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EXPLANATORY NOTES

WESTMORELAND 4-MILE GEOLOGICAL SERIES - SHEET E54-5.

by

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PREVIOUS GEOLOGICAL INVESTIGATIONS

The mapping programme on which the present map is based was the first systematic areal geological work carried out in the Westmoreland Sheet area. Leichhardt (1847) and A. C. Gregory (1861) passed through the Sheet area and recorded a few observations on the rock types of this or nearby areas.

In 1939 and 1940 H. I. Jensen and party made traverses along the Northern Territory-Queensland border (A.G.G.S.N.A. 1940a, b, and Jensen, 1941 (unpublished). D. M. Traves paid a brief visit to the area in 1948 (see Noakes and Traves, 1954). A considerable amount of prospecting and some mapping has been done by Company geologists and staff since 1954.

The reliability diagram on the map sheet shows that geological traverses were confined to the area of outcropping Precambrian rocks.

The remainder of the Sheet area is believed not to contain any outcrops of rock. Ferruginous laterite, and possibly some Recent compacted shell beds along the coastline, probably are the only surface exposures other than soil, sand and alluvium, outside the Precambrian outcrop area (which also has some Mesozoic cappings). Field work was done between 23rd June and 1st July, 1954, with some check work in 1957.

Soil boundaries were adopted from mapping by officers of the Land Research and Regional Survey Division of the Commonwealth Scientific and Industrial Research Organization.

PHYSIOGRAPHY

The Sheet area may be divided into three main physiographic units:

(a) The elevated, dissected area of extensive rock outcrop in the west and south-west.

(b) The level to gently undulating plain country, which occupies about two-thirds of the land area.

(c) The coastal dunes, swamp and tidal areas.

Stewart (1954) recognises four geomorphological units - the dissected country of the Gulf fall without lateritic remnants; the dissected country of the Gulf fall with lateritic remnants; the low-level Tertiary lateritic plain; and the post-Miocene coastal alluvia.

The hill country of the first physiographic unit, which consists essentially of Precambrian rocks, lies 200-800 feet above sea-level. Four main east-west trending elevated areas are separated by relatively flat broad valleys which contain the main water courses. The stream systems are Central and Lagoon Creeks, Yellow Waterhole and Cliffdale Creeks, and the Nicholson River. These all drain eastwards and tend to be braided and anastomising. The divides, though low, are rough and stony with steep-sided water courses. In places the weathering out of joints has produced extremely broken country that is very difficult to cross. Mesas, up to 200 feet high, and capped partly by Mesozoic sediments and partly by soil and leached Precambrian strata, occur particularly in the extreme south-west of the hill country. The soil and leached Precambrian strata formed a land surface in Tertiary times.

The plains, according to Stewart, lie between sea-level and 300 feet. They are drained in the south to the east and in the north to the north-east and north-north-east. Water courses are commonly deeply incised, but meandering, and anastomose in places. Lagoons are numerous and in the wet season marshes and lakes form in the eastern part. The soil is generally sandy but may have lateritic remnants in the more elevated parts and along creeks.

The coastal fringe extends as much as 20 miles inland in the east of the Sheet area. It is generally flat and subject to flooding. Water courses are tidal and tortuous with many oxbows. They are commonly extensively fringed by mangrove swamps. Sand-dunes have developed in places along the coast, and behind them swamps, lakes, and salt pans have formed.

STRATIGRAPHY AND LITHOLOGY

The stratigraphic names which appear on the Westmoreland Sheet and in these notes have been approved by the Queensland (and, where appropriate, the Territories) Stratigraphic Nomenclature Committees. The Precambrian units are fully defined and described in Carter, Brooks and Walker (in preparation). The Mesozoic strata have not been named.

The stratigraphy and a summary of the tectonic history of the area are set out in Table I.

PRECAMBRIAN

Age of the Units

David (1932), in his geological map of Australia, showed the rocks of the Westmoreland area as Archaeozoic. Jensen (1940) regarded the strata at Redbank, in the Northern Territory, with which he correlated the strata in the Border area, as most probably Cambrian in age, although he recognised affinities with the Proterozoic Mount Isa Series. In A.G.G.S.N.A. (1940 a and b) the age of the strata in the Border strip was left open, though they were recognised as being of similar age to the sediments of the Constance Range.

