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AND GEOPHYSICS

Record 1972/57

THE MESOZOIC AND CAINOZOIC GEOLOGY OF THE CLONCURRY 1:250 000 SHEET AREA, QUEENSLAND

by

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* Geological Survey of Queensland

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SUMMARY

The Mesozoic rocks of the Cloncurry Sheet area are of Jurassic to Lower Cretaceous age and comprise:

(a) Continental and marine sandstone and mudstone preserved as mesas in the Precambrian formations of the Mt Isa Block.

(b) Continental sandstone, overlain in turn by marine sandstone and by the dominantly argillaceous marine Rolling Downs Group in the Eromanga and Carpentaria Basins in the east.

The Carpentaria and Eromanga Basins are separated by the Euroka Arch, a remnant high area left by the relative down-warping of the two basins to its north and south. The Cainozoic history includes the development of a deep weathering zone on the Mesozoic and Precambrian rocks, and fluvial valley and plain deposits.

INTRODUCTION

In 1969 the Mesozoic and Cainozoic units of the eastern part of the Cloncurry Sheet were mapped as part of the regional mapping programme in the Carpentaria Basin (Doutch et al., 1970). A preliminary edition of the Sheet was issued in 1970 and accompanies this Record.

Access within the Sheet area is by a network of dry-weather station tracks with major access routes radiating out from Cloncurry: north via Quamby to Kajabbi or Normanton; north-northeast via Clonagh to Sedan Dip; east via the Flinders Highway to Julia Creek; and southeast via the Landsborough Highway to McKinlay. There are regular plane, rail, and bus services through Cloncurry. The area is covered by 1:84 000 scale RC-9 air photographs flown in 1966. Larger scale photographs are available over the Mount Isa Block, but these do not extend over the area discussed in this Record.

Previous mapping of the Precambrian rocks of the region by Carter et al. (1961) was incorporated in the First Edition of the Cloncurry Sheet (Carter, 1959), and prior investigations are referred to in the bibliographies of those two publications. The Precambrian rocks of the area are at present being remapped at 1:100 000 scale by the Bureau of Mineral Resources (e.g., Glikson & Derrick, 1970; Derrick et al., 1971).

Studies of the Mesozoic sediments include regional surveys by Whitehouse (1955), Ogilvie (1955), and Hill & Denmead (1960). Meyers (1969) summarized the geology of the Carpentaria Basin and Doutch et al. (1970) have discussed the southern part of it. Vine (1966) and Casey (1970) have summarized the geology of the northern Eromanga Basin. The Mesozoic and Cainozoic deposits of some of the sheets near Cloncurry have been described by Opik et al. (1959, 1961), Opik & Carter (1964), Vine (1963, 1964), Grimes (1972), and Smart (1972). Within the Cloncurry Sheet area the Mesozoic outliers on the Mount Isa Block have been described by White (1957). Crespin & Dickins (1955), and Skwarko (1963, 1966). In the basinal area Williamson (1967) studied the Toolebuc Limestone and Piggot (1970) reported on drilling near the margin. A brief description of the Mesozoic rocks is also given by Carter (1969). BMR drilled two shallow holes in the area as part of the mapping program in 1969 (Grimes & Smart, 1970). The stratigraphic nomenclature for the basinal deposits used in this paper is that evolved by Vine & Day (1965), Vine et al. (1967), and Smart et al. (1971; in press). The sandstone classification is that of Crook (1960).

PHYSIOGRAPHY

The physiography of the area has been described by Twidale (1956a, 1966a) and Carter (1959). The area is divisible into two major units (Fig. 1): The Isa Highlands, a unit of moderate relief and extensive outcrop of Precambrian rocks occupying most of the western and southern part of the Sheet area, and the Carpentaria Plains, occupying the northeastern part of the Sheet area, which are characterized by very low relief and are developed on Cretaceous and Cainozoic rocks.

FIG. 1

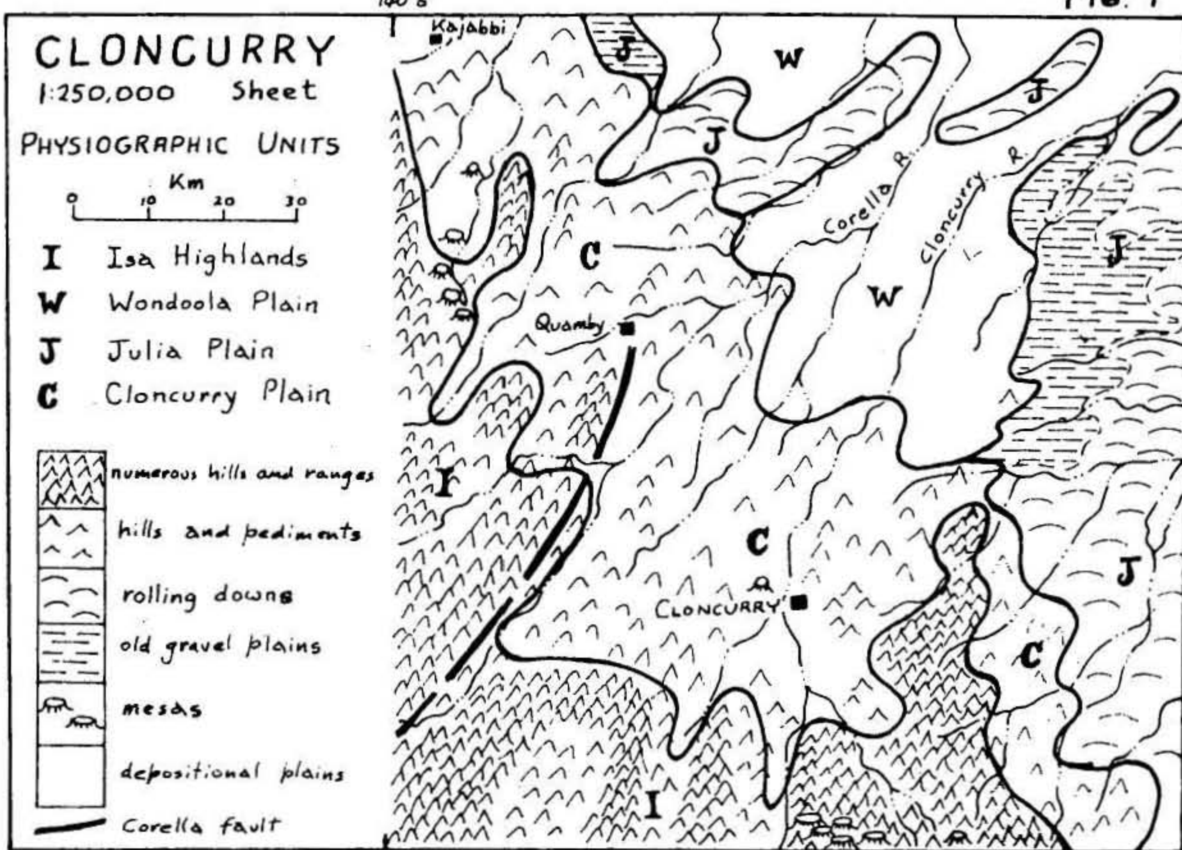
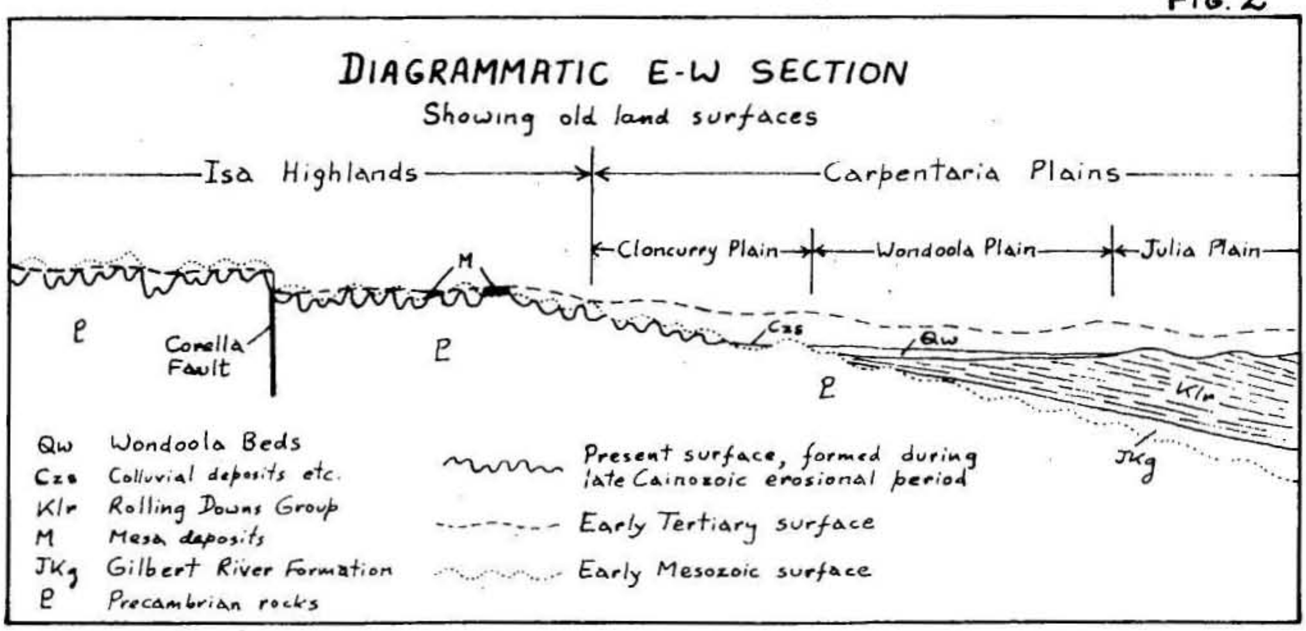

