-brown sandstone; and small fragments of white micaceous clay. The matrix is poorly sorted and contains quartz grains 0.5 to 1 cm across; the largest grains are angular.

The conglomerate also contains rounded ferruginous well sorted sandstone nodules 1 to about 15 cm across. They do not appear to be discrete bodies, but grade into the surrounding sandstones; they generally weather out preferentially. Iron is the main cement, with minor barite; there is no siliceous cement, and the grains do not appear to have any siliceous overgrowth. The nodules, which are

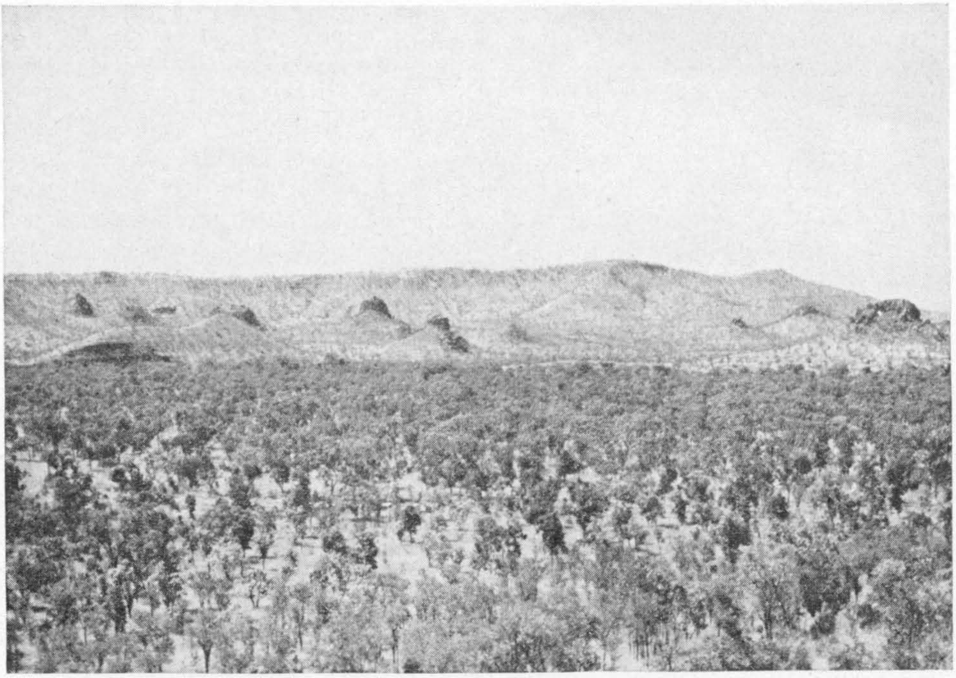


Fig. 25. Swarm of knolls constituting the Big Knob Beds; 10.5 km south-southeast of Bullo Gorge, east of the Bullo track. (GA/527)

present throughout the knobs, are particularly common in the upper conglomeratic part. A generalized section typical of knobs near the Bullo track comprises a basal 9 m of indurated ferruginous sandstone overlain by 0.5 m of soft muscovite-rich sandstone which in turn is overlain by 9 m of conglomerate. The conglomerate contains boulders and cobbles and passes down into conglomeratic sandstone in which cobbles of siltstone and sandstone are present. Boundaries between the sandstone and conglomerate are gradational and vaguely defined.

Discussion and correlation: The origin of the knobs is obscure. All the knobs are at the same topographic level as nearby outcrops of Shoal Reach Formation, but their distribution and composition suggest that they are not part of it.

The simplest explanation is that they are silicified remnant blocks of Bullo River Sandstone. The almost complete lack of bedding in the knobs weakens this hypothesis, but it cannot be ruled out completely as bedding can be masked by silicification.

The Shoal Reach Formation is composed of dolomitic sandstone, and another suggestion is that the knobs are composed of sediment which has filled sinkholes in the formation. If this is the case, the branched sublinear form of the swarms of knobs could reflect the valley system in which the sinkholes formed. Bonte (1963) described the formation of solution holes in carbonate formations having a sandstone capping which collapses into the hole as it is formed. The lithology of the Bullo River Sandstone is similar to that of the Big Knob Beds, so it is also possible that the knobs were formed in this way, the Bullo River Sandstone being the sediment source.

A third suggestion is that the knobs are the remains of eskers or kames which consolidated but subsequently were re-eroded by ice. A few linear features somewhat similar to glacial striations are exposed on the side of the knob adjacent to Big Knob Waterhole.

The sediment forming the Big Knob Beds is similar to the Beasly Knob Member of the Ranford Formation, which contains conglomerate and submature ferruginous sandstone containing opalescent blue, white, and yellow quartz. The fact that the Ranford Formation is associated with glacial rocks lends some support to the contention that the knobs are eskers or kames. Further evidence of a glacial origin is the presence of ferruginous nodules. Similar structures are found in sandstone associated with recent glacial sediments in Scotland; it is thought that ice-cemented lumps of sand became incorporated in the sandstone; when the ice melted it was completely or partly replaced by another cement, often iron oxide. The problem of the formation of the knobs has not been resolved, and no particular hypothesis is preferred.

DUERDIN GROUP

A summary of the stratigraphy of the Duerdin Group is given in Table 7.

The group, previously called the Ord Group (Dow et al., 1964) and subsequently modified (Dow & Gemuts, 1969), was first recognized in the Ord River region (Dow, 1965), where it consists of tillite, sandstone, siltstone, and shale. In the Auvergne Sheet area, tillite and associated conglomerate, sandstone, and minor dolomite have been divided into five formations and included in the Duerdin

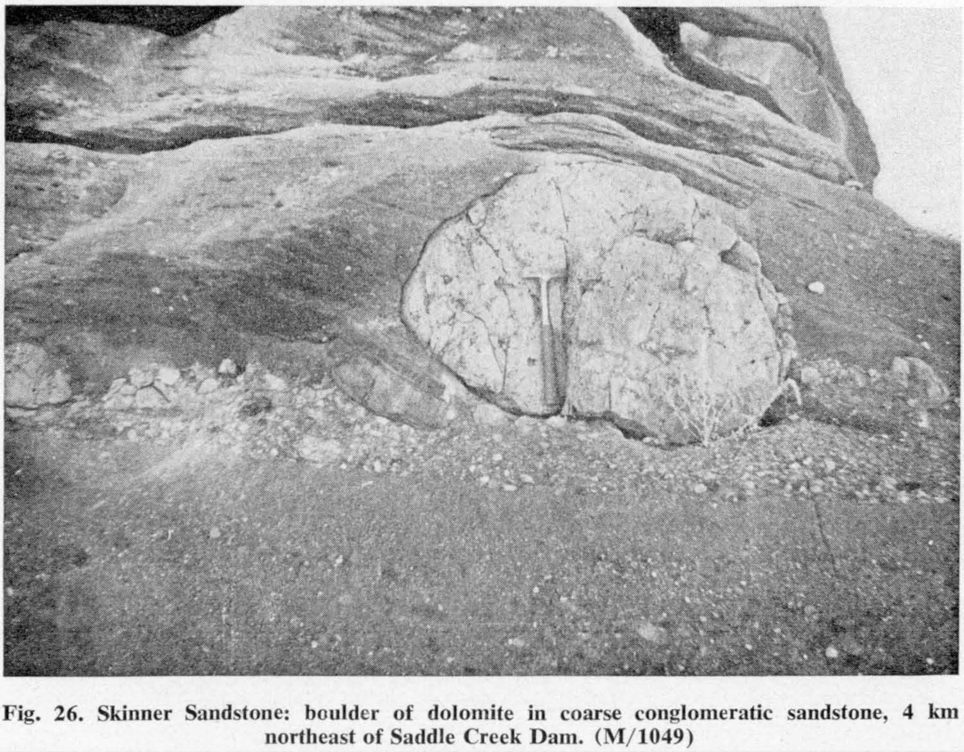


Fig. 26. Skinner Sandstone: boulder of dolomite in coarse conglomeratic sandstone, 4 km northeast of Saddle Creek Dam. (M/1049)

Group. The Skinner Sandstone and Blackfellow Creek Sandstone are found only in the Victoria River region, and no equivalent units are known in the East Kimberley area. Glacial rocks are restricted to the southwestern quarter of the Auvergne Sheet area, but extend into the Waterloo Sheet area to the south.

Skinner Sandstone (New name)

Distribution: The Skinner Sandstone is preserved in three ridges of hills which trend in a northeasterly direction from the southern margin of the Auvergne Sheet area (Figs. 28, 29).

Derivation of name: From Skinner Point, a prominent cliff-capped mesa 1 km south of the main Katherine-Kununurra road at 15°57′S, 129°35′E.

Type section: In the large mesa of which Skinner Point is a part; the type section is at 15°58′S, 129°33′E, about 3.5 km southwest of Skinner Point.

Stratigraphic relations: The Skinner Sandstone overlies the Auvergne Group unconformably and laps onto the Saddle Creek Formation 8 km northwest of Skinner Point (Fig. 29). In most other areas the Skinner Sandstone overlies only Angalarri Siltstone.

At the Skinner Point mesa the sandstone is overlain conformably by Fargoo Tillite. Farther south in the Waterloo Sheet area it is overlain with minor uncomformity by the Blackfellow Creek Sandstone.

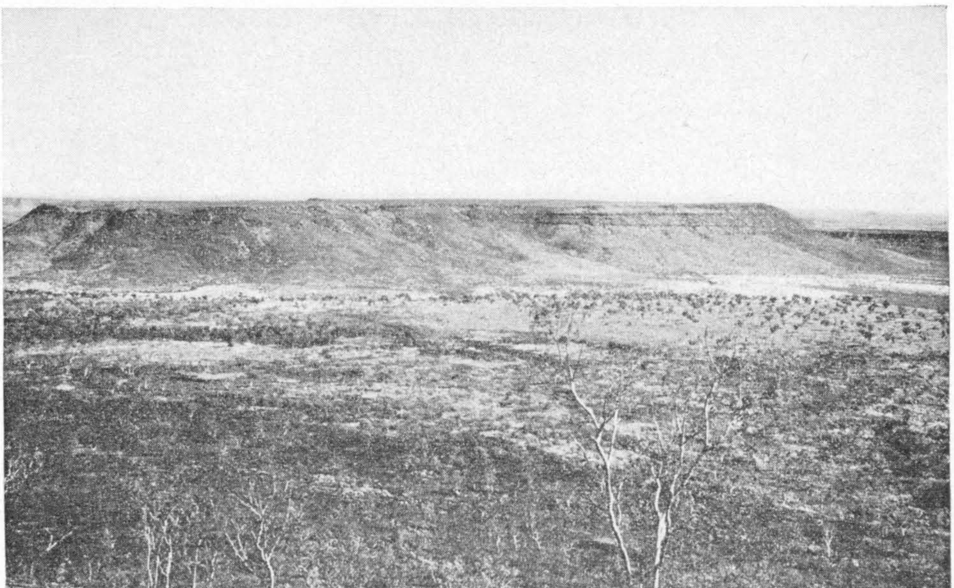


Fig. 27. Skinner Point mesa looking from the southeast. Lower slopes are Angalarri Siltstone; gently inclined bed at right is Skinner Sandstone and is truncated by the flat-lying Blackfellow Creek Sandstone capping the mesa. (GA/2446)

TABLE 7. SUMMARY OF STRATIGRAPHY, DUERDIN GROUP

	Rock Unit	*Map Symbol*	*Maximum Thickness (m)*	*Lithology*	*Physiographic Expression*	*Stratigraphic Relations*	*Remarks*
RANFORD FORMATION	Ernie Lagoon Member	Por	10	Quartz sandstone, minor grit and conglomerate interbeds	Low steep scarps	Conformable on Beasly Knob Member	Occupies central W Sheet area; youngest Precambrian unit
RANFORD FORMATION	Beasly Knob Member	Pob	130+ in SW	Quartz sandstone, siltstone, minor pebble conglomerate and grit	Prominent hills	Conformable on Moonlight Valley Tillite. Overlaps onto Saddle Creek Formation	Occupies central W and SW Sheet area. Correlation of outcrops in central W with those in SW not proved
RANFORD FORMATION	Bucket Spring Member	Pou	55	Siltstone and micaceous sandstone	Low rounded hills or gently inclined talus slopes	Overlies Bullo River Sandstone	Occupies central W Sheet area. Photo-pattern identical with Moonlight Valley Tillite
	Moonlight Valley Tillite	Pom	130+	Mainly boulder tillite. Some conglomerate, sandstone, and siltstone. Pink laminated dolomite at top	Low rounded hills or gently inclined scarps where protected by hard caprock	Overlies Auvergne Group and other older rocks with pronounced disconformity. Overlain conformably by Ranford Formation	Outcrop rare. Main key to recognition is thin pink dolomite band N of Hungry Billabong yard
	Blackfellow Creek Sandstone	Ꝑol	30+	Massive quartz sandstone; minor micaceous and conglomeratic sandstone	Flat mesa capping	Overlies Fargoo Tillite with minor unconformity	Seen only in Skinner Point mesa
	Fargoo Tillite	Ꝑof	160	Massive boulder tillite and coarse conglomerate containing dolomite clasts	Smooth slopes on side of mesa	Conformable on Skinner Sandstone	Seen only in Skinner Point mesa
	Skinner Sandstone	Ꝑoi	60	Cross-bedded quartz sandstone, pebbly sandstone; massive conglomerate, minor mudstone and tillite	Structural benches and low mesas	Unconformable on Auvergne Group (generally over Angalarri Siltstone)	

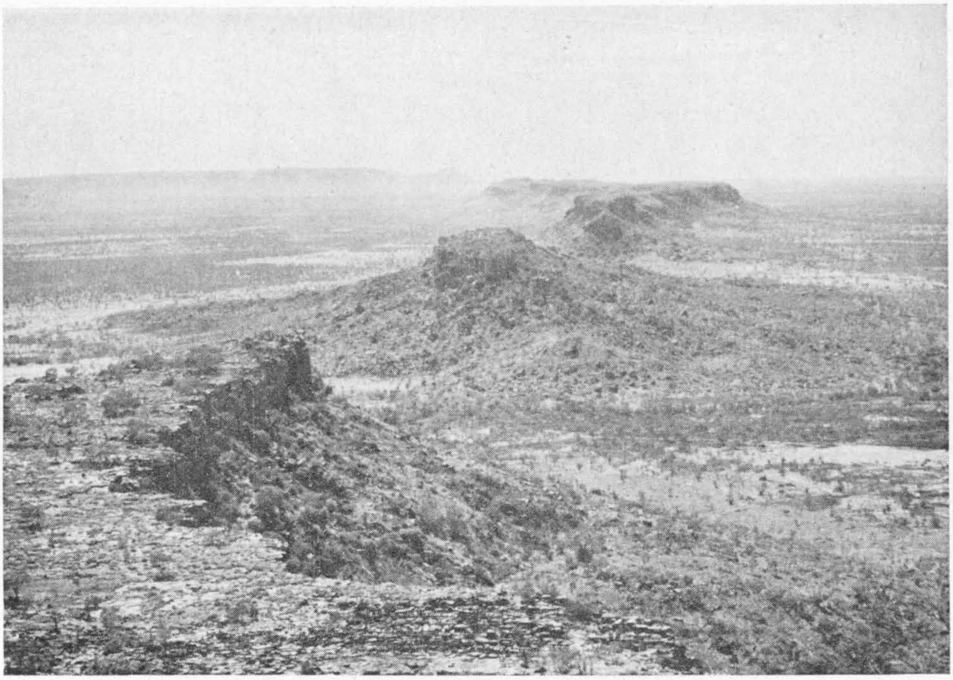


Fig. 28. Mesas of Skinner Sandstone northeast of Skinner Point (in foreground); Pinkerton Range in the distance.

Lithology and thickness: At its type locality the Skinner Sandstone is about 40 m thick, but its thickness is variable; 1 km east of the type locality it is nearly 60 m, but 8 km to the southwest it is only 10 m; 7 km to the south in the Waterloo Sheet area the Skinner Sandstone is almost 100 m thick (Sweet, Mendum, Bultitude, & Morgan, in press), although it is absent at the southern end of the Skinner Point mesa.

