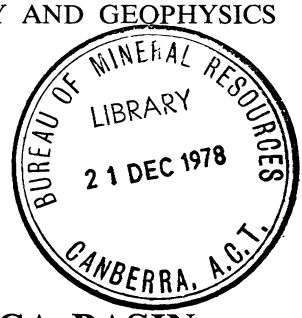
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BULLETIN 167

GEOLOGY OF THE EROMANGA BASIN

B. R. Senior, A. Mond, & P. L. Harrison

PART A. Notes on the geology of the northern part of the Eromanga Basin, Queensland

by

B. R. Senior, P. L. Harrison, & A. Mond

PART B. Notes on the geology of the central part of the Eromanga Basin, Queensland

by

B. R. Senior

PART C. Notes on the geology of the northwestern part of the Eromanga Basin, Northern Territory and Queensland

by

A. Mond & P. L. Harrison

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PART A

Notes on the geology of the northern part of the Eromanga Basin, Queensland

BY

B. R. SENIOR, P. L. HARRISON, & A. MOND

SUMMARY

The northern part of the Lower Jurassic to Upper Cretaceous Eromanga Basin rests on parts of the Georgina (Cambrian-Ordovician), Drummond (Devonian-Carboniferous), and Galilee (Permian-Triassic) basins and older basement. To the north, the Eromanga Basin is continuous with the Carpentaria Basin of similar age across a shallow basement feature, the Euroka Arch.

The Jurassic sequence is mainly terrestrial, with fluvial quartzose rocks interbedded with carbonaceous argillaceous rocks. The Lower Cretaceous sequence is largely marine. The marine transgression coincided with a change of provenance as quartz-rich sediments were succeeded by quartz-deficient labile arenites and argillaceous sediments derived from a basic to intermediate volcanic source. Late Lower Cretaceous rocks were deposited in a regressive sea and the youngest part of the Eromanga Basin sequence was laid down in a lacustrine and fluviatile environment. In the southwest the Upper Cretaceous rocks are extensively chemically weathered, and the profile is the host rock to precious opal deposits.

Parts of the northern Eromanga Basin are covered sporadically by Tertiary and more generally by unconsolidated Quaternary sediments. Most of the Tertiary sediments are arenaceous and were deposited in extensive river systems, and in small elliptical shallow basins filled by fine-grained clastics, together with a little limestone and chert. In the Middle Tertiary a second phase of chemical weathering transformed the quartzose Tertiary sediments into silcrete, and under a more humid climate in the north produced ferruginous cappings.

The northern part of the Eromanga Basin is essentially a near-horizontal sheet of strata dipping and thickening towards a central south-plunging axis; local structure is mainly of two types: drape folds over basement ridges, and basement faults which grade to monoclines at the surface.

Apart from potential hydrocarbons, groundwater is the main economic resource. Most aquifers are within Jurassic arenites. There is potential for further precious opal discoveries in the chemically weathered Winton Formation. Construction materials (gravel and sand) occur in Jurassic strata but are lacking in the Cretaceous. Indurated weathered rocks provide materials for local road surfacing.

INTRODUCTION AND PREVIOUS INVESTIGATIONS

The Eromanga Basin, one of the most extensive sedimentary basins in Australia, is part of the trans-Australian platform cover (Geol.Soc. Aust., 1971), and is delineated on the Tectonic Map by the preserved limits of Jurassic to Lower Cretaceous sediments. The Eromanga Basin stretches from 20° to 32°S and from 132° to 147°E. It is composed of Lower Jurassic to Upper Cretaceous sedimentary rocks. To the north it is separated by the subsurface Euroka Arch from another basin of similar age, the Carpentaria Basin; to the east, similarly, from the Surat Basin; and to the south and west it is bounded by older basins and partly by 'basement'. The Eromanga Basin has an area of about 1 000 000 km^2. In order to produce a series of geological maps at a scale of 1:10^6 it became necessary to subdivide those parts of the basin in Queensland and Northern Territory arbitrarily into the northern, central, and northwestern parts.

The northern part of the Eromanga Basin, which is the subject of Part A of this Bulletin (Plate A1), is not, therefore, a geological entity in itself; although, naturally, some geological features are peculiar to it, it must be considered in the context of the Basin as a whole.

The Eromanga Basin is the youngest and most extensive of a number of sedimentary basins that have, since the Cambrian, filled depressions in the area. Within the area encompassed in this study there are four such older basins: the Georgina Basin of Cambrian to Ordovician age, the Adavale and Drummond Basins of Devonian to Carboniferous age, and the Galilee Basin spanning the Late Permian and Triassic. Though the purpose of this Bulletin is to outline the stratigraphy, structure, history, and economic potential of the Eromanga Basin, some knowledge of these underlying basins is clearly necessary to an understanding of the Eromanga. However, they have

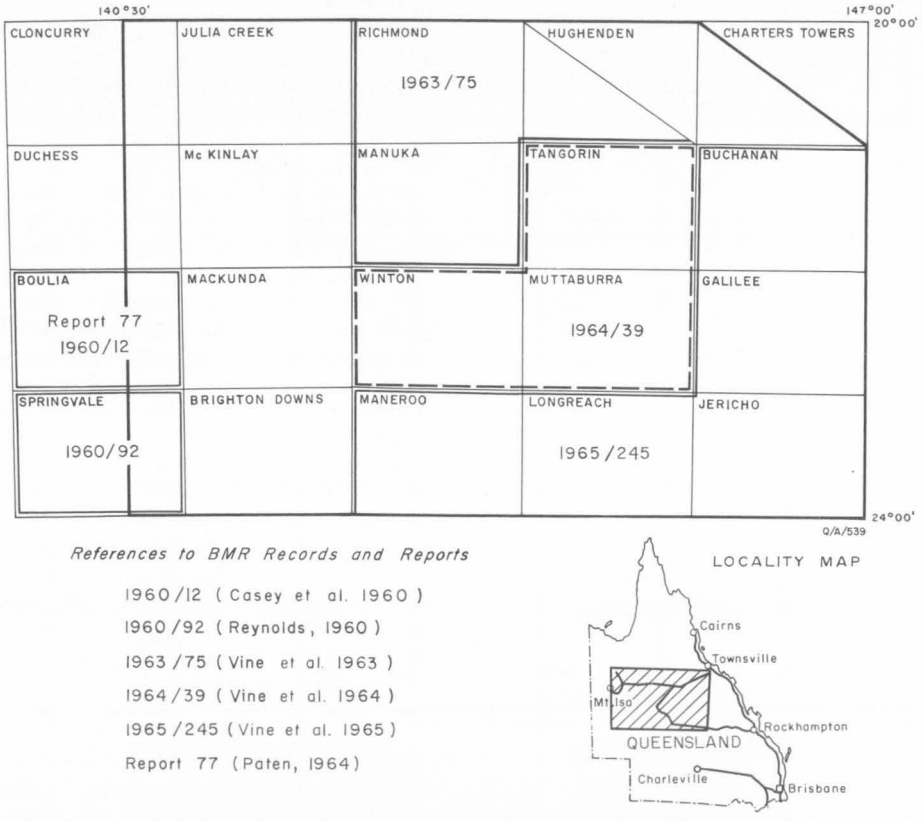


Fig. A1. Location map, and key to Explanatory Notes, BMR Reports, and BMR Records in the northern Eromanga Basin.

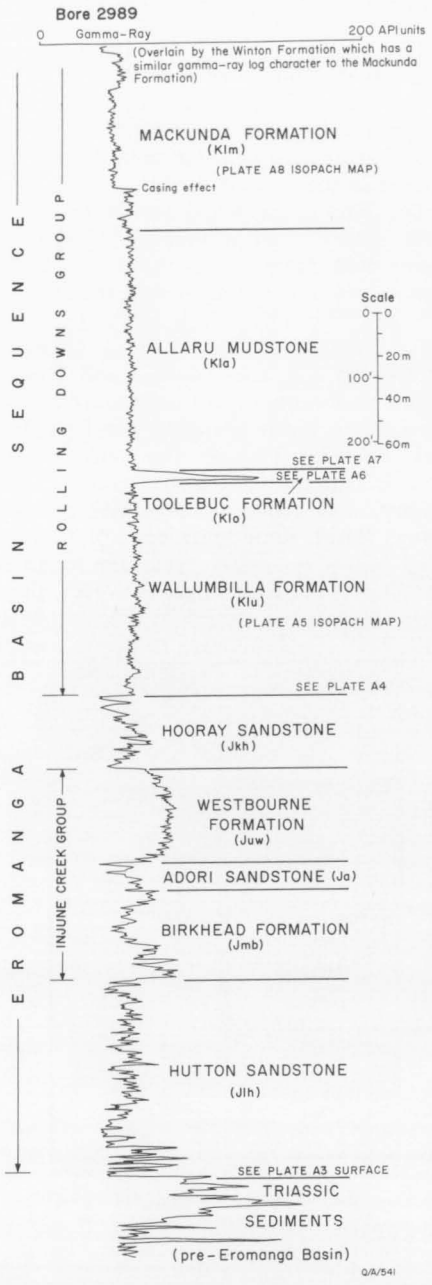


Fig. A2. Reference gamma-ray log of water bore showing divisions of the Eromanga Basin sequence, and the position of structure-contoured and isopached formations.

been adequately discussed in earlier reports and short papers and except where necessary will not be discussed further here.

This Bulletin is essentially a synthesis of the geological mapping of the Bureau of Mineral Resources and the Geological Survey of Queensland. The whole area was mapped at 1:250 000 scale between 1957 and 1967; the maps issued are listed, with date of issue and authors of accompanying notes, in Table A1, and located in Figure A1.

The joint mapping program provided the first comprehensive and systematic coverage of the area; earlier work on particular parts or aspects of the area is listed in references and, where relevant to the discussion, referred to in the text. Casey (1970) reported on the geology of the northern Eromanga Basin area with emphasis on the pre-Eromanga Basin rock succession.

The rocks are flat-lying, and outcrop is sparse; subsurface distribution and attitudes were interpreted with the aid of geophysics. Information on compilation of seismic surveys from the region is given in Appendix A1. The distribution of seismic lines and a key to companies or organisations that ran them are in Plate A2.

Gravity and magnetic surveys are listed in Table A2, and Bouguer anomalies derived from regional gravity surveys by the BMR are shown on the face of the map. Hsu (1974) synthesised and interpreted the magnetic data for the map area.

Gamma-ray logging of water bores in the northern part of the Eromanga Basin was begun by the Bureau of Mineral Resources in 1960 and still continues; by mid-1972 about 300 bores had been logged. Logs include gamma-ray, magnetic casing collar locator, self-potential and resistivity (in open or uncased holes), temperature, differential temperature, flowmeter, caliper, neutron, and some experimental spectral logging of anomalous zones of radioactivity. Water from most of the logged bores has been analysed; analyses may be consulted at BMR and the Queensland Irrigation and Water Supply Commission in Brisbane. Vine (1966) showed that basin-wide correlations could be made with gamma-ray logs, and his card index of formation tops, together with BMR and petroleum exploration drilling data, were a major source of information (Plate A2).

Some sixty stratigraphic drill holes, the deepest of which was 300 m, were drilled by BMR. Their location is shown in Plates A1 and 3. Cores and cuttings are available for examination at the BMR Core and Cuttings Laboratory, Fyshwick, ACT.

STRATIGRAPHY

EROMANGA BASIN

Basic information on the Jurassic and Cretaceous units in the northern part of the Eromanga Basin is summarised in Table A3. In addition to information on lithology, thickness, and relationships of strata, this table gives principal references to nomenclature and palaeontological work.

The distribution, structure and thickness of the units is portrayed in structure-contour and isopach maps at 1:1 million scale (Pls. A3 to 8).

A typical section through the main units showing their gamma-ray response, and the levels at which the structure contour and isopach maps have been drawn, is given in Figure A2. Time relations of the units are shown in Plate A1.

Brief descriptions of the main features of the structure contour and isopach map are given below.

Structure contours of the base of the Eromanga Basin sequence and the Rolling Downs Group (Pls. A3 & 4)

The structure contour maps were compiled using interpreted sections from petroleum exploration wells, gamma-ray-logged water bores, and seismic data. Contours are detailed and more reliable in areas with seismic coverage, particularly in the west-central area near Lovelle Downs 1 and in the southeast. Reliability is less in parts of the basin between areas of seismic coverage, and in these areas contours have been extrapolated over considerable distances. The regional structures shown by the two horizons—the bases of the Eromanga Basin sequence and the Rolling Downs Group—are broadly similar; the deepest part of the basin is an area bounded approximately by latitudes 22° and 24°S and by longitudes 142° and 144°E.

For the purpose of this Bulletin the base of the Eromanga Basin sequence (Pl. A3) is regarded as 'basement'. Within the basement the approximate limits of the Galilee (Permian-Triassic), Georgina (Cambrian-Ordovician), and Drummond (Devonian-Carboniferous) basins are shown. Where the unit underlying the Eromanga Basin sequence can be identified, it has been given a map symbol and described on the geological map reference (Pl. A1).

The geological map (Pl. A1) and the structure contours (Pls. A3 and 4) show that the northern part of the Eromanga Basin is cut by a series of normal faults trending northeast and downthrown to the west. Some faults trend between north and west. On both contour maps the two deepest areas are a trough-like depression trending north-northeast on the downthrown side of the Cork Fault near Lovelle Downs 1 and Goleburra 1, and a parallel texture west of Fermoy 1 and Mayneside 1. Several structural highs are apparent on the maps in areas without seismic coverage. On Plate A4 a high northwest of Langdale 1 can be seen, and on Plate A3 highs south of Fermoy 1 and northwest of Longreach.

The Eromanga Basin sequence is thickest and probably most prospective for petroleum in the southwest part of the map area. Much of this area has inadequate seismic coverage, especially the part north and west of Fermoy 1 and Mayneside 1. The area is cut by a major fault system, including the Cork Fault, which trends north-northeast and was mapped by seismic surveys between 22° and 23°S. The Holberton Structure mapped at the surface east of Ooroonoo 1 is probably part of the Cork Fault system. Whether the system extends to the area east and south of Ooroonoo 1 and whether there is a deep trough of sediments west of the fault in that area, similar to the trough west of the Cork Fault, can only be determined by further seismic survey.*

The seismic surveys in this area were mainly concerned with determining the structure and thickness of sediments older than the Eromanga Basin sequence, and the large quantity of seismic information is mainly relevant to the Permian and Triassic (Galilee Basin) sediments. The information about these older sediments was not examined in detail, but one area which requires further seismic coverage is south of Ooroonoo 1, where there appears to be a thick sequence of pre-Eromanga Basin sedimentary rocks. There, along a line of the Binburie seismic survey (Pl. A2), deep events, unconformable to the Eromanga Basin reflectors, were recorded down to 3 seconds, indicating that about 7000 m of sedimentary rock is present, 5000 m of which is probably older than the Eromanga Basin sequence.*

Isopach map of the Wallumbilla Formation (Pl. A5)

The Wallumbilla Formation can readily be distinguished on gamma-ray logs as it lies be-

* A seismic and gravity survey by BMR in 1975 threw some light on these problems (Harrison, Bauer, & Hawkins, in prep.).

tween the more highly radioactive Toolebuc Formation and arenitic strata of the Cadnaowie Formation or Hooray Sandstone (Fig. A2). The four members of the Wallumbilla Formation (Coreena, Ranmoor, Jones Valley, and Doncaster) are recognisable in outcrop (Pl. A1) but are difficult to differentiate on gamma-ray logs because labile arenite and argillaceous members have a similar radioactive response.

The Wallumbilla Formation ranges in thickness from 100 to a maximum of 240 m, near the axis of the basin in the south-central part of the area. South of the map area in the Wilson Depression it thickens to a maximum of 350 m (see Part B of this Bulletin).

Faults, many of which grade to monoclines at the surface, and folds were active during Wallumbilla time, and thickness variations straddle nearly all the structures. This is especially apparent across the Tara Structure, where gamma-ray logs indicate that the Wallumbilla Formation thickens eastwards from 44 to 57 m (see inset on Plate A6).

The Toolebuc Formation gamma-ray anomaly (Pl. A6)

The Toolebuc Formation is delineated on gamma-ray logs by a marked radioactive peak (Pl. A6). In outcrop the only portion of the unit seen is scattered limestone rubble and ovoid concretions. Drilling has shown that limestone is subordinate to black labile sandstone and siltstone with abundant shelly fossils. It seems likely that phosphate minerals associated with the shell debris give the marked radioactivity recorded on gamma-ray logs.

The gamma-ray anomaly is thickest and most pronounced in the south-central part of the map area, corresponding to the axial position of the Eromanga Basin. Senior (this volume, Part B) shows that this zone continues south to the central part of the Eromanga Basin, with further thick anomalies lying to the west of the Canaway Fault. The eastern margin of the Toolebuc Formation has thin rather elongate or reduced anomalies which may indicate the effect of weathering where the unit nears the surface. Major structures apparently had little effect on thickness or the sedimentological features responsible for the intensity of the gamma-ray anomaly. However, relatively small anomalies between the Weatherby Structure and Cork Fault may indicate minor interruptions to deposition due to movement along these faults in Toolebuc Formation time.

The Toolebuc Formation is commonly bituminous, and where it is close to the surface (Julia Creek and Hughenden Sheet areas) has been prospected for oil shale.

Structure contours on top of the Toolebuc Formation (Pl. A7)

The junction between the Allaru Mudstone and Toolebuc Formation can be defined with precision on gamma-ray logs (Fig. A2). It can be also picked on drillers' lithological logs of water bores where 'limestone' or 'black shale' is recorded within a monotonous sequence of 'shale' or 'mudstone'. Consequently this contour diagram has numerous data control points giving relatively reliable contours.

Most faults and folds are expressed by the Toolebuc Formation contour surface, indicating post-Toolebuc tectonism. The largest displacement of 250 m occurs along the central portion of the Cork Fault. On the St Elmo Structure, to the north, the Toolebuc Formation crops out; elsewhere outcropping Toolebuc Formation depicts the preserved limits of the northern part of the Eromanga Basin, and the outcrop distribution across the Euroka Arch shows connection with the Carpentaria Basin.

Towards the axis of the basin in the south-central part of the map the Toolebuc Formation contour surface extends to 900 m below sea level. In this and other deep parts of the basin a consistent reflector is seen on seismic records, which enabled the delineation of several ovate synclines and basins.

Isopach map of the Mackunda and Winton Formations (Pl. A8)

The lithological similarity between the Mackunda and Winton Formations makes their separation difficult. In the field the presence of marine fossils is the main criterion used to identify the Mackunda Formation. On gamma-ray logs they cannot be separated (see bore 1352, Pl. A8), but with other wireline logs run in petroleum exploration wells they can generally be distinguished. The conformable contact of the Mackunda Formation with the underlying Allaru Mudstone is also commonly difficult to determine on gamma-ray logs. The change from relatively smooth (Allaru Mudstone) to irregular lines (Mackunda Formation) on the graph is the basis of choosing the formation boundary (Fig. A2 and Pl. A8). Because of uncertainties in separating the Winton and Mackunda Formations on wireline logs and the absence of reliable lithological descriptions on water bore drillers' logs, the data are relatively sparse

and the isopachs show only a few major features.

The upper limit of the Winton Formation is an erosion surface coincident with the present land surface except where the unit is unconformably overlain by thin Cainozoic sedimentary rocks or more generally by Quaternary sediments.

The maximum thickness of the combined Winton and Mackunda Formations (800 m) is found in the south-central portion of the map area. In the Cooper Syncline and Wilson Depression south of the map they reach a maximum thickness of 1100 m (this volume, Part B).

In part of the McKinlay Sheet area the Mackunda and Winton Formations are characterised by anomalous high radioactivity as shown by gamma-ray-logged water bores (e.g. compare bores 3255 and 11142 in Plate A9). The anomaly is as intense as, and in places more intense than, that of the one corresponding to the Toolebuc Formation, and in bore 3255 it extends over 120 m. The cause is unknown, but it could be due to a higher than normal content of organic matter, or to the presence of phosphatic or potassium minerals. Smaller radioactive anomalies along the western margin of the Eromanga Basin in the Springvale Sheet area (Senior & Hughes, 1972) were shown to be due to the presence of alunite, svanbergite, and goyazite.

Chemical weathering

In the Late Cretaceous and Early Tertiary the Rolling Downs Group was deeply weathered. The labile arenites of the Mackunda and Winton Formations, which consist mainly of feldspar grains and rock fragments, were deeply weathered, in places to a depth of 100 m. The weathering involved an overall hardening of the parent rock, and the mobilisation of silica, iron, and alumina due to the breakdown of feldspar and transformation of montmorillonitic to kaolinitic clay minerals. Parent sedimentary textures are preserved and commonly emphasised by the accumulation of iron oxides along bedding planes. A distinct weathering profile is recognised, in which iron oxides are concentrated in the basal third of the weathered layer. The distribution of the chemical weathering in the Rolling Downs Group is shown on the geological map by a fine stipple pattern.

Senior (1972 & this volume, Part B) discusses the regional significance of chemically weathered rocks in southwest Queensland and suggests that they are one phase of a complex weathering history which produced three groups of weathered rocks.

Within the map area weathered Rolling Downs Group is preserved in a series of mesas in the southwest. They occupy a central zone within the basin as a whole, with an eastern margin which approximates the regional strike direction of the basin margin.

In the Central Eromanga Basin (Senior, this volume, Part B) these weathered rocks are gently folded and in places faulted. The weathered section is the host rock for precious opal.

CAINOZOIC SEDIMENTS (POST-EROMANGA BASIN)

Tertiary and Quaternary sediments cover large areas of the northern Eromanga Basin area (Pl. A1). Eight Tertiary units have been formally named (Noakes & Traves, 1954; Paten, 1960, 1964; Vine, 1964c), and include carbonates, argillaceous and arenaceous sediments, and siliceous sinters. No synthesis of the units has been published, although some areas have been described in detail, for instance in various unpublished Records and in Explanatory Notes to Sheet maps. However, specific areas within or close to the map area have been reported in detail, in particular by Paten (1964), who described the rocks, fossils, and weathering history of four Tertiary basins in the Boulia area.

The most extensive tertiary unit is the Glendower Formation, consisting mainly of quartzose rocks. It has a ribbon-like distribution in the map area, and is interpreted as having been formed in an ancient river system which drained towards the south of the area to link with widespread sedimentation in broad shallow tectonic basins (see Tectonic Map, Geol. Soc. Aust., 1971) within the central part of the Eromanga Basin. Quartzose sandstone beds of the Glendower Formation have been silicified to form silcrete (stippled areas on map). Senior & Senior (1972) discuss the origin of silcrete and show that western Queensland silcretes are markedly similar in composition throughout the region. In areas of thick quartzose sediments several beds of silcrete may occur—the result of silicification governed by bedding geometry and the porosity and permeability characteristics of the parent rock.

Unconsolidated Quaternary sediments are widespread and very varied, and in Plate A1 are collectively grouped as sediments of low

plains and slopes (map symbols Q and Cz) and younger sediments of floodplains (Qa). Two formations are differentiated in the northwest (Czy and Qw) and were photo-interpreted as continuing south into the map area from the Carpentaria Basin.

STRUCTURE

The Eromanga Basin sequence in the map area dips gently and thickens towards a south-plunging central axis (see inset structure and distribution of basin elements in Plate A1). Structure contour maps show that dips seldom exceed 1°.

The Holberton and Weatherby Structures and the Cork Fault trend north-northeast across the map area, and are adjacent to a marked gravity trend known as the Diamantina Gravity Gradient (Pl. A1). All are faults at depth and in part grade upwards to monoclinal folds. These structures form part of an *en echelon* zone of folds and faults which extends from the Cordillo-Betoota area of South Australia to the Georgetown Inlier and are long-surviving fundamental structures which delineate the margin of the Tasman Geosyncline and the Precambrian Craton.

The Stormhill Fault and Westland Structures, together with a parallel series of faults revealed by seismic surveys, outline a zone of tilted basement fault blocks in the south-central part of the map (Pl. A1, section EF). These faults are part of a major north-trending system which appears as a single large fault (Canaway Fault) to the south. Smaller structures are drape folds over basement ridges, such as the Beryl Anticline, and basement faults, some of which grade to monoclines near the surface, for example the Hulton-Rand and Tara Structures in the southeast. Both are generally represented at the surface by linear trends of calcareous lag gravel on a planar landsurface, which give a distinctive airphoto pattern.

GEOLOGICAL HISTORY

Eromanga Basin sedimentation started on a bevelled surface of Galilee Basin and older 'basement' rocks when quartzose and sublabile sand, with some silt and plant debris, were being deposited by rivers and in lakes. By late in Early Jurassic time two drainage systems were in existence, one draining north to the Burketown Depression (Carpentaria Basin), and a second, larger, radial system occupying the southern two-thirds of the map area, and draining south towards the region of maximum sagging of the basin. This region approximates the position of the concealed Cooper Basin to the south of the map area. The axial zones are delineated by a sinuous line of downwarps (Wilson Depression, Cooper and Thomson Synclines) and as these downwarps filled, the sediment spread laterally and northwards into the northern Eromanga Basin. By the late Early Jurassic the sediments overlapped pre-existing basin succession and basement. The only structural movement of note which affected the deposition of the Hutton sands was along a series of faulted basement blocks in the Stormhill Fault and Westland Structure area.

By the end of Early Jurassic time a blanket of sand (Hutton Sandstone) extended from the eastern margin of the Georgina Basin and Mount Isa Block to the Lolworth-Ravenswood Block and across the western part of the Drummond Basin.

Deposition of mud, silt, and sand (Injune Creek Group, the upper portion of the Eulo Queen Group, and the Blantyre Sandstone) by rivers and in lakes and deltas continued in Middle to Late Jurassic times. Initial deposition was confined to the same areas as the Lower Jurassic sediments, but eventually deposition extended beyond them onto the flanking basement areas. Fluviatile conditions dominated the Late Jurassic and persisted into the Early Cretaceous, resulting in the accumulation of quartzose sands (Hooray Sandstone and Gilbert River Formation). Sand deposition (Gilbert River Formation) buried the Euroka Arch that separated the Burketown Depression of the Carpentaria Basin from the Eromanga Basin.

The sea inundated the area in the Early Cretaceous, firstly in the northwest, where sands were deposited (Hooray Sandstone on the Boulia Shelf area of the Georgina Basin). Submergence continued until the entire area was covered by a shallow muddy epicontinental sea. The nature of the sediment changed and feldspar and rock fragments became dominant (Rolling Downs Group); some of

the debris was probably derived from a volcanic terrain (Exon & Senior, 1976). In the Early Cretaceous the zone between the Carpentaria and Eromanga Basins was marked by thinner deposition over the St Elmo Structure than in the basins proper. The Tara Structure in the southeast was also active in Early Cretaceous time.

The Cretaceous sea was only intermittently connected with the open ocean, and marine life was somewhat impoverished because of this, and because of the commonly very muddy substrate. However, molluscs flourished in shallow water at times, and in Toolebuc Formation time the sea was probably at its clearest and a thin layer of organic calcareous silt and lime, with shell debris, was deposited. The accumulation of further mud and silt (Allaru Mudstone) ended this short-lived episode. In late Early Cretaceous time the sea began to recede, and labile sand, silt, mud, and lime (Mackunda Formation) were laid down in shallow marine and paralic environments. Rivers continued to carry feldspathic sand into the area in late Early to Late Cretaceous time, and the Winton Formation was deposited along with silt and mud by rivers, and in lakes and swamps. The Euroka Arch separating the Eromanga and Carpentaria Basins was land at this time.

In the Late Cretaceous and Early Tertiary, sedimentation ceased, and the area was eroded, levelled, and intensely weathered. The exposed sediments, being predominantly labile, were altered to a considerable depth, resulting in the formation of a mantle up to 60 m thick of dominantly kaolinitic rocks with lesser silicified and ferruginised beds. By Early Tertiary time uplift of the eastern margin of the basin resulted in tilting and truncation of the Eromanga Basin sequence. A drainage system was established that carried quartzose sediments (Glendower Formation) towards several shallow depressions south of the map area (Thomson Syncline and Powell Depression) in the central part of the Eromanga Basin. Movements along the Cork Fault and associated structures resulted in ponding of part of this drainage system, and subsidiary shallow drainage systems developed, carrying limestone, siliceous cherty arenite, and argillaceous material to internal basins. Chemical weathering rather than erosion was dominant in the Cainozoic, and Tertiary sediments were lateritised in the northeast, but in the southwest, under a drier climate, silica was mobilised. Silica induration and leaching were the dominant weathering processes during the Middle Tertiary.

Further uplift of basement margins in the Late Cainozoic, and development of the Lake Eyre internal drainage system, led to the deposition of broad belts of alluvium in shallow valleys. The climate was probably much more humid in Pleistocene time, as indicated by remains of giant marsupials and of crocodiles, which are found in Pleistocene sediments in adjacent areas (Senior & Hughes, 1972). By the late Pleistocene the climate became semi-arid and rainfall unreliable, which may account for the aeolian sand, although dunes are rare. Soil development and alluviation are continuing at the present day, under a semi-arid climate in the southwest grading to a tropical monsoonal climate in the north.

ECONOMIC GEOLOGY

Groundwater

During this century the Queensland Irrigation and Water Supply Commission has collected all available information on water bores within the Queensland portion of the Great Artesian Basin. Much of the lithological and hydraulic data was transcribed from these records and is card indexed at BMR. Quality and quantity of groundwater data from individual Sheets in the map area are variable and a detailed synthesis is beyond the scope of this report. However, a study of the hydraulics of the entire Great Artesian Basin is in progress and will be reported in due course. Most of the unpublished Records and all Explanatory Notes of the area give lists of water bores, with relevant hydrological data.

Since 1960 the program of gamma-ray logging of water bores has produced considerable information for studying groundwater conditions and resources within the basin. In suitable bores, flowmeter, caliper, temperature, and differential temperature logs were run specifically for groundwater studies. Wireline-logged bores are shown in Plate A3, and the logs are available for study at the Bureau of Mineral Resources in Canberra. Plate A3 was updated just before this Bulletin went to press, and provides a complete Record of BMR's well-logging program in this region.

Much of the following description is summarised from Casey (1970), who gives a regional outline of groundwater in the area.

The artesian aquifers most utilised in the map area are the Hutton, Adori, and Hooray Sandstones and the Gilbert River Formation. Practically all the flowing bores in the eastern part of the area draw most of their water from the Hutton Sandstone. Pressure and flow have decreased in most bores and many have ceased flowing. Initial flows from the Hutton Sandstone averaged about 1350 m^3/d; the maximum was about 4500 m^3/d. The Hutton Sandstone thins onto the Maneroo Platform (see inset, Structure and distribution of basin elements, Pl. A1) near Longreach, and average flow there is reduced to less than 900 m^3/d.

Some groundwater is won from the Adori Sandstone and from sandstones in the Birkhead Formation, but measurements of flows from these aquifers have generally not been recorded. The Hooray Sandstone contains numerous aquifers, though yields are lower than those in the Hutton Sandstone, with most initial flows recorded at 900 m^3/d. In the western part of the area initial flows of up to 4500 m^3/d were obtained, but thinning over basement ridges reduces the capacity of the aquifers.

In the south-central part of the map area, where the Eromanga Basin sequence is thickest, few water bores have been drilled to the artesian aquifers: graziers rely on subartesian aquifers from lenses of labile sandstone within the Rolling Downs Group. The Winton and Mackunda Formations contain most of the aquifers in this Group, though the quality and quantity of water obtained are variable. Many bores have been abandoned because of high salinity, and only a few produce water fit for domestic use.

Petroleum

About 40 wells have been drilled for petroleum within the map area, mostly to test the potential of Galilee, Drummond, and Georgina Basin rocks. The marine argillaceous sedimentary rocks of the Rolling Downs Group in the Eromanga Basin sequence are potential source and cap rocks.

Permeable sandstones are abundant in the Jurassic sequence but any economic hydrocarbon accumulations would depend on favourable structural or stratigraphic geometry which would isolate the deposit from the effect of basin-wide, dominantly southwest movement of groundwater. Shows of oil and gas have been documented by Casey (1970, Appendix 3) and some of these shows were authenticated by analyses (G.S.Q., 1961). The Eromanga Basin sequence could provide reservoirs to hydrocarbons generated within older basin systems, particularly the Georgina and Galilee Basins. If this is the case exploration might be worthwhile in areas of folding and monoclinal flexuring which originate from faults within pre-Eromanga Basin rocks.

Traces of oil were detected in drill core recovered from the Toolebuc Formation (Senior & Smart, 1973), and large low-grade oil shale deposits occur within this unit in the Julia Creek area. The oil shale is associated with black argillaceous and calcareous mudstones and siltstones which apparently do not vary appreciably throughout the distribution of this unit in the Eromanga Basin.

Precious Opal

The abandoned Kynuna, Opalton, and Windsor opal fields lie in the southwest portion of the map area. Opalton was the largest opal-mining centre in Queensland, and in the early part of this century produced £40 000 worth ($400 000 at present-day values). With renewed interest by prospectors, and increasing price commanded by Queensland opal, it is likely that some of these mines will be reworked by open-cut methods.

Precious opal in Queensland is associated with 'ironstone' concretions which form in regular layers in the basal one-third of the chemically weathered Winton Formation (finely stippled areas on map). Jackson (1902) reported that opal at Opalton occurred at the contact between soft sandstone and clays. Studies in progress of open-cut opal mines in the Eromanga district show that bedding geometry (compaction faults, palaeochannels, and irregular bedding interfaces) controlled the precipitation of precious opal from silica-laden groundwater.*

Construction materials

The Eromanga Basin sequence is generally lacking in suitable construction materials. Aggregate and sand for local road construction are available from quartz pebble conglomerate

* The results of this study have subsequently been published; *see* Senior, B. R., McColl, D. H., Long, B. E., & Whiteley, R. J., 1977—Geology and magnetic characteristics of precious opal deposits, southwest Queensland. *BMR Journal of Australian Geology & Geophysics*, 2(4).

beds in the Jurassic sequence (Hutton Sandstone, Ronlow Beds, Adori and Hooray Sandstones) but little is used. Cainozoic sediments, particularly the Glendower Formation, have better sorted clastic beds which are more accessible and hence more widely used. Limestone rubble from the Toolebuc Formation has been used locally as a source of lime and more frequently for aggregate and causeway construction. Indurated beds from the weathered Winton Formation, when crushed, make a usable aggregate in the absence of more suitable material. The weathered rock aggregate disintegrates, yielding kaolinitic clays that make road surfaces dusty in dry weather and slippery in wet.

APPENDIX

Notes on the compilation of seismic data in the northern part of the Eromanga Basin

by
P. L. Harrison

Thirty-five subsidised seismic surveys and three seismic surveys by BMR have been made in the area up to March 1974. The locations of seismic traverses and an index of the surveys are shown in Plate A2. Structure contour maps and cross-sections of the horizons were copied from company reports and modified where necessary using geological information from petroleum exploration wells and water-bores, and seismic information from nearby or intersecting seismic lines. The seismic record sections were not re-interpreted. Seismic information from 14 surveys contributed to mapping the base of the Eromanga Basin sequence and 17 to mapping the base of the Rolling Downs Group. The surveys from which this information was derived and the general quality of the seismic reflection information are listed in the table below. The results available from them consisted of contour maps and some cross-sections showing reflection times or depths relative to various datum planes. Most information came from reflection recording, but refraction data were obtained from the Fermoy and Vergemont surveys.

