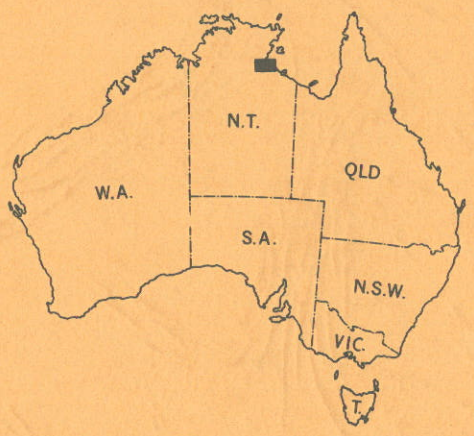
1:250,000 GEOLOGICAL SERIES—EXPLANATORY NOTES

BAUHINIA DOWNS

NORTHERN TERRITORY



SHEET SE/53-3 INTERNATIONAL INDEX

DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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SHEET SE/53-3 INTERNATIONAL INDEX

COMPILED BY J. W. SMITH

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Explanatory Notes on the Bauhinia Downs Geological Sheet

Compiled by J. W. Smith

The Bauhinia Downs Sheet area lies within the latitudes 16° 00′ S. and 17° 00′ S. and longitudes 135° 00′ E. and 136° 30′ E., near the south-western side of the Gulf of Carpentaria, Northern Territory.

The population is centred at Borroloola, at Mallapunyah and O. T. Downs Homesteads, a homestead in the upper Batten Creek area, and at the time of writing, at McArthur River Homestead, where drilling is in progress.

Road access within the area is good and has been improved by the construction of a formed road connecting Daly Waters on the Stuart Highway to Borroloola. This road continues eastwards to Robinson River Homestead on the Robinson River Sheet area, but is not formed beyond Borroloola. The other main roads in the area connect Borroloola to Mallapunyah Homestead (and thence to the Barkly Tableland), and O. T. Downs Homestead through Three Knobs to the Borroloola–Mallapunyah road at Leila Lagoon ; both are graded dirt roads.

Borroloola, McArthur River Homestead, and Mallapunyah Homestead all have dirt airstrips which are open most of the year. A weekly service by light aircraft connects them with Mount Isa, Queensland.

Photographs and maps covering the area are : Bauhinia Downs air photographs (Scale 1 : 50,000) flown by the Royal Australian Air Force in 1947 and 1952 ; Bauhinia Downs photoscale maps prepared by, and available from, the Division of National Mapping, Department of National Development ; Bauhinia Downs 4-mile uncontrolled photo-mosaic ; Bauhinia Downs 4-mile topographic Series—SE/53–3 Zone 5, Division of National Mapping, Department of National Development, published in 1960.

The annual rainfall of 20–30 inches falls mainly in the months January to March. The average temperature is about 85° in summer and 70–75° in winter.

Previous Investigations

Lead-zinc-copper mineralization was discovered in the area around McArthur River Homestead Mr Tom Lynott in 1887. Interest in the area revived in 1889, in 1909, when Cook's deposit was drilled, and again in 1953, when Bald Hills prospect was drilled by Consolidated Zinc Pty Ltd. Little systematic work was done in the field until Mount Isa Mines Ltd began a programme of

mapping and prospecting in 1955. Two promising prospects, the Reward and H.Y.C., were discovered; subsequently the Reward was abandoned, but Carpentaria Exploration Co. Ltd, a subsidiary company of Mount Isa Mines Ltd, is still drilling H.Y.C. (1963).

Until 1955 little was known of the geology of the Sheet area, apart from the region around McArthur River Homestead. Brown (1908), Woolnough (1912), and Jensen (1914) visited the area, but confined most of their observations to the route from Borroloola to the Barkly Tableland; Woolnough also travelled from Tanumbirini Homestead east to McArthur River Homestead. Hossfeld (1954) visited the McArthur River area and recognized the unconformity between the Cambrian rocks of the Barkly Tableland and the underlying dolomites of the McArthur River area, which he called the Carpentaria Group. In 1955–6 geologists of Mount Isa Mines Ltd (Kriewaldt, 1957) carried out reconnaissance mapping of the Bauhinia Downs Sheet area as part of a survey of the country between the Queensland Border and the Roper River.

The Bureau of Mineral Resources completed in 1959 a reconnaissance gravity survey from Burketown, Queensland, to Daly Waters, crossing the Bauhinia Downs Sheet area *en route*, and during 1960 mapped the Sheet area. Detailed mapping of an Authority to Prospect of 600 square miles around McArthur River Homestead was begun by geologists of Carpentaria Exploration Co. Ltd in the same year. In 1961 the Bureau of Mineral Resources conducted a geochemical survey in the McArthur River Homestead area (Fricker, 1962). In 1960–61 the adjoining 1 : 250,000 Sheet areas of Mount Young, Robinson River, Tanumbirini, and Wallhallow were mapped by the Bureau of Mineral Resources.

PHYSIOGRAPHY

The Sheet area lies mainly within the *Gulf Fall* (Stewart, 1954; Dunn, Smith, & Roberts, in prep.), but the *Coastal Plain* (Dunn et al., in prep.) extends on to the north of the Sheet area (Fig. 1) around Borroloola, and the *Barkly–Birdum Tableland* (Dunn et al., in prep.) extends on to the south-west of the Sheet area.

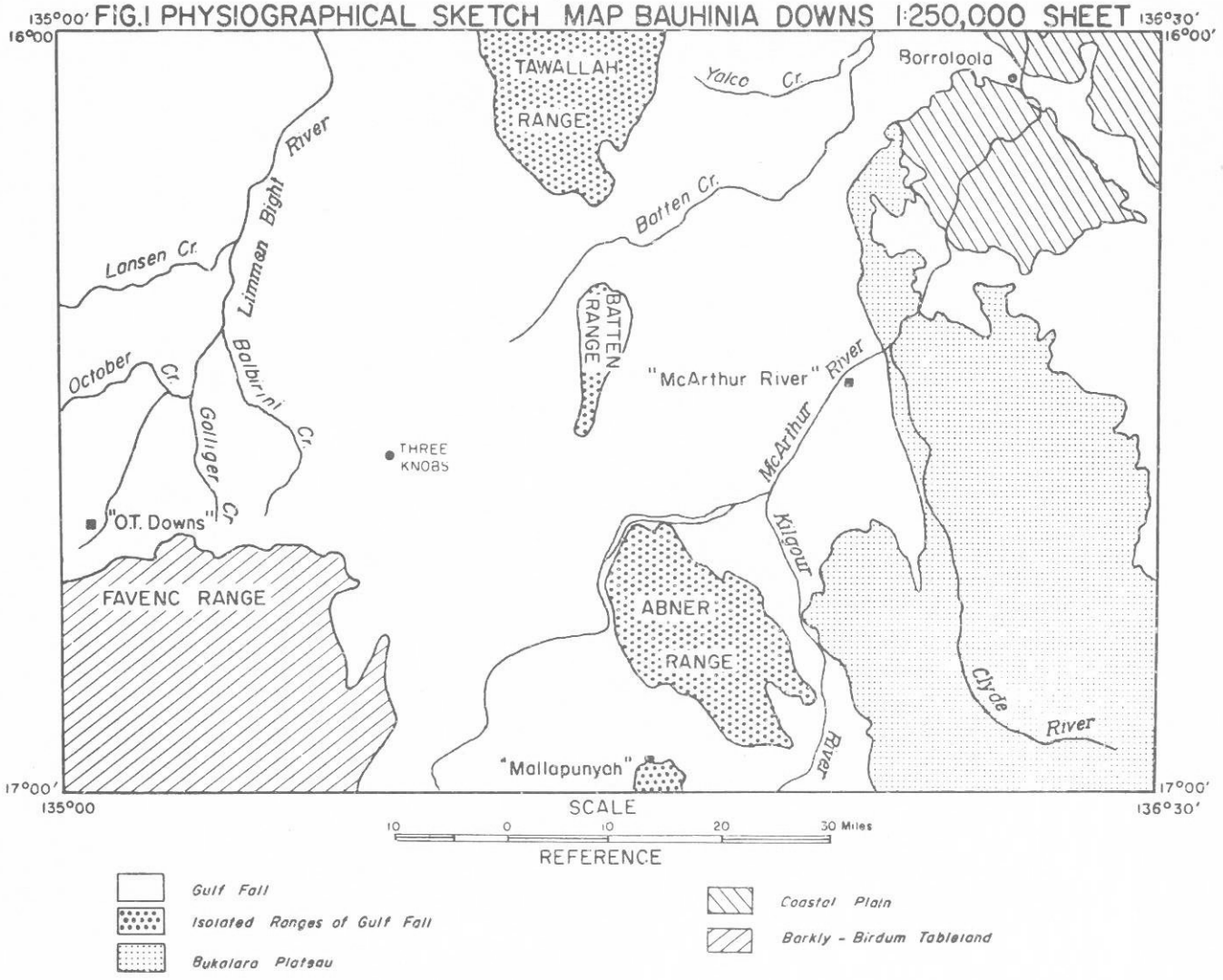
The *Gulf Fall* is defined as the hill country surrounding the Gulf of Carpentaria in which the drainage is towards the Gulf. Apart from isolated ranges, the country slopes gradually from about 800 feet above sea-level in the south and south-west to the Coastal Plain which is between 50 feet and 70 feet above sea level. The isolated ranges are 100–500 feet above the surrounding country.

