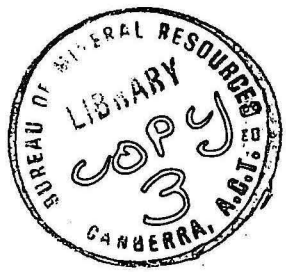
DEPARTMENT OF MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS



RECORD 1975/67

THE CADNA-OWIE AND TOOLEBUC FORMATIONS IN THE EROMANGA BASIN, QUEENSLAND

by

B.R. Senior, N.F. Exon & D. Burger

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ABSTRACT

The late Neocomian to early Aptian Cadna-owie Formation extends from South Australia into Queensland, where it is very widespread in the subsurface Eromanga Basin. It is a paralic unit consisting of quartz-rich sandstone and siltstone, and was formerly known as the 'upper Hooray Sandstone'; it overlies the Hooray Sandstone proper. A thin, widespread well-sorted quartzose sandstone sequence forming the upper Cadna-owie Formation is defined as the Wyandra Sandstone Member. The member was probably a transgressive marine sand laid down at the commencement of a major Aptian marine transgression. A subsurface type section near Wyandra has been established.

The former 'Toolebuc Limestone' of late Albian age consists predominantly of calcareous and bituminous siltstone and mudstone with subordinate limestone and is here renamed Toolebuc Formation. A subsurface type section near Boulia is defined.

INTRODUCTION

Since the early 1960s geologists of the Bureau of Mineral Resources (BMR) and the Geological Survey of Queensland (GSQ) have systematically mapped the Eromanga Basin in Queensland and produced syntheses of various parts of it (Exon, Galloway, Casey & Kirkegaard, 1972; Senior, in press; Senior, Harrison,& Mond, in press; Mond & Harrison, in prep.; Exon & Senior (in prep.). The Eromanga Basin is a wide, relatively shallow structural depression underlying about 600 000 km^2 of Queensland.(Figs. 1 and 2). It contains up to 3500 m of Jurassic and Cretaceous sedimentary rocks, and is partly mantled by Cainozoic stream sediments and sand dunes. The Jurassic sequence is largely non-marine, and the Cretaceous sequence largely marine.

The information used in this paper comes largely from regional mapping by BMR and GSQ, shallow stratigraphic drilling by BMR, petroleum exploration bores, seismic surveys, and an extensive program of wireline logging of water-bores by BMR.

The geological sketch map (Fig. 1) is generalized from three 1:1 000 000 scale maps, of the Eromanga Basin in Queensland. The structural sketch map (Fig. 2) has been generalized from a map produced by Exon & Senior (in prep.). In the last 15 years about 640 water-bores have been wireline-logged in the basin and they and 100 petroleum exploration wells have enabled basinwide correlations (Figs 3, 4, and 5) to be made and the basinwide stratigraphy to be understood. The correlation lines are located in Figure 2.

The purposes of this paper are to:

(i) Formally define a new unit, the Wyandra Sandstone Member of the Cadna-owie Formation (Wopfner, Freytag, & Heath, 1970).

(ii) Rename the Toolebuc Limestone (Casey, 1959; Vine, Day, Milligan, Casey, Galloway, & Exon, 1967) the Toolebuc Formation and present a type section.

(iii) Discuss changes of usage of the names Hooray Sandstone and Cadna-owie Formation and review the geology of these units and of the Toolebuc Limestone.

DISCUSSION

Whitehouse (1954) first introduced basinwide nomenclature for the Eromanga Basin (Table 1). As regional mapping in Queensland proceeded, Whitehouse's nomenclature was modified in turn by Casey (1959), Vine & Day (1965), Exon (1966), and Vine et al. (1967). The regional mapping in Queensland is now complete, and we propose the further updating of nomenclature to that shown in Table 1. The major changes are the recognition

TABLE 1. COMPARISON OF NOMENCLATURE

AGE	SOUTHWESTERN EROMANGA BASIN IN SOUTH AUSTRALIA Wopfner et al. (1970)	EROMANGA BASIN IN QUEENSLAND This paper	EROMANGA AND SURAT BASINS Whitehouse (1954)
Albian to earliest Cenamanion	Winton Formation	Winton Formation	Winton Formation
	Mt Alexander Sst Member	Mackunda Formation	Tambo Formation
	Oodnadatta Formation	Allaru Mudstone	
	Wooldridge Limestone Member	Toolebuc Formation	
		Wallumbilla Formation: Coreena Member	
Aptian	Bulldog Shale	Wallumbilla Formation: Doncaster Member	Roma Formation
	Mt Anna Sst Member	Wyandra Sst Member	Blythesdale Group: Transition Beds
	Cadna-owie Formation	Cadna-owie Formation	
Neocomian	Algebuckina Sandstone	Hooray Sandstone	Blythesdale Group: Mooga Sandstone; Fossil Wood Beds; Gubberamunda Sandstone
Jurassic		Westbourne Formation	Walloon Coal Measures
		Adori Sandstone	
	No deposition	Birkhead Formation	

of the Cadna-owie Formation throughout most of the Eromanga Basin, and renaming Toolebuc Limestone the Toolebuc Formation. The name 'Wyandra Sandstone Member' is proposed for a distinctive sandstone in the Cadna-owie Formation in Queensland. This rationalization makes a comparison with South Australian nomenclature relatively simple (Table 1).

A regional review of the entire Cretaceous sequence is provided by Exon & Senior (in prep.), so the following discussion will be confined to the Hooray Sandstone, Cadna-owie Formation, and Toolebuc Formation.

Hooray Sandstone

Exon (1966) defined the Hooray Sandstone from outcrop in the Tambo area and noted an unconformity within it. In outcrop the lower part consists largely of fine-grained sublabile sandstone deposited by southerly-flowing streams, and the upper part consists largely of pebbly, medium to coarse-grained sandstone deposited by northwesterly-flowing streams. The outcrop sequence is underlain by the Late Jurassic Westbourne Formation and overlain by the Aptian Doncaster Member of the Wallumbilla Formation.