The following were the main steps in preparing the structure contours:

1. The seismic reflection time or depth contours were converted to depth in metres relative to mean sea level, using either the reflection times and velocity functions or the depths, relative to particular datums.
2. Where a well or water-bore lay on or very close to a seismic traverse, the reflector was correlated to a geological boundary in the well provided that the depths were reasonably close and that the vertical velocity calculated from the reflection time and the depth in the well was within the range of vertical velocities found within the map area. The maximum difference in depth between a reflector and a horizon in a well to which it was correlated was about 200 m or about 20%.
3. Where only one well or water-bore was on or close to a seismic traverse the seismic contours were vertically adjusted by a value calculated from the difference between the reflector and well depth.
4. Where several wells or water-bores lay on or close to the seismic traverses, or where different survey lines were in close proximity or intersected one another, the seismic data were adjusted and contoured consistently incorporating all the seismic and drilling information. In a few cases significant velocity variations occurred between two wells and the contours were vertically adjusted by values which were varied smoothly between the wells.
5. Structure contours of the base of the Rolling Downs Group and the base of the Eromanga Basin sequence in the northern part of the Eromanga Basin were drawn from the seismic information modified to incorporate geologically mapped faults and fold axes and subsurface information from drilling.

Each survey had at least one well-tie. The contouring accuracy was poorer away from wells, because of possible variations of vertical velocities in the section, and near fault zones, where poor record quality made it difficult to follow the same phases of reflection events. Correlations of reflections with geological boundaries in wells and water bores was difficult because of errors in the depths to reflectors caused by uncertainties in the reflection times and vertical velocities. Reflectors were weak in some areas, and subject to interference; and there is insufficient control to measure possible lateral variations of velocity. The correlation was made easier by using other information such as the character of reflection associated with a given horizon, characteristic groups of reflectors, and correlation with adjacent surveys.

SURVEYS CONTRIBUTING TO STRUCTURE CONTOUR MAPS AND GENERAL QUALITY OF SEISMIC DATA

Survey	*Survey No. on Plate 2*	*Base of Rolling Downs Group*	*Base of Eromanga Basin Sequence*
Cairnhope-Rimbanda	8	good	good
Fermoy	9	good	fair (refraction data).
Vergemont	10	good	fair (refraction data)
Mayne	15	fair	fair
Longreach-Silsoe	16	fair	fair
Wokingham Creek	22	good	not mapped
Balmoral	23	fair	not mapped
Rodney Downs	24	fair	fair-poor
Brixton	25	poor	fair-poor
Wellshot Creek	26	fair	poor
Thomson River	27	fair	poor
Ruthven	28	good-poor	good-poor
Binburie	29	good-poor	good-poor
Barcoo	30	fair	not mapped
West Blackall	31	good-fair	not mapped
Maneroo	32	good	fair-poor
Rodney Creek	35	not mapped	good-poor
Williams Creek	38	good-fair	good-fair

TABLE A1: GEOLOGICAL MAPS AND EXPLANATORY NOTES AT 1:250 000 SCALE WITHIN THE NORTHERN PART OF THE EROMANGA BASIN

Sheet name	*International index umber*	*Author(s)*	*Year published*
CLONCURRY	SF/54-2	E. K. Carter	1959
JULIA CREEK	SF/54-3	R. R. Vine	1964
RICHMOND	SF/54-4	R. R. Vine	1970
HUGHENDEN	SF/55-1	R. R. Vine	1974
CHARTERS TOWERS	SF/55-2	D. E. Clarke & A. G. L. Paine	1970
DUCHESS	SF/54-6	E. K. Carter & A. A. Öpik	1963
McKINLAY	SF/54-7	R. R. Vine	1963
MANUKA	SF/54-8	D. J. Casey	1968
TANGORIN	SF/55-5	D. J. Casey	1969
BUCHANAN	SF/55-6	F. Olgers	1970
BOULIA	SF/54-10	J. N. Casey	1968
MACKUNDA	SF/54-11	R. R. Vine	1964
WINTON	SF/54-12	D. J. Casey	1966
MUTTABURRA	SF/55-9	R. R. Vine	1970
GALILEE	SF/55-10	R. R. Vine & H. F. Doutch	1972
SPRINGVALE	SF/54-14	M. A. Reynolds	1965
BRIGHTON DOWNS	SF/54-15	W. Jauncey	1964
MANERO	SF/54-16	W. Jauncey	1967
LONGREACH	SF/55-13	R. R. Vine	1970
JERICHO	SF/55-14	Danièle Senior	1973

TABLE A2: GRAVITY AND MAGNETIC SURVEYS IN THE NORTHERN PART OF THE EROMANGA BASIN

Brief title	*Reference*
GRAVITY SURVEYS	
Regional traverses eastern and central Commonwealth	Marshall & Narain, 1954
North Winton	Magellan, 1960
GAB reconnaissance (BMR helicopter)	Lonsdale, 1962
Boulia area	PAP, 1962
Central Queensland (BMR helicopter)	Gibb, 1963
Tambo-Augathella	Magellan, 1963
Barcaldine	Farmout Drillers, 1964
Central Queensland (BMR helicopter)	Flavelle, 1964
North Eromanga and Drummond Basins	Gibb, 1968
Western Queensland reconnaissance	Gibb, 1968
North Eromanga semi-detailed	Watts & Brown, 1976
MAGNETIC SURVEYS	
Winton area	Central Queensland Petroleum Pty Ltd & Catawba Corporation, 1957
Great Artesian Basin reconnaissance	Jewell, 1960
Aramac-Mount Coolon	Exoil, 1962

TABLE A3 STRATIGRAPHY OF THE NORTHERN EROMANGA BASIN SEQUENCE

Name	*Reference to formal description*	*Type section or area*	*Thickness*	*Relationships*
WINTON FORMATION Winton Series	WHITEHOUSE, 1954 Dunstan, 1916	'The blue shales and sandstones with intercalated coal seams met with in the bores in and about Winton' (Whitehouse, 1954, p. 10)	Few fresh exposures more than a few metres thick. Maximum 300 m subsurface (400 m in Maneroo Sheet area), but upper limit is an erosional surface	Conformable on Mackunda Formation, of which it is continuation in terrestrial environment
MACKUNDA FORMATION	VINE & DAY, 1965	Headwaters of Mackunda Creek on Gnalto Station, Mackunda Sheet area	Few exposures more than a few metres thick. On western and northern margins is only 15 to 60 m thick (top eroded). Subsurface, increases 90 m in west to 275 m in east (Muttaburra Sheet area)	Conformable on Allaru Mudstone. On margins, top is eroded
ALLARU MUDSTONE Allaru Member Wilgunya Formation	VINE ET AL., 1967 Vine & Day, 1965 Casey, 1959	Along main Richmond-Winton road from Richmond south to Twenty-Mile Creek, Richmond Sheet area	Few exposures more than a few metres thick, with maximum 30 m in Springvale Sheet area. Subsurface thickens south and east from 45 m to 120 m in Longreach Sheet area	Conformable on Toolebuc Formation. On margins, top is eroded
TOOLEBUC FORMATION Toolebuc Limestone Toolebuc Member	THIS BULLETIN Vine et al., 1967 Casey, 1959	Sequence from 25.3-35.8 in BMR Boulia 3A, 22°47'00"S, 140°43'00"E, Boulia Sheet area	6 to 12 m, with maximum 25 m in Cloncurry Sheet area	Conformable on Wallumbilla Formation (possible disconformity in Boulia, Springvale, and Duchess Sheet areas)
WALLUMBILLA FORMATION Wollumbilla Formation Wilgunya Formation	VINE ET AL., 1967 Clarke, 1865 Casey, 1959	Wallumbilla Ck from Wallumbilla township south for 19 km, Roma Sheet area	60 m in north (Julia Creek) to 245-350 m in south (Winton, Boulia Sheet areas)	Conformable on Jurassic units
COREENA MEMBER	VINE, 1966 Vine et al., 1967	Along western boundary of Coreena Station on formed road to homestead, Longreach Sheet area	60-245 m	Conformable on underlying units
RANMOOR MEMBER	VINE & DAY, 1965	East bank of Flinders River, 32 km ENE of Hughenden and 3 km south of Glendower homestead. Hughenden Sheet area	312 m in type section. In subsurface between 60 and 95 m	Conformable on Jones Valley Member
JONES VALLEY MEMBER	VINE & DAY, 1965	Cliff on small tributary of Jones Valley Creek beside the track to Strath Stewart homestead, 200 m north of southern boundary of station. Hughenden Sheet area	5-8 m	Conformable on Doncaster Member

TABLE A3 (CONTINUED)

Lithology	*Fossils*	*Series*	*Environment*
Interbedded bluish-grey sandstone, mudstone, and siltstone, in part calcareous; some intraformational conglomerate and coal seams. Sandstone, lithic, feldspathic, medium to very fine grained. Bedding medium or thick; crossbeds particularly in sandstones. Channel fill and lenticular beds locally	Well preserved fossils rare. Wood fragments common (White, 1962, 1964; Whitehouse, 1954). Freshwater bivalves (Vine & Day, 1965; Vine & Galloway, 1965)	Late Lower to Upper Cretaceous	Terrestrial-fluviatile, paludal, lacustrine. Low relief, wide river flats, local development of short lived lakes and swamps
Interbedded bluish-grey labile sandstone and mudstone with some calcareous siltstone. Mudstone thin to thick-bedded. Sandstone, thin-bedded and cross-laminated in places; ranges from fine sandstone to coarse siltstone. Some beds 40-60% calcite cement, in places grading into sandy limestone, and commonly concretionary. Minor cone-in-cone limestone, thin coquinite, and, near top, intraformational conglomerate	Rich fauna from coquinite bands (Vine & Day, 1965). Plant fragments common (White, 1962)	Lower Cretaceous (Albian)	Transition of paralic sedimentation between the marine Allaru Mudstone and the non-marine Winton Formation
Mainly bluish-grey mudstone with interbeds of very thin to thin calcareous siltstone. Minor very fine-grained labile sandstone. Thin seams of cone-in-cone limestone along bedding planes and coating concretions	Largely molluscan, mainly ammonites and bivalves (Vine & Day, 1965). Plant debris common in sediments containing rich marine fauna (Vine, 1970a)	Lower Cretaceous (Albian)	Shallow marine
Flaggy and concretionary white, grey and pink limestone, calcareous shale, oil shale, minor coquinite. Some black labile sandstone, siltstone, and mudstone	Richly fossiliferous. Bivalves, fish, belemnites, gastropods, ammonites (Vine & Day, 1965)	Lower Cretaceous (Albian)	Shallow marine
Bluish-grey mudstone and siltstone with grey concretionary limestone locally common. Minor lenticular sandstone, intraformational conglomerate, and cone-in-cone limestone. In places glauconitic and gypsiferous	Essentially molluscan, mainly bivalves (Day, 1967). Plant debris common in upper part where locally marine fossils lacking (Vine et al., 1967)	Lower Cretaceous (Aptian/Albian)	Shallow marine
Interbedded siltstone and mudstone, grey or bluish-grey where fresh, in part green, buff where weathered. Siltstone coarse-grained, gradational to very fine and fine-grained labile sandstone, some fine to medium-grained sublabile sandstone —in part calcareous and grades into silty limestone. Thin to thick bedded, commonly laminated, locally cross-laminated or thinly cross-bedded. In places abundant intraformational conglomerate; some beds glauconitic	Locally richly fossiliferous. Plant debris common in parts	Lower Cretaceous. Lower part lower Albian, upper part possibly middle Albian	Shallow marine, paralic
Grey to black mudstone with some siltstone, commonly carbonaceous. Upper part rich in kerogen (oil shale). Commonly calcareous near top with laminae of *Inoceramus* plates	Marine fossils collected only in Hughenden area, from near base and near top. Ammonites, belemnites, bivalves (Vine & Day, 1965).	Lower Cretaceous (lower Albian)	Shallow marine, paralic (possibly enclosed basin or lagoon)
In outcrop mainly pale brown siltstone with some calcareous siltstone and brown limestone. Siltstone grades to very fine labile sandstone. Fresh rock pale green (glauconite). Bedding very thin to thick, and some beds cross-laminated. Lenticular intraformational conglomerate also occurs	Fossils only at a few localities. Bivalves, belemnites, burrows, crinoids, scaphopods, brachiopods (Vine & Day, 1965)	Lower Cretaceous (Aptian)	Paralic (possibly lagoon or coastal plain)

TABLE A3 (CONTINUED)

Name	*Reference to formal description*	*Type section or area*	*Thickness*	*Relationships*
DONCASTER MEMBER	VINE & DAY, 1965	Cliffs in south bank of Flinders River on Glendower Station at Rockies Waterhole, 51 km NE of Hughenden, Hughenden Sheet area	Maximum exposed, 59 m in type section. Subsurface maximum between 120-150 m	Conformable on Jurassic units
WYANDRA SANDSTONE MEMBER	SENIOR ET AL., 1975	QIWSC bore No. 2049 (interval 357-373 m) located 15 km northeast of Wyandra town, Wyandra Sheet area	3-18 m varying slowly. Does not crop out in map area	Upper part of Cadna-owie Formation; conformable below Doncaster Member
CADNA-OWIE FORMATION	WOPFNER ET AL. (1970)		15-75 m. Does not crop out in map area	Conformable between Hooray Sandstone and Doncaster Member
GILBERT RIVER FORMATION	LAING & POWER, 1959	30 km east of Croydon, Georgetown Sheet area	1-65 m. Increases west from 1-12 m in Hughenden to 65 m in Cloncurry Sheet areas	Erosional unconformity at base or conformable on Eulo Queen Group
HOORAY SANDSTONE Longsight Sandstone	HILL & DENMEAD, 1960 (p. 311) Casey, 1959 (p. 34)	Hooray Creek, 19 km NE of Tambo township, Tambo Sheet area	Up to 30 m in outcrops. Thickens towards centre of basin from 40-60 m on west, north, and east margins to 180-230 m in south. 430 m in Mackunda/ Brighton Downs Sheet areas—may contain other units as well (possibly Triassic)	Unconformable on basement or conformable on Injune Creek Group
RONLOW BEDS	VINE ET AL., 1965	Type section 10 km south of Ronlow Park homestead.	30-150 m	Sharp boundary with Doncaster Member—possibly disconformity. Unconformable on Triassic or older. Forms undifferentiated Hutton Sandstone to Hooray Sandstone
BLANTYRE SANDSTONE Blantyre beds	CASEY, 1970 Vine 1966	?	40-90 m	Disconformable on Triassic. Local marginal facies, intermediate between Eromanga and Carpentaria facies to west and eastern marginal facies of Ronlow Beds to east. Separated by regional unconformity from Gilbert River Formation
EULO QUEEN GROUP	SMART ET AL., 1971			Unconformable on Precambrian and Palaeozoic basement in outcrop and around margins of depressions; and on older Jurassic in the deeper parts of the depressions
LOTH FORMATION	SMART ET AL., 1971	South of Hampstead Creek, 50 km east of Mt Norman homestead, lat. 19°54′S, long. 143°39′E, Gilberton Sheet area	7-50 m, thinning eastwards	Conformable between Hampstead Sandstone and Gilbert River Formation

TABLE A3 (CONTINUED)

Lithology	*Fossils*	*Series*	*Environment*
Mainly bluish-grey mudstone with glauconitic beds diagnostic. Some siltstone beds calcareous and some grade to very fine sandstone, particularly in lower 30 m. Dark grey concretionary limestone locally common; some concretions extensively brecciated and few have algal encrustations. Some cone-in-cone limestone	Sporadic fossils, in concretionary beds. Bivalves, ammonites, belemnites, gastropods, some crinoids, brachiopods, decapods, calcareous algae (Vine & Day, 1965)	Lower Cretaceous (Aptian)	Shallow marine, locally subjected to wave action
Medium to coarse quartzose to sublabile sandstone with scattered pebbles and carbonate cement. Porous and permeable; stratigraphically highest pressure aquifer in Basin	None in map area	Lower Cretaceous	Shallow marine; possibly beach sand laid down by a transgressive sea
Fine to medium quartzose sandstone, fine labile sandstone, siltstone and mudstone, minor glauconite	None in map area	Lower Cretaceous (Neocomian to lower Aptian).	Paralic and shallow marine
Fine to coarse, quartzose to sublabile sandstone, commonly pebbly and with lenticular pebble conglomerate; moderately sorted, subrounded to angular, thin to very thick bedded and cross-bedded		Upper Jurassic? to Lower Cretaceous (Neocomian?-Aptian)	Terrestrial and shallow marine. Start of marine transgression
Dominantly white quartzose to sublabile sandstone, very fine to medium, in places coarse, fairly well sorted, friable, with minor feldspars and kaolinitic matrix. Thin interbeds of siltstone and mudstone, some shale and conglomerate. In south, brown to black shale and clay with lignite (Springvale) and minor coal (Jericho)	Spores and pollens (Evans, 1962). Plants and marine molluscs (Reynolds, 1965). Marine fossils in Springvale, Boulia, Duchess Sheet areas—bivalves, gastropods, belemnites, starfish, arenaceous foraminifera (Casey et al., 1960)	Jurassic to Lower Cretaceous	Fluviatile; shallow marine towards west (Boulia, Springvale)
White to reddish brown, fine to coarse, quartzose to sublabile sandstone, commonly kaolinitic, with pebbly beds; thin to thick bedded and cross-bedded. Some micaceous siltstone, mudstone, and minor coal		Jurassic to Lower Cretaceous	Fluviatile, channel and flood plain deposition; local swamps
Quartzose sandstone, fine to medium, moderately to well sorted, thin to thick bedded and cross-bedded; interbedded sections of very fine micaceous sandstone and siltstone, mudstone, carbonaceous shale, coal; few thin breccia beds	Rich microflora (Evans, 1964; Burger & Kemp, 1972) and macroflora (White, 1964)	Upper Jurassic	Fluviatile, channel and flood plain deposition; local swamps
	Wood fragments	Probably Middle to Upper Jurassic *cf* sandstone sequence in BMR Richmond 3, dated by palynology (Burger *in* Grimes & Smart, 1970)	Fluvial
Fine to very fine micaceous, clayey, quartzose sandstone grading to coarse siltstone, thin to very thin bedded. In outcrop predominantly white soft sandstone and siltstone. Sandstone locally ferruginised.	Wood fragments	Probably Middle to Upper Jurassic (Burger *in* Grimes & Smart, 1970)	Fluvial, mainly flood plain deposition (possibly near-shore lagoon).

TABLE A3 (CONTINUED)

Name	*Reference to formal description*	*Type section or area*	*Thickness*	*Relationships*
HAMPSTEAD SANDSTONE	SMART ET AL., 1971	South of Hampstead Creek, 50 km east of Mt Norman homestead, lat. 19°54′S, long. 143°39′E, Gilberton Sheet area	6-115 m, thinning eastwards	Where visible, unconformable on Precambrian and Palaeozoic basement
INJUNE CREEK GROUP	EXON, 1966	—	About 30 m in Hughenden Sheet area	Conformable between Hutton and Hooray Sandstones
Injune Creek Beds	Jensen, 1921 (p. 92)			
WEST-BOURNE FORMATION	EXON, 1966	Interval 1279-1651 ft. in Amoseas Westbourne 1, near Westbourne homestead, 42 km south of Tambo township, Tambo Sheet area	0-50 m, maximum 90 m in Longreach Sheet area	Conformable on Adori Sandstone
ADORI SANDSTONE	HILL & DENMEAD, 1960 EXON, 1966	Adori Hill, 35 km ENE of Tambo, Tambo Sheet area	0-33 m	Conformable on Birkhead Formation
BIRKHEAD FORMATION	EXON, 1966	Interval 1880-2244 ft in Omoseas Westbourne 1 well, 42 km south of Tambo township, Tambo Sheet area	30-130 m	Conformable on Hutton Sandstone
HUTTON SANDSTONE	REEVES, 1947	Taroom Sheet area, western Surat Basin	90-120 m, maximum 160 m in Longreach Sheet area	Unconformable on Triassic or older: beginning of Eromanga Basin sedimentation

TABLE A3 (CONTINUED)

Lithology	*Fossils*	*Series*	*Environment*
Fine, medium, and coarse quartzose sandstone, some pebbly beds and conglomerate; strongly cross-bedded; interbedded micaceous siltstone, mudstone, and very fine sandstone	Wood fragments	Probably Jurassic (Burger *in* Grimes & Smart, 1970)	Fluvial, both channel and flood plain deposition
Siltstone, mudstone, and fine to very fine sandstone; minor coal	Plants and spores	Middle to Upper Jurassic	Fluviatile, lacustrine, deltaic
Brown micaceous siltstone and mudstone, with minor quartzose to labile sandstone	Spores, fragments of plant remains (Exon, 1966)	Upper Jurassic	Lacustrine, fluviatile
White medium to fine, quartzose to sublabile sandstone; minor siltstone and claystone		Middle to Upper Jurassic	Fluviatile, deposited by south-flowing stream
Grey and brown siltstone, mudstone, fine brown calcareous labile sandstone, minor coal.	Plants probably Jurassic, spores Middle Jurassic (Exon, 1966; Evans, 1966)	Middle Jurassic	Fluviatile, lacustrine
Brown and white medium to fine, quartzose to sublabile sandstone, commonly kaolinitic. Some micaceous siltstone and mudstone, minor conglomerate. In outcrop altered zone at top, leached, silicified, partly ferruginised	Silicified wood, plant debris, microspores and pollens (Vine et al., 1965; White, 1965; Olgers, 1970)	Lower Jurassic	Fluviatile, rivers, flood plains, and local lakes. Possibly some deltaic and estuarine

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PART B

Notes on the geology of the central part of the Eromanga Basin, Queensland

BY

B. R. SENIOR

SUMMARY

The Eromanga Basin is a Jurassic to Cretaceous sedimentary basin within the Great Artesian (hydrological) Basin. Below it are four older sedimentary basins: the Adavale Basin (Middle Devonian to Lower Carboniferous) and Cooper Basin (Lower Permian to Middle Triassic) are entirely concealed, but the Drummond (Upper Devonian to Lower Carboniferous) and Galilee (Upper Carboniferous to Upper Triassic) Basins crop out in the far northeast of the area described.

The Eromanga Basin has been arbitrarily divided for purposes of description; this Part B deals with the area in southwest Queensland between latitudes 24° and 29°S and longitudes 141° and 147°E.

The Eromanga Basin sequence ranges from Lower Jurassic to Upper Cretaceous. The Jurassic sequence is mainly terrestrial, the Lower Cretaceous shallow marine, and the Upper Cretaceous grades from paralic to fluvial and lacustrine. In Late Cretaceous time the uppermost 130 m of the Rolling Downs Group—the Cretaceous sequence—was kaolinised and partly silicified and ferruginised by chemical weathering, and in the Early Tertiary a second phase of chemical weathering transformed parts of the older Tertiary rocks into silcrete. The whole is covered sporadically by Late Tertiary and more generally by unconsolidated Quaternary sediments. One new Lower Tertiary unit (Whitula Formation) is defined.

The structure of the Eromanga Basin echoes that of the older basins: almost horizontal sediments overlying stable basement shelves are separated by a northeasterly belt of relative structural complexity, where long gentle folds formed during and after sedimentation over a broad basement horst that was active during the early days of the basin. The folds are accentuated by differential compaction.

Apart from potential hydrocarbons, groundwater is the main economic resource; of the 3700 bores, about 1300 tap artesian aquifers. The most prolific aquifer is the Hooray Sandstone, but in the centre and southeast it is too deep to be economically tapped; so in these areas the subartesian Cretaceous and Cainozoic aquifers are utilised. This water is of lower quality than that from the Hooray Sandstone, and is generally suitable only for stock.

Precious opal occurs in the chemically weathered sediments and is mined at several places, and increasing attention is being paid to the Eromanga district in a search for new deposits. Several large open-cut mines are producing precious opal from depths up to 10 m.

Jurassic arenite beds are a source of sand, gravel, and aggregate which are used in local road constructions. The Cretaceous rocks are deficient in construction materials except where weathering has indurated them. Silicified layers in the weathering profile and silcrete from Tertiary sedimentary rocks provide aggregate for causeway and road surfacing especially in the less populated western part of the map.

INTRODUCTION AND PREVIOUS INVESTIGATIONS

One of the most extensive sedimentary basins in Australia is the Eromanga Basin. It is part of the 'trans-Australian platform cover' (Tectonic Map of Australia, 1971) and is delineated by the preserved limits of Jurassic to Lower Cretaceous sediments. The Eromanga Basin stretches from 20° to 32°S and from 132° to 147°E. It is composed of Lower Jurassic to Upper Cretaceous sedimentary rocks. To the north it is separated by a subsurface feature (Euroka Arch) from another basin of similar age, the Carpentaria Basin; to the east, similarly, from the Surat Basin; and to the south and west it is bounded by older basins and partly by 'basement'. The Eromanga Basin has an area of about one million km². In order to produce a series of geological maps at 1:1 million scale it became necessary to subdivide those parts of the basin in Queensland and Northern Territory arbitrarily into northern, central, and northwestern parts (Fig. B1).

The central part of the Eromanga Basin, which is the subject of this Part B, is not, therefore, a geological entity in itself; although, naturally, some geological features are peculiar to it, it must be considered in the context of the Basin as a whole.

The Eromanga Basin is the youngest and most extensive of a number of sedimentary basins that have, since the Devonian, filled

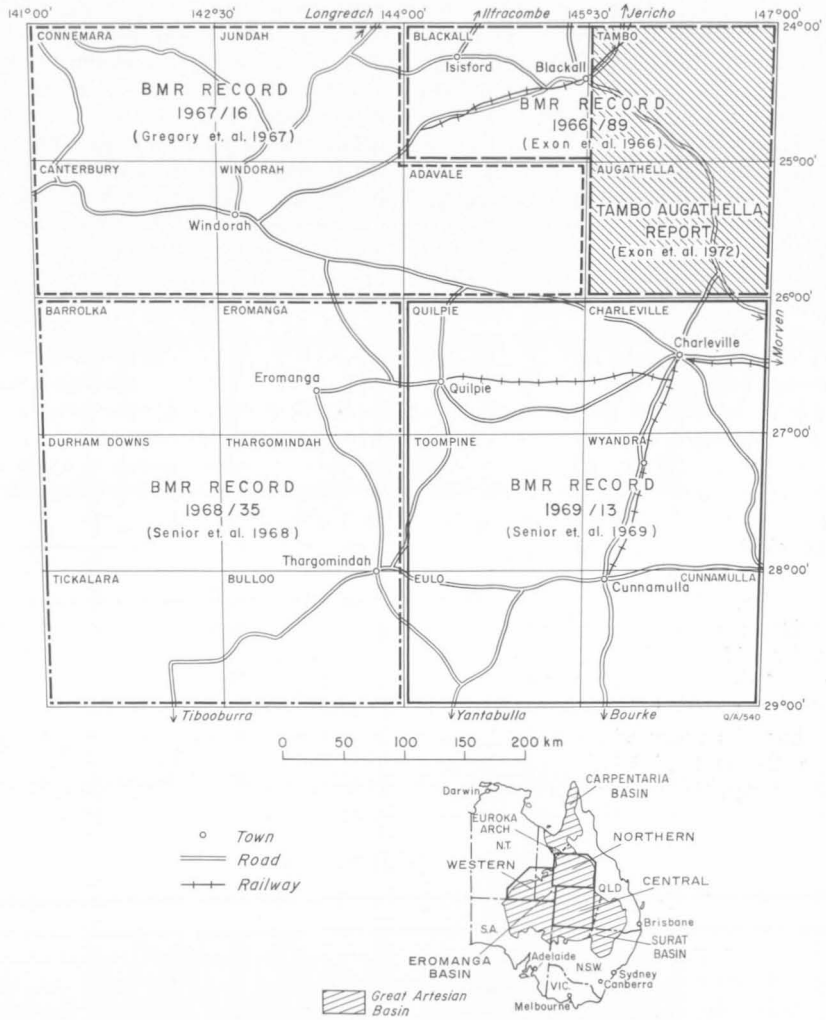


Fig. B1. Location map and key to Explanatory Notes, BMR Reports, and BMR Records in the central Eromanga Basin.

depressions in the area. Within the area encompassed in this study there are four such older basins: the Adavale and Drummond Basins of Devonian to Carboniferous age, and the Cooper and Galilee Basins spanning the Late Permian and Triassic.

Reports of previous geological investigations which cover the area are shown in Figure B1. In order to avoid tedious detail in presentation the bulk of the data is portrayed in a series of diagrams at one millon scale. Each contour or isopach map is designed to be laid directly over the geological map so that surface and subsurface comparisons can be made.

This Bulletin is essentially a synthesis of the geological mapping of the Bureau of Mineral Resources and the Geological Survey of Queensland. The whole area has been mapped at 1:250 000 scale during a field program lasting from 1964 to 1968; the maps issued are listed, with date of issue and authors of accompanying notes, in Table B1, and located in Figure B1.

The joint mapping program provided the first comprehensive and systematic coverage of the area. Earlier work on particular parts of the area or in particular geological and economic aspects is, when relevant to the discussion, referred to in the text; and all work is cited in the reference list.

An area of such sparse outcrop and flat-lying sediments could not be adequately interpreted without substantial geophysical work. The 70 or so relevant, and available, seismic surveys are shown in Plate B3; gravity and magnetic surveys are listed in Table B2; Bouguer anomalies are reproduced on the face of the geological map (Plate B1).

The Bureau of Mineral Resources began logging water bores in the central part of the Eromanga Basin in 1960. The program is continuing; by mid-1972 some 200 water bores in this part of the Eromanga Basin had been logged. Plate B3 was modified during final editing to show the status of the BMR logging program to the end of 1975. Logs include gamma-ray, magnetic casing collar locator, self-potential and resistivity (in open or uncased holes), temperature, differential temperature, flowmeter, and caliper. Water from most of the logged bores has been analysed; a few analyses are listed in Table B5, and the remainder are available on request from the Bureau of Mineral Resources. Vine (1966) showed that basin-wide correlations could be made with these gamma-ray logs, and, together with BMR and petroleum exploration drilling data, they were a major source of information for this Bulletin (Pls. B2-7).

A further necessary aid to interpretation is stratigraphic drilling. About 40 shallow stratigraphic holes, the deepest of which was 200 m, were drilled by BMR. Their location is shown on the geological map and in Plate B3. Cores and cuttings are stored at the BMR Core and Cuttings Laboratory, Fyshwick, ACT, where they are available for examination.

Petroleum exploration in the area led to comprehensive reviews of old basins concealed below the Eromanga Basin. The structure of the Eromanga Basin echoes that of these older basins and much of the discussion of pre-Eromanga Basin rocks has direct relevance, and was incorporated particularly in the network of geological sections (Plate B2) and in the structural synthesis of this report. The distribution and structure of sedimentary rocks of the Adavale Basin is after Tanner (1966, 1968) and Heikkila (1966). An unpublished account by Slanis & Netzel (1967) gives a comprehensive regional review of the Adavale Basin. The revision of nomenclature by Galloway (1970) was used for the stratigraphic divisions used on Plates B1 and 2.

A small part of the southern Drummond Basin extends into the northeast part of the map. This basin is the subject of a BMR Bulletin (Olgers, 1973) and the relation between it and the older Adavale Basin was discussed by Vine (1972).

The Cooper Basin is the subject of papers by Canaple & Smith (1965), Kapel (1966 & 1972), Martin (1967), Papalia (1969), Laing (1969), Gatehouse (1972) and Senior (1975).

PHYSIOGRAPHY

Relief is very subdued; elevation ranges from 60 m above sea level southwest to about 500 m in the northeast. Extensive alluviated plains are separated by interfluves of dissected plateaux. Although scarps in the plateau country are steep, the relief between plains and uplands is small, and seldom exceeds 80 m. The Grey Range is the principal drainage divide, separating the catchments of the Lake Eyre and Bulloo River internal drainage basins. In the east are tributaries of the Murray-Darling system. The most strongly dissected country is in the northeast along the Great Dividing Range, and landforms in this area

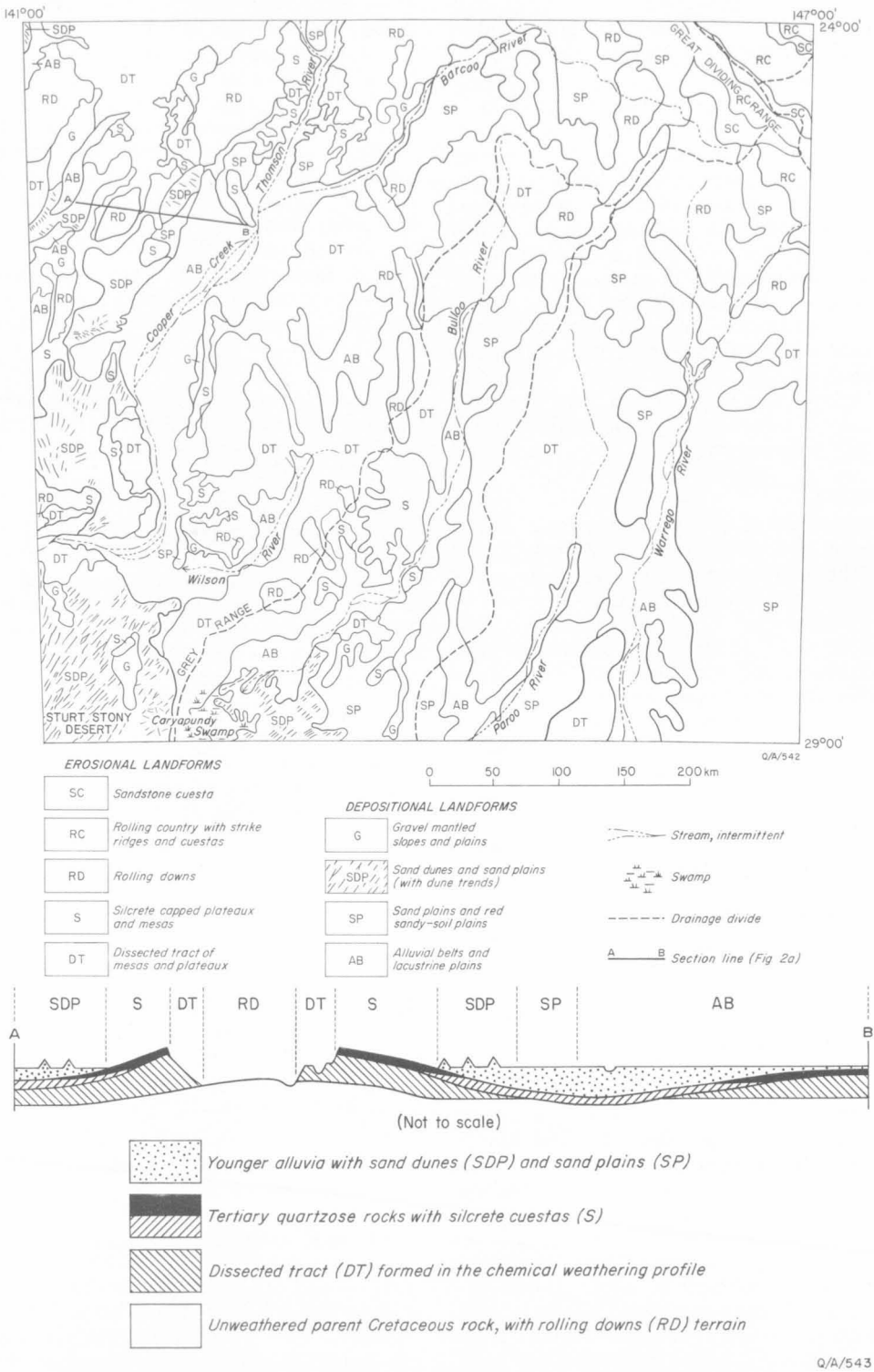


Fig. B2. Physiographic sketch map and diagrammatic section showing relation between landscape type and weathered Cretaceous rocks, Tertiary quartzose rocks, and younger alluvia.

feature numerous cuestas and strike ridges alternating with scrub-covered plains.

