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DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1960/68

MESOZOIC AND YOUNGER SEDIMENTS OF THE GILBERTON AND GEORGETOWN 4-MILE SHEET AREAS, QUEENSLAND

by

M.A. Reynolds

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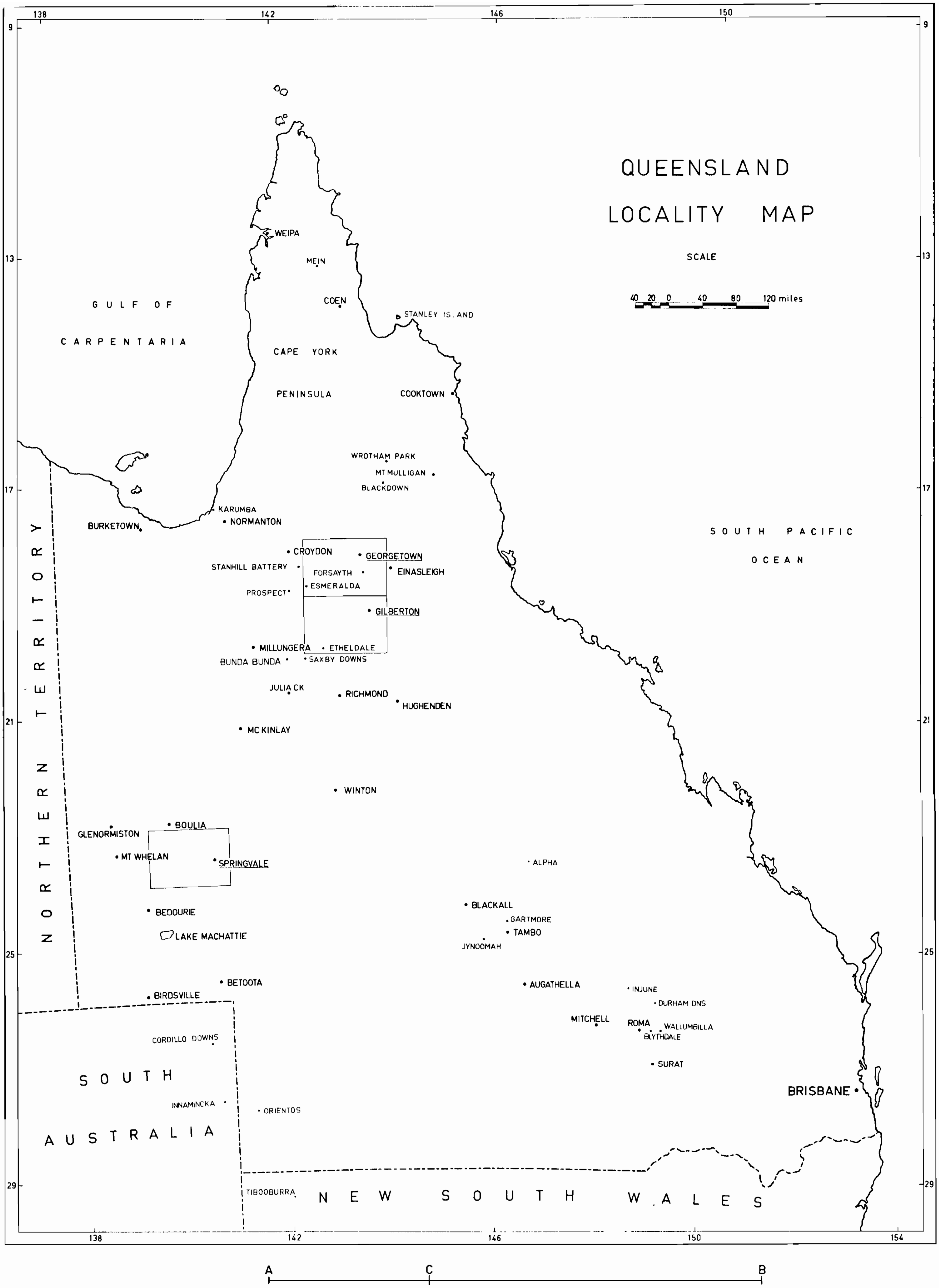

QUEENSLAND
LOCALITY MAP
SCALE
40 20 0 40 80 120 miles
GULF OF
CARPENTARIA
CAPE YORK
PENINSULA
SOUTH PACIFIC
OCEAN
NORTHERN TERRITORY
SOUTH
AUSTRALIA
NEW SOUTH WALES
WEIPA
MEIN
COEN
STANLEY ISLAND
COOKTOWN
WROTHAM PARK
MT MULLIGAN
BLACKDOWN
KARUMBA
NORMANTON
BURKETOWN
CROYDON
GEORGETOWN
STANHILL BATTERY
FORSAYTH
EINASLEIGH
ESMERALDA
PROSPECT
GILBERTON
MILLUNGERA
ETHELDALE
BUNDA BUNDA
SAXBY DOWNS
JULIA CK
RICHMOND
HUGHENDEN
MC KINLAY
WINTON
BOULIA
GLENORMISTON
MT WHELAN
SPRINGVALE
ALPHA
BLACKALL
GARTMORE
TAMBO
JYNOOMAH
BEDOURIE
LAKE MACHATTIE
BETOOTA
BIRDSVILLE
AUGATHELLA
INJUNE
DURHAM DNS
MITCHELL
ROMA
WALLUMBILLA
BLYTHDALE
SURAT
CORDILLO DOWNS
INNAMINCKA
ORIENTOS
BRISBANE
TIBOOBURRA
138
142
146
150
154
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13
17
21
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29
A
C
B

I. INTRODUCTION

D.A. White and party commenced mapping the geology in the Gilberton, Georgetown 4-mile Sheet areas in 1956 (White and Hughes, 1957). They concentrated on mapping the Precambrian and Palaeozoic rocks, and did very little work on the younger sediments. The purpose of the survey in 1959 was to examine Mesozoic and Cainozoic deposits and to complete the geological mapping of the Gilberton and Georgetown 4-mile Sheets.

R.J. Paten of the Queensland Geological Survey and I were in the Gilberton-Georgetown area for six weeks. We traversed the area as far as possible in the short time available, and also visited places outside the area to obtain information, particularly about bores, and to examine known fossil localities. The traverses, confined to main roads and tracks, were as follows:

From Esmeralda via the Prospect track to Glenmore and to Saxby Downs, and return along the stock route from Malpas;
from Esmeralda to Etheldale (via Burleigh) and return along the Richmond-Glenora track;
along the new Esmeralda-Croydon road (to fossil localities near Croydon);
along the old Esmeralda-Croydon road to Stanhill Battery;
along the Croydon-Einasleigh main road with branches to Agate Creek (Ortona copper mine track), Robertson River (North Head track) and Huonfels.

G. Mollan and F. Olgers, geologists of the Bureau of Mineral Resources and V.M. Bofinger, a student of the New England University, assisted with air photograph interpretation, drafting and petrological investig[illegible] report.

The Mesozoic sandstones in the Gilberton-Georgetown area were referred to by Daintree (1872) as Cainozoic 'Desert Sandstone'. A brief comprehensive review of the use of this name is given by Bryan and Jones (1944, p. 25). Jack (1889, and Jack and Etheridge, (1892) refers to the sandstones of the Croydon-Gilberton-Georgetown area and calls them 'Desert Sandstone' of Upper Cretaceous age. Maitland (1898) stated that in the neighbourhood of the upper Woolgar River, the 'so-called Desert Sandstone beds ...... pass beneath the Rolling Downs shales' and that these beds were part of the 'Blythesdale Beds' which had been traced without interruption from the head of the Flinders River as far as the town of Croydon. Jack (1898) disagreed with Maitland's interpretation. Maitland apparently made his interpretation before 1896 because Rands (1896) also disagreed with him; Rands worked mainly in the Croydon area. However, as shown in Bryan and Jones, Jack had included distinct sandstone units of different ages in his use of the name 'Desert Sandstone' and it was subsequently abandoned. Other workers in the area include Ball (1915) who called the sandstone caps of the Etheridge goldfield the 'Newer Sedimentaries'; he correlated them with the 'Desert Sandstone (Upper Cretaceous)' mapped by the Geological Survey at that time and also with beds which Cameron (1900) had called basal Lower Cretaceous.

The sandstones of the area were later given a Permian age by Whitehouse (1945b) in a discussion of the 'Northern sub-basin' (Carpentaria Basin) of the Great Artesian Basin. He also recognised beds of the Roma and Tambo 'Series' along the southern edge of the Gilberton area. Bryan and Jones (1946) then referred to the Mesozoic sandstones as 'Blythesdale Series'; they noted that the sandstones fringe much of the Great Artesian Basin and were laid down early in the Cretaceous Period. Younger Cretaceous formations described by Bryan and Jones were the 'Roma, Tambo and Winton Series'.

Originally the name 'Blythesdale Series' was introduced by Whitehouse (1940) to replace 'Blythesdale Braystone' (Jack, 1895, and Bryan and Jones, 1944, p. 10); 'Blythesdale Braystone' was the name given to sandstones below marine Lower Cretaceous shales at Blythesdale near Roma. Changes of names from 'Blythesdale Series' to 'Blythesdale Group', 'Roma Series' to 'Roma Formation', and 'Tambo Series' to 'Tambo Formation' are made by Whitehouse (1954). 'Blythesdale Group' is the name retained by White and Hughes (1957) for the Mesozoic sandstones in the Gilberton-Georgetown area. Laing and Power (1959a, b), whose mapping includes some of the northern part of the Georgetown 4-mile Sheet area, named the Inoruni Sandstone (?Jurassic) - not previously recognised, the Gilbert River Formation (Lower Cretaceous) and the Lynd Formation (Tertiary). These names have been adopted for use in the Gilberton and Georgetown 4-mile Sheet areas, and the complete list of Mesozoic and Cainozoic units mapped (in descending order of age) is as follows:

> Lynd Formation-Tertiary-Laing and Power, 1959b; Roma Formation-Lower Cretaceous-Whitehouse, 1954; Gilbert River Formation-Upper Jurassic to Lower Cretaceous-Laing and Power, 1959a; and Inoruni Sandstone - "possible Jurassic" - Laing and Power, 1959a.

