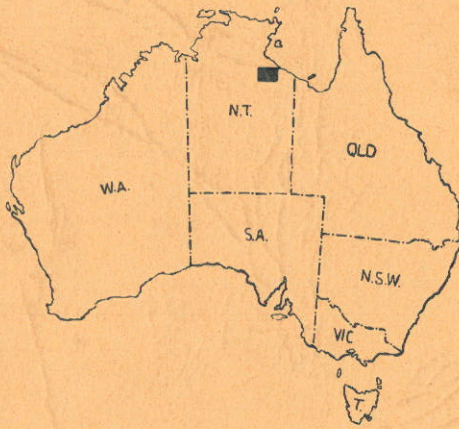


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EXPLANATORY NOTES

MOUNT YOUNG, N.T.



Sheet SD/53-15

International Index

COMMONWEALTH OF AUSTRALIA

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

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Compiled by K. A. Plumb and A. G. L. Paine

*Issued under the authority of Senator the Hon. Sir William Spooner,
Minister for National Development*

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DEPARTMENT OF NATIONAL DEVELOPMENT

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Secretary : SIR HAROLD RAGGATT, C.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Explanatory Notes on the Mount Young Geological Sheet

Compiled by K. A. Plumb and A. G. L. Paine

The Mount Young 1 : 250,000 Sheet area lies between latitudes 15° 00' and 16° 00' S., and longitudes 135° 00' and 136° 30' E. and is adjacent to the south-western corner of the Gulf of Carpentaria.

The only permanently inhabited settlement on the Sheet area is Bing Bong Station, on the coast ; it has a population of three Europeans and a few aborigines. Access to the area is by two vehicle tracks suitable for four-wheel-drive vehicles during dry weather. One track links Bing Bong Station to Borroloola (5 miles south of the Sheet area on the McArthur River), and the other links Mount Young to an all-weather graded road on the Bauhinia Downs Sheet area which connects Borroloola with Daly Waters. A weekly air service connects Borroloola with Mount Isa and Tennant Creek.

Maps and air photographs of the Sheet area available during 1961 were : air photographs at a scale of 1 : 50,000 flown by the Royal Australian Air Force in 1950 : an uncontrolled photomosaic at a scale of approximately 4 miles to 1 inch ; and a planimetric map at a scale of 1 : 250,000 prepared by the Division of National Mapping, Department of National Development, from a controlled, photo-scale slotted-template assembly. The geological map was compiled on a photo-scale trace of this assembly and reduced to 1 : 250,000 scale.

Previous Investigations

Leichhardt (1847) passed through the Sheet area. Parkes (1891) travelled from Borroloola to a point about 5 miles south of the Four Archers near the Limmen Bight River (the old 'Valley of Springs Homestead', whose exact location is now unknown) and noted a number of sandstone ranges.

The discovery of silver-lead mineralization at McArthur River encouraged prospecting in the region, and in 1918 copper mineralization was discovered at Coppermine Creek, in the south of the area.

In 1955 L. McAlister, of Mount Isa Mines Limited, made a geological reconnaissance of the country south-east of the Limmen Bight River, and in 1956, in collaboration with E. J. Malone of the Bureau of Mineral Resources, produced a photo-geological map covering the Urapunga, Mount Young, Hodgson Downs, and Bauhinia Downs 1 : 250,000 Sheet areas (Malone, 1956). Since then Mount Isa Mines Limited and Carpentaria Exploration Company have prospected and geologically mapped the McArthur River area and have extended this work northwards on to the southern part of the Mount Young Sheet area.

During 1958 geologists of Enterprise Exploration Company Pty Limited carried out a helicopter survey of the Bulman-Urapunga area which extended as far south as the estuary of the Limmen Bight River (Patterson, 1958).

These notes, and the map which they accompany, are based on a geological survey of the Carpentaria Proterozoic Province carried out during 1960-61 by the Bureau of Mineral Resources.

PHYSIOGRAPHY

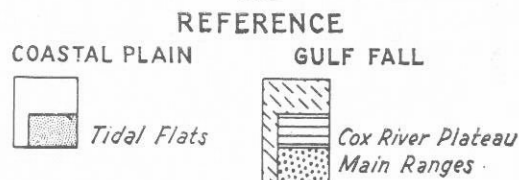
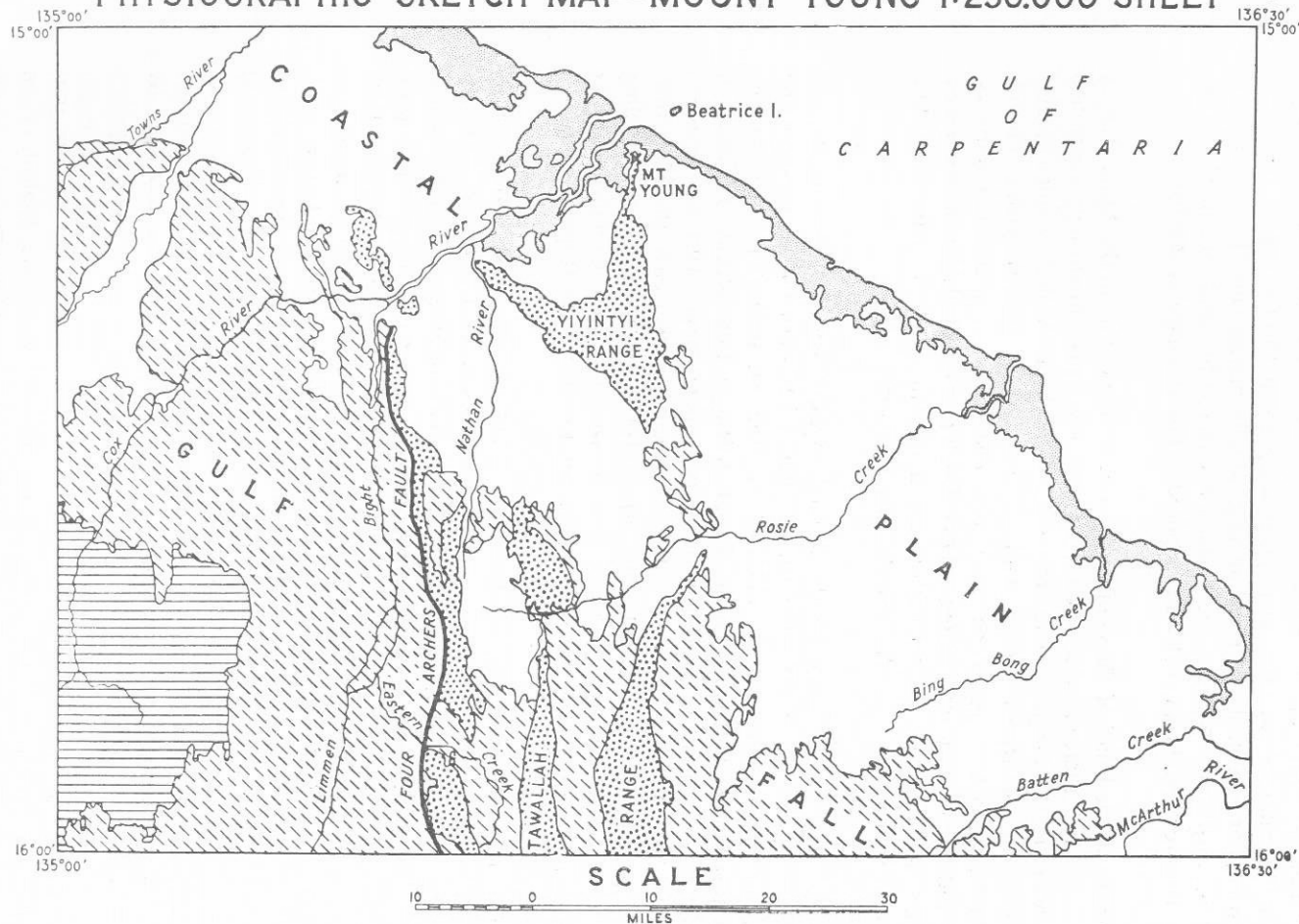
The western part of the Mount Young Sheet area is drained by the Limmen Bight River (and its tributaries, the Cox and Nathan Rivers), which flows into the Gulf of Carpentaria. The Towns River drains the north-west. The eastern part is drained by Rosie and Bing Bong Creeks and a few minor streams. The south-east is drained by the McArthur River and its tributary, Batten Creek. A Recent eustatic change in sea-level of about 30 feet has entrenched the streams into their own alluvium.

The Sheet area contains parts of two of the major physiographic divisions of the Carpentaria Province—the *Gulf Fall* (Stewart, 1954) and the *Coastal Plain* (Dunn, Smith, & Roberts, in prep.) ; each has a distinct drainage pattern (Fig. 1). The Gulf Fall has a complicated pattern of north-flowing subsequent streams, controlled by the structure of the bed-rock, but the Coastal Plain contains a simple drainage pattern of consequent streams flowing north-east.

The *Gulf Fall* is the area of dissected, mainly Proterozoic, rocks in the south and west of the area. The elevation of the Gulf Fall ranges from 150 feet in the east to over 600 feet in the south-west, and in the belt of ranges through the central part of the Sheet area. The division in places has been further subdivided into the Main Ranges and the Cox River Plateau, both of which occupy elevated parts of the Sheet area (Fig. 1).

The *Main Ranges* are the Tawallah Range, the Yiyintyi Range, and an unnamed range bordered on the west by the Four Archers Fault. They occur where resistant rocks of the Tawallah Group, particularly the Yiyintyi Sandstone and the Sly Creek Sandstone, crop out in a north-trending belt through the centre of the Sheet area. The Ranges have a uniform elevation of about 600 feet and may represent an old peneplain surface. The maximum relief at the southern end of the Yiyintyi Range is about 500 feet above the surrounding plains. The Ranges are bounded by either dip slopes or very steep fault scarps. Steep-sided valleys, up to 250 feet deep, are produced by the non-resistant Wollogorang Formation and Peters Creek Volcanics. The shape and distribution of these valleys is irregular because of extensive faulting.

PHYSIOGRAPHIC SKETCH MAP-MOUNT YOUNG 1:250.000 SHEET Fig.1



The *Cox River Plateau* lies in the south-east of the Sheet area, where the horizontal Lower Cambrian Bukalara Sandstone and Cox Formation crop out. The elevation of the Plateau is about 600 feet. Near Willara Twin Springs the Cox River Plateau is bounded by a marginal scarp about 150 feet high. Elsewhere this scarp is poorly defined and the Plateau gradually merges into the less elevated parts of the Gulf Fall. Most of the Plateau is covered by sand, but in places the horizontal Lower Cambrian rocks are exposed. The drainage is dendritic.

Elsewhere, the relief of the Gulf Fall is not as marked as in the Main Ranges and the Cox River Plateau subdivisions ; nevertheless, it is still strongly controlled by the underlying lithologies. The area west of the Four Archers Fault contains folded rocks of the Roper Group with some inliers of the McArthur Group. Differential erosion has caused the resistant sandstones to crop out as hog-backs, cuestas, and mesas, with intervening valleys developed on the less resistant rocks. The ridges are generally 100 to 200 feet above the valleys ; the individual sandstones forming the ridges have a characteristic topography.

Topographic relief, except for the Main Ranges, is generally less to the east of the Four Archers Fault. Near the headwaters of Eastern Creek, rocks of the Roper Group form strike ridges, and rocks of the McArthur Group form low rounded hills. Immediately east of the Tawallah Range, fault blocks of Masterton Formation and Warramana Sandstone form prominent mesas with less resistant rocks of the McArthur Group in the valleys between. Farther east, the McArthur Group crops out as low rounded hills, 50 to 100 feet above the surrounding plain. In the south-east of the Sheet area horizontal Lower Cretaceous rocks form mesas up to 50 feet high overlying horizontal rocks of the Roper Group.

The *Coastal Plain* is the low-lying area between the coast and the hilly country of the Gulf Fall ; its elevation ranges from sea level to about 100 feet. The Plain is normally about 30 miles wide, but in places it extends 40 miles inland. The Coastal Plain is underlain by mainly horizontal Lower Cretaceous rocks, with some inliers of Proterozoic rocks. A laterite profile, commonly truncated by erosion, is exposed in creek banks near the coast. The Coastal Plain is now covered by sand, probably of marine origin, and is commonly underlain by a cemented detrital laterite ; alluvial flats occur along the major streams. Ancient north-west-trending sand dunes of very low relief are exposed in many places on the Coastal Plain. They have been shown on the geological map as 'Fixed, ancient, coastal deposits'. They have been cemented by ferruginous material and probably were originally derived from coastal deposits, perhaps modified by wind action.

The *Tidal Flats* occur on the seaward side of the Coastal Plain and are part of it. The Flats, which form a zone about 5 miles wide, are typical of an emerging coast. The greater part of the zone represents low-lying emerged lagoons and is subject to seasonal and tidal flooding. Numerous meandering tidal creeks

cross this area ; ferruginous silt and fine sand and evaporites have been deposited. Dunes of ferruginous and shelly sand, up to 20 feet high, occur along the beaches ; they represent emerged off-shore bars. Smaller dunes are present along the inner edge of the Tidal Flats.

STRATIGRAPHY

A sequence of about 30,000 feet of Proterozoic sediments and volcanics is exposed in the Mount Young Sheet area and unconformably overlies the Lower Proterozoic Scrutton Volcanics. The sequence is divided into three Groups—the Tawallah Group, consisting mainly of arenites ; the McArthur Group, of dominantly dolomite and dolomitic rocks ; and the Roper Group, of interbedded arenites and lutites.

The Proterozoic rocks are unconformably overlain by the horizontal Lower Cambrian Bukalara Sandstone and Cox Formation. Horizontal Lower Cretaceous rocks unconformably overlie all the older units. Large parts of the Sheet area are covered by Cainozoic soil, sand and alluvium.

PROTEROZOIC

The Proterozoic* rocks of the Mount Young Sheet area were deposited within the *McArthur Basin* (Dunn et al., in prep.) which extended from *Arnhem Land* in the north to beyond the Queensland Border in the south. The oldest Group—the Tawallah Group—has a wide distribution within the Basin and shows a general similarity in thickness and lithology over wide areas. In this Sheet area the McArthur Group conformably overlies the Tawallah Group, but in the Robinson River Sheet area to the south-east the contact is unconformable (Yates, 1963). The McArthur Group is thickest in a north-trending trough within the McArthur Basin ; the trough passes through the eastern part of the Mount Young Sheet area and extends to the south of the Bauhinia Downs Sheet area. The Group is markedly thinner east of the trough ; facies changes are common. The Roper Group unconformably overlies the McArthur Group. It is widespread within the Basin and shows general lithological uniformity over wide areas. Its thickness increases to the west of the Sheet area, and decreases to the east. *Age of the Units* : Brown (1908) referred to sediments at Borroloola (now known as the 'Roper Group') as Permo-Carboniferous because of the presence of carbonaceous beds. Woolnough (1912) on the Bauhinia Downs Sheet area correlated his 'Bauhinia Limestones' (McArthur Group) with the Katherine River Limestone and considered them, together with the overlying sandstones (Roper Group), to be Cambrian. Jensen (1914) visited the McArthur River area, where he considered the dolomites (McArthur Group) to be Cambrian. The sediments at Borroloola (Roper Group) he considered to be Permo-Carboniferous on the basis of plant remains, which in fact occurred in Mesozoic cappings. Mapping later on the Redbank Copper Field on Calvert Hills Sheet area, Jensen (1940) revised his earlier opinions and considered all the rocks in the region to be Cambrian.