CLONCURRY
1:250,000 Sheet
PHYSIOGRAPHIC UNITS
Km
0 10 20 30
I Isa Highlands
W Wondoola Plain
J Julia Plain
C Cloncurry Plain
numerous hills and ranges
hills and pediments
rolling downs
old gravel plains
mesas
depositional plains
Corella fault
140°E
Kajabbi
Quamby
CLONCURRY
Corella R.
Cloncurry R.
20°S
21°S
140°E
141°E

FIG. 2


DIAGRAMMATIC E-W SECTION
Showing old land surfaces
Isa Highlands
Carpentaria Plains
Cloncurry Plain
Wondoola Plain
Julia Plain
M
Corella Fault
Czs
Qw
Klr
JKg
Qw Wondoola Beds
Czs Colluvial deposits etc.
Klr Rolling Downs Group
M Mesa deposits
JKg Gilbert River Formation
Precambrian rocks
Present surface, formed during late Cainozoic erosional period
Early Tertiary surface
Early Mesozoic surface

The two main rivers are the Cloncurry and Leichhardt, which rise in the Isa Highlands and drain northwards across the Carpentaria Plains to the Gulf of Carpentaria. They are both non-perennial within the Sheet area and for most of the year dry out to chains of waterholes.

The Isa Highlands

The highlands are a series of mainly north-trending ridges and hills which attain heights of 600 m above sea level but are commonly between 370 m and 500 m. The greatest local relief is 180 - 210 m. There is a marked accordance of crests coincident with small plateau remnants (see Fig. 3), suggesting that the area is a dissected plateau.

Twidale (op. cit.) considers that there were two early periods of erosion, the first in the early Mesozoic, producing a surface which was buried beneath the later Mesozoic deposits, and the second in the early Tertiary when the Mesozoic cover was eroded and partly removed and the resulting landsurface 'lateritized'.

The old plateau indicated by the present summit accordances is considered to be largely that of the early Tertiary land surface, with the Mesozoic element restricted to the eastern part. In the surrounding region the early Tertiary surface is generally smooth with broad undulations (e.g. Lawn Hill and Georgetown Sheet areas). In the western part of the Cloncurry Sheet area the hill tops and plateau residuals have been lateritized (I.H. Wilson, pers. comm.); lateritization is a feature of the early Tertiary surface but is not known on the Mesozoic surface in the Carpentaria Basin. Hence it is thought that in this area the higher regions of the early Mesozoic surface were exhumed and planed off during the early Tertiary and that only the lower parts of the surface were preserved beneath a cover of Mesozoic rocks.

Contour maps of the southern part of the Cloncurry Sheet area at 1:100 000 scale have recently become available. An examination of these suggests that the old land surface has been affected by faulting since its formation. The main displacement has occurred along the Corella Fault (Figs. 2 and 10). Here the eastern block has been displaced downwards by up to 180 m relative to the western block. This movement is in the same sense as that of the Boomarra Fault, which displaces Mesozoic units in the northern Cloncurry and Dobbyn Sheet areas (see Structure).

The present erosion cycle has dissected the early Tertiary plain and in the eastern Isa Highlands it has also exhumed and dissected the remnants of the early Mesozoic plain (see Fig. 2). The early Mesozoic plain is still preserved beneath late Mesozoic sediments in the east, where it had been downwarped to form the base of the present Carpentaria and Eromanga Basins.

Within the eastern part of the Isa Highlands and in adjoining parts of the Cloncurry Plain there are several groups of mesas (Fig. 1) developed on Mesozoic units. The upper surfaces of the mesas all lie at the same level, that of the early Tertiary land surface as discussed above. This surface shows

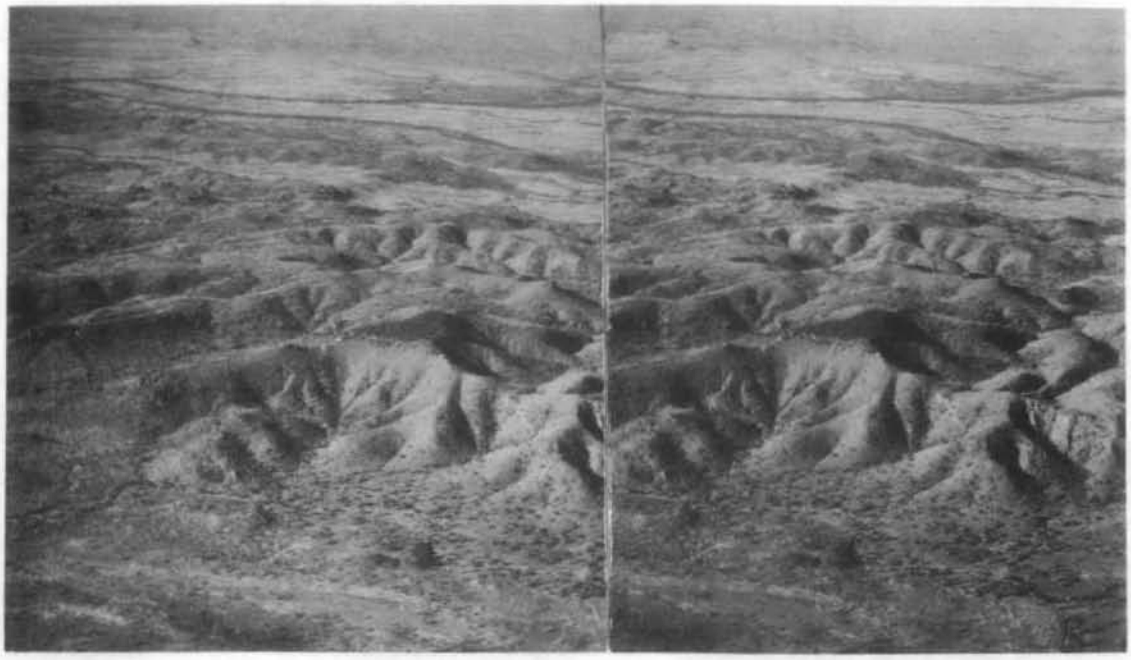


Fig. 3 - Stereo pair south of Roxmere, CLONCURRY, showing capping of Mesozoic sandstone resting on Precambrian
(Negs. 2912, 2913)

Fig. 4 - Capping of Mesozoic sandstone on Precambrian. Flat Top Mountain, CLONCURRY.
(Neg. 2488)

an apparent dip in some places (e.g. Fig. 4); this appears to be the original slope of the old land surface rather than a tectonic effect. However, the southern mesas in the Roxmere area stand above the level of the surrounding Precambrian peaks which in adjacent areas are in accordance with the early Mesozoic land surface on which the Mesozoic deposits were laid, whereas the mesas in Cabbage Tree Creek and to the north lie in what appears to have been an old valley, as the surrounding Precambrian peaks rise above their level. The distribution and stratigraphy of the mesas is discussed later in stratigraphy.

The Carpentaria Plains

The Carpentaria Plains lie 120 - 180 m above sea level in the Cloncurry Sheet area and slope gently to the northeast. Relief is low, reaching a maximum of 45 m near the Isa Highlands. Twidale (1956a, 1966a) divides the plains into a number of units, three of which extend into the Cloncurry Sheet area (Fig. 1); the Cloncurry Plain flanks the Isa Highlands, the Wondoola Plain extends into the northeast of the area, and the western margin of the Julia Plain is present in the east.

The Cloncurry Plain is developed mainly on Precambrian rocks, but also on Cretaceous and younger rocks and sediments to the east. It is undulating or broadly rolling, with a few low hills and ridges which become more numerous towards the Isa Highlands. The landforms consist of relict hills surrounded by piedmont slopes which merge into alluvial deposits. A few of the alluvial areas are of recent age (Qra) and are still forming; however, most are older (Czr and Qf on the map, Pl. 1) and have been subjected to some post-depositional erosion. Twidale (op. cit.) considers that there is an accordance of ridge crests on this plain, with the crest-line rising gradually towards the Isa Highlands, and that this indicates the level of the exhumed early Mesozoic surface which rises from beneath the Carpentaria and Eromanga Basins towards the Isa Highlands (q.v.). This surface has been considerably dissected since it was re-exposed.

The erosional period which resulted in the present surface of the Cloncurry Plain probably started in the late Tertiary and is the same as that in which the Isa Highlands were dissected. Some fluvial deposition occurred on the plain in Pleistocene times as extensions from the Wondoola Plain, but erosion has since become dominant, possibly as a result of minor upwarping to the south (the Selwyn Upwarp-Twidale, 1966b). The processes operating during the main period of erosion are uncertain. The climate at present is arid and erosion appears to be by scarp retreat with the formation of pediments (see, e.g., Twidale, 1956b). However, this may not have been the case in the late Tertiary or Pleistocene, as the contemporaneous deposits of the Wondoola Plain, which were derived in part from this area, are of fluvial origin and suggest a moister climate than the present.

