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STRATIGRAPHIC CORRELATIONS BETWEEN THE OLDER UNITS OF THE SOUTHERN CARPENTARIA AND NORTHERN EROMANGA BASINS

by

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CONTENTS

SUMMARY

Mesozoic sandstone units defined on the northeast margin of the Eromanga Basin can be traced in the subsurface using gamma ray logs northwards into the Carpentaria Basin. The oldest units, the Eulo Queen Group and its equivalents, are restricted to a series of basement lows in the Carpentaria and northernmost Eromanga Basins, but appear to be continuous with the Injune Creek Group farther south in the Eromanga Basin. The overlying Gilbert River Formation is a widespread blanket deposit in the Carpentaria and northern Eromanga Basins and appears to be equivalent to the Hooray Sandstone farther south in the Eromanga Basin.

INTRODUCTION

The general stratigraphy of the Carpentaria Basin was outlined by Laing & Power (1960). Meyers (1969) provided a revised account, based mainly on data from petroleum exploration wells. Systematic geological mapping by the Bureau of Mineral Resources and the Geological Survey of Queensland began in 1969 (Doutch et al., 1970, 1972, 1973) and was completed in 1974. Doutch (1974) provided an up to date summary of the basin, and Pinchin (1973) reviewed the geophysics. Surface mapping has been supplemented by shallow stratigraphic drilling (36 holes from 1969 to 1973), gamma ray-logging of water-bores, and results from petroleum exploration drilling and from drillers' logs of water-bores; as a result the subsurface geology and structure in the south of the Carpentaria Basin have been interpreted, and the sandstone units recognized in outcrop can now be reliably identified on wireline logs.

This paper is concerned with the southern part of the basin and the relationship of the sandstone units there (Eulo Queen Group and Gilbert River Formation) with those of the northern part of the Eromanga Basin. The structure of the underlying basement surface is also briefly considered.

BOUNDARY BETWEEN THE CARPENTARIA AND EROMANGA BASINS

The boundary between the Carpentaria and Eromanga Basins is problematical; it has never been defined. The Early Cretaceous Allaru Mudstone and all underlying Mesozoic units (including to some extent the Eulo Queen Group) can be traced from one basin to the other without break or apparent change in character, but with slight thinning in the boundary area. Outcrops of the units which overlie the Allaru Mudstone - the Normanton Formation (to the north) and the Mackunda Formation (to the south) - are separated by an area of Allaru Mudstone which coincides with the present structural boundary (Doutch et al., 1970) between the basins.

Hill (1951) and Mott (1952) assumed that the boundary was a basement ridge; Hill (op. cit.) called it the Euroka Ridge, in which she included the basement inliers of the Fort Bowen Ridge. Whitehouse (1954) used the term 'Euroka Shelf' for 'a shelf of shallow bedrock (i.e. basement) deepening northwards - this buried scarp was the limit of the (Eromanga) basin in pre-Cretaceous times'. Doutch et al. (1970) found that the Millungera and Canobie Depressions effectively marked the northern limit of Eromanga Basin deposition (Eulo Queen Group) before Gilbert River Formation time, and that the Burketown Depression and Landsborough Graben (new name), to the northwest, formed the southern limit of Carpentarian Basin deposition at the same time. The limits Whitehouse (op. cit., fig. 34) gave for his shelf are roughly similar to those of the Claraville Shelf bordering the depressions (Doutch et al., 1970; Fig. 1, this paper).

Doutch et al. (op. cit) gave the name Euroka Arch to the structural and tectonic complex which forms the basement high structural boundary between the two basins and bisects the outcrop area of Allaru Mudstone. They also recognized that the Normanton and Mackunda Formations are regressive sequences which may not have completely covered the area of the Arch. The Euroka Arch probably developed as a stable area between two areas of sagging basin (Carpentaria and Eromanga) in the Cretaceous and was brought to its present condition by slight uplift in the northwest in Pliocene times. The boundary between the Carpentaria and Eromanga Basins for the purposes of this paper is taken as the crest of the Euroka Arch as defined by structural contours.