* Except the Scrutton Volcanics, q.v.

Noakes & Traves (1954) used the term 'Carpentaria Complex' for the folded rocks between Mount Isa and the McArthur River and assigned them to the Lower Proterozoic. Hossfeld (1954) recognized the unconformity between the Cambrian limestone of the Barkly Tableland and the underlying dolomites of the McArthur River area (McArthur Group) and considered the dolomites to be Middle to Upper Proterozoic, and referred to them as the Carpentaria Group. This was supported by Noakes (1956).

On the basis of regional correlations and radiometric age determinations (A. Webb, I. McDougall, pers. comm.) the Tawallah Group is placed in the Lower Proterozoic. The McArthur Group is assigned tentatively to the Lower Proterozoic and the Roper Group tentatively to the Upper Proterozoic.

LOWER PROTEROZOIC

The *Scrutton Volcanics* are the oldest rocks exposed in the Sheet area ; they are moderately folded acid volcanics with interbedded feldspathic sandstone, tuff, and small intrusions of dolerite. Feldspar phenocrysts in the volcanics are saussuritized and the groundmass is highly altered ; fine quartz, feldspar, and chlorite can be identified.

The *Scrutton Volcanics* are exposed in the Tawallah Range, where they are unconformably overlain by the Tawallah Group ; they are considered to be Lower Proterozoic. Acid volcanics of similar type and structural relationship—the *Cliffdale Volcanics*—occur on the Calvert Hills Sheet area (Roberts, Rhodes, & Yates, 1963) ; they have been intruded by the Norris Granite, which has been dated by radioactive means as Lower Proterozoic. These older volcanic units do not form part of the major Proterozoic sedimentary succession of the McArthur Basin.

Tawallah Group : In the Mount Young Sheet area the Tawallah Group occurs mainly in a north-south belt through the central portion ; its maximum thickness is about 16,000 feet. The stratigraphy is summarized in Table 1. The dominant rock type is flaggy cross-bedded medium-grained quartz sandstone with ripple marks ; it makes up the *Yiyintyi Sandstone*, the *Sly Creek Sandstone*, and the *Masterton Formation*, with a total thickness of about 14,000 feet. The presence of poorly sorted lithic sandstone, arkose, and conglomerate in the lower part of the Yiyintyi Sandstone indicates tectonic instability during the initial sedimentation.

The *Peters Creek Volcanics* consist entirely of basalt. The basalt is extensively altered and characterized by abundant green, white, and pink amygdules, up to 3 or 4 inches in size, of chlorite, epidote, quartz, and microcline. Individual flows, up to 40 feet thick, can be recognized by the concentration of amygdules and by the gradual reduction in grainsize towards the tops of the flows.

The *Rosie Creek Sandstone* is a stratigraphic equivalent of the *Aquarium Formation* in the Calvert Hills Sheet area (Roberts et al., 1963). The quartz sandstone is frequently highly silicified; feldspar is abundant. Coarse glauconitic sandstone occurs near the top of the unit.

The *Wollogorang Formation* crops out very poorly. Usually dolomite is the main lithology in outcrop, but a few well-exposed sections show that the dominant lithologies are grey, purple-brown, and green dolomitic siltstones. A good marker bed of dolomite with pyrite pseudomorphs occurs about 100 feet below the top of the unit.

Three subdivisions can be recognized within the *Masterton Formation*; they are a flaggy, friable, ferruginous sandstone in the middle and more resistant quartz sandstones above and below. The *Mulholland Sandstone* crops out only around the headwaters of Eastern Creek; it is a lateral variant of the upper part of the *Masterton Formation*.

LOWER (?) PROTEROZOIC

McArthur Group. In the Mount Young Sheet area the *McArthur Group* comprises three separate but inter-related sequences. In the east (Batten Creek area) the Group is divided into the *Festing Creek Formation*, the *Warramana Sandstone*, and the *Batten Sub-Group*; in the Cox River area it is divided into the *Vizard Formation*, the *Mount Birch Sandstone*, and the *Kookaburra Creek Formation*; in the Eastern Creek area it is divided into the *Mallapunyah Formation*, the *Amelia Dolomite*, the *Bauhinia Downs Sub-Group*, and the *Billengarra Formation*. The stratigraphy of these units is summarized in Table 2. The development of these separate sequences was due mainly to the presence of a tectonic hinge-line and a biohermal reef along it, and by the consequent development of fore- and back-reef facies. Most of the information about this hinge-line and the reef is obtained from the *Bauhinia Downs Sheet* area to the south (Smith, 1963).

In the *Bauhinia Downs Sheet* area a north-trending hinge-line along the present position of the Tawallah Fault affected the sedimentation of the *McArthur Group*. During part of the sedimentation, a reef—the *Top Crossing Dolomite*—formed on the hinge-line and caused the formation of a back-reef facies in the west and a fore-reef facies in the east. The hinge-line continued on to the Mount Young Sheet area; the presence of distinct fore-reef and back-reef sediments indicates that the reef also continued on to the Mount Young Sheet area, but it has since been eroded. It passed through the south-eastern part of the Tawallah Range, then trended north-west to pass just south of the Four Archers.

The relative thickness of the *McArthur Group* in the Batten Creek, Cox River, and Eastern Creek areas, and the relationship between the three sequences, are shown diagrammatically in the margin of the Geological Map; they are summarized below.

TABLE 1

STRATIGRAPHY—MOUNT YOUNG SHEET AREA—SCRUTTON VOLCANICS AND TAWALLAH GROUP

Age	Rock Unit		Thickness (Feet)	Lithology	Topography	Distribution	Remarks
Lower Proterozoic	Group	Mulholland Sandstone .. (Ptm)	Up to 600	Flaggy, pink to grey, fine to medium quartz sandstone. Mud cracks and clay pellet impressions present	Moderately resistant, forming small, parallel strike ridges	Southern part of Sheet area between Four Archers Fault and Tawallah Range	Not recognized in east. Upper part of Masterton Formation is stratigraphic equivalent of Mulholland Sandstone
		Masterton Formation .. (Ptn)	2200*	Flaggy to blocky, white, pink and purple, medium quartz sandstone, ferruginous sandstone and feldspathic sandstone. Flaggy purple ferruginous siltstone. Some basalt. Ripple marks, cross-bedding and clay pellet impressions common	Resistant, forming strike ridges and mesas	Throughout area east of the Four Archers Fault	East of Tawallah Range a central unit of flaggy, friable ferruginous sandstone and siltstone can be separated from blocky sandstones above and below. Small lens of basalt present south of Eastern Creek
		Wollogorang Formation .. (Pto)	650*	Silty dolomite, laminated grey, purple-brown and green dolomitic siltstone and shale. Flaggy pink, red and grey dolomite and sandy dolomite, dolarenite, dolomitic sandstone; chert; ferruginous sandstone. Algal structures	Non-resistant, forming valleys between resistant sandstones	Throughout north-south central belt of Sheet area	Persistent bed containing pyrite pseudomorphs about 100 feet below top of formation. Siltstone and shale dominant, but crop out very poorly
		Rosie Creek Sandstone .. (Ptr)	830*	Flaggy and massive, purple to white, poorly sorted feldspathic sandstone, quartz sandstone, ferruginous sandstone, and siltstone. Sometimes micaceous. Locally glauconitic. Poorly cross-bedded and ripple-marked	Moderately resistant. Forms small strike ridges on back slopes of prominent ranges of Sly Creek Sandstone		Poorly sorted and richer in feldspar than rest of Tawallah Group
		Sly Creek Sandstone .. (Ptl)	1600* up to 3000 maximum	Flaggy to blocky, white to pink, medium quartz sandstone. Some feldspar. Scattered pebble bands. Strongly ripple-marked and cross-bedded	Very resistant, forming prominent ridges and ranges		Lithologically similar to Yiyintyi Sandstone
	Tawallah	Peters Creek Volcanics .. (Ptp)	740*	Massive amygdaloidal basalt. Amygdules contain quartz, microcline, chlorite, and epidote	Non-resistant, forming valleys between resistant sandstones		Extensive alteration. Separate flows, up to 40 feet thick, can be recognized
		Yiyintyi Sandstone .. (Pty)	8500	Flaggy to blocky, white to pink, medium to coarse quartz sandstone. Strongly ripple-marked and cross-bedded. Minor pebble conglomerate, arkose, and lithic sandstone	Very resistant. Forms core of the Yiyintyi and Tawallah Ranges		Conglomerates, arkose and lithic sandstones (containing volcanic fragments) present at base where rocks rest unconformably on Scrutton Volcanics. Thin quartz veins common near base
Lower Proterozoic		Scrutton Volcanics .. (Pls)	Greater than 3000. Base not exposed	Porphyritic dacite and rhyodacite with interbedded medium feldspathic sandstone and tuff. Minor dolerite intrusions	Rounded hills with moderate relief.	Southern border of Sheet area on western side of Tawallah Range. Against Four Archers Fault west of Rosie Creek	Unconformably overlain by Tawallah Group. Tentatively regarded as Lower Proterozoic

* Denotes thickness measured on ground. Other thicknesses estimated from maps.

In the southern part of the Sheet area, the McArthur Group west of the hinge-line is about 4000 feet thick ; east of the hinge-line it is 6500 feet thick, but correlations with surrounding areas indicate that an additional 3500 feet of sediment is missing from the top of this section—either not deposited or subsequently eroded. Around the Cox River in the north-west the sediments east of the hinge-line are about 5000 feet thick, but in the Urapunga Sheet area to the north-west are only 2500 feet thick (Dunn, 1963a).

West of the hinge-line, in the Eastern Creek area, the *Mallapunyah Formation* and the *Amelia Dolomite* represent ferruginous silt and sand with minor carbonate mud deposited in a shallow, subsiding shelf area with progressively greater increments of carbonate mud. The development of algal biostromes was greater during the deposition of the *Amelia Dolomite*. East of the hinge-line which had developed, this phase is represented by the lower part of the *Festing Creek Formation* in the Batten Creek area and by the basal *Vizard Formation* in the Cox River area. In the Batten Creek area volcanic activity produced the interbedded basalt, tuff, and sediments of the upper part of the *Festing Creek Formation*.

The Top Crossing Dolomite, which has since been eroded in the Mount Young Sheet area, represented the development of a reef along the active hinge-line. In the back-reef area (Eastern Creek), the *Bauhinia Downs Sub-Group* contains a basal sandstone—the *Tatoola Sandstone*—overlain by the *Tooganinie Formation*, which is an alternating succession of dolomite with algal limestones, siltstone, and fine- and medium-grained sandstone. In the Batten Creek area, the basal unit of the fore-reef facies is the *Warramana Sandstone*. In the Cox River area the equivalent of the basal sandstones of the fore- and back-reef facies is a prominent quartz sandstone low in the *Vizard Formation*. The fore-reef sediments are represented by the remainder of the *Vizard Formation* in the Cox River area, and by the *Batten Sub-Group* in the Batten Creek area.

The Batten Sub-Group was deposited within a trough which was subsiding more rapidly than the back-reef area west of the hinge-line. The *Lynott Formation* is the basal unit of the Group and consists of thin-bedded siltstone, dolomite, chert, chert breccia, and sandstone. Chert, chert breccia, and sandstone at the base has been named the *Hammer Creek Member*. The middle part of the *Vizard Formation* in the north-west is equivalent to the *Lynott Formation*. The sediments of the *Lynott Formation* were overlain by laminated silt and chert represented by the *Yalco Formation*, which is overlain by the *Stretton Sandstone*. The *Stretton Sandstone* is represented in the Cox River area by a prominent sandstone bed in the upper part of the *Vizard Formation*. The topmost beds of the *Vizard Formation* represent the final stages of fore-reef deposition in the north-west ; the *Looking Glass Formation*, which occurs on the *Bauhinia Downs Sheet* area (Smith, 1963), may have been deposited in the east and eroded before deposition of the *Roper Group*.

By the end of the deposition of the Batten Sub-Group and the Vizard Formation, development of the reef was ceasing and the activity of the hinge-line waning ; a sandstone-conglomerate sequence with abundant chert pebbles—the *Mount Birch Sandstone*—transgressed the hinge-line from the north. The *Billengarra Formation* in the south-west is an irregular succession of chert breccia, chert, siltstone, and sandstone. It grades laterally into the *Kookaburra Creek Formation* to the north, which overlaps the *Mount Birch Sandstone*. In the Bauhinia Downs Sheet area thick biostromes and carbonate mud—the *Emmerugga Dolomite*—were deposited as the lateral equivalent of the *Billengarra Formation* (Smith, 1963a).

Roper Group : The Roper Group occurs mainly to the west of the Four Archers Fault, where a total thickness of more than 5500 feet is exposed ; in the south-east of the Sheet area only about 1500 feet is preserved. The stratigraphy of the Group is summarized in Table 3.

The lowest unit of the Roper Group is the *Limmen Sandstone*. Near Batten Creek the formation is only 50 feet thick and consists largely of fine pebble conglomerate. In the north-west of the Sheet area a central flaggy, red, micaceous sandstone is present between blocky coarse-grained quartz sandstone beds above and below ; the total thickness is about 700 feet. In the south, beds of feldspathic sandstone are common, and form prominent ridges generally underlain by flaggy micaceous siltstones and fine sandstones which rarely crop out.

The boundary between the *Mainoru Formation* and the overlying *Crawford Formation* is gradational ; a thin (15 to 20 feet) but persistent bed of massive brown quartz greywacke at the base of a prominent scarp has been mapped as the base of the *Crawford Formation*. The *Crawford Formation* contains abundant glauconite.

The *Abner Sandstone*, which is divided into four members in the west, is dominated by well-sorted quartz sandstone. The quartz sandstone members, the *Arnold Sandstone Member* and *Hodgson Sandstone Member*, are well jointed and weather along these joints to form a 'Castle' topography ; this topography and the usual good outcrop of the sandstones make them useful marker beds for photo-interpretation. The *Jalboi Member* thins out southwards where the *Arnold Sandstone Member* is thickest. A ferruginous sandstone, the *Munyi Member*, caps the *Hodgson Sandstone Member* but does not always crop out.