Basal diamictite in a number of outcrops along the northwestern side of the Skinner Point mesa does not exceed 5 m in thickness and is generally less than 3 m. Three beds constitute this basal unit. The bottom bed is 1 to 3 m thick and consists of clasts of green shale up to 20 cm long, set in a green matrix of similar material. There is little or no quartz sand in the matrix, and the only other clasts are a few small dolomite pebbles. Overlying this bed is 1 to 2 m of diamictite in which megaclasts are more sparsely distributed in a heterogeneous dark greyish green matrix. Of 71 clasts counted, 51 (71%) were dark grey crystalline dolomite, 17 were other sedimentary rocks, and 3 were igneous rocks. Several other cobbles and boulders of granite and porphyry occur as talus below the outcrop.

Above the diamictite the bulk of the formation is medium-grained dolomitic sandstone containing lenses of grit, conglomeratic sandstone, and conglomerate. Medium and large-scale cross-bedding is ubiquitous; on the southeastern side of the Skinner Point mesa the cut-and-fill structures are up to 50 m long. Crudely graded bedding is present within some cross-bedded units.

The northwestern ridge of Skinner Sandstone is mostly conglomerate (Fig. 30), and where the base is exposed there is no diamictite. Up to 10 m of conglomeratic

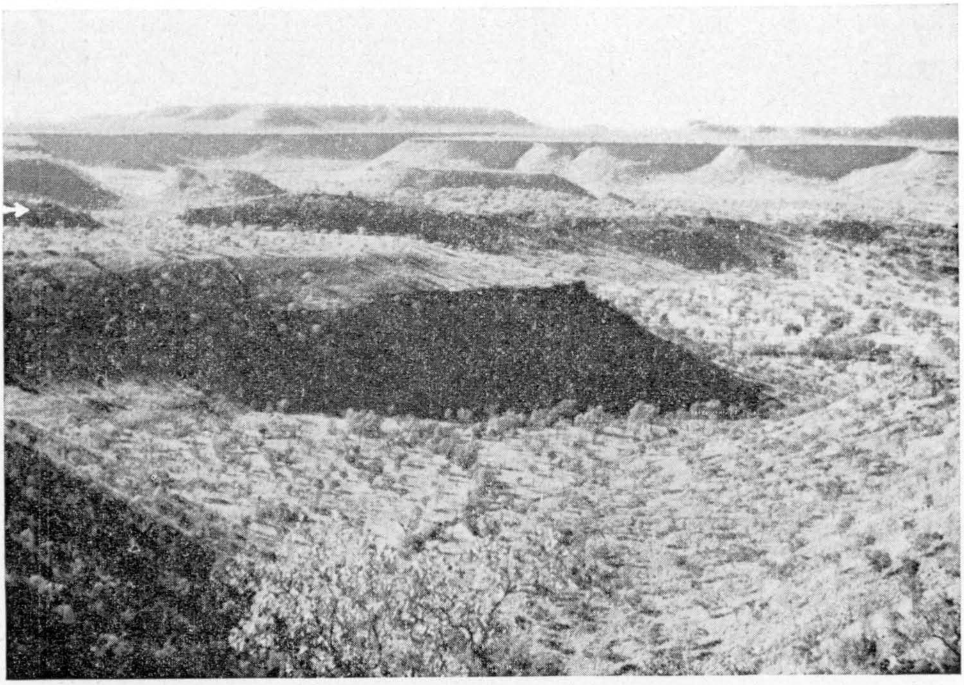


Fig. 29. Line of small hills arrowed are Skinner Sandstone occupying a valley eroded into the Auvergne Group during the late Adelaidean. (GA/607)

sandstone and grit are overlain by about 5 m of medium-grained quartz sandstone containing scattered grit and pebbles and a 1.5-m diameter boulder of quartzite. Four kilometres northeast of Saddle Creek Dam, a thick bed contains numerous large boulders (Fig. 26), one of grey dolomite being 1.5 m across. At this outcrop foreset beds indicate a southerly-flowing depositional current. Where the northwestern ridge runs into the Pinkerton Range, sandstone and grit overlap Angalarri Siltstone onto Saddle Creek Formation, establishing the unconformable relationship of the Skinner Sandstone with the Auvergne Group.

The small mesas 9 km southeast of Skinner Point also consist of inter-bedded conglomerate and sandstone. As in other localities, most clasts are of dolomite, with subordinate quartzite and chert. About 3 m of conglomeratic sandstone contains up to 50 percent limonite, some as pseudomorphs after pyrite or magnetite. Overlying this is a massive, friable, medium-grained yellow argillaceous sandstone. The top of the hill is covered with scattered rounded and polished quartzite boulders which could be derived from an eroded tillite or from another conglomerate.

The mesas immediately northeast of Skinner Point comprise massive sandstone and conglomerate, in some places without partings for 4 to 6 m.

Palaeogeographic significance: The area which Skinner Sandstone originally occupied is not known. However, the marked linearity of the present outcrops may indicate areas of maximum deposition of the unit, which may have been much thinner or non-existent between the linear zones.

Relief on the land surface on which the Skinner Sandstone was laid down was at least as great as, and probably considerably greater than, it is today. The summits of hills made up of Auvergne Group rocks are 100 to 120 m higher than the base of the Skinner Sandstone.

The clastic material in the Skinner Sandstone shows a general decrease in grainsize in a southwesterly direction. This, coupled with a decreasing thickness in this direction, and some south-facing foresets, indicate that the material was transported into the area from the north or northeast. However, the majority of clasts in the conglomerate are of dark grey medium to coarsely crystalline dolomite, many pebbles and cobbles of which contain stromatolites. No dolomitic rocks of the Auvergne Group bear any resemblance to the grey dolomite clasts which are very similar to dolomite from the Bungle Bungle Dolomite in the East Kimberley region of Western Australia.

The provenance of the Skinner Sandstone will be discussed further in the following section on the Fargoo Tillite.

Fargoo Tillite

The Fargoo Tillite was named by Dow & Gemuts (1969) from the East Kimberley region of Western Australia where it forms extensive outcrops immediately east of the Halls Creek Fault, but in the Auvergne Sheet area the only known outcrop is in the Skinner Point mesa. Although outcrop is not continuous from Western Australia, the outcrops in the Northern Territory are confidently assigned to the Fargoo Tillite on the basis of lithology and stratigraphic relations.

Lithology and thickness: The Fargoo Tillite conformably overlies Skinner Sandstone in the Skinner Point mesa. The contact is marked by a change from massive,

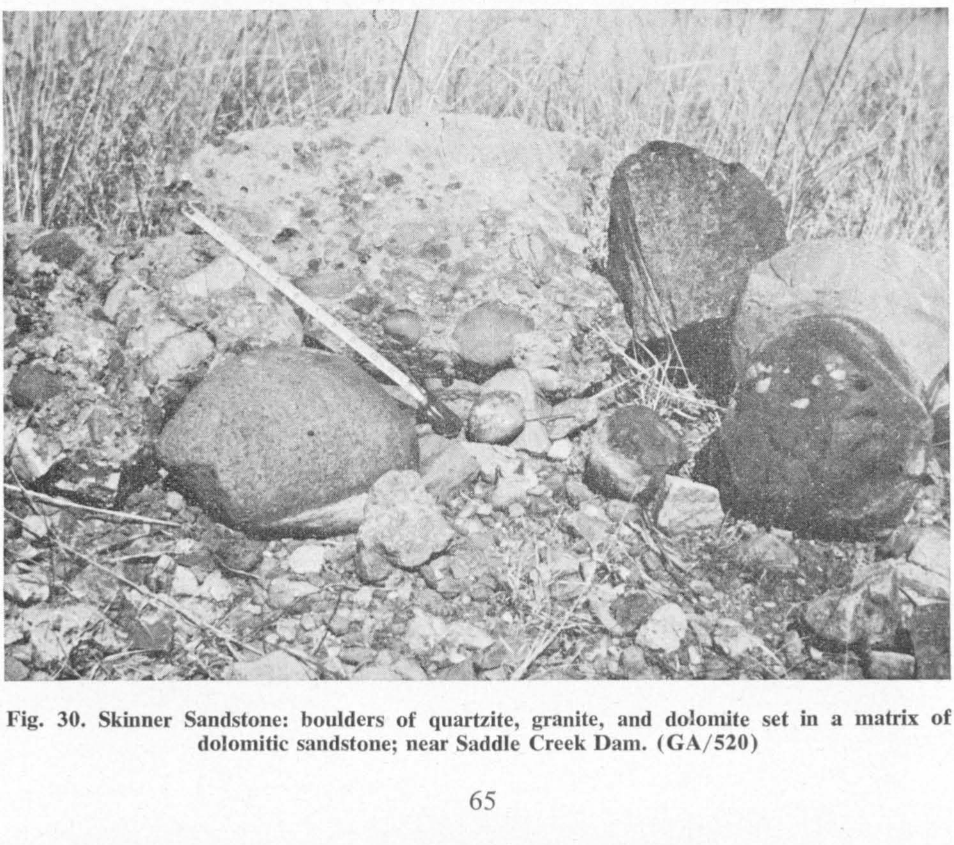


Fig. 30. Skinner Sandstone: boulders of quartzite, granite, and dolomite set in a matrix of dolomitic sandstone; near Saddle Creek Dam. (GA/520)

flaggy, and thin-bedded sandstone to fissile greyish green quartz siltstone which in turn grades upwards into a dull brownish grey massive siltstone overlain by tillite.

The true tillite at the northern end of the hill is 64 m thick. Although consolidated, the matrix weathers rapidly and megaclasts can easily be dug out of the existing outcrops. By far the most common type of clast is grey crystalline dolomite identical to clasts in the Skinner Sandstone. Most are pebbles (4 to 64 mm) or cobbles (64 to 256 mm), but several boulders were observed, the largest being 50 to 75 cm across. Other clasts are of various quartz-feldspar porphyries, schist, gneiss, quartzite, and chert. Many clasts approximate to a flattened ovoid shape; surface striations and polish are common features on the dolomite, but are absent on the harder rock types. The till matrix is dark greyish green when fresh and weathers to light yellowish green. It is heterogeneous and includes particles from clay to coarse sand and grit sizes.

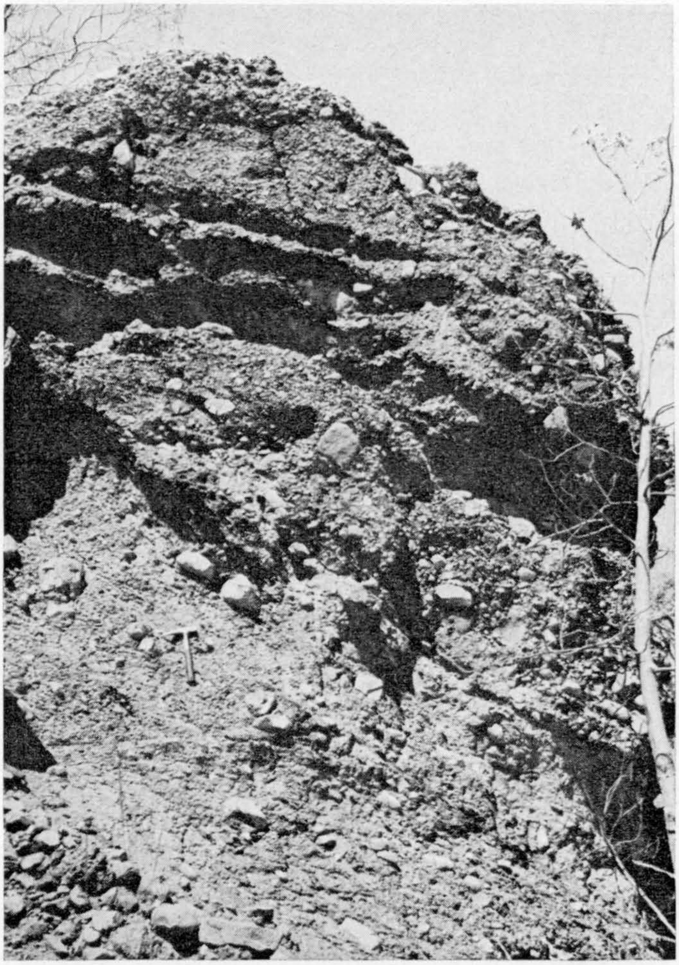


Fig. 31. Fargoo Tillite: tillite overlain by poorly sorted conglomerate; northwestern slope of the Skinner Point mesa.

Overlying the tillite is about 65 m of very coarse-grained poorly sorted massive conglomerate (Fig. 31). The rock is studded with many cobbles of grey dolomite and a few of quartzite; pebbles are of dolomite, chert, and quartzite. The matrix of the rock is a poorly sorted dolomite-quartz sand and comprises only 10 to 20 percent by volume of the rock. Lenses of the conglomerate are numerous within the tillite. On the southwestern side of the mesa are two prominent lenses, a lower lens of gritty sandstone and an upper of massive conglomerate; the section is 160 m thick (Section 29, Appendix).

Palaeogeographic significance: Dow & Gemuts (1969) postulated a landmass west of the East Kimberley region during deposition of the Fargoo Tillite. It shed sediment-laden ice into a sea covering the East Kimberleys and possibly areas in the Northern Territory. However, the Skinner Sandstone and Fargoo Tillite in the Auvergne Sheet area are non-marine. The nature of the clasts in the till is consistent with a westerly provenance, but the currents depositing the Skinner Sandstone came from the north or northeast where the Skinner Sandstone is coarser.

The most feasible sequence of events seems to be:

(1) ice advanced from the west, depositing a till layer of unknown thickness (the diamictite at the base of the Skinner Sandstone is a remnant);

(2) the ice-sheet retreated and the till was extensively reworked, most of the finer-grained material being removed from the area by rivers. The residual alluvial sediments constitute the Skinner Sandstone. At least some rivers at this stage must have been flowing in towards, and perhaps along the margin of, the ice-sheet;

(3) another major advance of the ice-sheet resulted in deposition of the Fargoo Tillite. Numerous very coarse poorly sorted conglomerate lenses within the tillite resulted from crude re-working of till by melt-water.

Blackfellow Creek Sandstone

Distribution: The Blackfellow Creek Sandstone crops out in the Skinner Point mesa in the Auvergne Sheet area, and more extensively to the south in the Waterloo Sheet area.

Derivation of name: From Blackfellow Creek in the Waterloo Sheet area where it drains a small portion of the northwestern quarter and flows northeast into the West Baines River.

Type section: At the northern end of the Skinner Point mesa at 15°57′30″S, 129°34′E.

Stratigraphic relations: These are not clearly understood. There may be a minor unconformity at the base of the formation as the Fargoo Tillite is absent in some areas. However, this is also explicable in terms of lensing and facies changes. Figure 27 shows Skinner Sandstone (lower band) converging upwards with flat-lying Blackfellow Creek Sandstone in the Skinner Point mesa.

The Moonlight Valley Tillite overlies the Blackfellow Creek Sandstone, probably with local unconformity, in the Waterloo Sheet area.

Lithology and thickness: A thickness of 32 m was measured by barometer at the northern extremity of the Skinner Point mesa; this is a minimum for the formation as there are no overlying beds in the mesa.

The Blackfellow Creek Sandstone is predominantly a massive, medium-grained quartz sandstone. The only place where the contact with underlying Fargoo Tillite is exposed is 0.5 km southwest of the northern extremity of the mesa. A number of fissile micaceous clayey interbeds and one 10-cm band of green mudstone crop out; their nature suggests there was some reworking of the underlying Fargoo Tillite. Figure 27 shows a slight angular discordance of the Skinner and Blackfellow Creek Sandstones, which suggests a hiatus in the sequence.

At the northern extremity of the Skinner Point mesa, the basal 3 m of sandstone is blocky, massive, and reddish, with numerous greyish green siltstone partings. Many beds contain minor lenses of quartz pebble conglomerate. Capping the cliff is a better sorted light-coloured medium-grained silicified sandstone; 100 m to the south is 3 to 5 m of red-purple more friable (less silicified) quartz sandstone. Few beds display any internal structure such as cross-bedding, but load casts were seen at the base of a massive bed on the eastern side of the mesa.

Palaeogeographic significance: The Blackfellow Creek sandstone is probably a fluvial unit derived mainly from glacial debris. Some erosion of the underlying Fargoo Tillite probably took place, but is not regarded as a major time-break. The extent of deposition south of Skinner Point is unknown. To the north the younger Moonlight Valley Tillite directly overlies a basement of Auvergne Group, indicating that the Blackfellow Creek Sandstone was probably not deposited in this area. The Skinner Point mesa marks approximately the northernmost extent of the formation.