The Wondoola Plain in the Cloncurry Sheet area is developed on late Cainozoic alluvial deposits and consists of flat treeless plains of grey and brown heavy textured soils cut by entrenched and braided stream channels.

TABLE 1 MESOZOIC AND CAINOZOIC STRATIGRAPHY, CLONCURRY

(updated since printing of Preliminary map, 1970)

AGE				FORMATION (letter symbol)	LITHOLOGY	THICKNESS (metres)	ENVIRONMENT	DISTRIBUTION
CAINOZOIC	QUATERNARY	Holocene		(Qra)	Sand, silt and minor gravel	Superficial	Recent alluvial deposits in stream valleys.	Chiefly in Leichhardt, lower Cloncurry, and Williams Rivers; and Middle, Cattle, Courtenay, Canal, Gypsum, and Scrubby Creeks. Most widespread in southeast.
CAINOZOIC	QUATERNARY	Pleistocene to Holocene?		Wondoola Beds (Qf) (Qw in adjacent sheets)	Dark grey silt and clay with minor grit; a surface cover of gravel and cobbles in some areas.	Superficial	Fluviatile deposits, and weathering of Cretaceous mudstone.	Extensive black soil plains northeast of Fort Constantine, and in southeast. Smaller areas elsewhere in east. In some areas associated with Mesozoic mudstone.
CAINOZOIC	QUATERNARY	Pleistocene to Holocene?		(Czr)	Red and brown sand, silt and clay with gravel beds. Cross bedded in parts.	Up to 30	Fluviatile	A large belt associated with Corella and Cloncurry Rivers. Smaller areas elsewhere in east.
CAINOZOIC	TERTIARY	Pliocene? to Holocene		(Czs)	Red and brown, poorly sorted gravel and sand, with minor silt and clay.	0 - 10	Colluvial blanket deposits, and lag gravels	On Cloncurry Plain, and as high plain between Courtenay Creek and Brymine, in northeast.
CAINOZOIC	TERTIARY	Early Tertiary		(Czd)	Mottled claystone; silcrete and ferricrete (duricrust).	1 - 7	Deep weathering phenomena.	Mesa cappings on Precambrian and Mesozoic rocks.
					UNCONFORMITY			
MESOZOIC	Lower Cretaceous	Albian	Rolling Downs Group	Allaru Mudstone (Kla)	Dominantly blue-grey mudstone, with minor siltstone, calcareous labile sandstone, and limestone, commonly cone-in-cone.	Up to 170	Shallow marine?	Isolated outcrops in northeast and east.

MESOZOIC	LOWER CRETACEOUS	Albian	Rolling Downs Group	Toolebuc Limestone (Klo)	Flaggy and concretionary limestone, calcareous shale, oil shale, minor coquinite. Abundant shelly fossils and belemnites.	variable 7 - 25	Shallow marine (biostromal and biohermal banks and mounds)	Low ridges in belt between Granada and Clonagh in northeast, and Courtenay Creek and Arrolla in southeast.
		Aptian to Lower Albian		Wallumbilla Formation (Klu)	Blue-grey mudstone with minor beds of cone-in-cone limestone, and fine grained glauconitic quartz sandstone.	100 - 150	Shallow marine and paralic	Does not crop out; observed in bores in Carpentaria and Eromanga Basins.
	JURASSIC	Upper Jurassic to Lower Cretaceous		Gilbert River Formation (M)	Quartzose sandstone, shale, conglomerate	0 - 65	Terrestrial and shallow marine	One outcrop in Corella River south of Quamby; subsurface in the Carpentaria and Eromanga Basins.
		Jurassic to Lower Cretaceous		(M) (undiff)	Quartzose, and sublabile sandstone micaceous siltstone, mudstone, shale and conglomerate.	up to 40	Terestrial and shallow marine	Isolated mesas on Mt Isa Block.

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Twidale (1956a, 1966a) describes the Wondoola Plain as a black soil plain developed on alluvial silts. This is true for the areas to the north, but within the Cloncurry sheet area the soil cover (Qf) appears to have been largely eroded away in recent times and the surface of the plain is now composed of the underlying red-brown sands and silts (Czr). This erosional period may have been initiated by the Selwyn Upwarp (Twidale, 1966b). Some of the eroded material appears to have been deposited in a flood-out area (Qra) of the Cloncurry River in the northeastern corner of Cloncurry Sheet area and the southwest of Millungera Sheet area. The localization of the flood-out deposits in this area appears to be due to a change in gradient of the Cloncurry River as it enters the Millungera sheet area, which in turn may have been caused by movements of the Selwyn Upwarp to the south. The surface of the plain at present appears to be generally static, with some erosional areas.

Beneath the late Cainozoic sediments of the plain, a buried late Tertiary erosional surface has been preserved. This surface is not present in the Cloncurry Plain and Isa Highlands as the erosion which began there at the same time has continued through to the present with only minor interruptions. The nature of this surface will be discussed by Grimes & Doutch (in prep).

The Julia Plain is a gently rolling erosional plain developed mainly on the soft Cretaceous mudstone and limestone of the Rolling Downs Group, which derives its name from the topography which is characteristic of the plain. The present landsurface consists of low interfluves separated by flood plains containing braided stream channels which are generally entrenched into their own alluvium. These flood plains could be considered as tongues of the Wondoola Plain which are extending into the area of the Julia Plain. In Cloncurry sheet area the Julia Plain also includes a gravel-surfaced plain which stretches north from Courtenay Creek to the Cloncurry River in the east (unit Czs in Plate 1). Present erosion is cutting back into this surface, producing low scarps and exposing the underlying Cretaceous sediments.

The Julia Plain appears to have formed in the same erosional period as the Isa Highlands and the Cloncurry Plain, commencing in the late Tertiary and continuing through to the present with minor halts. The Czs deposits discussed above must have formed during this period. They appear to be mostly lag gravels left by the breakdown and removal of the mid-Tertiary 'duricrusted' surface which once extended above this area.

MESOZOIC AND CAINOZOIC STRATIGRAPHY

The northeastern part of the Cloncurry Sheet area contains the western margin of the Carpentaria and Eromanga Basins, though the sedimentary rocks crop out only poorly as most of the area is covered by Cainozoic sediments derived from the Isa Highlands. The stratigraphy of these successions is summarized in Table 1.

MESOZOIC

The boundary between the Carpentaria Basin and the Eromanga Basin is discussed below under Structure. The stratigraphy of the two basins is identical within the Sheet area and will be discussed as a single system. The units consist of a basal fluviatile sandstone sequence which generally does not crop out on this side of the basins, as it pinches out against the Mt Isa Block, and the overlapping marine deposits of the Rolling Downs Groups. Mesozoic deposits, partly continental and partly marine, also occur as mesas overlying

Fig. 5 - Mesozoic sandstone cropping out in the Corella River

(Neg. 2486)

FIG 6 - MEASURED SECTIONS OF MESOZOIC ROCKS IN MESAS

To accompany Record 1972/57

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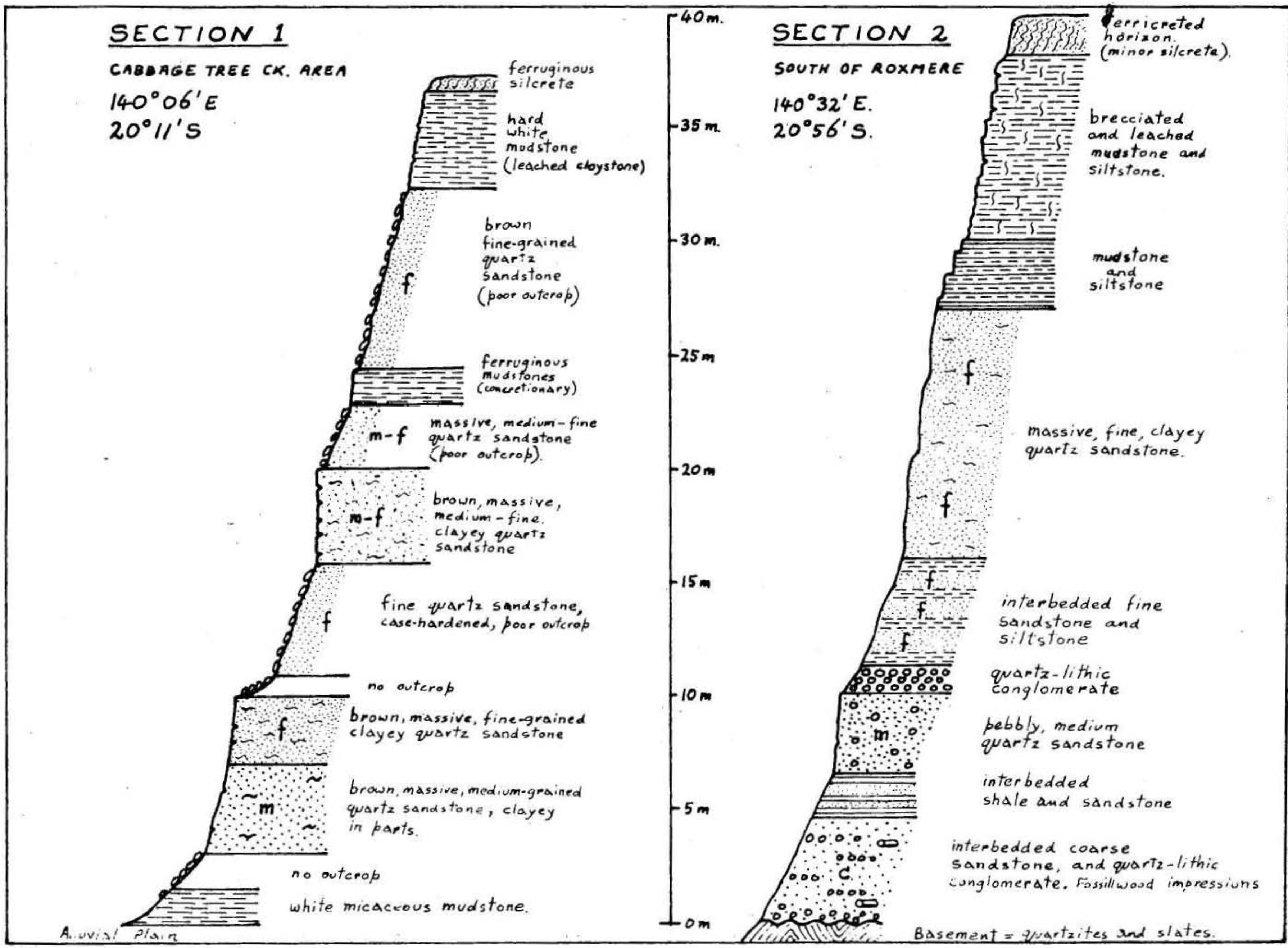