Most of the *Corcoran Formation* is obscured by soil cover ; it contains poorly outcropping shale and siltstone with more resistant interbeds of blocky sandstone in the upper half.

The *Bessie Creek Sandstone* is similar to the *Abner Sandstone*. Generally, however, it shows finer bedding and a closer joint system, and is more friable.

TABLE 2
STRATIGRAPHY—MOUNT YOUNG SHEET AREA—McARTHUR GROUP

Age	Rock Unit	Thickness (Feet)	Lithology	Distribution	Stratigraphic Equivalents	Remarks	
Lower (?) Proterozoic	Bauhinia Downs Sub-Group	Billengarra Formation .. (Pmb)	Up to 1000	Massive chert breccia, flaggy siltstone, quartz sandstone, chert. Slump structure common.	Around Eastern Creek and Blackfellow Creek	Kookaburra Creek Formation to north. Emmerugga Dolomite and Stott Formation on Bauhinia Downs Sheet area	Silicification common. Unconformably overlain by Roper Group
		Tooganinie Formation .. (Pmt)	1000 minimum. Thickens southwards	Rhythmically alternating sequence of flaggy purple dolomite, algal dolomite, purple dolomitic siltstone, fine-grained red sandstone with halite pseudomorphs, flaggy ripple-marked quartz sandstone		Part of Vizard Formation in north. Lynott Formation, Yalco Formation and Stretton Sandstone in east, plus Looking Glass Formation on Bauhinia Downs Sheet area	Rhythmic alternations very regular. Back-reef facies
		Tatoola Sandstone .. (Pmd)	350*	Flaggy white, reddish-brown, and yellow-brown fine-grained dolomitic sandstone and medium-grained quartz sandstone. Ferruginous in places. Shallow water sedimentary structures common	Around Eastern Creek and northwards along Limmen Bight River	Warramana Sandstone in east. Prominent quartz sandstone within Vizard Formation to north	Dolomitic sandstone commonly leached in outcrop forming porous ferruginous sandstone and quartz sandstone. Present throughout back-reef area
		Amelia Dolomite .. (Pma)	470*	Flaggy laminated fine-grained dolomite and dolomitic siltstone with chert bands; massive blue-grey dolomite; algal dolomite; fissile green siltstone		Upper part of Festing Creek Formation in east. Basal Vizard Formation to north	Dolomites silicified on tops of hills
		Mallapunyah Formation .. (Pml)	800*	Flaggy purple siltstone; ferruginous quartz sandstone with cross-bedding and ripple marks; yellow-brown dolomite. Minor chert, oolitic chert, algal chert, white siltstone	Central southern part of Sheet area	Basal Festing Creek Formation in east. Basal Vizard Formation in west	Botryoidal quartz growths up to 4 inches in diameter common in rubble derived from this unit
	Batten Sub-Group	Stretton Sandstone .. (Pmr)	About 500	Thinly flaggy pink fine to medium quartz sandstone with abundant shallow water sedimentary structures. Minor fissile green siltstone		Sandstone at top of Vizard Formation to north-west. Leila Sandstone Member in back-reef area on Bauhinia Downs Sheet area	'Wavy' bedding common
		Yalco Formation .. (Pmj)	About 500	Rhythmically alternating laminated white siltstone, claystone, and chert. Slump structures. Graded bedding visible in thin sections	South-eastern part of Sheet area	Part of Tooganinie Formation in west. Equivalent to part of Vizard Formation to north	Forms good marker bed owing to good outcrop. Fore-reef facies
		Lynott Formation .. (Pmn)	About 2000	Flaggy, grey to white dolomitic siltstone and cherty siltstone. Minor sandstone, chert, and chert breccia. Some slump structures. Graded bedding		Part of Tooganinie Formation in west. Part of Vizard Formation in north	Dolomitic siltstone leached in outcrop producing white porous siltstone. Fore-reef facies
		Hammer Creek Member .. (Pmg)	About 1700	Flaggy white chert and cherty siltstone, massive chert breccia, dolomitic siltstone, quartz sandstone, oolitic chert	Eastern part of Sheet area	Basal Lynott Formation in south. Basal Tooganinie Formation in west. Part of Vizard Formation to north	Distinguished from Lynott Formation as a whole by greater abundance of chert, chert breccia, and sandstone. Fore-reef facies
		Warramana Sandstone .. (Pmx)	About 100	Blocky, white to reddish-brown and pink medium quartz sandstone. Strongly cross-bedded		Thins out to south. Tatoola Sandstone in west. Prominent sandstone in Vizard Formation to north	Good marker bed; crops out well
		Festing Creek Formation (Pmz)	About 1100 maximum	Flaggy pink dolomite and dolomitic siltstone, blocky dolomite with gypsum (?) crystals. Minor oolitic chert sandstone and arkose. Massive basalt, amygdaloidal basalt. Minor trachyte, and laminated purple and green tuff	Eastern part of Sheet area	Amelia Dolomite and Mallapunyah Formation to south and west. Basal Vizard Formation in north	
		Kookaburra Creek Formation (Pmu)	Greater than 500	Cross-bedded oolitic chert, banded chert, dolomitic siltstone, chert breccia, massive algal dolomite, quartz sandstone	West of Four Archers Fault and north of Eastern Creek	Billengarra Formation to south. Stott Formation and Emmerugga Dolomite on Bauhinia Downs Sheet area	Silicification common. Lateral change into Billengarra Formation sudden
		Mount Birch Sandstone .. (Pmh)	About 300	Blocky, medium sandstone with chert pebbles and fragments, chert conglomerate. Strong cross-bedding		Smythe Sandstone to the south-east on Bauhinia Downs	Lenses out south of Eastern Creek. Good marker bed
		Vizard Formation .. (Pmv)	About 4000	Flaggy dolomitic siltstone; cherty siltstone; chert; blocky, medium to coarse quartz sandstone and feldspathic sandstone; dolomitic sandstone; massive chert and chert breccia	Crops out in area near junction of Cox and Limmen Bight Rivers	In west equivalent to Tooganinie Formation, Tatoola Sandstone, Amelia Dolomite and Mallapunyah Formation. In east equivalent to Stretton Sandstone, Yalco Formation, Lynott Formation, Warramana Sandstone and Festing Creek Formation	Originally defined on Urupunga Sheet area. Basal section not exposed on Mount Young Sheet area. Algal dolomites present at base on Urupunga Sheet area

* Denotes thickness measured on ground. Other thicknesses estimated from maps.

In the extreme north-west of the Sheet area the *Maiwok Sub-Group* overlies the Bessie Creek Sandstone. Outcrop generally is poor, but the *Moroak Sandstone Member* of the *McMinn Formation* forms scarps.

South of the Cox River, the subdivisions of the *Maiwok Sub-Group* cannot be recognized; the rocks overlying the Bessie Creek Sandstone have been called the *Cobanbirini Formation*. The top is not preserved and the maximum thickness is about 1500 feet; on the Tanumbirini Sheet area (Paine, 1963) the *Cobanbirini Formation* is at least 4500 feet thick.

Intrusive Rocks

In the north-west of the Sheet area concordant dolerite sills intrude the Crawford Formation and the Jalboi Member. They extend to the north-west, and on the Urapunga Sheet area (Dunn, 1963) are very extensive. They were deformed to the same degree as the sediments they intrude; their age is therefore considered to be Upper (?) Proterozoic.

PALAEOZOIC

The stratigraphy of the rocks ranging in age from Palaeozoic to Recent is summarized in Table 4.

The Lower Cambrian *Bukalara Sandstone* is of uniform lithology and rests with strong angular unconformity on the Roper Group. The *Cox Formation* conformably overlies the *Bukalara Sandstone*; the boundary is gradational. The formation consists of interbedded sandstone and siltstone passing up into siltstone and shale. The top of the unit is not preserved; the thickness is about 150 feet. No fossils have been found.

MESOZOIC

Lower Cretaceous rocks unconformably overlie older rocks in the Sheet area, and form the bedrock of most of the Coastal Plain. Their maximum observed thickness is about 80 feet, but their original thickness was probably far greater. Both terrestrial and marine deposits can be recognized and proximity to shore-lines has produced marked lateral variations in lithology.

The basal beds are generally plant-bearing quartz sandstone. These are overlain by quartz sandstone and clayey sandstone containing a marine shelly fauna; conglomerate is common. A marine transgression began in Middle Neocomian in the north and continued into Lower Aptian in the south of the Sheet area (Skwarko, 1962a and b).

Small isolated outcrops of locally derived conglomerate and sandstone containing plant remains occur in valleys and in depressions on the tops of the Main Ranges. Massive claystones, with a thick laterite profile developed on them, are present in creeks near the seaward edge of the Coastal Plain.

CAINOZOIC

The *Kulampirri Beds* consist of massive travertine associated with black soil; they are exposed on the Coastal Plain between the Yiyintyi Range and the Nathan River. The travertine may have been deposited in a Tertiary lake; a similar occurrence containing fossils occurs in the Bauhinia Downs Sheet area (Smith, 1963).

Laterite. A laterite profile, up to about 30 feet thick, is present beneath the sand of the Coastal Plain. The profile is truncated in places by erosion.

Beatrice Island Limestone. Beatrice Island is composed of a horizontal buff oolitic limestone, 30 feet thick, which unconformably overlies the Tawallah Group. Microfossils are gastropods and lamellibranchs of a Sub-Recent age.

Soils. Large areas are covered by alluvium, residual soil, cemented ferruginous detritus, and sand. The relationships are discussed in the physiography of the Coastal Plain and in Table 4.

STRUCTURE

The Proterozoic rocks of the Sheet area were faulted and folded in response to movements in the basement; no foliation or lineation was developed. Since the Upper Proterozoic the area has been stable except for some minor movements on pre-existing faults.

The structure of the Mount Young Sheet area (Fig. 2) is a broad north-trending anticlinorium, modified by faulting and folding, with the axis in the central part of the Sheet area. This structure can be divided into three zones:

- (1) A zone of associated folds and faults west of the Four Archers Fault.
- (2) A highly faulted zone in the central part of the Sheet area.
- (3) A stable block east of the Tawallah Range.

Fold-Fault Zone west of the Four Archers Fault

Rocks cropping out within this zone belong to the Roper Group, with minor inliers of McArthur Group; deformation has produced a series of faulted domes. The zone extends to the west on to the Hodgeson Downs Sheet area.

The faults trend north and dip steeply. Small asymmetrical domes, the axes of which trend north-west, are arranged in an en echelon pattern along the faults; the limbs of these folds dip up to 70° , with vertical dips against faults. The main fault movement appears to be horizontal wrenching; but some normal faulting can be recognized; the domes are best developed along the wrench faults. Minor subsidiary fault fans are associated with the major faults and make angles of 45° to 60° with them. Some north-west faults are present in the eastern part of the

TABLE 3

STRATIGRAPHY—MOUNT YOUNG SHEET AREA—ROPER GROUP AND IGNEOUS INTRUSIONS

Age	Rock Unit	Thickness (Feet)	Lithology	Topography	Distribution	Remarks
Upper (?) Proterozoic	Intrusions (Pdl)	Up to 200	Massive dolerite	Poor outcrop. Forms valleys between sandstone ridges	North-western corner of Sheet area	Sills intrude Crawford Formation and Jalboi Member
	Maiwok Sub-Group Roper Group	McMinn Formation Kyalla Member (Pry) ..	300 preserved	Flaggy fine micaceous sandstone, siltstone and shale	Low rounded hills and rises with poor outcrop	
		Sherwin Ironstone Member (Prz)	30	Medium-grained ferruginous quartz sandstone. Oolitic hematite	Locally caps dip-slopes of Moroak Sandstone Member	Interfingers with Kyalla Member and Moroak Sandstone Member
		Moroak Sandstone Member (Prk)	200	Blocky, red and white, medium quartz sandstone	Crops out well. Forms hog-backs and cuestas	
		Velkerri Formation (Prv) ..	1000	Laminated siltstone and shale	Featureless plains with very poor outcrop	Crops out only where preserved beneath scarp of Moroak Sandstone Member
		Cobanbirini Formation (Prb)	1500*	Flaggy, grey, micaceous sandstone; fine, white shale, siltstone	Featureless plains with very poor outcrop	West of Four Archers Fault. (Only crops out near Wilarra Twin Springs where preserved beneath scarp of Bukalara Sandstone)
		Bessie Creek Sandstone (Pre)	West 400* East 415*	Massive, white to red, medium to coarse, quartz sandstone. Ripple-marked and cross-bedded	Good outcrop. Forms cuestas, hog-backs, rare mesas and sand-covered plateaux	Weathering along joints produces 'Castle' topography. Sandstone is friable except where silicified
		Corcoran Formation (Pro)	West 420* East 520*	Black and white shale. Fuggy and blocky grey and white medium to fine quartz sandstone, siltstone	Poor outcrop. Forms valleys between resistant sandstone ridges	West of Four Archers Fault
		Abner Sandstone Undifferentiated (Pra)	80	Massive, white, medium to coarse, quartz sandstone	Forms capping on low plateaux	South-eastern corner of Sheet area
		Munyi Member (Prm)	West 95* East 25*	Massive and blocky purple coarse ferruginous quartz sandstone	Locally forms veneer on dip-slope of Hodgson Sandstone Member	Thickens to 200 feet on Hodgson Downs Sheet area
		Hodgson Sandstone Member (Prh)	West 325* East 390*	Massive and blocky, white and red, medium to coarse quartz sandstone. Ripple-marked and cross-bedded		Weathering along joints produces 'Castle' topography. Friable when not silicified
		Jalboi Member (Prj)	West 420* East 200*	Alternating massive quartz sandstone and blocky ferruginous quartz sandstone with rare glauconite; some flaggy fine micaceous quartz sandstone interbeds	Resistant units. Form prominent hog-backs and cuestas	Western part of Sheet area
		Arnold Sandstone Member (Prx)	West 160* East 175*	Massive to blocky, white to red, coarse to medium quartz sandstone. Some pebble conglomerate. Ripple-marked and cross-bedded		Thickens towards south
		Crawford Formation (Prr)	West 530* East 280*	Flaggy and blocky, red-brown, fine micaceous glauconitic quartz greywacke, minor massive quartz sandstone interbeds	Forms scarp beneath capping of Abner Sandstone	Western and southern parts of Sheet area
		Mainoru Formation (Pru)	West 1780*	Flaggy, brown and grey, micaceous siltstone and fine sandstone. Minor dolomite lenses 50 feet from base	Poor outcrop. Forms valleys between sandstone ridges	Western part of Sheet area
		Limmen Sandstone (Pri)	West 435*	Blocky and massive, purple and white, fine to coarse quartz sandstone and feldspathic sandstone; flaggy micaceous siltstone and sandstone; pebble conglomerate	Good outcrop. Forms prominent cuestas, hog-backs and mesas	Western and southern parts of Sheet area

* Denotes thickness measured on ground. Other thicknesses estimated from maps.