STRATIGRAPHY

Outcrop areas. The sequences of the southern Carpentaria and northern Eromanga Basins (Tables 1, 2) comprise Upper Jurassic to Lower Cretaceous quartzose sandstone overlain by Lower Cretaceous mudstone, siltstone, and labile sandstone, with some calcareous strata. In the Carpentaria Basin, nomenclature has been complicated by assignment of formal names before systematic mapping. Smart et al. (1971, 1972) and Smart (1972) have revised the stratigraphic nomenclature of the southern Carpentaria Basin; the latest nomenclature is shown in Table 1. The nomenclature of the Eromanga Basin is based mainly on Vine et al. (1967). The lithologies of the units are shown in Table 2. The published 1:250 000 maps of the northern Eromanga Basin antedate the current nomenclature of the sandstone units.

The Eulo Queen Group and possible equivalents mostly occur in erosional depressions and rest on pre-Mesozoic basement, except in some areas, such as the southeastern part of the Millungera Depression, where they overlie older sedimentary rocks probably of Triassic age (Galilee Basin sequence). In the outcrop area of the Eulo Queen Group (Fig. 1) the component formations are generally distinguishable; in the area around latitude 19°S and east of longitude 143°E, the Hampstead Sandstone thins and in places the Loth Formation rests on basement, but the formations cannot everywhere be separated in this area as the lithologies are less distinctive. Some areas in the Georgetown and Gilberton 1:250 000 Sheet areas are therefore mapped as undifferentiated Eulo Queen Group. The Group is absent north of about 18°50'S and east of 144°30'E, which probably approximates to its depositional limits (Needham, 1971; Smart, 1973b).

TABLE 1 - History of nomenclature, southern Carpentaria and northern Eromanga Basins

<table>
<tr><th colspan="5">SOUTHERN CARPENTARIA BASIN</th><th colspan="3">NORTHERN EROMANGA BASIN</th></tr>
<tr><th>Laing & Power (1959)</th><th>Reynolds (1960)</th><th colspan="3">Smart et al. (1971, 1972); Smart (1972); Senior et al (in prep.)</th><th colspan="2">Vine et al. (1967); Vine (1970); Senior et al. (in prep.)</th></tr>
<tr><td>Normanton Formation</td><td>Normanton Formation</td><td colspan="3">Normanton Formation
Allaru Mudstone</td><td>Mackunda Formation
Allaru Mudstone</td><td>ROLLING DOWNS GROUP</td></tr>
<tr><td>Kamileroi Formation</td><td colspan="2">Kamileroi Limestone</td><td colspan="2">Toolebuc Formation</td><td>Toolebuc Formation</td><td></td></tr>
<tr><td>Blackdown Formation</td><td colspan="2">Wallumbilla Formation</td><td colspan="2">Wallumbilla Formation</td><td>Wallumbilla Formation</td><td></td></tr>
<tr><td rowspan="2">Gilbert River Formation (Lower Cretaceous)</td><td rowspan="3">Gilbert River Formation (Lower Cretaceous)</td><td rowspan="2">Gilbert River Formation</td><td>Coffin Hill Member (Lower Cretaceous)</td><td rowspan="2">Yappar Member (Upper Jurassic? to Lower Cretaceous)</td><td colspan="2" rowspan="2">Gilbert River Formation (Lower Cretaceous)</td></tr>
<tr><td></td></tr>
<tr><td></td><td>Eulo Queen Group</td><td>Loth Formation (Upper Jurassic)</td><td colspan="2">REGIONAL UNCONFORMITY
Unit B (Jurassic)</td></tr>
<tr><td></td><td></td><td></td><td>Hampstead Sandstone (Jurassic)</td><td colspan="2">Unit A (Jurassic)</td></tr>
</table>

4

TABLE 2 - Lithologies of Jurassic and Cretaceous units.

FORMATION			LITHOLOGY - after Doutch et al., 1970; Smart et al., 1971
Allaru Mudstone			Mudstone with minor calcareous labile sandstone and cone-in-cone limestone
Toolebuc Formation			Calcareous, bituminous shale; shelly limestone
Wallumbilla Formation			Mudstone with calcareous concretions; labile sandstone and siltstone in lower part; minor cone-in-cone limestone
	Gilbert River Formation	Coffin Hill Member	Medium to fine clayey quartzose sandstone and siltstone in thin irregular beds; minor shale. Contains shelly fossils
		Yappar Member	Coarse to medium clayey quartzose sandstone, commonly pebbly, some conglomerate; upper part medium to fine clayey quartzose sandstone and minor siltstone
EULO QUEEN GROUP	Loth Formation		Medium to coarse clayey quartzose sandstone and micaceous clayey fine quartzose sandstone and siltstone; minor porcellaneous mudstone
	Hampstead Sandstone		Medium to very coarse sandstone, conglomerate, minor fine sandstone, and siltstone

The Gilbert River Formation crops out along the eastern margin of the basins, but in the west it is overlapped by the Wallumbilla Formation. It rests on basement or on Eulo Queen Group and equivalents. In outcrop it is separated from the underlying Eulo Queen Group by a marked topographic bench.