Noakes and Traves (1954) grouped the strata of the Westmoreland area with their "Carpentaria Complex" of Lower Proterozoic age. They recognised an unconformably overlying sequence in the Robinson River area, which they called the Robinson Beds, of Upper Proterozoic age.

TABLE I - STRATIGRAPHY AND TECTONIC HISTORY OF WESTMORELAND SHEET AREA

Era	Period	Stratigraphical Unit	Strati-graphical Symbol	Lithology	Maximum Thickness	Tectonic History and Comments
CAINOZOIC	Quaternary (Recent)		Qr	Coastal sediments, including sand dunes; riverine deposits.	-	Recent 20 ft. emergence due to eustatic sealevel changes. Pleistocene eustatic rise in sealevel. (After Stewart (1954))
	Tertiary		Czn	Non-lateritic soils and riverine sediments.		Post-Miocene warping, causing erosion of the western and south-western part of the sheet area; erosion is still in progress.
			Czl	Lateritic profile and associated soils.		Formation in Miocene time of laterite on upland plain. (After Stewart (1954))
MESO-ZOIC	Lower Cret-aceous-Jurassic?		M	"Porcellanite" Conglomerate, coarse sandstone, siltstone.		Uplift and erosion to a mature surface. Deposition of terrestrial or littoral sediments, followed by a short-lived(?) marine transgression.
PALAE-OZOIC						A long period covering the whole of the Palaeozoic, at least, during which there is no record of sedimentation.
				UNCONFORMITY		
PROTEROZOIC	Upper					An unconformable succession, probably Upper Proterozoic, occurs in Calvert Hills Sheet area, indicating a further period of sedimentation, not recorded in Westmoreland Sheet area.
				UNCONFORMITY		
						Moderate folding on east-west axis, and faulting. Sedimentation probably continued after Gold Creek vulcanicity, but no record preserved in Westmoreland Sheet area.
		Gold Creek Volcanics	Bug	Red, porphyritic acid(?) and other lavas, tuff and interbedded arenaceous sediments.	200' +	A period of intermittent, probably submarine, vulcanicity, with associated slight crustal movements resulting in interruptions to sedimentation. Nicholson Granite and Cliffdale Volcanics acted as "basement" to overlying strata, provided some sediments.
		Constance Sandstone	Bua	Coarse to medium grained sandstone; some conglomerate.	3,000' Probably only a few hundred feet in Sheet area.	
		??SLIGHT UNCONFORMITY??				
		Wollogorang Formation	Buh	Dolomite, chert, chert breccia, sandstone, siltstone.	1,500-1,000'	
		Peters Creek Volcanics	Bup	Interbedded intermediate and acid lavas, tuffs and arenaceous sediments.	1,000'+	
		Westmoreland Conglomerate	Buw	Conglomerate, pebble beds and coarse impure sandstone or quartz greywacke.	4,000'+	
				?UNCONFORMITY		
		Nicholson Granite	Bgn	Coarse, red, ferro-magnesian-poor adamellite and a porphyritic biotite granite. Some granophyre and porphyry.	-	Intrusion of the granites may have caused doming of the surface. The Nicholson Granite is regarded(in part at least) as a high-level granite co-magmatic with the Cliffdale Volcanics. Age relationships of the two granitic phases unknown.
		Cliffdale Volcanics	Buf	Intermediate and acid lavas. Red coarsely porphyritic lava is predominant.		Cliffdale Volcanics extruded onto land surface. No interbedded sediments.

Mapping in 1954 and earlier showed that the strata of the Westmoreland area can be correlated in part with those of the Constance Range and that the latter overlie the ?Lower Proterozoic sediments of the Lawn Hill area with a major unconformity. Company and Bureau of Mineral Resources geologists have also established broad relationships between strata from Arnhem Land to the Westmoreland area. Both these approaches to the problem indicate that most of the rocks in the Westmoreland Sheet area are Upper Proterozoic.