The main elevated areas can be divided into three :

(*a*) four isolated ranges in the centre of the Sheet area ;

(*b*) the Bukalara Plateau in the south-east ; and

(*c*) the Favenc Range in the south-west (fringing the Barkly–Birdum Tableland).


135°00'
FIG.1 PHYSIOGRAPHICAL SKETCH MAP BAUHINIA DOWNS 1:250,000 SHEET
136°30'
16°00'
16°00'
TAWALLAH RANGE
Yalco Cr.
Borroloola
Batten Cr.
Limmen Bight River
Lansen Cr.
October Cr.
Balbirini Cr.
Gollger Cr.
BATTEN RANGE
"McArthur River" River
McArthur River
THREE KNOBS
"O.T. Downs"
FAVENC RANGE
ABNER RANGE
Kilgour River
Clyde River
"Mallapunyah"
17°00'
17°00'
135°00
SCALE
136°30'
10 0 10 20 30 Miles
REFERENCE
Gulf Fall
Isolated Ranges of Gulf Fall
Bukalara Platgau
Coastal Plain
Barkly - Birdum Tableland

The isolated ranges are the *Tawallah Range*, the *Batten Range*, an unnamed range around Mallapunyah Homestead, and the *Abner Range*. The first three are composed of rocks of the Tawallah Group and the last of rocks of the Roper Group. All consist of resistant sandstone ridges, above steep-sided valleys formed by erosion of softer beds. The resistant sandstone ridges of the Roper Group have a characteristic strong rectangular joint pattern and weather into isolated pillars up to 50 feet high.

The *Bukalara Plateau* is a major feature of the Gulf Fall in the east and south-east of the Sheet area, and extends on to the adjacent Wallhallow, Robinson River, and Calvert Hills Sheet areas. The Plateau is composed of flat-lying Bukalara Sandstone standing 100–300 feet above the surrounding country. In places the rivers, principally the Clyde River and its tributaries, have cut through the Bukalara Sandstone and are superimposed on the McArthur Group and the Roper Group.

A lowland area between the Bukalara Plateau and a northerly line through Three Knobs is underlain mainly by rocks of the McArthur Group. The area, excluding the isolated ranges, is undulating with low rounded hills up to 50 feet high, but resistant beds such as the Yalco Formation and parts of the Lynott Formation form strike ridges rising to about 200 feet above the surrounding plain. Remnants of Mesozoic sediments form small plateau cappings, particularly in the south-west and north-east.

West of the northerly line through Three Knobs, a plain of sand and lateritic soil extends to the western edge of the Sheet area, where it is broken by low strike ridges of the Tawallah, McArthur, and Roper Groups. Low hills, mainly of Roper Group and Mesozoic sediments, are scattered throughout the plain. In the Golliger Creek/Balbirini Creek area, residual black soil plains have formed on Tertiary limestone (the Golliger Beds) ; black soils also occur between Lansen Creek and October Creek in the west of the Sheet area.

The *Favenc Range* fringing the Barkly–Birdum Tableland is composed of Mesozoic sediments. The northern edge of the Range is a continuous scarp rising to about 100 feet above the plain ; southwards the Range is dissected into scattered, low, flat-topped hills.

The *Coastal Plain*, which is mainly composed of sand, is in the north-east of the Sheet area, around Borroloola. Scattered residuals of Mesozoic and Roper Group rocks rise to 100 feet above the plain.

Most of the Bauhinia Downs Sheet area is drained by the McArthur River. The plain in the west of the Sheet area is, however, part of the drainage area of the Limmen Bight River, and the eastern side of the Bukalara Range is drained by tributaries of the Foelsche and Wearyan Rivers. The McArthur River rises on the Wallhallow Sheet area and flows north-eastwards across the Bauhinia Downs Sheet area. Along its central portion the river is braided, but at McArthur River Homestead it forms one main channel. The river is deeply incised, with steep

TABLE 1

STRATIGRAPHY—BAUHINIA DOWNS SHEET AREA—SCRUTTON VOLCANICS AND TAWALLAH GROUP

Era	Name	Thickness in feet	Rock Types	Topography	Distribution	Remarks
Lower Proterozoic	Tawallah Group — Ps		Microsyenite and syenite dykes.		Along the Emu Fault line. Also small dykes in east.	Always adjacent to major faults.
	Mulholland Sandstone (Ptm)	about 900	Flaggy white to grey, fine to medium-grained quartz sandstone.	Low resistant ridges.	Only on west side of Tawallah Range.	
	Masterton Formation (Ptn)	about 3000 Variable	Blocky, purple and white, medium-grained quartz sandstone, siltstone, ferruginous sandstone, conglomerate. Minor intermediate–basic lavas and lapili tuff.	Usually resistant ridges to 400 feet high.	Wide distribution.	Microgabbro associated with volcanics.
	Gold Creek Volcanic Member (Ptg)	about 20	Basalt, trachyte.	Poor outcrop.	Extreme south-east of Sheet area.	
	Wollogorang Formation (Pto)	about 700	Flaggy, finely crystalline dolomite dolarenite, dolomitic siltstone, dolomitic sandstone, sandstone, chert.	Low rounded hills and strike ridges.	In Tawallah Range, also Mallapunyah Homestead and west of McArthur River Homestead.	
	Settlement Creek Volcanics (Pte)	about 450	Basalt, tuff, siltstone.	Poor outcrop, very low rounded hills.	Only occur around Mallapunyah Homestead.	
	Rosie Creek Sandstone (Ptr)	about 1500	Flaggy, fine to very coarse-grained quartz sandstone, ferruginous sandstone, feldspathic sandstone, glauconitic sandstone. Some boulder conglomerate.	Usually resistant ridges 400 feet high.	Tawallah Range and north of Leila First Crossing, not present at Mallapunyah Homestead. Not exposed elsewhere.	Rock equivalent in Robinson River–Calvert Hills area is Aquarium Formation.
	Sly Creek Sandstone (Ptl)	about 2000	Blocky, white to pink, medium-grained quartz sandstone—sometimes pebbly. Minor ferruginous siltstone.	Resistant ridges.	Tawallah Range, north of Leila First Crossing, Mallapunyah Homestead. Not exposed elsewhere.	
	Peters Creek Volcanics (Ptp)	about 1200	Amygdaloidal basalt, minor trachyte.	Poor outcrop, low rounded hills.	Tawallah Range, and north of Leila First Crossing.	
	Yiyintyi Sandstone (Pty)	about 8500	Blocky, white, medium to coarse-grained quartz sandstone. Minor pebble to boulder conglomerate.	Resistant ridges to 500 feet high.	Tawallah Range and north of Leila First Crossing (top of unit only).	Rock equivalent in Robinson River–Calvert Hills area is Westmoreland Conglomerate.
			UNCONFORMITY			
	Scrutton Volcanics (Pls) . .	2000+	Porphyritic dacite, minor basalt, feldspathic sandstone, siltstone, shale, tuff. Minor basic intrusives.	Low rough hills to 50 feet high. Sandstone lenses more resistant.	Only crops east of Tawallah Homestead.	Basic intrusives are quartz gabbro and dolerite.

banks up to 50 feet high. During the dry season, scattered water-holes, some of which are permanent, are left in the upper and central reaches ; by McArthur River Homestead there is a gentle flow of water for most of the year, and the river becomes tidal about 6 miles upstream from Borroloola.