II. DESCRIPTIONS OF UNITS

Descriptions of Palaeozoic and Precambrian rocks of the Gilberton-Georgetown 4-mile Sheet areas have been given in the reports by White and Hughes (1957), White, Best and Branch (1959). Some additional information on rocks beneath the Mesozoic sediments is given in bore logs prepared from the Brisbane Irrigation and Water Supply Commission records and details supplied by station owners and managers. A fairly shallow pink granite or quartzite basement occurs from Esmeralda to Prospect and west and south to Julia Creek. This is the area of high temperature gradient referred to by Ogilvie (1954, p. 42). High fluorine content occurs in most of the water from bores in this area.

East of Julia Creek, more or less in a belt which extends along the southern margin of the Gilberton 4-mile area, are 'cooler' areas where red marls occur in the base of the Mesozoic sediments. The red marls are logged in Saxby Downs bores Nos. 16, 17 and 20; Irrigation and Water Supply Department records show them in Yanco, and Bylong Nos. 2 and 4, bores; Maitland (1898) lists red shale in the log of Prairie bore; Ogilvie mentions their occurrence in bores at Hughenden and Tangorin. "Slate" is recorded at the base of the Mt. Norman bore.

The Mesozoic and Cainozoic units which Laing and Power (1959a, b) have described are used in this report and as mapping units. The sandstone which they called 'Inoruni Sandstone' was not previously recognised as a separate formation; their name therefore has priority. Sandstones which lie unconformably over the Inoruni Sandstone and Palaeozoic-Precambrian rocks are called

'Gilbert River Formation' by Laing and Power. This name is preferred to 'Blythesdale Group' (Whitehouse, 1954) because the sandstones are only equivalent to upper beds of the Blythesdale Group. The youngest sandstones in the area mapped by Laing and Power have been called the 'Lynd Formation'; they were included in the 'Desert Sandstone' until that name was abandoned. The Lynd Formation is probably equivalent to Whitehouse's (1940) 'Glendower Series'. I have also used the name 'Lynd Formation' to preserve continuity in descriptions and maps of the Georgetown area.

A. Mesozoic Formations.

Two of Laing and Power's formations are discussed hereunder. The oldest is the Inoruni Sandstone whose exact age is uncertain. The overlying Gilbert River Formation is a mixture of conglomerate, sandstone and siltstone; it is fossiliferous in the upper part. More detailed work may enable subdivision of the Gilbert River Formation.

1. Inoruni Sandstone. The Inoruni Sandstone was named by Laing and Power (1959a). Typical lithology is recorded from Latitude 18°15'S, Longitude 142°41'E along Little River, a tributary of the Gilbert River; the formation extends for about 12 miles east-south-east from Inoruni homestead in a belt 10 miles wide. (The area given by Laing and Power, 30 by 25 miles, seems excessive). Outcrops occur along the main Georgetown-Croydon road from Venture Creek to 1½ miles west of Little River. These outcrops were examined during field work in 1959 and the formation was mapped by air photograph interpretation. It forms fairly well rounded hills in contrast to the Gilbert River Formation sandstones which form prominent mesas; its topography is not unlike that of the Croydon Felsite which it overlies in part.

Laing and Power describe 1,000 feet of 'moderately clean quartz sandstone with minor grits and shales' from the Little River section; colours are fawn, pink and white, grains angular to sub-rounded. The sandstone is micaceous and kaolinitic. The grits contain quartz fragments up to ¼ inch wide and angular quartz grain matrix; shale bands are very micaceous and fissile. Sandstones are massive to thin-bedded and fissile, cross-bedded in part. Some beds are ripple marked. The formation is white, silicified and very hard in surface outcrop in some places ('case hardened'). These parts reflect jointing as steep-sided clefts and could be mistaken for jointed igneous rocks (Croydon Felsite) in air photographs. Neither macrofossils nor microfossils have been found in these beds. Plant fragments have not been recorded either.

The formation is preserved as an outlier in a large pocket in the older rocks (mainly Croydon Felsite) of the area. Dips of up to 10° have been measured; their distribution and directions suggest that they might be partly depositional. In some places, shaly beds have been irregularly buckled; the fact that some mica grains are arranged across the bedding suggests that this minor folding may be due to slumping during deposition. Jointing of the beds has developed after induration of surface outcrop; minor brecciation shows that slight movement occurred at the time of jointing.

In the type area, the Inoruni Sandstone overlies the weathered surface of the Croydon Felsite (upper Palaeozoic). It is unconformably overlain by beds of the Gilbert River Formation. Three miles east of Little River crossing on the Georgetown-Croydon road, the Gilbert River Formation crops out as a flat, kaolinitic very-coarse-grained sandstone with large angular fragments of Inoruni Sandstone. 4½ miles further east, a section of 150 feet of indurated sandstone, thought to be Inoruni Sandstone, is capped by 10 feet of white siltstone (probably Gilbert River Formation and similar to the fossiliferous white shaly siltstone 5 miles east).

The age of the Inoruni Sandstone is given as 'possible Jurassic' by Laing and Power. This is because of its position between the Gilbert River Formation 'of Upper Jurassic to Lower Cretaceous age' and the Croydon Felsite (Upper Palaeozoic) and because Jurassic Sediments are known from elsewhere in the eastern part of the Carpentaria Basin.

2. Gilbert River Formation. The formation which overlies Inoruni Sandstone and older felsite and granite on both sides of the Gilbert River from north of Strathmore to just north of Forest Home, and in isolated outcrops between the Gilbert River Post Office and Croydon, has been named Gilbert River Formation by Laing and Power (1959a). The most typical outcrops of the formation occur 18 miles east of Croydon on the Georgetown road (Latitude 18°14'S, Longitude 142°31'E). Interbedded conglomerate, grit, sandstone and siltstone crop out in the area described but a complete section was not found in any one locality. The maximum measured thickness was 110 feet.

The sandstones which cap the Gregory Range are thought to form part of this formation. Laing and Power state that progressively older beds are exposed 'from west (Croydon, marine) to east where beds are freshwater or estuarine'. The beds are thinnest at the northern end of the Gregory Range and do not form the extensive cap as do the thicker beds to the south. The formation can be traced to the south-east as far as the head of the Flinders River where it is capped by Cainozoic basalt, (Maitland, 1898, p. 5). In the Gilberton area, the almost flat beds capping the range are up to 240 feet thick, although they generally have a steep scarp on the western side of the range, the beds continue below the scarp into the Great Artesian Basin to the west; the change from predominantly sandy freshwater facies in the east to interbedded sandstone and shaly siltstone transition to marine beds in the west was noted in the Gilberton area also. These features are shown in Figure 1; the sections given are generalised from sections measured in the field or are bore logs.

The Gilbert River Formation can be traced eastwards and north-east from the Gilbert River. It caps part of the Newcastle Range east of Forsayth; the lithology is similar to that in the type area. Descriptions of sandstones in central and eastern Cape York Peninsula by Jack (1881), Morton (1924a, b), Richards and Hedley (1924), David (1950) suggest that the Gilbert River Formation extends as a predominantly sandstone belt along the peninsula. Some fossil localities occur along the belt. The beds are overlain in places by Lower Cretaceous marine shales. Laing and Power (1959a) call sandstone l

PLATE I: Gilbert River Formation sections on top of the Gregory Range.

Fig. 1: Cross-bedded sandstone of Gilbert River Formation on western edge of Gregory Range, 4 miles south of Bellfield, Gilberton 4-mile Sheet.

Fig. 2: Eastern Scarp of the Gregory Range at Geo 15 locality west of the Robertson River; a strong conglomerate horizon overlying a thin siltstone bed at the top of a thick cross-bedded sandstone; the typical topography of Proterozoic rocks is shown east (left) of the scarp.

beds along the west side of Cape York Peninsula the 'Wrotham Park Sandstone'. They state that the Wrotham Park Sandstone occurs in an arcuate belt 'east of Wrotham Park Homestead from Lees Grave Springs to about 1 mile east of Blackdown Homestead'; the type area is 8 miles south of Wrotham Park Homestead on the Chillagoe road. The age is given as 'Upper Jurassic to Lower Cretaceous (Blythesdale Equiv.)' These predominantly sandstone beds are unfossiliferous and are conformably overlain by the 'Blackdown Formation' (Laing and Power, 1959a, p. 36) which can probably be correlated with the Roma Formation. The Wrotham Park Sandstone and Gilbert River Formation are thought to be equivalent but continuity in surface outcrop cannot be proved because of overlapping Tertiary sediments.

As noted above, some variation in lithology occurs in different parts of the Gilberton-Georgetown area. The variation was fairly well shown in sections in the following places:

(1) Gregory Range - the lithology is shown in Figure 1; briefly, the maximum thickness seen was about 240 feet in the western scarp 4 miles south of Glenora; arkose is fairly common in the top 100 feet - lower beds were predominantly current-bedded quartz sandstone; some conglomerate and grit beds were seen in the section; shales were rare. Current-bedding, common in the lower beds, is illustrated in Plate I, in Figure 1. The eastern scarp of the sandstones is also shown in Figure 2 of Plate I.