In the subsurface the very widespread aquifer-bearing sandy sequence between the Westbourne Formation and the Wallumbilla Formation has since been named Hooray Sandstone. This sequence also consists of lower and upper parts, and the terms 'lower Hooray Sandstone' and 'upper Hooray Sandstone' have been widely applied to them (e.g. Galloway, 1970). However in the subsurface, unlike outcrop, the lower part is coarse-grained, and the upper part fine-grained.

The upper pebbly coarse-grained sequence of outcrop is lithologically very similar to the 'lower Hooray Sandstone' sequence in the subsurface and we believe that the two sequences are the same. This means that the subsurface 'upper Hooray Sandstone'(Cadna-owie Formation) has no lithological correlate in outcrop and that the outcropping 'lower Hooray Sandstone' must be local marginal facies.

Accordingly, in the subsurface, we propose to restrict the name Hooray Sandstone to the coarse-grained sandstone sequence formerly known as 'lower Hooray Sandstone'. The upper sandstone-siltstone-mudstone part of Galloway's (1970) 'Hooray Sandstone' can be traced into South Australia (Fig. 3) where it was named the Cadna-owie Formation by Freytag, Heath, & Wopfner (1967) and fully defined by Wopfner et al. (1970). This name will now be used in the Queensland part of the Eromanga Basin.

The Hooray Sandstone can be traced westward in the subsurface into the Boulia area (Fig. 4) where it was named the Longsight Sandstone in outcrop (Casey, 1959). The Longsight Sandstone, unlike the Hooray Sandstone, is of marine origin. Because the two units are lithologically similar, laterally continuous, and cannot be differentiated in wireline logs, we believe that one name should be used for both. As the name Hooray Sandstone was used first (Woolley, 1941) and is widely accepted in the Eromanga Basin we propose that the name Longsight Sandstone be dropped. The Hooray Sandstone in the deeper part of the Eromanga Basin grades westward into the Algebuckina Sandstone (Table 1), northward into the partly marine Gilbert River Formation of the Carpentaria Basin, and eastward into the Mooga Sandstone, Orallo Formation, and Gubberamunda Sandstone of the Surat Basin. The formation crops out in the northwest, northeast, and south.

Cadna-owie Formation

The Neocomian to early Aptian Cadna-owie Formation can be readily traced eastward from South Australia into Queensland where it averages 60 m thick. In Queensland it is restricted to the subsurface, and consists of medium-grained quartzose to sublabile sandstone with siltstone especially abundant toward the base. A widespread quartzose sandstone unit at the top of the formation, a major aquifer, is here named the Wyandra Sandstone Member.

Shell fragments have been recorded in the formation in the Alliance Oil Development well completion reports of Gilpeppee No. 1 Cumbroo No. 1, Thunda No. 1, and Yongala No. 1 wells. Glauconite has been recorded in Cumbroo No. 1 and several other wells and a few microplankton are present in places. The formation is regarded as paralic in outcrop (Wopfner et al., 1970), and from the above evidence appears to be paralic in the subsurface as well.

The widespread, thin well-sorted quartzose Wyandra Sandstone Member is conformably overlain by marine mudstone of the Wallumbilla Formation and was probably a transgressive marine sand. The equivalent Mt Anna Sandstone Member of South Australia (Wopfner et al., 1970) is non-marine, lithologically distinct, and may not be laterally continuous with the Wyandra Sandstone Member.

The Cadna-owie Formation in the deeper part of the Eromanga Basin grades northwestward into the marine upper part of the Hooray Sandstone, northward into the marine upper part of the Gilbert River Formation of the Carpentaria Basin, northeastward into the freshwater upper part of the Hooray Sandstone, and eastward into the paralic Bungil Formation of the Surat Basin (Exon & Senior, in prep).

Toolebuc Formation

The late Albian Toolebuc Formation was named the Toolebuc Limestone by Vine et al. (1967). We have renamed it because it is a heterogeneous unit consisting dominantly of siltstone and mudstone, with limestone (including coquinite) a subordinate although characteristic rock type.

The formation has a strong positive gamma-ray anomaly which makes it a splendid wireline-log marker. This can be traced very widely in Queensland in the Eromanga Basin (Figs 3, 4, and 6) and into South Australia

(Fig. 3) and New South Wales (Fig. 5). In southwestern Queensland the anomaly persists although limestone is absent, indicating that limestone does not produce the anomaly. The formation pinches out in the southeast near the northern and northwestern margins of the Thargomindah and Cunnamulla Shelves (Fig. 6). It can be traced into northwestern New South Wales (Fig. 5), but its palynostratigraphic equivalents are not present in DM Wanaaring No. 1 (Byrnes, Morgan & Scheibnerova, 1975). The formation has not been reported in outcrop in New South Wales, but if the formation contains no limestone, its identification would be difficult.

WYANDRA SANDSTONE MEMBER OF THE CADNA-OWIE FORMATION-DEFINITION

Derivation of name and type section: The type section lies between 357 and 373 m in water-bore No. 2049 (Queensland Irrigation and Water Supply Commission records), located 15km northeast of Wyandra township in southeast Queensland, from which the member is named. The location of the type section (long. 146° 5' 30"E, Lat. 27° 10' 10"S) is shown in Figure 2 and a gamma-ray log of the sequence is shown in Figure 7.

Distribution: Widespread in the central part of the Eromanga Basin in Queensland, and extends into northeast South Australia and northwest New South Wales.

Lithology: Medium to coarse-grained quartzose to sublabile sandstone with scattered pebbles and carbonate cement. Driller's lithological logs of water-bores record it as 'sandrock' or 'sandstone'. The sandstone is porous and permeable and is stratigraphically the highest major aquifer in the Great Artesian Basin.