The present drainage system is post-Mesozoic and largely superimposed on Proterozoic rocks. Erosion has removed most of the Mesozoic sediments and the superimposed drainage has been modified by the structure of the Proterozoic rocks.

STRATIGRAPHY

The stratigraphy of the Bauhinia Downs Sheet area is summarized in Tables 1 to 4. The general distribution of the units is shown in Figure 5.

Lower Proterozoic volcanics are unconformably overlain by a thick sequence (the McArthur Basin Succession) of Lower to Upper(?) Proterozoic sediments and volcanics. This succession is overlain unconformably by a probably Lower Cambrian sandstone which is, on the southerly adjacent Wallhallow Sheet area, overlain unconformably by a fossiliferous Lower or Middle Cambrian limestone.

Mesozoic freshwater and marine sediments unconformably overlie all units. Tertiary lacustrine limestone crops out locally.

The Lower Proterozoic *Scrutton Volcanics* crop out east of Tawallah Homestead and extend northwards on to the Mount Young Sheet area. They consist of fine to medium-grained porphyritic dacite and minor vesicular basalt with lenses of feldspathic sandstone, siltstone, shale, and tuff. Minor intrusions of quartz gabbro and dolerite are also present. The thickness of the volcanics is not known but is in excess of 2000 feet.

McARTHUR BASIN SUCCESSIONS

A thick sequence of Proterozoic rocks was laid down in the McArthur Basin (Dunn et al., in prep.), which extended from the Queensland Border around the southern and western coasts of the Gulf of Carpentaria to Arnhem Land.

The succession is divided into three Groups ; the Roper Group of probable Upper Proterozoic age, overlies the Lower Proterozoic Tawallah Group and the McArthur Group of probable Lower Proterozoic age. In the Sheet area the older rocks are conformable, but on the Calvert Hills Sheet area (Roberts, Rhodes, & Yates, 1963) the McArthur Group is unconformable on the Tawallah Group.

TAWALLAH GROUP

The Tawallah Group crops out at several localities in the Bauhinia Downs Sheet area. The most complete section occurs in the Tawallah Range, although most of the section is also exposed in the Batten Range. Correlation is good between the Tawallah Group on the Bauhinia Downs Sheet area and that in the Robinson River and Calvert Hills Sheet areas, where the Group is best developed

The Group is mainly composed of sandstone with subordinate volcanics, siltstone, shale, conglomerate, dolomite, dolomitic siltstone, and dolomitic sandstone. The dominant rock type is white to pink, medium-grained quartz sandstone. Units dominantly composed of sandstone (the *Yiyintyi Sandstone*, *Sly Creek Sandstone*, *Rosie Creek Sandstone*, *Masterton Formation* and *Mulholland Sandstone*) are interbedded with units either dominantly volcanic (the *Peters Creek Volcanics*, *Settlement Creek Volcanics* and the *Gold Creek Volcanic Member* of the Masterton Formation), or dolomitic (the *Wollogorang Formation*).

A diagrammatic comparison of rock units of the Tawallah Group in the Bauhinia Downs and Calvert Hills/Robinson River areas is shown in Figure 2.

The thickness of the Tawallah Group in the Tawallah Range is about 13,000 feet.

COMPARISON OF THE ROCK UNITS OF THE TAWALLAH GROUP

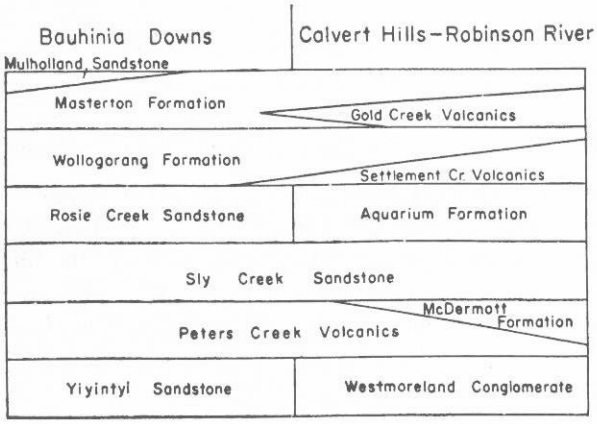


Fig. 2.

McArthur Group

The McArthur Group occurs throughout the McArthur Basin, but it is thickest and best exposed on the Bauhinia Downs Sheet area, where the main development is between the Bukalara Range and a north-striking line approximately through Three Knobs. It is not as well exposed in the extreme west (around Lansen Creek) and in the south-east and east.

The Group consists of dolomite and limy dolomite with limestone, conglomerate, sandstone, siltstone, shale, dolomitic sandstone, dolomitic siltstone, dolomitic shale, chert, chert breccia, and tuff.

The McArthur Group was laid down most thickly in a north-trending trough which extended from the southern part of the Mount Young Sheet area southwards to the northern part of the Wallhallow Sheet area ; its extension farther south is obscured by a cover of Cambrian and Mesozoic rocks and superficial deposits.

The depositional history of the McArthur Group in the central part of the Sheet area is complex ; it is summarized as follows (see also Fig. 3) :

(1) Deposition of sand, the *Mallapunyah Formation* (with minor other sediments), which represented a transition between the dominantly arenaceous Tawallah Group and the dominantly carbonate McArthur Group.

(2) Widespread deposition of carbonate mud which was accompanied by the growth of large algal reefs, mainly biostromal, and extensive slumping (*Amelia Dolomite*). Minor lenses of rhythmically alternating carbonate mud, silt, and sand were deposited locally and tuff was deposited in one locality (*Barney Creek Member*).

(3) Minor uplift, both marginal, which resulted in increased run-off and deposition of sand (the *Tatoola Sandstone*), and along the Tawallah Fault line. A biohermal reef (the *Top Crossing Dolomite*) was developed. In the north the reef occurred approximately where the Tawallah Range is today. It continued southwards along the Tawallah Fault line to Mystery Mine, where it swung east-south-eastwards to the margin of the Sheet area. Fore-reef sediments were deposited in the east, e.g., the *Lynott Formation* and *Yalco Formation*, and back-reef sediments in the west—the *Tooganinie Formation*.