Riverine plains widen to the south, where they consist of alluvial flats dissected by a complex of anastomosing channels and floodouts. Open prairie grassland or 'rolling downs' occupy elliptical tracts in the interfluve areas, and they are surrounded by extensive gravel plains and pediments mantled with gravel and 'gibbers'. Sandplains occupy the lowland areas in the west and south. Dunes occur in the more arid country in the west, but merge imperceptibly eastwards into flat sandplain and monotonous scrub-covered, red, sandy-soil plains.

Physiographic units in the area generally trend in a southerly direction, reflecting the regional tectonic grain.

Drainage

West of the Grey Range, the main divide, drainage is dominated by the Cooper Creek and Thomson River system and its principal tributaries, the Wilson and Barcoo Rivers (Fig. B1). The Cooper Creek system has a catchment of about 150 000 km^2 within the map area. The broad floodplains of these rivers together with the Diamantina River form part of the 'channel country' of southwest Queensland. Cooper Creek follows a southerly course, occupying a broad floodplain which widens to 60 km at the confluence with the Wilson River. It then swings westward and the floodplain shrinks until drainage follows a single channel into South Australia. The main floodplains of these rivers are between 60 m and 120 m above sea level. They have a very low southerly slope of less than 19 cm/km, and are characterised by a complex of anastomosing channels.

Potential evaporation in the area west of the Grey Range averages 200 cm/year and, as a result, all drainage is ephemeral. Rivers flow only after heavy rain locally or in their catchments to the north. Cooper Creek is flooded in most years between December and March, but only during very exceptional floods does the water reach the internal drainage basin at Lake Eyre in South Australia.

To the east of the Grey Range are the Bulloo, Paroo, and Warrego Rivers. The Bulloo River has a catchment of about 25 000 km^2 and lies within the area covered by this Bulletin. It terminates near the New South Wales border amongst tracts of sand dunes and floodouts in its own internal drainage system in Lake Bulloo and Caryapundy Swamp. The Paroo and Warrego River are tributaries of the Murray-Darling river system. The Warrego has a catchment of about 50 000 km^2 north of the State border. Floods in the Warrego reach the Darling each second year, on an average, but the Paroo flows less frequently and discharges into the Darling River at intervals of 3 or 4 years. The alluvial plains are extensively flooded on the average about twice per decade, following rainfalls in excess of 10 cm. Both rivers have extensive deltaform distributory networks in the southeast of the area, which feed small, lateral sump basins.

Landscape types

The area comprises nine landscape types, as shown in Figure B2; their relation to chemically weathered sediments is shown in diagrammatic section in Figure B2.

Sandstone cuestas (Unit SC)

In the northeast of the map area three narrow belts of sandstone cuestas parallel the Great Dividing Range. The cuesta cliffs face northeast, and slope gently to the southwest. They are formed by resistant sandstones in the Galilee Basin sequence and the basal Eromanga Basin sequence.

Rolling country with some strike ridges and cuestas (Unit RC)

Rolling country is interspaced with cuestas (SC) and overlies the less resistant part of the rock sequence. This division consists of two topographic forms which alternate across the strike. Rolling country forms on the less resistant finer-grained pre-Cretaceous rocks, and the strike ridges and cuestas on resistant sandstones. The rolling country includes: the Devonian to Carboniferous sediments and volcanics; Upper Permian and Triassic sediments; the upper part of the Lower Jurassic sandstone sequence; the Middle Jurassic silty sequence; and part of the Upper Jurassic to Cretaceous sandstone sequence. The cuestas generally dip to the northwest.

Rolling downs (Unit RD)

Broad tracts of rolling downs occur in the north and west of the map area. This landscape type consists of gently undulating soil downs with usually less than 10 m of relief. The downs have a mantle of khaki cracking-clay soil and are almost treeless prairie grassland. Drainage is by a closely branching system of watercourses, with alluvial floodplains along the larger channels. Many areas of rolling downs are directly related to zones of uplift. The Late Cretaceous chemically weathered

rocks and younger sediments in these zones have been stripped off by erosion, leaving the relatively unweathered Cretaceous sediments in which rolling downs develop. The soil plains are in places veneered with a one-pebble layer of silcrete clasts (gibbers), particularly where the plains merge with the low-plateau-and-mesa terrain of the dissected tract (Unit DT). In areas of poor or ponded drainage, extensive gilgai soils develop in this unit.

Silcrete-capped plateaux and mesas (Unit S)

Plateaux and mesas with gently sloping or flat summits and prominent bounding escarpments are formed by beds of resistant silcrete (strongly indurated siliceous sandstone). In general, silcrete cappings thin towards the east of the area as the Tertiary cover diminishes. In places there are cappings of fragmental silcrete, representing incomplete destruction of a silcrete bed by erosion. Commonly on the partly dissected mesas are remnants of silcrete ranging from tabular cappings to slightly separated and buried rounded boulders. These displaced blocks represent varying degrees of disturbance and removal of the original silcrete beds.

The silcrete-capped uplands delineate all the main structures; for instance, elliptical areas of this landscape type correspond to anticlinal and domal structures. Silcrete surfaces are particularly extensive along the Grey Range, especially north of Thargomindah. The surface of the silcrete is commonly mantled with silcrete boulders and cobbles up to 2 m thick. Where the mantle is absent there is a polygonal pavement of terminating silcrete columns.

An extensive silcrete tableland west and east of Jundah is strongly dissected by drainage systems within steep-sided valleys. On the periphery of the tableland the silcrete forms a vertical escarpment.

Dissected tracts of mesas and low plateaux (Unit DT)

Partial erosion has left a dissected tract of mesas, plateaux, and low rounded hills carved into weathered sediments of several ages. The Tertiary cover with its resistant silcrete beds is only a minor constituent, and much of it has been stripped by erosion. The landforms are similar to those preserved by silcrete cappings, but the summit levels are less concordant and the numerous indurated beds in the deep weathering profile form cappings and benches. Leached and selectively indurated beds in the weathered rocks, white and varicoloured, form spectacular cliffs in many areas. Black ironstone gravel pediments and plains are common, especially in the northwest.

The distribution of these weathered rocks is strongly controlled by Cainozoic tectonic movement and erosion.

Margins of mesas and plateaux are usually steep-sided and strongly crenulate. Erosion by unequal scarp retreat has formed lower plateau elements, such as benches, spurs, and low gravel-mantled rises. Back-tilted gravity slump blocks occur on the margins of the steeper escarpments.

Gravel-mantled plains and slopes (Unit G)

A gently undulating or sloping surface mantled by abundant coarse and fine alluvial and colluvial deposits forms a distinctive landscape type. Cobbles and pebbles of silcrete gravel, which are abundant on the surfaces, have been derived from silcrete uplands. Silcrete is the dominant clast-forming material, but 'ironstone' gravel and quartz gravel are locally common. Mantled plains and slopes occur in core zones and peripheries of anticlines. Rudites within the anticlinal core zones are lag gravels composed of the more indurated sediments within a former continuous layer of weathered rocks. Widespread silcrete gravels (lag gravels) indicate the former existence of silcrete beds across anticlines and domes.

Sand dunes and sandplain (Unit SDP)

Dunefields are common in the west, especially in the Sturt Stony Desert to the southwest and in a belt trending northward along the west side of the Cooper Creek floodplains. Smaller dunefields occur around the northeast margin of Caryapundy Swamp and border Farrars Creek.

In the Sturt Desert the dunes are similar in character to those in Simpson Desert to the northwest. For the most part they are longitudinal and are oriented north-northeast; they divide and rejoin and the corridors between them are therefore not always continuous.

The dunefields, whose position is strongly influenced by the pattern of Cainozoic deformation, are restricted to low-lying or downwarped areas. The dunes trend north-northeast, except near domal or anticlinal structures, where they may be deflected to the north-northwest. In such areas longitudinal dunes gradually merge with less regular dune forms, and in areas of varied wind direction reticulate dunes occur.

Dune-sand is usually brownish-pink or brick-red, though dunes in the vicinity of playa lakes

(Lake Yamma Yamma) or broad alluvial tracts are of light or even white sand. Older sand derived from initial aeolian action on former widespread alluvium and colluvium is brick-red owing to iron-oxide coatings. The dunes are generally stabilised and support a sparse vegetation growth of spinifex, cane grass, and xerophytic shrubs; in places their crests are active, and small barchan-like dunes develop along them.

The cores of most old dunes are consolidated by clay illuviation and cementation by iron oxides. The clay is blown onto the dunes from dust and from the curled clay skins of desiccated claypans.

Sand and red sandy soil plains (Unit SP)

Sand and red sandy soil plains are extensive throughout the area, particularly in the south and west, where they grade into sand dune and sandplain country (unit SDP). This unit contains two landscape types: aeolian sand surfaces and residual or transported fine red sandy soils. A boundary between them is difficult to define because of the very gradual change in the sand content.

The red sandy soil plains are characteristic of the lower slopes of structural uplands capped by a weathering mantle. Their undissected surfaces, sloping at 0.5 – 1°, lack well defined drainage lines and are subject to sheet flow. Scrub vegetation (mainly mulga species) shows on aerial photographs as arranged in concentric lines, probably because root systems penetrate regularly arranged expansion cracks in the weathered mantle. These surfaces commonly grade into sandplain in their lower parts.

Sandplains are level plains on which are only rare dunes and which are fully stabilised by vegetation. The sandplain south of Charleville is a typical example, and as is generally the case in arid Australia, aeolian sand is closely associated with lower sectors of river plains. However, in places this unit extends over upland surfaces adjacent to eroded silcrete and Tertiary sandstone cappings; for example, the sandplains north of Windorah.

Broadly undulating vegetated sandplain usually lacks local surface drainage and comprises some of the most uniform and monotonous landscapes in the area. Some areas receive runoff from adjoining uplands, and claypans are aligned along shallow depressions which mark disintegrated formed drainage lines. Some watercourses lose their identity as they approach the sandplain, owing to infiltration.

Alluvial belts and lacustrine plains (Unit AB)

The alluvial silt and clay plains of the larger river systems (Diamantina, Cooper, Wilson, Bulloo, Paroo, and Warrego) generally broaden southwards. In the upper sectors of the rivers, confined by higher ground, there is typically a belt of alluvium with interlacing channels up to 5 km wide. These channels form the elongate rectangular braids which Whitehouse (1944) described as 'reticular', and at intervals, especially in the westernmost rivers, there are long straight waterholes. The floodplains are consequent within synclinal depressions. In places they are up to 130 km wide and have complex tributary and distributary network systems. Lateral sump basins occur, but most are small; an exception is Lake Yamma Yamma, about 20 km wide.

The interlacing channels that cross the floodplains comprise deep channels of suspended-load type (Schumm, 1963) and shallower floodways. The complex anastomosing pattern of small channels re-forms at intervals into sinuous trunk sectors only about 200 m wide, in many of which there are permanent waterholes. Most of the trunk sectors are less than 15 km long.

Alluvial deposits range from the pale to dark grey cracking clays of the floodplains to the silts and fine sands in levee belts and meander scrolls in present and former channel zones. Islands of aeolian sand form low vegetated mounds on the floodplains.

STRATIGRAPHY

Eromanga Basin sequence

The stratigraphy of the central portion of the Eromanga Basin is summarised in Table B3. The Eromanga Basin consists of an essentially conformable sedimentary sequence of Early Jurassic to Late Cretaceous age. For the purpose of this Bulletin sediments of concealed or partly concealed older basins are regarded as 'basement' along with true basement rocks of an igneous or metamorphic nature.

In order to avoid tedious descriptive detail the stratigraphy of the Eromanga Basin is portrayed by a series of structure contour and isopach maps (Pls. B4-7): the maps are at the same scale as the geological map (Plate B1) to facilitate correlation of surface and subsurface data.

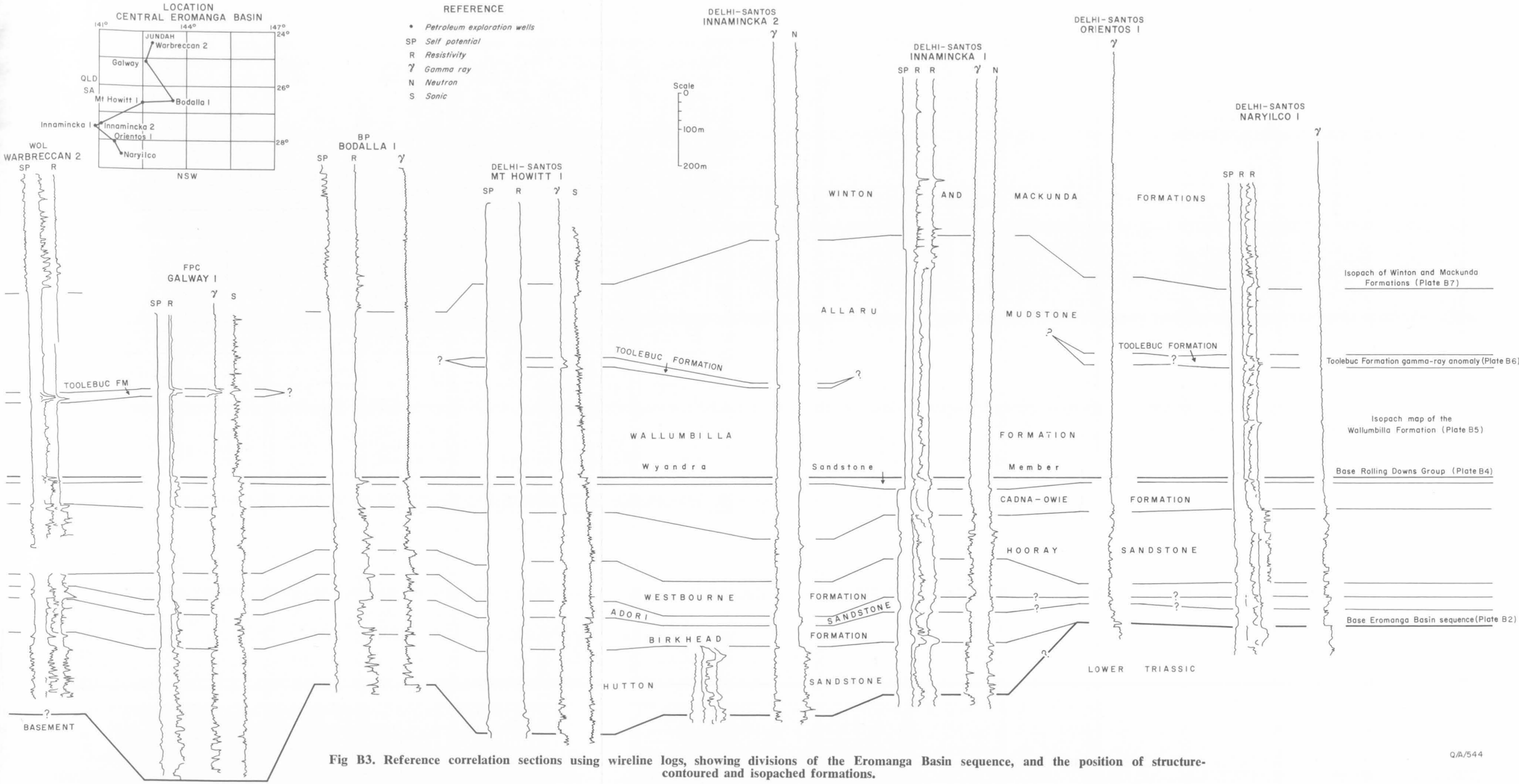


Fig B3. Reference correlation sections using wireline logs, showing divisions of the Eromanga Basin sequence, and the position of structure-contoured and isopached formations.

Q/A/544



B4. Pleistocene lacustrine sediments of Boondoona Creek (Boondoona Fault area) which contain vertebrate fossils. (BMR negative M/829).

typical section through the main units ving their wireline log response, and the ls at which the structure contour and iso- h maps have been drawn, is given in Figure .

The main features of Plate B2, the network geological cross-sections, and each structure ntour and isopach map are described briefly.

rspective sectional correlation (Pl. B2)

This fence diagram consists of geological cross-sections drawn at each 1° of latitude and 1°30′ of longitude. The Eromanga Basin sequence (Lower Jurassic Precipice Sandstone to Lower to Upper Cretaceous Winton Formation) unconformably overlies older basin systems and basement. The older basins lie in a diagonal zone trending northeast. The Eromanga Basin overlies the Lower Permian to Middle Triassic Cooper Basin in the western half, and the Upper Carboniferous to Upper Triassic Galilee Basin in the northwestern part, of the diagram. Two Devonian to Carboniferous basins (Adavale and Drummond) are mainly concealed below the Galilee Basin succession. The thickest preserved Eromanga sequences follow the zones occupied by the Adavale, Cooper, and Galilee Basins systems. Basement shelves of Lower Palaeozoic metamorphic rocks and granite plutons flank these old basins. In shelf areas, to the southeast and northwest, the geological sections show progressive thinning and wedging-out of Jurassic strata over a smooth basement surface. In the northeast there is progressive truncation until the Eromanga Basin sequence gives way to outcropping Galilee and Drummond Basin rocks.

Structure contours at the base of the Rolling Downs Group (Pl. B4)

There are two mappable seismic horizons in the central part of the Eromanga Basin Map area. The deepest consistent reflector lies in the Upper Permian (Cooper and Galilee Basins) and was contoured to provide depth, thickness, and shape control for the network of geological sections (Pl. B2); the second lies within the Eromanga Basin sequence close to the base of the Rolling Downs Group. Petroleum exploration companies refer to this reflector as the 'Blythesdale reflector', 'C Horizon' or 'Transition Beds'. Stratigraphically the reflector originates from the upper part of Cadna-owie Formation, where a thin but extensive sandstone bed (Wyandra Sandstone Member) is found. The results of seismic work were adjusted where necessary to conform with known

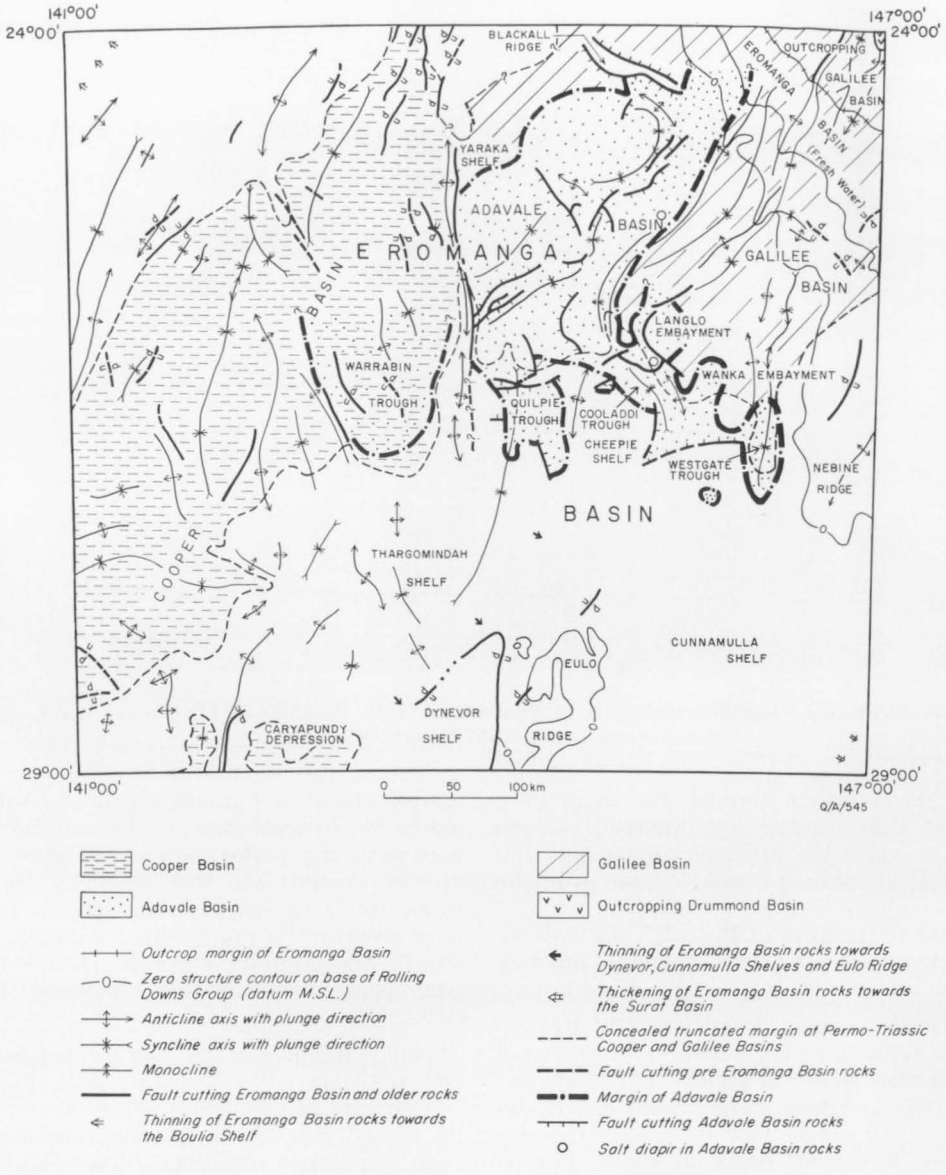


Fig. B5. Structural sketch map.

depths interpreted from petroleum exploration wells, BMR drill holes, and water bores. Plate B4 gives structure contours at the base of the Rolling Downs Group (top Cadna-owie Formation where present). Contour values are at 100 m intervals for the western half and 50 m intervals for the eastern half. Reference to the network of seismic lines (Pl. B3) shows which portion of the diagram has seismic control. The closer spacing of contours in the eastern half of the map is due to the existence of water bores, many of which were gamma-ray logged. A few additional control points were interpreted form drillers' lithological logs of water bores and BMR shallow stratigraphic drill holes.

This contour surface partly reflects the structure of the concealed basins and basement. For example, the axis of the Cooper Basin coincides with a sinuous line of downwarps which broadly follow the courses of the Thomson River and Cooper Creek. Similarly,

the position of the Adavale Basin and southern trough-like extensions can be seen to the east of the Canaway Fault. Contour intervals are closely spaced towards the structural margin of the Eromanga Basin in the northeast, but show gentle gradients over the basement shelves to the southeast and northwest.

Isopach map of the Wallumbilla Formation (Plate B5)

Differentiation of the Wallumbilla Formation on gamma-ray logs is relatively simple, as it mostly lies between the more highly radioactive Toolebuc Formation and arenitic strata of the Cadna-owie Formation and Hooray Sandstone (Fig. B3). The top of the Wallumbilla is difficult to interpret in the southeast of the area, where the Toolebuc Formation is absent (see bore QIWSC No. 96, inset in Plate B5). Two members (Coreena and Doncaster Members) were mapped in outcrop (Pls. B1 and 2), but are difficult to differentiate on gamma-ray logs because of the similarity of radioactive response of labile arenite and mudstone (see bores QIWSC Nos. 3954 & 96, inset in B5).

The Wallumbilla Formation varies in thickness from zero where it flanks basement inliers along the Eulo Ridge to an inferred 480 m along the axis of the Cooper Syncline. The map relies mainly on the results of petroleum exploration drilling, especially in the western part. Data points are relatively sparse and the effect of contemporaneous fault and fold movements on deposition is in places conjectural; however, faults shown do appear to have affected accumulation of sediments. Recorded lithology is consistent throughout the area and no changes were found even where the unit onlaps granite basement in the Eulo Ridge area.

The Toolebuc Formation gamma-ray anomaly (Pl. B6)

The Toolebuc Formation shows on gamma-ray logs as a marked radioactive peak (Pl. B6). In outcrops the only part of the unit seen is scattered limestone rubble and ovoid concentrations; but drilling has shown that limestone is subordinate to black labile sandstone and siltstone with abundant shelly fossils (Senior & Smart, 1973). It seems likely that phosphatic minerals associated with the shell debris give the marked radioactivity recorded on the gamma-ray logs. Limestone was rarely recorded by water-bore drillers and only found infrequently in cuttings from the Toolebuc Formation in petroleum exploration wells; there is probably very little limestone in the formation in the map area.

The gamma-ray anomaly is thickest in the central part of the map area, corresponding to the axial position of the Eromanga Basin. The eastern margin of the Toolebuc Formation shows thin, rather elongate anomalies which may indicate the effect of weathering where the unit is close to the ground surface. The amplitude and thickness of the anomalies diminish towards the depositional margin of the formation in the southeast and south. A group of Toolebuc gamma-ray anomalies in northwest New South Wales (Bulloo Embayment) to the south of the map indicate a probable southerly continuation of the formation following downwarps peripheral to the Wompah Anticline.

Major structures apparently had little effect on thickness or sedimentological features responsible for the intensity of the gamma-ray anomaly. However, the large anomalies west of the Canaway Fault indicate that it may have been active during deposition of the Toolebuc Formation, the shallow sea on the western upthrown side being more favourable to marine life and carbonate deposition than the deeper water to the east.

Isopach map of the Mackunda and Winton Formations (Pl. B7)

The lithological similarity of the Mackunda and Winton Formations makes their separation difficult. In the field the presence of marine fossils is the main criterion used to identify the Mackunda Formation. On gamma-ray logs the two cannot be separated (see bores 1183 and 2253, Pl. B7), but with other wireline logs run in petroleum exploration wells a distinction can generally be made. The conformable contact of the Mackunda Formation with the underlying Allaru Mudstone is also commonly difficult to determine on gamma-ray logs. The change from a relatively smooth-line graph (Allura Mudstone) to an irregular-line graph (Mackunda Formation) is the basis of picking the formation boundary (Fig. B3 and Pl. B7).

The upper limit of the Winton Formation is an erosion surface, both in outcrop and subcrop, and erosion partly accounts for the marked thickness variations apparent across fold structures and faults. The Mackunda and Winton Formations are thickest along the axial zones of the Cooper and Adavale Basins.

The Mackunda Formation (in common with the Allaru Mudstone and Toolebuc Formation) was not deposited in the southeast, where the Wallumbilla Formation grades up into a thickly bedded, nor-marine sequence of labile sandstone, siltstone, mudstone, and intraformational conglomerate of the Winton Formation.

Chemical weathering

In the Late Cretaceous and Early Tertiary the Rolling Downs Group was deeply weathered: the parent rock was hardened, and silica, alumina, and iron were released by the breakdown of feldspar and transformation of montmorillonitic to kaolinitic clay minerals. Rocks of the Wallumbilla, Allaru, Mackunda, and Winton Formations were weathered to depths over 100 m, and their weathered portions in outcrop are depicted by the stippled areas on the geological map (Plate B1); the map, of course, does not show the very considerable extent of weathered rock concealed below Tertiary rocks and unconsolidated Quaternary sediments.

Lithological descriptions given in Table B3 are only relevant to outcropping Rolling Downs Group rocks in the northeast portion of the map and rocks intersected below the weathering profile in drill holes. Recognising individual units in the weathered state is difficult, and special mapping techniques were adopted. Description of the altered rocks, emplacement of precious opal, and weathering history, although vital to the understanding of the region, are beyond the scope of this Bulletin. However, the regional significance of weathering is discusssed by Senior (1972 & 1977) and formations in the weathered state have been described in several BMR Records (see index in Fig. 1).*

CAINOZOIC SEDIMENTARY ROCKS (POST-EROMANGA BASIN)

Eight Cainozoic units are delineated in Plate B1, and their stratigraphy is summarised in Table B4. Although mainly thin, they are widespread, particularly in the southern part of the area. The older Cainozoic sedimentary rocks reflect a major change in provenance, and the quartzose nature of the sedimentary rocks contrasts markedly with the low quartz content of the labile arenites of the Cretaceous Rolling Downs Group.

Stratigraphic drilling shows that the Glendower and Whitula Formations (see Appendix) are thickest in and next to downwarps, and so echo inherited trends in the older Eromanga Basin. The Glendower Formation was deposited by an extensive river system draining the northeast margin of the basin. Outcropping Jurassic quartzose arenitic strata along the margin were probably the major source of sediment. Early Tertiary folding and faulting controlled the drainage direction of these rivers as they flowed southwest towards the Lake Eyre Basin. Downwarps such as the Thomson and Cooper Synclines, Yamma Yamma and Wilson Depressions, and peripheral zones were centres of sedimentation. Sediment accumulated in the adjacent Powell Depression, probably because the Canaway Fault obstructed southern tributaries of the palaeoriver system.

The Glendower Formation is extensively silicified to silcrete; the morphology and origin of silcrete in the western half of the map area is discussed by Senior & Senior (1972).

Widespread generally unconsolidated Quaternary sediments are mainly the product of aeolian and fluvial reworking of older Cainozoic rocks and those of the Eromanga Basin sequence.

STRUCTURE

The structure of the Eromanga Basin in the map area and the distribution of concealed or partly concealed older basin systems and basement is shown in Figure B5.

Structure contours at the base of the Rolling Downs Group and the network of geological sections (Pls. B1 and 4) illustrate the overall structure. A series of faults and fault-induced anticlines, trending north from the eastern margin of the Dynevor Shelf through the Canaway and Stormhill Faults, bisects the area. To the west of the Dynevor and Canaway Faults most structural axes trend northwards; to the east, the predominant trend is northeast. The Canaway-Stormhill Fault system can be traced farther to the north along the

* Since this Bulletin was written the weathered profiles of the region have been the subject of considerable research and the timing of weathering episodes established using palaeomagnetism; *see* IDNURM, M., & SENIOR, B. R., in press—Palaeomagnetic ages of Late Cretaceous and Tertiary weathered profiles in the Eromanga Basin, Queensland. *Palaeogeography, Palaeoclimatology, Palaeoecology.*

Beryl Ridge of the northern part of the Eromanga Basin (see Part A of this Bulletin). It forms a major fracture zone through the Eromanga Basin. A second major structural zone extends from South Australia (Cordillo Uplift) into the northwest of the map area and includes the Curalle Dome, Morney Anticline, and Warbreccan Dome. Seismic evidence indicates that these structures are probably drape folds over buried basement fault blocks. To the north of the Warbreccan Dome this structural zone merges at an angle of about 45° with the north-south Stormhill-Canaway-Dynevor line of faults.

In the western half of the map area faulted basement horsts displace the Eromanga Basin sequence and give rise to asymmetric surface anticlines or displace the sediments without apparent folding. All faulting and folding in the Eromanga Basin reflects stronger deformation either in underlying basin systems or in the basement. Folding contemporaneous with sedimentation appears to have had little effect on the type of sediments deposited: facies appear to be very similar in widely spaced drill holes.

The positions of the axes of the Cooper and Adavale Basins approximately correspond to synclines within the Eromanga Basin. Structural conformity with older basins is attributable to continued slight epeirogenic movement and differential compaction of Eromanga Basin sediments during Mesozoic and Cainozoic deposition.

Where the Eromanga Basin and younger sediments rest directly on metamorphic or igneous rocks, surface-expressed structure is attributable to drape over old basement features together with faulting and flexuring. Broad basement features such as the Cunnamulla, Thargomindah, and Dynevor Shelves (Fig. B4) dominate these areas, and the overlying sediments are virtually structureless and almost flat-lying. However, a few faults with apparently small displacements are present: for example, those near the Eulo Ridge. Along the crest of the Eulo Ridge, granitic and metamorphic rocks have been buried by the Eromanga Basin sediments, and the basement inliers are attributable to slight arching and erosion of sediment from the Eulo Ridge in Late Cretaceous and Cainozoic time.

The distribution of the weathered Rolling Downs Group sediments (stippled areas on the map) and beds of silcrete reflects the underlying structure (Pls. B1 and 2). Cainozoic movement is reflected in their tilting and erosion. Many of the larger structures such as the Mount Howitt and Durham Downs Anticlines are completely encircled by cuestas of altered rock, with dip slopes preserved in the resistant silcrete beds. In most of the larger structures deformation has been slight, but sufficient for erosion to remove the altered rocks from the axial zone of the fold. In all anticlines where fresh rock is exposed in the core zone it is estimated that at least 100 m of arching, involving two periods of structural movement, took place in Cainozoic time, an estimate based on the thickness of chemically weathered sediments that have been subsequently eroded. An unknown thickness of fresh rock has also been eroded from the core zones of such anticlines.

In smaller synclines the altered rocks are folded and covered with Cainozoic sediments. In large synclines, for example the Cooper Syncline, the folding was accompanied by establishment of a drainage system which initially resulted in the erosion of the altered rocks along parts of the fold axes (Senior, 1977).

In a few anticlines and along faults, chemically weathered sediments and younger silcrete beds are folded. Dips of up to 50° in silcrete occur on the western limit of the Curalle Dome, and dips of 15° to 37° along a fault just east of the Wompah Anticline.

GEOLOGICAL HISTORY

Sedimentation began in the Proterozoic and continued through the early Palaeozoic. Several basinal sedimentary successions (Drummond, Adavale, Cooper, and Galilee) had been deposited, deformed, and planed by erosion before the Eromanga Basin developed in the Early Jurassic. The earliest sediments (Precipice Sandstone and Boxvale Sandstone Member) were laid down in the northeast over truncated Galilee Basin rocks and low-grade metamorphic basement. Silt and mud (Evergreen Formation) accumulated in lakes and were deposited by rivers, though the sea may have briefly covered the northeast part of the map area during Evergreen deposition. Toward the end of Early Jurassic time sedimentation

spread southwestwards. Quartzose sand (Hutton Sandstone) was first deposited there by rivers, some of which drained hilly country in the vicinity of the Boulia Shelf in the northwest and the Thargomindah and Cunnamulla Shelves in the south and southeast. Further downwarping in Middle to Late Jurassic time resulted in deposition of silt, mud, and sand (Injune Creek Group) by rivers. These sediments eventually overlapped the margins of basement shelves. Fluviatile sedimentation persisted, and until Late Jurassic or Early Cretaceous time the area was blanketed in quartzose to sublabile sand (Hooray Sandstone and Cadna-owie Formation) except for a few hills of granite and metamorphic rocks along the Eulo Ridge.

The sea returned to the area in Early Cretaceous time, and with the sudden change of environment there was a change in provenance. Quartzose sediments gave way to labile and very labile sand containing abundant fresh feldspar, silt, mud, and a little carbonate (Rolling Downs Group). Most of this sediment accumulated in a shallow muddy sea connected only intermittently with the open ocean. Marine life was somewhat impoverished because of the muddy substrate, but molluscs flourished on shallow banks in clearer water. In Toolebuc Formation time the water was at its clearest, and a thin deposit of calcareous silt and some limestone packed with organic debris was deposited in the northwest; in the southeast the sea regressed. Except for the area of the Thargomindah and Cunnamulla Shelves the Eromanga Basin was still being slowly downwarped, and deposits of mud and silt (Allaru Mudstone) accumulated until late Early Cretaceous time, when the sea receded and sand, silt, and mud (Mackunda Formation) were deposited under paralic conditions.