Water: Major supplies of artesian water come from the member. Conductivity measurements (Thomas, 1971a, b) can be used to distinguish water-bores drawing water from this sequence, from bores drawing more saline water from the overlying Rolling Downs Group, or bores drawing less saline water from the underlying Hooray Sandstone. Chemical analyses and the conductivity

TABLE 2. CHEMISTRY OF WATER FROM THE WYANDRA SANDSTONE MEMBER AND HOORAY SANDSTONE ON THE CUNNAMULLA SHELF.

	WYANDRA SANDSTONE MEMBER* Analyses (ppm)		HOORAY SANDSTONE* Analyses (ppm)	
	Average	Range	Average	Range
Sodium	312	(277 - 393)	195	(163 - 247)
Calcium	4	(2 - 7)	3	(2 - 4)
Magnesium	0.8	(0 - 3)	0.8	(0 - 2)
Iron	-	-	-	-
Chloride	118	(64 - 260)	72	(60 - 92)
Fluoride	0.6	(0 - 1.0)	0.5	(0.45 - 0.60)
Sulphate	0.12	(0 - 6)	0.2	(0 - 1)
Carbonate	-	-	-	-
Bicarbonate	643	(605 - 693)	368	(326 - 526)
Conductivity at 25°C (microsiemens/cm)	1124	(1100- 1220)	758	(640 - 999)
Estimated corresponding total dissolved solids (ppm)	739	(592 - 964)	470	(390 -586)
pH	7.6	(7.3 - 7.9)	7.4	(7.0 - 7.9)

*5 analyses by the Government Chemical Laboratory, Brisbane.

of water samples from the Cunnamulla Shelf (Table 2) show that there are about 70 percent more dissolved solids in Cadna-owie water than in Hooray water.

Environment of deposition: Marine microplankton are present in Core 3 within this unit in stratigraphic drill hole BMR Eulo No. 1 (Senior, 1971). This widespread unit, with its uniform thickness and grainsize and good mineral sorting, lies within the paralic Cadna-owie Formation and immediately below the marine mudstone of the Doncaster Member of the Wallumbilla Formation. On this evidence it is probably a transgressive beach sand.

Thickness: Ranges from 3 to 18 m, with little variation over considerable distances (Figs 3, 4, 5).

Relations: The member forms the upper part of the Cadna-owie Formation (formation defined by Wopfner et al., 1970) in much of the Eromanga Basin, and is conformably overlain by the Doncaster Member of the Wallumbilla Formation. It may be laterally continuous with the fluvial Mt Anna Sandstone Member (Wopfner et al., 1970) of South Australia, but continuity has not yet been proved. The abundance of red rhyolite pebbles which characterizes the Mt Anna Sandstone is not known in Queensland, and the highly lenticular beds of the Mt Anna Sandstone are unlike those of the Wyandra Sandstone.

Fossils and age: Spores and microplankton of Evan's (1966) spore division Kla recovered from the unit in the Eulo Ridge area (Senior, 1971) are of Neocomian to early Aptian age. On stratigraphic grounds the age of the member is late Neocomian and earliest Aptian.

TOOLEBUC FORMATION

The late Albian Toolebuc Member of the Wilgunya Formation was defined by Casey (1959) from the Boulia area of the northwest Eromanga Basin. Its wider distribution was outlined by Vine & Day (1965) and

Vine et al. (1967) upgraded the member to 'Toolebuc Limestone'.

Smart (1972) discussed the Toolebuc Limestone in detail and showed that it was a heterogenous unit, and that 'Toolebuc Formation' would be a more appropriate name, although he did not rename it. Casey (1959) had defined the Toolebuc Member as consisting of "about 30 feet of sandy calcarenite, calcareous siltstone and coquinite with some calcareous concretions....". Vine & Day (1965) stated that a large part of the member was platy or flaggy limestone with very thinly interbedded calcareous shale, and noted that it corresponded to a strong positive deflection of gamma-ray well logs. They pointed out that petroleum exploration lithological logs generally recorded it as a shale sequence with subordinate limestone. Vine et al. (1967) upgraded the member to Toolebuc Limestone, stating that limestone was the dominant rock type.

The present authors agree with Smart (1972) that the formation is heterogenous, and recent drilling by BMR (Senior & Smart, 1973 ; Burger, 1974) has confirmed that limestone is subordinate to calcareous and bituminous siltstone, black labile sandstone, and shale. Limestone is absent in some areas (Williamson, 1967; D. Senior, 1971). In outcrop (e.g. in the type area) the more resistant limestone tends to dominate, leading to the use of 'Toolebuc Limestone' by Vine et al. (1967).

Accordingly, we propose to use the name Toolebuc Formation for the calcareous heterogenous sequence which overlies the relatively non-calcareous siltstone and mudstone of the Wallumbilla Formation, and underlies the relatively non-calcareous mudstone of the Allaru Mudstone.

The Toolebuc Formation can be distinguished from the adjacent formations by its general high carbonate content, and in wireline logs by the positive gamma-ray anomaly. The highest gamma-ray peaks generally coincide with organic-rich argillaceous sediments rather than limestone. They may be due to high potassium concentrations in clay minerals,

concentrations of uranium in organic matter, or uranium associated with the phosphate which is commonly present. Variations in the characteristic gamma-ray anomaly throughout the Eromanga Basin are shown in Figure 6.

Type section - discussion: Casey (1959) nominated a type area 'on the Boulia-Winton main road, 7 miles east of Hamilton', Boulia 1:250 000 Sheet area, and a reference section '6 miles west of Spring Creek artesian bore'at Longitude 140° 33'E and Latitude 23° 11'S. In accordance with the suggestions of the Australian Code of Stratigraphic Nomenclature, upgrading of the reference section to type section status was considered. Unfortunately this could not be done, because the published geographic location of the reference section is difficult to locate on the ground, and there are further uncertainties about the intended location as the unit crops out over several kilometres, whereas the reference section is a point. During discussion with the original proposer it was agreed that a new type section should be proposed which is typical of the original concept (J.N. Casey, pers. comm). Because outcrop is poor a drill-hole section near the type area is nominated (Fig. 8).

