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THE GEOLOGY OF THE CAPE MELVILLE 1:250,000 SHEET AREA, SD 55/9, NORTH QUEENSLAND

by

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SUMMARY

The Cape Melville 1 : 250,000 Sheet area was mapped geologically by the author and by J.T. Woods and L.G. Cuttler, of the Geological Survey of Queensland, during the winters of 1962 and 1963.

The area includes the northernmost exposures of the Hodgkinson Formation (Middle Palaeozoic), and the north-eastern limb and margin of the Laura Basin (Mesozoic). The older basin was geosynclinal - the northernmost structural-stratigraphic unit of the Tasman Geosyncline. It is represented by steeply-dipping, sharply-folded slate and greywacke, intruded by (?) Lower Permian granitic stocks which introduced the known metallic mineralization. This relatively stable complex forms the eroded, fairly uneven basement to the north-eastern limb of the Laura Basin, which is an open syncline plunging gently to the north-north-west beneath Princess Charlotte Bay. The Mesozoic sediments exposed in the Sheet area are freshwater Jurassic sediments and, transgressively overlying them, marine and freshwater Cretaceous sediments. This part of the Laura Basin has been uplifted by moderate (?) early Tertiary epeirogenic movements which accentuated the basin form. The uplift was probably accompanied by faulting and foundering of the basin margin, which caused the coastline to retreat to its present position, and was closely followed by erosion and superficial deposition, which produced substantially the present morphology.

Only gold and a little wolfram have been mined economically in the Sheet area. Probably between 3000 and 4000 oz. of alluvial gold were won in the Starcke River valley, in the south-east, between 1890 and 1898, and over 9000 oz. were recovered from about 4800 tons of vein quartz lodes in the same area between 1898 and 1908, after which there was little production.

Wolfram was mined by hand methods at and near the surface on Noble Island early this century and possibly later; total production is probably less than 20 tons of concentrate.

Deposits of antimony, tin, copper, silver, sand, and coal are also known. There are prospects for the production of underground water and possibly also of petroleum.

INTRODUCTION

The Cape Melville 1 : 250,000 Sheet area is bounded by longitudes 144°E and 145°35'E, and latitudes 14°S and 15°S. About half the area, mainly the north-eastern half, is part of the Coral Sea, in which the Great Barrier Reef maintains a distance of about 30 miles from the coast. Part of Starcke No.1 Gold Field and most of Starcke No.2 Gold Field are included in the south-east of the area.

Settlement is much sparser than in the Cooktown area to the south. Kalpowar and Lakefield homesteads are situated close to each other in the south-west, and Starcke homestead is three miles south of the boundary of the area in the south-east. A dry-weather track provides access to the area, joining Kalpowar and Starcke. With the recent increase in beef cattle prices, improvement of the area has begun: a homestead is being established near Police Lagoon in the centre of the area, and Starcke and Kalpowar managements are building roads with a view to developing the northern part of the area. Light aircraft land at Kalpowar and Lakefield, and may soon land farther north.

The geological map which these notes accompany was compiled from information gathered by a combined party of the Bureau of Mineral Resources and the Geological Survey of Queensland, which worked in the area between June and October of 1962. Until then only two small parts of the area had been geologically mapped, and the distribution and relationships of the rock units were not accurately known. The author re-visited the area in September 1963, and found that Cretaceous sediments are more extensive in the coastal range than had been thought. Specimen numbers quoted in this report refer to rocks in the catalogued Bureau of Mineral Resources museum collection. Other numbers appearing on the map and in the text (e.g., LB140) refer to the author's 1963 field localities.

The land area is covered by air photographs, at a scale of 1 : 48,000, flown in 1957-58; a small cloud-covered area in the south was re-flown in 1962. The off-shore areas were photographed at a scale of about 1 : 80,000 in 1959-60 (Great Barrier Reef Photography). All the photography was done by Adastra Airways Pty. Ltd. A contoured map at a scale of 1 : 250,000 was produced by the Royal Australian Survey Corps in 1961.

The Atlas of Australian Resources describes the climate of the area as that of the sub-equatorial coast and the tropical inland. The normal annual range of (daily maximum ?) temperature is relatively low for Australia - from less than 20°F, along the coast, to 35° in the south-west.

Average annual rainfall increases from at least 40 inches in the south-west to more than 60 inches along the coast. Most of the rain falls from December to April.

Sclerophyll shrub savannah covers most of the sandy southern part of the area, and mixed tropical woodland most of the rest. Tropical tussock grassland covers the sediplain bordering Princess Charlotte Bay. Many of the mesas of ferruginized Mesozoic sediment are almost bare of trees, and are lightly grassed. Thin lines of flourishing Bunya pine trees grow along scarps of Mesozoic sandstone on the Altanmoui Range between 1500 and 2000 feet above sea level.

PREVIOUS INVESTIGATIONS

The first recorded geological observations in the area seem to have been made by Cunningham and by King, who noted that Lizard Island and the Direction Isles are granitic (King, 1827, vii, p.17; Fitton, 1827, pp. 570,608), and that sandstone overlies black shale and conglomeratic coarse sandstone on Clack Island, Flinders Group (King, op.cit., p.25; Fitton, op.cit., pp.608, 09; see also Richards & Hedley, 1925, p.3). The observation on the granitic composition of Lizard Island was repeated by Jukes (1847) and MacGillivray (1852).

Coppinger in 1881 noted the abundance of secondary oxides of iron in the 'quartzite' blocks on the beach of Flinders Island, and also visited Clack Island (Coppinger, 1883, pp. 190-191).

The opening of mining fields south of Cooktown brought prospectors north to this area before the turn of the century. Traces of alluvial gold were found south of Ninian Bay in 1884 (Downs, 1884; Dunstan, 1913), but have never been worked there. Coarse alluvial gold was discovered at Diggings Creek, a tributary of the Starcke River, in 1890, and reef mining was carried on at nearby Munburra from 1896 until about 1909. Cameron (1907) and Ball (1909) reported on these workings and on the local geology. Ball noted the presence of Palaeozoic slate unconformably overlain by scarp-forming Triassic-Jurassic sandstone and by later basalt, and the existence of a low, coastal erosion plain. The association of the gold-bearing quartz reefs in the Palaeozoic rocks with leucophyre dykes was observed, and the mineralogy of the reefs described.

Small-scale wolfram production began on Noble Island in 1904, or earlier, and continued for at least four years. Traces of tin, copper, silver, and gold were also known on the Island (Cherry, 1908).

In the same year a 13-inch coal seam was reported on Stanley Island (Lee-Bryce, 1904; Cherry, op. cit.).

Observations on the coastal geology and on that of the Flinders Group were made by Richards & Hedley in 1925 as part of the work of the Great Barrier Reef Committee. They noted the regularity and sharpness of the outer barrier reef and its relative proximity and parallelism to the coast, from Cairns to Cape Melville. The stratigraphy, lithology, and structure of the probably Jurassic lacustrine sandstone and conglomerate of the Flinders Group were described, and they were likened to those farther north along the Peninsular coast. Richards & Hedley also noted that the conglomerate which is predominant at the base of the sequence is rich in chert and hornfels pebbles, whereas the sandstones up to 700 feet above are micaceous, and appear to have been derived from a granitic terrain. This indicated to them that the detritus was derived from a terrain of metasediment and intrusive granite, and that progressive erosion removed most of the sediment, and exposed a dominantly granitic provenance. The structure of the group appeared to them to be a fractured, heavily jointed north-north-east elliptical dome whose axis intersects the eastern end of Stanley Island. The occurrence of cliffs where dips are flat, and of dip slopes elsewhere, was noted. The habit and distribution of secondary limonite were described.

Recent elevation of a 20-foot-wide wave-cut platform by 4½ feet was deduced from an exposure in Owen Channel, and a more ancient submergence (of the order of 50 feet) was inferred from the morphology of Owen Channel. Foundering of the Melanesian Plateau after arid conditions in the area in the Jurassic was postulated (cf. Hedley, 1911). Attention was drawn to the influence of fracturing (along the cardinal directions and bisecting directions) in granitic rocks on the coastline from Cape Bowen (the most northerly outcrop of 'metamorphic' rocks) to Cape York.

Richards & Hedley (op.cit.) thought that the Reef generally might rest upon a basement of granite and Palaeozoic metamorphics, but that north of the Flinders Group it might rest upon Jurassic sediment.

In 1935 unsuccessful attempts were made to re-open some of the Starcke reef mines (Beck, 1935). In 1937 prospecting at Barrow Point by individual prospectors and the Broken Hill Pty. Co. Ltd. revealed small bodies of tin-bearing gully wash, but no deposits of economic size.

Hill (1951, pp. 16, 23-24) referred briefly to the area. In an unpublished paper (Hill, 1956), she reviewed the literature and the various hypotheses on the geological relations between the near-coastal mainland and the Great Barrier Reef zone. The geological map of Queensland (Hill, 1953) and the Tectonic Map of Australia (Geological Society of Australia, 1960) show an approximation to the geology of the Sheet area, as it was then known or inferred.

Jones & Jones (1956), in reviewing knowledge of the geology of some coastal islands, recorded the existence of a specimen of ignimbrite from Saddle Islet, near Lizard Island (op. cit., pp.46, 52), and discussed the age and affinities of the sandstone at the Flinders Group and Bathurst Heads, which they presumed to be Blythesdale Sandstone equivalents.

The first systematic geological mapping done in the area, apart from a sketch of the Starcke Gold Field, was completed in 1957 for Australian Mining and Smelting Pty. Ltd. (Mott, 1957a, b, 1958; Madden, 1957) as part of an assessment of the off-shore oil prospects of the area. Mott (1957a) suggested that the Laura Basin extends northward beneath Princess Charlotte Bay, and that the marine Cretaceous rocks may thicken there. He also suggested that the fault system now known as the Palmerville Fault (de Keyser, 1962) may have initiated the basin in the early Mesozoic (Mott, 1958, p.7).

Madden mapped the Flinders Group islands and Bathurst Head, and on them he distinguished two Mesozoic clastic sedimentary formations separated by a slight unconformity. The lower one rests unconformably on 'metamorphics'. In the upper (predominantly sandstone) unit, which he equated with the Blythesdale Sandstone, on the evidence of a collection of probably Lower Cretaceous plants from Clack Island, he noted the relics of an approximately domal structure which takes in the whole area mapped by him. In the lower (conglomerate/sandstone) unit, he noted areas of moderately steep dips, and folding and faulting on north-south lines. Mott (1958, p.6) correlated the upper unit with the Jurassic sandstones of the southern part of the Laura Basin on lithological grounds (in the present mapping the lower unit has been identified with these). He also suggested that the lower, probably freshwater unit might have a marine equivalent (op. cit., p.7). Probable marine Jurassic sediments were penetrated at about 3200 feet in an oil well (Cabot - Blueberry Marina No.1) recently completed at the head of Princess Charlotte Bay, about 40 miles to the south-west (Evans, 1962).

Madden (op.cit.) also thought that both Mesozoic units are present above the metamorphics at Cape Flattery, in the east of the Sheet area.

The next field mapping in the Laura Basin within the Sheet area was in 1959 (Swindon, 1960) as part of a search for oil. He erected a stratigraphical column (op.cit., fig.1) which included the Cainozoic marine and fluviatile sediments. The sections on the Flinders Group and Bathurst Heads, and Madden's work there, were summarized, but the significance of Madden's 'slight erosional unconformity' (op.cit., p.10) was minimized. The composition and textures of the Mesozoic and Tertiary sandstones were described, and the possibility was pointed out that marine Cretaceous shales similar to those at 'Fairview', near Laura, might underlie the Cainozoic deposits south of Princess Charlotte Bay.

He deduced from the regional gelogy that there were post-Permian and late Cretaceous - early Tertiary earth movements, and also a late Tertiary - Recent emergence of four to ten feet. A gravity traverse south-west from Combe Point (Bathurst Heads) yielded relatively high Bouguer anomaly values at Combe Point. These values diminished to the south-west, towards the deeper parts of the Laura Basin (Swindon, op.cit., Sheet 2, pp.15-16).