FIG 6

Precambrian rocks in several parts of the Mt Isa Block.

The Mesa rocks of the Mt Isa Block

Mesas of Mesozoic rocks cap the Precambrian rocks of the Mt Isa Block in three areas in Cloncurry sheet area (Plate 1): in the Cabbage Tree Creek area, south of Kajabbi; between the Cloncurry River and Soldiers Cap, south of Roxmere; and a single outcrop on Flat Top Mountain (Fig. 4) about 6km northeast of Cloncurry.

The area south of Roxmere is a northern extension of a much larger plateau in the Selwyn area of the Duchess sheet area, described by Opik & Carter (1964); the southernmost part of this plateau appears to be continuous with outcrops of Mesozoic rocks on the margins of the Eromanga Basin in the southern Duchess sheet area.

The mesa rocks are unconformable on Precabrian rocks and the unconformity has considerable local relief. The upper surface of the mesas is that of the Tertiary surface of erosion, which is associated with a deep weathering zone. The mesa strata, up to 40m thick, consist of fine to coarse quartzose to feldspathic-sublabile sandstone with granule and pebble conglomerate beds interbedded with micaceous mudstone, siltstone, and shale. The sandstone is generally poorly sorted and clayey. The sequence tends to become finer grained upwards and the upper part is generally a deep-weathering profile developed in mudstone (see Fig 6.).

Fossil plants have been described by White (1957) from similar sandstone deposits in mesas of the Selwyn area of the Duchess sheet area to the south. She considered them to be of Triassic or Jurassic, probably lower Jurassic, age. Elsewhere in the Carpentaria and Eromanga Basins continual deposition is known of Jurassic and earliest Cretaceous age.

Lower Cretaceous marine molluscs and arenaceous foraminifera have been described by Crespin & Dickins (1955) from micaceous siltstone and sandstone of the Soldiers Cap mesa in the southeast. Fossil wood impressions of uncertain age have been found by the author in the lower parts of several of the mesa successions. Thus it appears that both an older (Jurassic to early Cretaceous) continental sequence and a younger (Cretaceous) marine sequence are present within the mesa deposits. Unfortunately, except where fossils are present, it has not been possible to separate the deposits into two units as there is no diagnostic change in lithology.

The continental deposits of the mesas were probably fluvial sediments laid down in two valleys, one which drained north through the Cabbage Tree Creek area and opened into the fluvial plains of the early Carpentaria Basin in the Dobbyn sheet area, and a second which drained south through the Selwyn area and opened into the early Eromanga Basin in the southern Duchess sheet area. Both valleys are aligned north-south, parallel to the tectonic grain of the Mt Isa Block. The southern valley was broader and shallower than the northern. In the basin areas in the east there is evidence (discussed below) that the continental sandstone pinches out and is overlapped by transgressive marine mudstone. This transgression flooded the valleys also, and may have spread out over a large part, if not the whole, of the Mt Isa Block, though it is likely that the higher parts remained as islands and provided a source of

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sediments. Most of the sediments deposited on the Mt Isa Block during this transgression were removed during the erosional period that led to the formation of the lower Tertiary land surface. Only the thicker deposits overlying the continental sediments of the old valleys have been preserved.

The Carpentaria and Eromanga Basins

Basal sandstones have not been named on Plate 1, nor differentiated from the mesa deposits discussed above. Since the map was drawn further work by BMR and CSQ has clarified the affinities of some of the units.

In water bores the basal units are reported in drillers' logs as sandstones and mudstones; they contain the confined aquifers supplying the deeper water bores. They constitute a unit which reaches a thickness of 65m in the deeper parts of the basin; bore data shows that it thins towards the present basin margin and generally pinches out against the Mt Isa Block without cropping out. The transgressive marine deposits of the Rolling Downs Group overlap the unit and lie directly on the basement along the basin margin (e.g. in BMR Cloncurry 2-Grimes & Smart, 1970).

The only observed exception to this generalization in the Cloncurry sheet area is the outcrop in the Corella River near the Quamby-Cloncurry road crossing (see Pl. 1 & Fig. 5), where the sandstone unit is only about 10m thick. At this locality Precambrian granite is overlain by a basal conglomerate and then by interbedded fine and medium-grained, micaceous, quartz sandstone and micaceous siltstone and mudstone, with a few beds of coarse-grained sandstone. The sequence is overlain by blue-grey mudstone of the Wallumbilla Formation. Drilling to the east of the outcrop area (Piggott, 1970) has indicated that the sandstone thickens to the east and is continued with the basinal unit.

The sediments were most probably derived from the adjacent high areas of the Mt Isa Block and deposited in a fluvial plain, though the uppermost part of the unit could be shallow marine in origin. No fossils have been recorded within the area, but by a comparison with similar units elsewhere in the basin a Jurassic to early Cretaceous age is probable.

The Cloncurry sheet area lies on the margin of the Eromanga and Carpentaria Basins, and different nomenclature has been used for the basal sandstone units found in the area. J.N. Casey (1959) defined the Longsight Sandstone in the northwestern margin of the Eromanga Basin, and D.J. Casey (1970) showed that it was laterally equivalent to a much thicker succession in the eastern Eromanga Basin comprising the Hutton Sandstone, the Injune Creek Group, and the Hooray Sandstone, ranging from lower Jurassic to lower Cretaceous in age. In the Carpentaria Basin Smart et al. (1971) have recognised a Jurassic Eulo Queen Group and have redefined the overlying Jurassic to lower Cretaceous Gilbert River Formation. The Eulo Queen Group appears to be equivalent to the Hooray Sandstone and part of the Injune Creek Group (Vine, 1966). The interpretation of gamma-ray logs of water-bores by Doutch et al. (1970) in the Carpentaria Basin has indicated that the Eulo Queen Group is present in the northeastern corner of the Cloncurry sheet area and that it is overlapped by the Gilbert River Formation, which forms most of the basal sandstone unit of the Sheet. The Gilbert River Formation and the Eulo Queen Group combined are probably equivalent to the Longsight Sandstone to the south.

Fig. 7 - Toolebuc Limestone in Dugald River, north of Granada homestead.
(Neg. 2492)

Fig. 8 - Wondoola Beds (Czr) : red cross-bedded sand and gravel in earth tank east of Fort Constantine homestead.
(Neg. 2491)

The pinchout of the Gilbert River Formation against the Mt Isa Block suggests that it was separated from the contemporaneous deposits to the west by a nondepositional area. The geography of the time may well have been similar to that of the present-day Cabbage Tree Creek area, where Cainozoic fluvial deposits within the valley are separated from the widespread fluvial deposits of the Wondoola Plain to the east by an interfluve of Precambrian rocks.

The presence of Lower Jurassic plant fossils in the southern of the two valleys indicates that deposition preceded the formation of the Gilbert River Formation. Further, the deposits in this valley appear to be continuous with outcrops of the Longsight Sandstone and Wallumbilla Formation on the margins of the Eromanga Basin in the southern Duchess sheet area. Therefore it appears to be more justifiable to correlate these continental mesa deposits with the Longsight Sandstone than with the Gilbert River Formation. The marine beds would be equivalent to the Wallumbilla Formation.

The mesa remnants of the northern valley deposits have not yet yielded fossils; they appear to be outliers from a coal-bearing sandstone which underlies the Cainozoic beds to their north (Dunstan, 1920), and which may be continuous with the Gilbert River Formation farther north in the Dobbyn Sheet area.

<u>Rolling Downs Group</u>. This is a shallow marine sequence which conformably overlies the Gilbert River Formation. The individual units are described below. For detailed regional descriptions the reader is referred to Doutch et al. (1970), and Smart et al. (in press).