(2) Brennan's Knob - an outlier of Gilbert River Formation about 35 miles north of Esmeralda in the Georgetown area;

section ..... top .....

Sandstone, brown to red, and white mottled in top 15 feet to white below; fine-grained; silty; common feldspar or oolite? and brown limonite grains; sandstone fairly massive; lens of white siltstone from 10 to 15 feet above base; fossiliferous with <u>Maccoyella</u>, <u>Plagiostoma</u>, <u>Entolium</u>, <u>Trigonia</u>, <u>Panope</u>?, <u>Fissilunula</u>, <u>Cyrenopsis</u>, <u>Peratobelus</u>, wood fragments showing fibrous structure and with fine holes, burrows or tracks?, (Dickins, 1960); thickness 30 feet.

No outcrop seen; 10 feet.

Prominent bench; surface smooth, iron-stained.

Sandstone, light coloured to red; fine-grained; medium to thick-bedded; vertical pipes generally less than ½ inch diameter occur in this bed and, also, large iron-rich concretions; thickness 25 feet.

Sandstone, fine-grained, to Siltstone, white; thin-bedded to laminated and fissile; thickness 5 feet.

Bench.

Sandstone, white to red-brown; fine-grained; medium- to thick-bedded; partly indurated; vertical pipes exposed on surface of bed; thickness 30 feet.

Sandstone, white to light grey; very fine to fine-grained; some coarse-grained lenses; thin-bedded to laminated; lensing; silty; partly indurated; plant remains fairly common - White (1960) records indeterminate stems some of which may be of cycads -

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see Appendix I; thickness 20 feet.
Total thickness 120 feet.

(3) The lithology given by Laing and Power for the type area of the Gilbert River Formation is as follows: 'Interbedded conglomerates, grits, sandstones, siltstones. Conglomerate is usually lenticular, subangular pebbles and boulders of surgary white sandstone (possibly from the Inoruni Sandstone), felsite and granite up to 18 inches in diameter, in the area generally west of the Gilbert River, subrounded quartzite and siltstone up to 9 inches diameter east of the river; matrix of felspathic kaolinitic quartz grit. Grit is quartz, angular, felppathic with minor mica, alternates with sandstones of similar composition. The siltstone is white, yellow and purple massive, shows random silicification.' Outcrops seen in 1959 showed that bedding is thinner in this area than elsewhere and that lensing is more common. Mica is very common in some thin sandy lenses. These beds are fossiliferous and contain plant remains as well as marine shelly fossils. Localities and fossils are described by Dickins (1960) and White (1957). Briefly, Dickins records Pseudavicula, Pleuromya?, "Tellina", gastropod; he refers to it as a Roma Formation type of fauna. White has found Linguifolium, Cladophlebis, Phyllopteris, Cycadites sp.? and small cones, in samples submitted to her from a section about 5 miles north-west of Forest Home homestead; this locality is very near the place where indeterminate plant remains were found in 1959. White refers the fossiliferous beds to the 'Blythesdale Formation of Upper Jurassic - Cretaceous age'.

(4) Newcastle Range - 9 to 10 miles east of Forsayth along main road to Einasleigh;

general section ..... top .....

Sandstone, red ferruginised or brown limonitic and white kaolinitic mottled; soft; porous; thickness 10 feet.

Poor outcrop; some interbeds of fine-grained, micaceous, fissile sandstone, coarse-grained quartz sandstone with plant fragments, and white and brown micaceous, silty shale; tubular ?burrows; thickness 10 feet.

Conglomerate to Sandstone; conglomerate at base with small rounded white milky quartz pebbles and larger (up to 9 inch diameter) grey greywacke cobbles; sandstone is very coarse - to coarse-grained, mainly quartz and gritty, with thin irregular shaly laminae; thickness 40 feet.

A similar bed in a section 1 mile west of above had a prominent 1 foot fine-grained micaceous sandstone bed 19 feet above the base; this bed contained wood fragments; it was underlain by:

Sandstone, coarse-grained in basal 3 feet to fine-grained and siltstone above; thickness 5 feet.

Poor outcrop; includes beds of coarse-grained, current-bedded, micaceous sandstone; thickness 18 feet.

Sandstone, white; corase to very coarse-grained quartz in kaolinitic matrix; micaceous; with laminae of fine micaceous silty shale; thickness 12 feet.

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Arkosic conglomerate to coarse-grained sandstone made up of weathered granite fragments - rich in mica, quartz, kaolonized felspar; thickness 5 feet.

Unconformably over weathered granite.

Total composite thickness 100 feet.

The maximum thickness of the formation as seen in outcrop is 240 feet in the western scarp of the Gregory Range. In bores to the south andwest in the Great Artesian Basin, thicknesses of up to 1,030 feet (as in Saxby Downs No. 16 bore) are recorded.

Fossil localities are shown in the geological sketch map; I have extended the map beyond the limits of the Gilberton-Georgetown area to show fossil localities near Croydon. Table I shows the distribution of fossils. Dickins (1960) refers to occurrence of Maccoyella barklyi, Fissilunula clarkei and Cyrenopsis meeki, which occur in True Blue Hill, Mt. Angus and Geo 7 samples, as characteristic of the Roma Formation; additional forms in the fauna include Cucullaria sp. nov. Except for Pseudavicula papyracea, other species in the sample from Geo 13 cannot be identified with reference material; P. papyracea suggests that the sample is 'not substantially older than the Aptian Roma "Formation"'. No microfossils have yet been recorded from the Gilbert River Formation, but Miss Crespin found unusual tubes in samples of siltstone lenses or pebbles from a conglomerate band at the bottome of the uppermost unit at Gil 15 locality (eastern part of Gregory Range).

During the deposition of the Gilbert River Formation, the environment changed from one of freshwater to one of marine conditions (or possibly was originally shallow water marine but did not support a fauna). The lower beds suggest deposition in a shallow water lake of large volumes of sand carried in by sudden floods after heavy downpours. The composition of the lower sandstones in the formation may result from erosion of older sandstones which had been previously uplifted (?Inoruni Sandstone). If uplift occurred during deposition of the Gilbert River Formation, Palaeozoic igneous and sedimentary rocks, stripped of Inoruni Sandstone in most parts, would have been subjected to erosion - this would account for the more arkosic beds higher in the formation. Torrential deposits are less common in the upper beds of the formation and a gradual change occurs from predominantly sandy to more silty beds; siltstones and shales are commonly interbedded with sandstone and the beds become fossiliferous at the top. The absence of microfossils from samples from the upper beds, however, suggests that marine conditions when the sea had open access to the lake had not developed.

The Gilbert River Formation is Lower Cretaceous ('Lower Aptian') in age according to Laing and Power in their description of the unit (but 'Upper Jurassic to Lower Cretaceous' in their description of the 'Inoruni Sandstone'). Dickins (1960) lists Roma-type fauna, and White (1957, 1960 - see Appendix I) mentions plant remains, common in the Blythesdale Group, from the Gilbert River Formation; these determinations suggest that the age may range from Upper Jurassic to Lower Cretaceous. The Gilbert River Formation overlies Inoruni Sandstone and older rocks with unconformity. It is overlain unconformably by the Tertiary Lynd Formation, recent sands and alluvium in the Gregory Range area. Around the western and northern edges of the Gilberton-Georgetown area, the upper (transitional) beds of the formation are overlain, without unconformity, by Lower Cretaceous marine shales. The change is similar to that which occurs from the upper part of the Blythesdale Group to Roma Formation in the Roma area. The Gilbert River Formation is thought to be equivalent to the upper part of the Blythesdale Group because of its lithology and fossil assemblage.

3. Roma Formation. Beds of marine shales were not recognised in the Gilberton-Georgetown area until mapped by Whitehouse (1945b). Jack and Etheridge (1892) describe fossil occurrences in shales north of the area in the Walsh River - Mitchell River part of the west side of Cape York Peninsula, and south of the area along the Flinders River towards its head; these beds were called 'Rolling Downs Formation' (Name first used by Jack, 1886). Subsequent division of 'Rolling Downs Formation' into 'Roma Series' and 'Tambo Series' was made by Whitehouse (1926). He later (1954) called them 'Roma Formation' and Tambo Formation'. The shales in the Walsh River area were called 'Blackdown Formation' by Laing and Power (1959a). Although the beds of marine Cretaceous shales in the Gilberton area are most probably equivalent to the Blackdown Formation, they are called Roma Formation in this report because they have already been mapped as that unit in the Geological Map of Queensland (1953); the fossils in the beds are Roma Formation type. Also, the beds in the Gilberton area are in the main part of the Great Artesian Basin whereas the Blackdown Formation occurs in the Carpentaria Basin.

The Roma Formation crops out near the southern margin in the west part of the Gilberton 4-mile area. The lithology and fossils in this area and in the type area are similar. It has not been seen in outcrop in the Georgetown area.

The change of landscape from the outcrop of sandstone beds to that of Roma Formation shaly beds is quite marked. This not only applies to soils, which change from light-coloured sand to dark grey, swelling, clayey soil, but also to vegetation; sandy areas are covered by low scrub, mainly titree, but coarse Mitchell Grass clumps cover the clayey plains and trees are more or less confined to water courses. The vegetation distribution is probably partly controlled by water availability and water is apparently plentiful at shallow depths in the sandy, forest belt. Beyond the belt, water is not absorbed by the clays and is concentrated by run-off in the water courses.