Deposition of very labile sand, silt, and mud (Winton Formation) in rivers, lakes, and swamps extended into Late Cretaceous time. In the area of the Eulo Ridge and Cunnamulla Shelf the Winton Formation is diachronous and is conformable on Wallumbilla Formation sediments; elsewhere it overlies the paralic sediments of the Mackunda Formation. The shelf areas in the southeast were stable during Winton time and on them the Winton sequence is thin. The Eromanga Basin was still downwarping along earlier inherited lines of sinking, with an axis following the central Cooper and Adavale Basin regions, where the thickest of the Winton sediments accumulated.

Sedimentation of the Rolling Downs Group ceased in Late Cretaceous time. A period of uplift and erosion left a subdued landscape attacked by chemical erosion. The exposed sediments, being largely labile, were weathered to a considerable depth, probably by a combination of hydrolysis, oxidation, and carbonation. The result of these processes was to produce a trizonal profile, over 100 m thick, of chemically weathered sediments consisting of dominantly kaolinitic rocks which are indurated with silica at the top and ferruginised towards the base.

In Early Tertiary time the continued growth of deep-seated structures caused the weathered rocks to be slightly warped and in places eroded. Quartzose sand derived primarily from the relatively higher Jurassic and older rocks around the basin margin were spread by streams over much of the western half of the map area. Lakes formed in the larger depositional areas. The Tertiary rocks were themselves affected by weathering, and were silicified, the thin sequences (less than 3 m) completely, and the thicker ones selectively, to silcrete. Where Tertiary sediments were very thin or absent the previously weathered Cretaceous sediments were again altered by pedogenic processes to a depth of about 15 m, and a hard crust slightly enriched in iron or silica was formed.

After these two intense weathering phases erosion continued as a slow continuous process to the present day. Weathered rocks were stripped from the core zones of growing anticlines and quite thick sediments accumulated in major synclines. Consolidated scree and pediment deposits adjacent to chemically weathered outcrops were subjected to further weathering, differentiation, and cementation.

A more humid climate in late Pleistocene time resulted in fluviatile and lacustrine sedimentation and encouraged the growth of luxuriant vegetation adjacent to rivers, in which lungfish and crocodiles were plentiful. Since then the area has been eroded in arid and semi-arid climates, and alluvium, aeolian sand, and gravel have accumulated.



Fig. B6. Werewilke homestead bore (depth 380 m), which has a high-pressure supply of hot water. This bore is situated in the Eulo Ridge area and has an above-average yield probably because it taps a channel sandstone bed in the Hooray Sandstone. (BMR negative M/831).

ECONOMIC GEOLOGY

GROUNDWATER

Introduction

Most of the Map area is within the Great Artesian Basin, which contains artesian and subartesian aquifers. Some of the intake areas occur in the northeast, around the structural margin. Aquifers are numerous and occur in almost all arenaceous sediments of Permian to Quaternary age.

About 3700 water bores have been drilled in the central part of the Eromanga Basin. Of this total about 1300 are artesian bores, 130 are artesian bores which have ceased to flow, 1800 are subartesian bores or wells, and 470 are abandoned. The distribution of water bores is shown in Plate B1; the aquifers they tap are divided into systems older and younger than the base of the Wallumbilla Formation.

The first flowing bore in Queensland, completed in 1887, is sited to the east of Cunnamulla town (QIWSC No. 4514). Some of the deepest bores drilled for water, for example Springleigh bore (QIWSC No. 3489) near Blackall, which is 2134 m deep, are in the map area. The highest recorded pressure in a Queensland water bore was about 2000 kPa, recorded at the completion of Thargomindah town bore (Ogilvie, 1954).

The 1:250 000 geological maps of the area are the first to show accurately the positions of all bores. Because of the potential of drillers' lithological logs as a source of subsurface data most bores in the map area were located by visiting the bore site, by discussion with property owners, or by sighting from a light aircraft. Cadastral maps with bore locations, prepared by the Queensland Irrigation and Water Supply Commission, were used as a guide to this work. Many bores were gamma-ray logged for stratigraphic information, and differential temperature, flow-meter, and caliper logs were run in some. These logs are available for study at the Bureau of Mineral Resources, Canberra, and at the Geological Survey of Queensland, Brisbane.

The electrical conductivities of samples from most flowing bores and many subartesian bores in the southern half of the map area are listed in Senior et al. (1968, 1969). These allowed the quality of the water to be roughly deter-

mined, and large numbers of these measurements were found to be related to aquifer systems of slightly varying salinity. Examples of conductivity and water chemistry show the variations between the water in the Hooray Sandstone and Wyandra Sandstone Member aquifers in the Cunnamulla Shelf area (Table B5).

Pre-Wallumbilla aquifers

The Jurassic arenites, Hooray, Adori, Hutton, and Precipice Sandstones, are all capable of producing abundant pressure water. Drill stem tests run in petroleum exploration wells produced fresh water from these units, and the intervals tested showed excellent aquifer characteristics. Aquifers below the Hooray Sandstone are seldom used, except near their outcrop in the northeast, because they are too deep.

The Hooray Sandstone is tapped most commonly, and usually gives prolific supplies of fresh water suitable for town supply, domestic, and stock water. The water contains sodium and bicarbonate, and except in a few instances, is unsuitable for irrigation. For reasons yet unexplained the fluorine content of the Hooray aquifers is variable, and where it is greater than 2 ppm the teeth of children and young animals may be damaged. Concentrations of 10 ppm and more are not unusual.

Quartzose sandstone beds in the Hooray Sandstone sequence are illustrated in the correlation diagram in Figure B7. There appears to be good interconnection between the aquifers although some beds are lenticular. Water in the widespread quartzose to sublabile sandstone at the top of the Wyandra Sandstone Member of the Cadna-owie Formation is in some areas more saline than that of aquifers in the Hooray Sandstone. Chemical analyses and conductivity of water samples from the Cunnamulla Shelf (Table B5) show that there is about 70% more dissolved solids in water from the Wyandra Sandstone Member, and that in both aquifers sodium bicarbonate predominates over sodium chloride.

Intake areas for the Jurassic aquifer systems lie along the northeast geographical margin of the Eromanga Basin. Subsurface water movement is southwest (Ogilvie, 1954), and, in general, salinity in the Hooray Sandstone aquifers increases with distance from the intake areas. However, conductivity measurements show that Hooray Sandstone aquifers on the Cunnamulla Shelf contain water of considerably higher quality than the same aquifers to the north in the Charleville area: it seems that fresh water from older aquifer systems mingles with Hooray water at the onlap edge. Good quality water from the Adori, Hutton, and Precipice Sandstone may be moving along permeable sands which rest on the basement to gain access eventually into the Hooray Sandstone (Fig. B8).

Supply from the Hooray aquifers has diminished because it is being overdrawn. In some areas, especially to the north and east of Charleville, the potentiometric surface is now well below ground surface. In non-flowing areas older aquifers have been tapped, and the new Charleville town bore (No. 16982) obtained an initial flow of 140 m^3/hr from aquifers in the Adori and Hutton Sandstones.

Wallumbilla Formation aquifers

Water bores which penetrated the Wallumbilla sequence generally encountered some groundwater within labile sandstone beds; normally it was cased off because of the high salinity and small supply. In the southeast there is a labile sandstone with fair porosity and permeability which in a few areas yields economic supplies of brackish artesian water. The continuity of this sand, which occurs at the base of the Coreena Member, is shown in Figure B7. Conductivity measurements indicate slightly brackish water and range between 737 and 6270 microsiemens per centimetre at 25°C (Thomas, 1971).

In or close to the belt of Wallumbilla Formation outcrop in the northeast are a number of bores which intially flowed from the Coreena Member. They ceased flowing soon after completion and now yield pumping supplies of between 1100 and 4500 litres/hour. Salinity is variable, and some supplies are unsuitable even for hardy stock such as merino sheep.

Winton and Mackunda Formation aquifers

The Winton and Mackunda Formation contain numerous aquifers which give mainly subartesian supplies of variable quality and quantity. Most of the water is brackish and is suitable only for stock.

Micrologs of petroleum exploration wells show that the basal Winton Formation and the Mackunda Formation, in the general area between Windorah and Quilpie, have generally good permeability over a stratigraphic thickness of between 50 and 150 m. A few bores which tapped this basal section where it is near the surface, across the northeast of the Canaway Anticline, originally flowed. Gregory & Vine (1969) suggested that the high potentio-

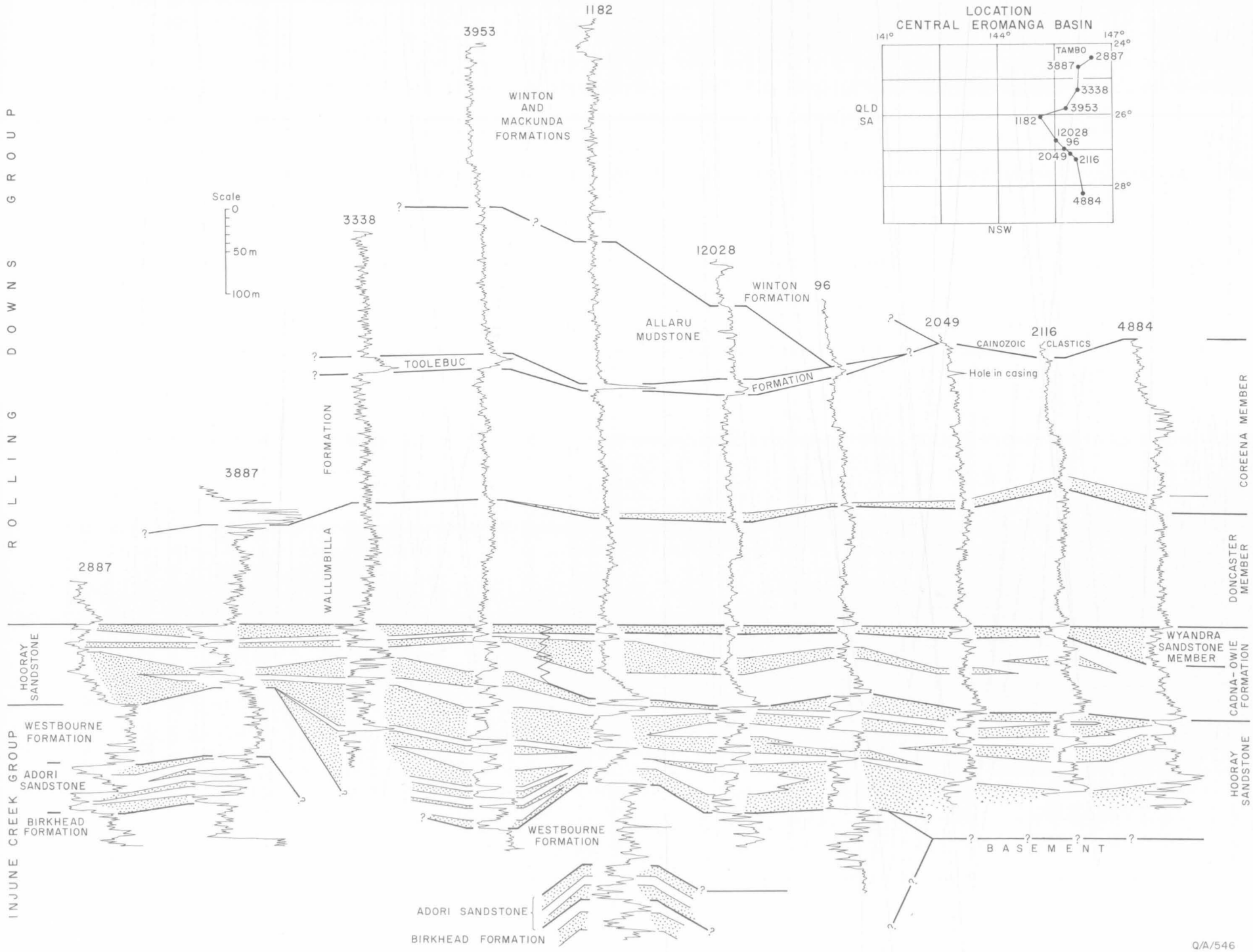
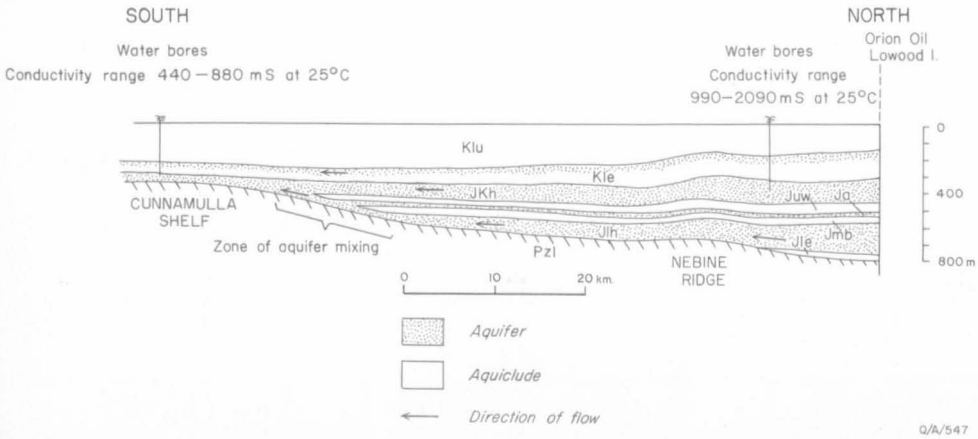


Fig. B7. Correlation of gamma-ray logs showing distribution of sandstone beds (aquifers) in Injune Creek Group to Rolling Downs Group sediments.



. B8. Diagrammatic section showing a zone of aquifer mixing along the north margin of the Cunnamulla Shelf.



ig. B9. Tunga bore (depth 65 m), typical of water bores with small flows tapping pinchouts of Hooray Sandstone against basement highs in the Eulo Ridge area. (BMR negative GA/1372).

metric surface in this area is probably due to good permeability extending to intake areas to the north and east.

In a small area about 15 km southeast of Quilpie are four artesian bores which tap a Winton Formation aquifer at about 130 m. Senior (1971) suggests that high hydraulic head in local intake areas in the hill country to the east of the Bulloo plains near Quilpie causes the artesian flow. The water is brackish (7700 to 9350 μS/cm at 25°C), and is suitable only for stock.

Elsewhere within the Winton Formation porous and permeable beds are thin and

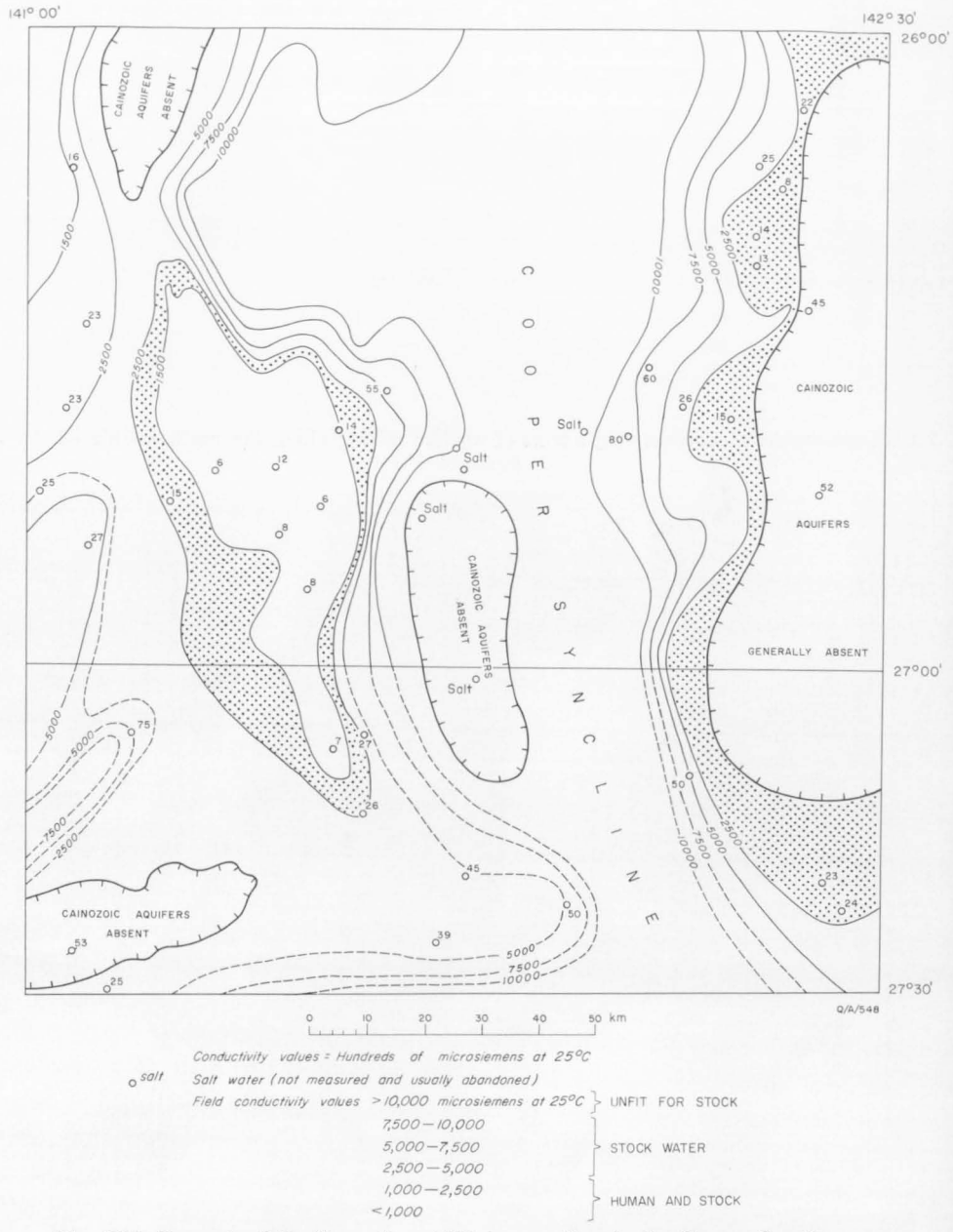


Fig. B10. Isoconductivity lines of post-Winton aquifers in the Cooper Syncline area.

sporadic. They are usually found by chance because they occur in lenticular beds of slightly cleaner labile sandstone. Quality varies from brackish to saline, and recorded supplies are from a few litres to over 9000 litres/hour. In some areas, for example the rolling downs country to the east of Stonehenge, only salt water was found.

Cainozoic aquifers

Thick sediments in the Cooper Syncli (Whitula Formation) and sandy country the west of Cooper Creek include confin and unconfined aquifers. The quality and qua tity of the groundwater is very variable. Su cessful bores may have good supplies of 36 to 5500 litres/hour of brackish to fresh wat

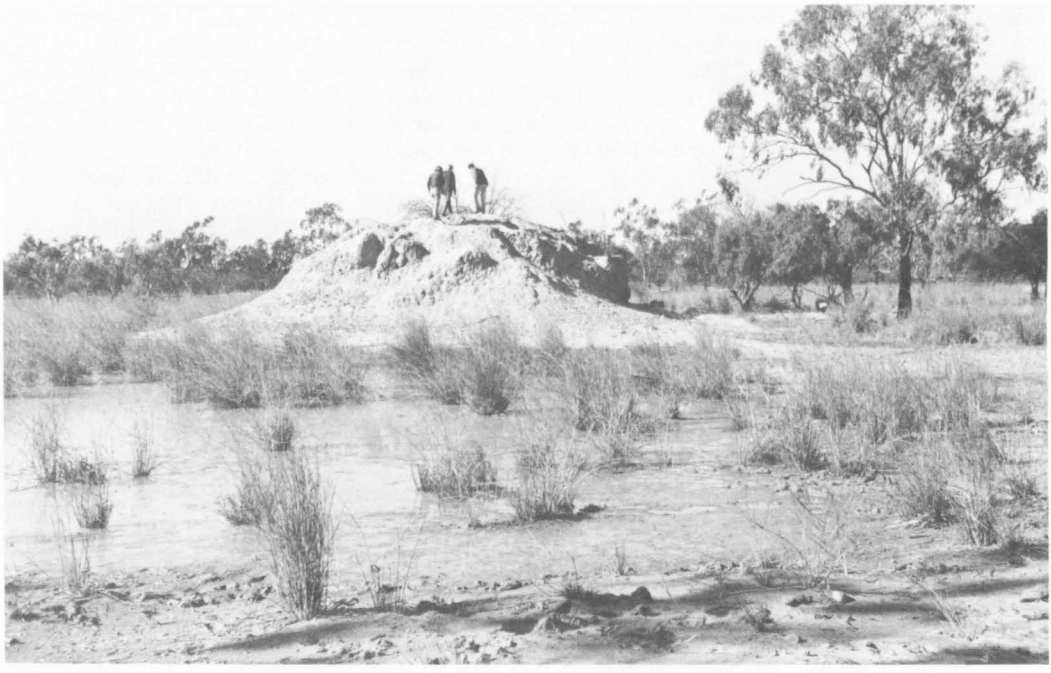


Fig. B11. Active mound spring near Eulo township. The outermost layer of mud is quite dry and hard but has a core and crater-like summit of soft plastic mud. Note flooded ground formed by artesian spring activity. (BMR negative M/829).

Shallow bores and wells on the east and west flank of the Curalle Dome tap aquifers in sandy ferruginous pisolitic sediments which rest on silcrete. Their continuation to the west of the map area in Cordillo area has been described by Wopfner (1961), who also gives details of natural springs which flow from them. He has since (1974) named these sediments the Doonbara Formation.

On the flanks of most large anticlines in the western half of the map area are a few successful bores or wells tapping aquifers within the Tertiary Glendower Formation. In the Cooper Syncline the Glendower and Whitula Formations contain thin gypsum beds and other salts, and aquifers are saline. Intakes along the margin of the Mount Howitt Anticline provide local supplies of fresh or brackish water, but quality as determined by conductivity measurements deteriorates towards the Cooper Syncline (Fig. B10).

Watercourses draining the flanks of some anticlines dissipate into the subsurface in sand country; and confined and unconfined aquifers occur at shallow depths below the dunes and sandplains. A BMR scout hole (Barrolka 3) drilled 25 km southwest of Lake Yamma Yamma obtained water from an unconfined aquifer which occurs above a tough silcrete bed at the base of the dune sand, and a confined aquifer below it; both produced fresh water.

Quaternary aquifers in the Warrego River alluvium near Charleville were investigated by the Queensland Irrigation and Water Supply Commission, which during 1971 drilled a number of large-diameter boreholes and tapped large supplies of fresh water from confined aquifers in buried channel sands (QIWSC pers. comm.).

Artesian leakage

Freshwater springs and mud springs occur in the Eulo Ridge area. Whitehouse (1954) stated that mud or mound springs are found along lines of faults, most commonly where the aquifer is near the surface. Their relation to shallow ridges of bedrock indicated that many such springs developed by water rising along tensional cracks, as the beds have been slightly arched over these subsurface blocks. He suggested that hot alkaline water under pressure puddled the clays in the aquiclude and that the developing springs burst out sud-

denly and quickly established a mound. Very many mound springs were examined and it appeared that the growth of mound springs is a very slow process. A few mounds which have a crater-like floor below ground level show that the mud core after mound-building had reversed its flow.

Concretions and pieces of indurated Cretaceous calcareous sandstone, siltstone, and mudstone have in places been transported to the surface with the flowing mud. Silcrete blocks and boulders of granite are not transported to the surface as reported by Whitehouse (1954), but are detrital boulders on a hard crust of dried mud which is elevated by upwelling from below. The maximum height of the mounds is 7 m.

Analyses of water-bore lithological logs show that where the Hooray Sandstone is close to the surface, springs of clear water without mounds flow from fractures, joints, or faults. Mound springs and clear water springs are popular sites for water bores, because depth to pressure aquifers is slight.

Before the area was tapped by bores there was considerable leakage by springs, now indicated by carbonate coatings and deposits of tufa in the Eulo area.

Holes less than 6 m deep provided sufficient supply of artesian water to supply bore drains in the early days of settlement. One of these, Double Well (No. 7915), is 4.5 m deep and was still flowing in 1968.

PETROLEUM

By the beginnning of 1972, 68 petroleum exploration wells had been drilled in the central part of the Eromanga Basin; of these only 13 were drilled specifically to test the Eromanga Basin sequence. Results are summarised in Table B6.

Jurassic and Cretaceous sediments of the Eromanga Basin sequence cover the entire area except for a small part in the northeast. Their maximum thickness is about 1200 m. Of those 13 wells drilled to test the sequence, 7 are percussion drill holes which penetrated only a short distance into the uppermost Rolling Downs Group.

The Eromanga Basin has been indirectly prospected by several hundred boreholes drilled for artesian water, but very few were drilled below the Hooray Sandstone. Petroliferous gas and oil shows, some authenticated by analysis (GSQ, 1960-65), were found by the water-bore drillers.

Many Jurassic sediments have excellent porosity and permeability and are usually prolific freshwater aquifers. There seems to be good lateral continuity in these aquifers (Plate B7) although they are of non-marine origin. Anomalous high-salinity water does occur; for example in the Adavale town bore the water from the Hooray Sandstone is too salty even for stock and runs to waste. As flushing was minimal Galloway (1970) suggests that any indigenous hydrocarbons could still be preserved in the Adavale area.

Prospects of finding commercial hydrocarbons in the Eromanga Basin in the light of present knowledge are poor. However, little is known about the pattern of groundwater movement and associated salinity variations in the Jurassic aquifers. The Jurassic sequence contains zones of excellent porosity and permeability and is effectively capped by lutites of the Rolling Downs Group. In situations where Triassic caprocks are absent, indigenous hydrocarbons in the Permian could migrate into the Eromanga Basin sequence. This situation is more likely to exist where post-Permian erosion has removed Triassic rocks from the crests of folds or where fault-induced folds overlie the concealed Permian margin (Fig. B5). Of particular interest is the margin of the Gidgealpa Group in the east embayment of the Wilson Depression, north across the southern part of the Mount Howitt Anticline and east to the Harkaway Anticline. Several large folds and faults exist in this zone but are poorly defined by seismic work, and none of the structures have been drilled. The presence of hydrocarbons in this area in common with any other Eromanga Basin target would depend on suitable structural or stratigraphic geometry to isolate the accumulation from dispersion by artesian water. Fault traps, particularly those upthrown to the west, might preserve any hydrocarbons from the flushing process. The fault-bounded Harkaway Anticline is singled out as a structure of interest which except for two shallow scout holes has not been drilled.

Sediments of the Eromanga Basin sequence older than the Hooray Sandstone wedge out against basement in the northwest towards the Boulia Shelf, and to the south towards the edges of the Thargomindah and Cunnamulla Shelves. No water bore or petroleum exploration well has been drilled to basement in the wedge-out areas, where there is a chance of petroleum traps.

The Cretaceous sequence is largely marine and contains numerous labile sandstone beds of fair to good porosity and permeability. The

marine argillaceous sediments could be considered potential source rocks.

The Toolebuc Formation is bituminous in the Julia Creek area to the north of the map area. Senior & Smart (1973) found traces of oil in this formation and suggested that there could be small accumulations of hydrocarbons, particularly where the unit is deeply buried along the axial zone of the Eromanga Basin.

Precious Opal

The Opalton Mineral Field near Jundah was first mined about 1880 and most activity took place between then and 1900. During that time the main centre of interest was 'Opalville', a now abandoned settlement (Connah, 1966). Connah reported that in 1900 there were over 100 men working the field and many others prospecting the surrounding area. Activity ceased in the early part of this century owing to severe drought.

In the Eromanga Mineral Field most opal mines were working at the end of the Nineteenth Century. Many of them have not been worked since Jackson (1902) visited them in 1901, when he found them deserted. One of the oldest mines in the area is the Aladdin Mine, which dates from 1872. Many others date from the mid-1880s. The Little Wonder Mine, which was working in 1891, was one of the richest, and at one time 50 men worked there.

Generally the workings consist of a number of shallow shafts less than 10 m deep. At any one mine there may be one or two or as many as 100 shafts, which were put down at random to intersect the opalised seams. In some, drives have been dug horizontally at the base of the shaft, following the intersection with the opal seam. In places where the opal-bearing sediment crops out, such as the Hayricks Mine at Mount Canaway (Senior et al., 1968), adits have been driven into the side of the hill.

Jackson (1902) records the total value of gems produced from all the Queensland opal fields from 1891 to 1901 as $262 000. This compared with $270 000 for one year from the same period at the White Cliffs Opal field in New South Wales.

Interest in the Eromanga district opal mines has been revived and large quantities of gem-quality opal are being mined by open-cut methods.*

All the known precious opal deposits within the map area occur within the chemically weathered sediments of the Winton Formation; no precious opal has ever been found in the unaltered Winton Formation, nor where the deep weathering profile is preserved below a cover of younger Tertiary sediments. The stippled areas on the map indicate the considerable area where precious opal could occur.

Construction Materials

Only in the northeast, where good quality quartz-pebble gravel and sand can be obtained from conglomerate beds in the Jurassic sequence, is construction material readily available.

Most of the principal access routes are graded and formed dirt roads, but because of a lack of gravel deposits most are surfaced only where they cross watercourses. In rolling downs terrain (Fig. B2, Unit RD) there are few gravel deposits: patches of silcrete (gidyea) gravel occur, but they are usually poorly sorted and the deposits are only one or two pebbles thick. Concrete has been made with the large cobbles to form causeways across larger watercourses.

Fair quality gravel can be selectively quarried from mesas and hills in Rolling Downs Group sediments (Fig. B2, Unit DT). It has low strength, but is plentiful and easily worked. Roads surfaced with this material, though reasonably smooth and well drained, are dusty in dry weather and slippery in wet, because of the ready abrasion of kaolinitic clay in the gravel.

Quartz gravel can be obtained from sandy conglomerate beds in the Glendower Formation and other Cainozoic sediment (Fig. B2, Units S and G). These beds are generally thin and may be entirely silicified to silcrete. Pediment material of silcrete gravel, mixed with gravel from the altered Rolling Downs sediments, makes good construction material, but many such deposits are poorly sorted. However, this material has been used with success on bitumen-surfaced Beef Developmental Roads.

The outcropping Hooray Sandstone and Adori Sandstone contain sandy conglomerate beds which may have been quarried and used on bitumen roads.

Sand deposits in the sandplains and sand dunes (Fig. B2 Units SP and SDP) are extensive, particularly in the south and west. Much of the sand is clayey, and the quartz grains are coated with iron oxide, which lessens its value as a constructional material.

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* *See* Senior, B. R., McColl, D. H., Long, B. E., & Whiteley, R. J., 1977—Geology and magnetic characteristics of precious opal deposits, southwest Queensland. *BMR Journal of Australian Geology & Geophysics*, 2(4).

Coal

The Eromanga Basin sequence contains some coal; numerous occurrences are reported in completion reports of petroleum exploration drilling. Coaly material is widespread in the Winton Formation but is lignitic, and no thick seams are known. Galloway & Ingram (1967) report coal seams up to 1 m thick in BMR drill holes in the Adavale area, but on analysis it was found to be of low rank and non-coking (Duff, Appendix 5 *in* Galloway & Ingram, 1967).

APPENDIX

The Whitula Formation, a new Tertiary stratigraphic unit

by

B. R. Senior

Derivation of Name. Whitula Creek, a south-flowing tributary of Cooper Creek, Canterbury 1:250 000 Sheet area, Queensland.

Distribution. Occupies a series of interconnected downwarps known as the Wilson Depression, Cooper Syncline (see Fig. B12), Yamma Yamma Depression, Farrars Syncline, and Thomson Syncline; Durham Downs, Barrolka, Canterbury, Windorah, and Jundah 1:250 000 Sheet areas.

Type section. Between 1.5 and 55 m in BMR Canterbury 4, Latitude 25°21′00″, Longitude 142°29′30″, Canterbury 1:250 000 Sheet (Figs. B12 and 13).

Lithology. Interbedded friable quartzose sandstone, laminar siltstone, mudstone and claystone, minor conglomerate; lignitic and gypsiferous in part. The sandstone beds vary from white to red-brown and the argillaceous beds are grey, black, sometimes yellow or pink. Indurated layers due to slight silicification or ferruginization are present throughout. Thin gypsum beds are numerous, and on resistivity logs of drill holes are correlatable over large distance (Fig. B13).

Thickness. Range 0-220? m. Maximum thickness intersected in a drill hole is 160 m in BMR Canterbury 5 (Fig. B12). It is inferred to be at least 150 m thick along the axes of major downwarps. In BMR Barrolka 1, on the west margin of the Yamma Yamma Depression, 104 m (base not reached) was intersected.

Relationships. Conformable below Quaternary alluvium of the Cooper, Farrars, and Whitula Creeks and Lake Yamma Yamma. Probably rests unconformably on the Glendower Formation or Winton Formation along the axes of downwarps, and is unconformable on the Glendower Formation due to onlap onto adjacent folds (Fig. B12).

Fossils and age. Core samples examined for spores and pollens were barren probably because of contemporaneous oxidation. The Whitula is younger than the Early Tertiary Glendower Formation and underlies alluvium of Quaternary age.

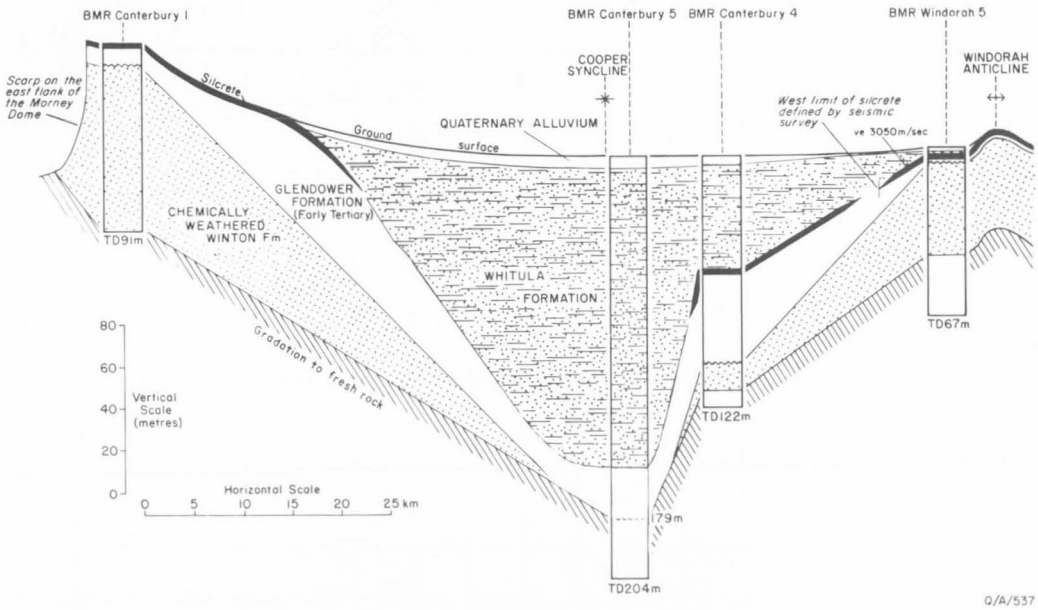


Fig. B12. Distribution of the Whitula Formation across the Cooper Syncline.