Type section - definition: The type section of the Toolebuc Formation is designated as the sequence between 25.3 and 35.8 m in stratigraphic drill hole BMR Boulia No. 3A. The hole was drilled 13.7 km east of Hamilton Hotel, about 100 m north of the Boulia-Winton Highway (hole location 140° 43' 30"E, 22° 47' 00"S). The sequence consists of black mudstone with a few thin limestone beds and shell fragments down to 30.5 m, and hard concretionary limestone and thin crystalline limestone beds interbedded with soft black mudstone down to 35.8 m. The core is available for inspection at the Bureau of Mineral Resources Core and Cuttings Laboratory, Fyshwick, A.C.T.

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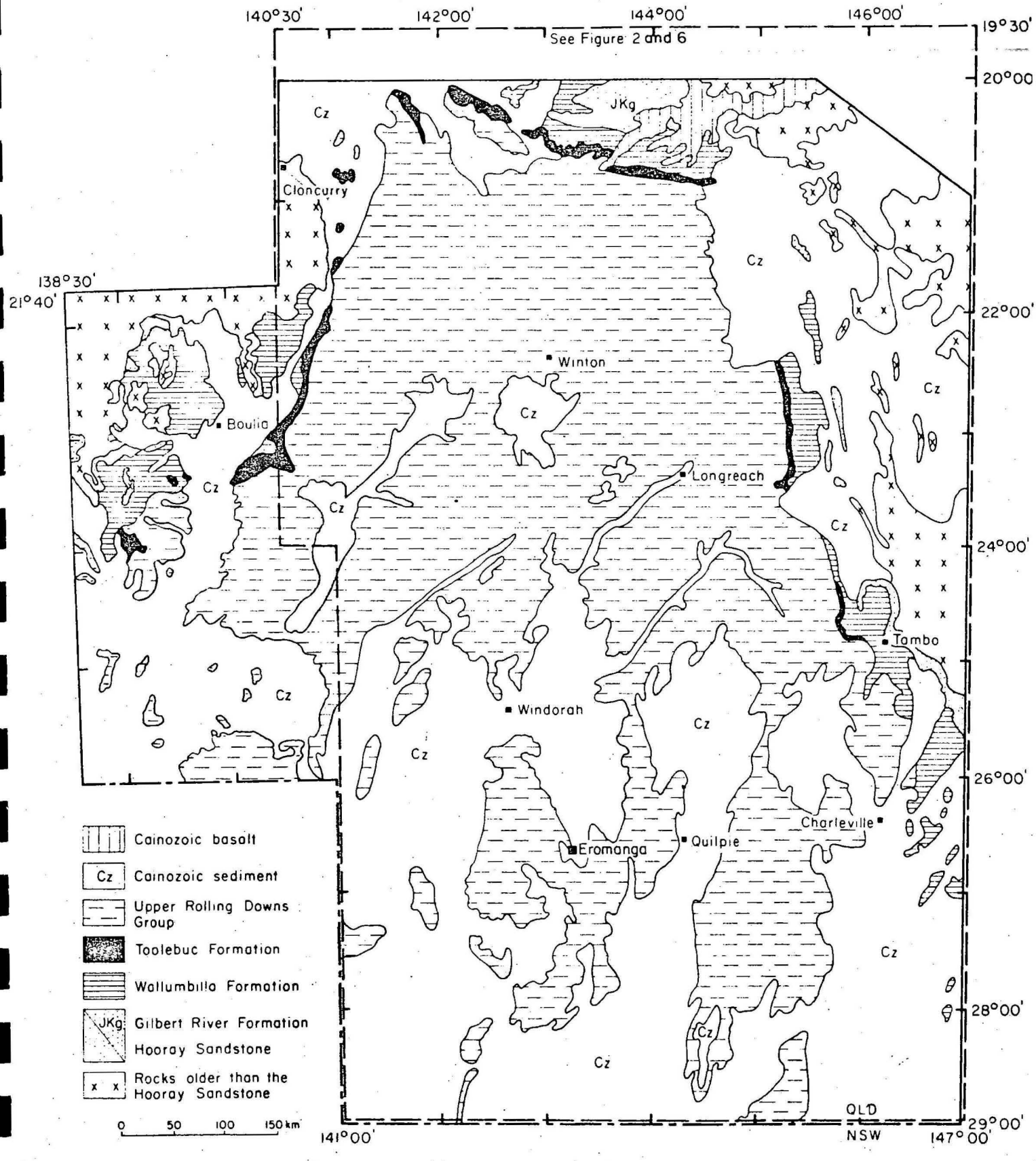

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Fig. 1 Geological sketch map