Sections of the Roma Formation are not common. At Gil 11 locality 200 yards east of Etheldale-Pialah track where it crosses Mill Mill Creek, a thin section was exposed. The south bank, at creek bed level, was composed of one foot of white to red and purple silty fine-grained fossiliferous sandstone with Rhizocorallium. The sandstone occurs above in lenses or thin beds in yellow-brown to grey silty shale with clayey, cone-in-cone limestone lenses, large, fossiliferous nodular limestone boulders and gypsum. Dallwitz and Bofinger have described brecciated glauconitic ashstone from these beds. The sample which they examined contained common small angular fragments of quartz and feldspar. The suggested volcanic source of some of this material is of interest because of David's (1950, pp. 509, 510) reference to 'the intercalation of beds of tuffaceous sandstone, as at the base of the Roma Series at White Cliffs'. The fossils in the limestone nodules at Gil 11 locality were generally very big, and coiled ammonites up to 2½ feet wide with body chambers 7 inches in diameter were found. Although these beds suggest an environment similar to that which must have prevailed at the time of the final deposition of the Gilbert River Formation and have a similar fossil assemblage to the upper beds of the Gilbert River Formation, they are regarded as marine Roma Formation because of the presence of ammonites and a rich microfauna (which includes foraminifera, radiolaria and diatoms). The presence of siliceous microfossils may be further evidence in support of the volcanic origin of some of the sedimentary material. Bores into the Great Artesian Basin near the southern and western margins of the Gilberton area give better sections of the Roma Formation.

Up to 500 feet of blue to grey and black shales are recorded in the bore logs; because of weathering the shales are yellow and clayey in the upper part. Lenses of 'green rock', 'green sandy rock' and 'sandy rock' up to 100 feet thick occur in the bores; their occurrence is sporadic. 'Salt' is shown from 120 feet in the log of Saxby Downs bore No. 21. Blue shale at 153 feet in the Saxby Trust bore was described as 'very oily'. These beds are not obviously related.

The fossils listed by Dickins (1960) include the cephalopods Australiceras, Peratobelus, pelecypods Maccoyella umbonalis, M. cf corbiensis, "Mytilus", (and a small ?pelecypod in sandstone interbeds at Gil 11 locality), algae?, Rhizocorallium burrows. Crespin (1960) lists the following microfauna: Gil 11, from sandy siltstone, Ammobaculites, Haplophragmoides, Spiroplectammina, cf. Involutina, Reophax, Trochammina, Verneuilina and Verneuilinoides; Gil 11b in limestone, diatoms and radilaria. Other genera were obtained from bore samples of this formation: ammobaculoides, Anomalina Bathysiphon, Dorothia, Globigerina, Gyroidina, Marginulina, Pseudoglandulina, Robulus, Saracenaria.

The Roma Formation is conformable above the

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Gilbert River Formation; it is overlain without apparent unconformity by the basal limestone member of the Tambo Formation.

4. Basal Tambo Formation. South of the Roma Formation and stratigraphically above is a bed of fossiliferous limestone which is similar in lithology and fossil assemblage to the Toolebuc Member of the Lower Cretaceous Wilgunya Formation of Casey, Reynolds, Dow, Pritchard, Vine and Paten (1960) and Casey (1959). It is probably equivalent to or an extension of the Ka ileroi Limestone of Laing and Power, (1959b) but continuity of outcrop has not been proved; also, this limestone is in the central sub-basin of the Great Artesian Basin whereas the Ka ileroi Limestone is described from the Carpentaria sub-basin. The limestone is conformably overlain by Lower Cretaceous marine shales farther south towards Nelia and Julia Creek.

The limestone bed forms a low ridge at Bunda Bunda Station homestead. It occurs on the surface at Exley block of Glenmore holding at the site of the new (1959) bore; a sample of this bed was submitted for chemical analysis - see Appendix II. These localities are about 25 miles from the south-west corner of the Gilberton area. Local residents said that the bed was fairly continuous to the west and to the east towards the basalts north-east of Richmond. The description of the 'Hughenden Beds' rich in '<u>Avicula hughendenensis</u>' (Jack and Etheridge, 1892, pp. 395, 396) and the fact that they occur about 400 feet above the base of the marine shales (as shown in the Hughenden bore - Maitland, 1898, p. 7) suggest that the limestone bed or its equivalent extends to Hughenden and is in about the same stratigraphic position. In the western part of the Great Artesian Basin, the Toolebuc Member can be traced from its type area on the east side of the Hamilton River north almost to McKinlay. The Kamileroi Limestone (Laing and Power, 1959b, p. 28) contains <u>Inoceramus</u>, the belemnite (<u>Dimitobelus</u>) and vertebrate fragments and is probably equivalent to the Toolebuc Member; the distribution of the Kamileroi Limestone is given as 'Euroka Shelf. Kamileroi and Wurung Stations.' Limestone outcrops 12 miles south-west of Kamileroi at the '"Grass Gunyah"', on the Leichhardt River 9 miles from the mouth of Gunpowder Creek and on the Williams River have been described by Jack (1885), Jack and Etheridge (1892, p. 397) and Dunstan (1920); from the descriptions given, the limestone can be identified with the Kamileroi Limestone. Laing (in preparation) refers cone-in-cone limestone in the A.A.O.No. 8 bore, Karumba, to the Kamileroi Limestone. Based on Crespin's (1958) identification of <u>Inoceramus</u> prisms, I would suggest that the Kamibroi Limestone, if present, is lower than the cone-in-cone limestone.

I have referred to the distribution of this thin bed (generally about 20 feet thick) in some detail because furtherwork may prove that it is a fairly important stratigraphic unit. Its distribution may be very similar to the capping of 'Tambo Series' shown in Figure B of Whitehouse (1945b, p. 26).

No time was available for collecting fossils from the limestone at Bunda Bunda but forms common to the Toolebuc Member were seen: <u>Inoceramus</u>, <u>Aucellina</u>. Fish and vertebrate remains and ammonites have been collected by local inhabitants; Mrs. Tuckett of Bunda Bunda showed us part of a partly uncoiled ammonite ?Myloceras (specimen 6½ inches long) and part of a spine (4 x 2½ inches in cross-section), and Mrs. Mott of Sutherland Station had other fossil vertebrate remains including part of a crushed skull with interlocking teeth still in place. Some of the limestone from the surface outcrop near Exley bore was examined by Miss Crespin for microfossils; she records: 'Hard calcernite with small foraminifera (*Globigerina* cf. *planispira*), *Inoceramus* prisms and fish remains.'

The assemblage is different from the microfaunas found in Roma Formation samples from the bore; it is similar to the microfossil assemblage of the Toolebuc Member. The *Globigerina* species referred to in the Roma Formation were *G. cf. graysonensis* and *G. aff. washitensis*.

B. Cainozoic Formations.

1. Lynd Formation. Laing and Power (1959) describe the Lynd Formation from beds exposed in both banks of the Lynd River at the crossing of the Chillagoe-Dunbar road. The type area is 7 miles south of Walsh Post Office, between the Blackdown road and the Walsh River. The formation is formed of up to 100 feet of sand, graveland clay - partly lateritised and with an upper layer of 'buckshot gravel'. Laing and Power have recognised the formation from Walsh River (Cape York Peninsula) to Wyaaba (F.B.H. 1) and Karumba (A.A.O. 8) bores. The age is given as Tertiary.

I have used this name for a formation which occurs sporadically throughout the Gilberton-Georgetown area. It is exposed mainly in beds of well-established creeks and rivers; elsewhere, it is probably covered by recent sands. The upper beds in some bores are referable to the Lynd Formation. (In the geological sketch map, small areas of predominantly Archaean outcrop in the south-east corner and at Woolgar have been incorrectly marked with the Lynd Formation symbol.)

The predominant lithology is unsorted clayey sandstone and conglomerate. Conglomerates are found at the base in many places and contain angular pebbles of locally derived rock. Some outcrops were slightly calcareous; sandy limestone was noted as a thin lens in the bed of a small sandy creek, ½ mile south-west of the new (1959) bore, 4 miles south of Sheep Paddock Bore on Etheldale (Burleigh) Station. Some induration (silicification?) was seen in thin bands. Distorted shaly cleavage was developed in the clay in some outcrops as though minor movement or slumping had occurred after deposition. In the south bank of Boomerang Waterhole partly lateritised Lynd Formation is exposed: the top 3 feet was composed of ferruginous, sandy pisolites and was pebbly; below was a 3 feet mottled zone; the basal 6 feet was a light grey, red to brown coarse-grained sandy to pebbly bed with clayey matrix. In the south bank of Redbank Creek, 19 miles east-south-east of Esmeralda, the upper pisolite zone of a similar section is covered by a red friable sandy soil which Mr. M.A. Condon (pers. comm.) suggests is the A (topmost) horizon of the laterite profile in a sandy rock. The red ferruginous nature of the beds in some places suggests that their source material may have been lateritic. Maitland (1898) refers to sandy beds in the western part of the Gilberton area which can be correlated with this formation.

Laing and Power have given a thickness of 100 feet. Owing to the nature of the lithology of the formation, samples obtained from drilling would be hard to separate from samples of recent alluvium or sand. Thickness is therefore hard to determine from bores.

At locality Geo 2, 20 miles north of Esmeralda near the road to Croydon, about 20 feet of Lynd Formation is exposed in a small scarp above a scree of round granite boulders some of which are incorporated in the basal part. In the central part is a thin band with fibrous white rock, similar to sinter but in thin section showing some cellular structure; it may be in part algal. The fossiliferous calcareous sandstone recorded at the top of the Karumba (A.A.O. 8) bore may have been contemporaneous with the Lynd Formation; Crespin (1958) identified Elphidium craticulatum, Rotalia schroeteriana from this bed.