TABLE 4
STRATIGRAPHY—MOUNT YOUNG SHEET AREA—PALAEOZOIC TO RECENT

	Age	Rock Unit	Thickness (Feet)	Lithology	Topography	Distribution	Remarks
Cainozoic	Quaternary	(Qa)	Usually 20 to 30. Greater than 50 in places	Alluvial black soil, sand, silt, gravel	River flats	Flood plains of major streams. Best developed around Limmen Bight River and its tributaries	Eustatic change in sea level entrenched rivers into own flood plains
		(Qa)	..	Coastal deposits. Fine sand, silt, evaporites	Tidal flats	Narrow strip up to 5 miles wide bordering the coast and major estuaries	
	Cainozoic Mostly Quaternary	(Czs)	..	Residual soils, sand, cemented ferruginous detritus	Coastal plains, valleys, plateau cappings	Ubiquitous	Widespread sand of probable marine origin covers Coastal Plain. Sand dunes bordering coast
	Cainozoic Probably Quaternary	(Czs)	..	Cemented ferruginous sand dunes	Low rises on Coastal Plain	Coastal Plain	Ancient sand dunes preserved by cementing of ferruginous material
	Quaternary	Beatrice Island Limestone (Cze)	30	Massive buff oolitic limestone UNCONFORMITY	Raised platform 30 feet above present sea level	Beatrice Island	Small gastropods and lamellibranchs indicate Sub-Recent age
	Tertiary (?)	Kulampirri Beds (Tk)	..	Massive travertine	Poor outcrop within black soil plain on Coastal Plain	Between Nathan River and Yiyintyi Range	Freshwater lake deposit
		(Czl)	..	Laterite and lateritic soil UNCONFORMITY	Outcrops in creek banks within Coastal Plain	Coastal Plain	Remnant of Tertiary Lateritic Plain. Best developed on Lower Cretaceous claystone
Mesozoic	Lower Cretaceous	Undifferentiated (Kl)	Maximum observed section 80	Friable yellow clayey sandstone, massive white quartz sandstone and conglomerate; claystone, sandy claystone UNCONFORMITY	Small mesa cappings, low outcrops within Coastal Plain, valley infillings	Small discontinuous outcrops throughout the Sheet area	Both marine and freshwater facies present. Marine overlies fresh-water when present together
Palaeozoic		Cox Formation (Clc)	150 preserved	Flaggy purple micaceous siltstone and fine sandstone; green shale; blocky to massive white medium quartz sandstone	Undulating surface on top of Cox River Plateau	Confined to Cox River Plateau in south-western corner of Sheet area	Contact with underlying Bukalara Sandstone gradational
	Lower Cambrian	Bukalara Sandstone (Clc)	Up to 100	Massive, buff, cross-bedded, medium to coarse, slightly feldspathic quartz sandstone UNCONFORMITY	Forms Cox River Plateau		Characteristic west-north-west joint system visible on air-photographs

zone ; they are probably subsidiary faults related to the *Four Archers Fault*, which forms the western boundary of the Central Fault Zone. The areas between the lines of faulted domes are tilted, with dips generally less than 10° .

The sandstones of the Roper Group show a pattern of intersecting joints, the angle of intersection being about 60° to 70° . The lines bisecting the acute angles of intersection of these joints generally trend east.

The northern edge of the zone is bounded by the *Hells Gate Hinge-Line*. Dips are very steep to the south (80° to 85°) and in places the beds are overturned and dip 80° to the north.

Central Fault Zone

The Central Fault Zone contains mainly rocks of the Tawallah Group, with some rocks of the McArthur and Roper Groups. In places uplift has exposed the Scrutton Volcanics. The structure is dominated by block faulting and tilting of the fault blocks.

The Yiyintyi Range is a large, faulted anticlinorium plunging south-east, but the anticlinal structure of the Tawallah Range area is obscured by intense faulting.

The major faults vary in strike between north-west and north-north-east ; north-north-east is the most common. The fault planes dip steeply and movements are mainly vertical, with apparent throws up to 20,000 feet (*Four Archers Fault*). The faults are marked in places by zones of brecciation and silicification about 30 or 40 feet thick. A closely-spaced set of subsidiary faults is developed, which makes angles of about 30° with the major faults. The most common trends are north-east, north, and north-west. The sandstones of the Tawallah Group have a well developed pattern of joints which parallels these subsidiary faults.

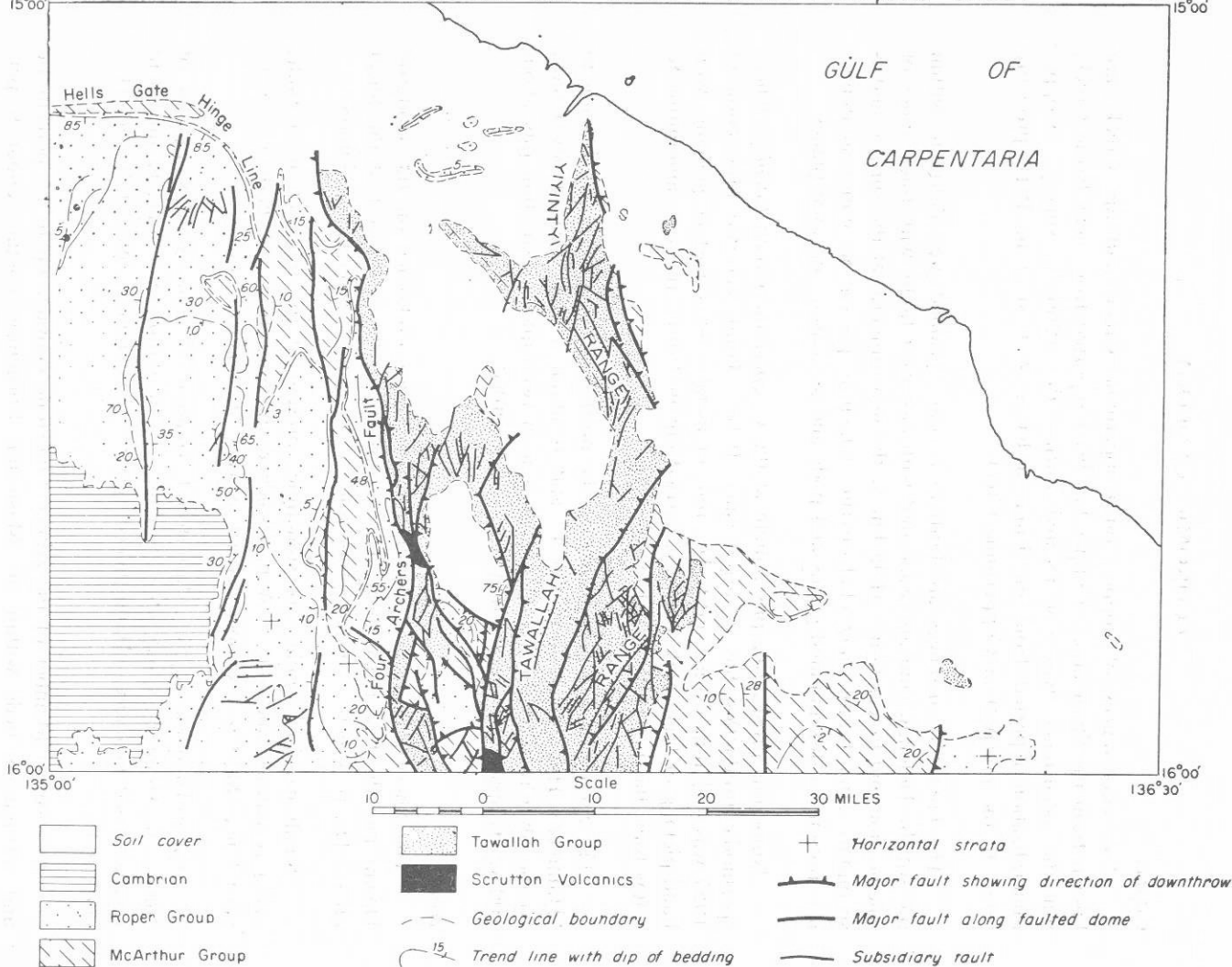
Minor warping, with north-west axes, is present in outliers of McArthur and Roper Groups. Within the outcrops of the Tawallah Group, fault blocks have been tilted with dips of 20° to 50° , locally steepened against faults.

A problematical structure is present immediately to the west of Mount Young. The Limmen Sandstone strikes west (i.e., at right angles to the regional structure) and dips about 5° to the north. This structure is probably related to the *Hells Gate Hinge-Line*.

Eastern Stable Block

Deformation decreases to the east of the Central Fault Zone ; the area east of the Tawallah Range is comparatively stable and is here referred to as the Eastern Stable Block. West of Batten Creek, McArthur Group rocks are warped into gentle north-west-trending folds. Dips are generally about 5° , with a maximum of about 20° . Some small north-striking faults are present. East of Batten Creek rocks of the Roper Group are sub-horizontal.

135°00' 15°00' FIG.2 TECTONIC SKETCH MAP - MOUNT YOUNG 1:250,000 SHEET 136°30' 15°00'



TECTONIC HISTORY

The tectonic history of the Sheet Area is summarized in Table 5.

ECONOMIC GEOLOGY

Copper

Two occurrences of copper, on Coppermine Creek and Sly Creek, are known from the Sheet area. Copper has been reported from near Rosie Creek, but the occurrence was not located during the 1960-61 survey. Copper mineralization reported from the Limmen River Watershed in 1918 probably refers to the prospect at Coppermine Creek.

The known occurrences are both in a coarse-grained grey dolomite within the Amelia Dolomite and are associated with east-west faults with thick zones of silicification and brecciation. Malachite is the main mineral at the surface and is secondary after bornite and chalcopyrite, which is present in minor amounts; it is present as disseminated grains and pods and as coatings on joint planes.

Numerous prospecting pits remain at the *Coppermine Creek Locality*, where spasmodic production has occurred since 1918. Total recorded production to 1957 was 44½ tons of ore and 0.162 tons of metal. Some surface gouging, with hand-picking of high-grade ore, was carried out in 1960; this ore, amounting to a few tons, has not been carted away.

The *Sly Creek* prospect occurs on the northern side of the track leading to 'Hammer's Hut' on Eastern Creek, and is about ¼ mile east of Sly Creek. At the Sly Creek locality, copper is present in two small prospecting pits about 100 yards apart. No production has been recorded.

Iron

The Sherwin Ironstone Member, which forms orebodies on the Hodgson Downs and the Urapunga Sheet areas, crops out in the north-west of the Sheet area. The rock here is of low grade and not of immediate economic interest.

Small hematite bodies are sometimes present at the intersection of faults and ferruginous sandstones. A hand-picked specimen from one body (75 x 15 yards) near Sly Creek copper deposit assayed 56.1 percent Fe.

An isolated outcrop of Masterton Formation 15 miles south-south-east of Bing Bong Homestead, extending over an area of 1 mile by ¼ mile, is altered to quartz-veined hematite. Hand-picked specimens contained only 21.9 and 31.2 percent Fe.

The Munyi Member of the Abner Sandstone contains up to 25 percent Fe and ferruginous beds within the Masterton Formation contain about 9 percent Fe.

Barytes

A small deposit of barytes, with minor amounts of galena, is present within dolomitic siltstone and silicified dolomite of the Kookaburra Creek Formation in the bed of Eastern Creek about 10½ miles west of the Mount Young track. The barytes occurs as irregular lenticular bodies up to 6 or 7 feet in length over a distance of about 100 yards. Farther east, within the Tooganinie Formation, small veinlets and vughs are exposed along an east-west line for 200 yards. Faulting is not evident.

Minor occurrences of barytes near Coppermine Creek were reported by geologists of Mount Isa Mines Limited.

Water

No bores have been drilled in the Sheet area. There are no permanently flowing streams, but surface water, in the form of permanent water-holes, is sufficient to support the present pastoral activity. Numerous springs and seepages occur around the edges of sandstone ranges of Tawallah Group and Roper Group rocks.

Salt

Salt deposits occur on the Tidal Flats, but are not being used.

TABLE 5
TECTONIC HISTORY—MOUNT YOUNG SHEET AREA

Age	—	Event	Remarks
Cainozoic	Tertiary to Recent	Slight epeirogenic uplift and downwarping with erosion and sedimentation	Continuous erosion of topographically high areas. Eustatic changes in sea level—alternating erosion and sedimentation on Coastal Plain. Alluvial flats developed around streams
	Tertiary	Deposition of sediments in freshwater lakes	Peneplain conditions on area corresponding to present Coastal Plain. Main Ranges present as topographic highs
		Lateritization	
		Epeirogenic uplift and marine regression. Slight erosion	Peneplain developed on Lower Cretaceous sediments
Mesozoic	Lower Cretaceous	Marine transgression and deposition of freshwater and marine sediments on stable shelf	Slow transgression of sea from north to south. Topographically high areas remained as islands with freshwater sedimentation in depressions
		Epeirogenic uplift and erosion	Area dissected to produce topography similar to present day
Palaeozoic	Lower Cambrian	Deposition of Bukalara Sandstone and Cox Formation on stable shelf	
		Orogenic uplift and erosion	Basement uplift and faulting produced faulting and folding of the Proterozoic rocks
Precambrian	Upper (?) Proterozoic	Deposition of Roper Group (5,500 + feet of micaceous siltstones and arenites) on shelf with variable rate of subsidence	Centre of sedimentation moved westward. Marked thinning out in east. Variable rate of subsidence shown by quartz sandstone alternating with micaceous siltstone and quartz greywacke
		Local uplift and erosion of the McArthur Group	Up to 3,500 feet of section eroded in the east
	Lower (?) Proterozoic	Formation of north-trending trough and deposition of the McArthur Group (up to 10,000 feet of carbonates)	Marked thinning out of sediments to east of Sheet area; no sediments to west. Area generally a subsiding shelf. Hinge-line formed during middle stage with increased subsidence in east. Total thickness in west 4,000 feet; up to 10,000 feet in east. Some volcanics near base of McArthur Group. (See Stratigraphy of McArthur Group for detail)
		Lower Proterozoic	Deposition of Tawallah Group (14,000 feet of arenites with some carbonates and volcanics) on an extensive subsiding shelf
	Lower Proterozoic	Orogenic uplift and folding	Sedimentation uniform over wide area. Sedimentation kept pace with subsidence giving rise to thick sequence of quartz sandstone
		Acid vulcanism—Scrutton Volcanics	Lower Proterozoic sediments and volcanics folded
			Oldest rocks exposed

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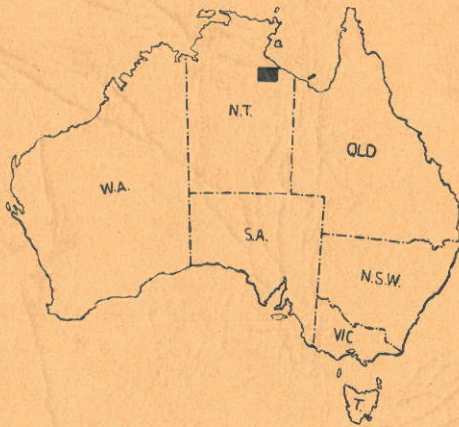
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MOUNT YOUNG, N.T.