Moonlight Valley Tillite

Distribution: The Moonlight Valley Tillite crops out in the southwestern Auvergne Sheet area. The largest outcrop area is about 150 km^2 between 15 and 30 km northeast of No. 7 Bore. There are several other large outcrops north and west of the bore; the northernmost outcrop seen was about 25 km from the bore.

Derivation of name: Previously used in describing glacial rocks in the East Kimberley region (Dow & Gemuts, 1969), the name is derived from Moonlight Valley, 145 km south of Kununurra.

Stratigraphic relations: In the Auvergne Sheet area the Moonlight Valley Tillite unconformably overlies a number of Precambrian formations ranging from Saddle Creek Formation to Bullo River Sandstone. It most commonly overlies the Bullo River Sandstone and in places it fills fossil valleys (pre-Duerdin Group) within this formation. The Bullo River Sandstone is the youngest known unit overlain by the tillite. The nature of the unconformity varies from a pronounced angular unconformity to a disconformity. Nowhere in the Auvergne Sheet area does the tillite overlie Blackfellow Creek Sandstone or the older Duerdin Group formations.

The tillite is overlain, apparently conformably, by the Ranford Formation. In Western Australia it is unconformably overlain by Antrim Plateau Volcanics, thus fixing the age of the tillite as Precambrian. About 3 km west of Bubble Bubble Spring, dolomite forms the top of the Moonlight Valley Tillite as it does in the Lissadell Sheet area.

Lithology and thickness: The only known outcrop is near Alligator Waterhole in the southwest corner of the Auvergne Sheet area where 'boulder clay' crops out. Elsewhere, the presence of boulders, cobbles, and pebbles scattered on the surface indicates subcrop of tillite. The range of sizes of megaclasts is large, from small pebbles up to boulders 2 m across; cobbles and small boulders are the most common. Most megaclasts are of light-coloured quartzite or silicified sandstone; less common are siltstone, algal dolomite, and conglomeratic sandstone. At Alligator Waterhole are numerous boulders (up to 0.5 m) of a coarse-grained pink-feldspar granite and dark grey mica schist.

Most megaclasts are well rounded, many are polished, and they are generally ovoid. Several display vague striations, and crescentic fractures are common. Some boulders display a series of parallel fractures which appear to be non-tectonic in origin. A striated glacial pavement on sandstone of Saddle Creek Formation 16 km northeast of Beasley Knob (Figs. 32, 33) had striations oriented at 200°, but the direction of ice-movement is not known.

The northern extent of the boulder-covered hills is about 11 km north of Bubble Bubble Spring, 1.5 km west of which are two interbeds of siliceous siltstone in the tillite. The siltstone is identical to the Bucket Spring Member of the Ranford Formation, which crops out to the north and west. This may be the northern limit of the tillite, which appears to be intertonguing with the Bucket Spring Member.

Because of the presence of polished, striated, and fractured boulders (Fig. 34), the rock is believed to be a true tillite rather than a fluvioglacial conglomerate derived from a tillite. By comparison, the conglomerates associated with the Skinner Sandstone are indurated and give measurable outcrop owing to their resistance to erosion.

Near Bubble Bubble Spring, about 2 m of pink thin-bedded to laminated dolomite overlies the tillite. This is one of the important criteria in recognizing the

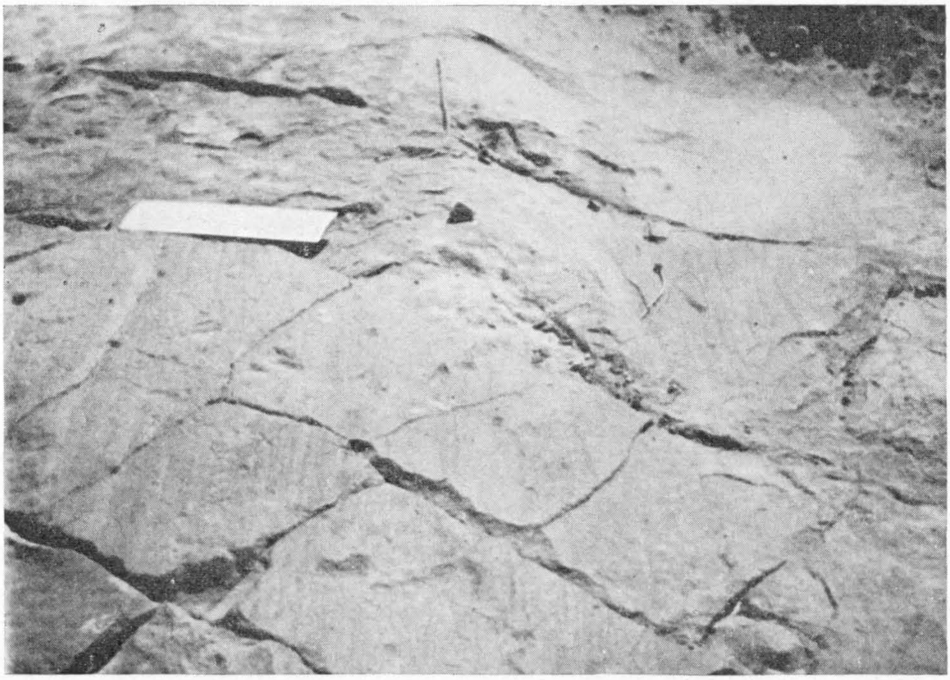


Fig. 32. Remnants of striated pavement developed on Saddle Creek Formation; 15 km northeast of Beasly Knob. (GA/548)

tillite as Moonlight Valley Tillite because identical dolomite was reported in the same stratigraphic position from adjacent areas in Western Australia by Dow & Gemuts (1969).

The thickness of the tillite is difficult to measure as it displays no bedding and lies on an irregular surface. Generally its upper limit is not present, but it is more than 30 m thick in many localities. A pre-tillite valley eroded along a fault zone near the southern end of the Spencer Range Fault is still occupied by tillite to a depth of about 130 m.

Distinguishing features: The Moonlight Valley Tillite characteristically forms low rounded spinifex-covered hills. There is a complete lack of indurated outcrop, although the surface is made very rough by the numerous boulders. The drainage pattern is dendritic, reflecting a uniform underlying rock type.

Ranford Formation

The Ranford Formation was defined by Dow & Gemuts (1969) as the rocks conformably overlying the Moonlight Valley Tillite in the Ord River region. The sequence conformably overlying the tillite in the Auvergne Sheet area is equated to the Ranford Formation, but because its composition does not correspond closely with that in the Ord River region it has been subdivided into three new members:

Ernie Lagoon Member
Beasly Knob Member
Bucket Spring Member

Fig. 33. Same pavement as in Fig. 32. Practically all polishing has been weathered away. (GA/544)

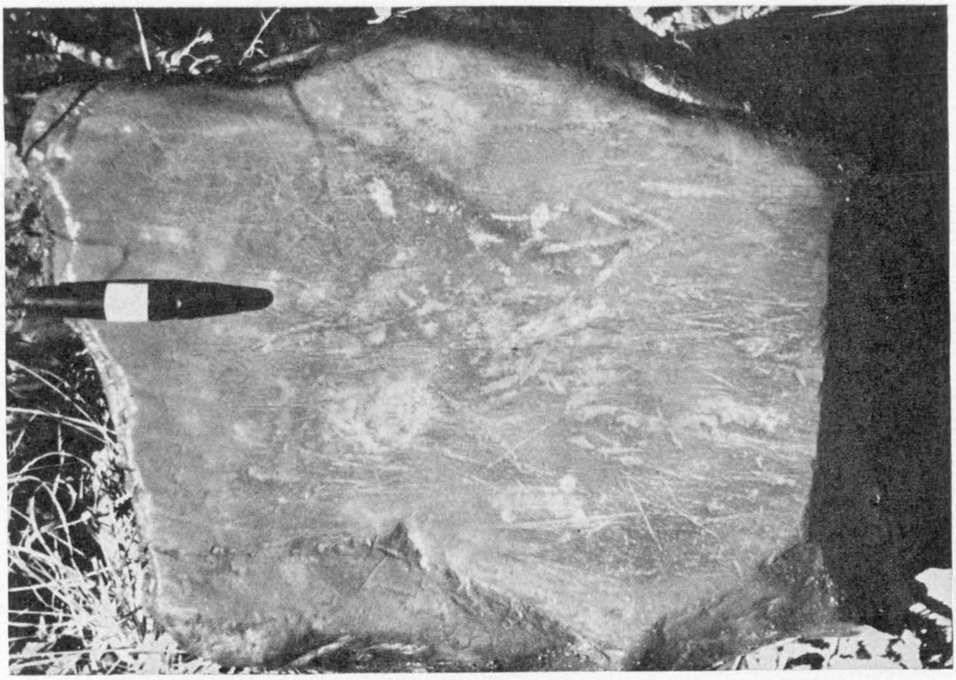


Fig. 34. Striated boulder from Moonlight Valley Tillite, near Bubble Bubble Springs. (GA/577)

Bucket Spring Member (New name)

Distribution: The Bucket Spring Member is exposed in the central-western Auvergne Sheet area. Most of it is confined to the core of a syncline south of the Victoria River Fault.

Derivation of name: After Bucket Spring in the west of the Sheet area.

Type section: In the core of the syncline 19 km northeast of Bucket Spring at 15°33′S, 129°22′E.

Stratigraphic relations: The Bucket Spring member is the basal unit of the Duerdin Group and overlies the Bullo River Sandstone, but an unconformable relationship has not been proved. It is conformably overlain by the Beasly Knob Member.

Lithology and thickness: Outcrop is limited to small exposures immediately below the massive sandstone of the Beasly Knob Member. The Bucket Spring Member consists of interbedded greyish green siltstone and fine-grained light grey micaceous sandstone. In thin section the rock is moderately sorted and has more than 5 percent clay matrix. The grains are apparently sub-angular, but quartz overgrowths mask their original shape. Fresh microcline (5%), thin flakes of muscovite (2%), and accessory zircon and tourmaline are also present.

The Bucket Spring member is 55 m thick along the Victoria River Fault. It is only 30 m thick 3 km south of the fault and is absent 10 km farther south where the tillites crop out.

Distinguishing features: The Bucket Spring Member forms low rounded hills or gently inclined debris slopes where it is capped by the Beasly Knob Member. Typically the hills show virtually no outcrop, and the absence of trees or scrub is distinctive. On aerial photographs the unit has a smooth light tone identical to that of the Moonlight Valley Tillite. In the field it is recognized by its fine micaceous nature.

Beasly Knob Member (New name)

Distribution: The Beasly Knob Member forms isolated outcrops in the southwestern and central-western Auvergne Sheet area.

Derivation of name: After Beasly Knob in the southwest corner of the Sheet area.

Type section: Near the Victoria River Fault 13 km east-northeast of Bucket Spring at 15°34′S, 129°20′E.

Stratigraphic relations: The Beasly Knob Member conformably overlies the Moonlight Valley Tillite, and unconformably overlaps the Saddle Creek Formation near the Keep River.

The sandstone and conglomerate separating the Bucket Spring and Ernie Lagoon Members in the central-western area is mapped as Beasly Knob Member, but this correlation is not proven.

Lithology and thickness: North of the Keep River the Beasly Knob Member consists principally of sandstone which is grey or brown, blocky or massive, thin to thick-bedded, poorly sorted, and medium-grained; green mud flakes are common. It contains several interbeds of poorly sorted pebble conglomerate and grit. The sandstone consists of poorly sorted rounded quartz grains with siliceous overgrowths, rounded grains of fresh microcline (1%), tourmaline, and sericitized rock fragments. Zircon, iron oxides, quartz, and a little clay form a matrix (5%). Pebbles in the conglomerate are fine-grained quartzite.

Near the Victoria River Fault 13 km east-northeast of Bucket Spring, the type section of the Beasly Knob Member comprises 70 m of siltstone overlying 15 m of sandstone containing minor pebble conglomerate (Section 30, Appendix). About 13 km south of this section the upper siltstone and the lower sandstone and conglomerate are both 15 m thick.

South of the Keep River the member is composed principally of sandstone, much of which is ferruginous. It is light brown, grey, or red-brown, massive or blocky, medium or thin-bedded, medium to coarse, and generally poorly sorted. The sandstone is composed of sub-angular to rounded quartz grains with siliceous overgrowths. The grains are poorly to very poorly sorted and generally have over 5 percent of a matrix of iron oxide, clay, and fine quartz. Fresh microcline (up to 10%), fragments of fine quartzite, and accessory tourmaline, zircon, and muscovite are all common. Grains of micropegmatite and a fine clayey siltstone occur in the sandstone south of the Keep River.

On Beasly Knob the sandstone is 80 m thick and is overlain by 40 m of inter-bedded siltstone and ferruginous friable grit. The siltstone has a patchy development of a ferruginous matrix and resembles the 'Zebra stone' of the Ranford Formation in the Lissadell Sheet area (Dow & Gemuts, 1969). It consists of poorly sorted, angular to subangular quartz grains with accessory zircon, tourmaline, and sericite. A clay matrix or an iron oxide cement forms about 50 percent of the rock, the coarser material tending to have the iron cement. The siltstone and grit are either finely but irregularly interbedded or sporadically distributed. The interbedded grit is poorly sorted; the larger quartz grains are rounded, the smaller subangular. It has a matrix of clay, granular iron oxide, and sericite, and is partly cemented by iron oxide.

Ernie Lagoon Member (New name)

Distribution: The Ernie Lagoon Member crops out only in the central-western Auvergne Sheet area, north of the Keep River.

Derivation of name: From Ernie Lagoon near the western margin of the Sheet area.

Type section: In the core of the syncline of Bullo River Sandstone south of the Victoria Fault 24 km northeast of Ernie Lagoon and 8 km east of Bucket Spring at 15°36′20″S, 129°17′30″E.

Stratigraphic relations: The member conformably overlies the Beasly Knob Member. It is the youngest Precambrian sedimentary unit preserved in the Sheet area.

Lithology and thickness: Most of the Ernie Lagoon Member is sandstone which is light brown or purple, blocky, medium to thin-bedded, medium-grained, and siliceous. Grit and pebble conglomerate interbeds are present 15 km east of Bucket Spring. The quartz grains in the sandstone are rounded to well rounded, and siliceous overgrowths fill the pore spaces. Sorting is moderate to good, except in the grit and conglomerate interbeds which are poorly sorted. Common accessories are tourmaline and zircon.

In the central-western part of the Sheet area, 10 m of the member is preserved in outcrops near the Victoria River Fault, and about 7 m 1 km north of the Keep River. The unit is apparently absent farther south.

Distinguishing features: The Ernie Lagoon Member forms low steep scarps above the siltstone at the top of the Beasly Knob Member. On aerial photographs it appears as a medium-toned unjointed unit. In the field it is recognized by its well washed, well sorted nature; it tends to weather into rounded boulders.

LOWER(?) CAMBRIAN

ANTRIM PLATEAU VOLCANICS

The Antrim Plateau Volcanics crop out over an enormous area extending from the East Kimberley region in a huge arc around to the Katherine/Daly River area. They overlie Precambrian rocks and mask their relations with other Precambrian rocks in the East Kimberley and Granites-Tanami areas.

The volcanics cover an area of at least 75 000 km^2, which must have been considerably greater in the past. Previous work has shown some variation in composition from undersaturated to oversaturated varieties, but they are generally considered to form a homogeneous petrographic province of tholeiitic basalts (Edwards & Clarke, 1940). The thickness ranges from less than 60 m over large areas to 1000 m north of Turner homestead in the East Kimberley region (Traves, 1955). Bultitude (1971, and in prep.) described the volcanics south of the Auvergne Sheet area.

The Antrim Plateau Volcanics have a limited extent in the Auvergne Sheet area, where they crop out in the southwest corner over an area of about 100 km^2. Two areas are recognized: one near Beasly Knob, and the other 20 km to the northeast near No. 7 Bore.

Stratigraphic relations: Stratigraphic relations were not determined in the Auvergne Sheet area. In the East Kimberley region Traves (op. cit.) presented evidence for a Lower Cambrian age because the volcanics fill valleys in Adelaidean sediments and are overlain, apparently conformably, by the Middle Cambrian Negri Group; he cited numerous examples of extensive erosion of pre-volcanic rocks, with basalt occupying valleys. Laing & Allen (1956) also recorded basalt filling valleys in Jasper Gorge Sandstone.

Lithology and thickness: The total thickness of the volcanics in the Sheet area is unknown; only about 30 m can be seen in outcrop. They vary from vesicular basalts near Low Bald Hill in the southwest to dark green compact basalt 24 km to the northeast. The vesicular basalt is interbanded with non-vesicular layers, apparently representing a number of flows each only a few metres thick.