The Yappar and Coffin Hill Members of the formation are generally distinguishable in outcrop in the northern part of the Gregory Range and in some areas farther north (Needham, 1971; Smart & Bain, in prep.), but in the southern part of the Gregory Range area they cannot be distinguished, although the unit present resembles the Yappar Member lithologically (Smart, 1973b), and the overlying altered and leached material may represent the Coffin Hill Member. South and west of the Gregory Range the members cannot everywhere be positively identified in outcrop or in the subsurface (Needham et al., 1971; Grimes & Smart, 1970).

The Wallumbilla Formation is poorly exposed and is covered by younger units over much of its area. In the Gregory Range it occurs as small mesa-cappings of leached and iron-stained siltstone and mudstone.

Subsurface interpretations. Several authors have shown subsurface correlations based on wireline and lithological logs in the Carpentaria and Northern Eromanga Basins (Vine, 1966; Meyers, 1969; Doutch et al., 1970). None of them was able to demonstrate that the subsurface units correspond directly with the units defined from outcrop areas. Doutch et al. (1970) presented subsurface correlations in the southern Carpentaria and northern Eromanga Basins based on gamma-ray logs of water-bores; the pre-Wallumbilla Formation sandstone units recognized on the logs appear to be equivalent to the units defined from outcrops in the Gregory Range and were labelled as such in their illustrations.

In order to substantiate this equivalence, two shallow stratigraphic holes were drilled in 1970. BMR Gilberton 1 was drilled on the Gilberton Plateau, in the south of the Gregory Range, to provide a continuous section of the sandstone units (Needham et al., 1971). A gamma-ray log of the hole was run to provide a basis for the correlation of the outcrop units of the Gregory Range with subsurface units recongizable on gamma-ray logs of water-bores.

A subsequent hole, BMR Gilberton 2, was drilled farther west (Fig. 1), and the sandstone sequence cored throughout to provide detailed lithological data and material for palynology (Needham et al., 1971). BMR Gilberton 2 was sited to penetrate the full sandstone sequence below the Wallumbilla Formation; it was sited adjacent to a gamma-ray-logged water-bore (IWSC Registered Number 4333) so that lithological units could be correlated with the pattern of gamma radiation on the gamma-ray log. Figure 2 shows a simplified lithological log of BMR Gilberton 2 alongside a gamma-ray log of the adjacent water-bore. The gamma-ray log shows two intervals of relatively low but variable gamma radiation which correspond with the units interpreted lithologically as the Gilbert River Formation and the Hampstead Sandstone. These are separated by an interval of relatively high radiation which corresponds to the lithological unit identified as Loth Formation. Similar patterns of gamma radiation are observed on gamma-ray logs in adjacent bores, e.g. Figure 3.

Comparison of the lithological log of BMR Gilberton 2 with that of Gilberton 1 shows a close correspondence of lithology and thickness of each unit (Fig. 2). The sandstone under the Hampstead Sandstone is not represented in outcrop and appears to be present only to the west of the Middle Park Structure (Fig. 1; Smart, 1973b). The Eulo Queen Group at its type section is similar in thickness to that in both stratigraphic holes, but the relative proportions of the formations differ. The Loth Formation thins to the north - from 60 m at the type section to less than 30 m at Glenora -

and the Hampstead Sandstone thickens (Doutch et al., 1970). A similar relationship is present to the south and west of the type section. Figure 3 shows the decrease in thickness of the unit as interpreted from wireline and lithological logs; in a distance of 50 km the formation thins from 60 m to 40 m.