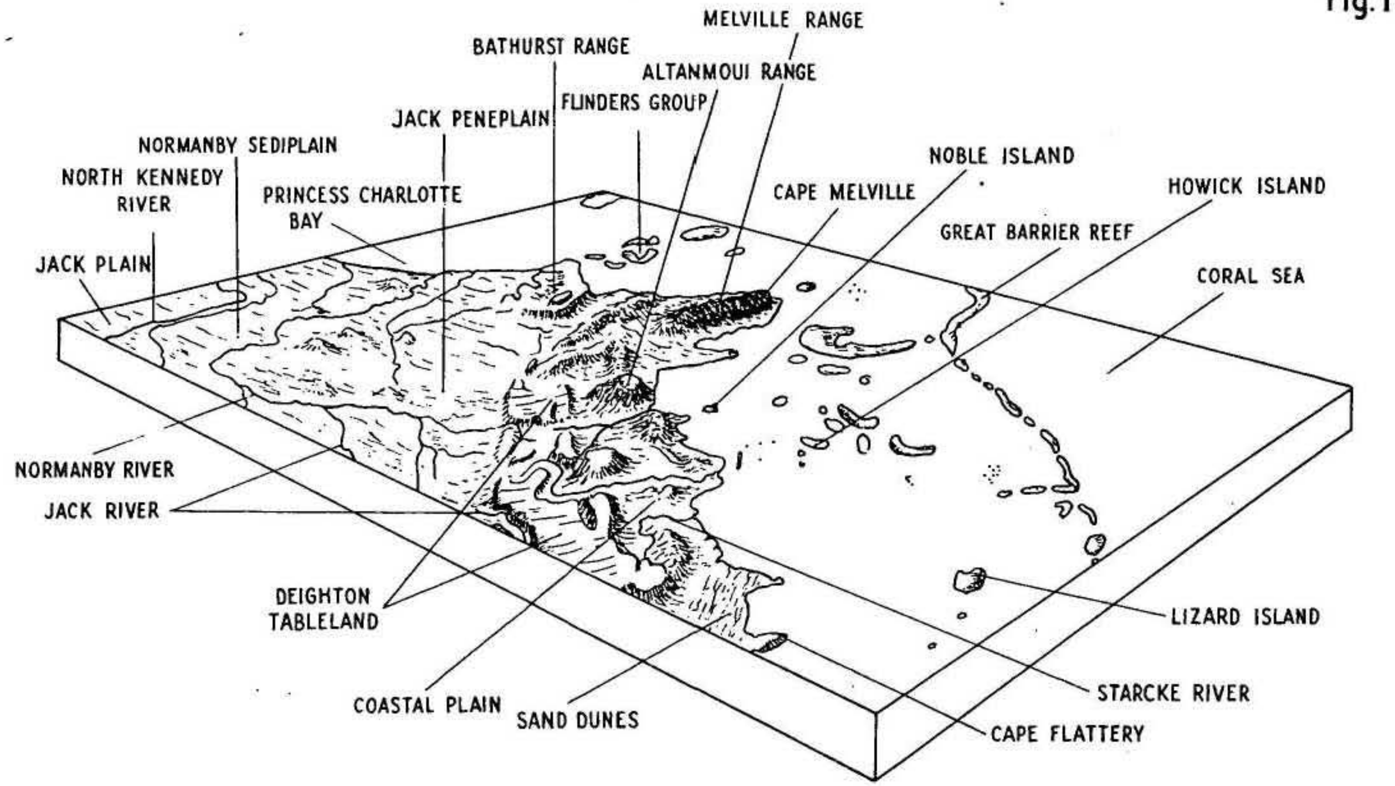
Brief references to the area were made in the symposium on the Geology of Queensland (Hill & Denmead, ed., 1960): the folded Palaeozoic rocks near the coast were identified with the Barron River Metamorphics (op. cit., p.130), and the Palaeozoic igneous rocks were mentioned (op.cit., pp. 244, 249). The finding of Hatchericeras sp. in glauconitic sandstone near 'Lakefield'Station was reported (op.cit. p.329, and Woods, 1962 b), and some of the little-known Cainozoic deposits of the region were mentioned (op.cit., pp.408, 411).

An off-shore gravity traverse from the Flinders Group to the Bloomfield River was completed between 1954 and 1956 by the Bureau of Mineral Resources (Dooley, 1961). Few readings were made in the Sheet area.

In 1962 an oil well, Cabot-Blueberry Marina No.1, subsidized by the Commonwealth Government as a stratigraphic hole, was drilled by Mines Administration for a consortium of several American and Australian companies. It was sited near the 'Marina-Plains' - 'Musgrave' road near Saltwater Creek, about eight miles west of the Sheet area. The well penetrated more than 3500 feet of marine and freshwater Cainozoic and Mesozoic sediments and a small thickness of moderately dipping Permian plant-bearing sediment, and was completed at 3829 feet in altered basic igneous rock (Mines Administration Pty. Ltd., 1962; also Plate 2 of this report).

In the same year an aeromagnetic survey was flown over the

Fig. 1



PHYSIOGRAPHIC UNITS, CAPE MELVILLE 1:250.000 SHEET

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sea from Princess Charlotte Bay and Bathurst Bay, in the south, north to Papua (Micro Magnetics Associates, 1963). The Laura Basin basement was interpreted as attaining a depth of at least 6000 feet in the west of the Sheet area, and a north-south anomaly was detected north of Bathurst Bay.

PHYSIOGRAPHY

The Cape Melville 1 : 250,000 Sheet area has been divided into five areas according to the land forms and superficial geology (Fig.1). These are all continuous along the southern boundary with those distinguished in the Cooktown Sheet area (Lucas, 1962, fig.2). They are, from north-east to south-west:

The Continental Shelf, in fact a large shallow back-reef area from which several hard-rock islands rise up to 1000 feet A.S.L., and many more platform reefs and associated deposits (see above) rise to just under or just above mean low tide level. The depth of water generally increases gradually from 10 feet within one to two miles from the coast, to 120 feet just behind the outer barrier reef (Admiralty, 1950).

The Coastal Plain extends from Cape Flattery to Bathurst Bay, and reaches from 6 to 15 miles inland from the generally flat, low coastline to the scarp-capped bounding slope separating it from the Deighton Tableland. It is interrupted by the granite inselbergs of the Melville Range and the Altanmoui Range, which rise to over 2000 feet, and are very bold and rugged (see Cainozoic Stratigraphy). The Altanmoui Range is partly capped by Mesozoic sandstone, and may be considered to be an outlier of the Deighton Tableland.

The coastal plain is generally covered by Cainozoic superficial deposits which give it a smooth profile: talus underlies the steep, concave bounding slopes beneath the Mesozoic sandstone scarp, and alluvial material (including re-worked talus) underlies the more gentle distal slopes. Dune sand covers large areas in the vicinity of tied islands such as Cape Flattery, Lookout Point, and (?)Barrow Point.

The Deighton Tableland, like the adjacent coastal plain, is an elongate belt parallel to the coast, stretching from the Jack River headwaters to Bathurst Head. It is nearly 30 miles across in the south, but in the north-west, where it was warped and faulted during the late Cretaceous or early Tertiary, it is disrupted and narrower. It is underlain by resistant Mesozoic sandstones which form the eastern, upraised margin of the Laura Basin (Fig.2), and so it has the form of a cuesta, dipping generally south-west, except for the Bathurst Range, where it dips south-east. Its height ranges from 200 to 300 feet A.S.L., near its boundary with the Jack Peneplain, to nearly 2000 feet in the more dismembered parts near the coast. It is partly sand-covered, and vegetated by stunted trees, shrubs, and undergrowth, except for parts in the north which support open forest. Surface water is extremely scarce.

The Jack Peneplain is a low, gently undulating, sand-covered plain from which a few small residuals of Cretaceous sediments rise up to 300 feet above the general level, which is 100 to 200 feet A.S.L. It is sharply separated from the Deighton Tableland to the east by a distinct, though low, modified (?)fault scarp, and in the west it has a distinct boundary against the Normanby Sediplain nicked in profile. Its watercourses, as well as its interfluves, are choked with sand, and drainage is especially sluggish in the south, where the Jack Lakes hold permanent water. It is fairly densely vegetated with trees and undergrowth.

The Normanby Sediplain is a very flat tract regularly flooded by the braided streams of the Normanby River system, and covered by dark, silty alluvium. Its surface probably rises from about 10 feet A.S.L. near Princess Charlotte Bay to 100 feet A.S.L. at 'Lakefield'. It is covered by savannah, and its surface tends to be pitted by 'melonholes'.

In the far south-west of the Sheet area there are some sand-covered interfluves which properly belong to the Jack Peneplain morphologically.

It is apparent that the physiographic units described have some antiquity: they are younger than Lower Cretaceous (the youngest lithified sediments of the Deighton Tableland), but older than the various Cainozoic colluvial and alluvial deposits (and Tertiary basalt) which modify them but are perfectly congruent with them. These deposits are well exposed by erosion in the Coastal Plain, but are probably also well developed beneath the Jack Peneplain and Normanby Sediplain. The Coastal Plain has grown at the expense of the Laura Basin cuesta - i.e., the Deighton Tableland - by scarp retreat, and penetrates it in many places as both broad and narrow river valleys subsequently partly filled with little-transported detritus, and, in the upper Starcke River, with Tertiary basalt. Apart from this filling of the valleys (which began before they attained their present extent - see below: two ages of talus, separated by a period of scarp retreat), they have been little modified by Quaternary erosion, and the landscape appears to be substantially inherited from the late Cretaceous or early Tertiary.

TABLE 1

STRATIGRAPHY OF THE CAPE MELVILLE 1:250,000 SHEET AREA

ERA	PERIOD	FORMATION	SYMBOL	THICKNESS (FEET)	LITHOLOGY	CORRELATIONS (APPROXIMATE)	STRATIGRAPHIC RELATIONS	ECONOMIC GEOLOGY	PRINCIPAL REFERENCES
CAINOZOIC	QUATERNARY	Alluvium	Qa	Up to 200?	Grey silty clay, sand, gravel	=Qm, Qs.	Overlies older rocks; also cut and fill.	Gold	
		Marine deposits	Qm	Up to 600?	Reef and associated deposits, salt pans, beach sands.	=Qa, Qs; may be partly Tertiary.	Overlies older rocks, intertongues with Qa	Salt, lime, heavy minerals?	Richards & Hill, 1942
		Residual sand	Qs	Up to 20?	Loose orange and white sand	= Qa, Qm.	Overlies Mesozoic sandstones and Czx	Water storage?	
		Ferricrete		0-10	Sandy ferricrete, underlain by mottled zone.	Variable age?	Overlies Klc, Jl, Czx, Czt, Czd.		
		Dune sand	Czd	max. 300 ASL	Younger: white quartz sand and peat. Older: ferruginous dune sand, kaolinitic sand, peaty sand.	= Qa, Qm, Qs. = Czt, Czx?	Overlies and abuts against older rocks.	Water storage; possible glass sand.	
		Talus	Czt	5-100	Ferruginous, earthy matrix containing sandstone and chert blocks.	At least two stages; = Czx	Overlies D-Ch below scarps of Mesozoic sand-stone.		
		Brixton Formation	Czx	5-150?	Mottled, pebbly, clayey sand and sandy clay.	Includes two stages; = Lynd Form-ation	Coarse fossil alluvia-overlie and abut against older rocks; Qa, Qs over-lie, Qa with cut-and-fill.	Poor, inhomogen-eous aquifer?	Laing & Power, 1959 (Lynd Formation)
		Piebald Basalt	Czp	5-100?	Olivine basalt and nepheline basanite.	= McLean Basalt, Ather-ton Basalt, Czx, Czt.	Overlies older talus?, overlain by younger talus.		Morgan, 1964b
MESOZOIC	LOWER CRETACEOUS	Wolena Claystone (Albian)	Klo	Not exposed in sheet area; 200 in Cabot-Blue-berry Marina No.1, 8 miles to west.	Olive calcareous claystone		Less extensive than Klc, dis-conformable beneath Cz units.	Small saline aquifers	
		Battle Camp Formation (Aptian - Neocomian)	Klc	Up to 900 exposed; 800-1450 in Marina No.1 (Core 6 critical)	White quartz sand-stone, thin con-glomerate, clayey and glauconitic sandstone, shaly siltstone.	=Wrotham Park Sandstone and Blackdown Formation.	Overlaps Jl, underlies Klo conformably?	Aquifer	

TABLE 1

ERA	PERIOD	FORMATION	SYMBOL	THICKNESS (FEET)	LITHOLOGY	CORRELATIONS (APPROXIMATE)	STRATIGRAPHIC RELATIONS	ECONOMIC GEOLOGY	PRINCIPAL REFERENCES
MESOZOIC	JURASSIC	Dalrymple Sandstone	Jl	Up to 800 exposed, 1650-2300 in Marina No.1.	Off-white quartz sandstone, conglomerate, shale.		Unconformable upon older rocks, overlapped by Klc.	Aquifer	
PALAEOZOIC	PERMIAN	Puckley Granite	Pgk		Porphyritic biotite adamellite.	All approximate correlatives of Mareeba Granite.	Intrude Hodgkinson Formation, unconformably overlain or abutted by post-Palaeozoic rocks	Source of mineralization (Au?, W, Sn, Cu, etc.)	Ball, 1909(Gold), Morgan, 1964 a,b
		Finlayson Granite	Pgf		Porphyritic biotite-muscovite granite				
		Altanmoui Granite	Pgi		Porphyritic muscovite-biotite adamellite				
	Lower Carboniferous to Middle Devonian.	Hodgkinson Formation	D-Ch	10,000	Greywacke, slate, minor volcanics		Unconformable beneath Mesozoic rocks (and any Permian strata). Intruded by granites. Unconformable on Precambrian and Silurian rocks at depth?		

STRATIGRAPHY

The oldest exposed rocks in the Sheet area are the folded, lightly metamorphosed Devonian sediments of the Hodgkinson Formation. These are intruded by late Palaeozoic post-tectonic granites and overlain by the low-dipping marine and freshwater Jurassic and Cretaceous sediments of the Laura Basin. A variety of terrestrial and coastal Cainozoic sediments and volcanics was deposited on all these rocks (Table 1).

MIDDLE DEVONIAN - (?)LOWER CARBONIFEROUS

The northernmost outcrops of the Hodgkinson Formation, a major flysch unit of the Tasman Geosyncline, are found in this area. The formation consists of rhythmically alternating beds of greywacke and slate in various proportions (Amos & de Keyser, 1964). The usual minor rock types - e.g., interbedded lava (sodic rhyolite) and reef limestone - were not seen in this area. The grain-size and proportion of the greywacke are maximal between Cape Bowen and the Altanmoui Granite. Thin-bedded to thick-bedded greywacke, consisting of fine to coarse arenite, grit, pebbly grit, and conglomerate, is closely set in intervening pelite. The pebbles consist of intraformational detritus (probably including limestone pebbles with (?)organic markings), and an appreciable proportion of harder, well rounded pebbles of sheared and granulated dark quartzite, micaceous metaquartzite, and silicified rhyolite - probably a Precambrian suite, except perhaps for the rhyolite. At Noble Island, six miles east of Cape Bowen, sandy to fine conglomeratic beds, though thin, are dominant, and slumps and turbidite structures, including truncation of tops, are common. The described features of these outcrops indicate high instability and nearby supply (probably emergent Precambrian rocks and perhaps an associated volcanic chain) for this part of the Hodgkinson Basin.