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EXPLANATORY NOTES

MOUNT YOUNG, N.T.

Sheet SD/53-15 International Index

Compiled by K. A. Plumb and A. G. L. Paine

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Minister for National Development*

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DEPARTMENT OF NATIONAL DEVELOPMENT

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Explanatory Notes on the Mount Young Geological Sheet

Compiled by K. A. Plumb and A. G. L. Paine

The Mount Young 1 : 250,000 Sheet area lies between latitudes 15° 00' and 16° 00' S., and longitudes 135° 00' and 136° 30' E. and is adjacent to the south-western corner of the Gulf of Carpentaria.

The only permanently inhabited settlement on the Sheet area is Bing Bong Station, on the coast ; it has a population of three Europeans and a few aborigines. Access to the area is by two vehicle tracks suitable for four-wheel-drive vehicles during dry weather. One track links Bing Bong Station to Borroloola (5 miles south of the Sheet area on the McArthur River), and the other links Mount Young to an all-weather graded road on the Bauhinia Downs Sheet area which connects Borroloola with Daly Waters. A weekly air service connects Borroloola with Mount Isa and Tennant Creek.

Maps and air photographs of the Sheet area available during 1961 were : air photographs at a scale of 1 : 50,000 flown by the Royal Australian Air Force in 1950 : an uncontrolled photomosaic at a scale of approximately 4 miles to 1 inch ; and a planimetric map at a scale of 1 : 250,000 prepared by the Division of National Mapping, Department of National Development, from a controlled, photo-scale slotted-template assembly. The geological map was compiled on a photo-scale trace of this assembly and reduced to 1 : 250,000 scale.

Previous Investigations

Leichhardt (1847) passed through the Sheet area. Parkes (1891) travelled from Borroloola to a point about 5 miles south of the Four Archers near the Limmen Bight River (the old 'Valley of Springs Homestead', whose exact location is now unknown) and noted a number of sandstone ranges.

The discovery of silver-lead mineralization at McArthur River encouraged prospecting in the region, and in 1918 copper mineralization was discovered at Coppermine Creek, in the south of the area.

In 1955 L. McAlister, of Mount Isa Mines Limited, made a geological reconnaissance of the country south-east of the Limmen Bight River, and in 1956, in collaboration with E. J. Malone of the Bureau of Mineral Resources, produced a photo-geological map covering the Urapunga, Mount Young, Hodgson Downs, and Bauhinia Downs 1 : 250,000 Sheet areas (Malone, 1956). Since then Mount Isa Mines Limited and Carpentaria Exploration Company have prospected and geologically mapped the McArthur River area and have extended this work northwards on to the southern part of the Mount Young Sheet area.

During 1958 geologists of Enterprise Exploration Company Pty Limited carried out a helicopter survey of the Bulman-Urapunga area which extended as far south as the estuary of the Limmen Bight River (Patterson, 1958).

These notes, and the map which they accompany, are based on a geological survey of the Carpentaria Proterozoic Province carried out during 1960-61 by the Bureau of Mineral Resources.

PHYSIOGRAPHY

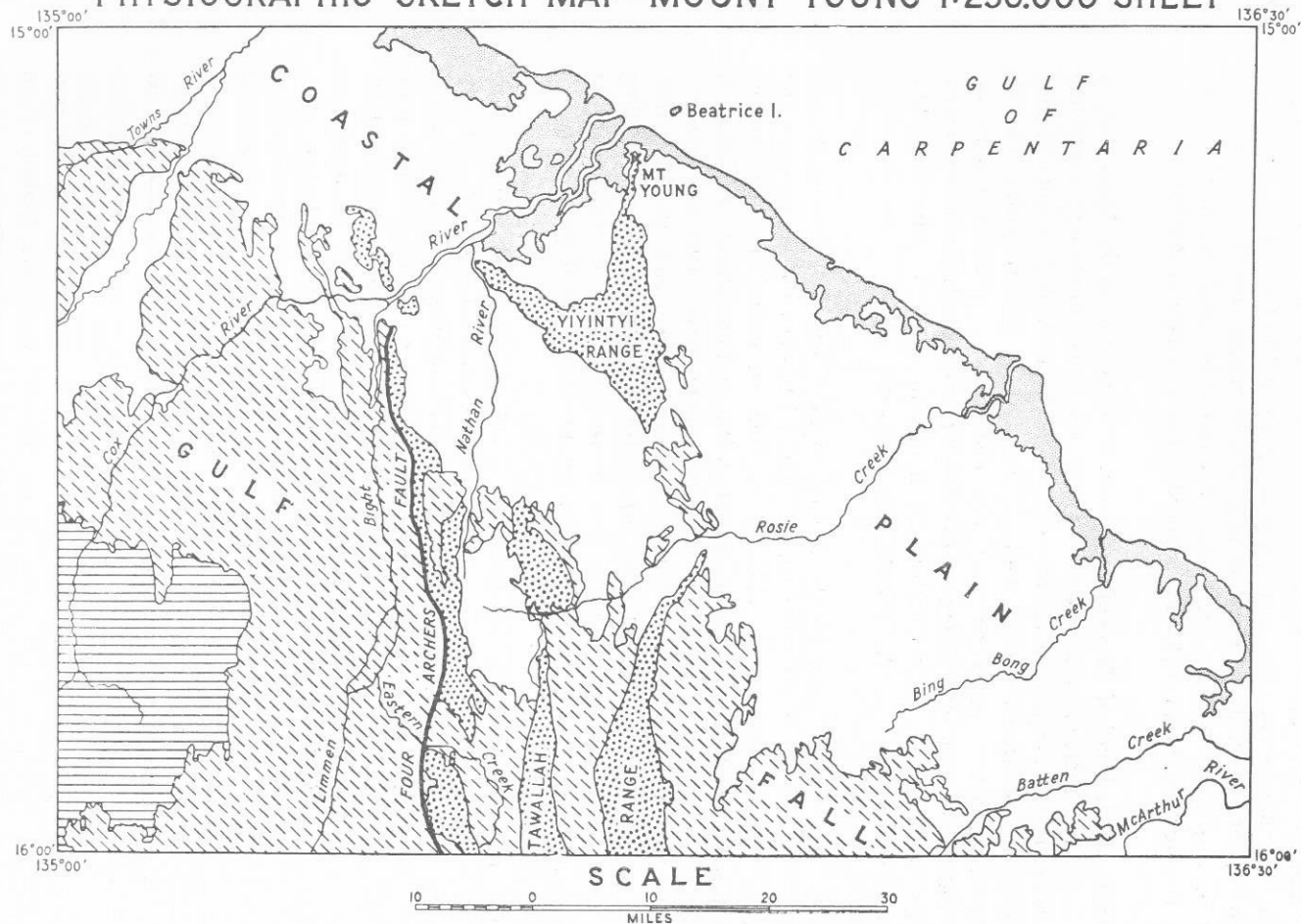
The western part of the Mount Young Sheet area is drained by the Limmen Bight River (and its tributaries, the Cox and Nathan Rivers), which flows into the Gulf of Carpentaria. The Towns River drains the north-west. The eastern part is drained by Rosie and Bing Bong Creeks and a few minor streams. The south-east is drained by the McArthur River and its tributary, Batten Creek. A Recent eustatic change in sea-level of about 30 feet has entrenched the streams into their own alluvium.

The Sheet area contains parts of two of the major physiographic divisions of the Carpentaria Province—the *Gulf Fall* (Stewart, 1954) and the *Coastal Plain* (Dunn, Smith, & Roberts, in prep.) ; each has a distinct drainage pattern (Fig. 1). The Gulf Fall has a complicated pattern of north-flowing subsequent streams, controlled by the structure of the bed-rock, but the Coastal Plain contains a simple drainage pattern of consequent streams flowing north-east.

The *Gulf Fall* is the area of dissected, mainly Proterozoic, rocks in the south and west of the area. The elevation of the Gulf Fall ranges from 150 feet in the east to over 600 feet in the south-west, and in the belt of ranges through the central part of the Sheet area. The division in places has been further subdivided into the Main Ranges and the Cox River Plateau, both of which occupy elevated parts of the Sheet area (Fig. 1).

The *Main Ranges* are the Tawallah Range, the Yiyintyi Range, and an unnamed range bordered on the west by the Four Archers Fault. They occur where resistant rocks of the Tawallah Group, particularly the Yiyintyi Sandstone and the Sly Creek Sandstone, crop out in a north-trending belt through the centre of the Sheet area. The Ranges have a uniform elevation of about 600 feet and may represent an old peneplain surface. The maximum relief at the southern end of the Yiyintyi Range is about 500 feet above the surrounding plains. The Ranges are bounded by either dip slopes or very steep fault scarps. Steep-sided valleys, up to 250 feet deep, are produced by the non-resistant Wollogorang Formation and Peters Creek Volcanics. The shape and distribution of these valleys is irregular because of extensive faulting.

PHYSIOGRAPHIC SKETCH MAP-MOUNT YOUNG 1:250.000 SHEET Fig.1



REFERENCE

COASTAL PLAIN

GULF FALL



Tidal Flats



Cox River Plateau
Main Ranges

The *Cox River Plateau* lies in the south-east of the Sheet area, where the horizontal Lower Cambrian Bukalara Sandstone and Cox Formation crop out. The elevation of the Plateau is about 600 feet. Near Willara Twin Springs the Cox River Plateau is bounded by a marginal scarp about 150 feet high. Elsewhere this scarp is poorly defined and the Plateau gradually merges into the less elevated parts of the Gulf Fall. Most of the Plateau is covered by sand, but in places the horizontal Lower Cambrian rocks are exposed. The drainage is dendritic.

Elsewhere, the relief of the Gulf Fall is not as marked as in the Main Ranges and the Cox River Plateau subdivisions ; nevertheless, it is still strongly controlled by the underlying lithologies. The area west of the Four Archers Fault contains folded rocks of the Roper Group with some inliers of the McArthur Group. Differential erosion has caused the resistant sandstones to crop out as hog-backs, cuestas, and mesas, with intervening valleys developed on the less resistant rocks. The ridges are generally 100 to 200 feet above the valleys ; the individual sandstones forming the ridges have a characteristic topography.

Topographic relief, except for the Main Ranges, is generally less to the east of the Four Archers Fault. Near the headwaters of Eastern Creek, rocks of the Roper Group form strike ridges, and rocks of the McArthur Group form low rounded hills. Immediately east of the Tawallah Range, fault blocks of Masterton Formation and Warramana Sandstone form prominent mesas with less resistant rocks of the McArthur Group in the valleys between. Farther east, the McArthur Group crops out as low rounded hills, 50 to 100 feet above the surrounding plain. In the south-east of the Sheet area horizontal Lower Cretaceous rocks form mesas up to 50 feet high overlying horizontal rocks of the Roper Group.

The *Coastal Plain* is the low-lying area between the coast and the hilly country of the Gulf Fall ; its elevation ranges from sea level to about 100 feet. The Plain is normally about 30 miles wide, but in places it extends 40 miles inland. The Coastal Plain is underlain by mainly horizontal Lower Cretaceous rocks, with some inliers of Proterozoic rocks. A laterite profile, commonly truncated by erosion, is exposed in creek banks near the coast. The Coastal Plain is now covered by sand, probably of marine origin, and is commonly underlain by a cemented detrital laterite ; alluvial flats occur along the major streams. Ancient north-west-trending sand dunes of very low relief are exposed in many places on the Coastal Plain. They have been shown on the geological map as 'Fixed, ancient, coastal deposits'. They have been cemented by ferruginous material and probably were originally derived from coastal deposits, perhaps modified by wind action.

The *Tidal Flats* occur on the seaward side of the Coastal Plain and are part of it. The Flats, which form a zone about 5 miles wide, are typical of an emerging coast. The greater part of the zone represents low-lying emerged lagoons and is subject to seasonal and tidal flooding. Numerous meandering tidal creeks

cross this area ; ferruginous silt and fine sand and evaporites have been deposited. Dunes of ferruginous and shelly sand, up to 20 feet high, occur along the beaches ; they represent emerged off-shore bars. Smaller dunes are present along the inner edge of the Tidal Flats.

STRATIGRAPHY

A sequence of about 30,000 feet of Proterozoic sediments and volcanics is exposed in the Mount Young Sheet area and unconformably overlies the Lower Proterozoic Scrutton Volcanics. The sequence is divided into three Groups—the Tawallah Group, consisting mainly of arenites ; the McArthur Group, of dominantly dolomite and dolomitic rocks ; and the Roper Group, of interbedded arenites and lutites.

The Proterozoic rocks are unconformably overlain by the horizontal Lower Cambrian Bukalara Sandstone and Cox Formation. Horizontal Lower Cretaceous rocks unconformably overlie all the older units. Large parts of the Sheet area are covered by Cainozoic soil, sand and alluvium.

PROTEROZOIC

The Proterozoic* rocks of the Mount Young Sheet area were deposited within the *McArthur Basin* (Dunn et al., in prep.) which extended from *Arnhem Land* in the north to beyond the Queensland Border in the south. The oldest Group—the Tawallah Group—has a wide distribution within the Basin and shows a general similarity in thickness and lithology over wide areas. In this Sheet area the McArthur Group conformably overlies the Tawallah Group, but in the Robinson River Sheet area to the south-east the contact is unconformable (Yates, 1963). The McArthur Group is thickest in a north-trending trough within the McArthur Basin ; the trough passes through the eastern part of the Mount Young Sheet area and extends to the south of the Bauhinia Downs Sheet area. The Group is markedly thinner east of the trough ; facies changes are common. The Roper Group unconformably overlies the McArthur Group. It is widespread within the Basin and shows general lithological uniformity over wide areas. Its thickness increases to the west of the Sheet area, and decreases to the east. *Age of the Units* : Brown (1908) referred to sediments at Borroloola (now known as the 'Roper Group') as Permo-Carboniferous because of the presence of carbonaceous beds. Woolnough (1912) on the Bauhinia Downs Sheet area correlated his 'Bauhinia Limestones' (McArthur Group) with the Katherine River Limestone and considered them, together with the overlying sandstones (Roper Group), to be Cambrian. Jensen (1914) visited the McArthur River area, where he considered the dolomites (McArthur Group) to be Cambrian. The sediments at Borroloola (Roper Group) he considered to be Permo-Carboniferous on the basis of plant remains, which in fact occurred in Mesozoic cappings. Mapping later on the Redbank Copper Field on Calvert Hills Sheet area, Jensen (1940) revised his earlier opinions and considered all the rocks in the region to be Cambrian.