TABLE 2
STRATIGRAPHY—BAUHINIA DOWNS SHEET AREA—McARTHUR GROUP

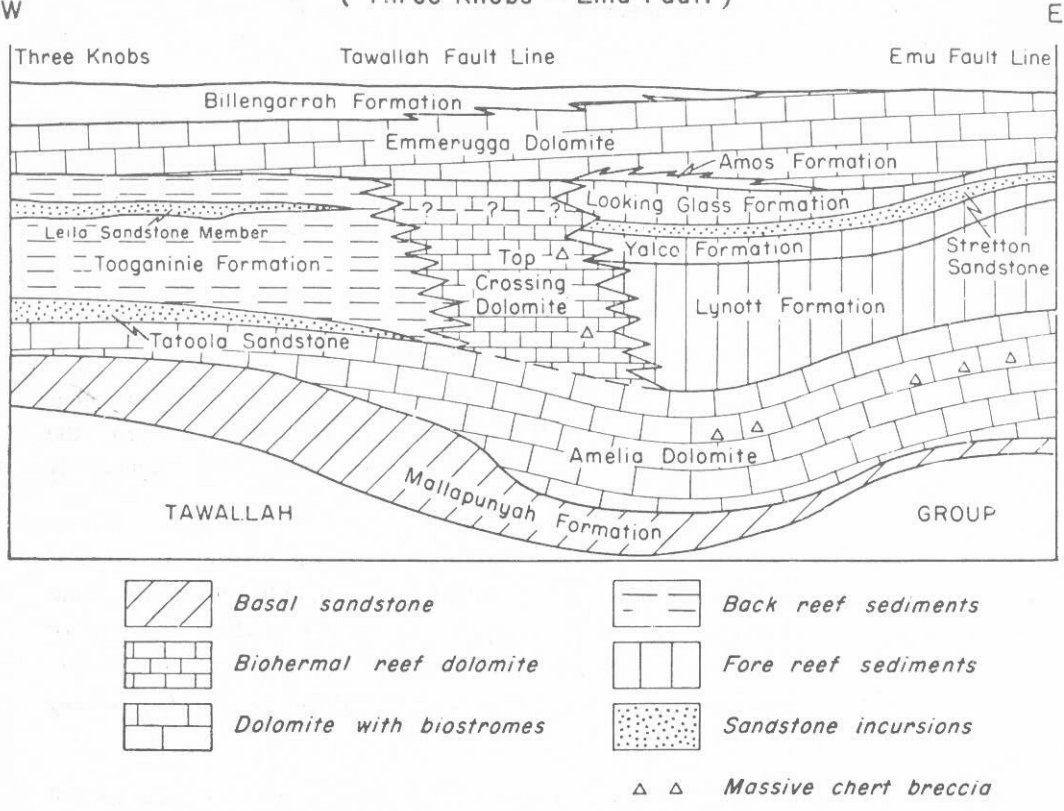
Era	Name	Thickness in feet	Rock Types	Topography	Distribution	Remarks
Lower (?) Proterozoic	McArthur Group — Karns Dolomite (Pmr)	about 300	Dolarenite, dolomite, algal dolomite, laminated oolitic and algal chert, dolomitic siltstone and sandstone, silty and sandy dolomite.	Low-lying areas between exposures of Masterton Formation, dissected plateaux.	Extreme east of Sheet area. Widely occurs on Robinson River and Calvert Hills Sheet areas.	Only representative of McArthur Group on the shelf area.
	Billengarrah Formation (Pmp)	Variable. To maximum 4000 in Three Knobs area.	Massive chert, chert breccia, fine to medium-grained sandstone, siltstone, dolomite.	Low hills, occasional strike ridges to 100 feet.	Widespread, irregular distribution.	Facies change with Emmerugga Dolomite in north-west.
	Emmerugga Dolomite (Pme)	2700	Massive dolomite, often algal. Also chert breccia, dolomite breccia, dolomite conglomerate, dolomitic sandstone, siltstone.	Rough low hills to 100 feet high.	Widespread irregular distribution. Not present in the Batten Creek area in the north-east.	
	Amos Formation (Pmm)	1150	Dolomitic siltstone, dolomitic sandstone, dolomite, sideritic chert.	Low hills to 50 feet high.	North and west of Abner Range.	Siderite-bearing cherts form local markers.
	Stott Formation (Pms)	about 2500	Silicified oolitic limestone, chert, minor dolomite, sandstone.	Poor outcrop, low rounded hills.	Batten Creek area only on east side of Tawallah fault line.	Equivalent to the Amos Formation and the Emmerugga Limestone.
	Smythe Sandstone (Pmy)	600	Quartz sandstone, feldspathic sandstone. Pebble to cobble conglomerate.	Resistant ridge to 200 feet high.	Restricted to east of Tawallah fault line in Batten Creek area.	
	Batten Sub-Group — Looking Glass Formation (Pmo)	260 to 750	Chert, chert breccia. Also dolomitic siltstone, sandstone.	Less resistant than Smythe Conglomerate and Stretton Sandstone.	Restricted to east of Tawallah fault line.	
	Stretton Sandstone (Pmr)	100 to 800	Flaggy fine to medium-grained, occasionally cross-bedded quartz sandstone.	Resistant ridge to 200 feet high.	Widespread distribution east of Tawallah fault line.	Thickens north-eastwards.
	Yalco Formation (Pmj)	450. Thickens in north-east	Laminated, white, cherty siltstone, shale, and chert.	Resistant ridge to 200 feet high.	Widespread distribution east of Tawallah fault line.	
	Lynott Formation (Pmn)	2200	Dolomitic siltstone, cherty siltstone, silty and sandy dolomite, dolomitic sandstone, dolomite, quartz sandstone, dolomite breccia, chert breccia, chert.	Low hills, higher in south-east, to 200 feet.	Widespread distribution east of Tawallah fault line.	Dolomite more abundant in south-east. Grain size decreases north-eastwards.
	Donnegan Member (Pmnd)	about 350	Fine to medium-grained quartz sandstone, dolomitic sandstone.	Low hills to 30 feet high.	Restricted to east of the Tawallah fault line in the Batten Creek area.	
	Hammer Creek Member (Pmg)	about 1700	Flaggy white chert and cherty siltstone; massive chert breccia.	Poor outcrops, low rubble covered rises.	Restricted to eastern side of Tawallah Range.	
	Top Crossing Dolomite (Pmp)		Massive dolomite, chert breccia.	Rough ridges to 200 feet high.	Restricted distribution along north-striking Tawallah fault line.	Some algae. A biohermal dolomite.
	Bauhinia Downs Sub-Group — Tooganinie Formation (Pmt)	about 2700	Dolomitic siltstone and shale, dolomitic sandstone, flaggy to massive dolomite	Dolomite as low ridges. Siltstone, shale, sandstone, mainly as rubble.	Restricted to west of Tawallah fault line and southern part of Sheet area.	Rhythmically alternating. Numerous halite pseudomorphs.
	Leila Sandstone Member (Pmi)	Generally about 60. Thickens to 500 in south-west.	Medium to coarse-grained, cross-bedded dolomitic sandstone, minor algal dolomite, quartz sandstone.	Low rough ridge to 30 feet high.	Restricted to west of Tawallah fault line and southern part of Sheet area. Not present in extreme north.	
	Tatoola Sandstone (Pmd)	460	Quartz sandstone, feldspathic sandstone, dolomitic sandstone. Minor dolomite and siltstone.	Cuesta ridge up to 100 feet high. Modified double ridge where dolomite or siltstone present.	Restricted to west of Tawallah fault line.	Ferruginous matter fills gypsum and calcite pseudomorphs. Subsidiary dolomite mainly in the north, siltstone in south.
	Amelia Dolomite (Pmd)	about 6000 max. 770 north of Leila First Crossing.	Dolomite, often algal, sandstone, chert, siltstone, chert breccia, dolomite breccia, minor siderite bands.	Rough hills to 100 feet high. Chert breccia resistant ridge to 200 feet high.	Widespread.	Thickest in the east of the area, under 1000 feet west of Tawallah fault line. Chert breccia mainly in the east.
	Barney Creek Member (Pmq)	1200	Ferruginous shale, dolomite breccia, dolomite, tuff.	Poor outcrop. Low hills. Crops out best in creeks.		Mineralized. Ore restricted to ferruginous (pyritic) shale at depth. Maximum thickness of Member occurs in H.Y.C. area.
	Mallapunyah Formation (Pml)	2500	Ferruginous sandstone, purple siltstone, dolomite, algal chert. Minor siderite bands.	Sandstone forms resistant hills. Elsewhere low rounded hills.	Wide distribution.	Usually pink to purple. Thins eastwards. More sandy to west of Tawallah fault line. Algal chert and beds containing botryoidal quartz form good local markers.
	Warramana Sandstone (Pmx)	about 200	Blocky, white to pink, medium quartz-sandstone.	Resistant ridges.	Restricted to eastern side of Tawallah Range.	Torrentially cross-bedded.
	Festing Creek Formation (Pmz)	about 500	Pink dolomite, chert, siltstone, dolomitic siltstone.	Poor outcrops, low rubble covered rises.	Restricted to eastern side of Tawallah Range.	