Elsewhere, the formation consists mainly of thin-bedded fine and medium-grained arenite in dominant slaty pelite. At Lookout Point a distinctive minor rock type, a medium-bedded, dark, muddy (unsorted) sandstone, was seen, and on the 'Munburra' track, a very clean quartzose sandstone crops out in a creek crossing.

(?)PERMIAN GRANITES

Four main granite bodies are known along the north-west-trending coastal belt, where they tend to give rise to areas of high and bold relief, modified by the extent to which they have been, and still are, covered by Mesozoic sandstone. The hard rocks of Howick Island, Lizard Island, and several other islets, are also granite. Petrographically the granites seem to fall into three (or more) groups: The Finlayson Granite (Lizard Island and the Direction Island) and the Puckley Granite (Jeannie River valley), both of which were recognised in the Cooktown 1 : 250,000 Sheet area to the south (Lucas, 1962; Morgan, 1964b); and the Altanmoui Granite (new name), which includes the granites of the Melville Range, Barrow Point, Wakooka Creek, and the Altanmoui Range.

They have been assigned a probable Permian age because of their post-Devonian, pre-Jurassic age, and because all radio-active age determinations so far made on similar granites to the south have yielded Permian ages for those bodies. Determinations have not yet been made on the three samples of Altanmoui Granite submitted (localities, see map).

The granite at Lizard Island (Finlayson Granite) is a cream to grey, massive, fairly even, medium to coarse-grained, tourmaline-bearing biotite-muscovite granite. It contains pegmatite segregations and veins, and aplite veins which have pegmatitic bands and swellings. The pegmatite consists of quartz, cream feldspar, muscovite (commonly in rosettes), and variable amounts of tourmaline. Tourmaline aggregates in the granite and the pegmatite are up to a foot across. The granite is cut at fairly widely-spaced intervals by regular, nearly vertical shears (joints along which there has been movement?), striking 325°, which probably cause the foliation in that direction noticeable on the air photographs. However, no shearing is visible in the thin sections (Morgan, 1964a), though it is in the Finlayson Granite of the type area (Morgan, 1964b). Some aplite veins follow flat-dipping joints.

Under the microscope, potash feldspar (microcline-perthite) and quartz are seen to exceed plagioclase, and accessory muscovite is more common than biotite and tourmaline, with which it is associated (Morgan, 1964a).

Jones & Jones (1956) report the presence of ignimbrite as well as granite on Saddle Islet, the westernmost, small, high island of the Lizard Island group.

The apparently stock-like intrusion of Puckley Granite into the Hodgkinson Formation in the Jeannie River headwaters is still partly covered by Mesozoic sediment. The Hodgkinson Formation greywacke below the northern scarp of this Mesozoic outlier appears to be contact-altered, and is cut by quartz and quartz-feldspar veinlets. Specimens were taken from an apparently involved part of the southern contact. There the granite is a grey, medium-grained, tourmaline-bearing, porphyritic biotite adamellite (Morgan, 1964a) containing equal quantities of quartz, microcline-perthite, and fairly calcic plagioclase. Biotite makes up about 5 per cent of the rock, but muscovite is rare. A biotite-quartz-muscovite hornfels was collected adjacent to the contact at this locality.

No landing could be made on the granite forming the eastern end of Howick Island. It appeared to be a grey, uniform, medium or coarse-grained granite with a slight north-west foliation dipping steeply east. At its northern end it is cut by regular cream fine-grained veins dipping generally south, and by steeper north-dipping joints. It may belong to the Puckley Granite.

The validity of uniting all the other granite outcrops - those west of long. 144°40'E - under the name Altanmoui Granite is problematic, because of insufficient sampling away from the contacts of the larger bodies, and the lack of any specimens from the southernmost group of small outcrops. The granite at the monument at Cape Melville, probably some distance from a contact, appeared to be uniform. The specimen is a grey, fairly even, medium-grained porphyritic biotite adamellite consisting mainly of equal quantities of quartz and oligoclase with albite rims, and lesser (25%) microcline-perthite (Morgan, op. cit.).

The granitic rocks along the invloved south-eastern contacts of the same body with the Hodgkinson Formation are variable and less simple petrographically. In common with the granites seen in and just north of the Altanmoui Range, many of them have abundant fresh tabular blue feldspar (oscillatory-zoned sodic andesine to sodic oligoclase - Morgan, op. cit., specimen R13089). Some of the granite in the contact-zone at the southern end of the Melville Range, south-east of Abbey Peak, is hornblende-bearing; an epidote-hornblende-plagioclase hornfels was collected in the same part of the contact-zone. The epidote probably formed by retrogressive metamorphism of a higher-grade mineral assemblage; all the other contact-metamorphosed rocks near the Altanmoui Granite belong to the albite-epidote hornfels facies (Morgan, op. cit.).

In the re-entrant into the granite east of the Melville Range, the Hodgkinson Formation is contact-altered and intimately intruded by small granitic bodies for up to three miles from the nearest exposures of the main contact. These minor intrusives are porphyritic biotite micro-granite containing blue plagioclase, aplitic granite, and tourmaline-muscovite pegmatite. The thin-bedded politic and semi-politic Devonian sediments exposed in the headland south of the mouth of Eumangin Creek are re-crystallized to biotite - and muscovite - rich hornfelses; quartz-rich beds are sugary.

The granite at Barrow Point appears to be uniform. A porphyritic biotite micro-adamellite was collected from near its contact with the small body of Devonian sediments, which include andalusite-quartz-muscovite hornfels, at its western side. At the same locality a small (?)dyke of fritted microgranite porphyry itself contains andalusite(Morgan, op. cit.). A fairly large concordant dyke of granophyric and porphyritic biotite micro-adamellite intrudes the north-north-east trending ridge of sediments which abuts against Ninian Bay farther west.

In the Altanmoui Range, the granite away from intrusive contacts is an even, medium-grained (?)adamellite containing weathered pink feldspar and fresh blue feldspar, minor quartz, biotite, and rare muscovite. At the south-western contact, the following varieties were found : porphyritic biotite microgranite with phenocrysts of quartz and fresh blue feldspar; a vein of foliated muscovite-biotite granite, granulated and sericitized along grain boundaries and microfractures (Morgan, op. cit.); and a pegmatitic aplite. Wolfram is reported on a granite/slate contact in the Altanmoui Range, probably on the eastern contact (see Economic Geology).

Hornfels is well developed in the Devonian sediments on the flanks of the Altanmoui Range, and near the granite south-east of the Melville Range; it is hard and well exposed between the granite and Cape Bowen, at which point alteration is still detectable through the presence of muscovite, biotite, and epidote in the matrix of a sheared greywacke(Morgan, op. cit.). A creek pebble in this area consisted of altered chiastolite hornfels, and near the south-western contact an unusually dark and heavy andalusite-cordierite-quartz-muscovite hornfels was collected.

A minor granite intrusion is poorly exposed west of the Altanmoui Range, a mile north of 'Wakooka' Out-Station. It consists of porphyritic biotite microgranite and muscovite-biotite granite, in both of which there is evidence of auto-brecciation (Morgan, op. cit.).

Comments upon the emplacement of the Altanmoui granite appear in the chapter on Structure.

Minor intrusions. Apart from the minor intrusions described above as associated with the larger granite intrusions, and the small granite outcrops which have not been visited, few minor intrusions are known. A small body of green, chloritized, richly porphyritic biotite microgranodiorite and micro-adamellite, of unknown form, crops out near the main track about half way between the Howick and Jeannie Rivers.

Extremely siliceous, fine-grained, thin quartz porphyry dykes

Fig. 2

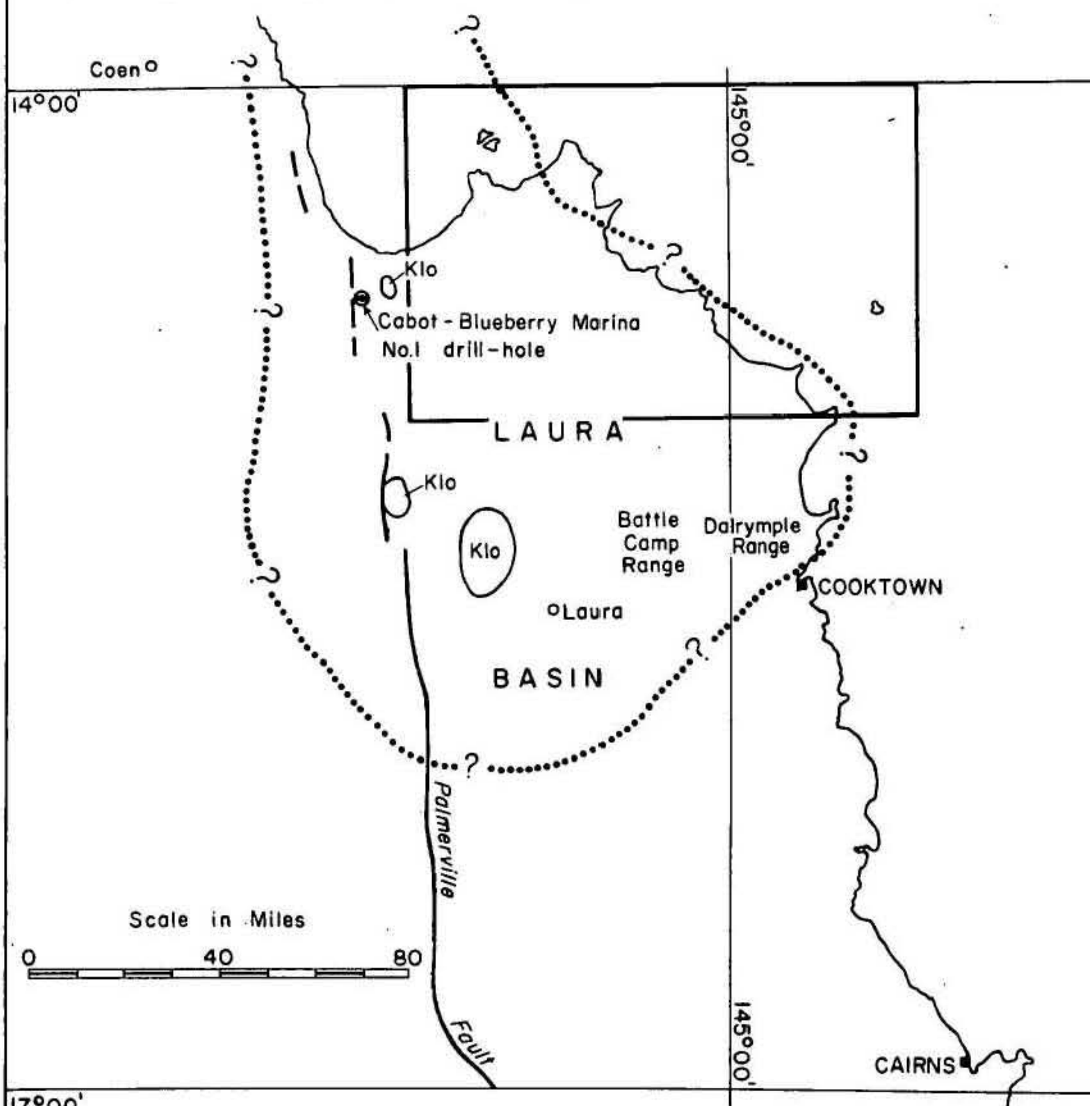
SKETCH MAP SHOWING POSITION OCCUPIED BY CAPE MELVILLE 1:250,000 SHEET IN LAURA BASIN

REFERENCE

Klo — *Wolena Claystone (Albian) – youngest outcropping marine Mesozoic sediments.*

——— *Palmerville Fault*

•?•••••• *Approximate original depositional boundary of Laura Basin*



Bureau of Mineral Resources, Geology and Geophysics *March 1964* Q/A57 JVF are closely (and genetically?) associated with the auriferous quartz veins of the Starcke No.2 Gold Field, mostly north-west of Munburra. In thin section the groundmass can be seen to consist of silicified spherulites and interstitial quartz and sericite. The dykes contain scattered pyrite crystals, and the lode wall-rocks are also silicified and carry pyrite.

These minor intrusions are presumably of Permo-Triassic age, and are certainly pre-Jurassic.

JURASSIC

The outcrops of the Dalrymple Sandstone, the basal formation of the Laura Basin (Fig.2), are similar to those in the Dalrymple Range and elsewhere in the Cooktown 1 : 250,000 Sheet area, immediately to the south (Lucas, 1962).

Outcrops of the formation along the coastal range in the Cape Melville 1 : 250,000 Sheet area consist of freshwater sandstone, conglomerate, and shale from 200 feet to at least 800 feet thick. In the Cabot-Blueberry Marina No.1 well, eight miles centrally west of the Sheet area, equivalent sediments, some of them marine, appear to be at least 1800 feet thick (Plate 2; and Evans, 1962). The formation partly covers an irregular basement of granite and folded Devonian sediment. In general the granites formed the higher parts of the basement, and in many places (the Melville Range and part of the Altanmoui Range) they appear never to have been covered by later sediment, but to have protruded above the Jurassic sediplain. The base of the formation displays appreciable initial dips (up to 15°) in such areas - e.g., the Altanmoui Range. In several places along the coastal range (e.g. south-west of 'Wakooka' Out-Station, and at the headwaters of Beattie Creek) the Hodgkinson Formation is not covered by the Dalrymple Sandstone, but is directly overlain by marine Cretaceous sediments.