* Except the Scrutton Volcanics, q.v.

Noakes & Traves (1954) used the term 'Carpentaria Complex' for the folded rocks between Mount Isa and the McArthur River and assigned them to the Lower Proterozoic. Hossfeld (1954) recognized the unconformity between the Cambrian limestone of the Barkly Tableland and the underlying dolomites of the McArthur River area (McArthur Group) and considered the dolomites to be Middle to Upper Proterozoic, and referred to them as the Carpentaria Group. This was supported by Noakes (1956).

On the basis of regional correlations and radiometric age determinations (A. Webb, I. McDougall, pers. comm.) the Tawallah Group is placed in the Lower Proterozoic. The McArthur Group is assigned tentatively to the Lower Proterozoic and the Roper Group tentatively to the Upper Proterozoic.

LOWER PROTEROZOIC

The *Scrutton Volcanics* are the oldest rocks exposed in the Sheet area ; they are moderately folded acid volcanics with interbedded feldspathic sandstone, tuff, and small intrusions of dolerite. Feldspar phenocrysts in the volcanics are saussuritized and the groundmass is highly altered ; fine quartz, feldspar, and chlorite can be identified.

The *Scrutton Volcanics* are exposed in the Tawallah Range, where they are unconformably overlain by the Tawallah Group ; they are considered to be Lower Proterozoic. Acid volcanics of similar type and structural relationship—the *Cliffdale Volcanics*—occur on the Calvert Hills Sheet area (Roberts, Rhodes, & Yates, 1963) ; they have been intruded by the Norris Granite, which has been dated by radioactive means as Lower Proterozoic. These older volcanic units do not form part of the major Proterozoic sedimentary succession of the McArthur Basin.

Tawallah Group : In the Mount Young Sheet area the Tawallah Group occurs mainly in a north-south belt through the central portion ; its maximum thickness is about 16,000 feet. The stratigraphy is summarized in Table 1. The dominant rock type is flaggy cross-bedded medium-grained quartz sandstone with ripple marks ; it makes up the *Yiyintyi Sandstone*, the *Sly Creek Sandstone*, and the *Masterton Formation*, with a total thickness of about 14,000 feet. The presence of poorly sorted lithic sandstone, arkose, and conglomerate in the lower part of the *Yiyintyi Sandstone* indicates tectonic instability during the initial sedimentation.

The *Peters Creek Volcanics* consist entirely of basalt. The basalt is extensively altered and characterized by abundant green, white, and pink amygdules, up to 3 or 4 inches in size, of chlorite, epidote, quartz, and microcline. Individual flows, up to 40 feet thick, can be recognized by the concentration of amygdules and by the gradual reduction in grainsize towards the tops of the flows.

The *Rosie Creek Sandstone* is a stratigraphic equivalent of the Aquarium Formation in the Calvert Hills Sheet area (Roberts et al., 1963). The quartz sandstone is frequently highly silicified; feldspar is abundant. Coarse glauconitic sandstone occurs near the top of the unit.

The *Wollogorang Formation* crops out very poorly. Usually dolomite is the main lithology in outcrop, but a few well-exposed sections show that the dominant lithologies are grey, purple-brown, and green dolomitic siltstones. A good marker bed of dolomite with pyrite pseudomorphs occurs about 100 feet below the top of the unit.

Three subdivisions can be recognized within the *Masterton Formation*; they are a flaggy, friable, ferruginous sandstone in the middle and more resistant quartz sandstones above and below. The *Mulholland Sandstone* crops out only around the headwaters of Eastern Creek; it is a lateral variant of the upper part of the Masterton Formation.

LOWER (?) PROTEROZOIC

McArthur Group. In the Mount Young Sheet area the McArthur Group comprises three separate but inter-related sequences. In the east (Batten Creek area) the Group is divided into the *Festing Creek Formation*, the *Warramana Sandstone*, and the *Batten Sub-Group*; in the Cox River area it is divided into the *Vizard Formation*, the *Mount Birch Sandstone*, and the *Kookaburra Creek Formation*; in the Eastern Creek area it is divided into the *Mallapunyah Formation*, the *Amelia Dolomite*, the *Bauhinia Downs Sub-Group*, and the *Billengarra Formation*. The stratigraphy of these units is summarized in Table 2. The development of these separate sequences was due mainly to the presence of a tectonic hinge-line and a biohermal reef along it, and by the consequent development of fore- and back-reef facies. Most of the information about this hinge-line and the reef is obtained from the Bauhinia Downs Sheet area to the south (Smith, 1963).

In the Bauhinia Downs Sheet area a north-trending hinge-line along the present position of the Tawallah Fault affected the sedimentation of the McArthur Group. During part of the sedimentation, a reef—the Top Crossing Dolomite—formed on the hinge-line and caused the formation of a back-reef facies in the west and a fore-reef facies in the east. The hinge-line continued on to the Mount Young Sheet area; the presence of distinct fore-reef and back-reef sediments indicates that the reef also continued on to the Mount Young Sheet area, but it has since been eroded. It passed through the south-eastern part of the Tawallah Range, then trended north-west to pass just south of the Four Archers.

The relative thickness of the McArthur Group in the Batten Creek, Cox River, and Eastern Creek areas, and the relationship between the three sequences, are shown diagrammatically in the margin of the Geological Map; they are summarized below.

TABLE 1

STRATIGRAPHY—MOUNT YOUNG SHEET AREA—SCRUTTON VOLCANICS AND TAWALLAH GROUP

Age	Rock Unit		Thickness (Feet)	Lithology	Topography	Distribution	Remarks
Lower Proterozoic	Group	Mulholland Sandstone .. (Ptm)	Up to 600	Flaggy, pink to grey, fine to medium quartz sandstone. Mud cracks and clay pellet impressions present	Moderately resistant, forming small, parallel strike ridges	Southern part of Sheet area between Four Archers Fault and Tawallah Range	Not recognized in east. Upper part of Masterton Formation is stratigraphic equivalent of Mulholland Sandstone
		Masterton Formation .. (Ptn)	2200*	Flaggy to blocky, white, pink and purple, medium quartz sandstone, ferruginous sandstone and feldspathic sandstone. Flaggy purple ferruginous siltstone. Some basalt. Ripple marks, cross-bedding and clay pellet impressions common	Resistant, forming strike ridges and mesas	Throughout area east of the Four Archers Fault	East of Tawallah Range a central unit of flaggy, friable ferruginous sandstone and siltstone can be separated from blocky sandstones above and below. Small lens of basalt present south of Eastern Creek
		Wollogorang Formation .. (Pto)	650*	Silty dolomite, laminated grey, purple-brown and green dolomitic siltstone and shale. Flaggy pink, red and grey dolomite and sandy dolomite, dolarenite, dolomitic sandstone; chert; ferruginous sandstone. Algal structures	Non-resistant, forming valleys between resistant sandstones	Throughout north-south central belt of Sheet area	Persistent bed containing pyrite pseudomorphs about 100 feet below top of formation. Siltstone and shale dominant, but crop out very poorly
		Rosie Creek Sandstone .. (Ptr)	830*	Flaggy and massive, purple to white, poorly sorted feldspathic sandstone, quartz sandstone, ferruginous sandstone, and siltstone. Sometimes micaceous. Locally glauconitic. Poorly cross-bedded and ripple-marked	Moderately resistant. Forms small strike ridges on back slopes of prominent ranges of Sly Creek Sandstone		Poorly sorted and richer in feldspar than rest of Tawallah Group
		Sly Creek Sandstone .. (Ptl)	1600* up to 3000 maximum	Flaggy to blocky, white to pink, medium quartz sandstone. Some feldspar. Scattered pebble bands. Strongly ripple-marked and cross-bedded	Very resistant, forming prominent ridges and ranges		Lithologically similar to Yiyintyi Sandstone
	Tawallah	Peters Creek Volcanics .. (Ptp)	740*	Massive amygdaloidal basalt. Amygdules contain quartz, microcline, chlorite, and epidote	Non-resistant, forming valleys between resistant sandstones		Extensive alteration. Separate flows, up to 40 feet thick, can be recognized
		Yiyintyi Sandstone .. (Pty)	8500	Flaggy to blocky, white to pink, medium to coarse quartz sandstone. Strongly ripple-marked and cross-bedded. Minor pebble conglomerate, arkose, and lithic sandstone	Very resistant. Forms core of the Yiyintyi and Tawallah Ranges		Conglomerates, arkose and lithic sandstones (containing volcanic fragments) present at base where rocks rest unconformably on Scrutton Volcanics. Thin quartz veins common near base
Lower Proterozoic		Scrutton Volcanics .. (Pls)	Greater than 3000. Base not exposed	Porphyritic dacite and rhyodacite with interbedded medium feldspathic sandstone and tuff. Minor dolerite intrusions	Rounded hills with moderate relief.	Southern border of Sheet area on western side of Tawallah Range. Against Four Archers Fault west of Rosie Creek	Unconformably overlain by Tawallah Group. Tentatively regarded as Lower Proterozoic

* Denotes thickness measured on ground. Other thicknesses estimated from maps.

In the southern part of the Sheet area, the McArthur Group west of the hinge-line is about 4000 feet thick ; east of the hinge-line it is 6500 feet thick, but correlations with surrounding areas indicate that an additional 3500 feet of sediment is missing from the top of this section—either not deposited or subsequently eroded. Around the Cox River in the north-west the sediments east of the hinge-line are about 5000 feet thick, but in the Urapunga Sheet area to the north-west are only 2500 feet thick (Dunn, 1963a).

West of the hinge-line, in the Eastern Creek area, the *Mallapunyah Formation* and the *Amelia Dolomite* represent ferruginous silt and sand with minor carbonate mud deposited in a shallow, subsiding shelf area with progressively greater increments of carbonate mud. The development of algal biostromes was greater during the deposition of the *Amelia Dolomite*. East of the hinge-line which had developed, this phase is represented by the lower part of the *Festing Creek Formation* in the Batten Creek area and by the basal *Vizard Formation* in the Cox River area. In the Batten Creek area volcanic activity produced the interbedded basalt, tuff, and sediments of the upper part of the *Festing Creek Formation*.

The Top Crossing Dolomite, which has since been eroded in the Mount Young Sheet area, represented the development of a reef along the active hinge-line. In the back-reef area (Eastern Creek), the *Bauhinia Downs Sub-Group* contains a basal sandstone—the *Tatoola Sandstone*—overlain by the *Tooganinie Formation*, which is an alternating succession of dolomite with algal limestones, siltstone, and fine- and medium-grained sandstone. In the Batten Creek area, the basal unit of the fore-reef facies is the *Warramana Sandstone*. In the Cox River area the equivalent of the basal sandstones of the fore- and back-reef facies is a prominent quartz sandstone low in the *Vizard Formation*. The fore-reef sediments are represented by the remainder of the *Vizard Formation* in the Cox River area, and by the *Batten Sub-Group* in the Batten Creek area.

The Batten Sub-Group was deposited within a trough which was subsiding more rapidly than the back-reef area west of the hinge-line. The *Lynott Formation* is the basal unit of the Group and consists of thin-bedded siltstone, dolomite, chert, chert breccia, and sandstone. Chert, chert breccia, and sandstone at the base has been named the *Hammer Creek Member*. The middle part of the *Vizard Formation* in the north-west is equivalent to the *Lynott Formation*. The sediments of the *Lynott Formation* were overlain by laminated silt and chert represented by the *Yalco Formation*, which is overlain by the *Stretton Sandstone*. The *Stretton Sandstone* is represented in the Cox River area by a prominent sandstone bed in the upper part of the *Vizard Formation*. The topmost beds of the *Vizard Formation* represent the final stages of fore-reef deposition in the north-west ; the *Looking Glass Formation*, which occurs on the *Bauhinia Downs Sheet* area (Smith, 1963), may have been deposited in the east and eroded before deposition of the *Roper Group*.

By the end of the deposition of the Batten Sub-Group and the Vizard Formation, development of the reef was ceasing and the activity of the hinge-line waning; a sandstone-conglomerate sequence with abundant chert pebbles—the *Mount Birch Sandstone*—transgressed the hinge-line from the north. The *Billengarra Formation* in the south-west is an irregular succession of chert breccia, chert, siltstone, and sandstone. It grades laterally into the *Kookaburra Creek Formation* to the north, which overlaps the *Mount Birch Sandstone*. In the Bauhinia Downs Sheet area thick biostromes and carbonate mud—the *Emmerugga Dolomite*—were deposited as the lateral equivalent of the *Billengarra Formation* (Smith, 1963a).

Roper Group: The Roper Group occurs mainly to the west of the Four Archers Fault, where a total thickness of more than 5500 feet is exposed; in the south-east of the Sheet area only about 1500 feet is preserved. The stratigraphy of the Group is summarized in Table 3.

The lowest unit of the Roper Group is the *Limmen Sandstone*. Near Batten Creek the formation is only 50 feet thick and consists largely of fine pebble conglomerate. In the north-west of the Sheet area a central flaggy, red, micaceous sandstone is present between blocky coarse-grained quartz sandstone beds above and below; the total thickness is about 700 feet. In the south, beds of feldspathic sandstone are common, and form prominent ridges generally underlain by flaggy micaceous siltstones and fine sandstones which rarely crop out.

The boundary between the *Mainoru Formation* and the overlying *Crawford Formation* is gradational; a thin (15 to 20 feet) but persistent bed of massive brown quartz greywacke at the base of a prominent scarp has been mapped as the base of the *Crawford Formation*. The *Crawford Formation* contains abundant glauconite.

The *Abner Sandstone*, which is divided into four members in the west, is dominated by well-sorted quartz sandstone. The quartz sandstone members, the *Arnold Sandstone Member* and *Hodgson Sandstone Member*, are well jointed and weather along these joints to form a 'Castle' topography; this topography and the usual good outcrop of the sandstones make them useful marker beds for photo-interpretation. The *Jalboi Member* thins out southwards where the *Arnold Sandstone Member* is thickest. A ferruginous sandstone, the *Munyi Member*, caps the *Hodgson Sandstone Member* but does not always crop out.

Most of the *Corcoran Formation* is obscured by soil cover; it contains poorly outcropping shale and siltstone with more resistant interbeds of blocky sandstone in the upper half.