The ages of the Cliffdale Volcanics and the Nicholson Granite (which see) have not been conclusively established. They were basement rocks to younger Upper Proterozoic strata. However they do not appear to have been involved in the tectonic movements which deformed the Lawn Hill Formation, farther south, and they have petrological similarities to overlying lavas. They are therefore regarded as Upper Proterozoic.

Cliffdale Volcanics

Most of the lavas are red, coarse-grained, and porphyritic; some have intricate flow lines. Ferromagnesian minerals are rare. Because of extensive alteration and the presence of finely divided hematite the lavas have not been identified. Many lavas contain little or no quartz and may be andesitic or dacitic, but some are rhyolitic. Some basic flows have been recorded. Extensive coarse agglomerate and tuff occur near the top of the succession. There are no sediments in the succession, which appears to have been extruded onto a land surface.

Westmoreland Conglomerate

The Westmoreland Conglomerate overlies the Cliffdale Volcanics and Nicholson Granite, probably with an unconformity, certainly with an erosional break. In several places, particularly in the Northern Territory, the Westmoreland Conglomerate has been observed to lie on the Nicholson Granite. Both phases of the Nicholson Granite (see p. 8) have been found to be older than the Westmoreland Conglomerate.

A basal conglomerate, up to 200 feet thick, contains boulders of acid lavas and quartz up to 18 inches across. The ill-sorted pebble beds and sandstone are poorly cemented, and contain a lot of clay - probably originally feldspar. Iron-rich laminae in places accentuate the bedding, including the numerous cross-beds.

The thickness of the formation in Queensland decreases sharply to the south but is maintained over at least 40 miles to the south-west, in the Northern Territory. Jointing is well-developed throughout.

Peters Creek Volcanics

A second volcanic succession overlies the Westmoreland Conglomerate. The relationship is not clear. In one place the lavas appear to lie at a slight angle to the conglomerate, but this may be due to an initial dip in the latter. Elsewhere the Peters Creek Volcanics directly overlie the Cliffdale Volcanics **apparently** because the Westmoreland Conglomerate lenses out. Some of the lavas are more basic in composition than the main body of the Cliffdale Volcanics. However, a thick flow (not less than 275 feet) of red, coarsely porphyritic ?acid lava is similar in appearance to the main rock type in the Cliffdale Volcanics. Some of the flows are scoriaceous; the vesicles are infilled by green earthy chlorite. The Peters Creek Volcanics also differ from the Cliffdale Volcanics in that the lavas are interbedded with sediments, in addition to tuff and agglomerate. The sediments are generally siliceous-sandstone, arkose and siltstone.

Wollogorang Formation

The name Wollogorang Formation has been adopted from Jensen (A.G.G.S.N.A., 1940a), who referred to limestone (dolomite) and associated sediments in the Redbank-Wollogorang area, in the Northern Territory, adjacent to the Westmoreland area, as the Wollogorang series. The equivalence of the strata in the type area and those in Queensland has been established, but the thickness of the unit in the main outcrop area in Queensland is several times that in the type area. The succession in Queensland is also more arenaceous at its eastern end than near the Northern Territory border.

The chert breccia in the formation is probably silicified dolomitic breccia. Some of the dolomite contains chert nodules. A specimen of dolomite which was analysed was found to be phosphatic.

Algal-type fossil structures have been found in dolomitic strata within the formation.

The contact between the Peters Creek Volcanics and the Wollogorang Formation is conformable; the boundary is fixed above the highest volcanic horizon.

Constance Sandstone

This formation is best developed in the Constance Range, south of the Westmoreland Sheet area. It consists essentially of arenaceous sediments ranging in grain size from quartz siltstone to coarse, poorly-cemented impure sandstone. A few cobble conglomerate and pebble beds occur, particularly near the base. Strata are flaggy to massive, commonly ripple-marked and cross-bedded and are poorly sorted; mica and clay impurities are common. The sediments of the formation tend to be coarser in the Westmoreland Sheet area than farther south.

Within the Sheet area the Constance Sandstone is underlain, where examined, by Wollogorang Formation; the contact may be very slightly unconformable but the relationship was not conclusively established. In the Constance Range (Lawn Hill Sheet area), particularly along the bounding eastern scarp, the Constance Sandstone lies with a major unconformity on the Lower Proterozoic Lawn Hill Formation. The Upper Proterozoic formations which underlie the Constance Sandstone in the Westmoreland Sheet area are not exposed and are probably entirely absent.