In thin section the basalt contains a single pyroxene, probably pigeonite. The rocks from the Beasly Knob area are fine-grained and have over 50 percent of highly altered plagioclase and a pyroxene. In contrast, the volcanics near No. 7 Bore are medium-grained slightly porphyritic basalt and are very slightly altered. The grainsize of the plagioclase and pyroxene is 0.1 to 0.6 mm with plagioclase phenocrysts up to 2 mm. Only the large grains appear saussuritized. The pyroxene is probably pigeonite, and the plagioclase is labradorite (An_{54}).

Distinguishing features: The volcanics generally form low hills or plateaux. Scarps can be recognized as containing volcanics by the prominent dark-coloured scree slopes. Jointing is generally the locus of weathering.

LOWER CRETACEOUS

MULLAMAN BEDS

The Mullaman Beds unconformably overlie rocks of the Auvergne Group in the northeastern part of the Sheet area. They are continuous with outcrops mapped by Skwarko (1966) and Randal (1962) in adjacent Sheet areas to the north and east. The beds have been extensively lateritized; the laterite and associated products of silicification typically form a tough cap rock on mesas and other remnants of a dissected plateau. The Mullaman Beds are in most places exposed in profiles underlying the laterite.

The beds consist essentially of sandstone, and as they generally lie below a lateritic profile they invariably are extensively altered. Based on Skwarko (1966), it seems likely that the unit in the Sheet area consists of marine sediments overlying freshwater sediments, but the composition of the beds and their apparent lack of fossils give no indication of this.

CAINOZOIC

Laterite (Czl). Remnants of ferruginous laterite and lateritic soil are found in the northeastern part of the Sheet area. The laterite has formed almost exclusively on the Mullaman Beds, thin remnants of which overlie units of the Auvergne Group —mainly Pinkerton Sandstone. The laterite forms part of the mature Tennant Creek Surface of Hays (1967) and is probably a remnant of a Tertiary laterite surface which previously covered much of north Australia. The Pinkerton Sandstone forms a plateau surface immediately below the Mullaman Beds and this seems to be resistant to lateritization. Thin lateritic soils have developed over Jasper Gorge Sandstone in the southern part of the Sheet area.

Undifferentiated gravels (Czg). Unconsolidated gravel overlies the Angalarri Siltstone at several localities on the southeastern side of the Whirlwind Plain between the West Baines and Victoria Rivers. It forms protective cappings up to about 3 m thick on the siltstone, and consists of subrounded to rounded pebbles and cobbles (up to 20 cm in diameter) of sandstone, chert, and jasper. The gravel could be a piedmont bed transported by rapidly-flowing streams from the nearby Newcastle Range. Alternatively, it may have been deposited by the Victoria and Baines Rivers during an earlier erosional and depositional cycle.

Gravel near the Victoria River was mapped by Traves (1955) as possible Weaber Group of Palaeozoic age, but there is nothing to substantiate this and it seems more likely that the gravel is Cainozoic.

Black soil (Czb). Areas of black soil on the Baines-Angalarri Plains and on the Cambridge Gulf Lowlands form typical rough surfaces with gilgais and desiccation cracks. Much of the soil appears to be derived from underlying carbonate rocks.

Superficial soils (Czs). Superficial sand, residual soils, eluvium, and minor travertine are found throughout the Sheet area. Sand is present on the tops of sandstone plateaux and as valley sediment adjacent to sandstone ranges, commonly associated with scree and gravel. A widespread blanket of sand also covers much of the Cambridge Gulf Lowlands. Many scarp slopes and some valley and plain pavements shown on the map as Angalarri Siltstone, Lloyd Creek Formation, and Spencer Sandstone, are in fact covered by thin sand and scree.

Terrace sediments (Qt). River-deposited mud, sand, and gravel along the banks of the Victoria River downstream from Timber Creek were not closely examined, but their distribution and landform led Perry (1967a) to interpret them as alluvial-terrace sediments.

River alluvium (Qa). Quaternary sediments have been, and still are being, deposited along all major streams in the Sheet area. Up to 10 m of sand, silt, clay, and gravel have been found along the banks of the Victoria, Keep, Bullo, and Baines Rivers. Most streams are now being entrenched into their own alluvium. Stony creek beds are common in the hilly areas.

Coastal alluvium (Qc). Coastal mud, silt, and evaporites are being laid down on the low-lying tidal flats bordering the estuaries of the Victoria and Keep Rivers and of the minor coastal streams in the north of the Sheet area. The lower-lying areas are subject to tidal and seasonal inundation and grade inland into emerged salt flats subject only to seasonal flooding. The emerged coastal and river flats are now being encroached on by Recent river alluvium.

AGE AND CORRELATION OF THE PRECAMBRIAN ROCKS

Traves (1955) regarded the Precambrian rocks of the Victoria River district as Upper Proterozoic. Later work in the Katherine-Darwin region (Walpole et al., 1968) and in the East Kimberley region (Dow & Gemuts, 1969; Bofinger, unpubl.), has provided a more detailed framework for time-stratigraphic subdivision based on isotopic age determinations. Compston & Arriens (1968) reviewed all isotopic age determinations on Australian Precambrian rocks.

During the mapping of the Auvergne Sheet area, an attempt was made to equate rock units with those of known age in the East Kimberley region. Correlations will be discussed more fully by Sweet (in prep.).

Archaean or Lower Proterozoic

The name Halls Creek Group is retained because rocks mapped as such in the Auvergne Sheet area are continuous with those in the East Kimberley area, where their age has been established only as older than 1961 m.y. (the age of major metamorphism). An age of 2700 m.y. for pegmatites intruding the Halls Creek Group in the Kimberley region is less reliable (Bofinger, unpubl.; Dow & Gemuts, 1969), but indicates that the group may be of Archaean age.

Carpentarian

Outcrop of both Bow River Granite and Whitewater Volcanics is continuous from the East Kimberley area, where they have been regarded as early Carpentarian. There is some evidence that they may be as old as late Lower Proterozoic (Dow & Gemuts, op. cit.).

Granite adjacent to the Victoria River Fault near the centre of the Auvergne Sheet area is isolated from known outcrops of Bow River Granite, but is tentatively regarded as having the same age.

Carpentarian or Adelaidean

The Limbunya Group is equivalent to the Bungle Bungle Dolomite (Sweet, Mendum, Bultitude, & Morgan, in press) which is probably late Carpentarian or early Adelaidean. Because the Bullita and Wattie Groups are younger they are now regarded as probable early Adelaidean.

Adelaidean

The age of the Fitzmaurice Group is still in question, although the Legune Formation is regarded as a certain equivalent of the Pincombe Formation (Carr Boyd Group) whose age has been determined as Adelaidean by an isotopic date of 1184 ± 123 m.y. on shale from the Golden Gate Siltstone (Dow & Gemuts, 1969).

The Auvergne Group, whose age was previously unknown, is now considered to be middle Adelaidean. A definite correlation of the Angalarri Siltstone with the Helicopter Siltstone has been made (Sweet, Mendum, Bultitude, & Morgan, in press), after suggestions made by both Dow and Dunn that correlation seemed likely (pers. comm.). The Helicopter Siltstone overlies the Wade Creek Sandstone which contains the Mount John Shale Member, isotopically dated as 1128 ± 110 m.y. old (Dow & Gemuts, 1969). As the Jasper Gorge Sandstone is regarded as equivalent to at least part of the Wade Creek Sandstone, this places the whole Auvergne Group in the Adelaidean. If the isotopic ages are correct, the Fitzmaurice and Auvergne Groups must be at least partly coeval.

STRUCTURAL GEOLOGY (Fig. 35)

The Auvergne Sheet area is divided into three major tectonic units: the Bonaparte Gulf Basin in the northwest; the Sturt Block in the southeast; and the Fitzmaurice Mobile Zone trending northeast across the centre.

Bonaparte Gulf Basin

The Bonaparte Gulf Basin contains over 3000 m of Palaeozoic sediments largely covered by alluvium. Its composition and structure were described in detail by Veevers & Roberts (1966, 1968).

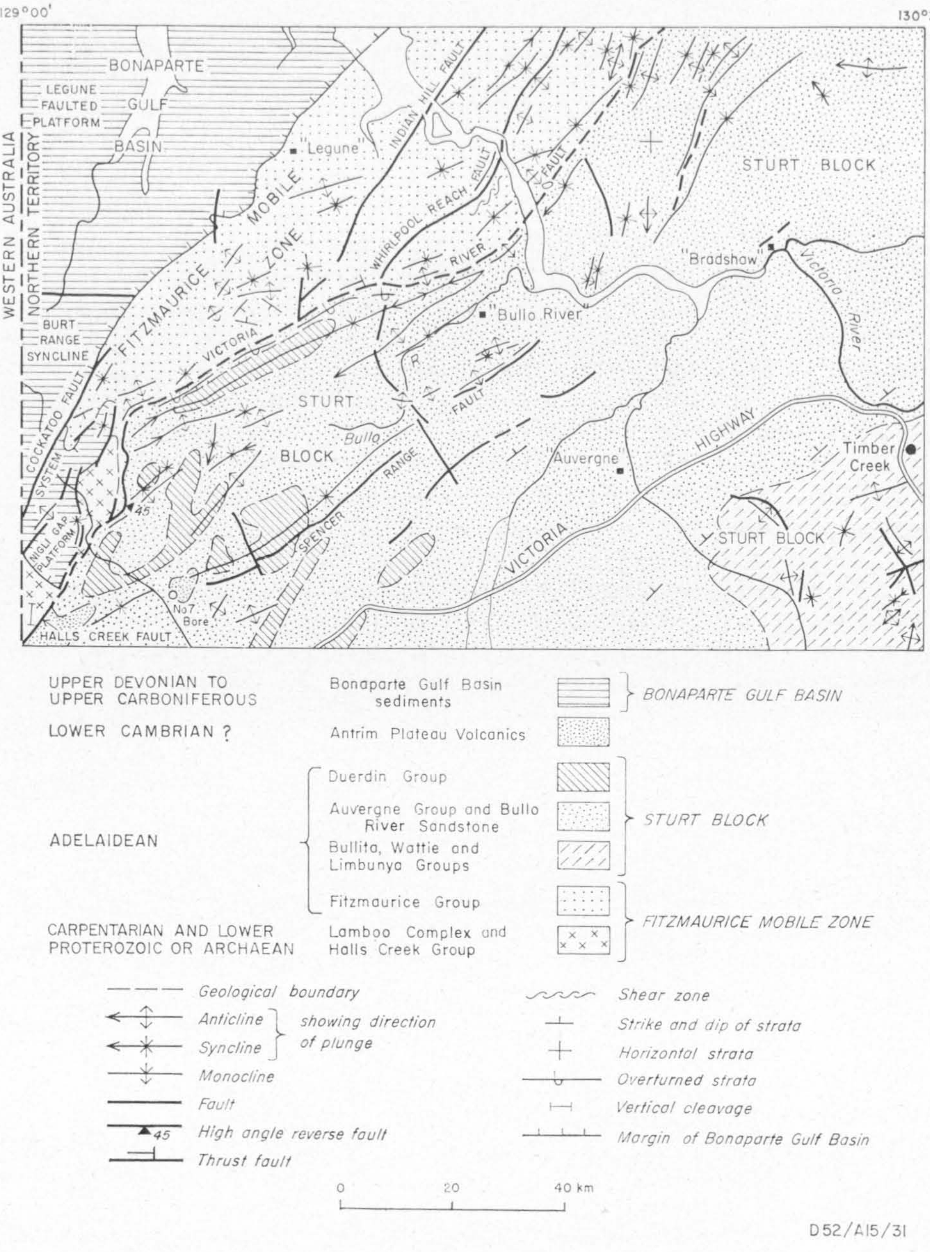


Fig. 35. Structural sketch map, Auvergne Sheet area.

Sturt Block

The Sturt Block is a stable platform southeast of the Victoria River Fault. It is covered by Bullita, Auvergne, and Duerdin Group rocks. Movements have been essentially epeirogenic; the rocks are gently warped in most of the area. The Bullita Group is gently folded, and the Auvergne Group gently warped with a regional dip.

Folding

The Bullita and older groups in the southeast corner of the Sheet area are very gently folded on broad, ill defined axes with dips of 5° to 15°. One monocline with easterly dips of over 26° occurs along a narrow zone about 30 km southeast of Auvergne homestead. In the southeast, Jasper Gorge Sandstone overlies Bullita and older groups with angular unconformity; its attitude varies from horizontal to about 5° northwest. Farther northwest the Auvergne Group dips gently northwest at 5° to 10° in the Pinkerton, Spencer, and Yambarra Ranges.

Between these ranges and the Victoria River Fault, the Auvergne Group is folded into broad folds; limbs dip mostly at 5° to 10°. However, in Koolendong Valley the sediments are almost horizontal. The folded belt is bounded to the south-southeast by a lineament which is probably a faulted monocline. A similar lineament occurs about 13 km from Bullo River homestead. The Spencer Range Fault extends parallel to the Victoria River Fault from No. 7 Bore in the southwest and dies out towards the northeast margin of the Sheet area. Bedding-dips along the structure range from shallow to vertical.

The strata adjoining the Victoria River Fault are severely folded; they are overturned along most of the length of Sandy and Paperbark Creeks.

Faulting

Faulting in the Sturt Block is not severe. Faults in the Newcastle Range have small throws, although one northeast-trending fault has produced local bedding-dips of up to 90°. Mount Dempsey is the focus of several radiating faults.

Faulting is more common in, and northwest of, the Pinkerton and Yambarra Ranges. Most faults trend either northeast, parallel to the Victoria River Fault, or approximately northwest. The northeast-trending faults are more prominent and displace rocks of the Auvergne Group, but some do not appear to displace Duerdin Group sediments. The Spencer Range Fault, which extends northeast from No. 7 Bore, brings the Saddle Creek Formation into contact with the Bullo River Sandstone, involving an upthrow to the northwest of about 500 m, but it does not cut the overlying Duerdin Group. It dies out near the Bullo River track and reappears to the northeast. Northeast of the Victoria River the Spencer Range Fault is associated with a steep monocline, and near Mussel Hole yard the upthrow is about 150 m to the west. A similar fault occurs about 10 km southeast of this fault zone and about 13 km northwest of Auvergne homestead.

The northwest-trending faults are much more numerous than those trending northeast. They are vertical or nearly so, and displace all units of the Duerdin and Auvergne Groups, as well as the Spencer Range Fault; the Victoria River Fault may also be displaced. They produce upthrows generally to the northeast of up to 180 m.

STURT BLOCK

The Sturt Block is a stable platform southeast of the Victoria River Fault. It is covered by Bullita, Auvergne, and Duerdin Group rocks. Movements have been essentially epeirogenic; the rocks are gently warped in most of the area. The Bullita Group is gently folded, and the Auvergne Group gently warped with a regional dip.

Folding

The Bullita and older groups in the southeast corner of the Sheet area are very gently folded on broad, ill defined axes with dips of 5° to 15°. One monocline with easterly dips of over 26° occurs along a narrow zone about 30 km southeast of Auvergne homestead. In the southeast, Jasper Gorge Sandstone overlies Bullita and older groups with angular unconformity; its attitude varies from horizontal to about 5° northwest. Farther northwest the Auvergne Group dips gently northwest at 5° to 10° in the Pinkerton, Spencer, and Yambarra Ranges.

Between these ranges and the Victoria River Fault, the Auvergne Group is folded into broad folds; limbs dip mostly at 5° to 10°. However, in Koolendong Valley the sediments are almost horizontal. The folded belt is bounded to the south-southeast by a lineament which is probably a faulted monocline. A similar lineament occurs about 13 km from Bullo River homestead. The Spencer Range Fault extends parallel to the Victoria River Fault from No. 7 Bore in the southwest and dies out towards the northeast margin of the Sheet area. Bedding-dips along the structure range from shallow to vertical.

The strata adjoining the Victoria River Fault are severely folded; they are overturned along most of the length of Sandy and Paperbark Creeks.

Faulting

Faulting in the Sturt Block is not severe. Faults in the Newcastle Range have small throws, although one northeast-trending fault has produced local bedding-dips of up to 90°. Mount Dempsey is the focus of several radiating faults.