TABLE 3
STRATIGRAPHY — BAUHINIA DOWNS SHEET AREA — ROPER GROUP

Era	Name	Thickness in feet	Rock Types	Topography	Distribution	Remarks
Upper(?) Proterozoic	Roper Group: Cobanbirini Formation (Prb)	West Centre East about 4000	Flaggy siltstone, medium-grained quartz sandstone.	Poor outcrop. Sandstone forms low ridges to 50 feet high.	Widespread throughout.	Nowhere fully exposed. Equivalent to the Maiwok Sub-group (Urapunga, Hodgson Downs Sheet areas).
	Bessie Creek Sandstone (Pre)	West Centre East about 1200 580 140	Strongly jointed, medium-grained quartz sandstone.	Ridges to 300 feet high. Isolated pillars, 50 feet high formed by jointing.	Widespread.	
	Corcoran Formation (Pro)	about 1700 500 60	Flaggy brown siltstone, medium-grained quartz sandstone, ferruginous, sandstone.	Poor outcrop, sandstone forms low ridges.	Widespread.	
	Abner Sandstone (Pra)	about 1385 725 220	Strongly jointed medium-grained quartz sandstone, minor siltstone, ferruginous sandstone, fine conglomerate.	Ridges to 300 feet high. Isolated pillars, 50 feet high, formed by jointing.	Widespread.	
	Hodgson Sandstone Member (Prh)	about 725	Strongly jointed, medium-grained quartz sandstone.	Ridges to 200 feet high.	Members only recognized in west of Sheet area.	
	Jalboi Member (Prj)	about 230	Purple ferruginous sandstone, minor shale bands.	Less resistant than other two members		
	Arnold Sandstone Member (Prx)	about 350	Strongly jointed, medium-grained quartz sandstone.	Ridges to 200 feet high.		
	Crawford Formation (Prr)	about 700 740 Three Knobs 450 Abner Range 430	Thickly flaggy, glauconitic, quartz sandstone, feldspathic sandstone. Flaggy, purple, micaceous siltstone.	Sandstone ridges to 100 feet high. Exposed in scarp of Abner Range.	Widespread.	
	Mainoru Formation (Pru)	about 1830 1780 Three Knobs 800 Abner Range	Flaggy, purple and green, micaceous siltstone and shale, fine-grained, glauconitic sandstone, feldspathic sandstone.	Very poor outcrop—low rounded hills. Mainly soil cover.	Widespread.	
	Kilgour Sandstone Member (Prg)	about 200 in the Abner Range	Fine to medium-grained sandstone, siltstone.	Cuesta 150 feet high.	The Abner Range and Emu Fault area. Not present in west.	
	Limmen Sandstone (Pri)	1400 to 3800 380. Three Knobs 10 to 100 Abner Range and farther east.	Fine to medium-grained quartz sandstone, flaggy micaceous sandstone and siltstone, conglomerate.	Resistant ridge to 200 feet high.	Widespread.	Conglomerate at base in south-west. Poorly outcropping siltstone at base in places.

(4) Minor marginal uplift during deposition of the fore and back-reef sediments, which resulted in the deposition of sand (the *Stretton Sandstone* in the east, the *Leila Sandstone Member* of the Tooganinie Formation in the west).

FIG. 3 DIAGRAMMATIC SECTION OF THE McARTHUR GROUP
(Three Knobs – Emu Fault)



(5) Cessation of the development of the reef and consequently of fore and back-reef sedimentation. Widespread deposition of carbonate muds followed (*Emmerugga Dolomite*). However, in the north-east sand with pebble and cobble fragments (*Smythe Sandstone*) was laid down before carbonate muds—here mainly oolitic—were deposited (*Stott Formation*). Elsewhere mud, carbonate mud, and chert (*Amos Formation*), were deposited,

as on the north side of the Abner Range. In the north and north-west, sand, mud, carbonate mud, and chert (*Billengarrah Formation*) were laid down in shallow water; towards the close of McArthur Group time these extended southwards to the Abner Range.

The back-reef sediments are termed the *Bauhinia Downs Sub-Group* and the fore-reef sediments the *Batten Sub-Group*.

In the north-east of the Sheet area the rocks below the Lynott Formation and above the Masterton Formation consist of siltstone, dolomite, quartz sandstone, and chert breccia. In detail they do not resemble the Mallapunyah Formation or the Amelia Dolomite and have therefore been mapped as separate units, the *Festing Creek Formation* and the *Warramana Sandstone*; chert and chert breccia at the base of the Lynott Formation have been mapped as the *Hammer Creek Member*, and a distinctive sandstone and dolomitic sandstone band at the top as the *Donnegan Member*. (Volcanics occur in the Festing Creek Formation in the Mount Young Sheet area (Plumb & Paine, 1964).

The lithologies of the outcrops in the extreme west and east of the area differ markedly from those in the main outcrop area. Around Lansen Creek in the extreme west of the Sheet area the McArthur Group consists of fine-grained sandstone, chert, siltstone, fine bands of rhythmically alternating dolomitic sandstone and dolomite with halite pseudomorphs, and pebble conglomerate. The sequence includes much less carbonate than that in the centre of the Sheet area, and as the Group is absent on the Tanumbirini Sheet area (Paine, 1963) the margin of the basin probably lay near the western edge of the Bauhinia Downs Sheet area.

In the extreme east of the Sheet area the McArthur Group is represented only by the *Karns Dolomite*, which is about 300 feet thick and appears to have been deposited on a stable shelf (Yates, 1963). It is uncomformable on the Tawallah Group.

The thickness of the McArthur Group in the east of the main area of outcrop is 13,000–14,000 feet, in the west about 11,000 feet, and in the north-west probably about 7000 feet. Around Lansen Creek in the extreme west of the Sheet area it is about 10,000 feet.

Roper Group

The Roper Group is widely distributed in the McArthur Basin. In the Bauhinia Downs Sheet area the three main areas of outcrop are the Abner Range, east of the Emu Fault, and in the west.

The Group is unconformable on the McArthur Group; with local exceptions the unconformity is very slight.

TABLE 4

STRATIGRAPHY — BAUHINIA DOWNS SHEET AREA — PALAEOZOIC TO RECENT

Era	Period	Name	Thickness in feet	Rock Types	Topography	Distribution	Remarks
Cainozoic	Quaternary	Czs	Usually thin — under 50.	Soil, sand, ferruginous cemented detritus.	Flat spinifex and grass-covered plains.	Widespread.	Mainly transported, possibly partly residual.
		Qa	80 maximum	Alluvium.	Flat grass-covered plains with gilgais.	Lynott Hill–McArthur River Homestead area, around Borroloola. Batten Creek, Limmen Bight River.	
		Czb	Thin.	Black soil	Flat grass-covered plains with gilgais	Mainly Balbirini Creek–Golliger Creek and south of Lansen Creek.	Overlying the Golliger Beds. Residual.
		Czl	Thin.	Lateritic soil including pisolitic ironstone rubble.	Flat low country and Mesozoic caps.	Mainly in west of Sheet area and Tawallah Range.	
	Tertiary	Golliger Beds (Tg)	Thin, possibly 50 or less.	Massive limestone.	Low outcrops. Usually only black soil cover.	Golliger Creek–Balbirini Creek area.	Contains gastropods. Lacustrine.
				UNCONFORMITY			
Mesozoic	Lower Cretaceous	Kl	300 about.	White, medium-grained quartz sandstone and conglomerate, yellow fine-grained clayey sandstone, leached siltstone.	Flat-topped hills to 300 feet high. Caps on Proterozoic sediments.	Widespread, isolated outcrops.	Marine mollusca and freshwater plant remains.
				UNCONFORMITY			
Palaeozoic	Lower to Middle Cambrian	Top Springs Limestone (Ct)	Not known.	Massive cavernous limestone, laminated cherty limestone.	Flat-lying with large boulders.	Extreme south of Sheet area.	Fossiliferous.
				UNCONFORMITY			
	Lower Cambrian?	Bukalara Sandstone (Clb)	100 to 300. 1000 in Abner Range	Jointed medium to coarse-grained sandstone usually feldspathic.	Flat-lying plateau to 300 feet with steep gorges.	Bukalara Range, within the Abner Range and extreme north-west corner of Sheet.	Probably Lower Cambrian.