Gold Creek Volcanics

This unit occurs mainly in the Northern Territory; only a few square miles, the northernmost exposures of Precambrian in the north-west of the State, crop out in Queensland.

Lithologically the unit is similar to the Peters Creek Volcanics.

The contact with the underlying Constance Sandstone is probably conformable, but in places in the Northern Territory the Gold Creek Volcanics are underlain by the Wollogorang Formation owing to the lensing out of the Constance Sandstone. The unit is overlain conformably by the Upper Proterozoic Masterton Sandstone, which does not crop out in Queensland.

MESOZOIC

Isolated small mesas occur on the Precambrian strata. Many of these are capped by flat-lying, generally lateritized, Mesozoic sediments.

The Mesozoic sediments generally reflect the composition of the adjacent Precambrian strata, but the upper beds tend to be more uniform, and finer grained than the basal beds. "Porcellanite" commonly forms the upper layers. This is a very fine-grained, white to light brown, even-textured rock, probably a claystone or calcilutite which has been more or less silicified by weathering processes.

Plant remains, probably worm burrows, and ?brachiopods have been recorded but all have been so extensively replaced by limonite or broken up that they have no diagnostic value. The lower beds are probably terrestrial in origin and the upper beds, including the "porcellanite", marine.

South of Elizabeth Creek, in the Lawn Hill Sheet area, geologists of Mount Isa Mines Ltd. in 1956 collected pelecypods which indicate marine sedimentation of Jurassic to Lower Cretaceous age.

The maximum thickness of Mesozoic strata measured in the Westmoreland Sheet area is 90 feet. A considerably greater thickness of Mesozoic strata probably lies beneath the soil and laterite of the plains country. They probably thicken seawards. Mesozoic rocks are known to occur on Mornington Island, in the Gulf of Carpentaria, and most, if not all, of the sediments through which a bore at Burketown penetrates for nearly 2,000 feet, are probably Mesozoic.

INTRUSIVE IGNEOUS ROCKS

NICHOLSON GRANITE

The Nicholson Granite contains two granitic rock types, whose relative ages and genetic relatonships have not been established, other than that both are older than the Westmoreland Conglomerate and both intrude the Cliffdale Volcanics. In the Gorge Creek area a coarse, porphyritic biotite granite, with white feldspar phenocrysts crops out. A contact with the Westmoreland Conglomerate may be seen in this area. Farther north the granite is mainly a coarse, red, porphyritic, ferromagnesian-poor, adamellite and has granophyre and quartz-feldspar porphyry dykes associated with it. By inspection of hand specimens the granitic rock appears to be similar in composition to the main body of porphyritic lava of the Cliffdale Volcanics, which it intrudes. Jensen (1941, unpub.) suggests that the (Nicholson) granite is co-magmatic with the Cliffdale Volcanics, having as common source a high-level magma. This appears to be the case, at least for the red, ferromagnesian-poor adamellite. Having extruded the lavas the magma continued to stope upwards and invaded the extruded lava. Fractures extending out from the intrusion were filled by intrusive porphyry.

Other acid dykes occupy west-north-westerly striking faults of the main fault system. These may be related to later volcanic activity.

The Nicholson Granite extends into the Northern Territory for about 40 miles on a westerly-striking axis.

DOLERITE

A north-west striking dolerite dyke has been observed in the Westmoreland Conglomerate and other dolerite dykes have been recorded near the Northern Territory border; most of the latter probably occur in the Northern Territory. The composition of the dolerite has not been determined.

METAMORPHISM

The lavas of the Sheet area have undergone metasomatic alteration, but it is not clear whether this has been produced by hypogene or supergene processes. The sediments have not been regionally altered. Cleavage has not been formed; superficial silicification appears to be the most profound change.

Feldspar in the lavas, both those that are younger than the Nicholson Granite and those that are older, is generally turbid and difficult to determine. The dark mineral in the intermediate lavas is uralitized hornblende, and epidote is abundant. These changes may be the result of low grade metasomatism. A body of porphyry which appears to intrude the Gold Creek Volcanics, in the Northern Territory west of Settlement Creek, could be a cause of the metasomatism. The observed alteration or part of it could also be the result of the profound weathering which has affected the rocks of the area.