Nature of depressions. The Eulo Queen Group and its equivalents infill basement lows - the Millungera and Canobie Depressions of the northern margin of the Eromanga Basin, and the Burketown Depression and Landsborough Graben to the west of the Claraville Shelf (Fig. 1). The depressions apparently represent the erosional modification of basement lows which are bounded by structural highs. The Fort Bowen Ridge is a complex structural high and may have its origins in a series of basement horsts. The St Elmo Structure is its southern continuation and is probably similar. East of the 142°E meridian, there is a dearth of bore data, and a basement high might be present in this area. The Boomarra and Kamileroi Horsts existed as topographic highs during Jurassic and Early Cretaceous times, and there was subsequent movement of their faulted margins (Smart, 1973a). The sagging either side of the Euroka Arch caused a reversal of plunge of the northern parts of the Canobie and Millungera Depressions, which are discussed in detail by Smart (1973a, b) and Grimes (1973).

The nature of the Burketown Depression and Landsborough Graben (new name) is far from clear owing mainly to the paucity of data in the vicinity of the 140°E meridian. Doutch et al. (1970) showed one large depression, but further work suggests that the Eulo Queen equivalents in the area may be present in two north-trending tracts (Fig. 1). The presence of basement in water-bore 3030 is suggested by the driller's log of the bore (Fig. 4); the gamma-ray log of the interval below the recognizable Gilbert River Formation is very similar to the interval corresponding to the Proterozoic sedimentary rocks in Burketown No. 1, and a basement high may exist in this area. Basement contours from aeromagnetic surveys show NNE-SSW trends, similar to those shown in Figure 1 (Hartman, 1962).

The existence of Eulo Queen Group equivalents in the Landsborough Graben was first indicated by gamma-ray logs of water-bores (Doutch et al., 1970; Smart, 1973a) and was confirmed by drilling in 1972 (Brunt, 1972). The continuation northwards of the Landsborough Graben is uncertain; it may fade out or it may continue and merge with the Burketown Depression offshore. In the Gulf of Carpentaria, seismic surveys (Marathon, 1966) indicate the presence of graben structures with a northerly trend, similar to that of the Burketown Depression.

Eulo Queen Group and equivalents. Units equivalent to the Eulo Queen Group are present in several places west and northwest of the outcrop area (Fig. 1, 2, 4) where they infill basement depressions. The lithology of these units as interpreted from gamma-ray logs and drillers' logs is variable, but all are distinguished from the overlying Gilbert River Formation by their consistently higher radioactivity. In parts of the area covered by Figure 1, drillers' logs report 'red shale' and 'brown sandstone'. The sandier beds yield artesian or subartesian water, but the supplies are variable. Immediately west of longitude 142°30'E supplies are good (many original flows exceeding 50 litres per second) and bores are mostly flowing. Farther west, the Eulo Queen Group equivalents are more argillaceous (e.g. R3714) and supplies are much smaller. In Mid-Eastern Burketown No. 1, the sequence under the Gilbert River Formation is predominantly argillaceous; the lowest part consists of angular clasts in a clay matrix, which Perryman (1964) has suggested is probably a mudflow sequence although Myers (1969) considers it to be of possible glacial origin. Attempts to obtain palynomorphs from the sequence have been unsuccessful (D. Burger, BMR, pers. comm.) and its origin is still in doubt. The sequence appears to be analogous to the Galilee Basin sequence under the Eromanga Basin.

Gilbert River Formation and younger units. The Gilbert River Formation is generally easily identifiable on gamma-ray logs, but in some areas the lower part of the overlying Wallumbilla Formation is sandy and the top of the Gilbert River Formation is less obvious (e.g. R14615 in Fig. 2; R1792 in Fig. 4). Immediately west and south of the Gregory Range, the formation is about 65 m thick, but it thins farther west (Fig. 2). It is locally thin or absent over parts of the Boomarra and Kamileroi Horsts and the Fort Bowen Ridge. Around the Burketown Depression the unit is about 30 m but it thickens to the north towards Mornington Island where it exceeds 60 m.

The thickness variations of the Gilbert River and overlying formations appear to be unrelated to the underlying basement depressions. These formations generally thicken towards the Gulf of Carpentaria and south into the northern part of the Eromanga Basin (Doutch et al., 1970). Therefore, by the onset of Gilbert River Formation deposition, the depressions had been filled or at least reduced to gentle hollows by a combination of deposition, and erosion of their margins. The subsequent sagging to accommodate the sediments of the Rolling Downs Group is unrelated to the underlying depressions.