Faulting is more common in, and northwest of, the Pinkerton and Yambarra Ranges. Most faults trend either northeast, parallel to the Victoria River Fault, or approximately northwest. The northeast-trending faults are more prominent and displace rocks of the Auvergne Group, but some do not appear to displace Duerdin Group sediments. The Spencer Range Fault, which extends northeast from No. 7 Bore, brings the Saddle Creek Formation into contact with the Bullo River Sandstone, involving an upthrow to the northwest of about 500 m, but it does not cut the overlying Duerdin Group. It dies out near the Bullo River track and reappears to the northeast. Northeast of the Victoria River the Spencer Range Fault is associated with a steep monocline, and near Mussel Hole yard the upthrow is about 150 m to the west. A similar fault occurs about 10 km southeast of this fault zone and about 13 km northwest of Auvergne homestead.

The northwest-trending faults are much more numerous than those trending northeast. They are vertical or nearly so, and displace all units of the Duerdin and Auvergne Groups, as well as the Spencer Range Fault; the Victoria River Fault may also be displaced. They produce upthrows generally to the northeast of up to 180 m.

Fitzmaurice Mobile Zone

The Fitzmaurice Mobile Zone is a belt of relatively highly deformed rocks parallel to, and separated from, the Sturt Block by the Victoria River Fault. It connects the Halls Creek Mobile Zone of the East Kimberley area with the Pine Creek Geosyncline to the northeast; it differs from both of them in that the great majority of rock exposed is unmetamorphosed sediment rather than older igneous and metamorphic rocks. Lateral displacements on faults in the Fitzmaurice Mobile Zone are apparently much less than in the Halls Creek Mobile Zone (Dow & Gemuts, 1969).

The rocks within the Fitzmaurice Mobile Zone are principally of the Fitzmaurice Group, with minor basement of Halls Creek Group and Carpentarian igneous rocks mainly in the southwest. These units are overlapped in the southwest corner by Palaeozoic rocks of the Bonaparte Gulf Basin, some of which are also highly deformed. The exposed width of the mobile zone, much of which is covered in the northwest by alluvium, varies from about 10 km in the southwest to about 30 km in the northeast.

The phyllite of the Halls Creek Group has a cleavage sub-parallel to the main Victoria River Fault, along which movement has probably obscured older units. The Lamboo Complex is poorly exposed, but the structure appears to be similar to that of the Halls Creek Group.

Deformation of the Fitzmaurice Group is predominantly by faulting. Folds are generally broad, with bedding-dips rarely greater than 45°; vertical bedding is locally common near major faults. Overturned strata are found only along the Victoria River Fault. Two small basinal synclines, 10 km and 30 km south of Legune homestead respectively, are probably controlled by two sets of intersecting faults.

Faulting

The mobile zone is cut by numerous faults. The faults are recognized by change in lithology and photo-pattern, truncation of bedding, and small drag folds, but displacements are difficult to estimate owing to the monotonous repetitive lithology. The faults have no dominant trend, but many are subparallel to the major faults.

The *Indian Hill Fault* extends north-northeast from a point near Nap Springs, 16 km southwest of Legune homestead, and separates the Moyle River Formation from the Legune Formation. At the northern margin of the Sheet area it has an apparent upthrow to the east of at least 1100 m. Southwest of Nap Springs the fault merges with a complex fault zone extending towards the Victoria River Fault.

The *Whirlpool Reach Fault* follows a sinuous northeasterly course from a point on the Victoria River Fault some 19 km west-northwest of Bullo River homestead to the northern margin of the Sheet area. In the north it separates the Lalngang Sandstone from the Moyle River Formation, involving an apparent downthrow to the west of at least 600 m. Immediately south of the Victoria River the fault is represented by a shear zone about 1 km wide, in which some or all of the Goobaieri Formation has been sheared out. Near the Victoria River Fault the Moyle River Formation is faulted against Legune Formation, involving an apparent downthrow to the east of about 1200 m. The Whirlpool Reach Fault truncates the eastern limb of a north-plunging syncline in the north Auvergne Sheet area, and the

Age of Folding

Most folds in the Fitzmaurice Mobile Zone and in the Sturt Block have their axes parallel to the major faults. It is reasonable to suppose they formed concurrently with the faulting.

Regional unconformities in the succession in the Sturt Block represent periods of epeirogenic movement. The unconformities recognized are:

(i) below the Jasper Gorge Sandstone; (ii) between the Bullo Sandstone and Shoal Reach Formation; (iii) below the Duerdin Group; and (iv) below the Antrim Plateau Volcanics. The strata were folded in the breaks represented by (i) and (iv). There was probably some faulting during (iii), and only minor uplift during (ii). Unconformities (i), (iii), and (iv) are marked by considerable erosion of older rocks.

GEOLOGICAL HISTORY

The stable Sturt Block and the Fitzmaurice Mobile Zone are two basic geotectonic units which had probably developed by Lower Proterozoic time, and the distribution and nature of the facies in the area indicate that they persisted throughout the remainder of the Proterozoic Era.

The sediments in the Fitzmaurice Mobile Zone are represented by the Fitzmaurice Group. They were laid down in a rapidly subsiding, unstable shelf or foreland along the margin of the stable Sturt Block. The greatest instability is indicated in the lower part of the sequence. The rocks are labile sandstone, grit, pebble beds, and rarely subgreywacke and feldspathic sandstone.

The sediments which accumulated on the Sturt Block are represented by a relatively undisturbed sequence of alternating sandstone, siltstone, and dolomite which form the Bullita and Auvergne Groups. They may be considered as stable facies by comparison with the facies of the marginal Fitzmaurice Mobile Zone. Minor glacial and fluvioglacial sediments and associated sands were deposited during the late Adelaidean (Duerdin Group).

The Bullita and Auvergne Group sediments were deposited in a marine environment on a stable epicontinental shelf or platform. The depth of water fluctuated between the intertidal and neritic zones. Isolated shallow basins of deposition almost certainly developed on the platform from time to time, but no organic reef-type environments have been recognized.

The relatively quiet, stable conditions of deposition ended at the top of the Auvergne Group, after which there was a period of deposition of sand, grit, and conglomerate in a non-marine, fluviatile environment (Bullo River Sandstone). The area was then uplifted, and gentle warping and faulting took place.

Glacial and fluvioglacial sediments were deposited in valleys and on plains by ice sheets and meltwater (Duerdin Group), and there were probably some marine and lacustrine sediments (Ranford Formation). Another period of uplift took place with gentle folding in, and adjacent to, the mobile zone.

At about the beginning of the Palaeozoic Era, tholeiitic basalts covered at least the southwestern part of the Sheet area, but little is known of the geological history for the remainder of the Palaeozoic and most of the Mesozoic.

ECONOMIC GEOLOGY

The only resources currently produced from the Auvergne Sheet area are road-building materials and water. In the past, small quantities of ochre have been mined. BMR mapping provided no positive indication of potentially economic mineral deposits. Exploration has been carried out in parts of the Sheet area from time to time, and comments on this work and on known showings of various minerals are given below.

Petroleum

The petroleum potential of the Palaeozoic rocks in the Auvergne Sheet area has been discussed by Veevers & Roberts (1968). Gas found in Palaeozoic sediments (Bonaparte No. 2 well) in the Cambridge Gulf Sheet area flowed 1.5 MMcfD, but the well was abandoned.

The petroleum potential of the Proterozoic rocks in the Auvergne Sheet area was investigated in 1956 (Laing & Allen, 1956). No drilling was carried out, and the investigation was based on reported oil seeps. The validity of the reports is doubtful, and the localities recorded are vague; as far as can be ascertained, no reports of oil seepages in Proterozoic rocks in the area can be substantiated. The Proterozoic rocks are not a likely prospect for the discovery of petroleum.

Metals

Accessory amounts of *pyrite* were found in the Angalarri Siltstone and in dolomites of Skull Creek Formation; several grains of *chalcopyrite* were found in dolomitic siltstone of the Bynoe Formation near Bullita homestead, 12 km south of the southeast corner of the Sheet area (Sweet, Mendum, Bultitude, & Morgan, in press). To date, however, there is no evidence of economic sulphides in these units. It is unlikely that they can be correlated in age with known Proterozoic deposits e.g. the McArthur River lead-zinc-silver deposit is probably older (Carpentarian) than the carbonate deposits in the Victoria River area (probable Adelaidean).

Several radioactive anomalies were found in the Fitzmaurice Mobile Zone in the adjacent Port Keats Sheet area, during a BMR reconnaissance survey in 1956. The survey did not extend into the Auvergne Sheet area, but it is likely that similar results would be found here. However, no radioactive mineral deposits are known from either Sheet area.

Copper minerals are known in the Antrim Plateau Volcanics in some districts, but no traces were found in the Auvergne Sheet area.

Since 1972 several companies have been exploring Palaeozoic carbonate rocks which crop out in both the Canning and Bonaparte Gulf Basins. In the Auvergne Sheet area, leases held cover the southern and southeastern margins of the Bonaparte Gulf Basin. *Lead-zinc* mineralization has been noted both in outcrop and in drill-holes, and results are believed to be encouraging.

Non-metals

A small quantity of *red ochre* has been mined from a deposit at the top of a hill 12 km west of Alligator Spring and 3 km north of the Legune track. The workings consist of an open cut about 5 m deep and 3 m wide. At least thirty

44-gallon drums of ochre were stockpiled at the mine in 1967. No estimates of the reserves were made, but considering the low demand for red ochre the deposit is unlikely to be of significant economic value.

Small pods and veins of *barite* were found in the Angalarri Siltstone. A lens about 6 m long and 2 m wide was found 1.5 km northwest of Saddle Creek Dam. Another vein, up to 3 m thick and 200 m long, in the Saddle Creek Formation 5.5 km northwest of the dam contains pure barite, and the adjacent country rock is rich in barite interstitial to, and replacing, sand grains. Small veins less than 1 cm thick, and tiny veinlets less than 1 mm, of barite are common in the Angalarri Siltstone, and workable deposits may exist.

Readily accessible deposits of *sand, gravel,* and *sandstone* suitable for aggregate are available near Timber Creek and most other parts of the Sheet area. Material suitable for road and airstrip foundation is readily available, mainly as sandstone and gravel at the bases of sandstone ranges. *Road metal* of reasonable quality, predominantly dolomite, is available mainly in the southeast, but also to a limited extent in poorly accessible range country, generally at least 30 km from the main highway. Chert and volcanic rocks suitable for road metal are accessible in the eastern and western parts of the Sheet area, respectively.

Water

Groundwater is required for stock and domestic use. The areas having greatest demand are in the grazing country on the inland plains, in the vicinity of Legune, and in isolated areas near Bullo River. On the inland plains on Auvergne station, some underground water is obtained from bores, but most water is drawn from permanent waterholes, perennial springs, and dams.

Laws (1967) considered that the Jasper Gorge Sandstone has excellent potential as an artesian aquifer. The overlying Angalarri Siltstone and Cainozoic sediments are poor aquifers, and most of the 'dry bores' on the Auvergne pastoral lease have bottomed in these units; had they penetrated the Jasper Gorge Sandstone they may have been successful. The depth of this aquifer increases from zero near its outcrop to more than 300 m along a northeast-trending line through Bradshaw. The successful Argument Camp Bore near Skinners Point intersected Jasper Gorge Sandstone at 252 m. A bore drilled near Bradshaw station (Reg. No. 6217) penetrated 214 m of Angalarri Siltstone without passing into the underlying formation, and was abandoned as a dry hole.

Near Legune station Laws (op. cit.) studied the saline coastal alluvium which forms grassed, treeless plains only a few metres above the tidal mud flats. Bores down to 300 m yield good flows of water, but too saline for most purposes (10 000 to 60 000 ppm dissolved salts). Several bores on the foothills of 'sand islands' have obtained freshwater from 'freshwater lenses' floating on the surface of salt water. Spirit Hill No. 1 oil exploration well, south of Legune, produced an artesian flow of good water at 7.6 litres/minute.

One bore near Bullo River homestead produces saline water suitable only for stock. Prospects in this area are probably better near hilly country away from salt-water contamination.

Details of bores drilled to the end of 1968 are recorded in Pontifex & Sweet (1972).

Surface water of good quality is available from permanent waterholes in most major rivers and creeks above the tidal limit. Several perennial springs are at the base of the Pinkerton Sandstone. Fault zones within coarse sandstone in the Fitzmaurice Group, and in the Pinkerton and Spencer Sandstones, give rise to perennial springs. Water in these areas is not in great demand because of poor access and poor grazing potential.

ACKNOWLEDGMENTS

The authors wish to acknowledge the support given to them in the field by field assistants A. D. Ashworth, G. Malafant, and R. I. Ordish, and to mechanic P. Van Kol, all of whom significantly contributed to the efficient execution of the field work.

Thanks are also due to Mr L. Fogarty, manager Auvergne station, and to Mr Bob Milligan of Doust-Milligan Ventures for their co-operation and hospitality.

REFERENCES

BOFINGER, V. M., 1967—Geochronology in the East Kimberley area of Western Australia *Ph.D. Thesis, Aust. Nat. Univ., Canberra* (unpubl.).

BONTE, A., 1963—Les remblissages karstiques (Karst cavity fill). *Sedimentology,* 2(4), 333-40.

BROWN, H. Y. L., 1895—Government Geologist's report on explorations in the N.T. *S. Aust. parl. Pap.* 82.

BULTITUDE, R. J., 1971—The Antrim Plateau Volcanics, Victoria River Disrict Northern Territory. *Bur. Miner. Resour. Aust. Rec.* 1971/69 (unpubl.).

BULTITUDE, R. J. (in prep.)—The geology and petrology of the Antrim Plateau Volcanics. *Bur. Miner. Resour. Aust. Rec.* (unpubl.).

CHILINGAR, G. V., 1955—Review of Soviet literature on petroleum source rocks. *Bull. Amer. Ass. petrol. Geol.,* 39(5), 764-8.

CLOUD, P. E., 1955—Physical limits of glauconite formation. *Bull. Amer. Ass. petrol. Geol.,* 39(4), 484-92.

COMPSTON, W., & ARRIENS, P. A., 1968—The Precambrian geochronology of Australia. *Canad. J. Earth Sci.,* 5, 561-83.

DONALDSON, J. A., 1963—Stromatolites in the Denault Formation, Marion Lake, Labrador, Newfoundland. *Geol. Surv. Canad. Bull.* 102.

DOW, D. B., 1965—Evidence of a late Precambrian glaciation in the Kimberley region of Western Australia. *Geol. Mag.,* 102(5), 407-14.

DOW, D. B., & GEMUTS, I., 1969—Precambrian geology of the Kimberley region: the East Kimberley. *Bur. Miner. Resour. Aust. Bull.* 106.

DOW, D. B., GEMUTS, I., PLUMB, K. A., & DUNNETT, D., 1964—The geology of the Ord River region, W.A. *Bur. Miner. Resour. Aust. Rec.* 1964/104 (unpubl.).

DUNN, P. R., 1965—Notes on a field trip to the Northern Territory, 1965. *Bur. Miner. Resour. Aus. Rec.* 1965/246 (unpubl.).

EARDLEY, A. J., 1938—Sediments of the Great Salt Lake, Utah. *Bull. Amer. Ass. petrol. Geol.,* 22, 1359-87.

EDWARDS, A. B., & CLARKE, E. DE C., 1940—Some Cambrian basalts from the East Kimberleys, W.A. *J. Roy. Soc. W. Aust.,* 26, 77-101.

FREEMAN, T., 1962—Quiet water oolites from Laguna Madre, Texas. *J. sediment. Petrol.,* 32, 475-83.

HARMS, J. E., 1959—The geology of the Kimberley Division, W.A., and of adjacent areas in the N.T. *M.Sc. Thesis, Univ. Adel.* (unpubl.).

HAYS, J., 1967—Surfaces and laterites in the N.T. *In* JENNINGS, J. N., & MABBUTT, J. A. (eds.) —LANDFORM STUDIES FROM AUSTRALIA AND NEW GUINEA. *Canberra, Aust. Nat. Univ. Press.*

KAULBACK, J. A., & VEEVERS, J. J., 1969—The Cambrian and Ordovician geology of the southern part of the Bonaparte Gulf Basin. *Bur. Miner. Resour. Aust. Rep.* 109.

LAING, A. C. M., & ALLEN, R. J., 1956—Geology of Victoria River area, Associated Freney Oil Fields N.L., Permit No. 1, N.T. *Mines Admin. Pty Ltd Rep.* N.T./VR/22 (unpubl.).

LAWS, A. T., 1967—Opinion on bore sites on Auvergne and Legune stations. *Bur. Miner. Resour. Aust. Tech. File* SD/52-15 Hydrology (unpubl.).