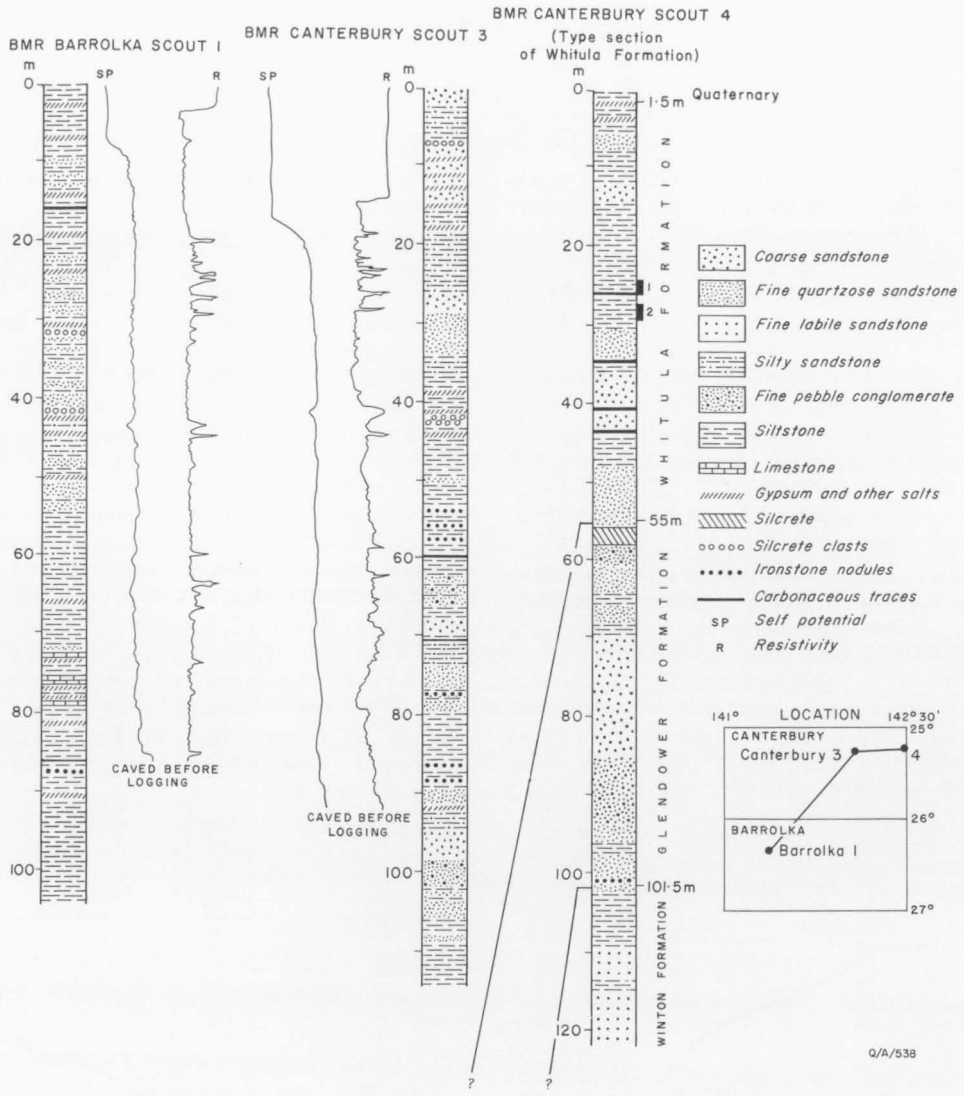


Fig. B13. Wireline log correlation and type section of the Whitula Formation.

TABLE B1: EXPLANATORY NOTES AND GEOLOGICAL MAPS AT 1:250 000 SCALE WITHIN THE CENTRAL EROMANGA BASIN AREA

Sheet name	*International index number*	*Author(s)*	*Year published*
Adavale*	SG/55-5	M. C. Galloway	1970
Augathella†	SG/55-6	M. C. Galloway	1970
Barrolka*	SG/54-11	B. R. Senior	1970
Blackall†	SG/55-1	M. C. Galloway	1970
Bulloo*	SH/54-4	J. A. Ingram	1971
Canterbury*	SG/54-7	C. M. Gregory & R. R. Vine	1971
Charleville*	SG/55-10	Danièle Senior	1971
Connemara*	SG/54-3	B. R. Senior	1969
Cunnamulla*	SH/55-2	B. M. Thomas	1971
Durham Downs*	SG/54-15	Danièle Senior	1968
Eromanga*	SG/54-12	J. A. Ingram	1972
Eulo*	SH/55-1	B. R. Senior	1972
Jundah*	SG/54-4	B. R. Senior	1969
Quilpie*	SG/55-9	B. R. Senior	1971
Tambo†	SG/55-2	N. F. Exon	1970
Thargomindah*	SG/54-16	Danièle Senior	1970
Tickalara*	SH/54-3	M. C. Galloway & Danièle Senior	1972
Toompine*	SG/55-13	J. A. Ingram	1971
Windorah*	SG/54-8	C. M. Gregory & R. R Vine	1969
Wyandra*	SG/55-14	B. M. Thomas	1971

* BMR mapping.
† Joint BMR & GSQ mapping.

TABLE B2: GRAVITY AND AEROMAGNETIC SURVEYS IN THE CENTRAL PART OF THE EROMANGA BASIN

Year of survey	*Abbreviated title*	*Company or organisation*	*Reference*
	GRAVITY SURVEYS		
1940–51	General report on investigations	Shell (Qld)	SQD, 1952
1951–52	Road traverses Tambo area	University of Sydney	Marshall & Narain, 1954
1957–61	West Queensland reconnaissance gravity	BMR	Gibb, 1967
1959–60	Tambo-Augathella aeromagnetic and gravity	Magellan Petroleum Corp.	Magellan, 1963
1960	Gravity traverses Quilpie to Roma	BMR	Lonsdale, 1962
1961	Eromanga gravity survey	Smart Oil	SOE, 1962a
1961	Regional reconnaissance gravity	BMR	Lonsdale, 1962
1963	Conbar gravity survey	Smart Oil	SOE, 1963b
1963	Windorah gravity survey	Alliance Oil	Stackler, 1963
1964	SW Queensland gravity survey	BMR	Lonsdale, 1965
1964	Chesterton gravity survey	Alliance Oil	Alliance, 1964b
1964	Semi-detailed gravity, Adavale Basin	BMR	Darby, 1966
1964	Blackall-Augathella gravity	Amoseas	Amoseas, 1964a
1965	Strzelecki-Cooper seismic and gravity	Delhi-Santos	Delhi-Santos, 1965
1965	Blackall-Barcaldine gravity	Amoseas	Amoseas, 1965
1966	Dartmouth area gravity survey	Phillips-Sunray	Darby & Ingall, 1966
1966	Eromanga-Frome seismic and gravity	Delhi-Santos	Delhi-Santos, 1966b
1966	Windorah-Wolgolla seismic and gravity	French Petroleum	FPC, 1966
1967	Tickalara seismic and gravity	French Petroleum	FPC, 1967
1967	Cooper Basin seismic and gravity	Delhi-Santos	Delhi-Santos, 1967
	AEROMAGNETIC SURVEYS		
	Innamincka-Betoota	Delhi-Santos	Delhi-Santos 1965e
	Cooper Creek	Delhi-Santos	Delhi-Santos, 1963a
	Cooper's Creek	French Petroleum	Delhi, 1964
	South Australia & Queensland	Delhi-Santos	Aero Services, 1962
	Surat-Bowen Basin	Union Oil	Aero Services, 1963
	Tambo-Augathella	Magellan Petroleum	Magellan, 1963
	Great Artesian Basin	BMR	Jewell, 1960
	Quilpie-Charleville-Thargomindah	Phillips-Sunray	Phillips-Sunray, 1961
	Central Great Artesian Basin	BMR	Waller, 1969
	Bowen Basin	BMR	Wells & Milson, 1969

TABLE B3: STRATIGRAPHY OF THE EROMANGA BASIN SEQUENCE IN THE CENTRAL PART OF THE EROMANGA BASIN

Name	*Derivation*	*Type section or area*	*Thickness*	*Relationships*
WINTON FORMATION	WHITEHOUSE, 1954 Dunstan, 1916	'The blue shales and sandstones with intercalated coal seams met with in the bores in and about Winton' (Whitehouse, 1954, p. 10)	Top eroded; no complete sequence known. Up to 1200 m thick in part of Cooper Syncline and Thomson Syncline	Conformable on Mackunda Formation. In south conformable on Wallumbilla Formation and locally unconformable on Middle Devonian granite
MACKUNDA FORMATION	VINE & DAY, 1965	In headwaters of Mackunda Ck on Gnalta Stn, Mackunda Sheet	Averages 60 m. Up to 150 m east of Canaway Fault in Powell Depression, and in north part of Cooper Syncline	Conformable between Allaru Mudstone and Winton Formation. Absent from Eulo Ridge and Cunnamulla Shelf
ALLARU MUDSTONE Allaru Member Wilgunya Formation	VINE ET AL., 1967 Vine & Day, 1965 Casey, 1959	Along main Richmond-Winton road, from Richmond south to Twenty-mile Creek, Richmond Sheet	270 m in outcrop, maintained in subsurface; thins southward to Eulo Ridge Cunnamulla Shelf area	Conformably overlies Toolebuc Formation where present. Elsewhere conformable over Wallumbilla Formation.
TOOLEBUC FORMATION Toolebuc Limestone Toolebuc Member	SENIOR ET AL., 1975 Vine et al., 1967 Casey 1959	Sequence from 25.3-35.8 in BMR Boulia 3A, 22°47′00″S, 140°43′30″E, Boulia Sheet area	3-75 m	Conformable between Wallumbilla Formation and Allaru Mudstone
COREENA MEMBER of Wallumbilla Formation	VINE, 1966 Vine et al., 1967	Along formed road to Coreena Homestead at western boundary of Coreena Station, Longreach Sheet	25 m in NE, thickening SW to 120 m in central part of Eromanga Basin. Uniform at about 180 m in Cunnamulla Shelf area	Conformable on Doncaster Member. Conformably overlain by Toolebuc Formation where present, Allaru Mudstone, or, in SE Winton Formation. Cunnamulla Shelf area, unconformably overlain by Cainozoic sediments
DONCASTER MEMBER of Wallumbilla Formation	VINE & DAY, 1965	Face of cliffs in south bank of Flinders River on Glendower Station at Rockies Waterhole, 51 km NE of Hughenden. Hughenden Sheet	150 m in NE, gradually thickening SW to 220 m in north-centre of map area and then thinning W towards Boulia Shelf; about 120 m at NW corner of map area. SE about 240 m thick over Cunnamulla Shelf and about 130 m thick elsewhere	Conformable on Hooray Sandstone or Cadna-owie Formation
WYANDRA SANDSTONE MEMBER	SENIOR ET AL., 1975	QIWSC bore No. 2049 (interval 357-373 m), 15 km northeast of Wyandra town, Wyandra Sheet	3-18 m varying slowly over considerable distances. Does not crop out in map area	Prominent marker bed at top of Cadna-owie Formation. Conformable below Doncaster Mudstone
CADNA-OWIE FORMATION (previous informal name "Upper Hooray Sandstone")	WOPFNER ET AL., 1970	4 km southwest of Algebuckina rail siding, Oodnadatta Sheet, South Australia	15-75 m. Does not crop out in map area	Conformable between Hooray Sandstone and Doncaster Member
HOORAY SANDSTONE	HILL & DENMEAD, 1960, p. 311; EXON, 1966	Hooray Creek, 19 km NE of Tambo township, Tambo Sheet	45-120 m in outcrop and generally subsurface. As much as 400 m in Nebine Ridge Cunnamulla Shelf area	Conformable above Injune Creek Group and below Cadna-owie where present. Elsewhere, conformable below Doncaster Member

TABLE B3 (CONTINUED)

Name	*Derivation*	*Type section or area*	*Thickness*	*Relationships*
INJUNE CREEK GROUP	EXON, 1966		200 m, thins NW and absent from Thargomindah & Cunnamulla Shelves	Conformable between Hutton & Hooray Sandstones
Injune Creek Beds	Jensen, 1921, p. 92			
WESTBOURNE FORMATION	GERRARD, 1964; EXON, 1966	Interval 389-503 m in Amoseas Westbourne 1	120 m near Tambo, thins to 60 m about 50 km to N. Subsurface about 100 m. Thins southward and wedges out against Thargomindah and Cunnamulla Shelves	Conformable between Adori and Hooray Sandstones
ADORI SANDSTONE	WOOLLEY, 1941; HILL & DENMEAD, 1960; EXON, 1966	Adori Hill, 35 km ENE of Tambo, Tambo Sheet	Maximum 71 m in outcrop. 26-70 m subsurface	Conformable between Birkhead and Westbourne Formations
BIRKHEAD FORMATION	EXON, 1966	Interval 573-685 m in Amoseas Westbourne 1 well, 42 km S of Tambo	Outcrop about 90 m, subsurface about 110 m. Absent from NE, S, and SE of map area	Conformable between Adori and Hutton Sandstones
HUTTON SANDSTONE	REEVES, 1947; MOLLAN ET AL., 1970	Just to S of Hutton Creek, 18 km ENE of Injune, Taroom Sheet	120-150 m in outcrop, up to 250 m in subcrop. Thin or absent on Thargomindah Shelf and absent from Cunnamulla Shelf. Thins towards S margin of Cooper Basin and absent from NW of map area because of elevated basement	Unconformable on basement or sediments of pre-Eromanga Basin systems. Conformable below Birkhead Formation
EVERGREEN FORMATION	MOLLAN ET AL., 1970	Dawson River Valley, NE of map area	11-40 m; probably thickens westwards down W flank of Anticline.	Conformable between Precipice and Hutton Sandstones
Evergreen Shale	WHITEHOUSE, 1952			
BOXVALE SANDSTONE MEMBER	MOLLAN ET AL., 1970		Thins NW from about 75 m at edge of map area to about 45 m near Birkhead Anticline	Conformable between Precipice and Hutton Sandstones
Boxvale Sandstone	Reeves, 1947			
Upper Formation Bundamba Group	Whitehouse, 1952, 1954			
PRECIPICE SANDSTONE	WHITEHOUSE, 1954 Mollan et al., 1970	Sandstone cliffs in gorge of Precipice Creek, a tributary of Dawson River, Taroom Sheet	Approx. 45 m over Birkhead Anticline. Probably reaches 100 m to SE. Wedges out to NW and thins and wedges out towards Cunnamulla Sheet	Unconformable over Galilee Basin sediments and basement. Conformably overlain by Boxvale Sandstone Member or Evergreen Formation

TABLE B3 (CONTINUED)

Lithology	*Fossils*	*Age*	*Environment*
Very labile sandstone, siltstone and mudstone, minor mudclast conglomerate and coal: all calcareous, carbonaceous, pyritic in part. In outcrop only calcareous rubble and concretions. Extensive chemical weathering profile consisting of kaolinised, silicified, and ferruginised rocks	Fragmentary plant material, usually as impressions in weathering profile, particularly ironstone beds. *Sphenopteris erecta, Phyllopteris lanceolata,* Cenomanian angiosperm leaves (White, 1966, 1969, 1974). Post-K2b pollen unit. (Burger *in* Exon et al., 1972)	Lower to Upper Cretaceous (Albian-Cenomanian)	Fluvial, lacustrine, terrestrial
Very labile to labile sandstone, siltstone and mudstone, calcareous in part, minor mudclast conglomerate, coquinite, cone-in-cone limestone. Presence of *Inoceramus* prisms used in identification. Chemical weathering same as Winton Formation	Bivalves, ammonites, belemnites, polyzoans, sharks teeth, wood fragment (Day, 1966, 1967, 1968; Day *in* Gregory et al., 1967). K2 microflora (Burger, 1968)	Lower Cretaceous (Upper Albian)	Shallow marine, paralic
Blue-grey mudstone with interbeds of indurated calcareous siltstone and fine-grained very labile sandstone, and concretions. Mudstone very thinly bedded. Where weathered is kaolinitic, white to pale pink or grey, and siliceous	Bivalves, ammonites, gastropods, belemnites (Day, 1966, 1968, 1969). K2 microflora and microplankton (Burger, 1968). Base of unit has K2a microflora in BMR Charleville 1 and Wyandra 1 (Burger *in* Senior et al., 1969)	Lower Cretaceous (Upper Albian)	Shallow marine. The proportion of whole shells preserved sugests deposition in quiet water
Fine-grained pale grey limestone; generally crops out as flat ovoid concretions averaging 15 cm across. Thin interbeds of grey to black calcareous labile sandstone and siltstone	Abundant sessile bivalves, *Inoceramus* sp. and *Aucellina hughendenensis* (Day, 1966, 1968, 1969). Fish teeth, Radiolaria, *Globigerina* (Terpstra, 1967). Albian K2a microflora and dinoflagellates (Evans & Burger *in* Exon et al., 1972)	Lower Cretaceous (Upper Albian)	Shallow marine
Coarse-grained siltstone to fine-grained very labile sandstone, interbedded with mudstone. Calcareous. Glauconite and fragments of andesite and plagioclase	Abundant bivalves, belemnites, scaphopods, few gastropods. Fossil wood, worm tubes in upper part. Spores of divisions K2b to K2a (Burger *in* Senior et al., 1969)	Lower Cretaceous (lower to middle Albian)	Shallow marine, paralic
In outcrop, dark blue-grey mudstone with fine-grained glauconitic labile sandstone and siltstone. Gypsum common. Partly calcareous. Mudstone, thinly laminated, laminated, and massive	Bivalves, gastropods, scaphopods, ammonites, belemnites (Day, 1966, 1967). Macroplankton at *Dingodinium cerviculum* Zone. Spores of K1b-c unit in AOG Talbalba 2 (Burger, op. cit.)	Lower Cretaceous (Albian)	Shallow marine
Medium to coarse quartzose to sublabile sandstone with scattered pebbles and carbonate cement. Porous and permeable; youngest pressure aquifer in the Eromanga Basin	Shelly fossils in Eulo Ridge area (Senior et al., 1969). Spores, pollen, and microplankton (Burger *in* Senior et al., 1969)	Lower Cretaceous (upper Neocomian or lower Aptian)	Shallow marine; possibly beach sand laid down by transgressive sea
Fine to medium quartzose sandstone and very fine labile sandstone and siltstone, minor glauconite	Recorded shell fragments in numerous petroleum exploration wells (Mulready, 1970; Laing, 1966)	Lower Cretaceous (Neocomian to lower Aptian)	Paralic and shallow marine
Interbedded porous quartzose sandstone and siltstone	Plant debris, spores, acritarchs, marine shelly fossils. Spores of units K1a and J5-6 in BMR Tambo 5 (Evans & Burger *in* Exon et al., 1972)	Upper Jurassic to Lower Cretaceous (Neocomian to Albian)	Fluviatile, paralic, and littoral

TABLE B3 (CONTINUED)

Lithology	*Fossils*	*Age*	*Environment*
Siltstone, mudstone and sandstone; coal	Plants, spores, and worm casts	Middle to Upper Jurassic	Lacustrine and fluviatile
Siltstone, mudstone, fine-grained quartzose sandstone	Spores of palynological units J5 and J6. Worm clasts, animal tracks, plant root impressions, and fragmentary plant material.	Upper Jurassic (Neocomian)	Lacustrine with possible minor marine incursions
White fine to medium clayey sublabile to labile sandstone, minor pebbles and coarse sandstone, minor siltstone and mudstone. Sandstone cross-bedded and medium to thick-bedded, friable and porous in part	Palynological unit J5 (Evans, 1966). Plant fossils include *Lepidopkis stormbogensis* (Seaward), *Taeniopteris spatulata* McClelland, *Cladophlebis australis* (Morr.), *Ptilophyllum pectin* (Phillips), *Sphenopteris* sp. *Ginkgo antarctica* Saporta (White, 1966)	Middle to Upper Jurassic (Evans, 1966). Upper Triassic or Jurassic (White, 1966)	Fluviatile
Outcrop: fine calcareous sandstone and siltstone. Subsurface: fine buff, grey, or green sublabile and labile sandstone, in part calcareous, grey siltstone, carbonaceous mudstone, and minor coal	Spores of division J4 (Evans, 1966). Jurassic plants also present	Middle Jurassic (Neocomian)	Lacustrine and fluviatile
Outcrop: quartzose sandstone with abundant siltstone and mudstone in upper part. Fine conglomerate beds and scattered quartz pebbles in sandstone. Bedding thick and poor, with some planar and scour cross beds. Siltstone and mudstone commonly carbonaceous—generally laminated to thinly bedded. Local claystone stringers. Botryoidal bog iron oxides, minor bog manganese oxides, coal and calcareous beds in upper part	Palynological division J3 to J5 (Evans, 1966)	Lower to Middle Jurassic	Fluviatile and lacustrine
Siltstone, mudstone, subordinate fine-grained labile sandstone	Spores of palynological division J1 (Evans, 1966; Evans & Burger *in* Exon et al., 1972)	Lower Jurassic	Fluviatile, lacustrine, shallow marine
Quartzose sandstone and siltstone. Can be divided into lower arenaceous and upper arenaceous and argillaceous sequences	Spores of palynological division J2 (Evans, 1965; Evans & Burger, op. cit.). Plant remains common but unidentified	Lower Jurassic	Fluviatile, lacustrine
Quartzose micaceous sandstone, siltstone, mudstone. Bedding medium to thick; strongly scour to planar cross-bedded. Ripple marks common. In subsurface, conglomerate, minor carbonaceous siltstone, and coal also present	Spores of unit J1 (Evans & Burger, op. cit.) (characterised by first appearance of abundant *Classopolis*). Fragmentary and indeterminate plant fossils	Lower Jurassic	Fluviatile, lacustrine

TABLE B4: CAINOZOIC STRATIGRAPHY (POST-EROMANGA) OF THE CENTRAL PART OF THE EROMANGA BASIN

Name (map symbol)	*Reference to formal description*	*Type section or area*	*Thickness*	*Relationships*
(Qa)	—	—	0-50 m	Unconformable upon various Mesozoic and Cainozoic rock bodies
(Q) (combined on map but mapped as distinct units on the various 1:250 000 Sheets)	—	—	0-5 m	As above but mainly unconformable over Cretaceous chemically weathered rocks
	—	—	0-10 m	Unconformable upon various Mesozoic and Cainozoic rock bodies
	—	—	Superficial	As above but mainly adjacent to the Cretaceous, chemically weathered rocks (stippled areas on map)
	—		Superficial	As above but mainly adjacent to silcrete-capped plateaux and mesas (stippled areas on map)
CADELGA LIMESTONE and DOONBARA FORMATION	WOPFNER, 1974	Both type sections in Cordillo 1:250 000 Sheet area	0-15 m	As above
(Cz)	—	—	0-60 m	Unconformable on various Mesozoic sedimentary rock bodies
WHITULA FORMATION	THIS BULLETIN (Appendix to Part B)	Type section is 1.5 m to 55 m in BMR Canterbury 4 Lat. 25°20′00″S, Long. 142°29′30″E Windorah-Birdsville road 19 km W of Windorah; Canterbury Sheet	0-220 m (160 m in BMR Canterbury 5). Inferred to be at least 150 m along axes of major downwarps (see Plate B3)	Conformable below Quaternary alluvium of Cooper and Whitula Creeks; and unconformable on Glendower & Winton Formations
MOSES SANDSTONE	VINE, 1964	Moses Cone, a small conical hill 1.6 km SW of Hunters Gorge on Diamantina R. Type section in Goyder Ranges, Brighton Downs Sheet	0-20 m. 19 m penetrated in BMR Connemara 1	Unconformable on Winton Formation. In type area is unconformable below Springvale Formation
GLENDOWER FORMATION Glendower Series	WHITEHOUSE 1954 Whitehouse, 1940	Type section on road from Prairie to Glendower 1.2 km south of Glendower Stn, Hughenden Sheet	0-70	Unconformable on Winton Formation (mainly overlies chemical weathering profile). Equivalent to the Eyre Formation of Wopfner et al. (1974)
(T)	—	—	0-10 m	Unconformable upon various Mesozoic rocks
(Tb)	—	—	0-5 m	Unconformable upon Adori Sandstone

TABLE B4 (CONTINUED)

Lithology		*Age*	*Environment*
Alluvium, sand, silt, conglomerate, gypsiferous in part. Surficial cracking clay (montmorillonitic) soils	Pleistocene *Diprotodon* Fauna at Boondoona Creek, Toompine Sheet (Senior et al., 1969)	Quaternary	Fluviatile, anastomosing channel, point bar, and floodplain deposits. Lacustrine sediments of Lake Yamma Yamma etc.
Ferruginous sandstone (sandy red earth) minor gravel, iron pisolites (maghemite)	—	Quaternary	Fluvial or sheetwash sediments with pedogenic reworking, minor aeolian
Quartzose iron-stained dune and sheet sand. Some poorly consolidated, silty-sandstone and fine grey siltstone. White quartzose sand at active dunes near alluvial source areas	—	Quaternary	Aeolian and micro-lacustrine in claypans
'Ironstone' gravel. Concretionary limonite and goethite. Pebble to cobble-sized clasts	—	Quaternary	Low-angle pediment and lag gravel on plains
Pebble to cobble-sized clasts of siliceous quartzose sandstone (silcrete). Clasts angular to rounded with polished surfaces and iron oxide coatings. Minor 'ironstone' and siliceous mudstone and siltstone	—	Quaternary	Low-angle pediment scree and lag gravel on 'gibber' plains
Limestone and poorly bedded red-brown ferruginous quartzose sandstone, with iron pisolites and small pebbles. Gypsiferous greenish-grey siltstone. Many outcrops extensively chalcedonized	Microscopic algal filaments and spores (Charophytes) (Gregory et al., 1967)	Quaternary or Late Tertiary	Valley floodplain and lacustrine sediments
Medium to coarse quartzose sandstone, iron-stained quartz-pebble conglomerate. Siltstone and claystone predominate in some areas	—	Cainozoic	Fluviatile, deposited by streams which carried quartzose detritus from the uplifted margin of the Eromanga Basin
Interbedded friable quartzose sandstone, laminar siltstone, mudstone and claystone, minor quartz granule and mixed rock conglomerate. Extensively oxidized by contemporaneous weathering. Thin layers of prismatic gypsum	Weathering has apparently destroyed organic content	Tertiary	Fluvial and lacustrine, probably warm humid (oxidising) climate
Medium cross-bedded quartzose sandstone, laminar siltstone and mudstone. Calcareous and ferruginous concretions and septaria	Fragments of calcified or silicified wood. (Gregory et al., 1967)	Tertiary	Fluviatile and lacustrine
Quartzose sandstone, quartz pebble conglomerate, sandy conglomerate with agate, chert, and rare volcanic clasts. Minor siltstone and mudstone. Reworked Winton Formation clasts and agate pebbles at base. Extensively silicified to silcrete	Fragments of silicified wood, tubules and root impressions	Early Tertiary	Fluviatile and lacustrine. Part of extensive radial drainage system off active basin margin and flowing towards Eyre Basin internal drainage system
Quartzose sandstone and sandy conglomerate, silicified quartzose sandstone (silcrete)	—	Early Tertiary	Fluviatile, deposited by small streams to east of present Warrego River
Olivine basalt: phenocrysts of olivine in fine groundmass of augite, andesine, and glass (Exon et al., 1972)	—	Early Tertiary	Volcanic flows

TABLE 5B: COMPARISON OF CHEMICAL ANALYSES AND CONDUCTIVITY OF WATER FROM THE WYANDRA SANDSTONE MEMBER AND HOORAY SANDSTONE IN THE CUNNAMULLA SHELF AREA

	WYANDRA SANDSTONE MEMBER		HOORAY SANDSTONE	
	Average (ppm)	*Range (ppm)*	*Average (ppm)*	*Range (ppm)*
Sodium	312	277–393	195	163–247
Calcium	4	2–7	3	2–4
Magnesium	0.8	0–3	0.8	0–2
Iron	—	nil	—	nil
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	—	nil	—	nil
Bicarbonate	643	605–693	368	326–562
Estimated total dissolved solids	739	592–964	470	390–586
Conductivity 25°C microsiemens/cm	1124	1100–1220	758	640–999
pH	7.6	7.3–7.9	7.4	7.0–7.9

TABLE B6: SUMMARY OF PETROLEUM EXPLORATION DRILLING

Well Name	*No.*	*Operator*	*Total depth (metres)*	*Year completed*	*Latitude*	*Longitude*	*Basin*	*Hydrocarbon shows*	*Status*	*References*
Alba	1	Amoseas	827	1965	26°31′37″	146°56′45″	E S	Spotty fluorescence and cut from Precipice Sandstone	Completed as water well	Campbell, 1965
Allandale	1	Beaver Oil	3004	1969	24°25′00″	145°54′15″	E G A	No shows	Plugged and abandoned	Leslie, 1971
Alva	1	Hartogen Exploration	3586	1972	25°11′47″	145°23′02″	E G A	No shows	Completed as water well	Hamilton, 1972
Arrabury	1	Flinders-Delhi-Santos	2944	1970	27°11′35″	141°04′50″	E C	No shows	Completed as water well	Flinders, 1970b
Balfour	1	Amoseas	1965	1966	25°32′00″	146°43′00″	E G	No shows	Dry and abandoned	Gerrard, 1966
Barcoo	1	Aust. Sun Oil	1716	1968	24°17′09″	145°08′18″	E G	No shows	Dry and abandoned	Garrett & Patterson, 1968b
Birkhead	1	South Pacific	1580	1957	24°37′00″	146°23′00″	E G A	Gas show in Permian	Plugged and abandoned	Grissett, 1957
Bodalla	1	British Pet. Dev.	2685	1967	26°25′43″	143°26′09″	E C A	Fluorescence in sandstone member of Log Creek Formation	Plugged and abandoned	Buchan, 1968
Bonnie	1	Phillips Sunray	2745	1966	25°00′49″	145°21′57″	E G A	No shows	Completed as water well	Kyranis, 1966a
Boree	1	Amoseas	2676	1964	24°45′32″	145°34′36″	E G A	No shows	Completed as water well	Gerrard, 1964b
Buckabie	1	Phillips Sunray	2765	1961	26°12′00″	144°16′00″	E A	No shows	Plugged and abandoned	Kitsman, Lewiss & Rowe, 1962
Budgerygar	1	Alliance Oil Dev.	1630	1968	25°14′19″	143°48′29″	E C	Minor gas shows in Hutton Sandstone	Plugged and abandoned	Cadart, 1969
Bury	1	Phillips Sunray	2944	1966	25°02′40″	145°36′20″	E G A	No shows	Plugged and abandoned	Patterson, 1966
Canaway	1	Alliance Oil Dev.	1505	1963	25°56′06″	143°57′47″	E	No shows	Dry and abandoned	Alliance, 1963b
Canaway Downs	1*†	Smart Oil Expln	480	1959	26°00′27″	143°57′00″	E	Numerous small gas shows	Plugged and abandoned	G S Q, 1960-65
Carlow	1	Phillips Sunray	3666	1966	24°50′27″	145°25′48″	E G A	No shows	Completed as water well	Kyranis, 1966b
Chandos	1	Alliance Oil Dev.	2978	1966	25°50′14″	143°19′36″	E C A	3.8 barrels 53 gravity oil in DST Lower Triassic. Oil bleeding from cores in Permian	Plugged and abandoned	Laing & Benedek, 1966
Chandos South	1	Alliance Oil Dev.	2450	1969	25°57′02″	143°22′00″	E C A	No shows	Dry and abandoned	Laing & Cadart, 1970
Collabara	1†	Phillips Sunray	3929	1966	25°14′00″	144°45′00″	E G A	No shows	Plugged and abandoned	—
Cothalow	1	Phillips Sunray	1836	1965	25°43′34″	144°23′22″	E G A	No shows	Plugged and abandoned	Lewiss, 1961
Cothalow (deepening)	1†	Phillips Sunray	2613	1965	25°43′34″	144°23′22″	E G A	No shows	Plugged and abandoned	Tanner, 1965
Crichton	1	Orion Oil	814	1966	26°42′00″	146°52′00″	E S	Show of gas and fluorescence in Evergreen Formation	Plugged and abandoned	Freeman & Stafford, 1966
Cumbroo	1	Alliance Oil Dev.	2207	1968	26°13′40″	143°22′47″	E C A	Trace of oil in Permian	Plugged and abandoned	Campe, 1969
Dartmouth	1	Phillips Sunray	3051	1966	26°08′39″	145°20′34″	E G A	No shows	Completed as water well	Knuth, 1967

TABLE B6 (CONTINUED)

Well Name	No.	Operator	Total depth (metres)	Year completed	Latitude	Longitude	Basin	Hydrocarbon shows	Status	References
Eastwood	1	Assoc. Aust. Oil Flds	3385	1969	24°46′23″	145°20′56″	E G A	No shows	Completed as water well	—
Epsilon	1†	Delhi	2209	1972	28°08′45″	145°09′24″	E C	Gas from Gidgealpa Formation at 12 MMcf/D	Shut in gas well	—
Etonvale	1	Phillips Sunray	3465	1961	25°10′00″	145°00′00″	E G A	No shows	Dry and abandoned	Lewis & Kyranis, 1962
Fairlea	1	Aust. Sun Oil	3120	1968	24°29′50″	145°19′52″	E G A	No shows	Dry and abandoned	Garrett & Patterson, 1968b
Galway	1	French Petroleum	2703	1966	25°04′30″	142°33′41″	E C	Gas shows	Plugged and abandoned	Jacque & Sweeney, 1966
Gilmore	1	Phillips Sunray	4346	1964	25°21′33″	144°48′38″	E G A	Gas from sandstone member of Log Creek Formation at 4.3 MMcf/D	Shut in gas well	—
Gilmore	2†	Phillips Sunray	4143	1965	25°24′03″	144°51′16″	E G A	Trace of oil from DST Nos. 3 and 11 in Log Ck Formation	Plugged and abandoned	—
Gilmore	3†	Phillips Sunray	4305	1965	25°14′23″	144°45′00″	E G A	Gas at 8.3 MMcf/D from sandstone member of Log Ck Formation. Oil trace	Shut in gas well	—
Gilmore	4†	Phillips Sunray	2076	1966	25°20′26″	144°47′27″	E G A	No shows. Rig moved 23 m west to site of Gilmore 4a	Plugged and abandoned after unsuccessful fishing	—
Gilmore	4A†	Phillips Sunray	3900	1966	25°20′26″	144°47′29″	E G A	Gas at 1.37 MMcf/D from sandstone member of Log Creek Formation	Shut in gas well	—
Gilpeppee	1	Alliance-Delhi-Santos	3265	1970	26°25′25″	141°33′17″	E C	No shows	Plugged and abandoned	Mulready, 1970
Gumbardo	1	Phillips Sunray	3944	1962	25°59′00″	144°42′00″	E G A	No shows	Plugged and abandoned	Phillips Sunray, 1963b
Gumbla	1†*	Smart Oil Expln	559	1959	26°52′09″	143°33′42″	E	Numerous small gas shows	Plugged and abandoned	GSQ, 1960-65
Harkaway	1†*	Smart Oil Expln	564	1960	26°26′00″	142°59′00″	E	No shows	Plugged and abandoned	GSQ, 1960-65
Innamincka	2	Delhi Santos	3385	1965	27°27′10″	141°03′16″	E C	Gas shows DST 2 and 3; 75 Mcf/D from Gidgealpa Formation	Completed as water well	Delhi-Santos 1965a
Leopardwood	1	Phillips Sunray	4184	1966	25°37′10″	144°40′13″	E G A	No shows	Plugged and abandoned	McDonagh, Knuth, & Patterson, 1966
Lissoy	1†	Phillips Sunray	4137	1966	25°09′25″	144°53′14″	E G A	No shows	Completed as water well	—
Log Creek	1	Phillips Sunray	4420	1965	25°15′46″	144°54′27″	E G A	Shows of oil and gas at 15 Mcf/D from sandstone member of Log Creek Formation	Plugged and abandoned	Kyranis & McDonagh, 1966
Lowood	1	Orion Oil	772	1966	26°42′00″	146°52′00″	E S	Methane gas show in Hooray Sandstone and Westbourne Formation	Plugged and abandoned	Freeman & Stafford, 1966

TABLE B6 (CONTINUED)

Well Name	No.	Operator	Total depth (metres)	Year completed	Latitude	Longitude	Basin	Hydrocarbon shows	Status	References
Maryvale	1	Orion Oil	845	1966	26°40′00″	146°51′00″	E S	Fluorescene in Precipice Sandstone	Plugged and abandoned	Freeman & Stafford, 1966
Mount Howitt	1	Delhi-Santos	2353	1966	26°37′27″	142°28′17″	E C	Shows in Jurassic and Triassic	Plugged and abandoned	Delhi-Santos, 1966a
Naryilco	1	Delhi-Santos	1477	1963	28°27′00″	141°42′00″	E C	Slight gold fluorescence in Birkhead Formation	Plugged and abandoned	Delhi-Santos, 1962
Nive River	1	Malta Oil	506	1924–26	24°55′00″	146°50′00″	E G	No shows	Plugged and abandoned	GSQ, 1960-65
Orient	1*	Smart Oil Expln	974	1961	27°41′00″	143°10′00″	E	Gas shows from Hooray Sandstone	Completed as water well	GSQ, 1960-65
Orient	2	Smart Oil Expln	1077	1962	27°40′00″	143°11′00″	E	No shows	Plugged and abandoned	GSQ, 1960-65
Orientos	1	Delhi-Santos	3513	1962	28°03′00″	141°26′00″	E C	No shows	Plugged and abandoned	Delhi-Santos, 1963b
Quilberry	1	Phillips Sunray	3052	1965	26°25′03″	145°30′07″	E G A	No shows	Plugged and abandoned	Cundill Meyers and Associates, 1965
Ravensbourne	1	Amoseas	2358	1968	24°50′06″	145°37′08″	E G A	No shows	Dry and abandoned	Sirovs, 1968
Ray	1†*	Smart Oil Expln	250	1957	26°07′25″	143°53′35″	E	No shows	Plugged and abandoned	GSQ, 1960-65
Roseneath	1	Total-Delhi-Santos	2197	1969	28°09′48″	141°14′43″	E C	Gas from Gidgealpa Formation at 8 MMcf/D	Shut in gas well	Jacque, Strobel & Sweeney, 1970
Stafford	1	Phillips Sunray	3141	1968	25°18′00″	145°26′00″	E G A	No shows	Plugged and abandoned	Netzel, 1967
Stormhill	1	Longreach Oil	1554	1969	24°08′45″	143°35′06″	E C	No shows	Dry and abandoned	Warris, 1969
Talbalba	1†*	Aust. Oil and Gas	236	1957	28°58′00″	146°34′00″	E	No shows	Plugged and abandoned	GSQ, 1960-65
Talbalba	2†*	Aust. Oil and Gas	304	1957	28°58′00″	146°34′00″	E	No shows	Plugged and abandoned	GSQ, 1960-65
Tallalia	1	Flinders Petroleum	3192	1970	27°33′00″	141°16′00″	E C	Gas at 88 Mcf/D from Gidgealpa Formation	Plugged and abandoned	Pemberton & Brereton, 1971
Thunda	1	Alliance Oil Dev.	2411	1968	25°29′30″	143°28′28″	E C A	No shows	Plugged and abandoned	Cadart, 1968
Tickalara	1	Total-Delhi-Santos	1957	1968	28°19′20″	141°24′50″	E C	No shows	Plugged and abandoned	TEA, 1968
Tregole	1	Amoseas	754	1966	26°28′00″	147°00′00″	E S	No shows	Plugged and abandoned	Campbell, 1966
Valetta	1	Beaver Oil	1340	1970	25°02′50″	146°36′00″	E G	Fluorescence and slow cut in Blackwater Group	Plugged and abandoned	Leslie, 1970
Warbreccan	1	Westland Oil	1655	1955	24°23′43″	142°45′43″	E	No shows	Dry and abandoned	GSQ, 1960-65
Warbreccan	2	Westland Oil	1592	1955	24°23′59″	142°46′34″	E	No shows	Dry and abandoned	GSQ, 1960-65
Warbreccan	3	Westland Oil	1845	1955	24°21′12″	142°45′47″	E	No shows	Dry and abandoned	GSQ, 1960-65
Westbourne	1	Amoseas	1483	1964	25°11′27″	146°08′02″	E G A	No shows	Dry and abandoned	Gerrard, 1964a
Yongala	1	Alliance Oil Dev.	3100	1965	25°30′19″	143°55′48″	E G A	No shows	Plugged and abandoned	Laing, 1966
Yongala	2	Alliance Oil Dev.	2027	1967	25°31′40″	143°53′33″	E G	No shows	Dry and abandoned	Laing, 1967

* Drilled with percussion rig and failed to fully evaluate structure. † Not subsidised by the Commonwealth Government.
E = Eromanga Basin. S = Zone of mixing between Eromanga and Surat Basins. G = Galilee Basin. C = Cooper Basin. A = Adavale Basin.