Correlations between the Carpentaria and Eromanga Basins. The Wallumbilla Formation, Toolebuc Formation, and Allaru Mudstone of the Eromanga Basin continue northwards without break into the Carpentaria Basin. The Gilbert River Formation and the Eulo Queen Group have not been definitely correlated with the units of the Eromanga Basin farther south. Vine (1970) correlated the subsurface sandstone units in the Richmond area with those farther south in the Eromanga Basin, but considered that correlation of the Gilbert River Formation and his Jurassic units 'A' and 'B' (Hampstead Sandstone and Loth Formation respectively, Table 1) with the Eromanga Basin sequence was uncertain.

However, the drilling of BMR Gilberton 2 and further gamma-ray logging has enabled a tentative correlation to be made (Fig. 3): The Gilbert River Formation correlates well with the Hooray Sandstone; the Eulo Queen Group is well marked and appears to correlate with the Injune Creek Group, and a study of gamma-ray logs suggests they are part of the same rock body (e.g. Doutch et al., 1970); and the Loth Formation can be correlated with the Westbourne Formation, and the Hampstead Sandstone with the more agillaceous Birkhead Formation. The Jurassic sandstone underlying the Hampstead Sandstone in BMR Gilberton 2 (Needham et al., 1971) is tentatively correlated with the upper part of the Hutton Sandstone (Fig. 4). Casey (1970) correlates the whole Injune Creek Group with Vine's (op. cit.) Jurassic unit 'B' (i,e. Loth Formation) and the Hutton Sandstone with Jurassic 'A' (i.e. Hampstead Sandstone). The logs shown in Figure 4 suggest that his correlation is unlikely. Vine (1970) points out the difficulties of subdividing the sandstones underlying the Wallumbilla Formation in the western part of Richmond 1:250 000 Sheet area and in areas to the west. However, the Hooray Sandstone (and equivalent Gilbert River Formation) can generally be distinguished from the underlying more argillaceous units (Doutch et al., 1970).

Diachronism of the sandstone formations (and probably also the Rolling Downs Group) is likely, and they may be much younger than their equivalents to the south. Spores from BMR Gilberton 2 (D. Burger, quoted in Needham et al., 1971) indicate an uppermost Jurassic age (spore unit J5-6) for the upper part of the Hampstead Sandstone, and an age close to the Jurassic-Cretaceous boundary for the Loth Formation. The lower part of the Gilbert River Formation was barren, but the upper part yielded Cretaceous spores. D. Burger (pers. comm.) has since found Upper Jurassic spores in the Gilbert River Formation in northern Cape York Peninsula.