Twenhofel (1950) points out that poor sorting results when the velocity of the water carrying sediment decreases rapidly; the load is dropped in a short time over a limited area. The poor sorting of the Lynd Formation, its angular fragments locally derived in the conglomerate bands and the sporadic distribution suggest similar conditions of deposition. After the Kosciusko Uplift in late Tertiary time suitable conditions would have existed for the deposition of the Lynd Formation: shaly and sandy beds uplifted; a steep gradient from uplifted areas to the flat, peneplained and partly lateritised Mesozoic and early Tertiary sediments. The Lynd Formation, and the Glendower Formation which is thought to be equivalent, have limited distribution mainly around the slopes of uplifted areas. The sea may have transgressed the Karumba area during, or as a result of the epeirogeny.

The formation is probably equivalent to the loosely compacted sediments of the Glendower Formation (Whitehouse, 1940, p. 57, and 1954, pp. 12, 13) of Pliocene age. 'These sediments are younger* than the main period of lateritic action, for they contain boulders of billy,' but are themselves 'lateritised to some degree'. In its type area the Glendower Formation is about 200 feet thick.

2. Spring deposits. Two types of deposit are exposed in some of the spring areas within the Gilberton-Georgetown area:

(a) that which occurs at the site of the spring and is due to the upwelling of water through a thin superficial layer of only partly consolidated sediment;

(b) chemical precipitates around the margin of the spring site.

The known deposits occur in the sandy country along the south-west side of the Gregory Range. Some of these were visited and described by Maitland (1898). Whitehouse (1954) also refers to them. A deposit near Saxby Downs homestead, just south of the Gilberton 4-mile Sheet boundary, was visited by K.R. Levingston (1959) and D. Wyatt in April 1959. Many of the spring-site exposures are characterised by mounds of black carbonaceous sediments rich in decaying vegetation and these support trees which are more densely packed and much taller than in the surrounding country. They are therefore fairly easy to recognise in areas of low relief in air photographs. Some positions have been plotted by air photograph interpretation particularly near the Langdon River and along the Gilbert River in the Georgetown 4-mile area. In these places, the springs may reflect buried faults.

* Whitehouse states 'older' but obviously means 'younger.'

Plate II: Wombat Springs near track from Pelham-Montague bore to Woodstock, western edge of Gilberton 4-mile Sheet. September, 1959.

Spring-site deposits may be black carbonaceous sandy soils rich in decaying vegetation with white, red, yellow, orange coloured efflorescences on the surface, or, clayey sandy beds which are lithologically very similar to beds of the Lynd Formation. Rounded quartz pebbles occur sporadically in the deposits. Where the black carbonaceous deposits are still wet in localities such as near Saxby Downs house and at Wombat Spring (see Plate II), thin wet black layers with vitreous lustre may be found within a foot of the surface. Results of analyses by the Geological Survey and Government Analyst in Brisbane are given by Levingston; they show that efflorescences at Saxby Downs are mainly sulphates of iron, calcium, magnesium and aluminium; a trace of calcium carbonate was found in one sample. The smell of these areas reminded me of some of the fumarolic areas which I visited in New Guinea. Levingston gives the size of the Saxby Downs deposits as 300-400 feet wide and rising to 8 feet above surrounding country; the mound at Wombat Spring was about 10 feet high and 30 yards in diameter.

Chemical deposition of calcium carbonate seems to have occurred at a much earlier time when the springs were more active. The deposits are generally around the spring sites but some distance from them. Maitland (1898) records that black mud surrounded the orifice of a spring at Plain Springs and that a calcareous deposit occurred on the surface for some distance from the edge of the black mud. Currajong and Pelham Springs were similar. Whitehouse (1954) states that at 'Waddy Spring', beside Saxby Downs homestead, 'some of the travertine is interbedded with the sediments of the late Pliocene, Glendower Formation.' Lynd Formation impregnated with travertine and calcite spherules with radiating fibrous internal structure (and which contain nearly 1% manganese - see analyses by S. Baker, Appendix II) crops out 5 miles south of Pelham-Montague bore along the stock-route to Malpas; residuals of other travertine mounds occur north of the track about ½ mile south of the bore. At Wombat Spring, mounds of dark grey sandy travertine up to 5 feet thick surround the main spring site; the travertine is vughy and tubes and holes are filled with black carbonaceous sandy soil similar to that at the spring orifice. Sandy brown ironstone pisolites, similar to those which form at the top of some of the sections of Lynd Formation were seen east and west of Wombat Spring and near Waddy Spring. These deposits either formed at the time of the ferruginisation of the Lynd Formation or were formed by deposition of iron from spring solutions (and perhaps indirectly from the Lynd Formation).

The presence of the black carbonaceous matter in the travertine at Wombat Spring and the association of travertine and Lynd Formation elsewhere suggests that swamp lakes may have existed in the area before deposition of the Lynd Formation.

3. Recent sands and alluvium. Alluvium is made up mainly of sand and in many places is difficult to separate from the sands developed from the erosion of the sandstones, both Mesozoic and Tertiary, which mantle a great part of the Gilberton-Georgetown area.

The recent sands are widespread and thickest west of, and around the northern margin of the Gregory Range. Deposits follow the belt of intake beds along the eastern edge of the Great Artesian Basin in the area.

As a result some small steams disappear in the sand above the intake beds. The density of vegetation, low scrub with titree mainly, may also result from this association. The dense vegetation inhibits much movement of sand so that the old topography is reflected by the sand and the sandy areas are slightly hilly. This type of country contrasts strongly with the open plains of the 'downs' country to the south and west of the area. Drillers record up to 40 feet of sand in bores in the sandy belt; this figure may include some Lynd Formation.

III. GEOLOGICAL HISTORY

A geological history of Queensland in Mesozoic times is given by Jensen (1925a, b). The only deposition which he shows for the Triassic-Lower Jurassic Periods is lacustrine and in the south-eastern corner of the state; the rest of the Queensland part of the continent was being peneplained. Continued erosion allowed the lake to spread during the Jurassic to the north, or a separate basin, or basins, were formed in the Cape York Peninsula area by local sag.

The Inoruni Sandstone (?Jurassic, Laing and Power, 1959a, p. 35) was possibly deposited in the Cape York Peninsula lake. David (1950, p. 455) refers to Jurassic strata in the Cooktown district, in the Sir William Thompson Range north of the Pascoe River and south from there towards the Coen Goldfield in scattered outliers. Jurassic strata were intersected by the Weipa bore Z.C.L.1 (Power and Lindhe, 1957). Lithologically, most of these deposits are very similar to the beds which cap the Gregory Range and which I have included in the Gilbert River Formation (See: Richards and Hedley, 1924; Morton 1924a, b). However, their greater thickness in some places (1250 feet at Mt. Mulligan - David, 1950, 700 feet on Stanley Island - Richards and Hedley) compared with the maximum measured 240 feet of the Gilbert River Formation may mean that some of the lower beds at least are of Jurassic age. Laing and Power give the thickness of the Inoruni Sandstone, which is unconformably below the Gilbert River Formation, as 1,000 feet. This suggests that these ?Jurassic sediments were fairly thick in the area around the south-east part of the Gulf of Carpentaria and that widespread erosion occurred before the Gilbert River Formation and the Wrotham Park Sandstone were deposited. Erosion may have been due to a slight epeirogeny near the end of the Jurassic Period. The Gregory Range ridge which extends through Croydon and possibly subsurface to the north-west may have formed the south-west margin of the deposition in the Cape area; it was probably uplifted during the epeirogeny near the end of the Jurassic.

Whitehouse (1954) gives the limit of the widespread Bundamba (Upper Triassic) deposits as 'the margin of the Euroka and Boulia Shelves, which form their northern and western boundaries, he states that they extend into a buried structural depression of the Euroka Shelf, giving a limb of valuable waters east of the Flinders Scarp. The western margin of this limb is a buried scarp along which movement has been repeated in a recent period as the Manfred Fault. (Tilted beds above this fault are shown in Figure 95, p. 47 of Ogilvie, 1954). The depression referred to is along the south-west side of the Croydon-Gregory Range ridge.

The erosion after the Inoruni Sandstone was deposited did not reduce the northern part of the Queensland mainland to a peneplain but topography which developed would have been of low relief to allow the widespread distribution of sandstone in the Lower Cretaceous Period. Some residual physiographic features are suggested by the varying thickness of the Gilbert River Formation below the marine horizon which occurs at the top. Jensen (1925 p. 460) points out that before marine Cretaceous beds were laid down, an uplift separated the Maryborough Cretaceous sea from the inland sea and uplift began in the region of the Great Dividing Range. Evidence in the Gilberton-Georgetown area suggests that upward arching in the Gregory Range began before deposition of the Gilbert River Formation had finished. The lower beds of the formation are predominantly cross-bedded quartz sandstones; they may be in part reworked Jurassic sandstones. In many parts of the Gregory Range, the lower beds reflect the strong jointing of the underlying igneous rocks. This effect is not shown by the upper beds which are also different in that they are more arkosic. The jointing probably resulted from the suggested up-arching; uplift in the underlying igneous rocks and their subsequent erosion yielded the feldspar fragments of the arkosic sandstones. Similar jointing is shown by the sandstones below a shaly upper bed at Mt. Mulligan - see Plate 41A in David (1950). The upward movement along the eastern edge of the Great Artesian Basin may be a direct response to the sagging which had commenced within the Basin area and which subsequently allowed the sea to enter the Basin. The sagging occurred not only in that part of the Basin bounded by the Euroka Shelf, but north of it as well and sediments equivalent to the Gilbert River Formation and marine beds were laid down on the Euroka Shelf and north in the Gulf of Carpentaria. Whitehouse (1954, p. 4) notes that upper Blythesdale sandstones spread into the Gulf and Cape areas in Aptian time. He later (p. 15) suggests that sag commenced after the extension of the basin to its full limits in the 'Aptian'. The increase in thickness of the Gilbert River Formation from the edge into the Basin, however, indicates that some sag had occurred earlier.