The thickest exposed section, of 800 feet, on Flinders Island, is also the coarsest (for diagrammatic sections, see Plate 2). Its base is not exposed, but it is overlain by (?)Cretaceous sandstone. It consists of thick-bedded and medium-bedded pebble and cobble conglomerate, grit, sandstone, and micaceous siltstone. Cross-bedding in the grit and conglomerate demonstrate transport from the north-east; the formation contains a much lower proportion of conglomerate on Dunham Island, and on the mainland, farther south. The pebbles consist of chert, jasper, greywacke, slate, and their contact metamorphosed equivalents (all from the Hodgkinson Formation), as well as quartzite, green quartz-feldspar porphyry, and a fine, even-grained (?)red granite (colour possibly due to weathering).

Probably between 500 feet and 600 feet of coarse sandstone and grit, thin angular quartz conglomerate, and ferruginized micaceous shale underlie Cretaceous sediments inland from the slight promontory four miles south-east of Bathurst Head. The base was not seen, but 'metamorphics' are reported on the beach nearby by Madden (1957, Pl.3). Within the lower 200 feet of this section there is a fine, silicified, flaggy grey sandstone with burrow marks ('pipe-rock').

In the thinner, complete section (100 to 150 feet) five miles north-west of 'Wakooka' Out-station, there are 80 feet of 'pipe-rock', which also contains laminae rich in unidentifiable plant stem remains. Below it is basal, angular, pebbly quartz grit, and above it are probable Cretaceous ferruginized pebbly sandstone, grit, and thin, fine conglomerate.

Most of the 550 feet of Mesozoic section in the Altanmoui Range may be Cretaceous. The lowermost 90 feet, below the probable base of the Cretaceous, consist of ferruginous shale near the base, medium-grained, even quartz sandstone with dark grains partly altered to hematite, and medium - and coarse-grained quartz sandstone.

South-east from here to the Sheet boundary, the formation is generally 100 to 300 feet thick, and may attain 500 feet in areas of high basement relief. In this area, as in the Cooktown Sheet area, the basal part consists of massive conglomerate and thinner-bedded sandstone and shale, commonly partly ferruginized. It is poorly exposed, and the exact position of the base (whose altitude commonly changes by 100 feet in 400 feet laterally) is difficult to photo-interpret. Above this there is almost everywhere about 100 feet of massive to thick-bedded, cliff-forming sandstone. In places the characteristic basal rock-types are missing, and this extensive sandstone rests directly upon the basement. The sandstone is a cross-bedded, medium to coarse-grained and gritty, off-white to pale grey quartz sandstone with minor dark lithic (chert?) grains and a sparse kaolinitic matrix. This forms the lower of two Mesozoic sandstone cliffs or scarps, usually 200 feet to 400 feet apart, which are fairly persistent all round the outcropping margins of the Laura Basin. Outcrop is mostly poor between the two cliffs, but the base of the marine Cretaceous sediments is generally no more than 100 feet above the top of this lower (Dalrymple Sandstone) cliff (see Plate 2).

In thin section the dominant rock type of the formation, the coarse to medium-grained sandstone, is seen to be unstratified and moderately sorted, and the grains are moderately to poorly rounded. They consist of quartz, minor chert, metaquartzite, (?)granitic fragments, and randomly-oriented, intergranular muscovite. A sandstone interbedded with the basal conglomerate near Rocky Trig. Point contains biotite as well as muscovite. A semi-opaque, amorphous or poorly crystalline clay mineral occupies a small part of the pore space, which has been slightly reduced by quartz outgrowth.

The Cabot-Blueberry Marina No.1 Well, drilled at Saltwater Creek, eight miles west of the Sheet area, penetrated probable marine sediments, including a biotite-bearing micaceous siltstone (Mines Administration Pty. Ltd, 1962, appendix 4a) at about 3200 feet (Evans, 1962), or about 300 feet above the base of the Jurassic section, which, according to Evans, is at least 1600 feet thick. No undoubtedly marine sediments are known from exposures of the Dalrymple Sandstone.

Cross-bedding, in sets from six inches to six feet thick, is fairly common in the grits and sandstones. It is generally fairly regular in the sandstones, but in places is more of the festoon type, especially in the coarser-grained rocks. The directions of sediment transport indicated by the cross-beds are generally congruent with the conformation of the Laura Basin - i.e., they have a component from the east.

No determinable plant fossils were found in the formation in the Sheet area, but in addition to the evidence for an (?)Upper Jurassic age from the plant macrofossils collected from the formations in the Cooktown area (Lucas, 1962; Woods, 1961), Evans (op.cit.) has assigned a Jurassic age (Upper Jurassic and partly Lower Jurassic, but probably not lowermost Jurassic) to the lower part of the Mesozoic section (presumably the Dalrymple Sandstone) in the Marina No.1 well, on the basis of the microfossils.

LOWER CRETACEOUS

The main outcrops of the Battle Camp Formation are in the higher parts and south-western slopes of the coastal range, and on the Flinders Group of islands in the north-west of the Sheet area. There its thickness ranges from 300 feet to 1000 feet. West of this belt, in the south-western part of the Sheet area, the formation is probably continuous beneath the terrestrial Cainozoic deposits (and possible beneath younger Cretaceous sediments) and above the Dalrymple Sandstone. It is apparently represented in the Cabot-Blueberry Marina No.1 section (Plate 2, and Evans, 1962) by about 1300 feet of sediment.

The best known sections, those in the far north-west, are lithologically somewhat different from that of the Battle Camp Range (Lucas, 1962). Quartz sandstone, only slightly different from the typical Dalrymple

(Faces page 16.)

Figure 3: Photograph of Flinders Island from the south, showing the slight unconformity there between the Battle Camp Formation (above) and the Dalrymple Sandstone.

Sandstone, crops out most strongly, and contains thin (up to 8-inch) interbeds of white, angular, fine quartz pebble conglomerate. Glauconitic sandstone and conglomerate are fairly well exposed, but deeply weathered. Softer beds - grey massive siltstone, red-brown silty shale, and carbonaceous shale with minor thin coal bands - are poorly exposed (Plate 2).

The formation rests upon the Dalrymple Sandstone, and this boundary is not easily determined. In the Flinders Group, it is marked by a sharp upward decrease in the proportion of conglomerate across the boundary, and a slight increase in the whiteness, sparkle, and porosity of the sandstones and thin conglomerates, which appear to be very clean and quartzose. In places there (Flinders Peak and Blackwood Island) it is also marked by a thin ferruginized horizon, and several views of the islands show that there is a slight unconformity between the two formations (Fig.3), although this could not be shown on the ground by Madden (1957) or the writer.

On the mainland, however, the (angular) unconformity is even less pronounced or absent, and the contrast between the two formations, in proportion of conglomerate, is less. The basal Cretaceous sediments (20 - 100 feet) in the coastal range are commonly very ferruginized, sandy, rounded pebble conglomerate, or pebbly, onco-glauconitic sandstone (the glauconite has weathered to iron oxides). These overlap the Dalrymple Sandstone, and directly overlie Palaeozoic rocks in places. They are commonly rich in ferruginized wood fragments and tree trunks, and, in places (e.g. at locality LB 140, south-west of 'Wakooka' Out Station) are rich in shelly fossil moulds.

The thickest section (about 500 feet) known in the Flinders Group is exposed on Stanley Island. Three distinct beds of sandstone, each about 20 feet thick, crop out strongly at regular intervals within the lowermost 350 feet (see Plate 2). They are medium to thick-bedded, coarsely-laminated, cross-bedded, sparkling quartz sandstones each characterized by various combinations of several of the following structures or inclusions: flagginess; 'plastic style' cross-bedding in sets up to 3 feet thick; alternating thick dark grey and white laminae; ripple marking; tracks and burrows; and content of grit and pebbles (rare), shale pellets, and silicified wood stems and impressions. At Flinders Peak, on Flinders Island, sparkling quartz sandstone displays (?)stylolitic micro-structure. The rest (or upper 150 feet) of the section on Stanley Island is mostly strongly ferruginized gritty sandstone. Within 100 feet of the base of the Stanley Island section, two feet of carbonaceous shale and six inches of such shale with coal bands are exposed in a sea-cliff at the northern end of the island. About 200 feet above the base, on the western side of the island, north of Stokes Bay, plant fossils were obtained from red-brown silty shale exposed in a sharp gully. They include Otozamites sp., Brachyphyllum sp., Elatocladus sp., Pagiophyllum sp., an assemblage which, according to Woods (1962d), lacks elements restricted to the Cretaceous. They are nevertheless, on stratigraphic grounds, likely to be younger, rather than older, than Madden's (?)Lower Cretaceous collection from Clack Island, five miles to the north, which the author did not visit. Madden's collection was made from shales which overlie a few feet of conglomeratic sandstone at the base of a massive pebbly sandstone cliff. In it, de Jersey (1957) identified inter alia, Taeniopteris spatulata, Sphenopteris burrumensis, and Microphyllopteris sp. - a 'Blythesdale' assemblage. The Clack Island shale may lie near or at the base of the formation; massive conglomeratic sandstone is not known in the formation elsewhere, and the few feet of it exposed below the shale may belong to the Dalrymple Sandstone.

The thickest outcropping section known is exposed for two miles south of the bluff promontory in Bathurst Bay, on the eastern side of the Bathurst Range (Plate 2). The position of the base is not known precisely; the formation is possibly 900 feet thick there, and rests upon a lesser thickness of Dalrymple Sandstone. Its top is not marked by junction with an overlying formation, but consists of at least 100 feet of sparkling quartz sandstone like that forming the free top of all the other sections of the formation south of here to Balzers Knob, and immediately underlying most of the Deighton Tableland to the south-east (Plate 2). Strong ferruginization has occurred probably for tens of feet below and for 300 feet above the base of this section, which is marked by the appearance of unsorted conglomeratic grit and impure quartz sandstone containing accessory, very pale (?)glauconite. Poorly exposed above this are softer, clayey, fine sandstones which may contain glauconite, silty shales like the plant-bearing ones at Stanley Island, and ferruginized, (?)once glauconitic, gritty sandstones, capped by the resistant, sparkling quartz sandstone.

The soft, impure sediments in the middle of this section are exposed in others to the south (Plate 2). At the southern end of the Bathurst Range, east of Clay Hole Yards, 80 feet of impure green clayey sandstone, lustre-mottled sandstone, and fine cross-laminated sandstone are exposed beneath 70 feet of pebbly grit in a small residual. In the outlier 5 miles north-west of 'Wakooka' Out-station, a similar succession up to 650 feet thick overlaps up to 100 feet of Jurassic sandstone. The central parts of this section consist of medium-bedded, glauconite-poor, fine white sandstone, thin quartz sandstone, pebbly sandstone and grit, and poorly exposed glauconitic (chamosite(?) - Morgan, 1964a, specimen R.15060) clayey sandstone.

The impure sandstones of the small inliers (or inselbergs) to the south and south-west of the Bathurst Range are green, flaggy, medium and fine-grained, calcareous and carbonaceous in places, but apparently not glauconitic. Some beds are burrow-marked. At Jane Table Hill 220 feet of these sediments are exposed, without their stratigraphic base, and are capped by 300 feet of white, friable to silicified, cross-bedded sandstone containing thin conglomerate and grit interbeds.

Farther south, the few exposures suggest a greater affinity stratigraphically with the sequence in the Cooktown 1 : 250,000 Sheet area. The glauconite-rich sandstone in the bed of the Normanby River at the 'Lakefield' - 'Kalpowar' crossing is fairly richly fossiliferous, and contains, inter alia, the ammonite Hatchericeras lakefieldense (Woods, 1962b), which indicates a Neocomian age. It may, therefore, be near the base of the formation. Only five miles to the east-south-east, again in the Normanby River bed, the rarely-seen fresh, glauconitic, shaly fine sandstone and olive mudstone of the top of the formation yielded (?)Nuculana sp. ; these are probably Aptian. In the Black Hills, 10 miles to the north-east of the latter locality, 80 feet of ferruginized and mottled siltstone, probably also belonging to the top of the formation, are exposed.

The Cabot-Blueberry Marina No.1 well, drilled 8 miles west of the Sheet's western boundary and 11 miles south of Princess Charlotte Bay (Fig.2), penetrated micaceous shale from 602 to 622 feet; calcareous, micaceous siltstone and shale from 925 to 935 feet; and glauconitic shell - and wood-bearing sandstone, conglomerate, and shale from 1546 to 1556 feet (Plate 2, and Mines Administration, 1962, Appendix 4). Cores at these intervals yielded Cretaceous macrofossils and microfossils (Woods, Evans, in Mines Administration, 1962, App. 2). There are between 1200 and 1500 feet of Lower Cretaceous sediments beneath the easily detectable base of the Albian formation - the Wolena Claystone - in the borehole. The horizon of the lowest Cretaceous core (Core 6, 1546 -1556 feet, see lithology above) may well have been included in the Dalrymple Sandstone in outcrop mapping, but may be identical with plant-bearing sediments near the base of the Battle Camp Formation in the Flinders Group. On the other hand, Core 6 may have no equivalent in the Sheet area; it is probable that the Mesozoic section penetrated in Marina No.1 is more nearly complete than any outcropping section of the Laura Basin.