The <u>Wallumbilla Formation</u> (Klu) is not exposed within the Sheet area; it is easily eroded, and where it is present it is covered by Cainozoic deposits. It occurs throughout the Mesozoic basins. The formation is known from water-bore logs, company drilling (Piggot, 1970), and two BMR scout holes (Grimes & Smart, 1970). The composite lithology is given in Table 1. Macrofossils are present but not abundant. The faunas have been described elsewhere in the basins by Vine & Day (1965) and other workers, who have placed the formation in the Aptian and lower Albian. The microfossils found in the BMR stratigraphic holes appear to belong to the K1b-d zones (Burger, <u>in</u> Grimes & Smart, 1970).

The <u>Toolebuc Limestone</u> (Klo) was first described by Casey (1959) in the Boulia Sheet area on the western margin of the Eromanga Basin. Mapping since then (Vine, 1966; Doutch et al., 1970) has shown that the unit extends over most of the northern Eromanga Basin and into the Carpentaria Basin, where it is equivalent to the Kamileroi Limestone of Laing & Power (1959).

In outcrop the Formation consists of flaggy pink and grey limestone beds overlying a hard grey and yellow calcareous shale containing concretions of limestone (Fig. 7). The flaggy limestone beds have been further divided into an upper vuggy limestone unit and a lower coquinite unit by Williamson (1967), who has shown that the thickness of these upper units is variable. He considers that they originated as biostromal and biohermal banks and mounds. The lower calcareous shale beds are black in bores and include oil shale (Smart, 1972). Fossils are abundant in the upper units and consist of bivalves (mainly <u>Aucellina</u> and <u>Inoceramus</u> spp.) ammonites, belemnites, fish scales and bones, and some possible algal structures. The fossils belong to

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Tambo fauna of Albian age (Vine & Day, 1965; S.K. Skwarko, pers. comm.). The unit is generally not recognized in drillers' logs of water-bores, but is easily identified in gamma-ray logs by its radioactivity. It thus forms a valuable marker bed separating the otherwise indistinguishable mudstones of the Allaru and Wallumbilla Formations, which lie conformably above and below it.

The Allaru Mudstone (Kla) crops out in the northeast and east, but exposures are generally poor and consist of low rubble-strewn rises.

Although the formation is composed predominantly of blue-grey mudstone (see Table 1), the more resistant cone-in-cone limestone beds form the characteristic green-brown rubble of the outcrop areas. Gypsum nodules and a mesh of gypsum crystals are often found in the soil associated with the outcrop areas. The sediments appear to have been deposited in a shallow sea in a slowly subsidising basin, although Burger (in prep.) considers that the unit could be non-marine in part. The formation has been assigned an Albian age by Vine & Day (1965), and is the topmost unit of the Rolling Downs Group to crop out in the Cloncurry sheet area.

CAINOZOIC

During early Tertiary times the area was peneplaned, and in the mid-Tertiary was deeply weathered with a 'duricrust'. Later erosion and deposition has resulted in the accumulation of the colluvial and alluvial sediments on which the Cloncurry and Wondoola Plains developed, and which are also found in many of the valleys within the Isa Highlands.

Several aspects of the Cainozoic geology of the area have been discussed in the Physiography section, which should be read in conjunction with this section.

The deep-weathering profile, Czd. The deep weathering profile (Czd) has now been largely removed and is present only in a few areas (Pl. 1): near Kajabbi, southeast of Quamby; capping the mesa deposits south of Roxmere; and as hillcappings and plateau remnants in the far west (not shown on Pl. 1). The deep-weathering zone generally consists of up to 10m of 'claystone' which has been mottled red, yellow, and grey, and is overlain by the silcrete and ferricrete of the 'duricrust' (Fig. 6). The 'claystone' was derived from the original rocks by in situ weathering and in places the original rock structures can be seen in the deep weathering profile, becoming obliterated towards its top (I.H. Wilson, pers. comm.).

The profile is developed on both the Mesozoic and the Precambrian rocks of the area; on the latter the mottled clay horizon is generally thin or absent. The ferricrete and silcrete in the upper part of the profile appear to be transitional between the laterite of the coastal regions to the north and apparently contemporaneous silcrete of the inland areas to the south.

The age of the 'duricrust' is a matter of conjecture. Woolnough (1927) considered a Miocene age most likely; Whitehouse (1940) recognized two periods of 'lateritization', both of Pliocene age. Both authors considered that the lateritization occurred in the same period throughout Queensland and they correlated isolated laterite areas on this basis. It appears more likely, however, that a climate conducive to lateritization and deep weathering in general existed in late Cretaceous, throughout much of the Tertiary, and perhaps even in Quaternary and Recent times in some parts of northern Australia. Any surface which remained stable for a sufficient time during these periods would be liable to deep weathering.

In the Eromanga Basin Senior (1972) has recognized an early to mid-Tertiary silcrete phase, and an older deep-weathering phase which he considers to be of late Cretaceous age. In South Australia Jessup & Norris (1971) have assigned a Paleocene to Eocene age to an apparently similar phase, the Stuart Pedoderm; deep weathering in the Cloncurry sheet area may be a pedological process. In the Northern Territory Hays (1967) considers that the main laterite horizon is diachronous, varying from late Cretaceous in the south to lower and middle Tertiary in the north. He also recognizes an earlier and two later phases of lateritization, the youngest of which is continuing at present.

In the Carpentaria Basin area there are at least two periods of deep weathering. The main episode is lateritic and appears to be mid-Tertiary in age as it postdates the late Cretaceous or early Tertiary Bulimba Formation, but in places underlies the Wyaaba Beds, which are probably of Pliocene to Pleistocene age (Doutch et al., 1970; Smart et al., in press). The Wyaaba Beds have been affected to a lesser extent by a later deep-weathering phase which may have been penecontemporaneous or post-depositional, i.e., Pleistocene or Holocene.

The deep-weathering zone in the Cloncurry Sheet area has more in common with the mid-Tertiary lateritic phase of the Carpentaria area than with older or younger phases there or elsewhere. It also appears to be similar in nature to the diachronous laterite zone of the Northern Territory. There is some evidence that the zone is diachronous in the Carpentaria Basin area also, inasmuch as the movements on the Corella Fault in the Cloncurry area which appear to postdate the landsurface with deep-weathering remnants (see Physiography), may be of the same age as similar movements of the Boomarra Fault farther north (apparently an extension of the Corella Fault), which appear to antedate the deep-weathered surface in that area. This matter requires further investigation.

The age of the deep-weathering profile in the Cloncurry Sheet area is therefore tentatively considered to be early to middle Tertiary.

<u>Unit Czs</u>. The Precambrian rocks of the Cloncurry Plain are mostly covered by a colluvial piedmont deposit of red and brown poorly sorted sand and gravel with minor silt and clay (Czs). The gravels are commonly angular, as would be expected from their origin from the underlying Precambrian rocks. They are overlain by the younger alluvial sediments of the Wondoola Beds in some areas. However, colluvial deposits are currently accumulating in other areas, so the

unit has a long time range. The unit postdates the erosion of the deep-weathering zone and must therefore range in age from late Tertiary to the present. Its relative thinness is due to the slowness of colluvial accumulation when compared with alluvial deposition.

In the area between Courtenay Creek and Brymine on the Cloncurry River (see Pl. 1) a high level plain of red gravel and sand (Czs) overlies Mesozoic rocks on a gentle buried ridge which separated the valleys of the ancestral Cloncurry and Williams Rivers (Grimes & Doutch, in prep.). Though these deposits are similar in lithology to the colluvial Czs deposits of the Cloncurry Plain, they are physiographically distinct, and are probably genetically unrelated. The pebbles are composed of silcrete and quartz with minor granitic and metamorphic components. The silcrete pebbles could have been derived as a lag deposit from a 'duricrust' which once extended above this area. The other rock types must have been derived from the Precambrian rocks to the south, and distributed by fluvial or colluvial means. Mount Margaret, a Precambrian inlier in the southern part of the Czs plain, could have contributed material locally. Outcrops of the Czs unit, in the area are poor, and no sedimentary structures were seen, so the environment of deposition is uncertain.

In an adjacent part of the Wondoola Plain, west of bore number R2716, an earth tank excavation in 1969 exposed a sequence of about 2 m of sandy gravel beds underlying red silt and clay of the Wondoola Beds. These gravels exhibited planar and festoon crossbedding (Fig. 8). This deposit could be an extension from the main gravel plain to the east, or a secondary deposit derived from it. The limited water-bore data suggest that the gravel beds extend for a short distance beneath the finer deposits of the Wondoola Beds, and that there are also isolated gravel beds within the Wondoola Beds elsewhere in the Cloncurry Sheet area. The Czs gravel plain could therefore be a facies equivalent of the Wondoola Beds. The reason for the localization of gravels in the east is not known.

<u>The Wondoola Beds</u> (Czr, Qf) Most of the Wondoola Plain within the sheet area, and parts of the Cloncurry Plain, are developed on the alluvial deposits of the Wondoola Beds (Smart et al., in press). In the Cloncurry sheet area there are two sub-divisions within this formation: unit Czr consists of red and brown sand, silt, clay, and gravel, and is apparently overlain by the dark grey sandy muds of unit Qf. (All sediments of the Wondoola Beds have the symbol Qw in the Sheet areas to the north). In a regional sense Czr is a red sand and silt member of the Wondoola Beds. As discussed in Physiography the upper Qf unit has been eroded from much of the area since the Selwyn Upwarp, and unit Czr has been exposed.