Bryan (1926) refers to the subsidence and change from freshwater to marine environment as 'quiet and general' but says that the movement was not continuous, 'for there is probably a disconformity of considerable time-value' separating the freshwater and marine beds. The evidence in the Gilberton-Georgetown area suggests fairly continuous deposition between the Gilbert River Formation and marine beds. A marine fossiliferous horizon occurs at the top of the Gilbert River Formation and shaly interbeds are much more common than lower in the formation. The presence of volcanic ejecta in the lower marine beds may be due to volcanism which followed the epeirogeny in eastern Australia in early Cretaceous (or late Jurassic) time. The only evidence of vulcanism at this time is given by the Graham's Creek Volcanic Series which David (1932, Table H) places in the 'Barremian', Lower Cretaceous below the Aptian.

Marine Cretaceous beds are confined to a very small area in the south of the Gilberton-Georgetown area; but these, and beds in the Carpentaria Basin in the north-west, show some features which are of interest in the study of the Mesozoic palaeogeography in Queensland:

(1) the occurrence of a limestone bed similar to the Toolebuc Member of the Boulia area and to the Kamileroi Limestone of Laing and Power (1959b) near the margin of the north-east part of the main southern basin and in the Carpentaria Basin beds (in about the same stratigraphic

position about 400 feet above the base of the marine beds) suggests that deposition occurred at a steady rate around the shallow parts of the Great Artesian Basin as a whole in the early Cretaceous seas;

(2) the limestone bed is possibly the base of the Tambo Formation; its occurrence introduces a new assemblage of macrofossils;

(3) some thickening probably occurred towards the centres of the main southern basin and the Carpentaria Basin; Laing (in preparation) identifies cone-in-cone limestone at nearly 1,000 feet above the base of the marine shales in the Carpentaria Basin as Kamileroi Limestone in the Karumba (A.A.O. No. 8) bore; Crespin (1958), however, describes Inoceramus prisms which are generally indicative of Tambo Formation to 1668 feet in that bore (i.e. 600 feet above the base of marine beds); some Inoceramus prisms are recorded from 1698 to 1707 feet but these may have come from cavings;

(4) Globigerina planispira has been recorded in samples almost from the base of the marine beds in the Karumba bore (Crespin, 1958) and in the Wyaaba bore (Belford, 1957); they therefore occur in the Carpentaria Basin both in beds equivalent to the Roma Formation (Blackdown Formation) and beds equivalent to the Tambo Formation (Kamileroi Limestone and Normanton Formation, Laing and Power, 1959b); in the main basin to the south of the Euroka Shelf, they are only known from the Tambo Formation; as this is one of the planktonic foraminifera, its distribution may mean that the main southern basin was a barred basin in Roma Formation times but the oceans had access to it in Tambo Formation times; the Carpentaria Basin was open to the oceans during most of the Lower Cretaceous;

(5) the environment of deposition over most of the Great Artesian Basin during the lower Cretaceous marine time was one of quiet conditions where large shells developed and bivalve shells generally settled in random fashion and, in some beds, remain as intact pairs; Jensen (1925b, p. 460) explains the absence of corals by suggesting that the seas were muddy and shallow; Whitehouse (1954, p. 11) says that the high content of calcium carbonate in the marine sediments might be due to arid conditions 'when with limited drainage and great evaporation, lime would be concentrated'; he further states that the presence of angular feldspars, however, may suggest cold conditions; as noted earlier, their presence could indicate volcanic activity.

Marine conditions changed to freshwater lacustrine after deposition of the Tambo Formation. Both Jensen (1925b) and Bryan (1926) attribute the retreat of the sea to general epeirogenetic uplift; this was accompanied by gentle folding which Bryan states was about N30°W axes. The lakes within the Great Artesian area and in which sediments were laid down in ?upper Cretaceous times, gradually diminished in size. This was probably due to factors such as siltation of the lakes, evaporation and drainage of the lakes by tilt or by late Cretaceous folding. David (1950, p. 509) states: 'The angular conformity of all folded Mesozoic rocks among themselves, and the unconformities existing between them and Lower Tertiary rocks, make it clear that folding occurred in Upper Cretaceous time, during what may be called the MARYBOROUGH orogeny'. He had earlier (p. 507) referred to Jack (1930) who showed unconformity between folded Eyrian (Lower Tertiary) and Winton beds at Cordillo Downs in north-east South Australia.

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David refers to folding at this time as due to horizontal pressure from the east-north-east. Some tilting and/or minor folding is thought to have occurred during the Tertiary Period but before the late-Pliocene orogeny to accout for drainage of early Tertiary lakes in which the 'Eyrian Series' formed. Bryan (1926, p. 50), Jensen (1925b) and the G.S.A. (1958, p. 99) refer to Tertiary movements. The times at which the movements occurred are given as late Eocene and middle Tertiary; the lakes, therefore, probably dried up by, or after, the middle Tertiary. Widespread lateritisation followed; its depth and extent suggest that it took a long time.

The most important orogeny in the Tertiary Period occurred in late Pliocene time; it was summarised by Whitehouse (1954, p. 5): 'Elevation of the eastern rim to 1,000 feet and more in most places and over 2,000 feet in others about the close of the Pliocene, during the Kosciusko Uplift' - (Andrews, 1911). Features thought to have resulted from this orogeny are

(i) the slight west dip observed in Mesozoic sandstones in the Cape York Peninsula (Morton, 1924a)

(ii) the deposition of the Lynd Formation and its unsorted nature; the incursion of the sea and formation of the marine bed cut by A.A.O. bore No. 8, Karumba (Crespin, 1958) may have been contemporaneous

(iii) the hydralulic surface of aquifers in the Great Artesian Basin was readjusted and a high gradient developed around intake areas - this caused the outbreak of springs in the Basin.

Ferruginisation (partial lateritisation?) in the upper part of the Lynd Formation and other formations may have resulted from the outbursts of the springs - either by the springs creating conditions favourable for lateritisation, or, by precipitation of iron derived from the earlier lateritised zone by the water.

In Pleistocene time, small lakes and moist swampy conditions existed inland; the abundance of extinct marsupials and birds at such localities as Lake Callabonna in north-east South Australia suggest such an environment. The change from these conditions to the Recent desert-like conditions is attributed by Jensen to

(i) capture of western drainage areas by east-coast streams and subsequent drainage of lakes thereby reducing evaporation;

(ii) uplift in interior causing drainage of lakes into the Murray basin;

(iii) sea removed from Murray area;

(iv) reduction in mountain range level by erosion;

(v) cessation of volcanic activity.

However, Mr. M.A. Condon (pers. comm.) has pointed out that none of these causes (even if established) are as important as the global climate changes which have now been well established (see Charlesworth, 1957).

The history given above of events in late Cretaceous - Cainozoic time is fairly general. Of specific interest to the Gilberton-Georgetown area is the evidence of fairly recent tilt. Changes of directions of active streams and cross-cutting of older courses is shown very clearly in aerial photographs of parts of the Georgetown area as in the Gilbert River Formation outcrops along the west side of the Robertson River.

From his studies, Whitehouse (1954, p. 16) decided that bedrock features may have controlled and structural evolution of the Great Artesian Basin by sagging, and that because the present topographic surface still reflects the bedrock features, sag is still in progress. He calculated the rate of sag would be about 1/12th inch per century.

IV. ECONOMIC GEOLOGY

1. Hydrology. Some information on the hydrology of areas visited in 1959 is included in this report because of the economic importance of water in this country. It was collected from the owners and managers of stations and from the records of the Irrigation and Water Supply Commission, Brisbane.

A. Gilbert River Formation Aquifers: The main supplies of water in the Gilberton-Georgetown area occur in the sandstones of the Gilbert River Formation. They supply water not only in the Great Artesian Basin in the southern and western part of the Gilberton area, but also from springs in the caps which they form over the Gregory Range and east of there.

The greatest initial flows were from bores along the western edge of the Gilberton area: East Creek (Millungera) which gave 3,000,000 gallons per day, Saxby (Euthella) Trust Bore - 2,000,000 gallons per day and 1½ million per day from Cockatoo Creek bore on Woodstock. Such supplies were not from a single aquifer; seven water bearing horizons are recorded in the Saxby Trust bore. There is no evidence of any of these supplies being derived from beds older than the Gilbert River Formation. South of the Gilberton area, supplies of up to ½ Million gallons per day are obtained from this formation in bores between Bunda Bunda and Burleigh Stations. Evidence of diminution of flow is given both by springs in the area and the bores. One of the most pronounced decreases occurred in the abandoned bore (Evercreech) whose position is plotted by the Irrigation and Water Supply Commission as in the north-east corner of Bunda Bunda Station. The supply from this bore, drilled in 1902, dropped from 2,200,000 to 100 gallons per day by 1927. The records of some of the bores on Saxby Downs suggest that the flow increased for 20 to 30 years after drilling but then slowly diminished.

Properties of the water are as follows:

(a) Known temperatures varied from 94° to 106°F; the temperature of water from 506 feet in the Saxby Trust bore was 94°F, that from 550 feet was 100°, and the final flow which included additional water from depths of 580, 600, 617 and 625 feet was 104°F. Ogilvie (1954, p. 42) states that the zone of high thermal gradient in the Julia Creek area roughly coincides with the distribution of pink quartzite basement; a red marl overlies basement in the cooler area to the east.

(b) The quality of the water from bores south of Esmeralda and Prospect (25 miles west of Esmeralda) is generally good with few dissolved salts. Water from many bores north and west of these stations is very salty and some is very hard. Although the Gilbert River Formation can be identified in the logs of a few bores, it is generally not possible to decide whether the water is from that formation or aquifers in the overlying marine shales or from a possible aquifer at the base of the Tertiary Lynd Formation. However, in this area, the acquifers are over shallow bedrock (Euroka Shelf) and, as fluorine distribution shows, are affected by local intakes; and, the most likely intake beds occur in the Gilbert River Formation.