LOGAN, B. W., 1961—*Cryptozoon* and associate stromatolites from the Recent, Shark Bay, W.A. *J. Geol.,* 69, 517-33.

MENDUM, J. R., 1972—Limbunya, N.T.—1:250 000 Geological Series, *Bur. Miner. Resour. Aust. explan. Notes* SE/52-7.

MORGAN, C. M., SWEET, I. P., MENDUM, J. R., & PONTIFEX, I. R., 1970—Geology of the Cape Scott, Port Keats, Fergusson River, and Delamere 1:250 000 Sheet areas, Northern Territory. *Bur. Miner. Resour. Aust. Rec.* 1970/3 (unpubl.).

ÖPIK, A. A., 1957—The Cambrian geology of Australia. *Bur. Miner. Resour. Aust. Bull.* 49.

PATERSON, S. J., 1970—Geomorphology of the Ord-Victoria area. *CSIRO, Land Res. Ser.,* 28, 83-91.

PERRY, R. A., 1970—Vegetation of the Ord-Victoria area. *CSIRO, Land Res. Ser.*, 28, 104-19.

PERRY, W. J., 1967—Photo-interpretation of Auvergne 1:250.000 Sheet area, N.T. *Bur. Miner. Resour. Aust. Rec.* 1967/76 (unpubl.).

PETTIJOHN, F. J., 1957—SEDIMENTARY ROCKS. *N.Y., Harper* (2nd edn).

PLUMB, K. A., & VEEVERS, J. J., 1971—Cambridge Gulf, W.A.—1:250 000 Geological Series. *Bur. Miner. Resour. Aust. explan. Notes* SD/52-14.

PONTIFEX, I. R., MORGAN, C. M., SWEET, I. P., & REID, A. G., 1968—The geology of the Auvergne 1:250 000 Sheet area (Victoria River Basin), Northern Territory (excluding Bonaparte Gulf Basin). *Bur. Miner. Resour. Aust. Rec.* 1968/117 (unpubl.).

PONTIFEX, I. R., & SWEET, I. P., 1972—Auvergne, N.T.—1:250 000 Geological Series. *Bur. Miner. Resour. Aust. explan. Notes* SD/52-15.

RANDAL, M. A., 1962—Fergusson River, N.T.—1:250 000 Geological Series. *Bur. Miner. Resour. Aust. explan. Notes* D/52-12.

RUSNAK, G. A., 1960—Some observations of Recent oolites. *J. sediment. Petrol.*, 30, 471-80.

SKWARKO, S. K., 1966—Cretaceous stratigraphy and palaeontology of the Northern Territory. *Bur. Miner. Resour. Aust. Bull.* 73.

SLATYER, R. O., 1954—General report on the survey of the Ord-Victoria area: climate. *CSIRO, Land. Res. Ser.* 4.

STOKES, J. L., 1846—DISCOVERIES IN AUSTRALIA. Vol. II, pp. 30-117. *London, Boone.*

SWEET, I. P., in prep.—The Precambrian geology of the Victoria River region. *Bur. Miner. Resour. Aust. Bull.*

SWEET, I. P., MENDUM, J. R., MORGAN, C. M., & PONTIFEX, I. R., in press—The geology of the the southern Victoria River region, Northern Territory. *Bur. Miner. Resour. Aust. Rep.* 167.

SWEET, I. P., MENDUM, J. R., MORGAN, C. M., & PONTIFEX, I. R., in press—The geology of the northern Victoria River region, Northern Territory. *Bur. Miner. Resour. Aust. Rep.* 166.

TRAVES, D. M., 1955—Geology of the Ord-Victoria region. *Bur. Miner. Resour. Aust. Bull.* 27.

VEEVERS, J. J., & ROBERTS, J., 1966—Upper Devonian and Carboniferous geology of the Bonaparte Gulf Basin, Western Australia and Northern Territory. *Bur. Miner. Resour. Aust. Rec.* 1966/113 (unpubl.).

VEEVERS, J. J., & ROBERTS, J., 1968—Upper Palaeozoic rocks, Bonaparte Gulf Basin of north-western Australia. *Bur. Miner. Resour. Aust. Bull.* 97.

WADE, A., 1924—Petroleum prospects, Kimberley district of W.A. and N.T. *Aust. parl. Pap.* 142.

WALPOLE, B. P., DUNN, P. R., & RANDAL, M. A., 1968—Geology of the Katherine-Darwin region, Northern Territory. *Bur. Miner. Resour. Aust. Bull.* 82.

WELLS, L. A., 1907—The Victoria River and the adjacent country. *S. Aust. parl. Pap.*

WOOLNOUGH, W. G., 1912—Report on the geology of the Northern Territory. *Bull. N. Terr.* 4.

WRIGHT, R. L., 1963—Deep weathering and erosion surfaces in the Daly River Basin, N.T. *J. geol. Soc. Aust.*, 10(1), 151-64.

APPENDIX — STRATIGRAPHIC SECTIONS

The appendix contains descriptions of most of the sections measured in the field and of 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. All sections were measured 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 included.

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 dolomite or limestone rather than micrite.

REFERENCES

DUNBAR, C. O., & RODGERS, J., 1957—PRINCIPLES OF STRATIGRAPHY. *N.Y., Wiley.*

FOLK, R. L., 1962—Spectral subdivision of limestone types. *In* Ham, W. E. (ed.)—Classification of carbonate rocks: A symposium. *Mem. Amer. Ass. petrol. Geol., I.*

PETTIJOHN, F. J., 1957—SEDIMENTARY ROCKS. *N.Y., Harper* (2nd edn).

WENTWORTH, C. K., 1922—A scale of grade and class terms for clastic sediments. *J. Geol.,* 30, 371-92.

MEASURED STRATIGRAPHIC SECTIONS

SECTION 1. Goobaieri Formation at 15°05′S, 129°48′E.

Thickness (m)	*Overlain by Lalngang Sandstone*
50	*Siltstone:* light grey, fissile, grading up into blocky, thin-bedded *sandstone* with ferruginous and micaceous partings towards top. Mud cracks common
30	*Siltstone:* grey fissile
5	*Interbedded siltstone and fine sandstone:* laminated to thin-bedded with mud cracks
140	*Siltstone:* grey fissile
10	*Sandstone:* white, blocky, thin-bedded, fine to medium, moderate sorting, friable because of soft white matrix which becomes more abundant towards top
380	*Mainly no outcrop,* few thin outcrops of sandstone: grey-purple, blocky, medium-grained, well rounded, well sorted
Total 615	Base of hill

SECTION 2. Legune Formation, 6.5 km east of Alligator Springs.

Thickness (m)	*Top of hill*
20	*Quartz sandstone:* fine, blocky, thin-bedded
50	Mainly sandstone scree covering *siltstone*
3	*Sandstone:* fine-grained, thin-bedded
15	Blocky sandstone scree covering coarse, friable, thin-bedded *sandstone*
37	*Sandstone:* fine-grained, thin-bedded, massive in bands up to 1 m thick. Intercalated with 10-20 cm bands and lenses of *shaly siltstone*
17	*Silty sandstone:* poorly sorted, abundant
2	*Sandstone:* massive, fine-grained
24	Largely scree-covered; some exposure of *sandy siltstone*
3	*Sandstone:* fine-grained, thin-bedded
44	*No outcrop,* scree-covered slope
52	*Sandstone:* fine, silty, thin-bedded; interbedded medium to coarse, thick-bedded sandstone. Fine cross-bedding, ripple marks, and abundant mud clasts
17	Reddish *shaly siltstone*
2	*Sandstone:* fine to medium, thin-bedded, ripple-marked
29	*Siltstone:* greyish green; minor thin sand lenses
3	*Sandstone:* massive, medium-grained, ripple-marked
76	Mainly scree covered slopes, poor exposure of *sandy siltstone*
Total 394	Base of hill

SECTION 3. Legune Formation, 20 km north-northeast of Ernie Lagoon.

Thickness (m)	*Victoria River Fault*
6	*Siltstone:* red-brown to grey, flaggy to fissile
64	No outcrop (probably siltstone)
135	*Sandstone* with interbedded *granule* (gritty) *sandstone* and *siltstone*. Coarser sediments poorly sorted. Mud cracks common in siltstone
17	*Granule sandstone:* interbeds of finer, poorly sorted *sandstone* and *siltstone*
5	*Granule sandstone:* grey, massive to flaggy, iron-stained matrix, siliceous, angular quartz grains up to 2 mm, minor feldspar grains
70	No outcrop; minor sub-outcrop of interbedded well sorted *sandstone* and poorly sorted *granule sandstone*

10	*Sandstone:* coarse, poorly sorted (0.5 to 2 mm), hematite-stained, sericitic matrix, flaggy, thick, and thick-bedded
80	*Sandstone:* thin-bedded, coarse, well sorted; minor interbeds of poorly sorted *granule sandstone* containing coarse (2 mm) angular quartz grains
72	*Sandstone:* grey, blocky, thin-bedded, coarse, well sorted; iron-stained clay matrix in some beds
Total 459	Underlain by Lalngang Sandstone

SECTION 4. Limbunya Group chert, 24 km southeast of Auvergne homestead.

Thickness (m)	*Overlain unconformably by Jasper Gorge Sandstone*
7.5	*Banded chert,* commonly disrupted and folded
1	No outcrop
1	*Bedded chert*
0.5	*Feldspathic sandstone:* light purple, thick-bedded, poorly sorted, coarse. Contains angular chert fragments at base, less common and smaller near top
0.5	*Sandstone as above:* medium to coarse. No chert, but feldspar grains up to 4 mm
0.5	*Bedded chert*
2	No outcrop
5	*Bedded chert:* folded, but not disrupted
Total 18	Underlain by dolomite (Limbunya Group)

SECTION 5. Timber Creek Formation, 6.5 km south-southeast of Timber Creek store.

Thickness (m)	*Overlain by Jasper Gorge Sandstone*
26	Little exposure; apparently easily eroded (?)siltstone. Several discontinuous *dolomite* bands up to 0.3 m thick
1	Thin *dolomite* band protecting *dolomitic siltstone*
8	Mainly fine-grained *sandstone;* fissile *siltstone* (5 to 10%) easily eroded; minor hard thin bands of *dolomite*
2	*Dolomite:* pinkish, silty; in 0.5 m band associated with easily eroded dolomitic siltstone
8	Mainly *siltstone* and *dolomitic siltstone:* thin-bedded and interbanded, bands up to 1 m thick. Thin bands of *dolomite* (up to 10 cm) contain chert. One distinctive band of *gritty (sandy) dolomite* consists of well rounded, spherical grains of quartz and feldspar (total 35%) in microcrystalline matrix of dolomite; 2 generations of quartz grains, one (?)aeolian. (Band of identical rock found about 16 m below Jasper Gorge Sandstone in scarp due east of Timber Creek police station.)
1.5	*Dolomite:* grey, thin-bedded, undulating bedding. Forms small cliffs. Contains lenses of chert up to 25 cm long. Thin interbeds of fine-grained *sandstone* with halite casts
14.5	Intercalated bands of *siltstone* (bands up to 1 m); *dolomite* containing minor chert (5 to 10 cm bands); chocolate *silty mudstone* (5 to 8 cm); fine *sandstone* and *siliceous siltstone*
3	*Siltstone,* interbanded (encrusted with secondary limestone) and *dolomite* in bands up to 1 m
1	Interbedded *dolomite* and very fine-grained *feldspathic sandstone:* thin bands 5 to 8 cm thick
15.5	Interbanded *silty dolomite,* thin flaggy *dolomite,* and light brown *sandstone.* Dolomite in bands up to 5 cm thick
Total 80.5	Base of hill

SECTION 6. Timber Creek Formation, 9.5 km south-southwest of Timber Creek store.

Thickness (m)	*Top of hill*
15+	Alternating flaggy *dolomite* and light purple, fissile *siltstone* and *shale*
24.5	*Dolomite:* massive and blocky, contains minor *silt* and *sand*. Ripple-mark laminations and halite casts
1.5	*Sandstone:* very fine-grained, purple-brown, indurated. Fine-scale cross-bedding and contorted (slumped laminae)
7	*Dolomite:* massive, silty. Minor interbedded white friable *siltstone*. Halite casts and minor small chert lenses
41	Mostly *dolomitic siltstone*. Some *dolomite:* fissile to flaggy, very fine-grained
1.5	*Quartz sandstone:* flaggy, fine-grained
4.5	*Dolomite:* massive, laminated, slightly recrystallized, contains numerous sub-spherical and elongate *chert* bodies up to 30 cm across. Bedding laminations continue through them and are contorted within them
3+	*Sandstone:* fine-grained, light brown, contains mud flakes and pellets
Total 98+	Base of hill

SECTION 7. Timber Creek Formation, 9.5 km southeast of East Baines Gorge at 15°58′S, 130°18′E.

Thickness (m)	*(?)Bardia Chert Member*
9.5	*Dolomite:* grey, thin-bedded, flaggy, contains irregular bands and pockets of *chert* and *dolomitic siltstone*
18.5	*Easily eroded band* (?calcareous siltstone). Several minor thin bands *dolomite,* and intercalated remnants of thin-bedded, tough, fine-grained, cross-bedded *dolomitic sandstone*
4.5	*Dolomite:* grey, flaggy to massive. Some bands very fine-grained, some medium to coarse. Contorted folding and crenulated slump-like structures in some interbeds; top 1 m contains unevenly pockmarked *chert* bands
3	*Dolomite and silty dolomite:* medium-bedded, pink-grey flaggy; irregular bands of *chert* up to 5 cm thick
4.5	Intercalated grey *silty dolomite* and *dolomitic limestone* in bands up to 0.6 m thick. Also bands of *dolomitic sandstone:* pinkish grey (weathers black), fine-grained, cross-bedded, in bands up to 25 cm thick
3.5	Small scarp of *dolomite:* pinkish grey, flaggy to massive. Interbeds of variants rare, hence continuous scarp. Top of scarp caused by introduction of sand and silt into sequence
7.5	Mainly *dolomite:* pinkish grey, flaggy to massive. Contains beds up to 1 m thick of chocolate-grey *calcareous mudstone* which contains rectangular fragments of silty dolomite which are broken, slightly displaced, bands
2.5	*Dolomitic siltstone and silty dolomite:* brownish grey bands up to 25 cm thick. Interbedded with thin bands (10 to 15 cm) whitish grey laminated *limestone*
6.5	*Dolomitic sandstone:* light brownish grey, fine-grained, thin-bedded, flaggy, forms bands up to 5 m. Interbedded with light grey *calcareous siltstone* and laminated *limestone*
Total 60	Base of hill

SECTION 8. Skull Creek Formation at 15°56′S, 130°26′E.

	Thickness (m)	*Overlain by Jasper Gorge Sandstone*
Bardia Chert Member	4.5	*Chert:* poor exposure, thin, irregularly banded, grey, brecciated, scattered loosely cemented lumps. Solid bands up to 1 m thick commonly standing on end
	3	No outcrop; rubble of chert and fine-grained quartz sandstone
	2	*Chert:* poorly defined band, highly contorted and brecciated, thin-banded with yellow ochreous earthy material along and across bands
	10.5	Mainly rubbly scree and boulders of thin-bedded chert. Appears to be weathered chert band. Abundant small cavities along banding contain yellow ochreous clay and manganese oxides
	6	No outcrop (possibly siltstone). Rubbly scree cover of chert and some fine-grained sandstone
	21.5	*Silty dolomite:* grey, thin-bedded and flaggy, forms hard bands up to 0.5 m thick showing small ripple marks. Some bands partly silicified and contain minor chert; some drusy cavities after calcite. Intercalated with *siltstone,* commonly encrusted with secondary limestone. Carbonate forms 60% of this section
	1	*Dolomite:* hard band, grey, thin-bedded, with interbands of *chert*
	1.5	*Dolomite:* grey, thin-bedded with *chert* as below. Interbedded *calcareous shaly siltstone*
	1	*Dolomite:* hard band, grey, thin to medium-bedded. Contains lenses of *chert* up to 15 x 5 cm and bands of chert 1 cm thick. Spotted with small crystals of dolomite
	15	*Dolomite:* thin-bedded, grey, minor *chert,* exposed through basal scree slope which forms bottom of hill
	2	*Silty dolomite:* small scarp formed by 5 bands, flaggy, pinkish or brownish grey; intercalated with thin bands of dolomitic and fine-grained *sandstone*
	16	Fine-grained *dolomitic sandstone* in bands up to 4 m thick. Interbedded with calcareous *siltstone* and *silty dolomite*
	1	Small scarp of *dolomite:* grey-pink, thin-bedded, flaggy, minor segregations of dolomite crystals. Irregular *chert* bands
	46.5	Basal slope of scarp. No rock exposure
Total	132.5	Base of hill

SECTION 9. Skull Creek Formation, adjacent to Bullita track in Delamere Sheet area.