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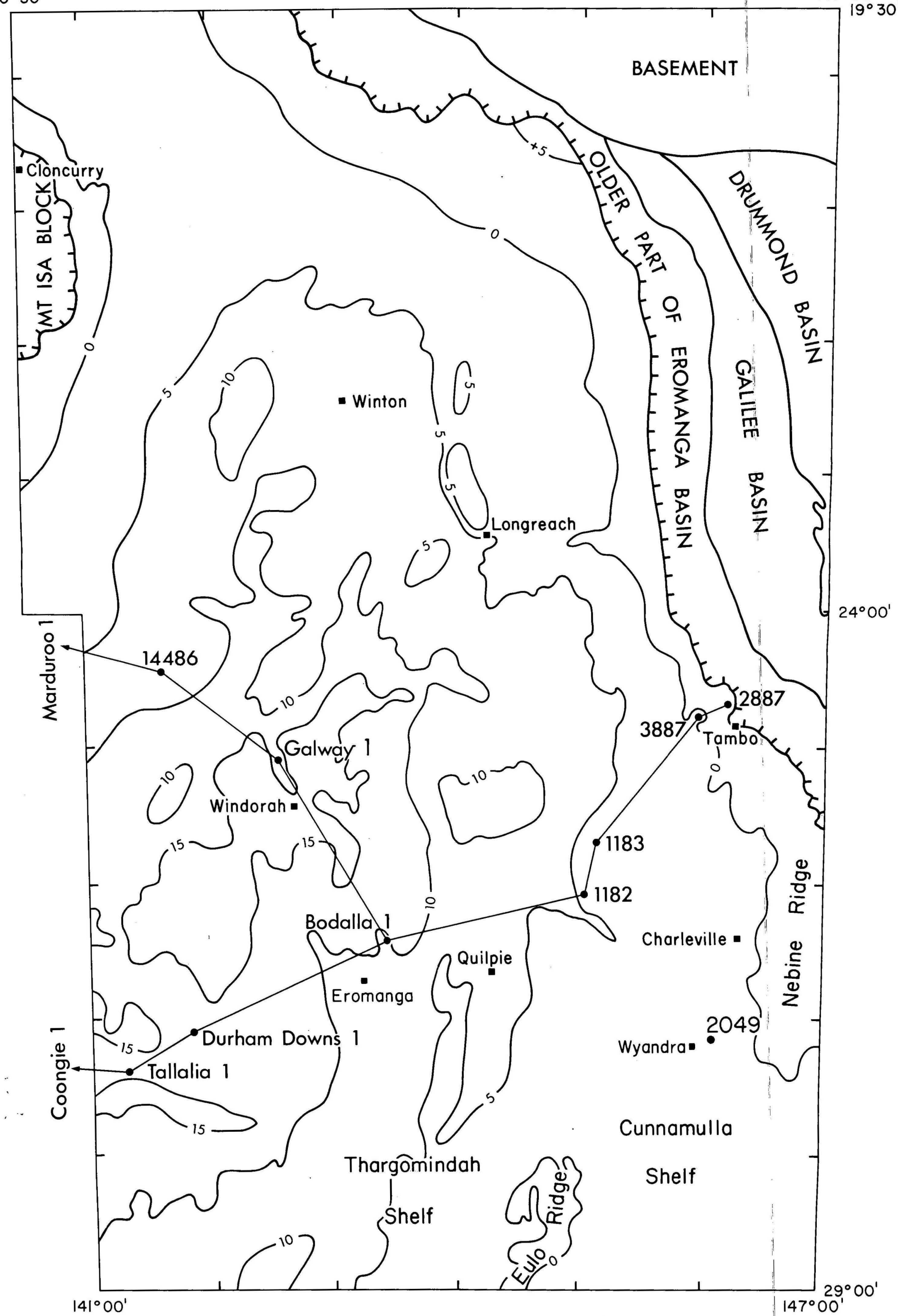

Fig. 2 Structural sketch map: contours on base of Rolling Downs Group

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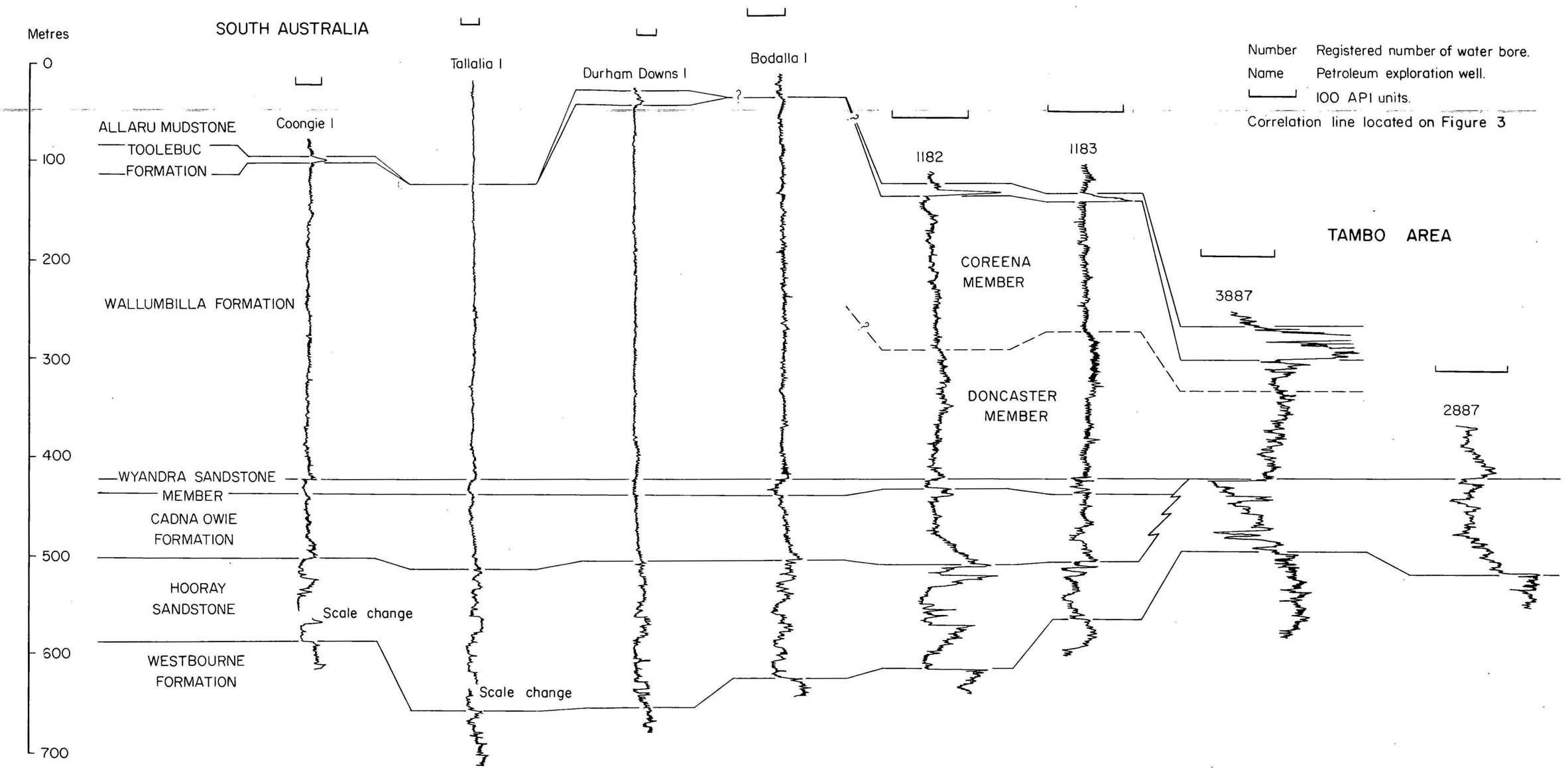


Fig 3 Gamma-ray log correlation line from the Tambo area to northeast South Australia.