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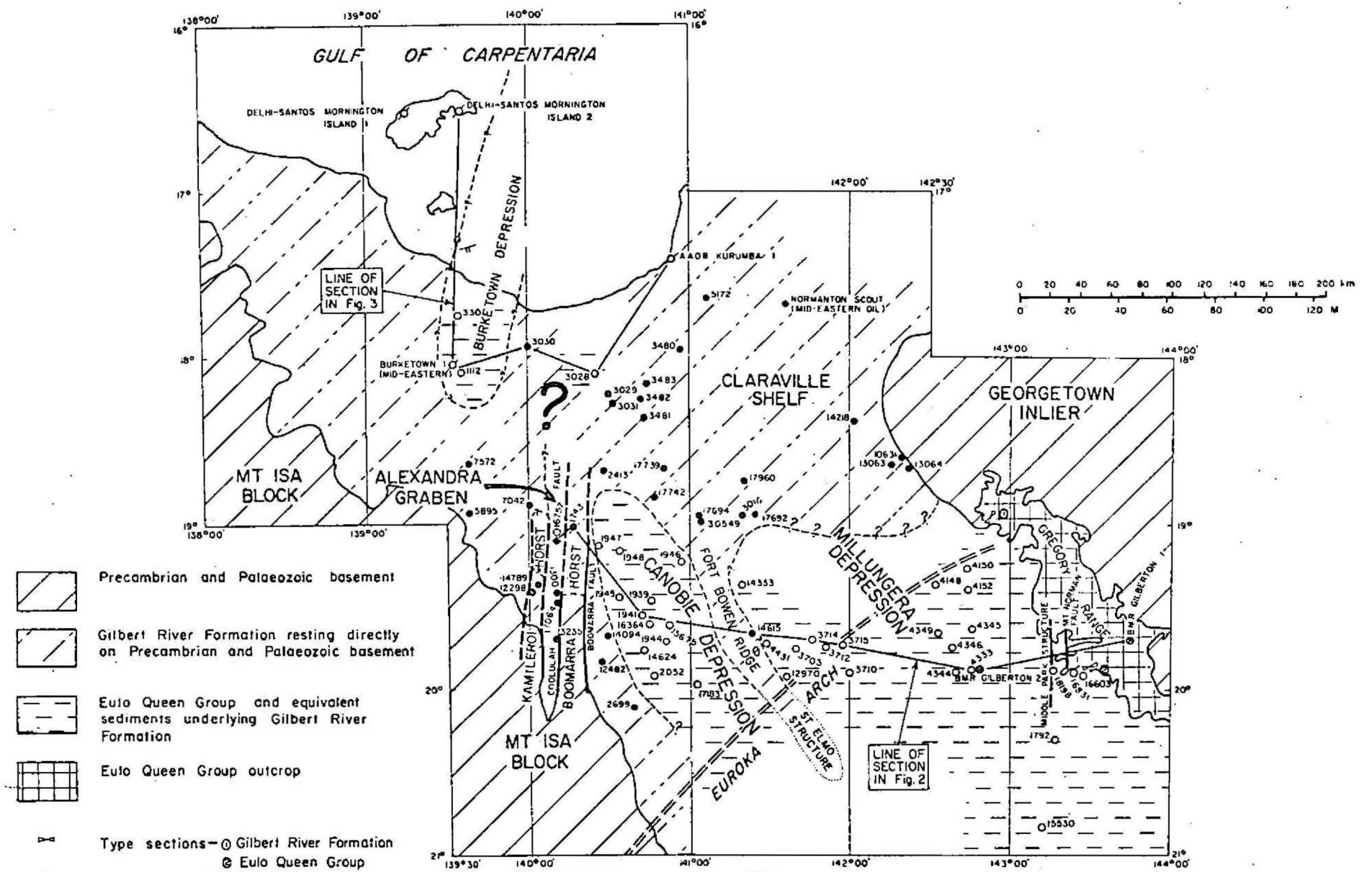

Precambrian and Palaeozoic basement

Gilbert River Formation resting directly on Precambrian and Palaeozoic basement

Eulo Queen Group and equivalent sediments underlying Gilbert River Formation

Eulo Queen Group outcrop

Type sections — ① Gilbert River Formation
② Eulo Queen Group

Shallow stratigraphic hole with name

Petroleum exploration well, dry, abandoned

JC-22 MTA drill hole with reference number

Bore in which Gilbert River Formation rests on basement

Bore in which Gilbert River Formation rests on older basin sediments

All bore registered numbers prefixed by I.W.S.C.