Thickness (m)	*Top of hill*
not known	*Top of ridge* consists of highly brecciated, banded *chert.* Where bands preserved, orientation mostly random. Generally rectangular banded chert fragments of various sizes and colours in reddish cryptocrystalline siliceous matrix. Poorly defined bands at base roughly conformable to underlying dolomite—*Bardia Chert Member*
30	*Dolomite:* bands 1 to 1.5 m thick, massive to flaggy; discontinuous *chert* bands 1 m thick intercalated with purplish grey *silty dolomite* and *dolomitic siltstone* that weathers to dark grey
6	*Dolomite* containing abundant *chert,* chert dominant toward top. Some bands consist of angular chert fragments in light brown, cryptocrystalline, siliceous matrix
24	*Dolomite:* purplish grey, cherty, overlain by about 6 m of *chert:* massive, nodular, and bedded
15	*Microcrystalline dolomite:* light brownish grey, massive, contains very thin plates and scales of *chert* along *bedding.* Rare silt-rich bands up to 1 cm thick

18	*Silicified dolomite:* several bands up to 1 m thick, distinctive, spotted, pinkish grey, massive. Spots consist of euhedral crystals of dolomite (up to 2 mm across) in microcrystalline dolomitic matrix. Bands of *chert* up to 1 cm thick in dolomite are intercalated with *silty dolomite* and *siltstone* which make up about 75% of this unit
4	*Dolomite sandstone:* pinkish brown, thin-bedded, fine-grained, cross-bedded, several bands up to 0.5 m thick
6	*Dolomite:* massive, thin-bedded, banded; minor *chert*
2+	*Pure dolomite:* grey, massive; weathered surface light grey and shows thin bedding with fine-scale cross-bedding, ripple marks, and minor convolute bedding structures
Total 105+	Base of hill

SECTION 10. Jasper Gorge Sandstone, 1 km north-northwest of Timber Creek store.

Thickness (m)	*Top of hill*
14	*Interbedded silty sandstone:* reddish to light brown (on weathered surface), fine-grained, and *micaceous siltstone:* fissile, poorly bedded. Forms uppermost scarp. Both rock types contain abundant mud flakes and laminated ripple marks. Intercalated bands 15 to 20 cm thick of massive, hard *sandstone*
7.5	*Sericitic siltstone:* predominantly reddish, fissile, fine-grained, weathers to platy fragments. Poorly exposed, tends to form bench on underlying beds
10	*Sandstone:* basal, strongly outcropping, rather massive band. Reddish (weathered surface), massive to medium-bedded, coarse-grained to gritty (2-4 mm) sandstone. In places poorly sorted; some lenses of gritty sandstone and fine conglomerate contain feldspar grains and mud flakes. Sandstone forms bands 1.5-2 m thick. Minor intercalated fissile *siltstone* bands up to 5 cm. Upper beds ripple-marked, some friable. Cross-bedding very common, with foreset beds up to 60 cm thick
Total 31.5	Underlain by Timber Creek Formation

SECTION 11. Jasper Gorge Sandstone at headwaters of Little Horse Creek.

Thickness (m)	*Top of hill*
3+	*Sandstone:* poorly outcropping, blocky and flaggy, slightly ferruginous
7.5	*Quartz sandstone:* white, blocky, fine-grained
32	Fine-grained *silty and micaceous sandstone.* Large-scale cross-bedding, abundant primary current lineations
12	*Sandstone:* strongly outcropping band, medium to coarse, grains well rounded, slightly argillaceous. Ripple-marked and cross-bedded
Total 54.5+	Underlain by Timber Creek Formation

SECTION 12. Jasper Gorge Sandstone, 24 km southeast of Auvergne homestead.

Thickness (m)	*Top of ridge*
110 maximum measured	*Sandstone:* white, blocky, thin-bedded, medium to coarse. Interbeds of coarse sandstone. Tends to form thick bands on lower sandstone shelf
15 maximum	*Sandstone:* white, blocky to flaggy, medium to thin-bedded, fine to medium, rather friable (tends to form lower bench)
variable from 0.5 to 3	Interbedded *sandstone* and *conglomerate;* conglomerate has sandy matrix and clasts of quartzite, chert, and clay
maximum 3 (very limited extent)	Mixed *conglomerate* (as above) and *chert breccia*
Total 130 (max)	Underlain by Limbunya Group chert

SECTION 13. Angalarri Siltstone and part of Saddle Creek Formation measured in Koolendong Valley, southern Port Keats Sheet area.

	Thickness (m)	*Lithology*
	15	Basal sandstone of Saddle Creek Formation forming top of dissected tableland
Angalarri Siltstone	45	*Siltstone:* greyish green, reddish brown, intercalated with *quartzitic sandstone* bands up to 0.5 m thick. The bands are glauconitic and may have a silty matrix
	30	*Siltstone:* greyish green, laminated, platy. Slightly coarser than the underlying 110 m
	110	*Siltstone:* greyish green, highly fissile, shaly, laminated. Fairly homogeneous sequence
Total	200	Bottom of slope (base not exposed)

SECTION 14. Saddle Creek Formation in Pinkerton Range scarp, 8 km south of No. 7 Bore.

Thickness (m)	*Overlain by Pinkerton Sandstone*
41	Minor scree of flaggy, fairly pure *dolomite,* patches of *dolomitic siltstone:* light grey on weathered surface
6	*Sandstone:* very friable, blocky to flaggy, contains abundant mud flakes
44	Mainly soft, very *silty and ferruginized sandstone,* varies from red to yellow and brown. Interbedded with *siltstone*
4.5	*Quartz sandstone:* blocky and flaggy, cross-bedded, contains minor feldspar and glauconite
Total 95.5	Underlain by Angalarri Siltstone

SECTION 15. Saddle Creek Formation in Pinkerton Range scarp, 1.5 km east of Saddle Creek.

Thickness (m)	*Overlain by Pinkerton Sandstone*
16.5	*Siltstone:* grey, calcareous, flaggy to fissile. Contains bands of sandy oolitic dolomite up to 1 m thick
58	*Siltstone:* grey-khaki, calcareous. Bands of very fine-grained *dolomite* up to 5 cm thick
1.5	*Dolomite:* light brown, grey, sandy, glauconite
15	*Siltstone and mudstone:* light green, grey, chocolate, dolomitic
7.5	*Sandstone:* light green, grey, very friable, massive, thin to medium-bedded, large-scale cross-bedding. Poorly sorted coarse-grained beds and discontinuous lenses; glauconitic
Total 98.5	Underlain by Angalarri Siltstone

SECTION 16. Saddle Creek Formation in Pinkerton Range scarp, 1.5 km west of Bullo River track (type section).

Thickness (m)	*Overlain by Pinkerton Sandstone*
21.5	*Dolomitic siltstone:* light brownish grey, flaggy, fissile. Minor fine-grained *sandstone*
1.5	*Dolomitic siltstone,* varying to *silty dolomite:* flaggy, forms bands up to 15 cm thick
20	*Siltstone* as in uppermost 20 m
3	*Dolomitic siltstone* and *silty dolomite* intercalated with some grey fissile *siltstone* (carbonate rich)
7.5	*Siltstone* as in uppermost 20 m
1.5	*Dolomitic siltstone* and *silty dolomite*
9	*Siltstone* as in uppermost 20 m
1.5	*Dolomite:* grey, oolitic, nodular, minor chert
24.5	*Siltstone* as in uppermost 20 m
10.5	*Siltstone and fine-grained sandstone:* light brown, grey, and greenish grey, interbedded, fissile to flaggy, abundant primary sedimentary structures
Total 100.5	Underlain by Angalarri Siltstone

SECTION 17. Saddle Creek Formation in Pinkerton Range scarp, due north of Hayes Billabong.

Thickness (m)	*Overlain by Pinkerton Sandstone*
20	*Siltstone:* light greyish brown, calcareous, very fissile
3	*Dolomitic siltstone,* grey. Also bands of flaggy fine-grained *dolomite* up to 15 cm thick
15	*Siltstone:* greenish grey, very fissile
9	*Quartz sandstone:* light greyish brown, very fine-grained, silty, massive, friable
29	*Siltstone:* greenish brown, very fissile, contains abundant glauconite
9	*Sandstone* and *silty sandstone:* light brownish grey, flaggy, fine siltstone interbeds. Abundant primary sedimentary structures
Total 85	Underlain by Angalarri Siltstone

SECTION 18. Saddle Creek Formation at Karracumby Peak.

Thickness (m)	*Overlain by Pinkerton Sandstone*
24.5	Poor exposure, apparently *dolomitic siltstone*. Minor concretionary iron nodules up to 5 cm long in lower 3 m
1.5	*Quartz sandstone:* white, well sorted, friable, low clay content
21.5	*Siltstone:* dark brown, varies to fine-grained *sandstone*. Isolated nodules of concretionary secondary iron oxides
7.5	*Silty sandstone:* light brown, silt interbeds common at base, poorly sorted. Sedimentary structures common
Total 55	Underlain by Angalarri Siltstone

SECTION 19. Saddle Creek Formation in Yambarra Range scarp, 8 km northeast of the mouth of Lobby Creek.

Thickness (m)	*Overlain by Pinkerton Sandstone*
10.5	*Shaly siltstone:* fissile, poor exposure
2.5	Fine-grained *sandstone* and *silty sandstone:* massive, greyish green to light brown. Commonly contain irregular flame structures
5	No outcrop: scree-covered slope
1	*Shaly siltstone:* greyish green
5	*Siltstone* and fine-grained *silty sandstone:* massive, essentially non-bedded, although lower 1 m shows flame structures and other pre-consolidation sedimentary structures
2	Interbedded fine-grained *sandstone* and *siltstone:* greyish green, weathering to light brown. Irregularly alternating fairly 'clean' *quartz sandstone* (commonly with up to 5% small glauconite pellets) and *sericitic* 'dirty' *siltstone:* thin-bedded, fine structures, fissile to flaggy. Mud cracks and ripple marks
28	*Siltstone:* shaly, fissile, laminated, greyish green, chloritic and sericitic, some light brown limonite-rich bands (possibly weathered glauconite)
9	Basal *sandstone* band: light grey, weathers to brown and dark grey, thin-bedded, fine to coarse, poorly sorted. Commonly pale green owing to glauconite and flakes of green clay. In lower 3 m abundant cross-bedding, scour-and-fill, flame structures, minor ripple marks, mud cracks
Total 63	Underlain by Angalarri Siltstone

SECTION 20. Saddle Creek Formation at eastern margin of Koolendong Valley, 17 km south of the Fitzmaurice River in the Port Keats Sheet area.

Thickness (m)	*Overlain by Pinkerton Sandstone*
28.5	*Sandstone:* flaggy to blocky, medium-bedded, white to purplish
5	*Sandstone:* white, medium-grained, large-scale foreset beds which are thinly bedded and show up through differential weathering
33.5	Blocky to massive *sandstone:* some medium-scale cross-beds. Interbedded with flaggy sandstone and minor purple and green *siltstone*
Total 67	Underlain by Angalarri Siltstone

SECTION 21. Pinkerton Sandstone, 90 km west-southwest of Auvergne Homestead.

Thickness (m)	*Overlain by Lloyd Creek Formation*
45.5	*Sandstone* and *silty sandstone:* yellow and purple-brown, thin-bedded, flaggy, fine-grained, occasionally medium to coarse; well rounded quartz grains. Mud flakes, some mud cracks, small ripple marks and cross-beds
15	Flaggy *sandstone:* similar to above; green shaly partings common
18.5	Interbedded purple and light greyish green *siltstone* and fine to medium *sandstone*
4.5	*Sandstone:* medium-grained, massive to blocky, white. Cross-beds, ripple marks and dark-coloured ferruginous spots up to 5 mm across
Total 83.5	Underlain by Saddle Creek Formation

SECTION 22. Pinkerton Sandstone, 4 km northeast of Bullo Gorge.

Thickness (m)	*Top of hill*
30+	*Sandstone:* thin-bedded, contains mud flakes
12	Thin-bedded *sandstone* with blocky to massive partings. Many mud flakes, ripple marks and small-scale cross-bedding
10.5	Interbedded fine-grained *sandstone, siltstone* and green and purple *mudstone:* all thin-bedded
21.5	Slightly *feldspathic sandstone:* buff to yellow, medium-grained. Yellow to brown limonite spots up to 5 mm across
Total 74+	Underlain by Saddle Creek Formation

SECTION 23. Pinkerton Sandstone in Lobby Creek area.

Thickness (m)	*Top of hill*
6+	*Sandstone:* thin-bedded, flaggy, fine to medium. Some ripple marks
24.5	Fine-grained *sandstone:* dark brown weathered surface; not well sorted, some beds have silt content, mud flakes common; some thinly interbedded chocolate *siltstone* and *sandstone* with abundant mud flakes
24.5	*Quartz sandstone:* white, friable, fine-grained, reddish brown weathered surface, prominent vertical jointing
Total 55+	Underlain by Saddle Creek Formation

SECTION 24. Lloyd Creek Formation, 5 km north of Pinkerton Range scarp, adjacent to Bullo track (type section).

Thickness (m)	*Overlain by Spencer Sandstone*
6	No outcrop
2.5	*Dolomite:* light grey, blocky, 70% oolites
20.5	No outcrop
3	*Sandstone:* green-brown, with *dolomite* lenses and inter-beds up to 10 cm thick
3	*Sandstone:* brown, blocky, fine-grained, feldspathic

18.5	Light grey *dolomite:* very closely packed oolites. Occasional tabular fine-grained dolomite fragments and lenses of more ferruginous material, both more apparent on weathered surface
9	*Dolomite:* up to 80% oolites; oolitic and non-oolitic dolomite are interbedded.
3.5	*Sandstone:* grey, blocky, thin-bedded, grains cemented by dolomite up to 3 mm in grainsize and constituting up to 10% of the rock
4.5	*Sandstone:* white, flaggy, friable, medium-grained, halite pseudomorphs
0.5	Light grey *oolitic dolomite*
3	*Sandy dolomite:* light grey, blocky, thin-bedded, medium to coarse
Total 74	Underlain by Pinkerton Sandstone

SECTION 25. Spencer Sandstone, 10 km south of Bullo Gorge at 15°44′S, 129°38′E (type section).

Thickness (m)	*Overlain by Shoal Reach Formation*
55	No outcrop
21.5	Poor outcrop, mainly scattered remnant blocks of white fine-grained *sandstone*
52	No outcrop
7.5	*Sandstone:* white, blocky to flaggy, thin-bedded, fine to medium. Minor coarse-grained. Up to 10% *feldspathic sandstone* interbedded with softer fine *sandstone* which has a sericitic matrix and a red weathered surface
1.5	No outcrop
5	*Sandstone:* light brown, blocky, thin-bedded, medium-grained, up to 5% feldspar. Some fissile, silty interbeds. Contains abundant mud flakes
Total 142.5	Probable base of unit

SECTION 26. Spencer Sandstone, measured 6.5 km south of Bullo Gorge.

Thickness (m)	*Overlain by Shoal Reach Formation*
52	*Sandstone:* fine-grained, about 2% glauconite
13	*Sandstone:* grey, fine-grained, friable, up to 10% feldspar
10	No outcrop
30	*Sandstone:* white, blocky, thin-bedded, medium to coarse, poorly sorted, interbedded with fine fissile *feldspathic sandstone.* Generally poor exposure
60	*Sandstone:* white, blocky to flaggy, thin-bedded, fine to medium, abundant chocolate and green mud flakes
Total 165	Underlain by Lloyd Creek Formation

SECTION 27. Spencer Sandstone, 8 km southeast of Ernie Lagoon.

Thickness (m)	*Overlain by Shoal Reach Formation*
5	*Feldspathic sandstone:* fine, friable
4.5	*Sandstone:* grey, flaggy, thin-bedded, fine to medium. Up to 3% green glauconite grains or pellets up to 1 mm across. Minor quartz grains of same size
5	*Sandstone:* fine-grained, up to 5% feldspar
76.5	*Sandstone:* poor exposure, white, blocky to flaggy, fine to medium, limonite-spotted

2.5	*Sandstone:* fine-grained, abundant green and brown clay clasts 2 to 5 mm across, which preferentially weather out and give the rock a pockmarked appearance
2.5	No outcrop
45.5	*Sandstone:* white, blocky to flaggy, thin-bedded, fine to medium, friable, up to 15% feldspar
3.5	*Sandstone:* basal band, massive to flaggy, white, fine-grained, friable, brown
Total 145	Underlain by Lloyd Creek Formation

SECTION 28. Shoal Reach Formation, 10 km southeast of Bullo Gorge.