Cross-bedding in the sandstones is generally slightly more regular, and the sets are more nearly straight in plan, than those in the Dalrymple Sandstone, which are also generally larger. Sets in the Cretaceous sandstones range from very small cross-laminae in the impure clayey fine sandstone up to about three feet thick in pure quartz sandstone. Some in the quartz sandstone display a plastic style of over-steepening not seen in the Jurassic ones.

Directions of sediment transport indicated by cross-bedding are generally congruent with the present conformation of the Laura Basin (Fig.2). Several indications of transport from the west were seen in the north-western outcrops; this may be due to contemporaneity of local tectonic activity (warping and north-north-west faulting), the effects of which are preserved in the area.

The Cretaceous quartzose sandstones appear whiter, cleaner (more porous), and more sparkling (owing to crystalline quartz outgrowths) than the Jurassic ones. They also possess a slight bedding foliation, possibly owing to the orientation of muscovite flakes, which are large and prominent on the bedding planes of some sandstones - e.g., in the Flinders Group. Muscovite may be more common in the massive Jurassic sandstones, but, owing to its smaller grain-size and random orientation as intergranular material in pore spaces, it is less prominent than in the Cretaceous sandstones. The Cretaceous sandstones appear to contain less intergranular detritus, mainly clay and micas, than the Jurassic ones - hence, perhaps, their greater pore-space silicification.

Other accessory detritus in the quartz sandstones consists of plagioclase, potash feldspar, chert, quartzite, zircon, apatite, and tourmaline. One sandstone on Blackwood Island contains biotite as well as muscovite (Morgan, 1964a). The provenance evidently consisted of a terrain of Hodgkinson Formation and granite; granite pebbles were found in sandstone near Sandalwood Creek and at the 'Lakefield' crossing.

The impure sandstones of the central parts of the Cretaceous sections south of Bathurst Heads contain a moderate proportion of intergranular clay, and some contain a high proportion of calcite. Up to 30 percent of their sand grains consist of mostly metastable detritus: plagioclase, potash feldspar, siltstone, slate, muscovite, biotite, felsite, and intermediate and (at Jane Table Hill) basic volcanic rock fragments (Morgan, op.cit.).

This relative impurity, the presence of granite pebbles in some sandstones, the coarseness of the muscovite flakes in those of the

Flinders Group, and the possibly anomalous local current directions, together with the existence of an unconformity at the base of the formation in the Flinders Group and of an overlapping disconformity elsewhere, is evidence for re-activation of the north-eastern margin of the Basin and source area before and perhaps during the earliest Cretaceous sedimentation.

The Battle Camp Formation has yielded Neocomian marine fossils from the sandstones, and Aptian marine fossils from shale, in the south-west of the Sheet area, as in the Cooktown Sheet area, where it is overlain conformably or with a slight unconformity by the Albian Wolena Claystone. The shelly fossils at the transgressive base of the formation near 'Wakooka' Out-station are probably Neocomian (preliminary identifications by Woods, pers.comm.)

The Wolena Claystone (Lucas, 1962) was intersected, beneath Cainozoic sediments, from 240 to about 450 feet in the Marina No.1 well to the west of the Sheet area (Fig.2). It may extend thinly within the Cape Melville Sheet area beneath the Cainozoic cover. It is a calcareous, olive claystone containing fossiliferous silty calcareous concretions (Woods, in Mines Administration, 1962, App.2) and minor micaceous silty and sandy lenses.

CAINOZOIC

In the low country east of "Kalpowar", sub-outcrops of ferruginized gravel may represent an equivalent of the Fairview Gravel (Tertiary) of the Laura area to the south (Lucas, 1962). Loose cobbles of conglomerate and billy on the flat-topped Black Hills (80 feet residuals of Cretaceous shale) in the same area may also belong to the same, thin, incoherent, superficial deposit.

A northern outlier of the Piebald Basalt, a Tertiary formation, with which some recent hot-spring activity was associated (Lucas, 1962), occupies about a square mile of the steep, narrow valley of the upper Starcke River in the south-east. Exposures consist of hard, fresh, fine-grained, porphyritic olivine basalt which crops out in the river bed (together with some Palaeozoic rock) and up to 100 feet above it along its flanks. Glassy nepheline basanite (olivine-bearing feldspathoidal basalt - Morgan, 1964a) forms a bar in the river bed.

The basalt may overlie some talus, and may be overlain by other talus. A few basalt outcrops, overlain by mottled gravel and clay, are exposed in the river bed up to two miles below the main mapped outcrops visible on the air photographs.

A widespread, loosely united group of older, consolidated, alluvial deposits has been called Brixton Formation in conformity with usage in mapping the Cooktown Sheet area (Lucas, 1962). These sediments blanket a large part of the intermontane valleys and coastal plain, and in places, notably round the southern end of the Melville Range, they seem to have built up low-dipping fans or wash-plains extending out from the valley-bounding slopes and inselbergs of the (?)early Tertiary landscape.

In several localities (e.g., Starcke and Jeannie River crossings), and also in general, there seems to be a division into an older, mottled, dominantly clayey unit, and a younger, less consolidated, coarser, more sorted one. The younger phase includes a characteristic porous sand, pebbly sand, and gravel, cemented by limonite and manganese oxides, which, in the Starcke River valley and at several localities in the Cooktown Sheet area, has basalt pebbles in it. Away from areas of basaltic provenance this textural type is not so distinctive, but is recognisable. Such sorted sands can be interbedded in mottled clayey deposits, but in general there is a tendency for these and other sandy to gravelly deposits to overlie and abut mottled, dominantly clayey deposits. The latter contain many sandy and gravelly lenses of low porosity. They are more commonly capped by siliceous or ferruginous duricrust than the younger type.

The operation of complicating factors in the matter of original clay content and iron-staining has been observed. On the new Cooktown - 'Battle Camp' road, in the adjoining 1 : 250,000 Sheet area to the south, a fresh cutting displayed pods of mottled, sandy, white clay evidently forming in weathered Dalrymple Sandstone (containing a high proportion of quartz sand grains) under the influence of living tree roots. Under a cover of (older) talus west of the Jeannie River, slate of the Hodgkinson Formation has been made over to a white, semi-plastic clay. Thus clay may have been generated in some superficial deposits and subjacent rocks by deep weathering in situ - e.g., the deflated peneplain west of the mouth of the Jeannie River, where a thin, incoherent layer of ferruginous pebbly sandstone overlies three to fifteen feet of greenish-white sandy detrital clay, which overlies deeply weathered Hodgkinson Formation. Epigenetic (modern?) movement of clay is demonstrated by the presence of excrescences on the walls of the small contraction cracks in outcrops of the Brixton Formation.

The coarser detritus in these deposits along the coastal plain and ranges normally reflects the pre-existing rock types; south of the granitic Melville Range it is quite feldspathic. In the far south-west, the older alluvials are masked by Recent alluvium except in stream banks. Their top seems to dip north under the alluvium in this area, and is generally below the level of the alluvial plain farther north. Some ferruginized pebbly outcrops east of 'Kalpowar' may belong here, rather than to the older, definitely Tertiary, Fairview Gravel. In the Normanby River at the end of the 'Kalpowar' airstrip, these sediments are unusually coarse (pebbly, gritty, and sandy) and well-sorted, or poor in clay. The grits display the only example of cross-bedding seen in the formation. It is possible that these coarse sediments mark the course of the ancestral Normanby River.

The Marina No.1 well, to the west of the area (Fig.2), penetrated ferruginous clayey sand and grit down to 140 feet, and (?)clean, fresh feldspathic sand and 25 feet of basal gravel from there to 240 feet. The lower, apparently clean part may be equivalent to the Fairview Gravel.

Fossil earthy talus, identical with that mapped in the Cooktown area to the south (Lucas, 1962), has been mapped in intermontane valleys and along the main scarps bounding the coastal plain. It is found almost exclusively below Mesozoic sandstone scarps, and most of its coarse fraction (blocks commonly 2 feet to 6 feet long) consists of sandstone; a minor amount consists of resistant rocks of the Hodgkinson Formation, which probably supplied a high proportion of the earthy, generally ferruginous matrix where the Hodgkinson Formation made up the lower slope.

Two main ages of talus formation are represented - the older by outlying perched remnants up to a mile from their related bounding slopes, the younger by more continuous, scarcely dissected blankets constituting the present valley-bounding slopes, congruent with the present minor stream regime. The two deposits can be seen side by side - e.g., below the main coastal scarp west of the Jeannie River. The older ones may be quite thin (order of 10 feet) and perched, commonly on deeply weathered Hodgkinson Formation, up to 100 feet above the surrounding sloping plain, which may constitute the surface of the distal end of the younger talus. Thus there has been considerable scarp retreat, and some inversion of topography where the older talus is preserved, between the two periods of talus formation (or fixation). The older talus is mostly more or less strongly ferruginized, and the younger are less. Ferruginized coarse fragmental rocks, possibly derived from the older talus, were found in the younger talus west of the Jeannie River. The talus at Cape Flattery (equivalent to the younger talus?) overlies a steep ferricrete surface developed on the softer rocks of the Dalrymple Sandstone. Thus ferruginization has probably promoted the preservation of the older talus.

Natural exposures are not good enough to reveal the texture of the deposit; however, the proportion of matrix does appear to be high, and the blocks generally appear to be supported in it, as is the case in the Cooktown Sheet area. The surfaces of the deposits slope at between 10° and 30° approximately, but may be inclined at less than 10° at distal ends.

Associated with these exposures west of the Jeannie River, coarse outwash gravels which show colluvial affinities constitute the upper, coarser part of the Brixton Formation there. It is thus possible that the upper, coarse phase of the Brixton Formation has a fairly close relation with the younger talus, but it is possible too that it represents a period of removal of slope debris rather than of its accumulation. Exposures in the upper Starcke River valley are poor, but the basalt there may overlie and abut some talus, and be overlain by other talus. This is consistent with the slight reversal of topography that the basalt-covered areas have undergone.

The large, chaotic jumble of granite boulders on the Melville Range and other granite bodies in the region (cf. the 'metal hills' of Chillagoe) may represent talus formation on slopes underlain by this rock, but these deposits have not been mapped as talus. They appear to be residual, in situ deposits, rather than the product of scarp collapse. It may, therefore, be suggested that they are residual core boulders from a since - removed, deeply-weathered profile, but their generally large size and the fair angularity of many of them seem consistent only with their being derived from near the base of such a profile. In some places on the Melville Range, large spine-like and other steep, jointed outcrops protrude from the jumble of boulders, which are generally very large in the vicinity of these true outcrops.

No exposures of the definitely <u>older</u>, ferruginized <u>dune sand</u> distinguished south of Cape Flattery and west of Cape Bedford (Lucas, 1962) were mapped in this area, but it crops out as small wasting inliers west of Cape Flattery among the <u>younger</u>, white <u>dune sands</u>, which invariably lie inland from north-south stretches of the coast south-east of Cape Melville. The older dune sands may also underlie the loose orange sand crossed by the track 10 miles west of Barrow Point.

<u>Ferruginization</u> has affected many long-exposed surfaces of the

Sheet area, particularly the fairly flat, porous Mesozoic sandstones and Cainozoic sediments. The ferruginous zone, at least on fairly flat surfaces, is generally the cap, and most prominent zone, of a lateritic profile of deep weathering and mottling. Along the coastal range, where the lower part of the Battle Camp Formation is generally impure and/or coarse-grained, porous sediment, this part of the formation is commonly very heavily ferruginized (for 50 to 300 feet above the base). The ferruginization commonly extends about 50 feet into the immediately underlying Dalrymple Sandstone (as deposits on joints, concentric zoning in sandstone, and replacement of shale) or Hodgkinson Formation. It is not certain to what extent the ferruginization follows these basal Cretaceous sediments throughout the section, i.e. away from the present land surface, which has been fairly stable since the early Tertiary. The coarse basal Cretaceous sediments are good aquifers, and most of the ferruginization there, particularly on steep slopes, may be the result of precipitation from ground-water at the intersection of the aquifers and the stable land surface. In the Flinders Group (Flinders Island and Blackwood Island) the base of the Battle Camp Formation makes a slight unconformity with the Dalrymple Sandstone, and is marked by a thin ferruginous zone. This was not examined at close quarters, but it may belong to this boundary chronologically. Other exposures in the Flinders Group (e.g., Stokes Bay) demonstrate the replacement-penetration of limonite down joints and minor faults in Cretaceous quartz sandstone, and along shale beds.

Ferruginization is most prominent on the flat sandstone bench which forms most of the Bathurst Range, and is the top of the relatively coarse and impure lower part of the Cretaceous section there (see Plate 2). Looking from the north-west, the ferruginized surface at Bathurst Head can be seen to cut slightly across the bedding. Elsewhere it generally appears to follow the present surface, and therefore cuts very sharply across the bedding in places - e.g., at Cape Flattery and the Altanmoui Range. It is not generally found in the sparkling quartz sandstones which form the highest points, but affects the softer, more impure underlying Mesozoic rocks, especially the shales, and also to some extent the slates of the Hodgkinson Formation on the spurs below.

Ferruginization of older talus (overlying deeply weathered slate), and of dune sand has been mentioned above; some younger talus is also ferruginized. Various Cretaceous and Cainozoic outcrops and sub-outcrops at the surface of the Normanby sediplain (Fig. 1) in the south-west are strongly ferruginized.

Deep weathering and mottling below the ferricrete cappings are apparently not as intense as the ferruginization. In some places weak siliceous duricrust has formed on Brixton Formation outcrops where ferruginization is absent or minor.

At Bathurst Heads the main ferruginization probably predated the gully formation there, and minor, rather earthy ferruginous deposits have since formed in the gullies.