J.Q. M(G) 530

Number Registered number of water bore
Name Petroleum exploration well
100 API units
Correlation line located on Figure 3

Metres

BOULIA AREA

EROMANGA AREA

14486

Marduroo 1

Galway 1

Bodalla 1

0
100
200
300
400
500
600
700
800
900

WINTON FORMATION

MACKUNDA FORMATION

Cainozoic sediments

ALLARU MUDSTONE

TOOLEBUC FORMATION

WALLUMBILLA FORMATION

HOORAY SANDSTONE

WESTBOURNE FORMATION

Proterozoic basement

WYANDRA SANDSTONE MEMBER

CADNA-OWIE FORMATION

Fig 4 Gamma-ray log correlation line from the Eromanga area to the Boulia area.

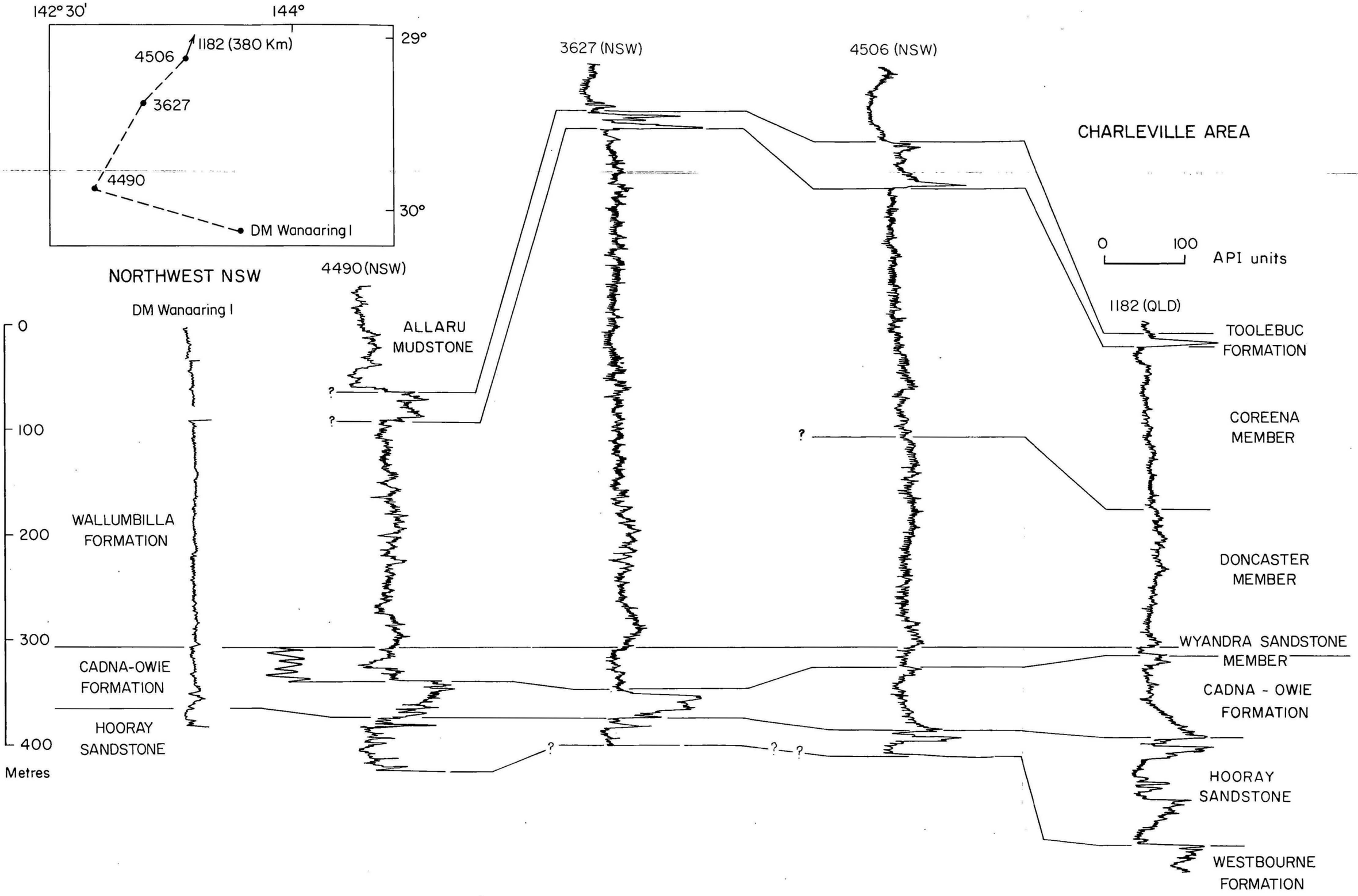
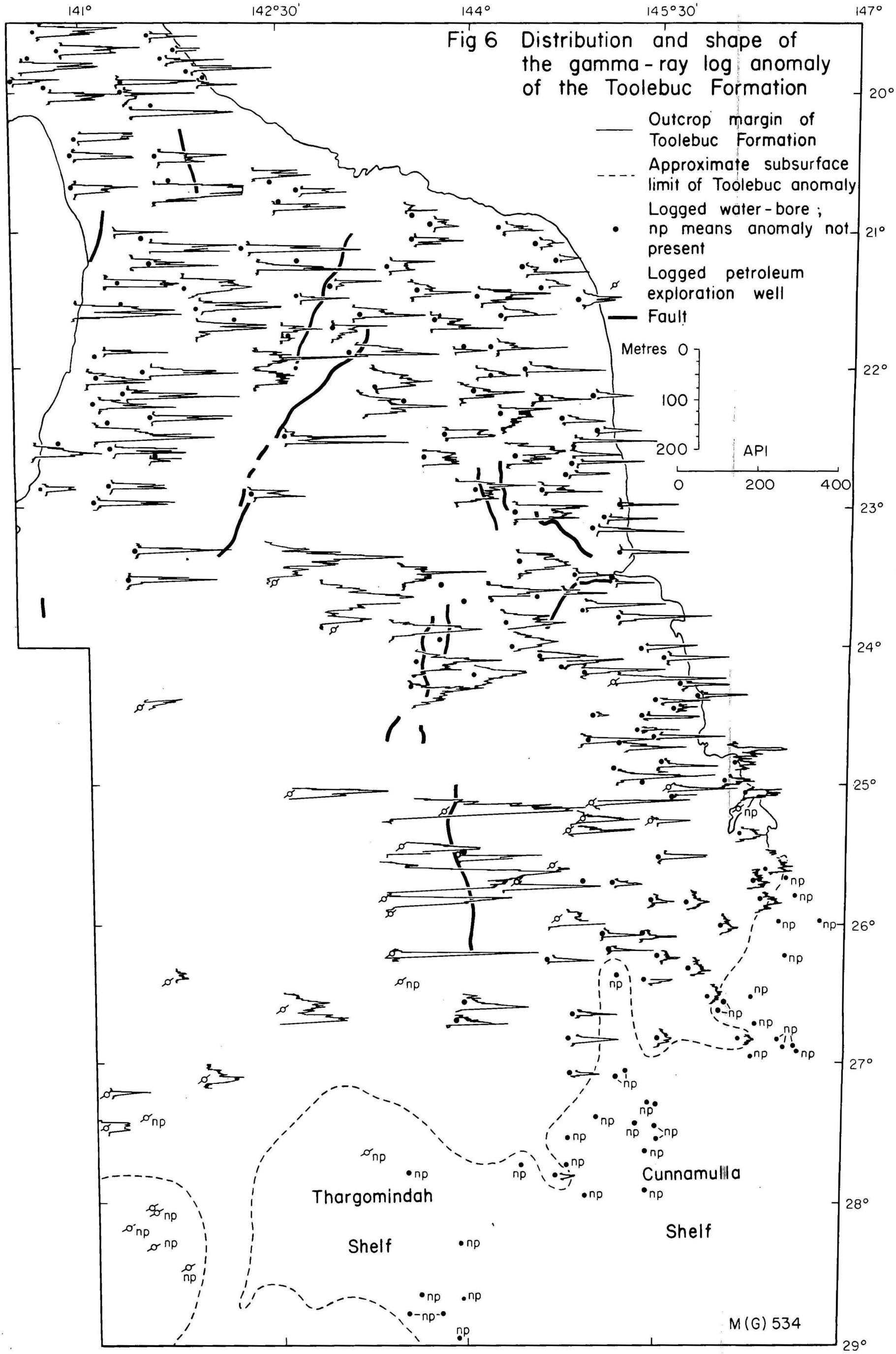