Thickness (m)	*Overlain by Black Point Sandstone Member (Bullo River Sandstone)*
2	No outcrop
10	*Sandy dolomite:* grey, blocky to massive, thin to medium-bedded, medium-grained; minor fissile beds. Interbeds of fine *dolomite*
9	*Sandstone:* blocky, some probably dolomitic
7.5	*Dolomitic sandstone:* interbedded with *siltstone* (?dolomitic) which forms up to 60% of the rock
19	*Dolomitic sandstone:* grey, blocky to fissile, thin-bedded, fine-grained; fissile beds mainly silty
8.5	Interbedded *sandstone, dolomite,* and *dolomitic sandstone*
Total 56	Underlain by Spencer Sandstone

SECTION 29. Fargoo Tillite measured on southwest slope of Skinner Point mesa, 3.5 km southwest of the point.

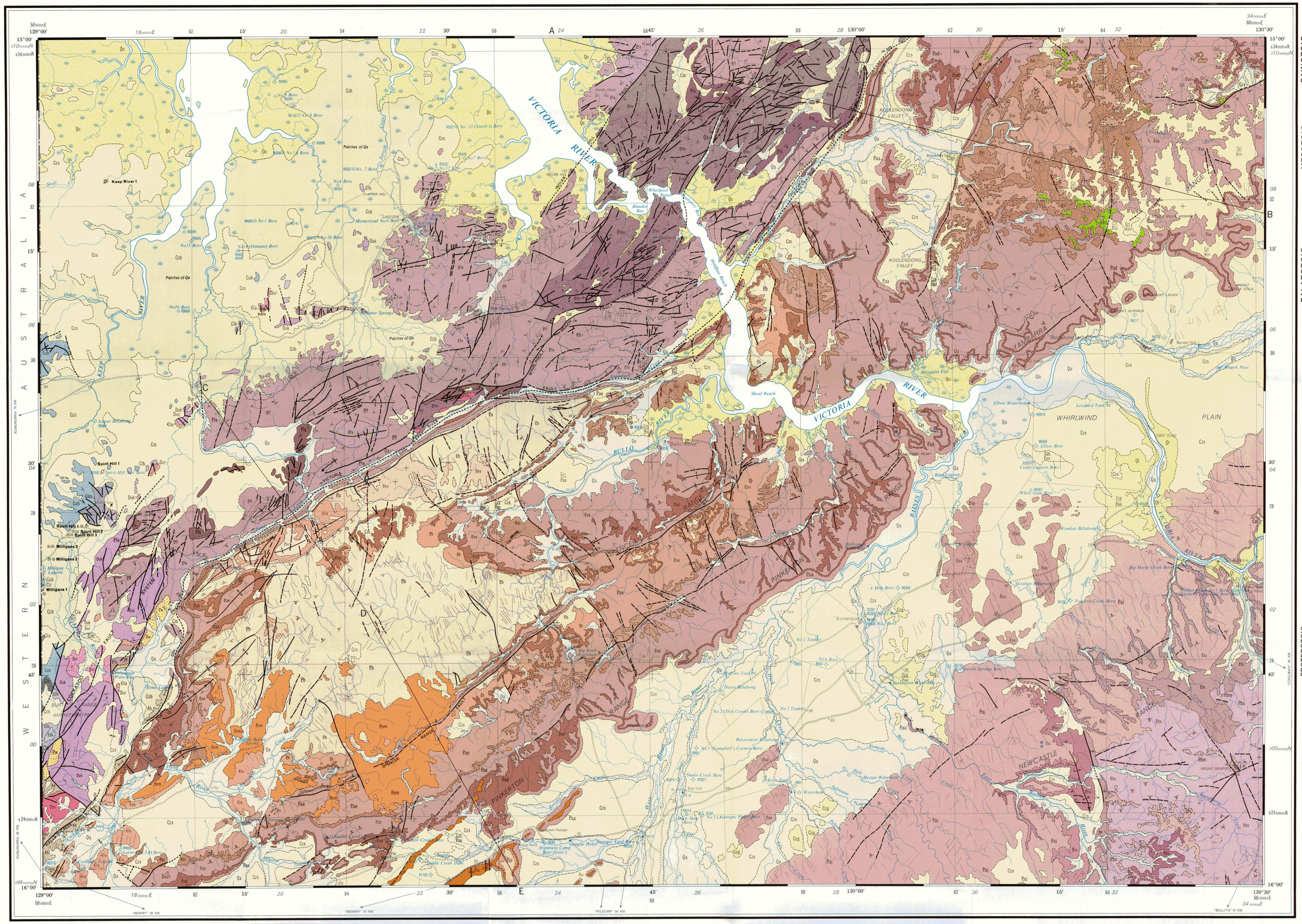
Thickness (m)	*Overlain by Blackfellow Creek Sandstone*
41	Talus of *sandstone:* fine to medium, flaggy; some flute casts, ripple-marks and cross-beds; well laminated in places
37	*Conglomerate:* massive, no partings, very thick-bedded, some large-scale cross-beds
42	*Tillite*
10	*Sandstone:* medium to coarse, some gritty and pebbly layers
30	*Tillite*
Total 160	Underlain by Skinner Sandstone

SECTION 30. Beasly Knob Member of Ranford Formation; type section, 13 km east-northeast of Bucket Spring.

Thickness (m)	*Overlain by Ernie Lagoon Member*
71.5	No outcrop: possibly siltstone
0.5	*Pebble conglomerate:* very poorly sorted
15	*Sandstone:* red or grey, massive to blocky, medium to thick-bedded, coarse, poorly sorted, with granule and minor pebbly interbeds
Total 87	Underlain by Bucket Spring Member

AUVERGNE

NORTHERN TERRITORY



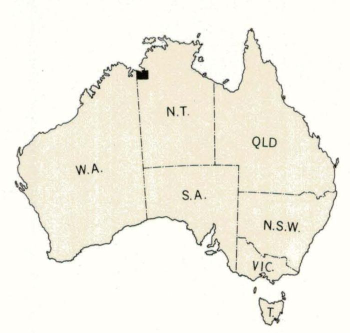
Reference

- Geological boundary
- Anticline, showing plunge
- Syncline, showing plunge
- Monocline
- Fault (D,U indicate relative movement down, up)
- Fault, low-angle thrust (⊢— indicates upper plate)
- Fault, showing relative horizontal movement
- Shear zone
- 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
- Measured strike and dip of strata
- Prevailing strike and dip of strata
- Strike and dip of overturned strata
- Horizontal strata
- Vertical strata
- Dip < 5° (air-photo interpretation)
- Dip 5°-15° (air-photo interpretation)
- Dip 15°-45° (air-photo interpretation)
- Dip > 45° (air-photo interpretation)
- Trend lines, showing dip (air-photo interpretation)
- Joint pattern (air-photo interpretation)
- Dip slope
- Measured strike and dip of cleavage
- Prevailing strike and dip of cleavage
- Strike of vertical cleavage
- Strike of vertical joints
- Glacial striae
- Abandoned ochre mine
- • Ba Minor mineral occurrence (Ba – Barite)
- Petroleum exploration well - dry, abandoned
- Petroleum exploration well with show of gas, abandoned
- ⊗ St Stratigraphic hole
- Water bore (R10648 refers to bore registration number of Mines and Water Resources Branch, Northern Territory Administration)
- Abandoned bore
- Wind pump
- Earth tank
- • WH Waterhole
- WH Waterhole on stream
- Sink hole
- Spring
- Pipeline
- Swamp
- Highway
- Vehicle track
- State boundary
- Fence
- Landing ground
- "Bradshaw" Homestead
- Building
- Yd Yard
- Astronomical station
- •24 Elevation in metres - accurate
- •18 Elevation in metres - approximate
- pd Position doubtful

Reference

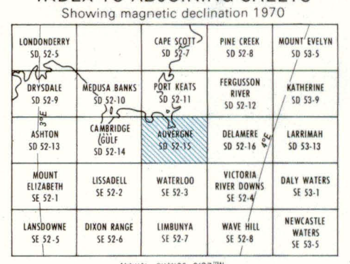
CAINOZOIC	QUATERNARY		Qa	Alluvium
			Qc	Coastal deposits: mud, silt, evaporites
			Qt	Terrace deposits: mud, sand, gravel
			Czs	Sand, soil, colluvium
			Czb	Black soil
			Czg	Sand, gravel, colluvium
			Czl	Laterite, lateritic soil
MESOZOIC	CRETACEOUS	Mullaman Beds	Klm	Friable and ferruginous sandstone
PALAEOZOIC	UPPER CARBONIFEROUS	Border Creek Formation	Cub	Quartz sandstone, conglomerate, siltstone
	LOWER CARBONIFEROUS	Burvill Beds	Clr	Sandstone, shale and sandy limestone
		Milligans Beds	Clm	Silty shale, siltstone
		Zimmermann Sandstone	Clz	Quartz sandstone and siltstone
		Septimus Limestone	Cls	Limestone, minor calcareous sandstone
		Enga Sandstone	Cle	Calcareous quartz sandstone
		Burt Range Formation	Clb	Limestone, minor shale and sandstone
	UPPER DEVONIAN	Cockatoo Formation	Duc	Sandstone, conglomerate
		Kellys Knob Sandstone Member	Duk	Quartz sandstone, pebbly in part
		Ragged Range Conglomerate Member	Dur	Conglomerate, sandstone
	LOWER ? CAMBRIAN	Antrim Plateau Volcanics	Ꞓla	Basalt
PROTEROZOIC	ADELAIDEAN	Duerdin Group: Ranford Formation, Ernie Lagoon Member	Ᵽor	Light brown quartz sandstone; minor grit
		Beasly Knob Member	Ᵽob	Brown quart sandstone; minor conglomerate and grid
		Bucket Spring Member	Ᵽou	Siltstone and micaceous sandstone
		Jarrad Sandstone Member	Ᵽoj	Ferruginous sandstone
		Moonlight Valley Tillite	Ᵽom	Tillite overlain by dolomite. Sandstone, granite clasts predominate
		Blackfellow Creek Sandstone	Ᵽol	Quartz sandstone
		Fargoo Tillite	Ᵽof	Tillite, dolomite clasts common
		Skinner Sandstone	Ᵽoi	Grey and brown dolomitic sandstone conglomeratic sandstone, conglomerate
	ADELAIDEAN ?	Bullo River Sandstone	Ᵽb	Reddish brown quartz sandstone and conglomerate
		Black Point Sandstone Member	Ᵽk	Reddish brown feldspathic quartz sandstone, minor conglomerate
		Big Knob Beds	Ᵽn	Reddish brown ferruginous sandstone, grit and conglomerate
		Auvergne Group: Shoal Reach Formation	Ᵽah	Dolomite, sandy and silty; minor siltstone and intraformational breccia
		Spencer Sandstone	Ᵽae	Quartz sandstone, silty sandstone, dolomitic sandstone
		Lloyd Creek Formation	Ᵽal	Dolomite, oolitic and stromatolitic; sandy and silty dolomite; siltstone
			Ᵽa	Ᵽa – undivided Ᵽah, Ᵽae, Ᵽal
		Pinkerton Sandstone	Ᵽap	Massive quartz sandstone, siltstone, minor mudstone
		Saddle Creek Formation	Ᵽad	Basal crossbedded sandstone: upper siltstone and oolitic dolomite
		Angalarri Siltstone	Ᵽaa	Greyish green siltstone, minor dolomitic siltstone, shale and limestone
		Jasper Gorge Sandstone	Ᵽaj	Massive quartz sandstone, minor siltstone; Basal conglomerate
		Bullita Group: Skull Creek Formation	Ᵽbs	Dolomite, dolomitic siltstone, silty dolomite, chert, minor sandstone
		Bardia Chert Member	Ᵽbm	Massive laminated chert, brecciated chert
		Supplejack Dolomite Member	Ᵽbu	Massive dark grey dolomite, some stromatolites
		Timber Creek Formation	Ᵽbt	Dolomitic siltstone, siltstone; fine sandstone, dolomite, minor chert
		Wattie Group	Ᵽiu	Sandstone, siltstone, minor dolomite
		Limbunya Group	Ᵽhu	Massive dark grey dolomite, chert
		Fitzmaurice Group: Legune Formation	Ᵽfe	Quartz sandstone and siltstone
		Lalngang Sandstone	Ᵽfl	Quartz sandstone, grit, conglomerate, minor siltstone
		Goobaieri Formation	Ᵽfg	Quartz sandstone overlain by siltstone and sandstone
		Moyle River Formation	Ᵽfm	Quartz sandstone; minor siltstone, grit and pebble conglomerate
	CARPENTARIAN	Lamboo Complex: Bow River Granite	Ᵽbo	Coarse-grained and porphyritic biotite granite
		Whitewater Volcanics	Ᵽw	Acid lava, tuff, intrusive quartz-feldspar porphyry
ARCHAEAN OR LOWER PROTEROZOIC		Halls Creek Group	Ah	Slate, green schist, mica schist and andalusite schist

Published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. R. W. Swartz, M.B.E., E.D., Minister for National Development.
Base map compiled by the Division of National Mapping from aerial photography at 1:50,000 scale.



INDEX TO ADJOINING SHEETS

Showing magnetic declination 1970



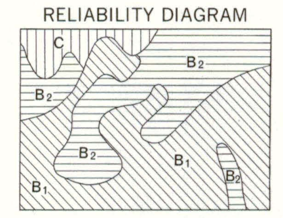
Scale 1:250,000

5 0 5 10 15 20 25 KILOMETRES

5 0 5 10 MILES

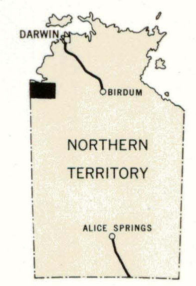
GREY NUMBERED LINES ARE 20,000 METRE INTERVALS OF THE AUSTRALIAN MAP GRID, ZONE 52
GREY TICKS WITH ITALIC NUMBERS INDICATE THE 20,000 YARD GRID, ZONE 4 (AUSTRALIA SERIES)
TRANSVERSE MERCATOR PROJECTION

RELIABILITY DIAGRAM

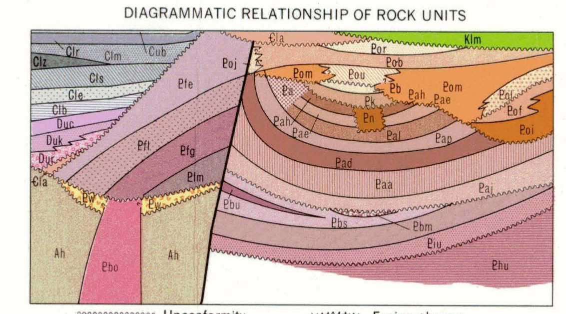


- B1 Detailed reconnaissance: numerous traverses and air-photo interpretation
- B2 General reconnaissance: some traverses and air-photo interpretation
- C Air-photo interpretation

Geology 1966 by J. J. Veevers, J. Roberts, J. A. Kaulback
1967 by I. R. Pontifex, C. M. Morgan, I. P. Sweet, A. G. Reid
Compiled 1968 by I. R. Pontifex, C. M. Morgan, I. P. Sweet
Cartography by Geological Branch BMR
Drawn by W.E. Polytech Engineering Pty. Ltd
Printed by Mercury–Walch Pty. Ltd., Hobart, Australia



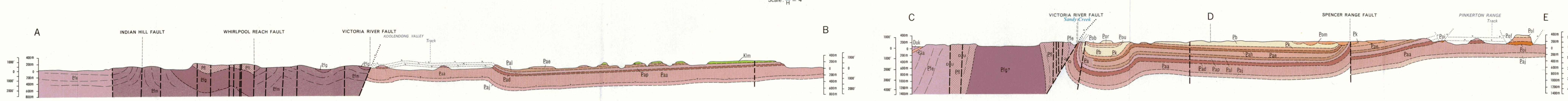
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Sections

Cainozoic sediments omitted. Folding schematic

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



FIRST EDITION 1971

AUVERGNE

SHEET SD 52-15

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