Loose residual sand covers interfluves in all the low, gently-undulating tracts known, or thought, to be underlain by Mesozoic sandstone (especially on the Jack Peneplain). It has apparently been derived from these, perhaps in many places via the Tertiary superficial deposits of the Brixton Formation. In the Jack Peneplain, the wasting sand also chokes the watercourses (see also Lucas, 1962).

A variety of on-shore and off-shore marine deposits has been formed. The on-shore deposits are most extensive in the Princess Charlotte Bay plains, where they extend ten miles inland at the surface. They are sand and mud salt flats, abandoned strandlines (commonly up to four miles inland), raised fringing reefs (in the Flinders Group), pumice berms, and modern beach sands. A slightly porcellanised coquina containing oysters, barnacles, and a Pecten was found in sandy marl under three feet of grey clay at the tank site on the eastern flank of Jane Table Hill. This probably represents an older (Pleistocene, Woods, 1963) strandline, and may have extensive correlatives beneath the Normanby River alluvium and the on-shore tidal muds and sands which border Princess Charlotte Bay.

Little is known of the off-shore reef and associated deposits in the area. They consist of the outer barrier réef, and, in the sheltered, shallow seaway behind it, platform reefs and coral sand cays, and fringing reefs round hard rock islands and cays. In two widely separated boreholes into the reefs farther south, about 500 feet of dominantly coralline reef material overlies at least 200 feet of terrigenous, possibly partly shallow-water sand and clay (Richards & Hill, 1942; Fairbridge, 1950).

The basement to the Barrier Reef deposits east of the Flinders Group probably consists mostly of Hodgkinson Formation and Upper Palaeozoic granite, possibly together with some downfaulted Mesozoic sediment in places - e.g., near Cape Flattery. West of the Flinders Group the reefs probably rest upon Mesozoic and Tertiary sediments.

Quaternary alluvium (from gravel to fine silt) covers small, unmapped areas, especially along the coastal plain, where it overlies and

Fig. 4

POST CAMBRIAN GEOLOGICAL HISTORY - CAPE MELVILLE 1:250,000 SHEET

H. UPPER CAINOZOIC

Continued terrestrial reworking and deposition, deep weathering and ferruginisation.

G. UPPER CRETACEOUS - LOWER TERTIARY

Emergence and marginal faulting, erosion to present physiography (Fig.1), deposition of basalt, sandy clay, talus, dune and residual sand; deep weathering etc.?

F. LOWER CRETACEOUS

Accentuation of Laura Basin, marine invasion and overlap, then withdrawal; marginal faulting.

E. TRIASSIC - JURASSIC

Erosion; formation of Laura Basin. lacustrine sedimentation.

D. PERMIAN
Local sedimentation?, block faulting?, granite emplacement.

C. CARBONIFEROUS

Orogeny, emergence.

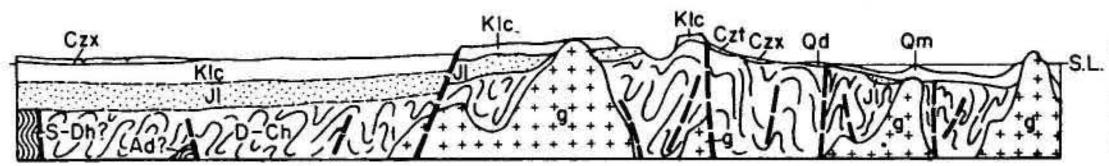
B. MIDDLE - UPPER DEVONIAN

Thick geosynclinal sedimentation.

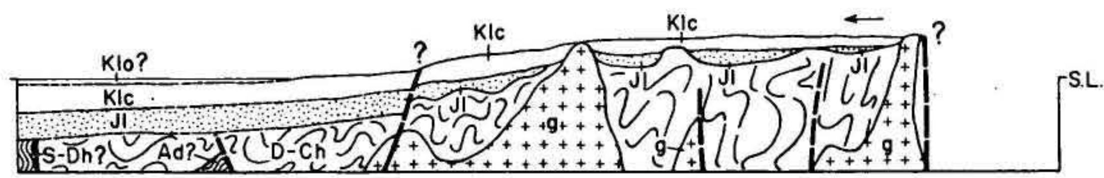
A. UPPER SILURIAN

Initiation of Tasman Geosyncline - limestone etc., deposited on shelf in far west.

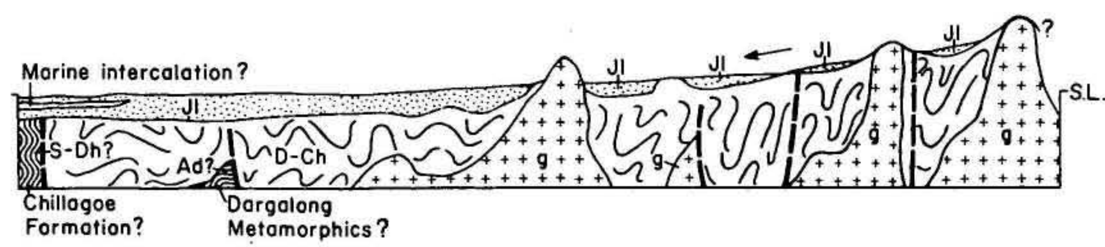
Stage G. Lower Tertiary



Stage F. Lower Cretaceous (Albian)



Stage E. Upper Jurassic



Bureau of Mineral Resources, Geology and Geophysics *March 1964* D55/A9/3 JMF abuts against older superficial deposits, but it is extensive, and probably up to 100 feet deep, in the Normanby Sediplain in the west. In this area it overlies older, mottled, consolidated alluvials and Cretaceous sediments with cut-and-fill relationships, but its base is rarely exposed. It consists of silty and fine sandy, unconsolidated, dark grey, dense, swelling, calcareous clay, commonly modified to a shallow depth by soil-forming processes.

A pale grey podsolic soil has developed fairly recently over the whole area, and is cut back only by modern stream erosion and marginal encroachment by the salt flats. Small, mammillated concretions of cream, aphanitic calcium carbonate which are shed locally from a stream-bank exposures of quaternary alluvium three to ten feet below the surface appear to belong to a low horizon of this soil profile, as in parts of the Cooktown area.

STRUCTURE

The outcropping rocks of the area may be divided into three structural regimes, such that an historical treatment of the structure is appropriate:

1. Pre-Mesozoic rocks forming a relatively stable basement to the Laura Basin - mainly steeply-dipping, closely folded and lightly metamorphosed, thick Devonian sediments (Hodgkinson Formation), and late Palaeozoic intrusive granite - i.e., the rocks of the Hodgkinson 'Basin'. Other rocks may be included in the basement (see below).

2. The north-eastern limb of the Laura Basin - shallow south-west-dipping Mesozoic sediments, thickening down-dip from 200 feet to (?)3000 feet (unexposed) within the Sheet area.

3. Unconsolidated Cainozoic deposits and minor basalt - up to 200 feet, mainly in the south-west. These will be treated below as congruent with the latest movements affecting the Laura Basin.

1. The exposed Palaeozoic basement is probably underlain at depth by a Precambrian crystalline metamorphic and granitic complex (equivalent to the Dargalong Metamorphics - Amos & de Keyser, 1964), which has undergone the Palaeozoic orogeny beneath the base of the geosynclinal pile. The Chillagoe Formation (Amos & de Keyser, op.cit.), a Silurian - Devonian unstable shelf formation deposited against the Precambrian rocks at the western margin of the geosyncline, may extend, or may have equivalents

extending, some distance eastward between the Precambrian and Devonian rocks (Fig.4).

The basement to the Laura Basin may also include narrow, north-south, infaulted belts of unmetamorphosed Permian sediments and acid volcanics such as crop out in the Sheet area to the south (Lucas, 1962), and as were penetrated for 220 feet, at a depth of over 3500 feet, in Cabot-Blueberry Marina No.1 well to the west of the Sheet area (Mines Administration Pty. Ltd., 1962).

The subject of the regional environment and structural history of the Hodgkinson Formation is too large to be treated here, and it is intended to discuss it in another place. The formation is steeply folded and faulted on roughly meridional lines, and has undergone light regional metamorphism. The folding is not simple. The formation does not crop out over large areas as it does farther south, but steeply plunging folds can be seen on some air photographs of the coastal areas round the Jeannie River. This and the limited field work indicate that the structural characteristics of the formation in this area are the same as those elucidated by Amos (1961 ; 1962 ; and summarized for the Cooktown area in Lucas, 1962).

In addition to the regional structural characteristics of the formation, there is a strong development of approximately north-easterly disruptive trends in the northern outcrops (north-west and west of Barrow Point). Such a structure appears to be present east of the Jeannie River, and may be the same as the brittle, post-slaty-cleavage minor folding and faulting at Lookout Point and Cape Flattery (also at Cape Bedford, Indian Head, and Nob Point, north of Cooktown, see references above).

The disrupted, trending east-north-east ridges 10 miles west of Barrow Point consist of cherty slates whose slaty cleavage has been refolded into gently-plunging north-east trending minor folds. The style of the second deformation is relatively brittle. (?)Close-joints cleavage marks the axial planes of the secondary folds, and quartz veins have been emplaced along them and also along the original cleavage. These rocks have also been contact-metamorphosed (Morgan, in prep.), although they are some distance from any known granite outcrop. The same structure and metamorphism are visible in coastal outcrops on the flanks of Beaboy Hill, south-east of the Melville Range. The distribution of this post-metamorphic-cleavage folding and the granite outcrops, the widespread contact metamorphism, and the discordant trend of the late folding, suggest that the latter may have prepared the way for granite intrusion by block-fracturing on oblique lines in the Hodgkinson Formation. Such fracturing would have facilitated stoping, which does appear to have taken place in the contact zone south-east of the Melville Range (see Altanmoui Granite).

The granites are small, post-orogenic, high-level, regularly-shaped plutons. How closely they are connected at depth with one another and with those to the south (especially in the case of the Puckley Granite and Finlayson Granite outcrops in the Sheet area) is unknown. The probable connexion between disruptive north-east structures in the Hodgkinson Formation and the later granite intrusion south and south-east of the Melville Range has been mentioned above. It is probable that granite lies close to the surface in several places in this area, and that its distribution has a high degree of structural control.

Contact zones around the granites are generally narrow, as is the rule in the Mossman and Cooktown Sheet areas to the south (Morgan, 1964b).

2,3. Laura Basin and Cainozoic Deposits. The Sheet area covers the north-eastern part of the Laura Basin (Fig.2). The thickest outcropping Mesozoic section is about 1400 feet, at Bathurst Bay (Plate 2), but it probably exceeds 2000 feet or even 3000 feet in the west; it was nearly 3500 feet in Cabot-Blueberry Marina No.1, eight miles west of the boundary of the Sheet area.

The thickness of the basal unit, the Dalrymple Sandstone (Jurassic), ranges from a few feet to about 1000 feet along the coastal range, and may attain 1500 feet elsewhere within the Sheet area (there are about 1800 feet of Jurassic sediment in Marina No.1). It overlies, and fills in the depressions of, an irregular basement in which the late Palaeozoic granites formed the high points, commonly standing several hundred feet above the surrounding Hodgkinson Formation, and in places were never covered by Jurassic or even Cretaceous sediment (see below).

The Dalrymple Sandstone is overlain, in the Flinders Group with slight unconformity, and in other places along the eastern margin of the basin transgressively, by the Battle Camp Formation. This formation, whose thickness ranges from 300 feet to 1000 feet along the coastal range, is, nevertheless, more regularly tabular than the underlying, basement-filling Dalrymple Sandstone, and like it also thickens towards the south-west (1200-1500 feet in Marina No.1 borehole).

There are diastems in the coarse sediment of both formations in the northern exposures, but these probably disappear towards the west.

The low, broken, eroded, but straight scarp forming the western boundary of the Deighton Tableland probably marks a fault-zone continuous with the diffuse probable fault-zone along the Normanby River in the Cooktown Sheet area (Lucas, 1962). Its net vertical displacement is probably a downthrow to the west, of the order of 100 to 500 feet (see also Swindon, 1961). Other nearly meridional faulting (there is a distinct tendency for faults to swing from north-west in the south to north-south near Bathurst Head) is known farther west (e.g., Jane Table Hill), and is probably continuous beneath the Cainozoic cover in the south-west. The Battle Camp Formation at Jane Table Hill is probably upfaulted relative to the Cretaceous strata to the west. Some of the residuals of the same formation in the Jack Peneplain are adjacent to faults. One of these, and the Neocomian outcrop at the 'Lakefield' - 'Kalpowar' crossing of the Normanby River, lie on a north-east-trending fault trace which curves at its north-eastern end in a manner suggestive of a basement-controlled ring fracture. The zone of oblique north-east fracturing, late orogenic deformation, and granite intrusion into the Hodgkinson Formation in the Barrow Point - Melville Range area lies on the coastward prolongation of this fault.

The present extent of Albian sediments, and of original Albian sedimentation, in the area are unknown, but there is likely to be some soft sediment of this age preserved at shallow depths in the west (see Wolena Claystone). It is possible that the low fault scarp east of the Peneplain was the Albian shoreline. Earlier movement along it could have caused the unconformity at the base of the Battle Camp Formation in the Flinders Group.

The earth movements which have affected this part of the Laura Basin were epeirogenic. They were part of the long-continued uplift of the eastern side of Cape York relative to the western (Carpentaria) side, and include warping as well as vertical movement on north-west to north-south faults.