Fig. 1

Pre Gilbert River Formation geology

Q/A 446

Record no. 1975-51

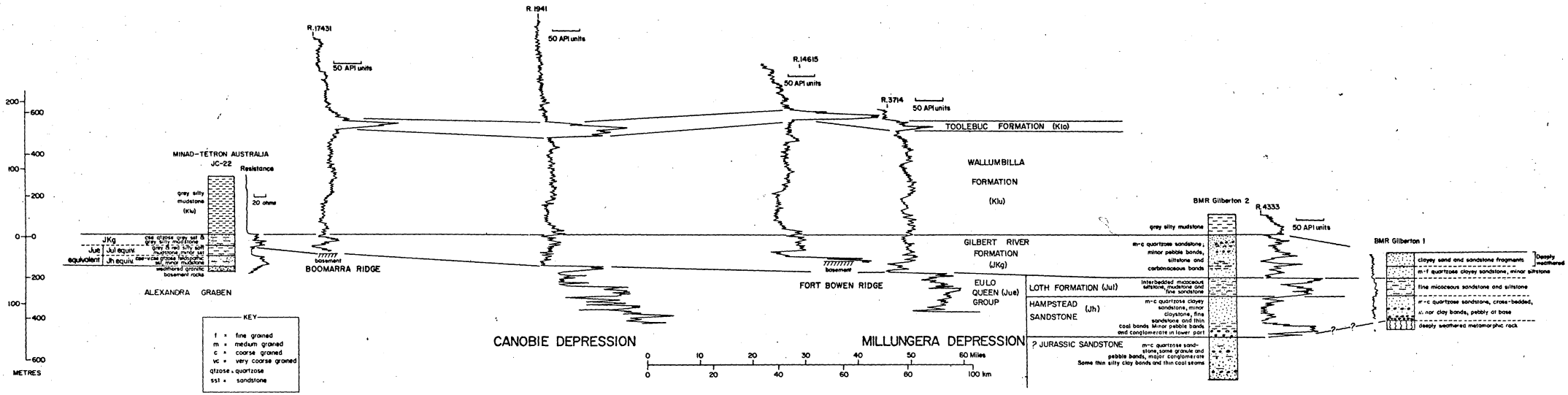

Fig. 2 Correlations of Mesozoic sandstone units in southern part of area

O/A 447
Record no. 1975/51

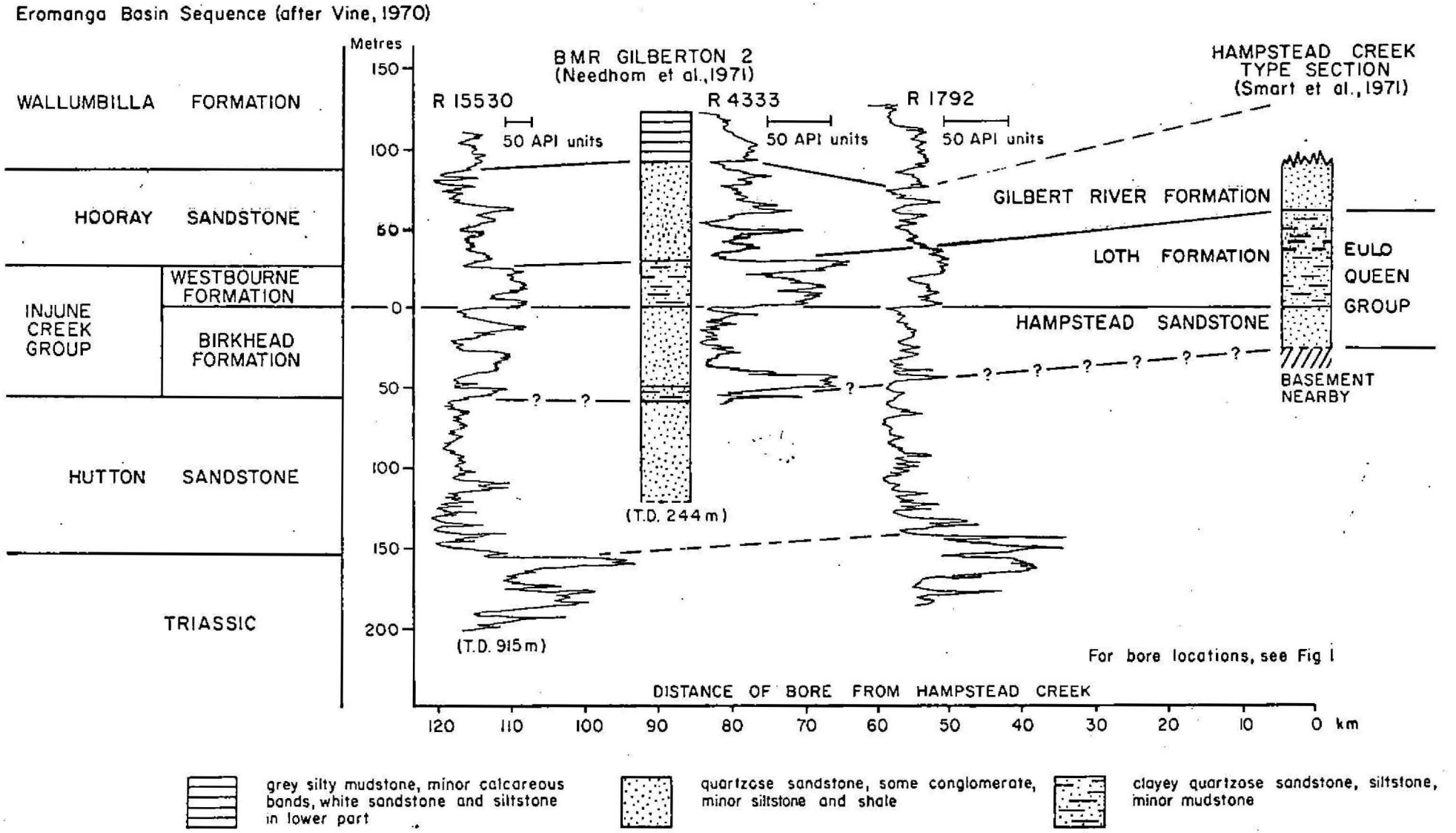

Fig 3 Correlation of Mesozoic sandstone units, northern Eromanga Basin.