The Roper Group consists of quartz sandstone, siltstone, shale with subordinate ferruginous siltstone, ferruginous sandstone, feldspathic sandstone, fine to cobble conglomerate, glauconitic sandstone, glauconitic, micaceous siltstone, and micaceous shale. Units comprised dominantly of medium-grained quartz sandstone, the *Limmen Sandstone*, *Abner Sandstone*, and *Bessie Creek Sandstone*, alternate with units that are dominantly finer-grained, the *Crawford Formation* and *Mainoru Formation* (these two formations are characteristically glauconitic), *Corcoran Formation,* and the *Cobanbirini Formation.* These alternations, which may indicate a change in provenance conditions rather than variation in depth of water, and the remarkably uniform lithology throughout the McArthur Basin of the various units are the Group's outstanding characteristics. In the Bauhinia Downs Sheet area the Group thickens westwards (see Fig. 4) and is thickest (preserved thickness about 16,000 feet) on the eastern part of the Tanumbirini Sheet area (Paine, 1963). This indicates a shift of the area of maximum deposition from the central Bauhinia Downs Sheet area during deposition of the McArthur Group to the east Tanumbirini Sheet area (or further westwards) during deposition of the Roper Group. It also indicates a probable extension of the Basin, because the McArthur Group does not occur in the Tanumbirini Sheet area.

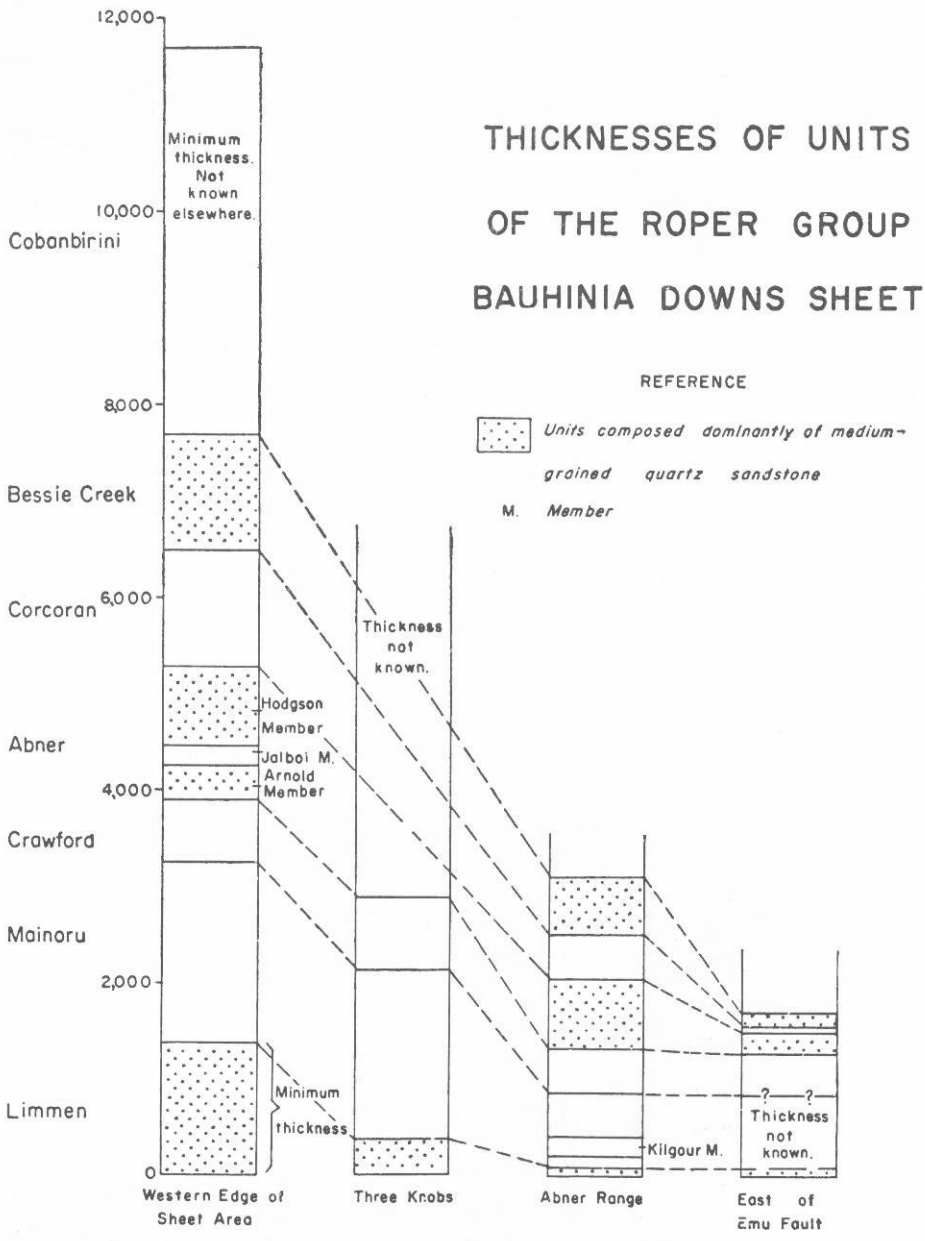
Regionally in the McArthur Basin the Roper Group becomes thinner northwards and north-eastwards, and may suggest a provenance to the south or south-west. This suggestion is supported by the fact that its equivalent, the South Nicholson Group (Smith & Roberts, 1963), is not less than 22,000 feet thick in the south of the Mount Drummond Sheet area.

Cambrian

The *Bukalara Sandstone* occurs widely throughout the Carpentaria region. It crops out principally in the east and south-east of the Sheet area, but also occurs in the Abner Range and in the extreme north-west. The Sandstone, which is flat-lying or, in places, gently warped, forms a plateau over the folded Proterozoic rocks. Throughout the Sheet area, it is characterized by its slight feldspathic nature, its long, arcuate cross-bedding, and its joint pattern.

The Sandstone is normally 100–300 feet thick, but in the Abner Range, where it is folded into a syncline, it is 1000 feet thick. In the Hodgson Downs Sheet area (Dunn, 1963a) sandstone dykes of the Bukalara Sandstone project into the overlying Lower Cambrian Nutwood Downs Volcanics and therefore suggest that the Bukalara Sandstone is also Lower Cambrian. No fossils have been found in the formation.

Fig.4


THICKNESSES OF UNITS
OF THE ROPER GROUP
BAUHINIA DOWNS SHEET
REFERENCE
Units composed dominantly of medium-grained quartz sandstone
M. Member
12,000
10,000
8,000
6,000
4,000
2,000
0
Cobanbirini
Bessie Creek
Corcoran
Abner
Crawford
Mainoru
Limmen
Minimum thickness. Not known elsewhere.
Hodgson Member
Jalboi M.
Arnold Member
Minimum thickness
Thickness not known.
Kilgour M.
? ?
Thickness not known.
Western Edge of Sheet Area
Three Knobs
Abner Range
East of Emu Fault

JMF

The *Top Springs Limestone* crops out only in the extreme south of the Bauhinia Downs Sheet area ; it occurs more widely on the Wallhallow Sheet area. It unconformably overlies units of the McArthur Group and Roper Group and, on the Wallhallow Sheet area, the Bukalara Sandstone. At Top Springs Homestead, Wallhallow Sheet area, fossils including *Redlichia* (not determined specifically) of upper Lower Cambrian or lower Middle Cambrian age, have been found (Randal & Nichols, 1963, Appendix 1). The Limestone is unconformably overlain by Mesozoic sediments.

Mesozoic

In the Bauhinia Downs Sheet area Mesozoic sediments crop out extensively ; they are best exposed in the west and south-west.

Claystone and clayey sandstone overlie quartz sandstone. A basal conglomerate with some boulders up to 3 feet across occurs in some places ; pebbles occur intermittently throughout the quartz sandstone. Neocomian and Aptian marine Mollusca have been collected from the claystone and clayey sandstone, and Neocomian plant remains from the quartz sandstone and conglomerate (Skwarko 1961a, 1961b, 1962a, 1962b). Fossils identified (Skwarko, 1962b) include :

Pelecypoda :

Astarte (?) sp. nov., *Astarte* (?), *Barbatia* (?) sp.
Camptonectes sp. nov., *Camptonectes* sp. indet.
Entolium sp., *Exogyra* sp.
Fissilunula clarkei (Moore), 1870, *Maccoyella corbiensis* (Moore), 1870. *Maccoyella* sp., *Nototrigonia* cf. *cinctuta* (Etheridge Jnr), 1902.
Tatella aptiana Whitehouse, 1925, (?) *Thracia primula* Hudleston, 1890, *Trigonia* sp. nov.