(c) Ogilvie (1954) states that the amount of fluorine in water from the Great Artesian Basin 'is usually greater for waters close to bedrock, and notably near the Croydon Goldfield, which carries fluoride minerals'. The fluorine content figures which I have for bore waters increase from less than 1 part per million in the Saxby Trust bore to up to 19-22 ppm in No. 1 Prospect bore and 17-20 ppm in Lily bore (Prospect). Intermediate values occur between Prospect and the Trust bore. Fluorine distribution suggests that intakes into aquifers of the Gilbert River Formation occur locally around Croydon. Laing (in preparation) records high fluorine (8 ppm) also from the main aquifer in the A.A.O. No. 8 bore, Karumba.

A form of osteosclerosis? or bone-weakening, locally known as 'hooky-hooky' is reported from the sandy forest belt between Croydon and Saxby Downs. The bones of animals stocked in this area are apt to snap easily. This may be due to the high fluorine content of the water and/or calcium deficiency in the animals.

It is because of 'hooky-hooky' and the very nature of the country itself that few stock are kept in the area and that the condition of bores has been allowed to deteriorate to the extent suggested by Ogilvie (1954): 'there are others such as Euthella Trust, the most wasteful bore in Queensland, and the private bores between the heads of the Norman and Saxby Rivers, which give minimum efficiency.'

B. Other Aquifers: Lenses in the marine shales overlying the Gilbert River Formation yield supplies of water, mostly sub-artesian and salty, from some of the bores in the Gilberton area (and south and west of it). Where aquifers occur in the weathered yellow clays in the upper parts of bores, they may be attributed either to upper marine shales or to the Tertiary Lynd Formation. Because they are so salty, these aquifers are of little use.

C. Springs: Two types of springs which are related to the Gilbert River Formation occur in the Gilberton-Georgetown area.

(a) Sandstones which cap the Gregory Range and high country farther east towards Georgetown act as storage reservoirs of water. Ball (1915) records springs from this source ('Newer Sedimentaries') in the Etheridge Gold-field. The water which flows into the heads of the Yappar and Woolgar Rivers is from a similar source.

(b) Springs in the sandy forest country west of the Gregory Range are also from the Gilbert River Formation, but these have welled up in a restricted basin formed by the Euroka Shelf on the west to north side and the Gregory

Range-Croydon ridge on the north-east side. They became active after the formation in the intake area had been raised by the 'Kosciusko Uplift'. Ogilvie (1954, p. 46) infers that spring water supplies in the area are fairly hard. Maitland (1898) referred to some of these springs:

> Plain Springs - 'The water as it issues from the ground is clear, limpid, and wholesome to the taste, and has a temperature at the orifice of 97 degrees Fahrenheit.' (See Figures 66 and 72, Ogilvie, 1954).

Currajong Spring - identical to above.
Pelham Spring - yielded much more water than above.
Five Springs - yielded a small but continuous supply of water.

Most of these springs have ceased flowing. A small trickle of water was noted at Wombat Spring and at the spring area just south of the Nara crossing of the Clara River. Potable water (black with suspended carbonaceous matter) was obtained from a soak, ½ mile east of the road to Glenmore and Bunda Bunda, 10 miles south of Prospect; this was probably a receded spring area.

2. Oil, Gas and Coal. Mott (1952) records oil and gas from the Inverleigh West and Vanrook bores in the Gulf Sub-basin. To these can be added the following references from bore logs:

(a) the blue-grey shale at 153 feet in the Saxby Trust bore was reported to be 'very oily';

(b) 'considerable amount of gas' has been reported from Boombah No. 6 bore, Saxby Downs, and the casing of the bore was entirely corroded in 8 years;

(c) odourless gas occurred with the initial flow of the abandoned (Evercreech) bore and Culberry bore was blown out at one stage by gas and sealed for a short period; both bores are on Bunda Bunda; Ogilvie (1954, p. 45) noted that bores at Bunda Bunda originally gave flows 'of such volume that the friction impaired drilling efficiency, and some actually "drilled themselves in"'; the high pressure may have been due in part at least to the gas content;

(d) small quantities of gas are recorded from No. 1 Pinaba Creek bore (Bunda Bunda), Crooked Creek bore (Prospect), No. 14 bore (Saxby Downs).

Shales which are black and very carbonaceous give the appearance of oily shales; beds of this nature occurred in the Exley (Glenmore) bore at 389 feet and occur near the surface in some of the spring deposits.

Most bores in the Great Artesian Basin probably yield small amounts of gas when they are drilled, particularly if they contain coal bands. Bore logs give no evidence of the nature of gases recorded.

Coal is recorded from 257 to 259 feet in the Ellendale bore on Esmeralda; it is underlain by 25 feet of 'chalk'. Lane Park bore, shown by the Irrigation and Water Supply Commission just south of the Gilberton Sheet, had 3 feet coal seams below 502 and 580 feet; Debella No.

2 bore, west of the south-west corner of the Sheet, finished in 35 feet of 'sandrock with seams of coal and decomposed wood'. These beds are in the Gilbert River Formation or possibly older sandstones. Maitland (1898, pp. 8, 9) refers to a coal seam with silicified wood at 200 feet in No. 4 bore, Burleigh; it is not clear from his descriptions whether this band occurred in blue shale or underlying sandstone. He also reports a coal seam, 'less than 9 feet thick', at 304 feet in No. 2 bore, Burleigh.

3. Gold. Brief references to alluvial gold associated with the basal beds of the Gilbert River Formation ('Desert Sandstone') are given by Jack and Etheridge (1892) on pages 525 and 540. Localities given are at the 'Upper Gilbert, at Croydon, at the Cape, at the Hodgkinson, at the Starcke, and at Cania, ...' localities from which the Desert Sandstone has been recently denuded.' Maitland (1898) records reports of gold from beneath sandstone escarpments in the Woolgar gold-field. Whitehouse (1954, p. 9) also refers to these localities and gives his opinion that the 'Desert Sandstone' in some localities is 'Upper Blythesdale'. He mentions alluvial gold from the same source in the areas south-west of Cooktown, at Hampstead and in the Palmer River.

ACKNOWLEDGEMENTS. I am grateful to Mr. R.J. Paten of the Queensland Geological Survey who accompanied and helped me in the surveys in the Gilberton-Georgetown area and provided much useful information including copies of bore logs from the Irrigation and Water Supply Commission and some of the photographs figured. We were indebted to residents of the area for their help and hospitality; particularly, I would like to thank Mr. and Mrs. Frank Vicary of Esmerald and Mr. and Mrs. Des Nissen of Prospect. I acknowledge also the help of our assistants R. Hamilton and A. Paterson.

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APPENDIX I.

Plant Fossil Collections from the Great Artesian Basin, Queensland.

(Extract from report by M.E. White, 7 / 4 / 60).

GEORGETOWN 4-MILE SHEET

Locality Geo. 3: 3 miles N. of Nonda Ck. on old Esmeralda-Stanhill Battery - Croydon track. Indeterminate.

Locality Geo. 7a: Brennan's Knob Section; sample from sandstone in bottom 20' of section. (100' below invertebrate fossil horizon = Upper Blythesdale Group, Lower Cretaceous). Casts of wide, wrinkled stems, may be pith casts of Cycads. Indeterminate. Impressions of narrower stems with coaly film on surface are also indeterminate.

Locality Geo. 14: $\frac{3}{4}$ mile N. E. of bore on Rocky Creek, 8 miles E. of Gilbert River crossing of main Georgetown - Croydon Road. (Forest Home Cattle Station). *Taeniopteris spatulata* (McClelland) and a fragment of ribbed stem of *Equisetites*? are the only determinate fossils.

APPENDIX II.

CHEMICAL ANALYSES

(1) Locality Gil 1: Millungera 4-mile sheet, east side. 5 miles south of Pelham-Montague bore at side of road to Malpas. Spherulitic calcite with internal radiating structure in old spring mound.

SiO_2	2.36
$CaCO_3$	90.5
$MgCO_3$	3.1
Fe_2O_3	0.70
Al_2O_3	1.40
MnO_2	0.70
H_2O(105°C)	0.40

Analysis by S. Baker 22/3/60
Lab. No. 60/881.

(2) Locality Gil 1a: As above. Clayey limestone in old spring mound.

SiO_2	15.96
Al_2O_3	5.01
Fe_2O_3	3.00
FeO	n.d.
CaO	38.82
MgO	1.20
Na_2O	0.71
K_2O	0.34
TiO_2	0.26
P_2O_5	0.13
MnO	0.13
CO_2	26.60
SO_3	n.d.
Loss 100°	1.32
Loss 1000°	32.62
Total	99.50

Analysis by A. McClure 4/3/60.

(3) Exley bore (1959): Millungera 4-mile Sheet; south-east corner. Sample of weathered limestone (? basal Tambo Formation) at surface.

SiO_2	2.79
$CaCO_3$	90.1
$MgCO_3$	3.9
Fe_2O_3	0.60
Al_2O_3	-
MnO_2	0.10
H_2O (105°C)	1.10

Analysis by S. Baker 22/3/60
Lab. No. 60/881.