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PART C

Notes on the geology of the northwestern part of the Eromanga Basin, Northern Territory and Queensland

BY

A. MOND & P. L. HARRISON

SUMMARY

The Eromanga Basin covers roughly one million square kilometres. Part C of this Bulletin deals with that portion of the basin which lies north of latitude 26°S and west of longitude 141°E.

The aim is to summarise present knowledge of the geology and extent of the basin in this area, and to establish a common basis for future studies.

In this area the Eromanga Basin sequence consists of Early Jurassic to Late Cretaceous rocks which are underlain partly by older sedimentary basins and partly by crystalline basement, and which are overlain by Cainozoic sedimentary rocks of the Lake Eyre Basin and other widespread unconsolidated Quaternary sediments. Synthesis of the geology of the Eromanga Basin has established that units of the same lithology and in the same stratigraphic position have been given different names in different parts of the basin. As a result, the names Tarlton Formation, De Souza Sandstone, Longsight Sandstone, Rumbalara Shale, and Wilgunya Formation have been dropped, and stratigraphic names used in the central, northern and South Australian parts of the Eromanga Basin—Hooray Sandstone, Cadna-owie Formation, and Wallumbilla Formation—have been extended into the northwestern area.

The structural pattern is dominated by normal faults and related anticlines. The anticlines are commonly drape folds over deeply buried fault blocks or basement ridges, or both. Structure contours show a deep depression in the Simpson Desert, where Jurassic to Cretaceous sediments are up to 2200 m thick. From here toward the west, north, and northeast the units thin progressively against rising basement, to the present erosional margin of the basin. To the east they also thin but continue across the Boulia Shelf and Birdsville Track Ridge to the central and northern parts of the Eromanga Basin.

The depositional environment of the Eromanga Basin sequence ranged from freshwater to shallow-marine. Fluvial sedimentation in the Jurassic to early Neocomian was replaced by paralic and shallow-marine deposition in the late Neocomian and Aptian. Palynological evidence indicates that on the northwestern margin of the basin sandy deposition continued longer than in the deeper parts; these sands are equivalent to the mudstones which characterise this part of the sequence throughout the rest of the basin. The sea, after temporarily withdrawing in the early Albian, returned to the Eromanga Basin from the north early in the late Albian, but before the end of the Albian it had already begun to recede again, and deposition of the Eromanga Basin sequence was concluded in early Cenomanian times by meandering streams on a broad plain, and in lakes and swamps.

In the Late Cretaceous there began a long period of erosion which persisted well into the Tertiary. The exposed sediments were deeply weathered, especially around the basin margins. At the end of Cretaceous or in Early Tertiary times uplift of the eastern basin margin resulted in tilting to the northwest and truncation of the Eromanga Basin sequence. The uplift was characterised by broad regional warping, associated with minor movements along old structures. Subsequent tectonic movements in ?late Oligocene to early Miocene time resulted in further folding and warping in the deeper parts of the basin. The regional fall of the area changed from northwesterly to southwesterly, the once monotonous plains became subdivided into distinctive morphological and structural units and this led to the development of the present endorheic drainage system of Lake Eyre. Modifications which occurred in the northwestern part of the Eromanga Basin in the late Cainozoic were caused almost entirely by variations in climate coupled with some minor epeirogenic re-adjustments.

The only economic resource so far identified is groundwater. The most prolific aquifer is the Hooray Sandstone, but younger Cretaceous and Cainozoic aquifers are also used. The hydrocarbon potential of the Toolebuc Formation is debatable. The Eromanga Basin sequence contains only minor resources of construction materials. Limited amounts of sand and gravel can be selectively quarried from the Jurassic arenite beds; the Rolling Downs Group can provide material for local road surfacing only where deeply weathered, and can be improved if mixed with silcrete gravel. Very small quantities of limestone for lime production or for use as gravel could be obtained from the Toolebuc Formation.

INTRODUCTION

The Eromanga Basin is the largest of a group of sedimentary basins that form the Trans-Australian Platform Cover (Geological Society of Australia, 1971), and contain rocks of Lower Jurassic to Upper Cretaceous age. The basin covers an area of about one million km^2 and extends from latitude 20° to 32°S and from longitude 132° to 147°E. It was named by Mott (1952), who divided the area covered by the hydrological Great Artesian Basin into three depositional and tectonic units: the Carpentaria, Eromanga, and Surat Basins. Stratigraphic units of the Eromanga Basin are continuous with similar units in the Carpentaria Basin to the north across the Euroka Arch, and with the Surat Basin to the east across the Nebine Ridge and Cunnamulla Shelf. To the south and west the Eromanga Basin is bounded either by older sedimentary basins or by crystalline basement.

For descriptive purposes the Eromanga Basin is divided into central, northern, and northwestern parts. The northwestern part, with which this Part C deals, comprises the Northern Territory portion of the basin and an area of similar size in western Queensland. This part of the basin is underlain by Permian rocks of the Pedirka Basin, Precambrian to Carboniferous rocks of the Amadeus Basin, Cambrian to Devonian rocks of the Georgina Basin, and Precambrian crystalline basement. It is overlain by Cainozoic sediments of the Lake Eyre Basin and other Quaternary deposits.

Access (Pl. C1)

In western Queensland the Eromanga Basin is sparsely populated. Cattle stations and a few sheep stations occupy most of the area, and are serviced by the townships of Birdsville, Betoota, Bedourie (administrative centre of the Diamantina Shire), and Boulia. This part of the basin can be reached by road from Adelaide via Marree, from Sydney via Bourke and Windorah, from Brisbane via Windorah or Winton, and from Mount Isa via Dajarra. Main roads within the area are well graded, but unsurfaced and sandy in parts. In good weather, tracks between stations provide good access and, away from tracks, gravel-covered areas are easily traversed by four-wheel-drive vehicles. The channel country, comprising the Diamantina and Georgina river systems, is more difficult to traverse and during the wet season, roads and tracks become boggy and most rivers and creeks are impassable. There are scheduled fortnightly flights from Brisbane and Mount Isa to Birdsville, Betoota, Bedourie, and Boulia. Most stations have dry-weather airstrips suitable for small aircraft.

In the Northern Territory most of the area is occupied by the Simpson Desert. The largest settlement is at Finke, a small railway station on the Alice Springs/Port Augusta railway. Small sidings have been constructed at intervals of about 15 km along the railway. Except for a few cattle stations along the western and northern margins, the area is uninhabited. The highway (unsealed) between Adelaide and Alice Springs runs north-south about 60 km west of the mapped area, and main access from the highway is the road from Kulgera to Finke. Several roads and cattle station tracks connect homesteads to main access roads, railway sidings, and various wells, bores, and dams. Access to the Simpson Desert is from Finke via New Crown and Andado stations to North Bore. From North Bore one track runs north to Alice Springs via Highway Bore and Allambi Station. The track that runs from North Bore east via East Bore and Poodinittera Hill to the Northern Territory/South Australia border was made, and maintained, from 1971 to 1974 by Geosurveys of Australia as the main access for petroleum exploration surveys. The track from the Birdsville Track via Cowarie station to Poeppel Corner has been made and is periodically maintained by various exploration companies. On the northern side of the Simpson Desert, access is by tracks along the Hale, Plenty, and Hay Rivers. The tracks can be reached from the road that connects Alice Springs with western Queensland via Tobermory and Urandangi, or Glenormiston. These tracks, however, extend only for a short distance; they are seldom used and are very sandy in places.

Access to the rest of the Simpson Desert area, although possible by four-wheel-drive vehicles, presents a number of logistic problems such as fuel, water, and food supply. The dominant southeast trade wind has formed longitudinal sand dunes, which are the characteristic feature of the Simpson Desert and make travelling difficult. While travelling parallel to dunes in a light four-wheel-drive vehicle, slow but steady progress can be maintained at rates of up to 10 km/hour (petrol consumption is about 2.5 km/litre). Driving at right angles to sand dunes is much more difficult, even when following bulldozed tracks, especi-

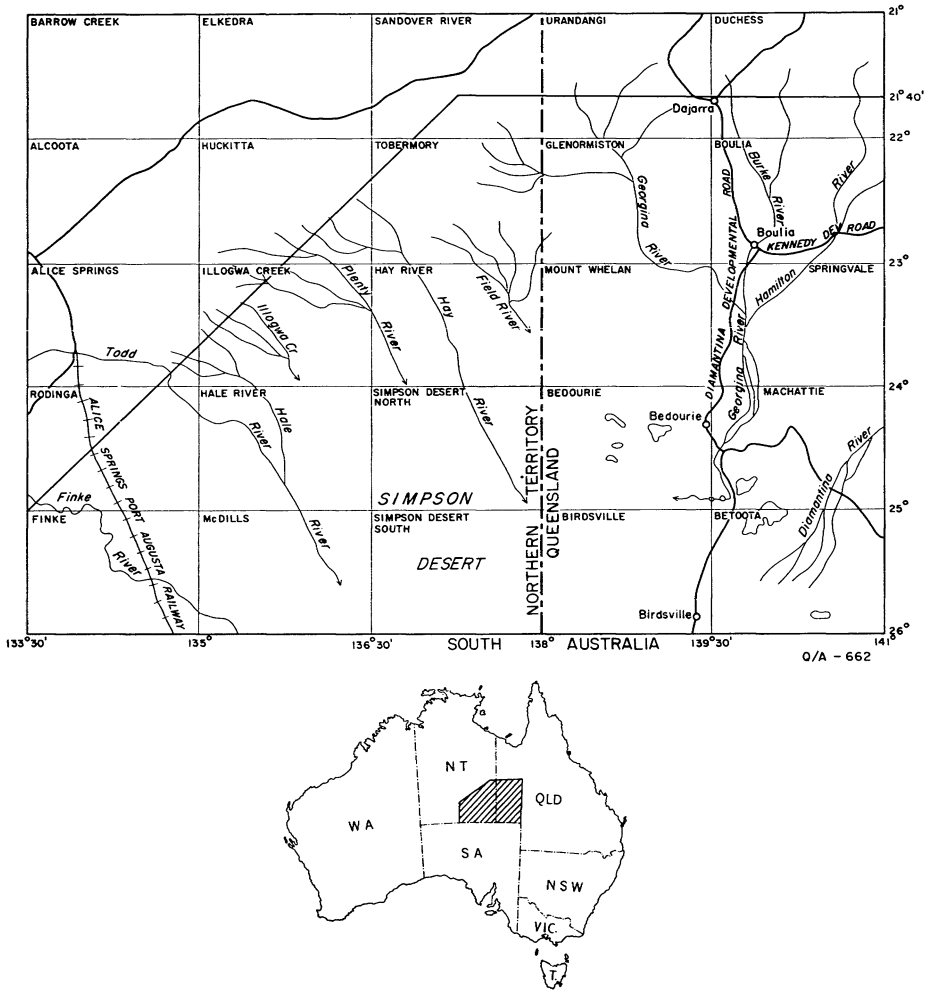


Fig. C1. Location map.

ally the crossing of active dune crests, which are undulating areas of unconsolidated sand up to 30 m wide. Travelling east is much easier than travelling west because the dunes are asymmetrical. The most convenient means of transport is helicopter.

Climate

Because most of the region is uninhabited, meteorological stations are few, and few data on the climate are available. The climate is arid to semi-arid. The average annual rainfall varies from 100 mm in the south to 355 mm in the north because of the greater influence of summer monsoons in the north. Although the annual distribution of rainfall is fairly even in the long term, rainfall in any one year or season is sporadic.

The summers in the area are hot, and the winters mild. Summer maximum temperatures frequently exceed 38°C, but nights are generally cool. Frosts do not occur in the north, but in the southern half may be expected during the period from late May to late August. The mean annual temperature at Charlotte Waters telegraph station over a 30-year period (Wiedemann, 1971) was 21.9°C, with a mean maximum of 29°C and mean minimum of 14.5°C. Monthly mean temperatures range from 22.5°C (January) to 12.3°C (July). The maximum recorded temperature is 48.5°C and the minimum 5.3°C.

Vegetation

Vegetation ranges from grassland or shrubland to low woodland. In contrast to more humid parts of Australia, eucalypts are rare and acacias are the most common trees and shrubs. Except for the remarkable absence of thorny and succulent plants, the species have many features in common with species from other arid and semi-arid areas throughout the world.

PREVIOUS INVESTIGATIONS

Exploration

The northwestern part of the Eromanga Basin has been traversed by several well known explorers (Madigan, 1936, 1938, 1945; Feeken, Feeken & Spate, 1970). In 1845, Captain Charles Sturt led the first expedition to enter the Simpson Desert. Other 19th Century explorers included Stuart, Burke and Wills, Lewis, Favenc, Barclay, Winnecke, and Lindsay. Madigan made an aerial reconnaissance in 1929, and both he and Colson made extensive journeys in the 1930s. It was Madigan who named the Simpson Desert and described it as a distinct physiographic unit.

Geological and Geophysical investigations

The first geological observations were recorded in Queensland by Daintree (1872) and Jack & Etheridge (1892). Whitehouse (1930, 1940, 1945, 1948) outlined the principal features of the geology of western Queensland, and (1955) gave a general account of the geology of the Great Australian Artesian Basin in Queensland. Hill & Denmead (1960) summarised the knowledge of the basin at that time.

In the Northern Territory almost all the early geological work was concentrated on the pre-Eromanga Basin rocks. The first geological observations were recorded by East (1889) at Cunninghams Gap, near Crown Point. Tate (1897), David (1898), and David & Howchin (1924), all made observations on Permian glacial rocks in the Finke area. Ward (1925) summarised all information available and gave a general account of the geology of central Australia. He regarded the Jurassic sands as resting directly on the sandstones of the 'Finke Series' (now Devono-Carboniferous? Finke Group—Wells et al., 1970), used the name Rolling Downs Formation for the Lower Cretaceous marine shales, and described the siliceous capping covering a great variety of rocks throughout the area.

During the following years, reconnaissance geological work was done by Government departments, universites, prospectors, and mining and petroleum exploration companies. C. T. Madigan made a major contribution to knowledge of the Northern Territory portion of the Eromanga Basin in 1939, when he organised and led a scientific expedition across the Simpson Desert (Madigan, 1945, 1946a. b; Crocker, 1946). Sullivan & Opik (1951) described the geology of the ochre deposit near the Rumbalara, Yellow Queen, and Yellow King Mines. They named the Jurassic De Souza Sandstone, and the Lower Cretaceous Rumbalara Shale.

In the early 1950s BMR began systematic geological mapping in northwestern Queensland and this was later extended into the Northern Territory. By the late 1960s almost the whole northwestern part of the Eromanga Basin had been mapped at 1:250 000 scale, in Queensland in cooperation with the Queensland Mines Department, and in 1969 the interim results were compiled by Vine & Daric (1971) at 1:1 million scale. The last two Sheet areas covered in the mapping program—Simpson Desert South and Simpson Desert North, in the Northern Terrtory—were mapped in 1971 (Table C1).

As part of the regional geological mapping BMR carried out gamma-ray logging of selected water bores, and shallow stratigraphic drilling. Altogether 46 water bores have been logged in this part of the basin, either by, or under contract to, BMR: 6 in 1961 and 23 in 1966 in Queensland (Table C2); 17 in 1972 in the Northern Territory (Table C3). Most of these logs have contributed much to the understanding of subsurface geology in this area, although those from the Northern Territory are of poor quality. The 21 shallow stratigraphic holes drilled (Table C4) have helped the mapping by providing fresh material for palaeontological and petrological studies. Cores and cuttings are available for examination at the Core and Cuttings Laboratory, Fyshwick, A.C.T.

From the late 1950s company geologists have been active in the area, and Sprigg (1958) published a summary report of the petroleum prospects of the Great Artesian Basin. Following aerial geological mapping and air-

photo-interpretation of the whole of the Simpson Desert by Sprigg in 1958-59 (Sprigg, 1963), several petroleum exploration companies explored parts of the area. Seismic surveys made by BMR and the companies are listed in Plate C2, and aeromagnetic and gravity surveys in Table C5. Although these surveys and the subsequent petroleum exploration wells (Table C6) had as their primary objectives targets in Permian or Lower Palaeozoic rocks, they made a significant contribution to the understanding of the regional geology and helped to establish the stratigraphy of the Eromanga Basin sequence in this area.

All available geophysical data have been examined and, where necessary, re-interpreted (P.L.H.). The results were integrated with geological data to produce structure-contour maps on the base of the Eromanga Basin sequence (Plate C3) and on the base of the Rolling Downs Group (Plate C4).

The results of the 23 subsidised seismic surveys and four BMR seismic surveys (Plate C2) carried out in the area were presented as contour maps and some cross-sections showing reflection times or depths relative to various datum planes. Most information came from reflection recordings, but some was derived from refraction data.

The structure contour maps represent two seismic reflectors which have been extensively mapped throughout the Eromanga Basin. A strong and persistent reflector which has been referred to in various company reports as the 'Blythesdale reflector' or 'C horizon', is located in the upper part of the Cadna-owie Formation and is generally mapped as the base of the Roling Downs Group. The other, a weaker reflector whose character is less consistent, corresponds to an unconformity between Mesozoic and older sediments or basement.

PHYSIOGRAPHY

Extensive monotonous plains and dissected plateaux and escarpments are the main morphological features of the region. The land slopes towards the southeast. The average elevation in the north and west is 250-300 m above sea level, but some western plateaux and mesas reach 500 m. In the east the average elevation is only 100-150 m above sea level, and in the southeast it is as low as 40 m.

Drainage

The region lies within the Lake Eyre drainage basin. Lake Eyre, which at its lowest point is 14 m below sea level, forms the focus of this large endorheic system. Although the region itself is mainly arid, the large catchment area of the rivers flowing through it includes some parts of north and central Queensland which have a markedly greater rainfall.

All rivers in the northwestern part of the Eromanga Basin are braided and ephemeral. After flooding, they shrink to a few large permanent waterholes. In the Northern Territory only the *Finke River* has been known to carry water into Lake Eyre (Madigan, 1938). The *Todd, Hale, Plenty, Hay, and Field Rivers* all drain into the Simpson Desert. The Field River is fed by several large tributaries, and flows more frequently than the others.

In Queensland the major streams are the *Mulligan, Georgina, and Diamantina Rivers and Eyre Creek,* which form part of the Channel Country of western Queensland. The Mulligan River rises in the Toko Range and its course is controlled by strike valleys in the Toko Syncline. The Georgina is mainly a system of braided channels with a gradient of less than 0.2 m/km. It flows less rarely than the other rivers because its headwaters are some 300 km to the north in a region of higher rainfall. It is also joined by a number of large streams in the northern part of the map area —the Burke and Hamilton Rivers and Pituri and Cottonbush Creeks. The wide, braided Diamantina River trends generally southwest and has a gradient of only about 0.25 m/km. Like the Georgina River, it rises some 300 km to the north. After heavy rain, locally or in the headwaters, its channels overflow and flood a wide area, including the east-trending depression occupied by Lakes Koolivoo and Machattie.

Landforms

The northwestern part of the Eromanga Basin is not a distinct physiographic entity, and includes several landform assemblages which extend beyond its confines.

The major erosional landform groups are hills, cuestas, and ridges of basement rocks; rolling downs; plateaux, cuestas, mesas, and escarpments; and armoured (gravel-mantled) plains and slopes.

The major depositional landform groups are sand dunes and sandy soil plains; alluvial belts and lacustrine plains; and miscellaneous plains (gypcrete, calcareous plains, etc.).

The *hills, cuestas, and ridges of basement rocks* around the western and northern margins of the basin include isolated steep hills in the north (e.g. Mount Winnecke), the Harts Range in the far northwest, and the Toomba and Toko Ranges in the northeast. The ranges are rugged in comparison to the landforms developed within the basin. In the Queensland part of the basin, large parts of the Betoota, Birdsville, Machattie, Bedourie, Springvale, and Boulia 1:250 000 Sheet areas are characterised by gently undulating areas of soil known generally as *'rolling downs'*. Relief is generally less than 10 m, the soil cracks readily, and numerous rills have developed. The drainage pattern is closely branching, but there are sporadic poorly drained areas in which polygonal shrinkage cracks and gilgai are well developed in clayey soil. Trees and shrubs are rare; the vegetation is mainly grass (Mitchell grass in good seasons). Many areas of rolling downs are closely related to zones of uplift where the late Cretaceous chemically weathered rocks and Cainozoic sediments have been eroded, exposing the relatively unweathered Cretaceous sediments.

Plateaux, cuestas, mesas, and escarpments capped by silcrete (strongly silicified beds) protrude up to 30 to 50 m above the general plain level, particularly in areas recently uplifted by tectonic movements. The silcrete capping is up to 10 m thick. Although they occupy only a relatively small part of the area they constitute the main relief in the northwestern part of the Eromanga Basin, mainly along the margins of the basin. Leached and selectively indurated beds in the weathered rocks below the silcrete capping form benches and striking varicoloured cliffs in many areas (e.g. near Rumbalara Siding—Yellow King and Yellow Queen Mines, Finke Sheet area).

In certain areas, such as northeast from Andado homestead to the Plenty River, erosion of the Tertiary sediments and resistant silcrete has proceeded to a stage in which the summit levels are no longer concordant. Low rounded hills are developed, in addition to mesas and plateaux, in weathered older rocks of several ages. Other landforms are benches, spurs, and low rises mantled by gravel. The distribution of this landform group appears to have been closely controlled by Cainozoic tectonic movements.

Gently undulating, armoured (gravel-mantled) plains and slopes form a very distinctive landscape type. Most of the clasts are of silcrete, but 'ironstone' and quartz gravel are locally common. The cobbles and pebbles of silcrete have been derived from uplands and are most common in core zones and peripheries of anticlinal structures. Widespread silcrete gravels indicate the former presence and extent of silcrete beds across anticlines and domes.

Sand dunes and sandy soil plains are characteristic of most of the northwestern Eromanga Basin. Sand dunes of the Simpson Desert cover the central part of the map area while sandy soil plains (in places red) are present round the desert margins.

The Simpson Desert is a classic area for parallel dunes. The sand dunes are 10 to 30 m high, have a mean trend of 334°, and commonly extend continuously for up to 160 km (some dunes are as long as 300 km). They are straight and generally have an even spacing of about 400 m. They have characteristic tuning-fork junctions opening to the south-southeast, which are caused, according to Folk (1971), by the helicoidal flow (Langmuir circulation) of air cells moving with the prevailing south-southeasterly winds. The dunes have serrated, active crests, and are asymmetrical in cross-section, the western slope averaging 15°, the eastern 25°. The asymmetry was produced by occasional strong side-winds that came mostly from the west. Apart from the crests, which are 15-30 m wide and support only rare spinifex clumps or small bushes, the dunes have been colonised by plants and are considered to be stable.

Flat or gently undulating sand or sandy soil plains covered by spinifex and scrub are characteristic of the margins of the Simpson Desert. Sand dunes are rare, and drainage channels are ill-defined or absent. The soils range from coarse sand to fine clayey sand, and in places red earth. The boundary between aeolian sand and residual or transported sandy soil is difficult to define.

In the Queensland portion of the northwestern Eromanga Basin the upper reaches of the streams are confined to a variable extent by high ground and form braided tracts of *alluvium* up to 5 km wide. Lower down, they spread to form extensive flood plains, 60-80 km wide, and have braided drainage systems. Lateral *lacustrine sump basins* are common, some quite large (Lakes Phillippi, Koolivoo, Machattie, Moonda). Alluvial deposits range from pale to dark grey clayey soil in the flood

plains to silts and fine sands in levees and meander scrolls in present and former channel zones.

In the Northern Territory portion of the basin, the flood plains of the major rivers are typically up to 3 km wide in the upper and middle reaches, widening to 8 km wide in the lower parts of the flood plains. In contrast to Queensland the alluvial basins are small. Local drainage is commonly by close branching small creeks connecting with the main channels. Alluvial soil in the uper part of streams contains also some calcareous earths; in the lower parts silty alluvial soils are the most common.

STRATIGRAPHY

Pre-Eromanga Basin rocks (basement)

Basement to the northwestern part of the Eromanga Basin is formed by the metamorphic and igneous complexes of the Mount Isa Fold Belt and of the Arunta and Musgrave Blocks, and by the sedimentary rocks of the Georgina, Amadeus, and Pedirka Basins (Plate 1).

The *Musgrave Block* (Thomson, 1969) extends from the northwest corner of South Australia into the Northern Territory and Western Australia. It crops out in the southwestern corner of the Finke Sheet area where it consists of gneiss and amphibolite, granite, and dolerite (Wells et al., 1966). Geophysical evidence indicates that it extends to the northeast under the Amadeus and Pedirka Basins into the southeastern corner of the Northern Territory.

The *Arunta Block* (Mawson & Madigan, 1930) consists mainly of gneiss, schist, metaquartzite, granite, and some basic intrusives. In the map area biotite, muscovite, and andalusite schists predominate; quartz-feldspar-biotite gneiss and quartz-hornblende gneiss are fairly common.

The *Mount Isa Block* (Carter et al., 1961) consists of Lower Proterozoic to Carpentarian sedimentary, metamorphic, and igneous rocks.

The *Georgina Basin* (Smith, 1965a) consists of Cambrian and Ordovician marine sediments and a Silurian-Devonian freshwater sequence, underlain in some marginal areas (Mount Whelan, Hay River, and Tobermory Sheet areas) by Upper Proterozoic to Lower Cambrian(?) sediments. It extends southeast beneath the Eromanga Basin to about latitude 25°S.

The *Amadeus Basin* (Wells et al., 1970) is bounded to the north and south by Precambrian rocks of the Arunta and Musgrave Blocks; its eastern margin is concealed beneath overlapping Permian and Mesozoic rocks of the Pedirka and Eromanga Basins.

The *Pedirka Basin* containing Upper Carboniferous to ?Triassic sediments, (Canaple & Smith, 1965; Williams, 1973) is almost entirely subsurface. It is bounded on the west and north by the Musgrave and Arunta Blocks; to the east it is separated from the *Cooper Basin* by the northeast-trending Birdsville Track Ridge (which extends from south of the study area up through Birdsville—see Pl. C3).

Eromanga Basin sequence

The stratigraphy of the northwestern part of the Eromanga Basin is summarised in Table C7 and the evolution of the nomenclature in Table C8. Interpretation of the subsurface stratigraphy is based on petroleum exploration wells, geophysical data, shallow stratigraphic drilling, and information from adjacent areas.

The concurrent syntheses of the geology of the Eromanga Basin (This Bulletin, Parts A and B) have established that units of the same lithology and in the same stratigraphic position have been given different names in different parts of the basin. Some of these names have now been dropped and certain stratigraphic names used in the central, northern and South Australian parts of the Eromanga Basin have been extended into the northwestern area (Table C8).

Hooray Sandstone

Although the name Hooray Sandstone was first published in Hill & Denmead (1960) the unit was first named by Woolley (1941), who measured a section along Hooray Creek in the northeastern part of the Tambo Sheet area, near the eastern margin of the basin. Since then the name Hooray Sandstone has been widely used for the Upper Jurassic to Lower Cretaceous part of the Eromanga Basin sequence in the eastern part of the basin.

In the northwestern part of the Eromanga Basin Jurassic to Lower Cretaceous rocks crop out along the northern margin and are present in the subsurface throughout the whole area. In the east they were originally mapped as the Jurassic to Lower Cretaceous Longsight Sandstone, in the centre as the Permian-Triassic(?) Tarlton Formation, and in the west and south as the Jurassic(?) De Souza Sandstone.

The *Tarlton Formation* was assigned a probable Permian age by Condon & Smith (1959) because of the believed fluvio-glacial origin of part of the unit and its stratigraphic position. Poorly preserved plant fossils collected by Smith et al. (1961) from the upper part of the formation were assigned a Triassic or Jurassic age by White (1961), and on this evidence Smith (1963a, 1965b) placed the whole sequence in the Triassic. However, the possibility that the lower part of the Tarlton Formation is fluvio-glacial and hence Permian was left open. Plant fossils collected in 1973 from the Tarlton Formation at the top of the Tarlton Range (Tobermory Sheet area), are considered by Gould (Appendix to this Part C) to be Jurassic to Early Cretaceous in age. The age of the fluvio-glacial beds in the lower part of the Tarlton Formation is uncertain. They have been assigned a possible Permian age in the Tarlton Range area, but similar fluvio-glacial beds underlying the Tarlton Formation farther east, west of the Craigie Fault, have been mapped as Upper Proterozoic(?) Field River Beds (Smith, 1965b). In most localities the base of the Tarlton Formation is not exposed and the lowest exposure is a pebble or cobble conglomerate succeeded by silty sandstone and sandy siltstone.

In Plate C1 of this Bulletin, the upper part of the Tarlton Formation is mapped as Hooray Sandstone; the lower fluvio-glacial part is possibly Permian or older.

The *De Souza Sandstone is lithologically* similar to the upper part of the Tarlton Formation and its stratigraphic position is the same, namely between a Permian fluvio-glacial unit (Crown Point Formation) and palaeontologically dated Lower Cretaceous rocks. It contains plant fossils that are not diagnositic and its probable Jurassic age (Wells, 1969b) is based on its similarity in lithology and stratigraphic position to the Algebuckina Sandstone in South Australia which contains an Upper Jurassic to Lower Cretaceous flora (Harris, 1962).

The De Souza Sandstone is almost invariably cross-stratified, and the thickness of sets in places reaches 3 m. It is most commonly composed of quartzose sandstone, in places rich in kaolin, and lenses and continuous beds of siltstone and shale. In several places cut-and-fill structures and anglar discordances are present at the contact with the overlying Lower Cretaceous rocks, but elsewhere the contact appears to be conformable (Wells et al., 1970).

The name De Souza Sandstone was used locally (Sullivan & Opik, 1951) and later applied by several authors to probable Jurassic rocks in the western part of the Eromanga Basin. However, throughout the Eromanga Basin the Algebuckina Sandstone has been correlated with the Hooray Sandstone, and to avoid future confusion it seems appropriate to replace the name De Souza Sandstone with Hooray Sandstone.