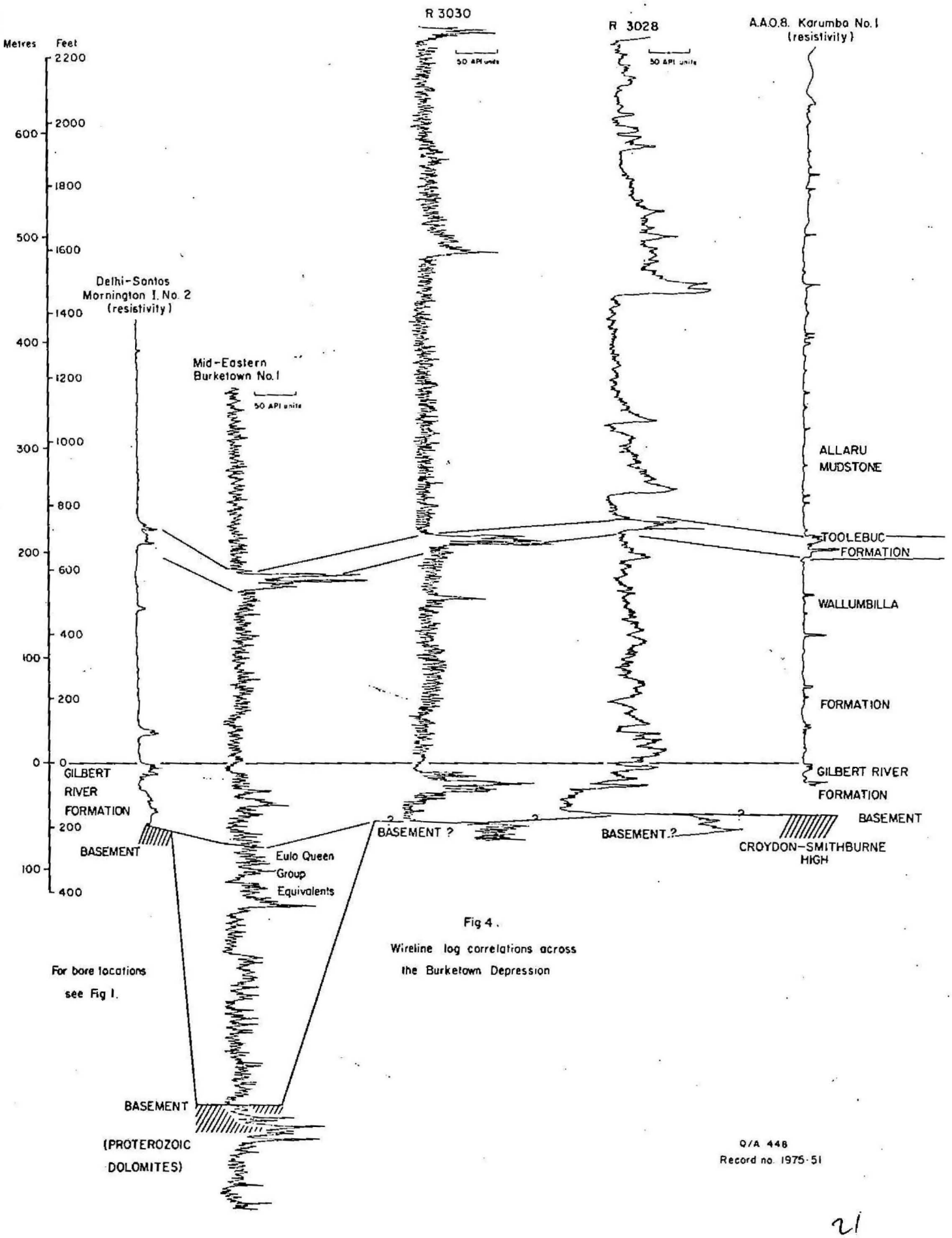

Fig 4.

Wireline log correlations across the Burketown Depression

For bore locations see Fig 1.

Q/A 448
Record no. 1975-51