Some of the Qf areas shown on Plate 1 are black soils derived by <u>in situ</u> weathering of the underlying Cretaceous mudstone. It is extremely difficult to distinguish them from the black-soil plains developed on the grey sandy muds of the Wondoola Beds. Some areas that could be of this nature are near Granada and Clonagh in the north and near BMR Cloncurry 2, and north of Arrolla, in the south.

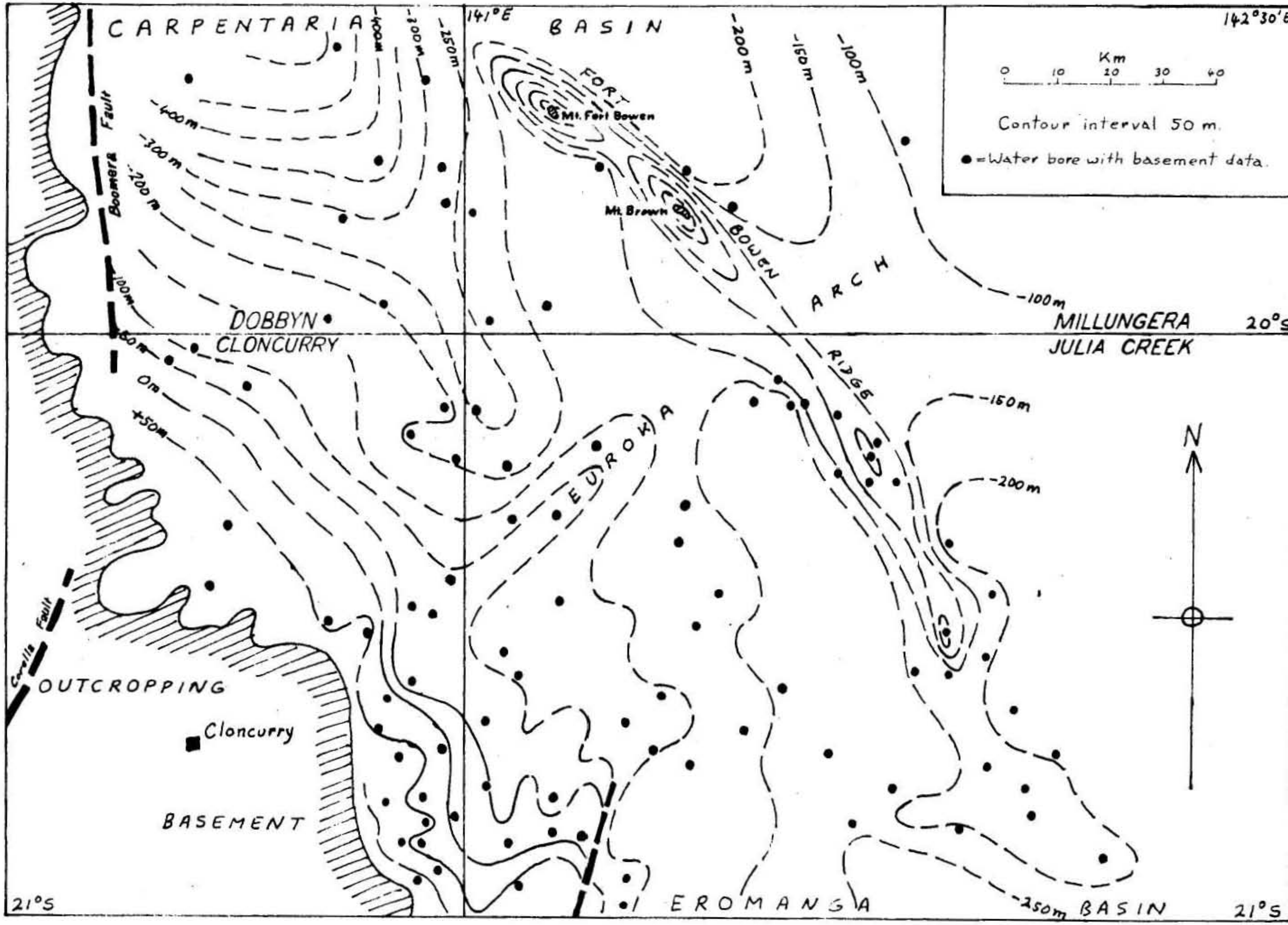

FIG. 9

FIG 9. BASEMENT STRUCTURE - CLONCURRY AND ADJACENT SHEETS

To accompany Record 1972/57

Q/A/401

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A common feature of parts of unit Qf of the Wondoola Beds in the Cloncurry Sheet area is the presence of a patchy surface cover of scattered cobbles and pebbles, generally of silcrete or quartz. These are commonly concentrated into lines separated by gilgai depressions. On air-photographs this forms a characteristic 'fingerprint' pattern, similar in appearance to the patterned ground found in arctic areas, where heaving of the soil by alternate freezing and thawing is cited as the cause. The origin of the patterns in the Cloncurry Sheet area appears to be due to similar movements in the black soils due to the swelling and shrinking of clay minerals in the wet and dry seasons.

The Wondoola Beds are considered to be of Pleistocene to Holocene (?) age by Doutch et al., (1970) and Smart et al. (in press).

Recent Alluvium, Qra. Some of the present valleys are filled by modern alluvial deposits (Qra), which are of very similar lithology to the underlying and adjacent older alluvial deposits of the Wondoola Beds. They are therefore difficult to distinguish on a lithological basis, but can be mapped by airphoto interpretation of the landforms. They are thought to be of Holocene age and postdate the Selwyn Upwarp.

MESOZOIC AND CAINOZOIC STRUCTURES

The structural setting of the Sheet area and its surrounds is shown in Figure 10. The structural terminology is that used by Doutch et al. (1970), who provide the basis for most of the following discussion. The Mesozoic deposits dip gently to the north and east into the Carpentaria and Eromanga Basins respectively. The two basins are separated by the Euroka Arch, a zone of relatively shallow basement which extends northeast from Cloncurry (see Fig. 9).

The Canobie and Millungera depressions shown in Figure 10 can be regarded as an earlier phase of the Eromanga Basin, which originally extended farther north than its present structural boundary at the Euroka Arch. The two depressions were formed in the early Mesozoic, possibly the late Triassic, by a combination of faulting, warping, and erosion. The Boomarra Horst and Fort Bowen Ridge appear to have been upfaulted blocks which separated the depressions from each other and from the Burketown Depression to the northwest. Contemporaneous warping and later, but ante-depositional, erosion may also have contributed to the Jurassic form of the depressions. The depressions plunged to the south during the Juarassic to early Cretaceous fluvial depositional phase, but the structure has been distorted by the later movements which created the Euroka Arch.

Investigations by Doutch et al. (1970) suggest that the Euroka Arch is a broad relict structure left by the downwarping of the Carpentaria and Eromanga Basins to the north and south. The warping probably began at the time of early Cretaceous marine transgression and continued during the rest of the Cretaceous depositional period. Post-'duricrust' uplift occurred in the Pliocene in the Gregory Plateau to the east and may have further developed the structure of the arch.

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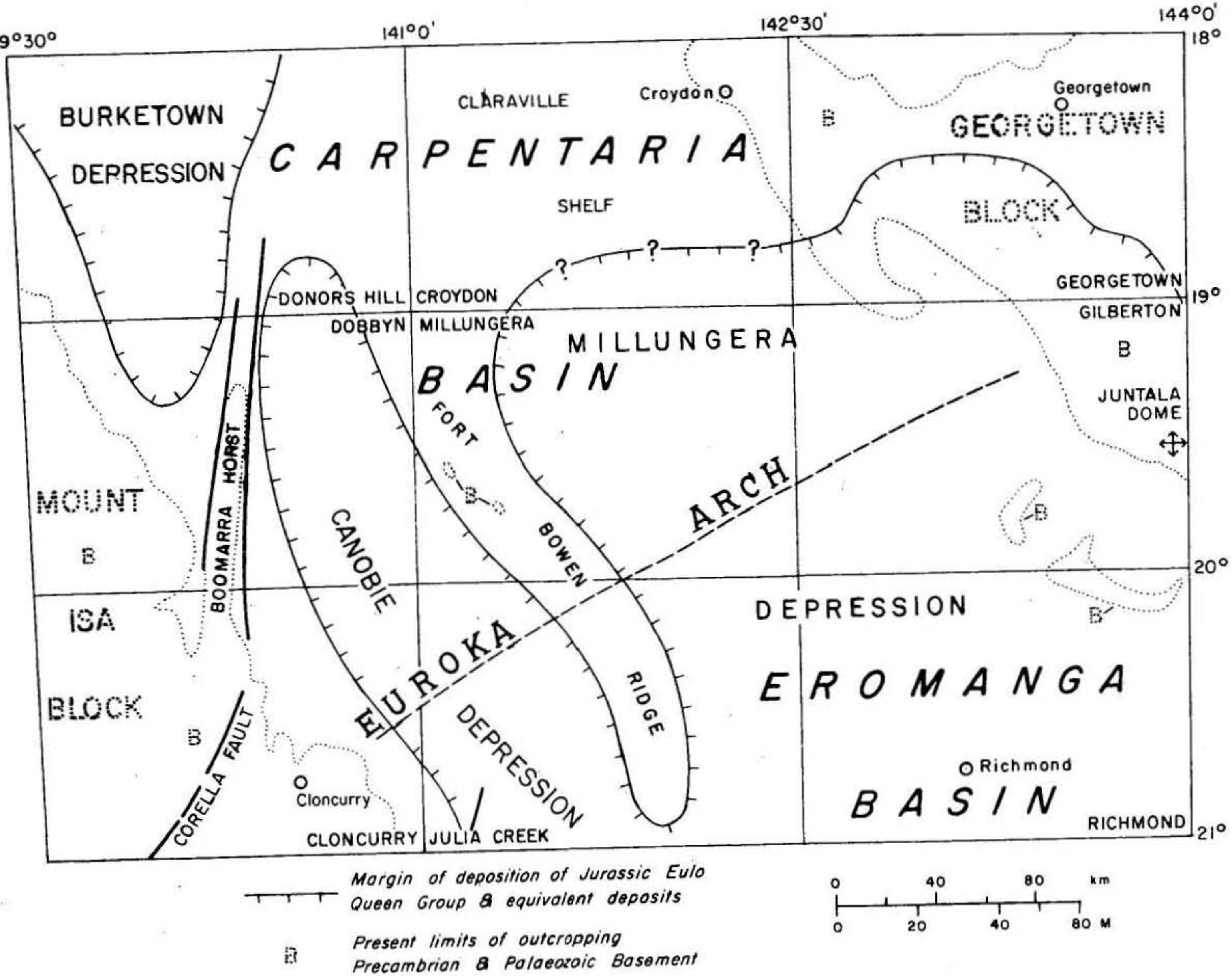