Gastropoda :

Gen et sp. nov. aff. *Nerita*

Cephalopoda :

New species of Dimitobelidae.

Plants :

Arthrotaxites sp., *Brachyphyllum* sp., *Elatocladus planus* (Feistmantel), *Elatocladus* sp., *Hausmannia* sp., *Microphyllopteris gleichenioides* (Oldham & Morris), *Otozamites bechei* Brongniart, *Otozamites bengalensis* (Morris), *Pagiophyllum* sp., *Pterophyllum fissum* (Feistmantel), *Thinnfeldia pinnata* (Walker), *Williamsonia* sp.

In most places the thickness of the Mesozoic is less than 100 feet, but locally it is 300 feet thick, e.g., east of Tawallah Homestead. The Mesozoic sediments were deposited throughout most of the area and covered a pre-Mesozoic land surface with a relief similar to that of to-day. Mesozoic sediments cap parts of the Tawallah Range—about 600 feet above present sea level.

Tertiary

Golliger Beds

The *Golliger Beds* crop out poorly in the Golliger Creek area between O. T. Downs Homestead and Three Knobs, and in the Limmen Bight River north-west of Bauhinia Downs Homestead. The Beds, which are massive white to light yellow limestone, are commonly covered by residual black soil. Black soil around Lansen and October Creeks may also overlie the Golliger Beds. The Beds contain freshwater Tertiary gastropods (J. M. Dickins, pers. com.) and are lacustrine. Similar limestones, also considered to be Tertiary, are found elsewhere in the Carpentaria Province and the Barkly Tableland, e.g., Cleanskin Beds (Smith & Roberts, 1963). The thickness of the Golliger Beds is not known, but is probably less than 50 feet.

Igneous Intrusions

Small gabbro and dolerite intrusions are associated with the Scrutton Volcanics and the volcanics in the Masterton Formation. Dykes of syenite and microsyenite up to 200 feet thick crop out in the eastern side of the Tawallah Range and in the Emu Fault Zone, east of McArthur River Homestead.

STRUCTURE

The structure of the area is shown in Figure 5.

Though the Scrutton Volcanics are usually slightly more folded than the McArthur Basin Succession the two units had a similar tectonic style. Any deformation that the Scrutton Volcanics suffered before the deposition of the McArthur Basin Succession was slight. Dips in the Volcanics are under 50°.

The Proterozoic sequence in the Bauhinia Downs Sheet area may be divided into three structural areas :

(1) an eastern area lying to the east of the Emu Fault ;

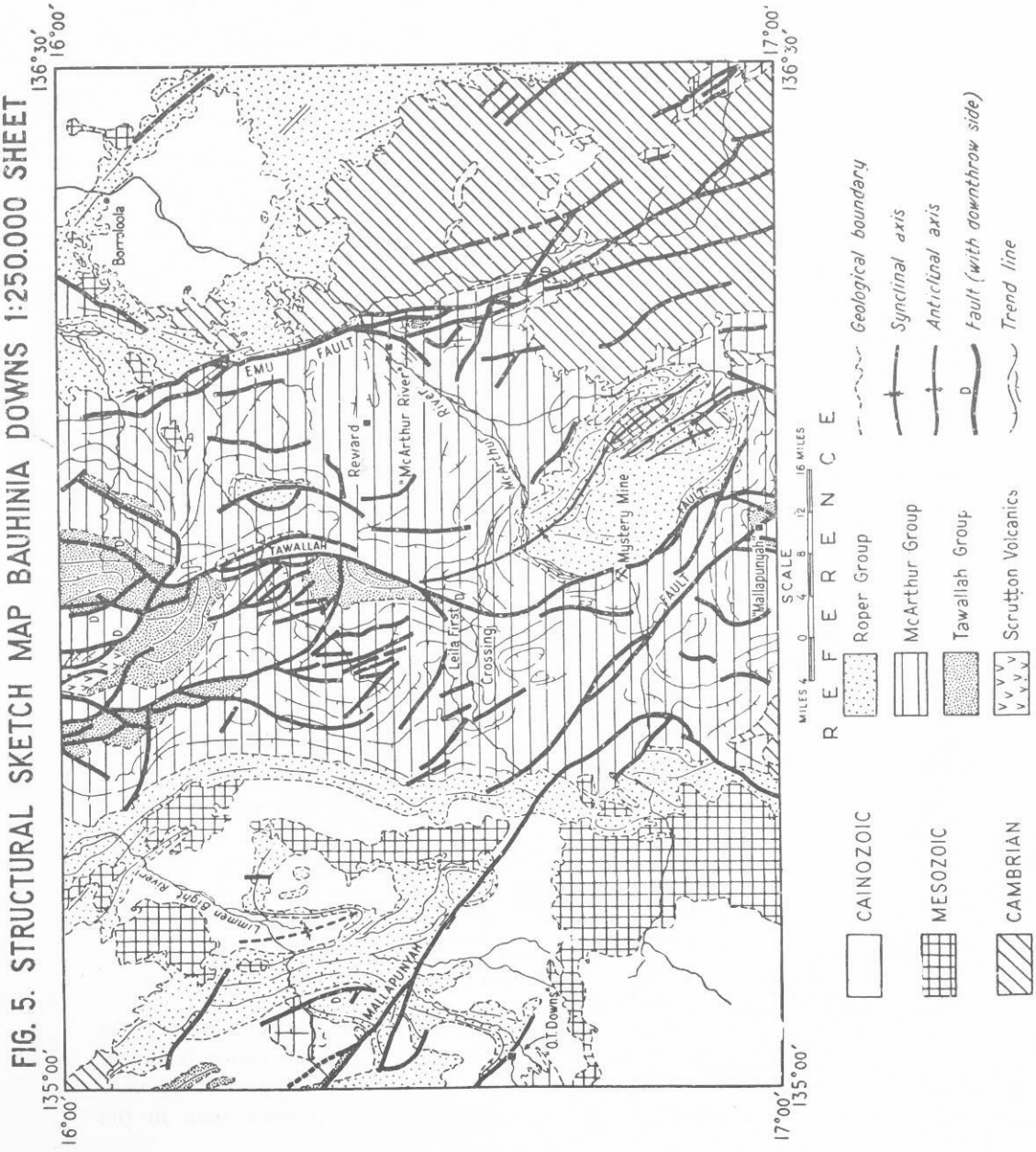
(2) a central area between the Emu Fault and a north-striking line approximately through Three Knobs ;

(3) a western area lying to the west of the line through Three Knobs.

The *eastern area*, which is part of a larger area which extended over the Robinson River Sheet area, was stable. The McArthur Basin Succession is largely obscured by the Cambrian Bukalara Sandstone, but the rocks appear to be very gently folded, along north-westerly axes. Faulting is less intense than in the

central part of the Sheet area. The dominant strike of the faults is north-west, and most of them also affect the Bukalara Sandstone. In the extreme south-east faulting is more intense and in places the beds dip at over 35°.

The outstanding tectonic feature of the Sheet area is the intense faulting which has affected the *central area.* Faults trend north to north-west ; those



trending north have the largest vertical throws and some in the Tawallah Range area have throws of more than 7000 feet. Three faults dominate the area—the *Tawallah Fault*, the *Emu Fault,* and the *Mallapunyah Fault.*

The *Tawallah Fault* runs right across the Sheet area, from south to north, although in the Tawallah Range area it is obscured by the presence of other major faults. Although markedly sinuous, the overall strike is north. The eastern side is downthrown by varying amounts, but little lateral movement is apparent ; the largest throw is north-north-east of Leila Creek First Crossing. The fault dips steeply to the east.

Evidence of initial activity on the fault line is the major effect it had on the distribution of rocks during deposition of the McArthur Group. It appears to have had no effect on the deposition of the Roper Group, but was active again in the Upper Proterozoic or Lower Cambrian, as is indicated by the unusual thickness of the Bukalara Sandstone in the Abner Range.