Jurassic and Lower Cretaceous sedimentation extended, deepening westwards, from at least as far east as the present coastline - in fact the coastline is probably fairly close to those palaeo-shorelines (Fig.4). Detritus was apparently contributed to these Mesozoic deposits from the north-east, and it is problematic how much farther the basement was exposed in this direction - presumably no farther than the site of the Great Barrier Reef. Evidence so far available from bore-holes into the Reef farther south suggests that it consists of Cainozoic marine deposits directly overlying a basement of Palaeozoic rocks (Hill & Denmead, 1960, pp.369-371).

Foundering of the Basin's margin here - probably along north-west-trending faults - could have begun as early as the Albian, when marine sedimentation in the Basin may have been restricted to its axial zone, but can have been no later than the late Cretaceous or early Tertiary erosion which produced the coastal plain (Fig.4). The top of the Cretaceous section along the coastal range is of Neocomian or Aptian age, and now rests at about 1500 feet above sea level. Although it (the sparkling sandstone) may be non-marine, it was probably deposited at or not far above sea level. Its subsequent elevation may have begun in Albian time, and probably proceeded pari passu with the foundering of the margin beyond it.

The erosion of the coastal plain probably began with these movements, and could also have more or less kept pace with them. The presence of piedmont deposits of two ages preserved against the coastal range may be taken as evidence of saltation in the erosive processes, but the generation, and even the mere preservation, of such deposits can have a climatic cause equally as well as a tectonic one.

Some of the vertical adjustment between uplift along the coastal range and foundering beyond it has taken place within the present land area - e.g., between Cape Flattery (where basal Jurassic sediments are at sea level) and the main scarp 15 miles to the west (where they are about 750 feet above sea level); at the fault, on which the north-east side has been downthrown, near 'Rocky' Trig. Point, west of the Jeannie River; and perhaps along the conspicuous fracture (apparently only a joint) passing north-west along the front of the coastal range for 20 or 30 miles, south-west and possibly north-west of 'Wakooka' Out-station. The marked local stream sluggishness and heavy alluviation on the eastern side of the Jack Peneplain suggests that there may have been quite recent east-side-downwards vertical movement on a north-north-west axis there.

Foundering may have been facilitated by the rhomboidal break-up produced by fracturing on intersecting north-west and north-east lines in the Palaeozoic basement, as noted above. The rectilinear pattern of the sluggish drainage system on the Jack Peneplain, and the position and direction of the river valleys which breach the coastal range, are evidence for the influence of north-east-trending fractures equally with those trending north-west.

ECONOMIC GEOLOGY

Gold and wolfram are the only minerals which have been mined economically in the area, but no mining is carried on now. Uneconomic deposits of gold, antimony, tin, tungsten, copper, silver, and coal have been reported; there are prospects for the production of water, gold, quartz sand, and possibly petroleum.

METALS

Gold

Alluvial gold was discovered in Diggings Creek ('Old Starcke' workings, Starcke Gold Field No.2) in 1890, and 2300 oz. were recovered before the deposits were exhausted in 1895. In 1896 a smaller alluvial deposit was discovered at Munburra, farther downstream (Ball, 1909, Map 2), and yielded 638 oz. in two years (1479 oz. according to Cameron, 1907, p.6). This second find led to the discovery of the auriferous quartz reefs immediately to the north; between 1898 and 1908 these yielded 9190 oz. from 4858 tons of ore (table of production figures, Ball, 1909, p.10). Of this the Last Hit produced 4151 oz. from 1402 tons of ore, and the Boomerang 1100 oz. from about 200 tons. Total production from the field is, therefore, not much more than 12,128 oz., because it was almost abandoned in 1909. Cessation of mining seems to have been due to poor company management, to the small scale of operations generally, to the water table's being reached, and to high treatment costs and poor battery recovery, rather than to complete working out of ore. Few mines were worked below the water-table (50 to 100 feet) and the deepest workings were about 150 feet. Details of values below the water table are not available. Only high-grade ore (over 1 oz. or 2 oz. per ton) could be treated economically, and it seems probable that there may be fairly large bodies carrying ½ oz. to 1 oz. gold per ton (Ball, 1909, pp. 9, 31).

The auriferous reefs are white quartz veins, commonly about a foot wide, emplaced at various attitudes, and striking from south-west to north-north-west in the steep north-south striking greywacke and slate of the Hodgkinson Formation. They are generally closely associated with oblique to sub-concordant grey quartz porphyry dykes (silicified spherulitic quartz porphyry - Morgan, 1964a), which post-date the cleavages of the Hodgkinson Formation. The dykes appear to cut some quartz veins, but in places are cut by quartz veinlets. They also contain sulphide. The slates near the reefs are more slickensided than usual, and the country rocks near the lodes contain more disseminated pyrite than usual. The veins are fissure-filling and replacement veins in which and between which fragments and screens of brecciated country rock are partly or wholly replaced by a mosaic of fine quartz. The cavity-filling quartz is a coarser variety, and is accompanied by plagioclase, of the same grain-size, which Ball (op.cit., pp. 14-15) appears to assume is albite. Other gangue minerals are calcite (in shoots), arsenopyrite (as replacement of country rock), and pyrite (replacement and cavity-mineral). Stibnite was reported from the field, and an attempt was made to re-open the Uncle Sandy mine, 2½ miles east-south-east of Munburra, as a gold and antimony mine (Ball, 1909, p.47).

The gold is commonly fairly coarse and yellow, but patchy. Values generally fall with increase in width of the reef. Shoots are generally pipelike, and pitch westwards. Values reach 10 oz. per ton or even 100 oz. per ton in places (e.g., Last Hit Mine, Ball, 1909, pp.31,33). Silver attains values of 5 dwt per ton.

Coarse alluvial gold (less than 20 oz. in all) was won from the headwaters of the Jack River, about six miles south-south-west of Munburra (Ball, 1909, pp.11,17). A gold-bearing quartz pebble was found (Ball, op.cit.) in the Jurassic conglomerate capping which walls the valley (cf. auriferous Jurassic basal conglomerate north of Maytown, Cooktown 1 : 250,000 Sheet area - Lucas, 1962).

An attempt to develop the Rio Tinto mine, Munburra, is recorded (Beck, 1935), but there is no record of development or production after that.

Traces of gold were found in a 'slatey' (sic) creek about two miles inland (south) from Ninian Bay, by an early prospecting expedition (Downs, 1884). A trace of gold is also reported in association with native copper and silver in a thermal spring deposit at Noble Island (Cherry, 1908; see below).

Tungsten

Wolfram was discovered on Noble Island shortly after the turn of the century; in 1904, four or five men in several months won by hand methods about four tons of wolfram concentrate from within six feet of the surface (Lee-Bryce, 1905). Similar methods employed two men for at least another three years (Cherry, 1908).

The wolfram is contained in an abundant network (or stockwork) of regular sub-conjugate quartz veinlets (from 1mm. to 3 cm. thick) emplaced in the Hodgkinson Formation. The veinlets strike at 310° (dominant), and more randomly north to north-east, and dip at about 60° to the east. Black and clear quartz crystals line the walls of the veinlets, and the wolfram occupies small cavities between the quartz crystals. Slight malachite stains appear in some of the veinlets (see copper), and pyrite is irregularly distributed in the wall rock, generally within six inches of a veinlet. A persistent, relatively thick (1 ft.) barren, milky quartz vein crops out along the eastern side of the island, and dips about 70° to the west.

Wolfram is reported by prospectors from a regular slate/granite contact in the Altanmoui Range (Ball, 1939).

Tin

Cassiterite is known in alluvial deposits at Barrow Point, and a trace is reported on Noble Island (Cherry, 1908). It was found in two creeks draining into the eastern part of Ninian Bay from the granite hills south of Barrow Point by a Broken Hill Pty Co. Ltd prospecting party in 1937 (Ball, 1939). Elsewhere near Barrow Point the creek sands were found to be mainly garnet-bearing. The beach sands and dunes south of Barrow Point were also drilled, but the results were not encouraging. (Ball, op cit.).

A sample of modern stream grit taken during the recent mapping from the creek which runs along the southern granite contact in the Altanmoui Range was barren.

In what purports to be a factual account of a stay on Howick Island, Idriess (1938, p.19) reports up to ½ oz. of cassiterite per dish in (?)colluvium at the base of the main granite hill. He also mentions quartz-cassiterite-wolfram veins in the top of the hill (op.cit., p.35), and records a production of at least ½ ton of cassiterite concentrate and ¼ ton of wolfram. However, the averred association of wolfram and tin, together with copper-staining in the veins (loc. cit.), and also a sketch (op.cit., p.243) unmistakeably modelled on Noble Island, make it seem improbable that the account refers to Howick Island, or that it is wholly factual in other respects.

Antimony

Stibnite and cervantite were probably fairly common accessory minerals in the gold lodes, but were not often reported. Some ore from the Uncle Sandy Mine, 2½ miles east-south-east of Munburra, assayed 9 percent antimony (Ball, 1909, p.47).

Native copper and silver and a trace of gold were found together in uneconomic quantities below high water mark on the eastern side of Noble Island (Cherry, 1908). They were found up to eight feet below the surface of coral and sand, as small threads and beads in black clay and yellow clay. The lower of two assays of yellow clay 3 feet below low tide mark was gold, 3 dwt per ton; silver, 240 oz. per ton. The metals were apparently being deposited by reduction from hot spring water which entered the 8-foot deep shaft fast enough to impede work in it.

Silver was present in the gold ore of many of the Munburra reefs in amounts up to 5 dwt per ton (Ball, 1909).

NON-METALS

Building stone

The blocky, medium to coarse-grained Mesozoic sandstones which form the conspicuous cliffs along the coastal range may be suitable for local use.

Clay

The larger clay deposits of the area are of the following types: the marine salt pan clays (probably mostly rather sandy), the grey swelling clays of the Normanby River system alluvium, and the mottled sandy and silty clays of the late Cainozoic Brixton Formation. Slate of the Hodgkinson Formation under a protective cover of Brixton Formation is in places completely reconstituted to a fairly plastic white clay. The Normanby River alluvium may have some prospects for industrial use, but is probably montmorillonitic and also rather silty.

Coal

A 13-inch seam of possibly fair quality coal was reported on Stanley Island (Lee-Bryce, 1905), but no development ever took place. Carbonaceous shales and a six-inch coal-bearing shale are known at the northern end of the island, and similar rocks are reported from the base of Clack Island; such sediments, or at least very impure coals, were often reported as possibly economic coal deposits in the Cooktown district early this century. The outcrops in the Flinders Group are probably all near the base of Battle Camp Formation.

The only coal seen elsewhere by the mapping party was thin beds and laminae about 100 feet above sea level in a gully on the western side of the round hill west of Cape Flattery. This is probably about 150 feet above the base of the Dalrymple Sandstone; coaly horizons in the Dalrymple Sandstone farther south are also mostly in the basal part, which generally consists mostly of rudites and pelites.

Lime

No limestone deposits are known on the land in the Sheet area, but the large deposits of the Great Barrier Reef and inner platform reefs lie not far offshore. The magnesium content of the coralline limestones drilled near Cairns and Gladstone was low (Richards & Hill, 1942), and there was little ferruginous material above 400 feet.

Petroleum

The area might be considered to have some petroleum prospects in the south-west, where impervious Albian claystone (Wolena Claystone) may be present. This formation and younger alluvium overlie Neocomian-Aptian marine sandstones of the Battle Camp Formation, and the marine Cretaceous sequence probably totals about 1200 feet in nearby Marina No.1 well (Plate 2), in which part of the thicker underlying Jurassic sequence was also found to be marine. There is evidence for faulting in the area on the aerial photographs.

Micro Magnetic Associates (1963), in a report to Gulf Interstate Overseas Ltd recommended drilling at the south-west corner of Corbett Reef, in the north-west corner of the Sheet area. The recommentation was based on an interpretation of an anticline in the Mesozoic sediments there, between two north-south-trending flanking basement "highs".

Road metal

Aggregate is available in the granite outcrops, the most accessible and best exposed of which are those on the northern and western sides of the Altanmoui Range.

The mottled sandy white clays of the Brixton Formation are probably fairly suitable road-bed binding material, and are readily available in most parts of the area. Ferruginous buckshot gravel (part of a soil profile?) makes an excellent road surface, but is available in only small quantities in the south-west.

The lessee of 'Kalpowar' (Mr S. Watkin) intends to use the (?)elevated marine salt pans west of the Bathurst Range as landing fields for light aircraft during the dry season: very little preparation of the surface should be necessary.

Sand

The dune and beach sands from Barrow Point to Cape Flattery constitute large deposits (of unknown depth) of quartz sand. Their heavy mineral impurities (ilmenite, zircon, rutile, tourmaline, magnetite) are small - probably much less than 0.1 percent. Ferric oxide staining distinguishes a series of older dunes partly re-exposed in the Cape Flattery deposit, but these are not known farther north-west, and in any case the bulk concentration of ferric impurity is probably small. Moreover, these ferruginized dunes are easily recognised, and could easily be avoided in mining. They constitute only a few percent of the surface of the Cape Flattery body, but may make up a greater proportion of deeper parts of the deposit. Another impurity likely to be common is the stratified (dished?) peaty layers representing buried freshwater lagoon deposits. Peaty solutions from these have stained underlying sand.

However, large tonnages could probably be won from recently and modern active dunes, most of which are free from all but the heavy mineral impurities.