TABLE I

FOSSILS FOUND IN THE GILBERT RIVER FORMATION
OR ITS EQUIVALENT AND THEIR LOCALITIES

LOCALITY	REFERENCE	"Rhynchonella" croydonensis	A fine-ribbed terabratuloid	Nuculana ? sp. ind.	Cucullaria sp. nov.	Parallelodon ? sp. ind.	Maccoyella barkly: var. mariaeburiensis	M. sp. ind.	"Ostrea" sp.	Placuna sp. ind.	Trigonia sp. A	T. sp. B	Fissilunula clarkei	Venilicardia ? sp.?	Teredo sp. ind.	Plagiostoma sp.	Entolium sp.	Panope ? sp.	Cyrenopsis cf. meeki
True Blue Hill, Croydon	Jack and Etheridge 1892 Rands 1896 Maitland 1898	x					x		x	x					x				
	Dickins 1960	x	x	x	x	x	x		x		x		x	x					
Mt. Angus, Croydon	Jack and Etheridge 1892	x																	
	Dickins 1960	x						x				x							
Geo 7, Brennan's Knob	Dickins 1960							x				x	x			x	x	x	x
Geo 13, Georgetown-Croydon road 2½ mls. west of Gilbert R.	Dickins 1960																		
½ mile N.E. of Mein Mein station well																			

LOCALITY	REFERENCE	Pseudauicula cf. anomala	P. papyracea	Pleuromya ? sp.	"Tellina" sp.	Malletia elongata	Nucula sp.	Idonearca robusta	"freshwater unio"	Acmaea ? sp.	"Natica" cf. variabilis	Siphonaria Samwelli	cf. Siphonaria	incompletely coiled gastropod	Ammonites fragments	Peratobelus sp.	Burrows	Wood
True Blue Hill, Croydon	Jack and Etheridge 1892 Rands 1896 Maitland 1898											x						
	Dickins 1960									x	x			x			x	
Mt. Angus, Croydon	Jack and Etheridge 1892																	
	Dickins 1960												x					
Geo 7, Brennan's Knob	Dickins 1960															x	x	x
Geo 13, Georgetown-Croydon road 2½ mls. west of Gilbert R.	Dickins 1960	x	x	x	x													
½ mile N.E. of Mein Mein station well						x	x	x	x						x			

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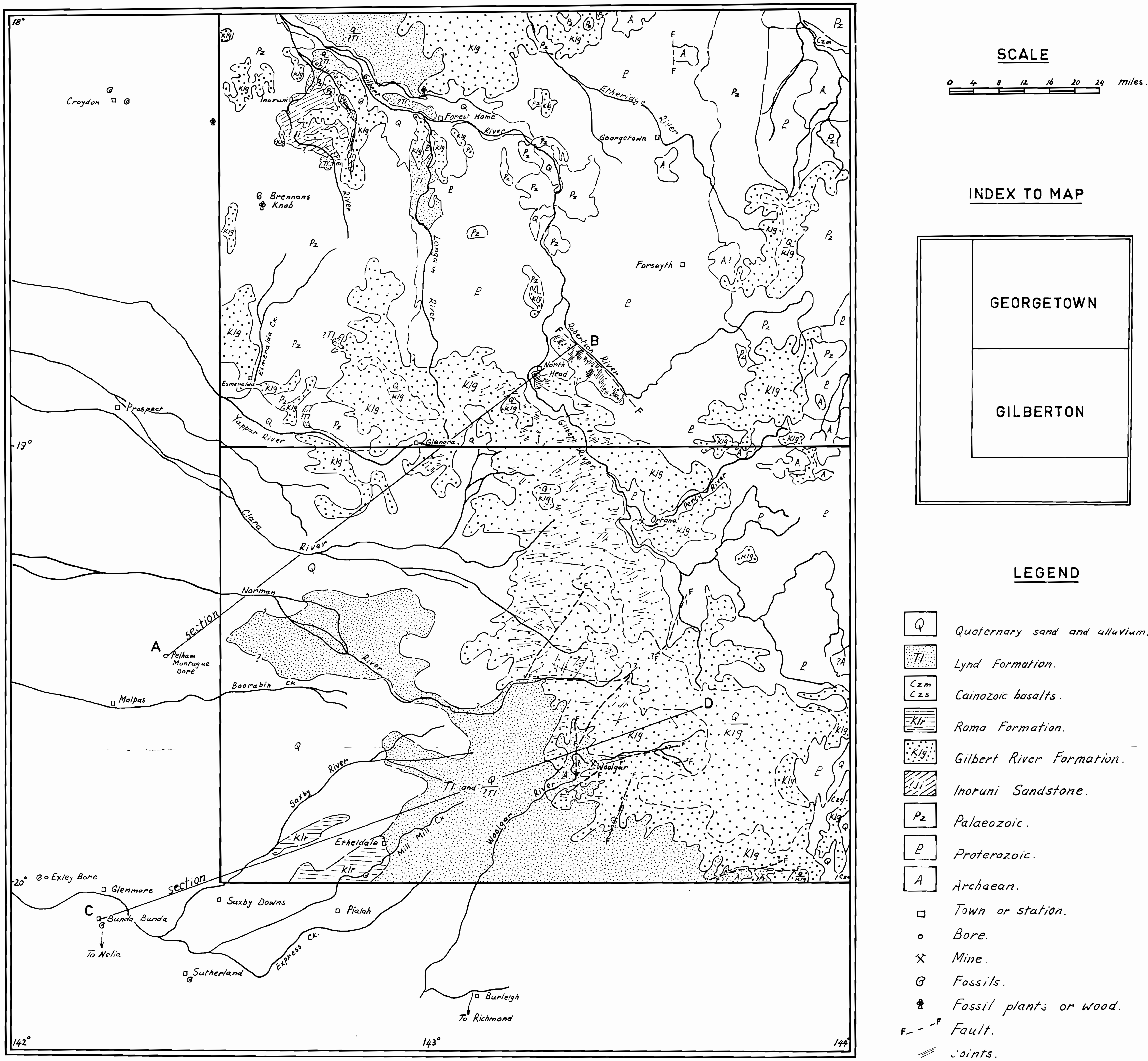
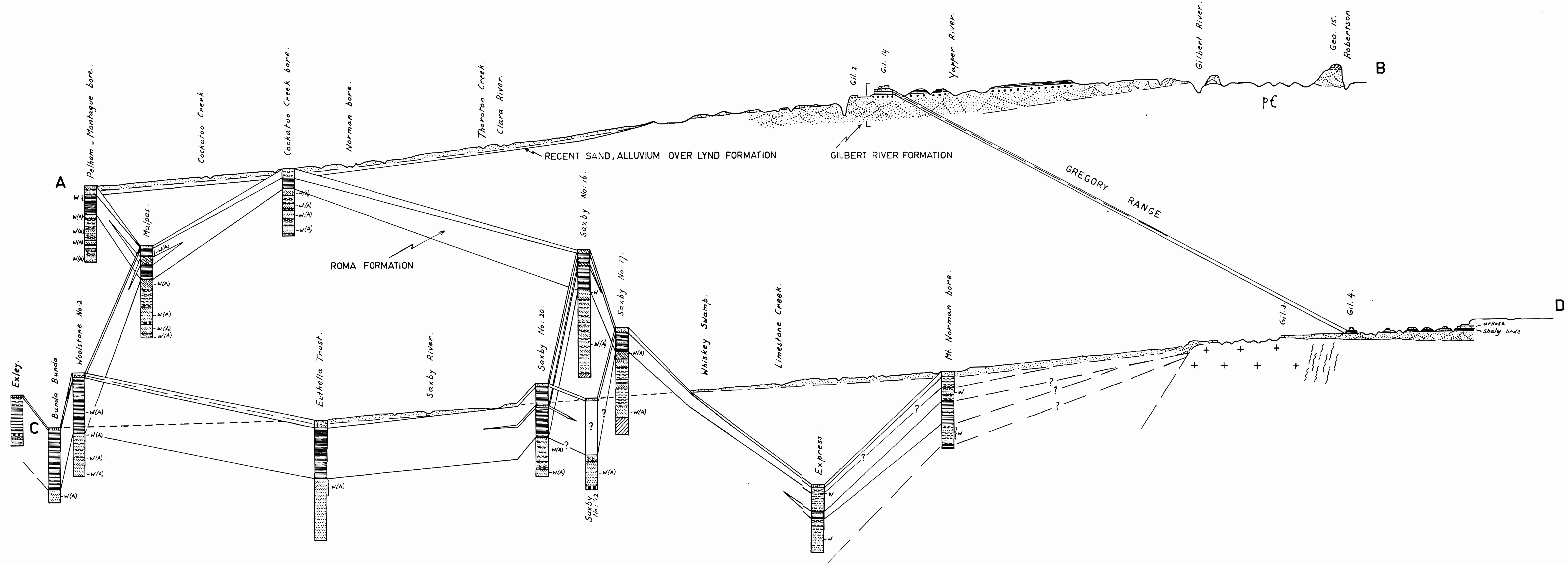
SKETCH MAP SHOWING MESOZOIC AND YOUNGER FORMATIONS IN THE GILBERTON, GEORGETOWN 4-MILE AREA.



DIAGRAMMATIC REPRESENTATION OF TWO SECTIONS FROM THE GREAT ARTESIAN BASIN TO THE GREGORY RANGE.



LEGEND

BORES

- Unconsolidated sand.
- limestone.
- Shale.
- Sandstone and Conglomerate.
- Clay, Pipeclay.
- Hard bands.
- Green beds
- Red marl.
- Slate
- W Water bearing bed.
- (A) Artesian supply.

OUTCROP

- Arkose.
- Shaly beds.
- Sandstone and conglomerate.
- Claystone, Siltstone.
- Mainly crossbedded sandstone.
- PЄ Precambrian.
- Archaean.

SCALE

0 4 8 12 miles

Horizontal scale along sections is 1" = 4 miles.

Vertical scale is 1" = 500 Feet.

0 500 1000 Feet