The *Bessie Creek Sandstone* is similar to the *Abner Sandstone*. Generally, however, it shows finer bedding and a closer joint system, and is more friable.

TABLE 2
STRATIGRAPHY—MOUNT YOUNG SHEET AREA—McARTHUR GROUP

Age	Rock Unit	Thickness (Feet)	Lithology	Distribution	Stratigraphic Equivalents	Remarks		
Lower (?) Proterozoic	McArthur Group	Bauhinia Downs Sub-Group	Billengarra Formation .. (Pmb)	Up to 1000	Massive chert breccia, flaggy siltstone, quartz sandstone, chert. Slump structure common.	Around Eastern Creek and Blackfellow Creek	Kookaburra Creek Formation to north. Emmerugga Dolomite and Stott Formation on Bauhinia Downs Sheet area	Silicification common. Unconformably overlain by Roper Group
			Tooganinie Formation .. (Pmt)	1000 minimum. Thickens southwards	Rhythmically alternating sequence of flaggy purple dolomite, algal dolomite, purple dolomitic siltstone, fine-grained red sandstone with halite pseudomorphs, flaggy ripple-marked quartz sandstone		Part of Vizard Formation in north. Lynott Formation, Yalco Formation and Stretton Sandstone in east, plus Looking Glass Formation on Bauhinia Downs Sheet area	Rhythmic alternations very regular. Back-reef facies
			Tatoola Sandstone .. (Pmd)	350*	Flaggy white, reddish-brown, and yellow-brown fine-grained dolomitic sandstone and medium-grained quartz sandstone. Ferruginous in places. Shallow water sedimentary structures common	Around Eastern Creek and northwards along Limmen Bight River	Warramana Sandstone in east. Prominent quartz sandstone within Vizard Formation to north	Dolomitic sandstone commonly leached in outcrop forming porous ferruginous sandstone and quartz sandstone. Present throughout back-reef area
			Amelia Dolomite .. (Pma)	470*	Flaggy laminated fine-grained dolomite and dolomitic siltstone with chert bands; massive blue-grey dolomite; algal dolomite; fissile green siltstone		Upper part of Festing Creek Formation in east. Basal Vizard Formation to north	Dolomites silicified on tops of hills
			Mallapunyah Formation .. (Pml)	800*	Flaggy purple siltstone; ferruginous quartz sandstone with cross-bedding and ripple marks; yellow-brown dolomite. Minor chert, oolitic chert, algal chert, white siltstone	Central southern part of Sheet area	Basal Festing Creek Formation in east. Basal Vizard Formation in west	Botryoidal quartz growths up to 4 inches in diameter common in rubble derived from this unit
		Batten Sub-Group	Stretton Sandstone .. (Pmr)	About 500	Thinly flaggy pink fine to medium quartz sandstone with abundant shallow water sedimentary structures. Minor fissile green siltstone		Sandstone at top of Vizard Formation to north-west. Leila Sandstone Member in back-reef area on Bauhinia Downs Sheet area	'Wavy' bedding common
			Yalco Formation .. (Pmj)	About 500	Rhythmically alternating laminated white siltstone, claystone, and chert. Slump structures. Graded bedding visible in thin sections	South-eastern part of Sheet area	Part of Tooganinie Formation in west. Equivalent to part of Vizard Formation to north	Forms good marker bed owing to good outcrop. Fore-reef facies
			Lynott Formation .. (Pmn)	About 2000	Flaggy, grey to white dolomitic siltstone and cherty siltstone. Minor sandstone, chert, and chert breccia. Some slump structures. Graded bedding		Part of Tooganinie Formation in west. Part of Vizard Formation in north	Dolomitic siltstone leached in outcrop producing white porous siltstone. Fore-reef facies
			Hammer Creek Member .. (Pmg)	About 1700	Flaggy white chert and cherty siltstone, massive chert breccia, dolomitic siltstone, quartz sandstone, oolitic chert	Eastern part of Sheet area	Basal Lynott Formation in south. Basal Tooganinie Formation in west. Part of Vizard Formation to north	Distinguished from Lynott Formation as a whole by greater abundance of chert, chert breccia, and sandstone. Fore-reef facies
			Warramana Sandstone .. (Pmx)	About 100	Blocky, white to reddish-brown and pink medium quartz sandstone. Strongly cross-bedded		Thins out to south. Tatoola Sandstone in west. Prominent sandstone in Vizard Formation to north	Good marker bed; crops out well
		Festing Creek Formation (Pmz)	About 1100 maximum	Flaggy pink dolomite and dolomitic siltstone, blocky dolomite with gypsum (?) crystals. Minor oolitic chert sandstone and arkose. Massive basalt, amygdaloidal basalt. Minor trachyte, and laminated purple and green tuff	Eastern part of Sheet area	Amelia Dolomite and Mallapunyah Formation to south and west. Basal Vizard Formation in north		
		Kookaburra Creek Formation (Pmu)	Greater than 500	Cross-bedded oolitic chert, banded chert, dolomitic siltstone, chert breccia, massive algal dolomite, quartz sandstone	West of Four Archers Fault and north of Eastern Creek	Billengarra Formation to south. Stott Formation and Emmerugga Dolomite on Bauhinia Downs Sheet area	Silicification common. Lateral change into Billengarra Formation sudden	
		Mount Birch Sandstone .. (Pmh)	About 300	Blocky, medium sandstone with chert pebbles and fragments, chert conglomerate. Strong cross-bedding		Smythe Sandstone to the south-east on Bauhinia Downs	Lenses out south of Eastern Creek. Good marker bed	
		Vizard Formation (Pmv)	About 4000	Flaggy dolomitic siltstone; cherty siltstone; chert; blocky, medium to coarse quartz sandstone and feldspathic sandstone; dolomitic sandstone; massive chert and chert breccia	Crops out in area near junction of Cox and Limmen Bight Rivers	In west equivalent to Tooganinie Formation, Tatoola Sandstone, Amelia Dolomite and Mallapunyah Formation. In east equivalent to Stretton Sandstone, Yalco Formation, Lynott Formation, Warramana Sandstone and Festing Creek Formation	Originally defined on Urupunga Sheet area. Basal section not exposed on Mount Young Sheet area. Algal dolomites present at base on Urupunga Sheet area	

* Denotes thickness measured on ground. Other thicknesses estimated from maps.

In the extreme north-west of the Sheet area the *Maiwok Sub-Group* overlies the Bessie Creek Sandstone. Outcrop generally is poor, but the *Moroak Sandstone Member* of the *McMinn Formation* forms scarps.

South of the Cox River, the subdivisions of the *Maiwok Sub-Group* cannot be recognized; the rocks overlying the Bessie Creek Sandstone have been called the *Cobanbirini Formation*. The top is not preserved and the maximum thickness is about 1500 feet; on the Tanumbirini Sheet area (Paine, 1963) the *Cobanbirini Formation* is at least 4500 feet thick.

Intrusive Rocks

In the north-west of the Sheet area concordant dolerite sills intrude the Crawford Formation and the Jalboi Member. They extend to the north-west, and on the Urapunga Sheet area (Dunn, 1963) are very extensive. They were deformed to the same degree as the sediments they intrude; their age is therefore considered to be Upper (?) Proterozoic.

PALAEOZOIC

The stratigraphy of the rocks ranging in age from Palaeozoic to Recent is summarized in Table 4.

The Lower Cambrian *Bukalara Sandstone* is of uniform lithology and rests with strong angular unconformity on the Roper Group. The *Cox Formation* conformably overlies the *Bukalara Sandstone*; the boundary is gradational. The formation consists of interbedded sandstone and siltstone passing up into siltstone and shale. The top of the unit is not preserved; the thickness is about 150 feet. No fossils have been found.

MESOZOIC

Lower Cretaceous rocks unconformably overlie older rocks in the Sheet area, and form the bedrock of most of the Coastal Plain. Their maximum observed thickness is about 80 feet, but their original thickness was probably far greater. Both terrestrial and marine deposits can be recognized and proximity to shore-lines has produced marked lateral variations in lithology.

The basal beds are generally plant-bearing quartz sandstone. These are overlain by quartz sandstone and clayey sandstone containing a marine shelly fauna; conglomerate is common. A marine transgression began in Middle Neocomian in the north and continued into Lower Aptian in the south of the Sheet area (Skwarko, 1962a and b).

Small isolated outcrops of locally derived conglomerate and sandstone containing plant remains occur in valleys and in depressions on the tops of the Main Ranges. Massive claystones, with a thick laterite profile developed on them, are present in creeks near the seaward edge of the Coastal Plain.

CAINOZOIC

The *Kulampirri Beds* consist of massive travertine associated with black soil; they are exposed on the Coastal Plain between the Yiyintyi Range and the Nathan River. The travertine may have been deposited in a Tertiary lake; a similar occurrence containing fossils occurs in the Bauhinia Downs Sheet area (Smith, 1963).

Laterite. A laterite profile, up to about 30 feet thick, is present beneath the sand of the Coastal Plain. The profile is truncated in places by erosion.

Beatrice Island Limestone. Beatrice Island is composed of a horizontal buff oolitic limestone, 30 feet thick, which unconformably overlies the Tawallah Group. Microfossils are gastropods and lamellibranchs of a Sub-Recent age.

Soils. Large areas are covered by alluvium, residual soil, cemented ferruginous detritus, and sand. The relationships are discussed in the physiography of the Coastal Plain and in Table 4.

STRUCTURE

The Proterozoic rocks of the Sheet area were faulted and folded in response to movements in the basement; no foliation or lineation was developed. Since the Upper Proterozoic the area has been stable except for some minor movements on pre-existing faults.

The structure of the Mount Young Sheet area (Fig. 2) is a broad north-trending anticlinorium, modified by faulting and folding, with the axis in the central part of the Sheet area. This structure can be divided into three zones:

- (1) A zone of associated folds and faults west of the Four Archers Fault.
- (2) A highly faulted zone in the central part of the Sheet area.
- (3) A stable block east of the Tawallah Range.

Fold-Fault Zone west of the Four Archers Fault

Rocks cropping out within this zone belong to the Roper Group, with minor inliers of McArthur Group; deformation has produced a series of faulted domes. The zone extends to the west on to the Hodgeson Downs Sheet area.

The faults trend north and dip steeply. Small asymmetrical domes, the axes of which trend north-west, are arranged in an en echelon pattern along the faults; the limbs of these folds dip up to 70° , with vertical dips against faults. The main fault movement appears to be horizontal wrenching; but some normal faulting can be recognized; the domes are best developed along the wrench faults. Minor subsidiary fault fans are associated with the major faults and make angles of 45° to 60° with them. Some north-west faults are present in the eastern part of the

TABLE 3

STRATIGRAPHY—MOUNT YOUNG SHEET AREA—ROPER GROUP AND IGNEOUS INTRUSIONS

Age	Rock Unit	Thickness (Feet)	Lithology	Topography	Distribution	Remarks
Upper (?) Proterozoic	Intrusions (Pdl)	Up to 200	Massive dolerite	Poor outcrop. Forms valleys between sandstone ridges	North-western corner of Sheet area	Sills intrude Crawford Formation and Jalboi Member
	Maiwok Sub-Group Roper Group	McMinn Formation Kyalla Member (Pry) ..	300 preserved	Flaggy fine micaceous sandstone, siltstone and shale	Low rounded hills and rises with poor outcrop	
		Sherwin Ironstone Member (Prz)	30	Medium-grained ferruginous quartz sandstone. Oolitic hematite	Locally caps dip-slopes of Moroak Sandstone Member	Interfingers with Kyalla Member and Moroak Sandstone Member
		Moroak Sandstone Member (Prk)	200	Blocky, red and white, medium quartz sandstone	Crops out well. Forms hog-backs and cuestas	
		Velkerri Formation (Prv) ..	1000	Laminated siltstone and shale	Featureless plains with very poor outcrop	Crops out only where preserved beneath scarp of Moroak Sandstone Member
		Cobanbirini Formation (Prb)	1500*	Flaggy, grey, micaceous sandstone; fine, white shale, siltstone	Featureless plains with very poor outcrop	West of Four Archers Fault. (Only crops out near Wilarra Twin Springs where preserved beneath scarp of Bukalara Sandstone)
		Bessie Creek Sandstone (Pre)	West 400* East 415*	Massive, white to red, medium to coarse, quartz sandstone. Ripple-marked and cross-bedded	Good outcrop. Forms cuestas, hog-backs, rare mesas and sand-covered plateaux	Weathering along joints produces 'Castle' topography. Sandstone is friable except where silicified
		Corcoran Formation (Pro)	West 420* East 520*	Black and white shale. Fuggy and blocky grey and white medium to fine quartz sandstone, siltstone	Poor outcrop. Forms valleys between resistant sandstone ridges	West of Four Archers Fault
		Abner Sandstone Undifferentiated (Pra)	80	Massive, white, medium to coarse, quartz sandstone	Forms capping on low plateaux	South-eastern corner of Sheet area
		Munyi Member (Prm)	West 95* East 25*	Massive and blocky purple coarse ferruginous quartz sandstone	Locally forms veneer on dip-slope of Hodgson Sandstone Member	Thickens to 200 feet on Hodgson Downs Sheet area
		Hodgson Sandstone Member (Prh)	West 325* East 390*	Massive and blocky, white and red, medium to coarse quartz sandstone. Ripple-marked and cross-bedded		Weathering along joints produces 'Castle' topography. Friable when not silicified
		Jalboi Member (Prj)	West 420* East 200*	Alternating massive quartz sandstone and blocky ferruginous quartz sandstone with rare glauconite; some flaggy fine micaceous quartz sandstone interbeds	Resistant units. Form prominent hog-backs and cuestas	Western part of Sheet area
		Arnold Sandstone Member (Prx)	West 160* East 175*	Massive to blocky, white to red, coarse to medium quartz sandstone. Some pebble conglomerate. Ripple-marked and cross-bedded		Thickens towards south
		Crawford Formation (Prr)	West 530* East 280*	Flaggy and blocky, red-brown, fine micaceous glauconitic quartz greywacke, minor massive quartz sandstone interbeds	Forms scarp beneath capping of Abner Sandstone	Western and southern parts of Sheet area
		Mainoru Formation (Pru)	West 1780*	Flaggy, brown and grey, micaceous siltstone and fine sandstone. Minor dolomite lenses 50 feet from base	Poor outcrop. Forms valleys between sandstone ridges	Western part of Sheet area
		Limmen Sandstone (Pri)	West 435*	Blocky and massive, purple and white, fine to coarse quartz sandstone and feldspathic sandstone; flaggy micaceous siltstone and sandstone; pebble conglomerate	Good outcrop. Forms prominent cuestas, hog-backs and mesas	Western and southern parts of Sheet area

* Denotes thickness measured on ground. Other thicknesses estimated from maps.