Towards the northern margin of the Eromanga Basin the Jurassic to Lower Cretaceous sequence was named the *Longsight Sandstone* by Casey (1959). It crops out in the north-eastern part of the map area in the Duchess, Urandangi, Boulia, Glenormiston, and Mount Whelan 1:250 000 Sheet areas. In the type area at Longsight Peak, near Alderley homestead the Longsight Sandstone consists of very fine to medium-grained quartzose sandstone, generally ferruginous and micaceous, with some conglomerate. It is well sorted and current-bedded, and contains fossil plants. Towards the top it is dominantly siltstone and contains Lower Cretaceous shallow-marine fossils (Casey, et al., 1960). In the Mount Whelan Sheet area (Reynolds, 1968b) the lower part of the sequence consists of silty sandstone with plant fossils and worm burrows, and the upper part of glauconitic sandstone with marine fossils. In the shallow stratigraphic hole BMR Hay River 4 it consists mainly of well sorted fine-to-medium quartz sandstone with lesser amounts of clayey sandstone, carbonaceous sandstone with a detrital dark mineral, calcareous sandstone, micaceous quartz sandstone, mudstone, and thin lignite seams (Yeates, 1971). In places it is pyritic and ferruginous. It contains Lower Cretaceous shallow-marine to brackish spores and pollens (Burger & Mond, 1973).

Rocks described as Longsight Sandstone by Casey (1959) represent at least two facies: a lower, fluvial unit composed almost entirely of quartzose sandstone and some conglomerate and an upper, shallow-marine unit made up of calcareous sublabile sandstone interbedded with siltstone and mudstone. This sequence was not re-examined in the field and it is possible that the rocks represent two formations. Regional wireline log correlations of Senior et al. (1975) show that the Longsight Sandstone is an exact correlate of the Hooray Sandstone and as a result the former name has been dropped. However, the possibility still remains that the upper marine facies may belong to the Cadnaowie Formation. This problem cannot be resolved using the available data and for convenience the name Hooray Sandstone is used

on the Map (Plate C1) to identify this sequence. Facies variations in the Hooray Sandstone occur across the map and the lithological variation is given in the map reference. In the northeast there are quartzose sandstones occupying a similar stratigraphic position which belong to the Gilbert River Formation.

Cadna-owie Formation

The Neocomian to early Aptian Cadna-owie Formation can be readily traced northward and eastward from South Australia into Queensland where it averages 60 m in thickness. In the northwestern Eromanga Basin, as is the case elsewhere in Queensland, it is restricted to the subsurface and consists largely of medium-grained sublabile sandstone with siltstone especially abundant toward the base. A widespread quartzose sandstone at the top of the formation, a major aquifer, was named the Wyandra Sandstone Member by Senior et al. (1975).

Petroleum exploration companies frequently refer to this formation as the 'Transition Beds' (e.g. Magnier, 1965; C.G.G., 1964b; Amerada, 1966b and Geosurveys, 1971). In southwest Queensland it was informally known by several authors as 'upper Hooray Sandstone' (e.g. Galloway, 1970). The name Cadna-owie Formation was first used by Freytag et al. (1967) and was fully defined by Wopfner et al. (1970) from outcrops in South Australia. Senior et al. (1975) recognised that this sequence was an exact correlate of the informal 'upper Hooray Sandstone', demonstrated its widespread subsurface occurrence in southwest Queensland, and recommended that the name Cadna-owie Formation be adopted.

The top part of the Cadna-owie Formation (Wyandra Sandstone Member) and base of Rolling Downs Group coincide with a widespread marker known as the 'C' horizon. This seismic horizon was combined with picks of the base of the Rolling Downs Group to compile the structure contours depicted in Plate C4.

Rolling Downs Group

In order to establish uniform regional nomenclature throughout the Eromanga Basin, the name Rumbalara Shale, although having priority, is here replaced by Wallumbilla Formation, which is part of the Rolling Downs Group. Ward (1925) used the name Rolling Downs Formation for the Lower Cretaceous marine shales that crop out in the Finke area (N.T.). Sullivan & Opik (1951) investigated ochre deposits at Rumbalara Ochre Mines and proposed the name Rumbalara Shale for horizontal leached shale and sandstone containing numerous fossils of Early Cretaceous age. Later the term Rumbalara Shale was applied by other authors to all Lower Cretaceous rocks that crop out in the Finke, McDills, Rodinga, and Hale River 1:250 000 Sheet areas (Wells, 1969b; Stewart, 1968; Cook, 1969; Shaw, 1968; Wells et al., 1970). Recent geological mapping by Mond & Yeates (1973) and palynostratigraphic interpretations of Burger & Mond (1973) have shown that the Rumbalara Shale is restricted to a small area in the vicinity of the Rumbalara Ochre Mines and probably a narrow strip to the southwest. With the exception of the southwestern Finke Sheet area, where some outcrops could be Rumbalara Shale, the area of Mesozoic rocks mapped previously as Rumbalara Shale belongs to the Rolling Downs Group, which is now recognised throughout the whole of the northwestern part of the Eromanga Basin. The Rumbalara Shale represents the lowermost part of the Rolling Downs Group and corresponds to the Wallumbilla Formation.

Post-Eromanga Basin rocks

Cainozoic sediments cover most of the northwestern part of the Eromanga Basin. Knowledge of them is uneven and no synthesis has been published. Information about particular areas can be obtained from BMR Records and Explanatory Notes and in particular from Paten (1964) who described the rocks, fossils, and weathering history of four Tertiary basins in the Boulia area.

The nine Tertiary units that are recognised (Plate C1) include argillaceous and arenaceous sediments, siliceous sinters, and carbonates. The most extensive units are the basal quartzose Glendower, Etingambra, and Marion Formations. They consist mainly of coarse-grained fluvial sandstone and conglomerate/breccia which rest disconformably on the weathered and uneven surface of the younger Mesozoic rocks. The sandstone and conglomerate/breccia are commonly silicified and the top parts of exposures are, in most places, converted to silcrete. Judging from the distribution and amount of their weathering products (silcrete pebbles and cobbles—'gibbers'), the sandstone and conglomerate/breccia were originally much thicker than their present outcrops would suggest. All three formations are interpreted as having been formed in old river systems at approximately the same time in the early Tertiary.

The Springvale Formation, Mount Coley Sinter, Noranside and Austral Downs Limestones, and Horse Creek Formation consist mainly of carbonates, siliceous sinters, and some argillaceous sandstone. They were deposited in small, tectonically controlled sedimentary basins that occur throughout the area but have been described in detail only within the Boulia, Glenormiston, Springvale, and Mount Whelan 1:250 000 Sheet areas (Paten, 1964).

The Waite Formation consists of interbedded chalcedonic limestone, sandstone, siltstone, and minor sandy conglomerate. It was deposited in rivers and lakes, and northwest of the map area, in the Alcoota Sheet area, the lacustrine beds in the upper part of the unit contain late Miocene to early Pliocene vertebrate fossils (Woodburne, 1967; Senior, 1972).

Undifferentiated Tertiary rocks that crop out along the western and southern margins of the dry lakes in the Simpson Desert North Sheet area have been tentatively correlated with the Etadunna Formation of South Australia (Mond, 1974). They consist of sandstone, mudstone, and siltstone, with layers of gypsum and in places silcrete and ironstone. Shark teeth and fragments of lungfish toothplates were recovered in this area; however none were in situ and they may all have been reworked from the underlying Cretaceous rocks.

Unconsolidated Quaternary sediments are widespread on sand plains, in alluvial belts, and on lacustrine plains.

STRUCTURE

The Eromanga Basin sequence generally thickens and deepens in a south to southeast direction (Pl. C3). Post-Cretaceous movements that have affected the sequence comprise broad warping, mainly normal faulting and draping due to rejuvenation of basement structures, and tilting related to uplift in the north and west. Thinning of units across major structures (e.g. McDills Anticline) and an upward decline in amplitude of folds (e.g. McDills Anticline and Betoota Dome) show that some movements occurred during sedimentation.

Structure contours at the base of the Eromanga Basin sequence (Pl. C3) and Rolling Downs Group (Pl. C4) show that, within the map area, the Eromanga Basin is deepest in the south near 26°S and 137°E, where Jurassic to Cretaceous sediments are up to 2200 m thick. From here towards the west, north, and northeast the Basin sequence thins progressively against rising basement, to the erosional margin, whereas to the east it also thins but continues across the Boulia Shelf and the northernmost extension of the Birdsville Track Ridge to the central and northern parts of the Eromanga Basin.

In the eastern part of the map area the general southerly thickening is interrupted by several 'deeps', some fault-bounded (Pl. C3). Seismic velocity data suggest that the extra thickness of sediments in some of these 'deeps' is above the widespread seismic reflector which represents the base of the Mesozoic. This was also confirmed by drilling in the vicinity of the Toko Syncline where the petroleum exploration well A.O.D. Ethabuka No. 1 penetrated over 600 m of probable Jurassic to Cretaceous sediments. Folded Tertiary sediments on the flanks of the Betoota Dome indicate that some folding occurred during the Cainozoic.

Faults in the northeastern part of the Machattie 1:250 000 Sheet area are indicated partly by seismic data (Pl. C3) and partly by the outcrop distribution of the Mackunda and Winton Formations (Pl. C1). Some of the fault lines were interpreted from airphoto lineaments (Senior, 1973). The depression occupied by Lakes Machattie and Koolivoo in the southwestern corner of the Machattie 1:250 000 Sheet area is bounded in the south by a linear zone of outcrop which forms a drainage divide; the land surface slopes very gently to the southeast. Seismic data in this area are generally lacking and the structure was interpreted by Senior (1973) as a possible fault at depth grading into a monocline at the surface (Pl. C1).

The Betoota Dome, coincident with a local northeast-trending gravity high, is an elongate, slightly asymmetrical structure with the steeper dips on the western flank. The axis of the structure has been eroded forming an ovate, gently undulating lowland which is surrounded on three sides by scarp-bounded cuestas. The northern part of the Betoota Anticline is less well defined physiographically and the interior lowland merges with the alluvial and aeolian landforms at the Diamantina River. The topographic form of this structure has numerous

counterparts farther to the southeast in the Central Eromanga Basin. In outcrop the structure is approximately 58 km long by 13 km wide.

In the southwest of the map area are several northeast and north-trending faults and associated anticlinal structures which have no surface expression and were discovered by seismic surveys. One of these, McDills Anticline, has been tested by drilling; another four—Border, Colson, East Colson, and East Border Anticlines—have been detailed by seismic studies. They may have developed during Permian to early Cainozoic times as drape folds. All five structures coincide with positive Bouguer anomalies; all available geological, geophysical, and drilling data have been summarised by Williams (1973).

GEOLOGICAL HISTORY

Beginning in the Upper Proterozoic, several sedimentary sequences (Georgina, Amadeus, and Pedirka Basins) had been deposited, deformed, and part eroded prior to development of the Eromanga Basin. Erosion resulting in planation probably continued throughout Triassic times until sedimentation commenced in the Early Jurassic.

The Jurassic to early Neocomian sediments were derived mainly from low basement rises that provided dominantly quartz-rich detritus. Most of the sequence (Hooray Sandstone) was deposited by low-gradient streams on a stable, senile land surface, where the sands were extensively weathered and reworked. A seasonally arid climate, as suggested by the presence of dreikanters, was followed by a moist subtropical climate indicated by the fossil flora. Carbonaceous silt and labile sand were deposited in swamps and deltas, where burial was quicker and weathering and reworking limited.

In Neocomian or early Aptian times the sea entered the northwestern part of the Eromanga Basin from the north. Sand and silt that accumulated in it and along its shores (Cadna-owie Formation) were still mainly derived from the low basement rises surrounding the basin. The transgression reached its maximum in the late Aptian, when labile and very labile sand, silt, and mud (Wallumbilla Formation) were laid down in a shallow inland sea. Sandy deposition persisted longer along the northwestern margin of the basin than in the deeper parts where mudstone is dominant (Burger & Mond, 1973). During the early Albian, sand deposition extended over large parts of the Eromanga Basin (upper Wallumbilla Formation), coincident with temporary withdrawal of the sea (Burger, 1968).

In early Late Albian times the sea returned to the Eromanga Basin from the north, deposition slowed, and marine life flourished. Silt and mud were laid down in reducing conditions and limestone developed as bioherms (Toolebuc Formation). Very probably algae extracted carbonate from the sea water, producing a firm substrate which was colonised by molluscs. Accumulation of mud and silt persisted (Allaru Mudstone) until towards the end of Late Albian times when the sea began to recede from northwest to southeast, leaving behind layers of labile sand, silt, mud, and lenses of limestone (Mackunda Formation) deposited in shallow-marine and paralic environments. Following the regression, and until early Cenomanian times, feldspathic sand, and mud (Winton Formation) were laid down by meandering streams on a plain, and in lakes and swamps. The most likely source of this quartz-poor detritus was the Cretaceous volcanic ranges to the northeast (Exon & Senior, 1976).

In the late Cretaceous there began a long period of erosion which persisted well into the Tertiary. The exposed Eromanga Basin sediments were deeply weathered, especially around the margins of the basin, and their labile constituents were altered to clay minerals. Silica and iron, released during weathering, became concentrated in selected beds. By the end of Cretaceous or early Tertiary times uplift of the eastern basin margin (outside the map area) resulted in tilting and truncation of the Eromanga Basin sequence.

In the early Tertiary a veneer of fluvial sands (Glendower, Etingambra, and Marion Formations) was laid down on a deeply weathered and uneven surface of the Rolling Downs Group. Other Tertiary deposition was restricted to small, tectonically controlled sedimentary basins. Carbonate-rich, and argillaceous and arenaceous sediments were deposited and siliceous sinters were formed. Subsequent tectonic movements in late Oligocene(?) to early Miocene time, possibly associated with basic volcanism in the north and east, altered the regional slope of the basin from northwesterly

to southwesterly, and resulted in the development of the present endorheic drainage system of Lake Eyre.

The late Tertiary geological history was marked by intensive silicification of the superficial rocks. Most Tertiary formations were almost completely silicified and survive as an extensive silcrete capping, which on dissection gave rise to the gibber plains. Modifications which occurred in this area in the late Cainozoic (sand dunes, ephemeral lakes) were caused almost entirely by variations of climate coupled with some minor epeirogenic re-adjustments.

ECONOMIC GEOLOGY

Groundwater

The northwestern part of the Eromanga Basin is part of the hydrological Great Artesian Basin and it contains several artesian and subartesian aquifers. Some of the intake areas of the main aquifers are in the western and northern portions of the map area where the Jurassic to Lower Cretaceous Hooray Sandstone and the Lower Cretaceous Wallumbilla Formation crop out along the structural margin of the basin.

Recording and evaluation of groundwater data from different areas is variable. Most of the unpublished BMR Records and the Explanatory Notes accompanying 1:250 000 Geological Series maps give lists of water bores with relevant geological and hydrological information. Several water bores were gamma-ray logged (Tables C2 & 3) and the results used in the interpretation of subsurface structure (Plates C3 & 4). In selected bores, flowmeter, caliper, temperature, and differential temperature logs were run, specifically for groundwater studies.

Confined aquifers which provide water from artesian and subartesian water bores are Jurassic and Cretaceous sandstones. The main confining beds are the Lower Cretaceous argillaceous sediments. Practically all the flowing bores within the northwestern Eromanga Basin draw their water from the Hooray Sandstone. Although pressure and flow have decreased in the last fifty years owing to excessive and uncontrolled usage, in most of the area the potentiometric surface is still above ground level. The potentiometric surface of the younger Cretaceous aquifers, within the Wallumbilla, Mackunda, and Winton Formations, has always been below the ground level and the bores tapping them are all subartesian.

In general, the quality of water from the Hooray Sandstone is good, particularly from the lower part. In some bores, younger Cretaceous aquifers yield water of very poor quality, mostly brackish and suitable only for stock. In many parts of the northwestern Eromanga Basin water of variable quality is drawn from the shallow Cainozoic aquifers.

Petroleum

Thirteen petroleum exploration or deep stratigraphic wells drilled within the map area (Table C6) were all designed to test the petroleum potential of the underlying Amadeus, Pedirka, and Georgina Basins sedimentary sequences. Several shows of hydrocarbons were detected in the Eromanga Basin sequence, but all tests were negative.

The Lower Cretaceous marine argillaceous rocks of the Rolling Downs Group are potential source and cap rocks, and permeable sandstones are present throughout the sequence. Depth of burial appears to have been sufficient for generation of hydrocarbons within the basal two-thirds of the Eromanga Basin sequence. It is also possible that hydrocarbons generated within older basin systems could under favourable circumstances migrate up into porous and permeable sandstones within the Jurassic and Lower Cretaceous. Entrapment would depend on favourable structural or stratigraphic geometry to isolate the deposit from the effect of basin-wide southwest movement of groundwater.

A potential source of hydrocarbons is the oil shale associated with argillaceous and calcareous rocks of the Toolebuc Formation. Elsewhere in the Eromanga Basin, near Julia Creek, large reserves have been evaluated (Swarbrick, 1974), and in two places traces of oil have been found in porous interbeds in the unit (Senior & Smart, 1973). The extent of the Toolebuc Formation, together with the possible occurrence of associated oil, indicates the possibility of economic accumulation of hydrocarbons in favourable areas within the deeper parts of the Eromanga Basin. However, in the northwestern part of the basin the depth of burial is now only 908 m at the deepest part and decreases rapidly towards the margin.

Petroleum prospects for the Eromanga Basin sequence can be regarded as only fair, but much work remains to be done before an

accurate assessment is possible. Future geophysical surveys and drilling will probably concentrate on the pre-Eromanga sequence, particularly the Permian rocks of the concealed Pedirka Basin.

Yellow Ochre

Yellow ochre deposits occur in the base of the Wallumbilla Formation at the Rumbalara Ochre Mines (Yellow Queen and Yellow King Mines) in the northeastern corner of Finke 1:250 000 Sheet area.

The existence of the ochre deposits in this locality was known to the Aboriginals long before the settlement of this area, and the ochre was highly prized by them for the decoration of their bodies and weapons. It was in special demand for ceremonial occasions and was traded over long distances. Commercially it was mined from 1939 to 1951, when the mine was closed; the total production was 7875 tonnes.

Sullivan & Opik (1951) inspected the area, assessed the potential for ochre production, and made several geological observations. The ochre band occurs in several mesas in a horizontal bed 30-120 cm thick. The ochre contains 45-55 percent Fe_2O_3; the remainder is made up mainly of kaolin, and minor quartz and muscovite. They estimated that the possible reserves are 25 000-30 000 tonnes of ochre if the band maintains its thickness through the mesas in this area. These days, however, artificial pigments are widely used in paint manufacture, and it is unlikely that the mine will be reopened.

Construction materials

The Eromanga Basin sequence is generally lacking in good construction materials. However, in the absence of any other source, the sand and gravel from the Hooray Sandstone and the crushed deep weathered profile from the Rolling Downs Group can be selectively quarried for local purposes. Limestone rubble from the Toolebuc Formation could be used locally as a source of lime or as an aggregate for causeway construction.

Chemically weathered rocks of the Mackunda and Winton Formations provide a usable aggregate, often mixed with crushed silcrete gravel. It has low strength, but it is plentiful, easily accessible, and provides a reasonable road surface with fair drainage. However, because of a high kaolin content, roads surfaced with this material are dusty in dry weather, slippery when wet, and erode easily.

Better construction material can usually be obtained from the Tertiary sediments overlying the Eromanga Basin sequence. The basal beds have better sorted clastic material which is readily accessible. Crushed silcrete gravel (gibbers) is used for construction of causeways; Cacoory homestead in the Betoota Sheet area was constructed some sixty-five years ago from locally cut Tertiary limestone; the hotel and Custom Post at Betoota are built of locally quarried sandstone.

APPENDIX

Report on plant fossils from the Tarlton Range, Tobermory 1:250 000 Sheet area, Northern Territory

R. E. Gould

The University of New England

A number of specimens of fossil plants were collected from the top of the Tarlton Range by A. Mond during field work on the Tobermory Sheet area. The fossils are preserved as clear impressions in a micaceous sandstone, thought to be in the Tarlton Formation. Accuracy of the determinations of impression material is generally somewhat restricted, but the fossils in this case are fairly distinctive types and sufficiently well preserved to show some fine details.

DETERMINATIONS:

Equisetalean stem (?*Schizoneura* sp.) Fig. 1.

Ptilophyllum sp. (*P. pecten* as figured by Hill, Playford, & Woods 1966). Figs. 2-6.

Taeniopteris (Macrotaeniopteris) sp. Fig. 7.

Brachyphyllum sp. Fig. 8.

Pagiophyllum sp. Fig. 9.

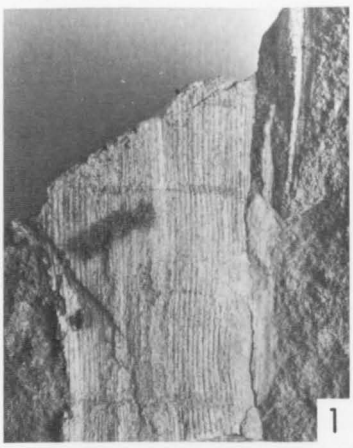
AGE OF THE FLORA:

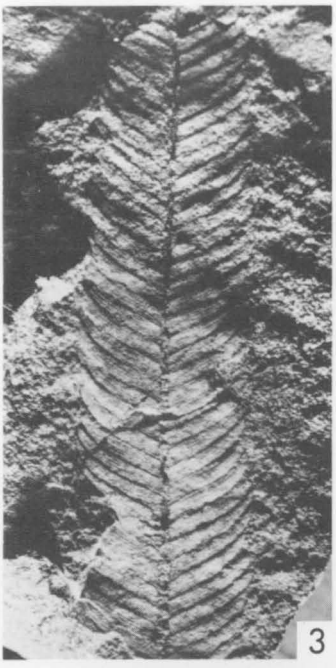
The flora exhibits a definite Jurassic aspect. The presence of *Ptilophyllum* sp., and the conifer shoots *Pagiophyllum* sp. and *Brachyphyllum* sp., are characteristic of Jurassic/Early Cretaceous floras. The *Schizoneura*-like equisetalean stem would tend to suggest an Early or Middle Jurassic age at the latest (Harris, 1961), while large taeniopterid leaves occur throughout much of the Mesozoic. However, since the flora contains only a few elements, the safest guide to the age is given by the most abundant form, *Ptilophyllum* sp., which is assigned a Jurassic to Early Cretaceous range by Hill et al. (1966).

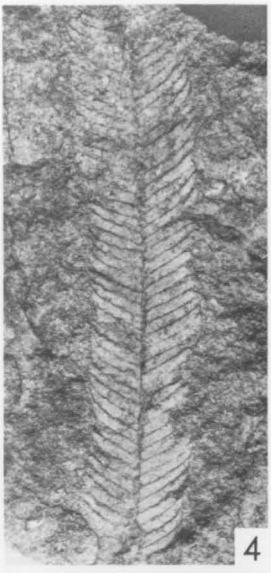
REFERENCES

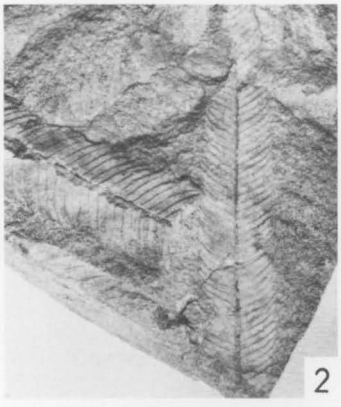
HARRIS, T. M., 1961—The Yorkshire Jurassic flora. I. Thallophyta-Pteridophyta. *British Museum (Natural History).*

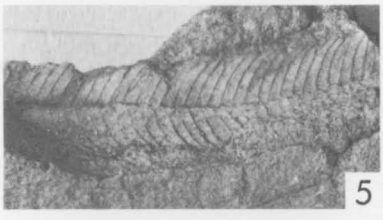
HILL D., PLAYFORD, G., & WOODS, J. T., 1966—Jurassic fossils of Queensland. *Qd Palaeontogr. Soc.*

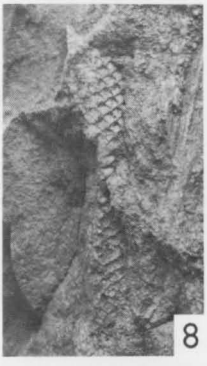


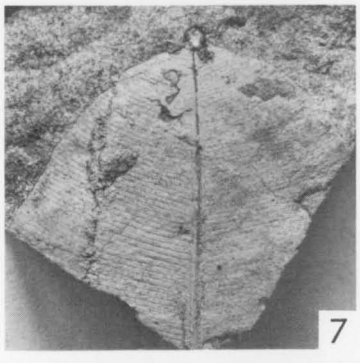


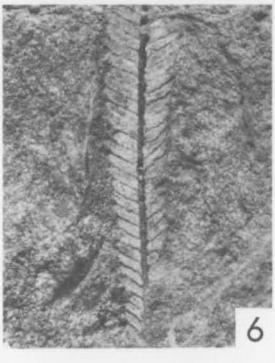














EXPLANATION OF PLATE

Fig. 1. *?Schizoneura* sp. Note part of leaf sheath at upper right. CPC 17925; x0.7.
Figs. 2-6. *Ptilophyllum* sp. 2, CPC 17926; x0.5. 3, frond in Fig. 2 showing venation; x1.2. 4, CPC 17927; x0.7 5, CPC 17928; x0.7. 6, base of frond, CPC 17929; x0.7.
Fig. 7. *Taeniopteris (Macrotaeniopteris)* sp. CPC 17930; x0.55.
Fig. 8. *Brachyphyllum* sp. CPC 17931; x0.6.
Fig. 9. *Pagiophyllum* sp. CPC 17932; x0.6.

TABLE C1: LIST OF EXPLANATORY NOTES AND GEOLOGICAL MAPS IN THE 1:250 000 GEOLOGICAL SERIES WITHIN THE NORTHWESTERN PART OF THE EROMANGA BASIN

Sheet name	*International index number*	*Author*	*Year published*
SANDOVER RIVER	SF/53–8	Nichols	1966
URANDANGI	SF/54–5	Noakes, Carter & Öpik	1959
DUCHESS	SF/54–6	Carter & Öpik	1963
HUCKITTA	SF/53–11	Smith	1963a
TOBERMORY	SF/53–12	Smith	1965
GLENORMISTON	SF/54–9	Reynolds	1965a
BOULIA	SF/54–10	Casey	1968
ALICE SPRINGS	SF/53–14	Wells	1969a
ILLOGWA CREEK	SF/53–15	Shaw & Milligan	1969
HAY RIVER	SF/53–16	Smith	1963b
MOUNT WHELAN	SF/54–13	Reynolds	1968b
SPRINGVALE	SF/54–14	Reynolds	1965b
RODINGA	SG/53–2	Cook	1969
HALE RIVER	SG/53–3	Shaw	1968
SIMPSON DESERT NORTH	SG/53–4	Mond	1974
BEDOURIE	SG/54–1	Reynolds	1968a
MACHATTIE	SG/54–2	Senior; 2nd edition	1973
FINKE	SG/53–6	Wells	1969b
McDILLS	SG/53–7	Stewart	1968
SIMPSON DESERT SOUTH	SG/53–8	Yeates	1974
BIRDSVILLE	SG/54–5	Olgers	1964
BETOOTA	SG/54–6	Jauncey	1965

TABLE C2: WATER BORES LOGGED USING GAMMA RAYS. NORTHWESTERN EROMANGA BASIN QUEENSLAND

Reg. No.	*Name*	*Latitude Longitude*	*Elev.**	*Year drilled*	*Total depth*	*Year logged*	*Depth logged*	*Status*
316	Bedourie 2	24°22′22″ 139°28′06″	91	1905	400	1961	382	F
1668	Breadalbane 9	23°54′57″ 139°34′37″	110	1919	238	1961	217	S
1674	Brighton Downs 4	23°03′04″ 140°58′40″	171	1910	472	1966	456	F
1676	Brighton Downs 6	23°09′57″ 140°54′14″	158	1915	436	1966	436	F
2062	Cluny 3	24°28′39″ 139°48′24″	124	1922	673	1966	503	F
2392	Ingledoon 2	24°06′48″ 140°31′33″	147	1909	542	1966	536	F
2419	Gulgong 1	24°38′06″ 138°53′36″	59	1926	706	1966	564	F
3457	Locharoch 4	22°50′10″ 140°58′58″	204	1901	414	1966	395	P
4322	Sandringham 4	24°03′54″ 139°10′52″	101	1916	236	1961	140	F
4323	Sandringham 5	24°17′21″ 138°56′50″	81	1917	263	1966	235	F
4391	Prairie Creek	23°31′48″ 140°27′32″	144	1899	274	1966	260	F
4621	Propstick	22°06′58″ 140°53′53″	225	1925	209	1966	133	P
5115	Lucknow	22°43′51″ 140°58′56″	195	1936	343	1966	307	P
10794	Springvale 9	23°41′12″ 140°36′09″	126	1947	354	1966	335	F

TABLE C2 (CONTINUED)

Reg. No.	Name	Latitude Longitude	Elev.*	Year drilled	Total depth	Year logged	Depth logged	Status
12040	Ludlow	24°11′45″ 139°26′37″	93	1957	312	1961	275	F
12165	Bedkira	24°36′50″ 139°48′38″	90	1953	553	1966	549	F
12177	Oasis	25°14′33″ 139°33′54″	78	1953	815	1966	812	F
12312	Georgtina	24°47′44″ 140°16′42″	101	1954	840	1966	837	F
13088	Adria Downs	25°32′15″ 138°59′00″	72	1957	942	1961	930	F
13130	Coorabulka 11	24°14′28″ 140°08′40″	110	1956	460	1961	412	F
13149	Philippi 2	24°23′49″ 129°11′40″	75	1956	374	1961	326	F
13173	Coorabulka 12	23°59′10″ 140°21′41″	148	1956	411	1966	408	F
13201	Dover 4	22°32′31″ 140°51′40″	196	1956	218	1966	187	P
14048	Slashes Creek	22°51′32″ 140°42′47″	171	1959	217	1966	204	P
14318	Warra	23°08′06″ 140°39′47″	178	1960	305	1966	294	?
14645	Birdsville Town	25°54′10″ 139°20′36″	49	1961	1221	1961	1221	F

RN 316—Registered number issued by Queensland W.I.C.
Status—
F—flowing bore
P—pumped bore
S—standing water
*—Elevation in metres above mean sea level.
All depths in metres.

TABLE C3: WATER BORES LOGGED USING GAMMA RAYS. NORTHWESTERN EROMANGA BASIN (NORTHERN TERRITORY)

Reg. No.	Name	Lat.	Long.	Elev.*	Total depth	Depth logged	Max. temp.	Logs run
SG 53–6	Archies	25°28′	134°50′	221	79	76	36.0°	G,N,T,dT
SG 53–6	Beerstreet	25°33′	134°30′	235	117	50	36.5°	G,N,T,dT
SG 53–7/16	Birthday	25°20′	135°13′	172	171	167	50.0°	G,N,T,dT
SG 53–6/33	Bloodwood 2	25°46′	134°18′	307	174	162	35.0°	G,T,dT
SG 53–7/4	Boundary	25°55′	135°06′	178	427	340	43.0°	G
SG 53–6/82	Camel Flat	25°33′	134°57′	135	70	60	43.0°	G,N,T,dT
SG 53–6/83	Centenary	25°28′	134°49′	137	76	59	43.0°	G,N,T,dT
SG 53–6/86	Cindy	25°37′	134°42′	227	93	82	34.5°	G,N
SG 53–6/27	Coglin	25°56′	134°39′	221	108	85	29.5°	G,N,T,dT
SG	Draught	25°37′	134°50′	213	76	75	32.0°	G,N,T,dT
SG 53–7/10	East	25°07′	135°36′	162	342	70	35.5°	T,dT
SG 53–6/120	Easter	25°17′	134°56′	226	161	106	34.0°	G,N,T,dT
SG 53–7/5	Emu	25°25′	135°17′	161	214	176	32.0°	G
SG 53–6/73	Gidyea	25°59′	134°47′	182	198	72	28.0°	G,N
SG	Highway	24°48′	135°21′	214	80	71	32.0°	G,N
SG	Ladybird	25°55′	133°56′	391	?	71	31.0°	G,N,T,dT
SG 53–6/51	Marianne	25°45′	134°52′	206	147	124	26.0°	G,T,dT
SG 53–7/12	Mayfields	25°47′	135°15′	165	396	383	39.0°	G,T,dT

TABLE C3 (CONTINUED)

Reg. No.	Name	Lat.	Long.	Elev.*	depth Total	logged Depth	temp. Max.	Logs run
SG 53-6/135	Mono	25°33′	134°35′	247	113	100	37.0°	G,N,T,dT
SG	Mulga	25°38′	134°23′	275	?	149	35.5°	G,N
SG 53-6/113	New Bore	25°21′	134°50′	250	120	113	33.0°	G,N
SG	New Crown	25°35′	134°35′	201	88	86	27.0°	G,N,T,dT
SG 53-6/21	New Mallee	25°54′	134°06′	366	183	175	31.0°	G,T,dT
SG 53-3/12	Safari	24°54′	135°17′	220	79	71	35.0°	G,N
SG 53-6/52	Sandy	25°40′	134°33′	234	91	84	36.5°	G,N,T,dT
SG 53-6/85	Siberia	25°18′	134°57′	210	88	87	36.0°	G,N,T,dT
SG	Sunrise	25°50′	134°13′	340	183	175	35.0°	G,T,dT

SG 53-6 indicates 1:250 000 Sheet International Index;
/16 indicates number of well within the sheet area.
G—gamma-ray.
N—neutron.
T—temperature.
dT—differential temperature.
*—Elevation in metres above mean sea level.
All depths in metres.