To accompany Record 1972/57

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REGIONAL STRUCTURAL SETTING

FIGURE 10.

TABLE 2 - POST-PALAEOZOIC GEOLOGICAL HISTORY - CLONCURRY SHEET

PERIOD (not to scale)			Erosional and Depositional events	Tectonism
QUATERNARY	Holocene		deposition of Qra	
	Pleistocene		deposition of Wondoola Beds; deposition of Czs	Selwyn Upwarp
TERTIARY	Pliocene		erosion	Uplift of Gregory Plateau; some local uplift and warping?
	Miocene			
	Oligocene		Deep weathering and Duricrusting	mid-Tertiary movemen on Boomarra and Corella Faults
	Eocene		Formation of a peneplain	
	Paleocene		deposition of Floraville Formation to north	
CRETACEOUS	Upper		erosion ?; (Normanton Formation to north)	
	Lower	Albian	regression; Allaru Mudstone, Toolebuc Limestone	differential downwarping of Carpentaria and Eromanga Basins north and south of Euroka Arch
		Aptian	(marine); Wallumbilla Formation; transgression	
		Neocomian	deposition; Gilbert River Formation) Longsight sandstone	
JURASSIC	Upper		(continental) Eulo Queen Group) Longsight sandstone	
	Lower & Middle			
TRIASSIC	Upper		erosion, together with tectonism responsible for	formation of Cano bie and Millunger Depressions. Boonarra and Fort Bowen Horsts.
	Middle			
	Lower			

The Boomarra Fault in the Dobbyn Sheet area was reactivated after Cretaceous deposition. The eastern block was displaced downwards. This movement is thought to be younger than the late Cretaceous or early Tertiary Floraville Formation, but it could antedate the formation of the deep weathering profile in the Dobbyn Sheet area. The Boomarra Fault extends into Cloncurry Sheet area but is obscured by late Cainozoic deposits. In the north it probably passes west of Granada and east of Buffalo Plains homestead. The fault cannot be detected in the Precambrian outcrops north of Quamby, but to the south the Corella Fault is roughly in line with the trend of the Boomarra Fault, and Cainozoic movements on the Corella Fault are in the same sense as that of the Boomarra Fault (see Physiography). The two faults could therefore be parts of the same major structure.

The Quaternary Selwyn Upwarp has affected the Cainozoic deposits of the area (see Stratigraphy), but its effect on the Mesozoic strata is overshadowed by the greater Creaceous downwarping.

POST-PALAEOZOIC GEOLOGICAL HISTORY (Table 2)

In early Mesozoic times the Precambrian rocks in the area were being eroded. Terrestrial sediments were being land down in the Galilee Basin to the far southeast. In the late Triassic the Canobie and Millungera Depressions were formed by a combination of faulting, warping, and erosion. The Boomarra Horst and Fort Bowen Ridge were formed at this time.

During the Jurassic fluviatile deposition extended north from the Eromanga Basin into the Canobie and Millungera Depressions, which by late Jurassic time had been filled by quartzose sand (Eulo Queen Group). Jurassic sediments were also deposited in a depression in the Selwyn area of the Duchess Sheet area and may have extended north into the Cloncurry Sheet area. By the end of the Jurassic, sand deposition (Gilbert River Formation) was spreading beyond the area of the depressions. The landscape in the Sheet area at this time was probably a broad fluviatile plain in the east with tongues of sediment extending into major valleys within the hilly area of the Mt Isa Block, a picture analagous to that of the present physiography.

In the early Cretaceous the sea flooded the lower parts of the area and arenaceous deposition (Gilbert River Formation) soon gave way to mainly mud deposition (Rolling Downs Group). The limestone of the Toolebuc Formation apparently reflects a period of reduced sedimentation when shell banks formed beneath much of the shallow sea. The sea spread over most of the Mount Isa Block, the higher parts remaining as low islands, until it began to recede in Allaru time.

Contemporaneous sagging during the later part of the Cretaceous depositional period formed the depressions of the Carpentaria and Eromanga Basins, while the Euroka Arch remained as a relatively high area between them.

After the withdrawal of the sea erosion began again, and the fluvial Floraville Formation was laid down at the same time to the north. The area had been reduced to a peneplain by mid-Tertiary time; the thin Mesozoic deposits overlying the Mount Isa Block were largely removed and the early Mesozoic landsurface was exhumed and planed off in the western part of the Sheet area. The peneplain was subjected to deep weathering and a 'duricrust' had been formed by the end of Miocene time. The Boomarra and Corella Faults were reactivated during the time of deep weathering and the rocks were down-faulted to the east. Towards the end of the Tertiary uplift was followed by more erosion and the duricrust was warped in some parts of the region, but any effects in the Cloncurry Sheet area are difficult to detect, as later erosion has destroyed most of the old 'duricrusted' surface. Colluvial and fluvial deposition (e.g., the Wondoola Beds) occurred in the eastern part of the Cloncurry Sheet area in Pliocene and Pleistocene times.

Late Pleistocene or Holocene movement of the Selwyn Upwarp to the south increased the stream gradients and initiated an erosional episode over the Wondoola Plain in the Sheet area, deposition being restricted to a few stream channels, and to the floodout area in the northeast in the Millungera Sheet area.

ECONOMIC GEOLOGY

Groundwater

The main aquifer within the Mesozoic basins occurs in the Gilbert River Formation. This formation pinches out against the basin margin. In the sheet area the depth of the aquifer below the surface varies from 30 m adjacent to the basin margin to 350 m in the northeast corner. The structural contours on the top of the sandstone (Doutch et al., 1970) are parallel to those of the basement shown in Figure 9. None of the bores in Cloncurry have artesian flows. The water quality is fair, though some areas have high fluoride concentrations.

Shallow water supplies have often been obtained from Cainozoic sands and gravels and from weathered or fractured basement rocks.

Hydrocarbons

The petroleum potential of the Cloncurry Sheet area is poor. The pinchout of the Gilbert River Formation below the Wallumbilla Formation would provide an excellent trap; but water-bore data suggest that the system is thoroughly flushed. Recent exploration in the Julia Creek area has shown the presence of large deposits of oil shale associated with the Toolebuc Limestone (Allen & Hogetoorn, 1970). Assessment of the economic potential of these deposits is still in progress.

Coal has been reported from Cabbage Tree Creek, near Kajabbi, by Dunstan (1920, p. 28-30), presumably from the basal Mesozoic sandstone. The seam was only a few inches thick, but was reported to be of fair quality.

Phosphate

The phosphate potential of the Toolebuc Limestone was investigated by Williamson (1967). The grade was generally low and non-economic.

Limestone

The Toolebuc Limestone would have some potential as a smelting flux, but reserves are limited, the limestone beds within the unit being generally thin. Specimens collected from outcrop and drill-cores were analysed by BMR (Doutch et al., 1970) with the following average composition:

Residue insol. in 10% HCl	Fe	Ca	Mg
1.44%	0.79%	40.63%	0.13%

Sedimentary uranium

The sandstones of the Eulo Queen Group equivalents (M on map) commonly show marked zones of high radioactivity on gamma-ray logs of water bores. The group is restricted to the Canobie Depression in the northeastern edge of the Cloncurry Sheet (Fig. 10). Whether the radioactivity indicates economic and recoverable concentrations of uranium is not yet known.