Fig 5. Gamma-ray log correlation line from the Charleville area to northwest New South Wales

Fig 6 Distribution and shape of the gamma-ray log anomaly of the Toolebuc Formation



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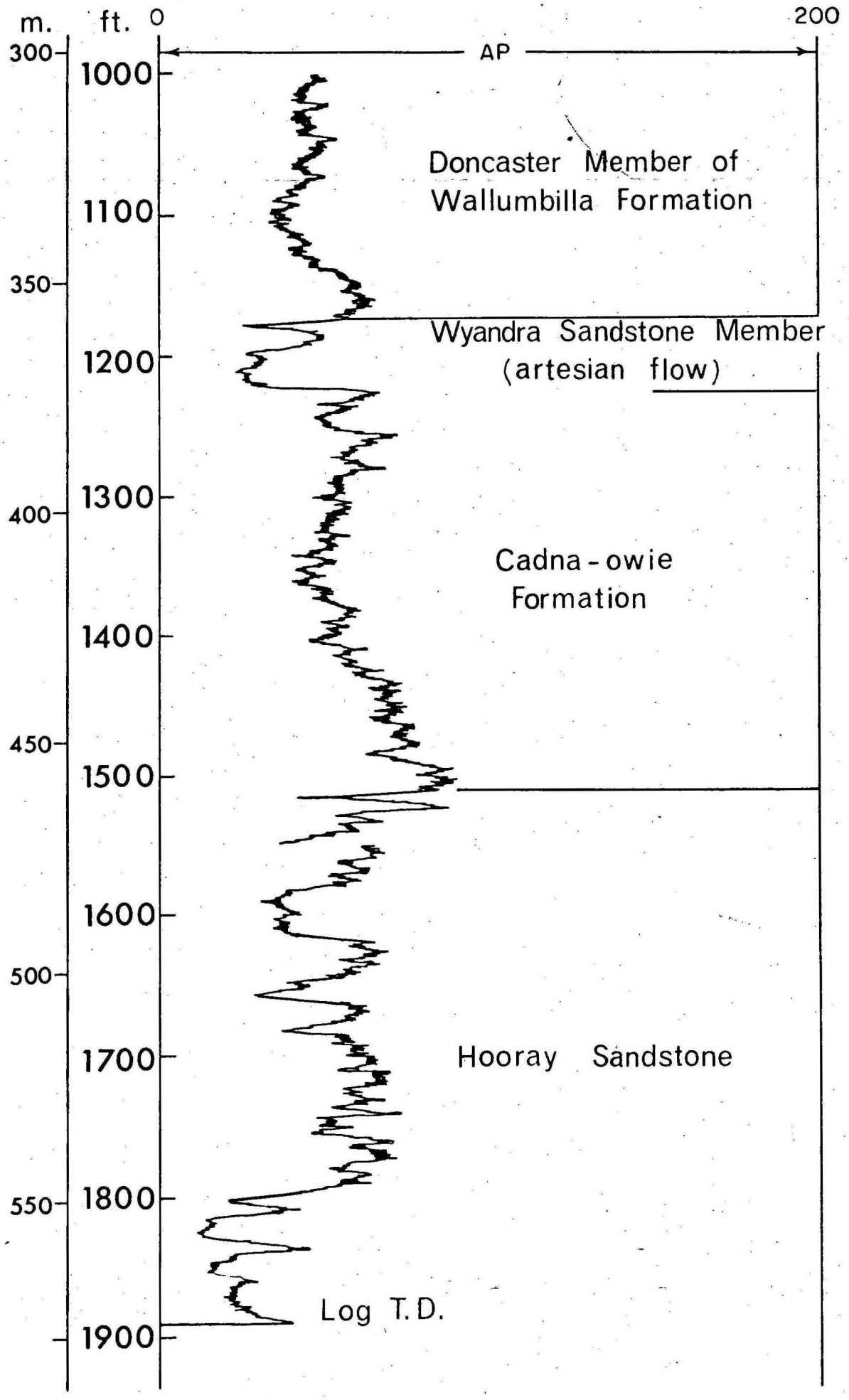