TABLE 4
STRATIGRAPHY—MOUNT YOUNG SHEET AREA—PALAEOZOIC TO RECENT

	Age	Rock Unit	Thickness (Feet)	Lithology	Topography	Distribution	Remarks
Cainozoic	Quaternary	(Qa)	Usually 20 to 30. Greater than 50 in places	Alluvial black soil, sand, silt, gravel	River flats	Flood plains of major streams. Best developed around Limmen Bight River and its tributaries	Eustatic change in sea level entrenched rivers into own flood plains
		(Qa)	..	Coastal deposits. Fine sand, silt, evaporites	Tidal flats	Narrow strip up to 5 miles wide bordering the coast and major estuaries	
	Cainozoic Mostly Quaternary	(Czs)	..	Residual soils, sand, cemented ferruginous detritus	Coastal plains, valleys, plateau cappings	Ubiquitous	Widespread sand of probable marine origin covers Coastal Plain. Sand dunes bordering coast
	Cainozoic Probably Quaternary	(Czs)	..	Cemented ferruginous sand dunes	Low rises on Coastal Plain	Coastal Plain	Ancient sand dunes preserved by cementing of ferruginous material
	Quaternary	Beatrice Island Limestone (Cze)	30	Massive buff oolitic limestone UNCONFORMITY	Raised platform 30 feet above present sea level	Beatrice Island	Small gastropods and lamellibranchs indicate Sub-Recent age
	Tertiary (?)	Kulampirri Beds (Tk)	..	Massive travertine	Poor outcrop within black soil plain on Coastal Plain	Between Nathan River and Yiyintyi Range	Freshwater lake deposit
		(Czl)	..	Laterite and lateritic soil UNCONFORMITY	Outcrops in creek banks within Coastal Plain	Coastal Plain	Remnant of Tertiary Lateritic Plain. Best developed on Lower Cretaceous claystone
Mesozoic	Lower Cretaceous	Undifferentiated (Kl)	Maximum observed section 80	Friable yellow clayey sandstone, massive white quartz sandstone and conglomerate; claystone, sandy claystone UNCONFORMITY	Small mesa cappings, low outcrops within Coastal Plain, valley infillings	Small discontinuous outcrops throughout the Sheet area	Both marine and freshwater facies present. Marine overlies fresh-water when present together
Palaeozoic		Cox Formation (Clc)	150 preserved	Flaggy purple micaceous siltstone and fine sandstone; green shale; blocky to massive white medium quartz sandstone	Undulating surface on top of Cox River Plateau	Confined to Cox River Plateau in south-western corner of Sheet area	Contact with underlying Bukalara Sandstone gradational
	Lower Cambrian	Bukalara Sandstone (Clc)	Up to 100	Massive, buff, cross-bedded, medium to coarse, slightly feldspathic quartz sandstone UNCONFORMITY	Forms Cox River Plateau		Characteristic west-north-west joint system visible on air-photographs

zone ; they are probably subsidiary faults related to the *Four Archers Fault*, which forms the western boundary of the Central Fault Zone. The areas between the lines of faulted domes are tilted, with dips generally less than 10° .

The sandstones of the Roper Group show a pattern of intersecting joints, the angle of intersection being about 60° to 70° . The lines bisecting the acute angles of intersection of these joints generally trend east.

The northern edge of the zone is bounded by the *Hells Gate Hinge-Line*. Dips are very steep to the south (80° to 85°) and in places the beds are overturned and dip 80° to the north.

Central Fault Zone

The Central Fault Zone contains mainly rocks of the Tawallah Group, with some rocks of the McArthur and Roper Groups. In places uplift has exposed the Scrutton Volcanics. The structure is dominated by block faulting and tilting of the fault blocks.

The Yiyintyi Range is a large, faulted anticlinorium plunging south-east, but the anticlinal structure of the Tawallah Range area is obscured by intense faulting.

The major faults vary in strike between north-west and north-north-east ; north-north-east is the most common. The fault planes dip steeply and movements are mainly vertical, with apparent throws up to 20,000 feet (Four Archers Fault). The faults are marked in places by zones of brecciation and silicification about 30 or 40 feet thick. A closely-spaced set of subsidiary faults is developed, which makes angles of about 30° with the major faults. The most common trends are north-east, north, and north-west. The sandstones of the Tawallah Group have a well developed pattern of joints which parallels these subsidiary faults.

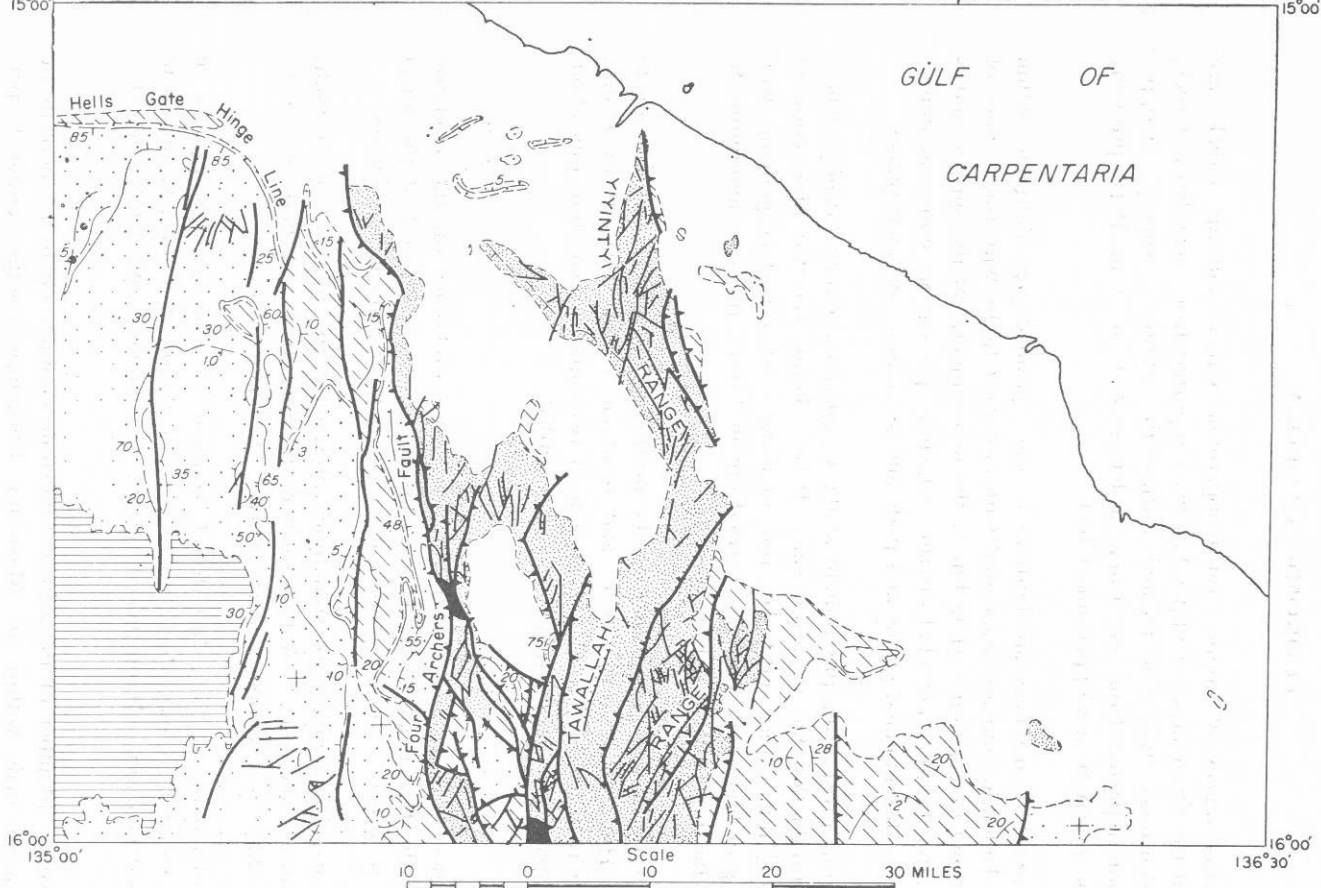
Minor warping, with north-west axes, is present in outliers of McArthur and Roper Groups. Within the outcrops of the Tawallah Group, fault blocks have been tilted with dips of 20° to 50° , locally steepened against faults.

A problematical structure is present immediately to the west of Mount Young. The Limmen Sandstone strikes west (i.e., at right angles to the regional structure) and dips about 5° to the north. This structure is probably related to the Hells Gate Hinge-Line.

Eastern Stable Block

Deformation decreases to the east of the Central Fault Zone ; the area east of the Tawallah Range is comparatively stable and is here referred to as the Eastern Stable Block. West of Batten Creek, McArthur Group rocks are warped into gentle north-west-trending folds. Dips are generally about 5° , with a maximum of about 20° . Some small north-striking faults are present. East of Batten Creek rocks of the Roper Group are sub-horizontal.

135°00' 15"00" **FIG.2 TECTONIC SKETCH MAP - MOUNT YOUNG 1:250,000 SHEET** 136°30' 15"00'



- Soil cover
- Cambrian
- Roper Group
- McArthur Group

- Tawallah Group
- Scrutton Volcanics
- Geological boundary
- Trend line with dip of bedding

- Horizontal strata
- Major fault showing direction of downthrow
- Major fault along faulted dome
- Subsidiary fault

TECTONIC HISTORY

The tectonic history of the Sheet Area is summarized in Table 5.

ECONOMIC GEOLOGY

Copper

Two occurrences of copper, on Coppermine Creek and Sly Creek, are known from the Sheet area. Copper has been reported from near Rosie Creek, but the occurrence was not located during the 1960-61 survey. Copper mineralization reported from the Limmen River Watershed in 1918 probably refers to the prospect at Coppermine Creek.

The known occurrences are both in a coarse-grained grey dolomite within the Amelia Dolomite and are associated with east-west faults with thick zones of silicification and brecciation. Malachite is the main mineral at the surface and is secondary after bornite and chalcopyrite, which is present in minor amounts; it is present as disseminated grains and pods and as coatings on joint planes.

Numerous prospecting pits remain at the *Coppermine Creek Locality*, where spasmodic production has occurred since 1918. Total recorded production to 1957 was 44½ tons of ore and 0.162 tons of metal. Some surface gouging, with hand-picking of high-grade ore, was carried out in 1960; this ore, amounting to a few tons, has not been carted away.

The *Sly Creek* prospect occurs on the northern side of the track leading to 'Hammer's Hut' on Eastern Creek, and is about ¼ mile east of Sly Creek. At the Sly Creek locality, copper is present in two small prospecting pits about 100 yards apart. No production has been recorded.

Iron

The Sherwin Ironstone Member, which forms orebodies on the Hodgson Downs and the Urapunga Sheet areas, crops out in the north-west of the Sheet area. The rock here is of low grade and not of immediate economic interest.

Small hematite bodies are sometimes present at the intersection of faults and ferruginous sandstones. A hand-picked specimen from one body (75 x 15 yards) near Sly Creek copper deposit assayed 56.1 percent Fe.

An isolated outcrop of Masterton Formation 15 miles south-south-east of Bing Bong Homestead, extending over an area of 1 mile by ¼ mile, is altered to quartz-veined hematite. Hand-picked specimens contained only 21.9 and 31.2 percent Fe.

The Munyi Member of the Abner Sandstone contains up to 25 percent Fe and ferruginous beds within the Masterton Formation contain about 9 percent Fe.

Barytes

A small deposit of barytes, with minor amounts of galena, is present within dolomitic siltstone and silicified dolomite of the Kookaburra Creek Formation in the bed of Eastern Creek about 10½ miles west of the Mount Young track. The barytes occurs as irregular lenticular bodies up to 6 or 7 feet in length over a distance of about 100 yards. Farther east, within the Tooganinie Formation, small veinlets and vughs are exposed along an east-west line for 200 yards. Faulting is not evident.

Minor occurrences of barytes near Coppermine Creek were reported by geologists of Mount Isa Mines Limited.

Water

No bores have been drilled in the Sheet area. There are no permanently flowing streams, but surface water, in the form of permanent water-holes, is sufficient to support the present pastoral activity. Numerous springs and seepages occur around the edges of sandstone ranges of Tawallah Group and Roper Group rocks.

Salt

Salt deposits occur on the Tidal Flats, but are not being used.

TABLE 5
TECTONIC HISTORY—MOUNT YOUNG SHEET AREA

Age	—	Event	Remarks
Cainozoic	Tertiary to Recent	Slight epeirogenic uplift and downwarping with erosion and sedimentation	Continuous erosion of topographically high areas. Eustatic changes in sea level—alternating erosion and sedimentation on Coastal Plain. Alluvial flats developed around streams
	Tertiary	Deposition of sediments in freshwater lakes	Peneplain conditions on area corresponding to present Coastal Plain. Main Ranges present as topographic highs
		Lateritization	
		Epeirogenic uplift and marine regression. Slight erosion	Peneplain developed on Lower Cretaceous sediments
Mesozoic	Lower Cretaceous	Marine transgression and deposition of freshwater and marine sediments on stable shelf	Slow transgression of sea from north to south. Topographically high areas remained as islands with freshwater sedimentation in depressions
		Epeirogenic uplift and erosion	Area dissected to produce topography similar to present day
Palaeozoic	Lower Cambrian	Deposition of Bukalara Sandstone and Cox Formation on stable shelf	
		Orogenic uplift and erosion	Basement uplift and faulting produced faulting and folding of the Proterozoic rocks
Precambrian	Upper (?) Proterozoic	Deposition of Roper Group (5,500 + feet of micaceous siltstones and arenites) on shelf with variable rate of subsidence	Centre of sedimentation moved westward. Marked thinning out in east. Variable rate of subsidence shown by quartz sandstone alternating with micaceous siltstone and quartz greywacke
		Local uplift and erosion of the McArthur Group	Up to 3,500 feet of section eroded in the east
	Lower (?) Proterozoic	Formation of north-trending trough and deposition of the McArthur Group (up to 10,000 feet of carbonates)	Marked thinning out of sediments to east of Sheet area; no sediments to west. Area generally a subsiding shelf. Hinge-line formed during middle stage with increased subsidence in east. Total thickness in west 4,000 feet; up to 10,000 feet in east. Some volcanics near base of McArthur Group. (See Stratigraphy of McArthur Group for detail)
		Lower Proterozoic	Sedimentation uniform over wide area. Sedimentation kept pace with subsidence giving rise to thick sequence of quartz sandstone
	Lower Proterozoic	Orogenic uplift and folding	Lower Proterozoic sediments and volcanics folded
		Acid vulcanism—Scrutton Volcanics	Oldest rocks exposed

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