STRUCTURE

The structure of the Precambrian in the Westmoreland Sheet area is very simple. The outcropping Precambrian strata are arched on an east-west axis along the Cliffdale-Yellow Waterhole stream system, with minor flanking flexures, as shown in the cross-section which accompanies the map. Approximately north-west and north-east faults have caused considerable displacement of some of the strata. East-west axial faulting has also been recorded.

Dips in the sediments generally do not exceed 30° and over wide areas dips greater than 10° are rare. Drag-folding in the Westmoreland Conglomerate along faults near the Northern Territory border has tilted the conglomerate up to 80°. Apparently the Cliffdale Volcanics were updomed before the deposition of the Westmoreland Conglomerate but it is not known whether the strata were folded in the process or merely differentially elevated.

The most important faults appear to be those which strike west-north-west to north-west. As some are filled by sheared porphyry dykes movement on this fault system is probably of at least two ages. It is not known whether the faulting was tensional or transcurrent, but it was probably normal faulting. All faults dip at high angles.

The Westmoreland Conglomerate, Cliffdale Volcanics, and portions of the Constance Sandstone are strongly jointed. Minor movement has probably taken place on some of the joints.

The Mesozoic strata are flat-lying and no faulting has been recorded in them in the Westmoreland Sheet area. Similar sediments in the Calvert Hills Sheet area, to the west, and the Lawn Hill Sheet area, to the south, have been slightly faulted. These movements were probably related to the Tertiary warping which has largely produced the present land-form (see Stewart, 1954).

ECONOMIC GEOLOGY

No production of economic metallic minerals has been recorded. A.G.G.S.N.A. (1940 b, p.12) report copper and lead workings in the Gorge Creek area, in narrow fissure veins which contain malachite and galena. Other copper workings are known in the Northern Territory within a few miles of the border and spasmodic small-scale production of high grade, hand-picked copper ore has been maintained for 40 years from the Redbank copper field, 14 miles west of the border.

In 1956 a large radiometric anomaly was detected 20 miles south-west of Westmoreland Homestead, in Westmoreland Conglomerate, in the course of an airborne scintillograph search for uranium by the Bureau of Mineral Resources. A ground inspection of the location revealed torbernite at the surface. The deposit is at present being tested by company interests; its importance has not yet been ascertained.

Evaporite salt deposits near the coast would probably provide a source of salt for stock purposes for local properties, but the lack of a market would prevent commercial exploitation.

Surface water is generally fairly abundant, particularly in the plains country, which provides the best feed for stock. During the dry season the water holes and rock holes in the hill country tend to dry up and surface water becomes difficult to find.

Little data is available on underground water supplies as no bores have been sunk within the Sheet area. At Burketown, on the **Albert** River, 3 miles east of the eastern boundary of the Sheet, good supplies of artesian water were obtained at a depth of 1,990 feet. Adequate supplies should be obtainable in the plains country at progressively shallower depths to the west and south-west of Burketown. Within the area of outcropping Precambrian water should be readily available along the main watercourses. In the crystalline granite and lavas the only possible reservoirs for water would be in joints and faults; bores would need to be sited on such structures. Many of the sediments, on the other hand, are extremely pervious and bores sited with regard to geological structure and surface catchment area should provide water.

ACKNOWLEDGMENTS

The map which these notes accompany was based mainly on the work, in 1954, of those named on the map sheet. However,

some alterations were made as a result of subsequent field work in adjoining areas by other officers of the Bureau of Mineral Resources.

Mesozoic marine fossils, which provided the first conclusive evidence of marine Mesozoic sedimentation in the region, and the algal fossils in the Wollogorang Formation, were found by members of the geological staff of Mount Isa Mines Ltd. Valuable information on the regional geological setting has been obtained from time to time from the same source. Grateful acknowledgment is made to the Chief Geologist, Mount Isa Mines Ltd., and his staff, for their co-operation.

Soil boundaries are based largely on the Land Research and Regional Survey Division, Commonwealth Scientific and Industrial Research Organization, Canberra.

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