The *Emu Fault* lies some 20 miles to the east of the Tawallah Fault and strikes north-north-west in a straight line—unlike the sinuous Tawallah Fault. In the north, the Emu Fault is a single shear-plane, but in the Coxco Valley, east of McArthur River Homestead, where movement is greatest, at least three parallel fault-lines exist. Farther south the fault bifurcates. Movement, which is sub-vertical, is east side down. Vertical movement apparently is small, although the adjacent rocks are considerably distorted. The large thickness of the McArthur Group deposited to the west of the Fault suggests that it may have initially been west side down. Further, the marked thinning of the upper units of the Roper Group to the east of the Fault (see Fig. 4) also suggest movement on the Fault with west side down during, or immediately prior to, deposition of these units. Late movement on the Fault has affected the Cambrian Bukalara Sandstone.

The *Mallapunyah Fault* is the major north-west-trending fault. Unlike the north-trending faults it is transcurrent, the south side having been moved up to a mile west.

The regional strike of the rocks in the central area is north, although a west-striking cross-fold occurs in the Reward area. Folding is gentle, with dips averaging about 20°. In the Abner Range, where the Roper Group crops out in a closed syncline, the dips steepen to about 50°. The beds, where adjacent to major faults, such as the Tawallah and Emu Faults, are in many places steeply dipping, and locally they are overturned by 15°.

In the *western area,* west of a north-striking line through Three Knobs, the Roper Group is the main outcropping unit of the McArthur Basin Succession. Like other areas where the Roper Group crops out, e.g., the Abner Range, this area is little faulted. The rocks are folded into a broad south-pitching syncline which has an anticline flexure in its centre. The average dip is about 20° but in the Lansen Creek area dips of over 55° have been recorded.

The Cambrian, Mesozoic, and Tertiary sediments are mostly flat-lying, but in places the Bukalara Sandstone is gently folded, in particular in the Abner Range, where it is folded into a syncline in which dips as high as 25° occur. Faulting in the Cambrian sediments appears to have been mainly along established faults such as the Emu Fault, and minor movement occurred locally along pre-existing faults after the deposition of the Mesozoic rocks.

Jointing

Strong rectangular jointing is characteristic of both the Abner and Bessie Creek Sandstone. The strike of the joints varies with the strike of the bedding, one joint commonly being normal to the strike of the bedding. Pillars up to 50 feet high are formed by weathering of the rock along the joint planes.

The Bukalara Sandstone is strongly jointed in a west to north-west direction. In many places the joints persist over several miles and in places are faulted.

ECONOMIC GEOLOGY

Lead, zinc, and copper mineralization occurs mainly in the McArthur River Homestead area. Table 5 (modified from Kriewaldt, 1957) lists the main occurrences.

The prospects in the area may be divided into two groups : those in the Coxco Valley and those in the Reward–H.Y.C. area. The Coxco Valley prospects are Cooks, Coxs, Turnbull, Squib, and Cooleys. They are all close to the Emu Fault Zone, and may be remobilized syngenetic deposits, that is, mineralization may be syngenetic and have suffered remobilization, for instance at Cooks, which is at the junction of two faults. The second group includes the H.Y.C., Reward, W. Fold, Bald Hills, Barneys, and Teena prospects. All prospects occur within the Amelia Dolomite ; H.Y.C., W. Fold, and Teena are within the Barney Creek Member. Mineralization at H.Y.C. consists of sphalerite with galena and minor copper and silver minerals and occurs in pyritic shale at depth. At the surface, secondary minerals hemimorphite, hydrozincite, and smithsonite migrate into other rock types such as the dolomitic breccia. Poor outcrop and faulting east of the H.Y.C. make the extent of the ore-bearing rocks difficult to trace. The Member appears to be restricted to the McArthur River Homestead area, but the possibility of other similar beds elsewhere within the Amelia Dolomite cannot be ignored. The ore is considered syngenetic.

Bornite and chalcopyrite are associated with dolomite and chert in the Wollogorang Formation south-east of Tawallah Homestead in the Tawallah Range, and secondary malachite occurs in the Billengarrah Formation at Darcys prospect in the south of the Sheet area. Malachite is present in barytes-filled cavities in the Leila Sandstone Member of the Tooganinie Formation. Barytes also has been observed in one place in the Mallapunyah Fault zone. Manganese occurs locally in small amounts in the Stott Formation.

Ironstone of probable economic importance has been found elsewhere in the Gulf of Carpentaria region—in the Roper River area (Dunn, 1963b) and in the South Nicholson Basin (Carter & Zimmerman, 1960; Smith & Roberts, 1963). In the Bauhinia Downs Sheet area ferruginous fine conglomerate, sandstone, and siltstone occur at the top of the Abner Sandstone in the Roper Group, and ferruginous sandstone and siltstone are found in the Mallapunyah Formation at the base of the McArthur Group. These occurrences are probably uneconomic. Coarse-grained siderite bands occur in the McArthur Group—mainly in the Mallapunyah Formation and the Amelia Dolomite—but are not persistent and are too small to be economically important at present.

Water

Most of the lower ground is suitable for cattle raising and sufficient surface water is available for stock needs. One successful bore (at O. T. Downs Homestead) has been drilled for water.

Bores were drilled unsuccessfully at Borroloola in the early part of the twentieth century in the hope of finding coal in the Roper Group and Cretaceous rocks (which were then considered to be Carboniferous).

TABLE 5
MINERAL DEPOSITS

Deposit	Minerals	Occurrence	Structure of Host Rock
Cooley	Galena, minor malachite and hydrozincite.	Small veins and vughs in massive, grey to brown Amelia Dolomite.	Steeply dipping—adjacent to Emu Fault.
Cooks	Galena, hydrozincite, cerussite, smithsonite, amorphous lead carbonate.	Vughs and veins with some gossanous loam in siliceous and ferruginous cap rock. Extends along north-striking line bounded by massive dolomites and silty dolomites (Amelia Dolomite).	Junction of two faults.
Coxs	Hydrozincite, galena, smithsonite.	Veins and vughs within massive Amelia Dolomite.	Flat-lying. Adjacent to north-striking fault passing through Cooks.
Turnbull	Malachite, galena, cerussite.	Vughs in massive Amelia Dolomite below contact with a massive chert breccia within Amelia Dolomite.	Steeply dipping east.
Squib	Malachite, cuprite, chalcocite.	Veins and stringers in Amelia Dolomite below contact with a chert breccia within Amelia Dolomite. Same stratigraphic position as Turnbull.	As above.
H.Y.C.	Sphalerite, pyrite, galena at depth. Hemimorphite, hydrozincite and smithsonite on surface.	Disseminated fine sphalerite and galena confined to pyritic shales at depth. Supergene enrichment at surface with complete removal of ore minerals from shales and redeposition within dolomite breccias enclosed by shales. Within Barney Creek Member of Amelia Dolomite.	Steeply dipping beds on eastern limb of north-pitching anticline. Inferred fault about 600 yards to the east.
Barneys	Galena.	Disseminated crystals and veins within brown, massive Amelia Dolomite. Immediately underlying Barney Creek Member.	Moderately dipping beds on western limb of H.Y.C. anticline.
W. Fold	Cerussite and lead oxide. Minor hydrozincite and ankerite.	Disseminated low grade mineralization in pyritic shale. Same stratigraphic position as H.Y.C.	Tightly folded overturned synclinal structure.
Bald Hills	Galena, minor sphalerite.	Veins, vughs and disseminated crystals of galena in ferruginous gossan within massive dolomite of the Amelia Dolomite. Same stratigraphic position as Barneys.	Moderate dip to south.
Teena	Cerussite, anglesite.	Disseminated low-grade mineralization in silicified pyritic shales of the Barney Creek Member. Same stratigraphic position as H.Y.C.	Low dips to east.
Reward	Cerussite, anglesite, pyromorphite and lead oxides. Argentite and cerargyrite.	High-grade supergene enrichment of silicified chert breccia overlying pyritic shale of Barney Creek Member.	Low dips to south. Small faults in vicinity.

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