Water

Stock water is all obtained from the surface so far, and it is permanent in the main channels and billabongs of the Normanby and North Kennedy Rivers, which make heavy cattle grazing possible in the rich pastures of the south-west. Brackish conditions prevail in open channels near Princess Charlotte Bay, however; the Marret River is tidal at the road crossing north-east of Balzers Knob, 17 miles from the coast in a straight line. Earth-storage tanks are being constructed in this area

Apart from places where surface water is retained by alluvial clays along these rivers and in depressions such as the Jack Lakes and Police Lagoon, and from places where bedrock outcrops maintain the water table at the surface (e.g., Starcke River crossing), water disappears from the watercourses during the first two months of the dry season, i.e., by the end of May. This is probably largely due to the presence of the semi-porous sandy clay of the Brixton Formation which underlies much of the area. The sand-covered interfluves and sand-choked watercourses of the undulating plain between the coastal range and the Normanby River (the Jack Plain, Fig.2) are among the driest parts of the area.

The large area of sand dunes west of Cape Flattery contains shallow, peat-floored lakes of vegetable-tainted but quite potable water. The smaller areas of dune sand are generally dry. A tepid, gas-charged, freshwater spring was found on the beach about four miles north-west of Cape Flattery.

Small supplies of underground water should be obtainable at shallow depth (less than 200 feet) from the porous superficial deposits. However, the sand dunes should yield large initial supplies. Sub-artesian water should be available at greater depths (increasing from 100 feet in the north-east to between 500 and 1500 feet in the south-west) in the porous sandstones of the Lower part of the Battle Camp Formation and of the Dalrymple Sandstone, the basal aquifer of the Laura Basin (Denmead, 1949).

Prospects

In view of the likely continuation of the gold lodes between Cocoa Creek (McIvor District, Cooktown 1 : 250,000 Sheet area) and Munburra, and of the finding of alluvial gold in the intermediate area in the headwaters of the Jack River, it is possible that additional economic alluvial (and lode) deposits may exist where the Jurassic cover has been dissected in this area. Relatively large low-grade alluvial prospects may exist in the Starcke River valley downstream from Munburra, and even on the coastal plain north of Munburra.

A small volume of <u>wolfram</u>-bearing superficial deposits (colluvium and fringing reef) may remain on Noble Island, but the hard rock with its stockwork of quartz-wolfram veinlets will probably never be economic to mine as a whole. Traces of wolfram were seen in similar quartz veinlets at Red Point, south of Noble Island. This part of the mainland may contain mineralization (W-Sn, Cu - Ag - Au) similar to that of Noble Island, but does not show signs of unusual deformation or alteration.

Several of the non-metalic deposits (clay, lime, and sand) could be mined in large quantities if a market were available, and the underground water resources will probably be tapped soon. In many places except on the sand-covered Jack Plain, however, surface storage of water may be preferred.

Petroleum prospects of the Laura Basin are probably best to the west and north-west of the Sheet area, where the Mesozoic section is likely to be thickest.

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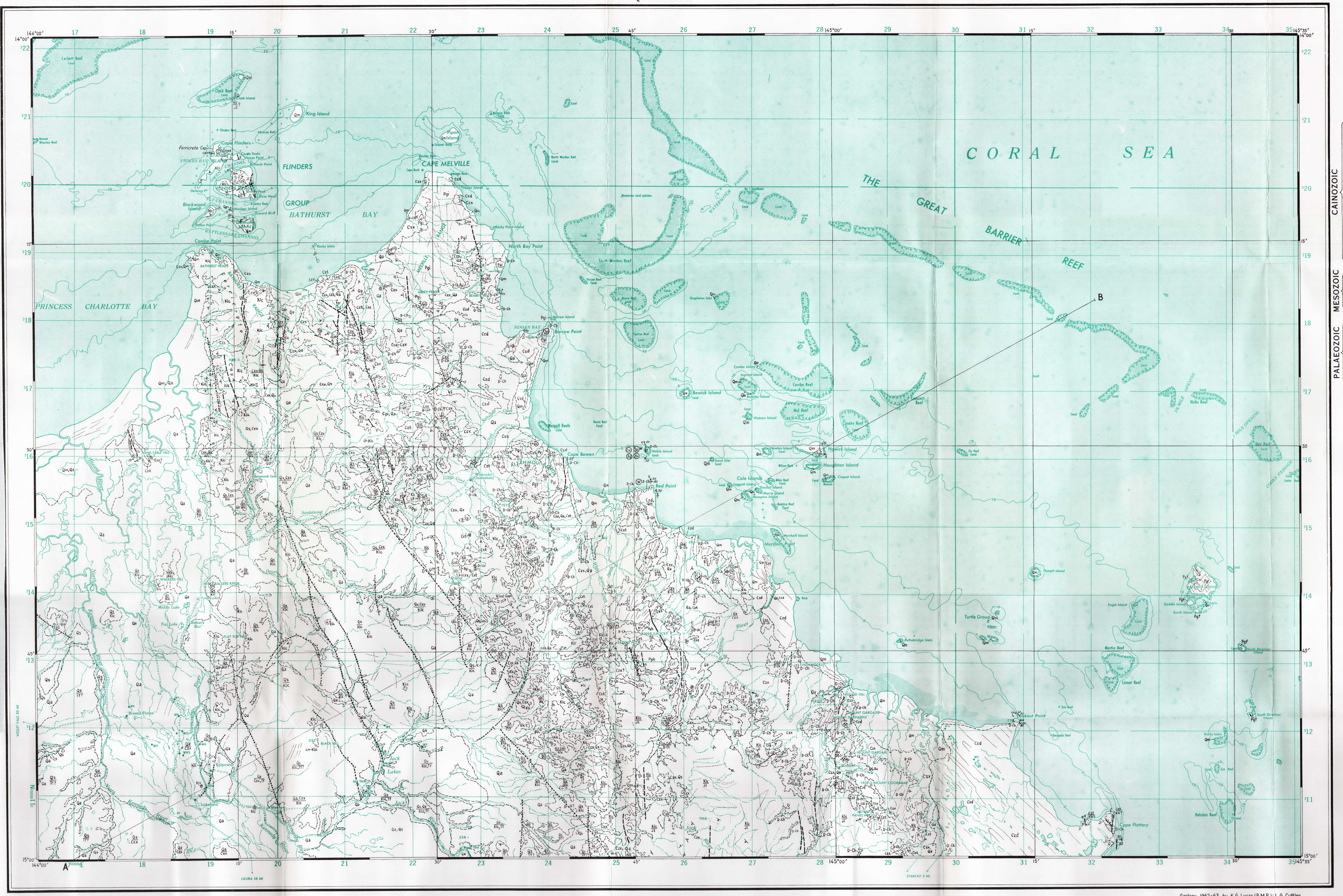
AUSTRALIA 1:250,000

CAPE MELVILLE

QUEENSLAND

1:250,000 GEOLOGICAL SERIES SHEET SD 55-9

PRELIMINARY EDITION, 1964
SUBJECT TO AMENDMENT



Reference

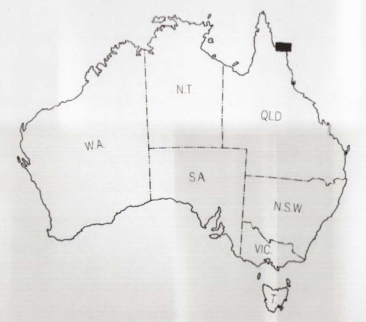
CAINOZOIC	QUATERNARY		Qa	Alluvium: grey silty clay, sand, gravel
			Qm	Marine deposits: reef limestone, salt pans, beach sands, pumice berms; Strand-line
			Qs	Orange and white residual sand
	UNDIFFERENTIATED		Czd	White younger dunes, ferruginous older dunes, peat
			Czt	Talus: sandstone and chert blocks in a ferruginous earthy matrix
		Piebald Basalt	Czp	Olivine basalt, nepheline basanite
		Brixton Formation	Czx	Mottled pebbly sand, sandy clay
	TERTIARY	Fairview Gravel	Tf	Pebbly quartz gravel
MESOZOIC	CRETACEOUS APTIAN-NEOCOMIAN	Battle Camp Formation	Klc	Quartz sandstone, glauconitic sandstone, conglomerate, sandy and silty shale
	JURASSIC	Dalrymple Sandstone	Jl	Quartz sandstone, conglomerate, shale, impure coal; Conglomerate
PALAEOZOIC	PERMIAN (?)	Puckley Granite	Pgk	Medium-grained porphyritic biotite adamellite
		Finlayson Granite	Pgf	Coarse even-grained biotite adamellite with tourmaline
		Altanmoui Granite	Pgi	Medium-grained porphyritic biotite adamellite with marginal variations
	LOWER CARBONIFEROUS (?) -MIDDLE DEVONIAN	Hodgkinson Formation	D-Ch	Greywacke, slate, meta-volcanics

Geological boundary
Anticline
Syncline, showing plunge
Fault
Where location of boundaries, faults and folds is approximate line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes
Strike and dip of strata
Vertical strata
Curving dip
Overturned strata
Dip <30°, *Trend lines*, *Joint pattern* — *air-photo interpretation*
Strike and dip of cleavage
Lineation on cleavage or joint
Direction of sedimentation
Plunge of lineation
Macrofossil locality
Plant fossil locality
Fossil wood
Dyke or vein; q = quartz, a = aplite or microgranite, g = granite
Sample locality for age determination

Mine
Alluvial workings
Sb *Antimony*
C *Coal*
Cu *Copper*
Au *Gold*
Ag *Silver*
Sn *Tin*
W *Tungsten*
Circle around mineral symbol indicates unexploited deposit or prospect

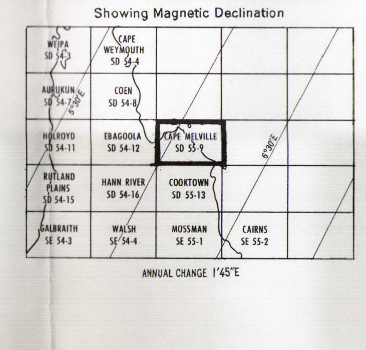
Earth tank with windpump
Waterhole
Vehicle track
"Kalpowar" *Homestead*
Yd *Yard*
Landing ground
Trigonometrical station
254 *Height in feet; datum: mean sea level*
Scarp
Coral reef

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Royal Australian Survey Corps. Aerial photography by Adastra Airways Pty. Ltd. Land area, 1:50,000 scale, 1957; sea area, 1:80,000 scale, 1960 (Great Barrier Reef). Transverse Mercator Projection.



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination



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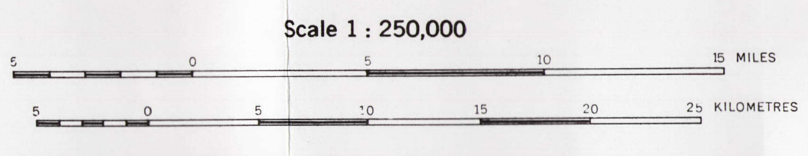
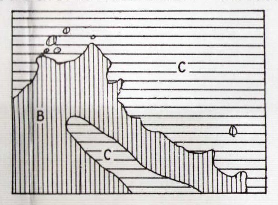


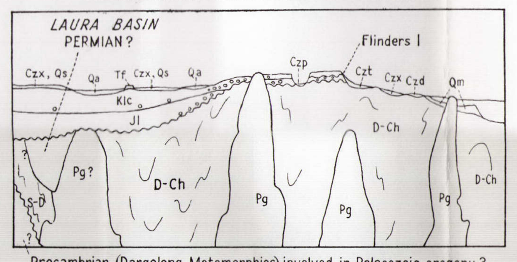
GEOLOGICAL RELIABILITY DIAGRAM



B Reconnaissance and air-photo interpretation
C Air-photo interpretation

Geology, 1962-63, by K.G. Lucas (B.M.R.); L.G. Cuttler, J.T. Woods (G.S.Q.)
Compiled, 1963, by K.G. Lucas
Drawn by G. Matveev

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS

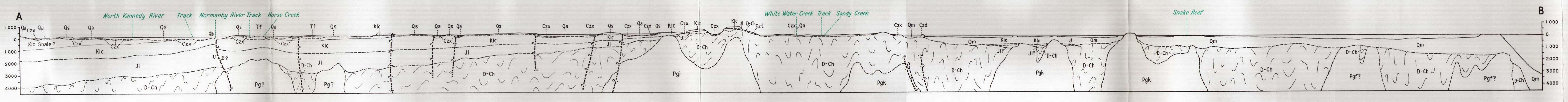


Precambrian (Dargalong Metamorphics) involved in Palaeozoic orogeny ?
Unconformity
S-D SILURIAN-DEVONIAN (Chillagoe Formation)
Pg undifferentiated Permian granite

Section

(Folding Diagrammatic)

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



CAPE MELVILLE

SHEET SD 55-9

GRAPHICAL CHART OF MESOZOIC SECTIONS CAPE MELVILLE SD 55-9 SHEET AREA

Scale
5 0 5 10 15 MILES

Compiled by K. G. Lucas

REFERENCE

- Thickness of section in feet
- Probably marine sediments
- Geological section line, showing stratigraphic top (T)
- Lithologic-stratigraphic correlation line; probable, conjectural
- Klc Battle Camp Formation (Lower Cretaceous)
- Jl Dalrymple Sandstone (Jurassic)
- Basement-Palaeozoic sediment and granite
- Conglomerate, pebbly beds
- Grit
- Sandstone-coarse, medium, fine
- Shale partings and beds
- Coal (impure)
- "Pipe-rock"-sorted fine siliceous sst. with vertical burrows
- Cross-bedding and lamination -oversteepened
- Ripple marks, small scale asymetrical
- Discoidal clay pellets
- Common muscovite flakes
- U Burrows, variously inclined
- Tracks and trails
- Marine macrofossils _abundant e.g.
- Plant macrofossil
- Wood-replaced fragments or impressions
- Gl Glauconite-bearing sediment
- Fe Ferruginisation, esp. along joints and shale beds