D

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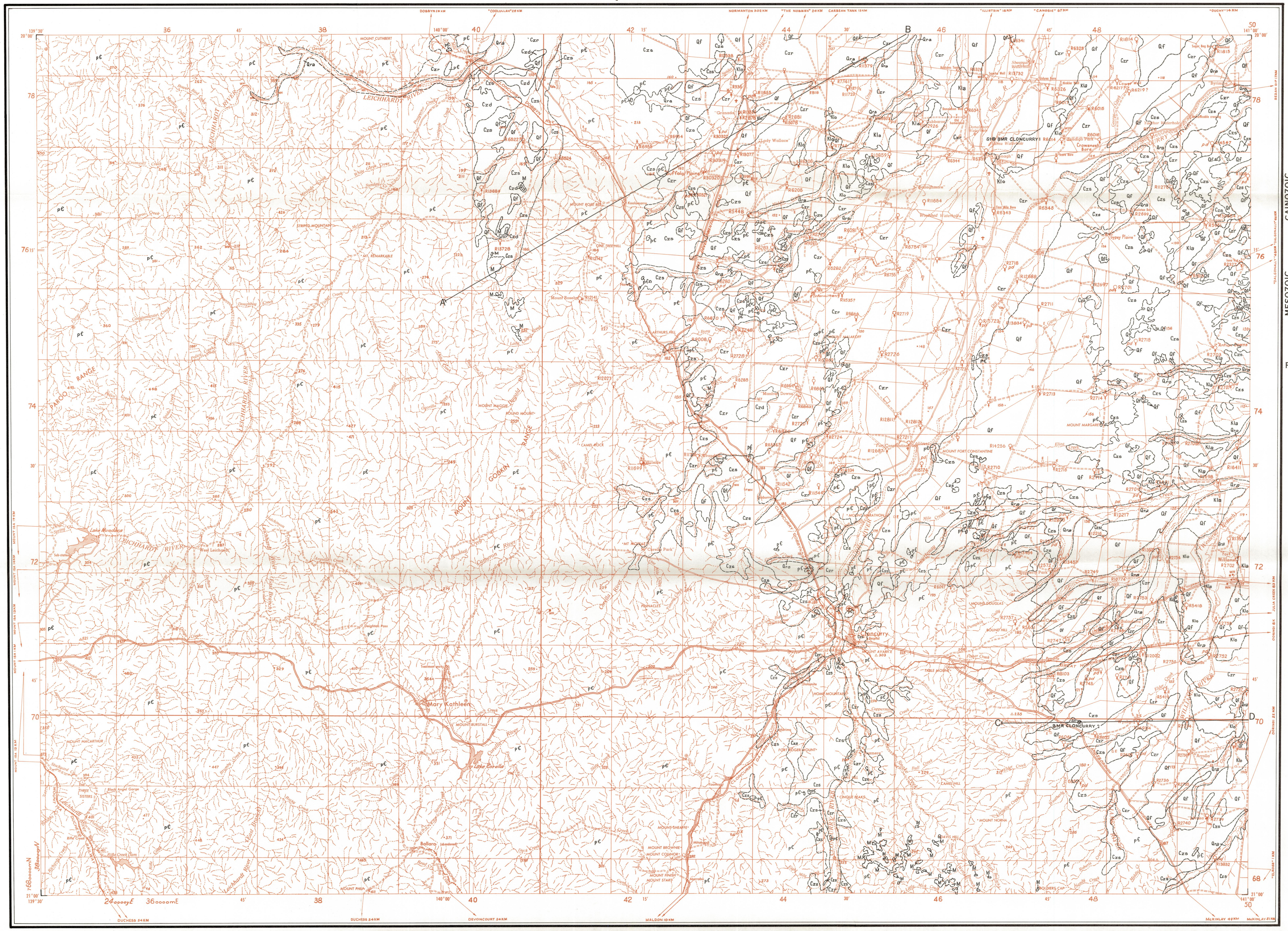
CLONCURRY

QUEENSLAND



Reference

CAINOZOIC	QUATERNARY	RECENT		Qra	*Modern alluvium: sand and silt*
				Qf	*Older alluvium: grey clay and silt*
				Czr	*Red and brown sand, silt and clay*
				Czs	*Colluvium: sand, gravel and clay*
	LATE CRETACEOUS TO EARLY TERTIARY			Czd	*Duricrust: mottled clay and silcrete*
MESOZOIC	LOWER CRETACEOUS	Rolling Downs Group	Allaru Mudstone	Kla	*Mudstone; minor limestone, labile sandstone*
			Toolebuc Limestone	Klo	*Limestone, calcareous shale*
			Wallumbilla Formation	Klu	*Mudstone, minor glauconitic sandstone. Section only*
	UPPER? JURASSIC TO LOWER CRETACEOUS			M	*Quartzose and sublabile sandstone, siltstone, mudstone, minor conglomerate*
PRECAMBRIAN				p€	*Undifferentiated metamorphics, indurated sediments, volcanics, and igneous rocks*

Geological boundary

Where location of boundaries is approximate, line is broken

⊗ St *Stratigraphic hole*

Artesian bore - ceased to flow
Sub-artesian bore or well
R6097 *refers to bore registered number of the Queensland Irrigation and Water Supply Commission records*

Windpump

E *Earth tank*

WH *Waterhole*

Highway

Road

Vehicle track

Railway - with station and siding

Airport

Landing ground

"Granada" *Homestead*

Building

Yd *Yard*

Fence

Built-up area

Telephone line

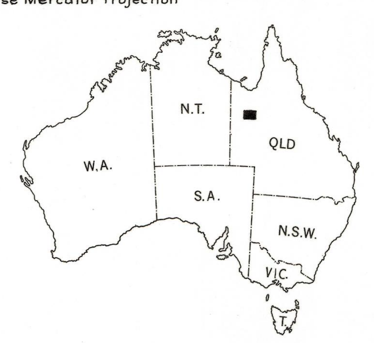
△225 *Trigonometrical station*

Astronomical station

·180 *Elevation in metres - approximate*

pd *Position doubtful*

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. R.W. Swartz, M.B.E, E.D., Minister for National Development.
Base map compiled by the Royal Australian Survey Corps from aerial photography at 1:80,000 scale
Transverse Mercator Projection



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination 1970

MOUNT DRUMMOND SE 53-12	LAWN HILL SE 54-9	DONORS HILL SE 54-10	CROYDON SE 54-11	GEORGETOWN SE 54-12
RANKEN SE 53-16	CAMOOWEAL SE 54-13	DOBBYN SE 54-14	MILLUNGERA SE 54-15	GILBERTON SE 54-16
AVON DOWNS SF 53-4	MOUNT ISA SF 54-1	CLONCURRY SF 54-2	JULIA CREEK SF 54-3	RICHMOND SF 54-4
SANDOVER RIVER SF 53-8	URANDANGI SF 54-5	DUCHESS SF 54-6	McKINLAY SF 54-7	MANUKA SF 54-8
TOBERMORY SF 53-12	GLENORMISTON SF 54-9	BOULIA SF 54-10	MACKUNDA SF 54-11	WINTON SF 54-12

6°E 7°E

ANNUAL CHANGE 0′35″E

Scale 1:250,000

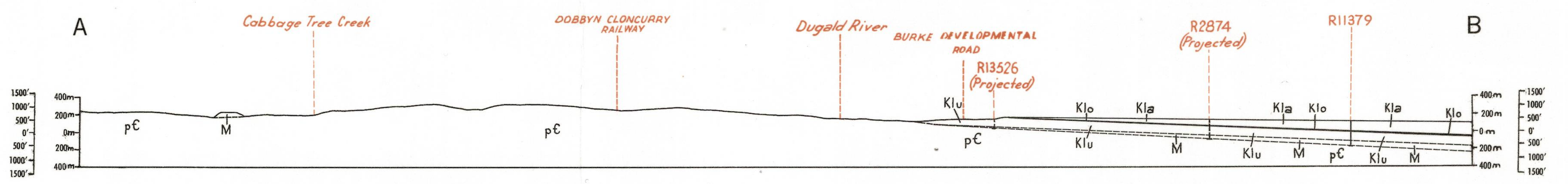
5 0 5 10 15 20 25 KILOMETRES

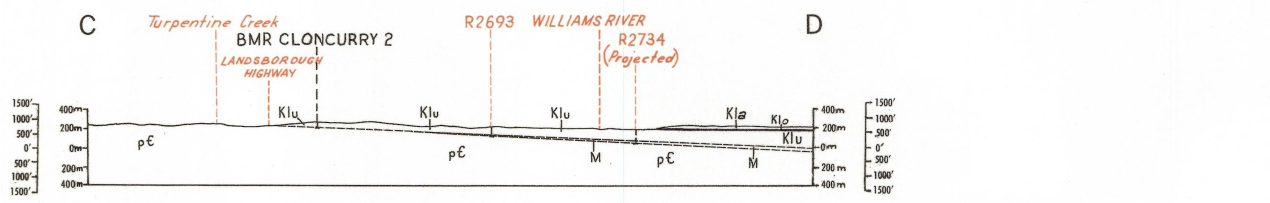
5 0 5 10 MILES

Sections

Cainozoic sediments omitted

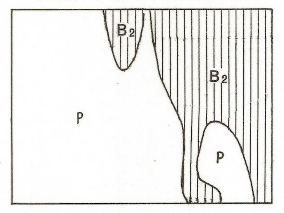
Scale: $\frac{V}{H} \simeq 4$





Geology 1969 by K.G. Grimes, Geological Survey of Queensland
Compiled 1969 by K.G. Grimes and M.A. McLaren
Cartography by Geological Branch BMR
Drawn 1970 by M.A. McLaren

RELIABILITY DIAGRAM



Geology B2 General reconnaissance: many traverses, and air-photo interpretation

P Published 1958 at 4 miles to 1 inch scale as Cloncurry sheet F54-2

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SUBJECT TO AMENDMENT

CLONCURRY

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