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Fig. 7 Gamma-ray log of type section of Wyandra Sandstone Member of Cadna-owie F. from water bore number 2049

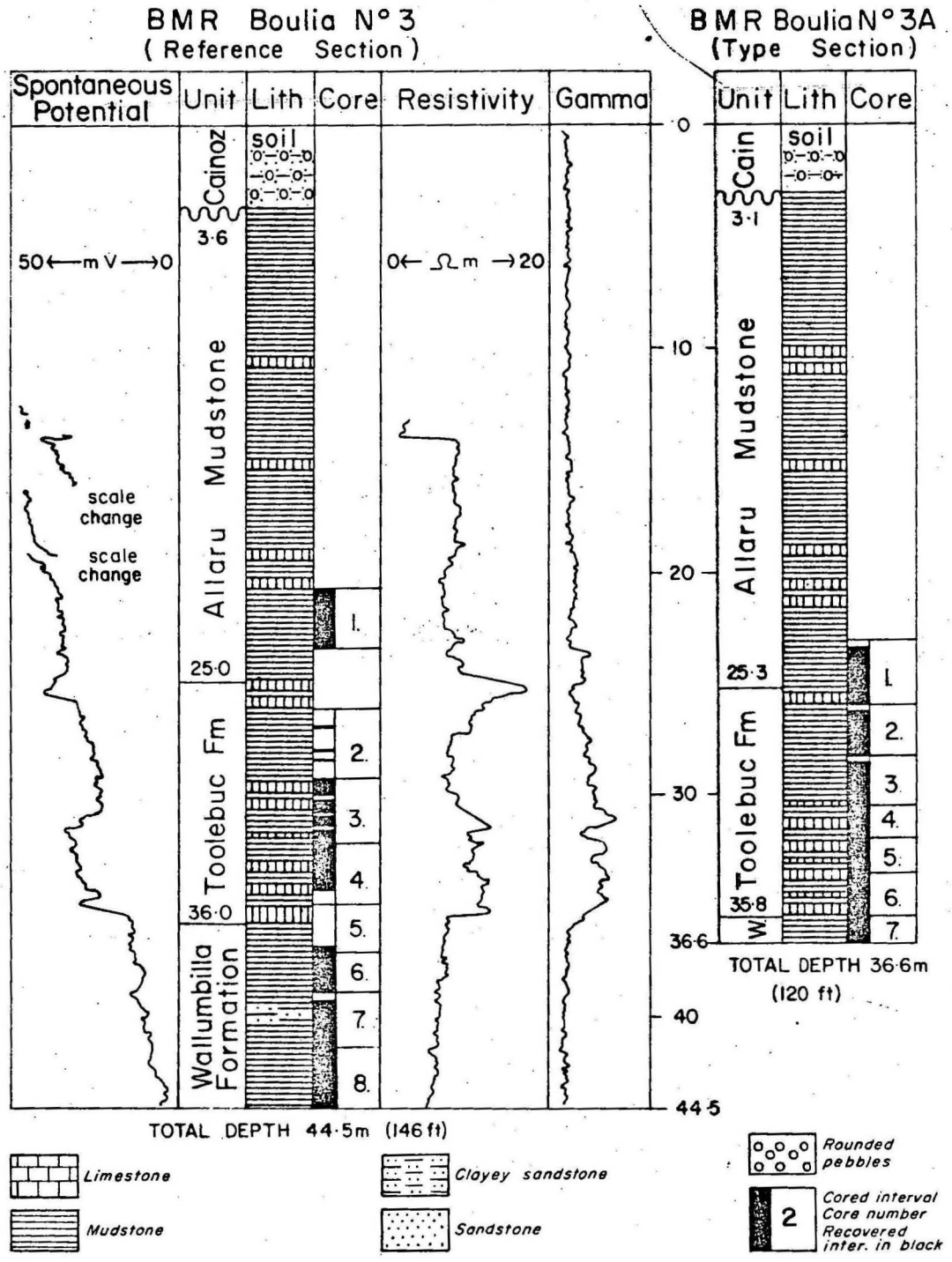

Fig.8 Type Section of Toolebuc Formation in B M R Boulia N° 3A Stratigraphic Drill Hole and reference sec B M R Boulia N° 3

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