TABLE C4: SHALLOW STRATIGRAPHIC HOLES DRILLED BY BMR

Name	Year	Lat./Long.	TD	Reference
BMR Hay River 1	1971	23°15′55″ 137°00′28″	140.5 m	Yeates, 1971
BMR Hay River 2	1971	23°36′15″ 137°10′00″	196.3 m	Yeates, 1971; Burger & Mond, 1973
BMR Hay River 3	1971	23°22′50″ 136°31′30″	199.0 m	Yeates, 1971; Burger & Mond, 1973
BMR Hay River 4	1971	23°52′05″ 136°43′20″	241.1 m	Yeates, 1971; Burger & Mond, 1973
BMR Springvale 1	1964	23°19′??″ 139°44′??″	143.9 m	—
BMR Springvale 2	1971	23°33′18″ 140°10′03″	24.0 m	Senior & Hughes, 1972
BMR Springvale 3	1971	23°33′30″ 140°09′33″	30.0 m	Senior & Hughes, 1972
BMR Springvale 4	1971	23°33′45″ 140°08′51″	29.0 m	Senior & Hughes, 1972
BMR Springvale 5	1971	23°32′54″ 140°10′48″	23.0 m	—
BMR Springvale 6	1971	23°43′48″ 139°58′51″	90.0 m	Senior & Hughes, 1972; Burger & Mond, 1973
BMR Springvale 7	1971	23°43′48″ 139°55′55″	33.0 m	Senior & Hughes, 1972;Burger & Mond, 1973
BMR Springvale 8	1971	23°55′00″ 139°34′43″	76.0 m	Senior & Hughes, 1972; Burger & Mond, 1973
BMR Boulia 1	1968	22°55′00″ 139°54′20″	20.4 m	—
BMR Boulia 1A	1968	22°55′00″ 139°54′20″	91.1 m	—

TABLE C4 (CONTINUED)

Name	*Year*	*Lat./Long.*	*TD*	*Reference*
BMR Boulia 2	1973	22°59′45″ 140°17′20″	88.7 m	Burger, 1974
BMR Boulia 3	1973	22°47′00″ 140°43′30″	44.5 m	Burger, 1974
BMR Boulia 3A	1973	22°47′00″ 140°43′30″	36.6 m	Burger, 1974
BMR Grg 9A	1962	21°42′10″ 138°19′48″	128.0 m	Milligan, 1963
BMR Grg 11	1962	22°20′00″ 137°22′30″	139.0 m	Milligan, 1963
BMR Grg 12	1962	22°41′00″ 136°46′15″	230.1 m	Milligan, 1963
BMR 12 Cockroach	1964	22°32′54″ 137°09′36″	1219.2 m	Smith, 1967

TABLE C5: GRAVITY AND AEROMAGNETIC SURVEYS IN THE NORTHWESTERN EROMANGA BASIN

Brief title	*Organisation*	*Reference*
	GRAVITY SURVEYS	
Western Queensland, 1957-61	BMR	Gibb, 1966
Georgina Basin, Qld	BMR	Neumann, 1959a
Toko Range, western Qld	BMR	Neumann, 1959b
Georgina Basin, NT and Qld, 1959	BMR	Barlow, 1965
Boulia area, Qld, 1959	Papuan	Papuan Apinaipi, 1962
OP 34 and 42, NT	Flamingo	Burbury, 1960
ATP 54P, Qld	Papuan	Starkey, 1960
Andado, NT (revised)	Geosurveys	Denton & Dennison, 1960
Georgina Basin, NT and Qld, 1960-61	BMR	Barlow, 1966
OP 36, NT	Freney	Burbury, 1961
Great Artesian Basin, Qld	BMR	Lonsdale, 1962
Amadeus Basin, NT	BMR	Langron, 1962a
Amadeus Basin, NT 1961	BMR	Langron, 1962b
Simpson Desert, NT, OP 57	Beach Pet.	Sprigg & Stackler, 1962
Anacoora Bore, OP 57, NT	Beach Pet.	Stackler, 1964
Dakota Bore, OP 57, NT	Beach Pet.	Stackler, 1965
Australia	BMR	Vale, 1965
Simpson Desert, NT and Qld	French Pet.	Laherere & Drayton, 1965
NT and Qld	BMR	Flavelle, 1965
Simpson Desert, OP 177, NT	Beach Pet.	Geosurveys, 1967
	AEROMAGNETIC SURVEYS	
Great Artesian Basin, 1959	BMR	Jewell, 1960
South Australia and Queensland, 1961	Delhi	Aero Service, 1961
Simpson Desert, NT 1962	BMR	Quilty & Milsom, 1964
Northern Territory	Flamingo	Isaacs & Hartman, 1963
Amadeus Trough, OP 72 and 78	Exoil	Hartman, 1963
Georgina Basin, Qld and NT, 1963	BMR	Wells & Milsom, 1964
OP 75, NT	Flamingo	Hartman, 1964
Coopers Creek, OP 66 and 67, Qld	French Pet.	Adastra Hunting, 1964
Simpson Desert, NT and Qld	French Pet.	Laherere & Drayton, 1965
Georgina Basin, Qld and NT, 1963-4	BMR	Wells, Milsom & Tipper, 1966
Hay River, PE 146, NT	Exoil	Adastra Hunting, 1967

TABLE C6: OIL EXPLORATION OR STRATIGRAPHIC WELLS IN THE NORTHWESTERN EROMANGA BASIN

Name	*Year*	*Lat./Long.*	*TD*	*Reference*
DFS Beetoota	1960	25°42′30″ 140°49′46″	2994.3 m	Harrison et al., 1961
PS Black Mountain 1	1962	22°31′58″ 140°17′55″	1679.7 m	Green et al., 1963
PS Canary 1	1962	23°15′30″ 140°22′43″	980.8 m	Green et al., 1963
PS Beantree 1	1962	22°42′48″ 140°06′30″	629.1 m	Green et al., 1963
PS Elizabeth Springs 1	1963	23°20′44″ 140°34′12″	429.8 m	Green et al., 1963
FPC Bedourie Scout Hole 1	1964	24°04′00″ 139°06′40″	305.7 m	CGG, 1964b
FPC Marduroo 1	1964	24°02′20″ 139°54′15″	1176.8 m	Magnier, 1965
FPC The Brothers 1	1964	24°15′40″ 139°20′30″	1271.9 m	Magnier et al., 1965
PAP Netting Fence 1	1964	22°56′05″ 138°02′06″	2031.8 m	Mines Admin., 1965
Amerada McDills 1	1965	25°43′50″ 135°47′25″	3205.0 m	Amerada, 1965
APA Mulga 1	1965	21°42′00″ 137°38′18″	915.3 m	APA, 1965
Amerada Hale River 1	1966	25°15′50″ 136°43′35″	1732.2 m	Amerada, 1966b
AOD Ethabuka 1	1973–4	23°41′20″ 138°25′30″	1959.8 m	AOD, 1975

DFS—Delhi-Frome-Santos.
PS—Phillips Sunray.
FPC—French Petroleum Company.
PAP—Papuan Apinaipi Petroleum.
Amerada—Amerada Petroleum Corporation.
AOD—Alliance Oil Development.
APA—Alliance Petroleum Australia NL.

TABLE C7: STRATIGRAPHY OF THE EROMANGA BASIN SEQUENCE

Name	*Derivation*	*Type section or area*	*Thickness*	*Relationship*
WINTON FORMATION Winton Series	WHITEHOUSE, 1955 Dunstan, 1916	"The blue shales and sandstones with intercalated coal seams met with in the bores in and about Winton" (Whitehouse, 1955, p. 10), WINTON Sheet area	6-20 m in outcrop, rapidly increasing from 200 m up to 400 m in BIRDSVILLE Sheet area	Conformable on Mackunda Formation or where the Mackunda Formation is not recognised, on Allaru Mudstone. The top is an erosional surface
MACKUNDA FORMATION	VINE & DAY, 1965	Headwater of Mackunda Creek, Gnolta Station, MACKUNDA Sheet area	Less than 15 m in outcrop, in subsurface 30-200 m. No information from SIMPSON DESERT NORTH, McDILLS & HALE RIVER Sheet areas	Conformable on Allaru Mudstone. At N and W margins top is eroded
ALLARU MUDSTONE Allaru Member Wilgunya Formation	VINE ET AL., 1967 Vine & Day, 1965 Casey, 1959	Along Richmond-Winton Road, from Richmond S. to Twenty-mile Creek, RICHMOND Sheet area	About 30 m in outcrop, increasing SE from 45 m in BOULIA up to 376 m in BETOOTA Sheet area	Conformable on Toolebuc Limestone or Wallumbilla Formation. In N (Hay River Sheet) ?conformable on Hooray Sandstone. On N and W margins top is eroded
TOOLEBUC FORMATION Toolebuc Limestone Toolebuc Member	SENIOR ET AL., 1975 Vine et al., 1967 Casey, 1959	Sequence between 25.3-35.8 m in BMR Boulia 3A, 22°47′00″S, 140°43′30″E; BOULIA Sheet area	3-20 m, mostly about 10 m	Conformable on Wallumbilla Formation
WALLUMBILLA FORMATION Wilgunya Formation Wallumbilla Formation	VINE ET AL., 1967 Casey, 1959 Clarke, 1865	Type section along Wallumbilla Creek, from Wallumbilla township S for 19 km; ROMA Sheet area	Up to 30 m in outcrop, subsurface 150-230 m. In general thickens SE towards the centre of the Eromanga Basin	Conformable on Cadna-owie Formation
CADNA-OWIE FORMATION Longsight Sandstone	WOPFNER ET AL., 1970 Casey, 1959	Big Cadna-owie Spring, 5.5 km SW of Mount Dutton, OODNADATTA Sheet area	Maximum 60 m, restricted to subcrop	Conformable on Hooray Sandstone. To north, grades into upper part of Hooray Sandstone
HOORAY SANDSTONE Longsight Sandstone De Souza Sandstone Tarlton Formation	HILL & DENMEAD, 1960 Casey, 1959 Sullivan & Opik, 1951 Smith, 1963b	Hooray Creek, 19 km NE of Tambo township, TAMBO Sheet area	30-40 m in outcrops along NW margins gradually increasing in subsurface up to 300-400 m in the S	Unconformable on Precambrian and Palaeozoic rocks over whole area

TABLE C7: (CONTINUED)

Lithology	*Fossils*	*Age*	*Environment*
Labile feldspathic sandstone, siltstone and mudstone, calcareous in part; some coal, limestone; minor mudclasts and intraformational conglomerate	Silicified wood and leaves	Late Lower to Upper Cretaceous	Terrestrial, fluvial, paludal, lacustrine
Yellowish brown lithic sandstone with beds of mudstone and siltstone, calcareous, carbonaceous or glauconitic in places. Sandstone is fine to medium, slightly micaceous, thinly bedded to flaggy. In places thinly laminated and cross-stratified (sets up to 15 cm). Some pink massive sandstone with concretionary weathering. Burrows common in all rock types	Bivalves, gastropods, plant remains (Vine & Day, 1965; Casey et al., 1960)	Lower Cretaceous (Albian)	Transitional paralic sedimentation between marine Allaru Mudstone and non-marine Winton Formation
Dark grey to bluish grey mudstone and siltstone, carbonaceous and calcareous in places with some silty and cone-in-cone limestone, some glauconite	Marine fauna is largely molluscan-ammonites, bivalves (Vine & Day, 1965). Arenaceous foraminifera, spores and pollens (Burger & Mond, 1973)	Lower Cretaceous (Albian)	Shallow marine
Grey calcareous siltstone, white, brown, pink limestone; coquinite; some sandy interbeds	Bivalves, mainly *Inoceramus* and large *Aucellina,* gastropods, ammonites, fish scales, foraminifera, mainly *Globigerina,* radiolaria (Vine & Day, 1965)	Lower Cretaceous (Albian)	Shallow marine
Dark grey mudstone and siltstone, commonly calcareous or carbonaceous, pyritic in part, glauconitic labile sandstone; some gypsum. In outcrop deeply weathered and leached to white or mottled purple, red and yellow silty rocks; in part silicified to a porcellanite	Mainly arenaceous foraminifera, radiolaria, gastropods, *Inoceramus* fragments (Casey et al., 1960)	Lower Cretaceous (Aptian and Albian)	Shallow marine. Large marine intracontinental basin with restricted access to ocean
Medium quartzose to sublabile sandstone with increasing siltstone towards base	Spores, pollen, dinoflagellates and microplankton (Wopfner et al., 1970). Spores, pollens from SPRINGVALE & HAY RIVER Sheet areas (Burger & Mond, 1973). Marine bivalves, gastropods, belemnites, starfish and arenaceous foraminifera from SPRINGVALE, BOULIA, DUCHESS, BEDOURIE, MOUNT WHELAN and GLENORMISTON Sheet areas (Casey et al., 1960)	Upper Jurassic to Lower Cretaceous (Neocomian to Early Aptian)	Dominantly paralic; shallow marine in places
In east, dominantly sandstone with conglomerate and sandy siltstone. Carbonaceous siltstone and lignite in subsurface. The sandstone is fine to medium-grained, more conglomeratic towards the base and silty towards the top. It is thin to medium bedded, cross-stratification rare, burrows common. In west, sandstone is medium to coarse-grained, commonly conglomeratic with high angle cross-stratification	Plant fossils from BOULIA, GLENORMISTON, TOBERMORY Sheet areas (White, 1961; Gould, this Bulletin, Appendix to Part C)	Upper Jurassic to Lower Cretaceous	Fluvial, shallow marine in NE

TABLE C8: EVOLUTION OF THE EROMANGA BASIN SEQUENCE NOMENCLATURE.

		Queensland and Northern Territory	Western Queensland	Boulia Area, Queensland	Northern part of the Eromanga Basin			Northwestern part of the Eromanga Basin			South Australian part of the Eromanga Basin
		Jack, 1886 – Qld Ward, 1925 – NT	Whitehouse, 1955.	Casey, 1959	Vine and Day, 1965	Vine et al., 1967	Senior et al, 1975	Eastern Part – Qld Vine and Daric, 1971	Western Part – NT Wells et al., 1970 Vine and Daric 1971	This Bulletin	Wopfner , 1969
Eromanga Basin Sequence	? Cenomanian	Rolling Downs Formation	Rolling Downs Group: Winton Formation		Rolling Downs Group: Winton Formation	Winton Formation	Winton Formation	Winton Formation	Rumbalara Shale	Rolling Downs Group: Winton Formation	Neales River Group: Winton Formation
	Albian		Tambo Formation	Wilgunya Formation Toolebuc Mbr	Mackunda Formation	Manuka Sub-group: Mackunda Formation	Mackunda Formation	Allaru Mudstone Toolebuc Limestone		Mackunda Formation Allaru Mudstone Toolebuc Formation	Oodnadatta Formation Wooldridge Limestone Coorikiana Member
	Aptian		Roma Formation	Longsight Sandstone	Wilgunya Formation	Wilgunya Sub-group: Allaru Mudstone Toolebuc Limestone Wallumbilla Formation	Allaru Mudstone Toolebuc Formation Wallumbilla Formation	Wallumbilla Formation		Wallumbilla Formation	Bulldog Shale
	Upper Jurassic to Lower Cretaceous						Cadna-owie Formation Hooray Sandstone	Longsight Sandstone Tarlton Formation (Triassic)	De Souza Sandstone Permian	Cadna-owie Formation Hooray Sandstone Permian	Cadna-owie Formation Algebuckina Sandstone Permian

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GEOLOGY OF THE NORTHERN EROMANGA BASIN

QUEENSLAND

1977

SCALE 1:1 000 000

0 20 40 60 80 100 KILOMETRES

Lambert Conformal Conic Projection Standard Parallels 20° 40' and 23° 20' S.

PLATE A1

Published by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Resources, in conjunction with the Geological Survey of Queensland. Issued under the authority of the Minister for National Resources

Topographic base compiled by the Bureau of Mineral Resources, Geology and Geophysics, from 1: 250 000 Planimetric Series of the Division of National Mapping, Department of National Resources and the Royal Australian Survey Corps

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Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T.

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Geology by Officers of the Bureau of Mineral Resources and Geological Survey of Queensland, 1974–1977, from 1:250 000 scale regional mapping

Compiled by R. B. Senior, R. Senbeckle, A. Mond

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CAINOZOIC

QUATERNARY

WOONDOOLA BEDS

- Q — *Sand, gravel, sandy soil, clay, silt.*
- Qa — *Alluvium: sand, silt, clay, gravel*

PLIOCENE TO PLEISTOCENE

- Qw — *Silt, clay and sand*
- Cz — *Unsolvated sandy sediments, soil, sand and gravel*
- Czb — *Basalt, olivine basalt*
- *Silicified sediments; silcrete and ferruginized sediments*

TERTIARY

- T — *Argillaceous sandstone, sandy mudstone, clay; minor ferruginized sediments*
- **QLD CORK BEDS MUELLER SANDSTONE** — Ts — *Sandstone, claystone, limestone*
- **HORSE CREEK FORMATION** — Th — *Limestone, green claystone, chalcedony*
- **SPRINGVALE FORMATION** — Tv — *Silicified clay, chert, limestone*
- **MOSES SANDSTONE** — Tm — *Quartzose sandstone, siltstone, sandy limestone, minor concretionary ironstone*
- **EDKINS FORMATION** — Te — *Quartzose sandstone, siltstone, pebble conglomerate, silicified at top*
- **WERITE BEDS** — Tr — *Mudstone and quartzose sandstone*
- **NORANSIDE LIMESTONE** — To — *Limestone, red calcareous silty sandstone, chalcedony*
- **GLENDOWER FORMATION** — Tg — *Quartzose sandstone, minor siltstone, silcrete*

EROMANGA BASIN SEQUENCE

Chemical weathering (kaolinized, silicified and ferruginized sedimentd profile

LOWER TO UPPER CRETACEOUS

- **WINTON FORMATION** — Kw — *Labile sandstone, siltstone, mudstone, calcareous in part; minor coal, mudclast conglomerate*
- **MACKUNDA FORMATION** — Km — *Labile sandstone, mudstone, siltstone, calcareous in part; minor coquina limestone*
- **ALLARU MUDSTONE** — Ka — *Mudstone, some calcareous siltstone; minor sandstone and limestone*
- **TOOLEBUC FORMATION** — Ktu — *Limestone, calcareous shale, coquinite; minor oil shale*
- **WALLUMBILLA FORMATION** — Ku — *Mudstone, siltstone, minor limestone, labile sandstone, intraformational conglomerate; in part glauconitic, pyritiferous*

ROLLING DOWNS GROUP

LOWER CRETACEOUS

- **Coreena Member** — Kc — *Siltstone, mudstone, labile sandstone, in part calcareous, minor silty limestone, mudclast conglomerate, glauconite*
- **Resmoor Member** — Kr — *Mudstone, commonly carbonaceous, minor siltstone*
- **Jones Valley Member** — Kj — *Siltstone, labile sandstone, limestone, calcareous and glauconitic; minor intraformational conglomerate*
- **Doncaster Member** — Kd — *Mudstone, siltstone, glauconitic, calcareous, minor limestone, gypsiferous*
- **Wyandra Sandstone Member** — Kwd — *Quartzose to sublabile sandstone; carbonate cement (section only) interbedded quartzose to sublabile sandstone, minor labile sandstone, siltstone and mudstone (section only)*
- **CADNA-OWIE FORMATION** — Kw

UPPER JURASSIC TO LOWER CRETACEOUS

- **GILBERT RIVER FORMATION** — JKg — *Quartzose to sublabile sandstone, commonly pebbly, cross-bedded*
- **HOORAY SANDSTONE** — JKh — *Quartzose to sublabile sandstone, cross-bedded, minor siltstone, conglomerate, claystone and lignite*

LOWER JURASSIC TO LOWER CRETACEOUS

- **RONLOW BEDS** — JKr — *Quartzose to sublabile sandstone, commonly kaolinitic; cross-bedded some pebbly beds, micaceous siltstone, mudstone, minor coal*

UPPER JURASSIC

- **BLANTYRE SANDSTONE** — Jub — *Quartzose sandstone, cross-bedded; micaceous sandstone, siltstone, mudstone, carbonaceous shale and coal, minor limnocia*

MIDDLE TO UPPER JURASSIC

- **EULO QUEEN GROUP** — Jue — *Micaceous clayey cross-bedded quartzose sandstone, siltstone, some mudstone*
- **WESTBOURNE FORMATION** — Jum — *Micaceous siltstone, mudstone; minor quartzose to labile sandstone (section only)*
- **ADORI SANDSTONE** — Ja — *Quartzose to sublabile sandstone; minor siltstone, claystone (section only)*
- **BIRKHEAD FORMATION** — Jmb — *Siltstone, mudstone, calcareous labile sandstone, minor coal*

HUTTON GROUP

LOWER JURASSIC

- **HUTTON SANDSTONE** — Jh — *Quartzose to sublabile sandstone, commonly kaolinitic, some micaceous siltstone and mudstone; minor conglomerate*

GALILEE BASIN SEQUENCE

MIDDLE TO UPPER TRIASSIC

- **MOOLAYEMBER FORMATION** — Rm — *Siltstone, mudstone, quartzose to labile sandstone, calcareous in part*
- **WARANG SANDSTONE** — Rw — *Kaolinitic quartzose to sublabile sandstone; minor siltstone, mudstone*
- **CLIWATTI SANDSTONE** — Rg — *Quartzose sandstone; minor conglomerate, siltstone*

LOWER TRIASSIC

- **DUNDA BEDS** — Rld — *Quartzose to labile sandstone, siltstone, mudstone*
- **REWAN FORMATION** — Rc — *Mudstone, siltstone, labile sandstone*

PALAEOZOIC

UPPER PERMIAN

- **BLACKWATER GROUP BLACK ALLEY SHALE PLANBADDY FORMATION** — Pw — *Conglomerate, rhyolite, acid pyroclastics, tuffaceous sandstone and siltstone*
- **BETTS CREEK GROUP** — Pz — *Labile to quartzose sandstone, siltstone, mudstone, carbonaceous shale and coal; minor conglomerate*
- Pzc — *Labile to quartzose sandstone, siltstone, commonly micaceous; mudstone, pebbly mudstone; carbonaceous shale locally abundant; conglomerate, minor breccia and tuff*

LOWER PERMIAN

- **COLINLEA SANDSTONE** — Pcl — *Labile to quartzose sandstone, minor siltstone, coal*
- **BOONDEROO BEDS** — Pb — *Varves, claystone, siltstone, sandstone, some limestone; minor conglomerate, striated and faceted pebbles and cobbles*

UPPER CARBONIFEROUS TO LOWER PERMIAN

- **JOE JOE FORMATION** — CPj — *Labile to quartzose sandstone, mudstone, siltstone, some tuffaceous beds; minor coal and conglomerate*

DRUMMOND BASIN SEQUENCE

Granodiorite, adamellite, granite, aplite and other finely crystalline acid components, rhyolite and quartz-feldspar porphyry

LOWER CARBONIFEROUS

- **NATAL FORMATION** — Cln — *Sublabile to quartzose sandstone, olive siltstone*
- **BULLIWALLAH FORMATION** — Clb — *Sublabile to quartzose sandstone, minor olive mudstone, acid volcanic, conglomerate*
- **DUCABROOK FORMATION** — Clu — *Lithic sublabile sandstone, mudstone, shale, limestone; tuff*
- **STAR OF HOPE FORMATION** — Cls — *Sandstone, conglomerate, mudstone, chert, tuff*
- **RAYMOND FORMATION** — Clr — *Flaggy quartzose sandstone, olive-mudstone, minor limestone*
- **MOUNT HALL FORMATION** — Clh — *Quartzose sandstone, pebbly sandstone, conglomerate*

MIDDLE DEVONIAN TO LOWER CARBONIFEROUS

- **SAINT ANNS FORMATION UKALUNDA BEDS** — DC — *Conglomerate, lithic sandstone, shale, phyllite, algal, oolitic and fossiliferous limestone, acid and intermediate flows and tuff*

UPPER DEVONIAN TO LOWER CARBONIFEROUS

- **SILVER HILLS VOLCANICS** — DCs — *Flow-banded and spherulitic rhyolite*

UNDIFFERENTIATED BASEMENT

LOWER PALAEOZOIC

- Pzl — *Section only*

PALAEOZOIC AND PRECAMBRIAN

- pMs — *Undifferentiated sediments*
- pMm — *Undifferentiated metamorphics*
- pMi — *Undifferentiated intrusives*
- pMv — *Undifferentiated volcanics*

- *Geological boundary*
- *Fault*
- *Anticline* / *Syncline* — *showing plunge*
- *Monocline*
- *Overturned anticline*
- *Where location of folds and faults is approximate, line is broken; where inferred, queried; where concealed, folds are dotted, faults are shown by short dashes*
- *Trend line* / *Joint pattern* — *arcpatch interpretation*
- *Drill hole*
- h — *Stratigraphic hole*
- bh — *Scout hole*
- os — *Oil shale*
- *Petroleum exploration well, dry-abandoned*
- *Well with show of oil, abandoned*
- *Well with show of gas, abandoned*
- *Well with show of oil and gas, abandoned*
- *Minor mineral occurrence*
- Op — *Opal*
- Mn — *Manganese*
- *Water bore*
- *Highway*
- *Road*
- *Railway*
- *Town*
- Brighton Downs — *Homestead*
- *Isogals (5 milligals interval)*
- *Gravity anomaly — relative high*
- *Gravity anomaly — relative low*

For the calculation of Bouguer anomalies 1.9 g/cm³ and 2.2 g/cm³ have been adopted as average rock densities

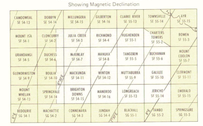
LOCALITY MAP



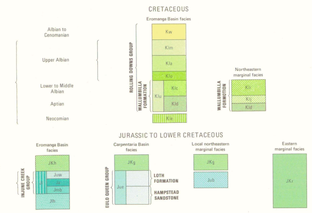
EROMANGA BASIN
1 Northwestern (Bull. 167 part C)
2 Northern (Bull. 167 part A)
3 Central (Bull. 167 part B)

INDEX TO 1:250 000 SHEETS

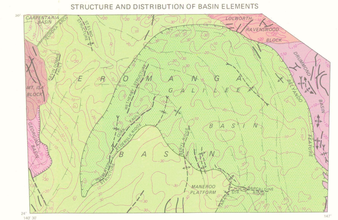
Showing Magnetic Declination



TIME RELATIONSHIPS OF THE EROMANGA BASIN SEQUENCE



STRUCTURE AND DISTRIBUTION OF BASIN ELEMENTS



Margin of Permian-Triassic (Galilee Basin)

Margin of preserved Eromanga Basin rocks

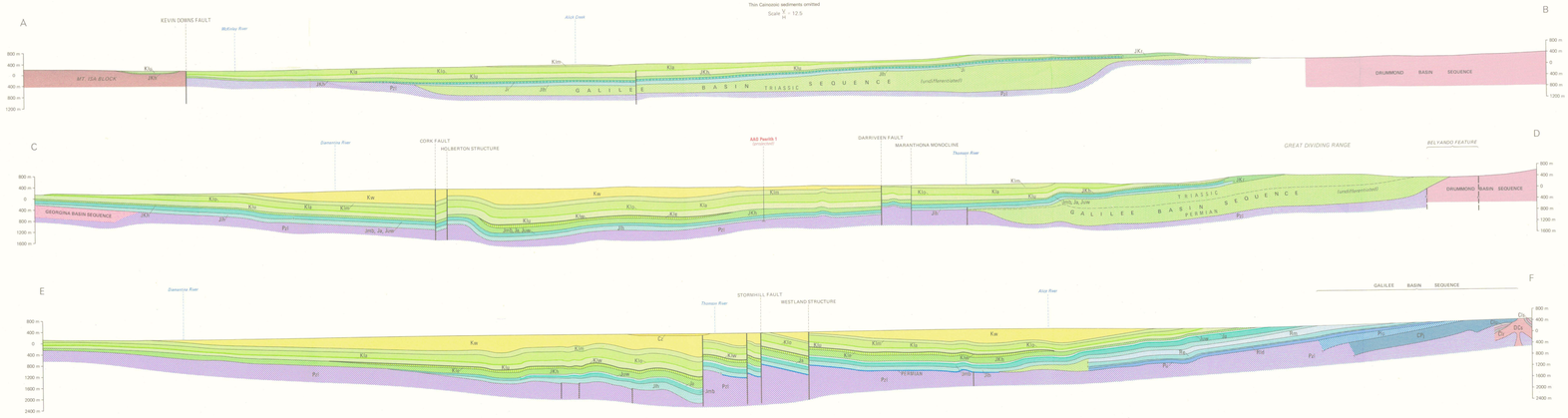
Generalized trend and dip of the Eromanga Basin sequence

Margin of Georgina Basin

SECTIONS

Thick Cainozoic sediments omitted

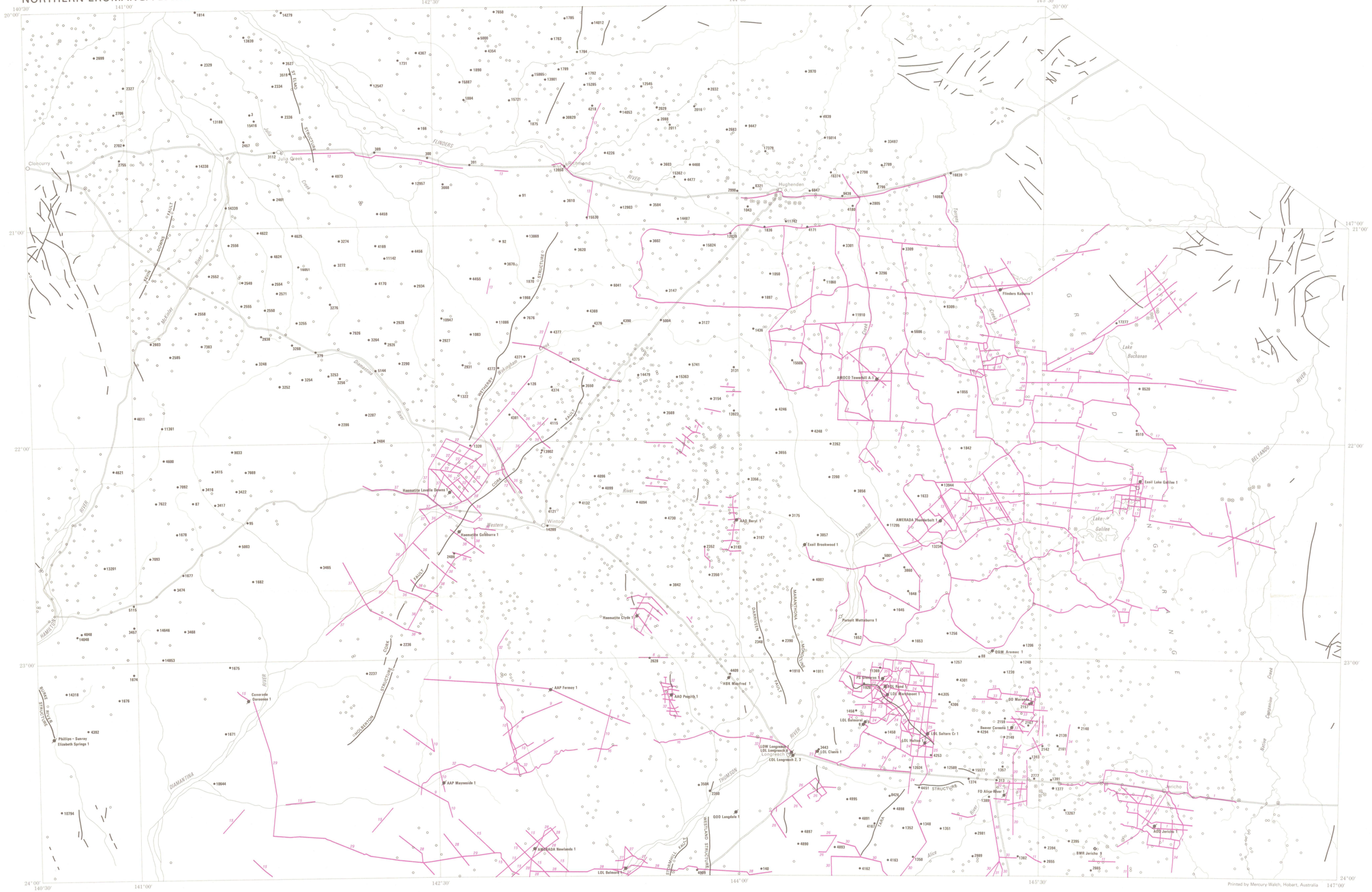
Scale $\frac{V}{H}$ = 12.5



NORTHERN EROMANGA BASIN
1:1 000 000

NORTHERN EROMANGA BASIN

PLATE A2


140°30'
141°00'
142°30'
144°00'
145°30'
147°00'
20°00'
21°00'
22°00'
23°00'
24°00'
Cloncurry
Julia Creek
Richmond
Hughenden
Winton
Longreach
Jericho
Flinders River
Cloncurry River
Leichhardt River
Diamantina River
Thomson River
Barcoo River
Cooper Creek
Lake Buchanan
Lake Galilee
Lake Dunn
Lake Constance
Lake Machattie
Toko Range
Toko Syncline
Julia Creek Structure
Richmond Structure
Hughenden Structure
Winton Structure
Longreach Structure
Jericho Structure
Coxco Structure
Cork Structure
Cork Fault
Dobbyn Fault
Mackunda Fault
Wyandra Fault
Thorntonia Fault
Glenhill Fault
Diamantina Fault
Hamilton River
Blake Structure
Mayne Basin
Eromanga Basin
Galilee Basin
Cooper Basin
Warenda Trough
Taroom Trough
Nebine Ridge
Canal Creek Terrace
Coxco Terrace
Cabawin Trough
Roma Shelf
Bowen Basin
Denison Trough
Springsure Shelf
Collinsville Shelf
Peak Downs Fault
Comet Ridge
Mimosa Syncline
Taroom Trough

NORTHERN EROMANGA BASIN

PLATE A3

STRUCTURE CONTOURS ON BASE OF EROMANGA SEQUENCE

WITH MARGINS OF OLDER BASIN SYSTEMS AND "BASEMENT"

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

— — — Margin Eromanga Basin
— — — Margin Galilee Basin
— — — Margin Georgina Basin

pMm Undifferentiated metamorphics
pMg Undifferentiated granite
R Undifferentiated Triassic rocks
Rm Moolayember Formation
Pu Undifferentiated Upper Permian rocks
Pl Undifferentiated Lower Permian rocks
b Undifferentiated "basement" sedimentary, igneous or metamorphic rocks

—0— Structure contour in metres (accurate)
— — 0 — — Structure contour in metres (approximate)
Contour interval 50 metres

•-180 Base Eromanga Basin Sequence in metres below M S L
•-155 Bottom of borehole — base Eromanga Basin Sequence not reached
Rand 1 Petroleum exploration well with data as above
+ − Positive and negative values Datum Mean Sea Level

Printed by Mercury-Walch, Hobart, Australia

NORTHERN EROMANGA BASIN

PLATE A4

STRUCTURE CONTOURS ON BASE OF ROLLING DOWNS GROUP

Scale 1 : 1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

- 900 — Contour interval 50 metres
  Datum, Mean Sea Level
- Water bore
- Petroleum exploration well
- BMR shallow stratigraphic hole

  Data control points
- Interpreted margin of Rolling Downs Group

Printed by Mercury-Walch, Hobart, Australia

ISOPACH MAP OF THE WALLUMBILLA FORMATION

WITH GAMMA-RAY LOG REFERENCE SECTIONS

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

—180— Contour interval 20 metres
Datum, Mean Sea Level

Outcrop margin
Outcrop margin (concealed)

155 Watr bore
200 Petroleum exploration well
Figures denote thickness of Wallumbilla Formation in metres

Gamma-Ray Log Data
0
0 100 API
100m

R4167 *Water bore with registered number*

Printed by Mercury-Walch, Hobart, Australia

NORTHERN EROMANGA BASIN

PLATE A6

TOOLEBUC FORMATION GAMMA-RAY ANOMALY

Scale 1 : 1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

0
30
60m

Approximate Intensity

0 100 200API

Limit of Toolebuc Formation (accurate)

Limit of Toolebuc Formation (approximate)

4909 *Water bore with registered number*

Newlands 1 *Petroleum exploration well*

Printed by Mercury-Walch, Hobart, Australia

NORTHERN EROMANGA BASIN

PLATE A7

STRUCTURE CONTOURS ON TOP OF THE TOOLEBUC FORMATION

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

—+100— Contour interval 50 metres

Datum, Mean Sea Level

Margin of Toolebuc Formation (accurate)

Margin of Toolebuc Formation (approximate)

Water bore

Petroleum exploration well

Data control points

Printed by Mercury-Walch, Hobart, Australia

NORTHERN EROMANGA BASIN

PLATE A8

ISOPACH MAP OF THE MACKUNDA AND WINTON FORMATIONS

WITH GAMMA-RAY LOG REFERENCE SECTIONS

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

—200— Isopach, interval 100 metres

Outcrop margin

Outcrop margin (concealed)

• 107 Water bore

320 Petroleum exploration well

Figures denote thickness of Mackunda and Winton Formations in metres

Gamma-Ray Log Data

0 — 100 API — 100m

• R1352 Water bore with number, QIWSC records

Printed by Mercury-Walch, Hobart, Australia

PLATE B1

GEOLOGY OF CENTRAL EROMANGA BASIN

AUSTRALIA — QUEENSLAND

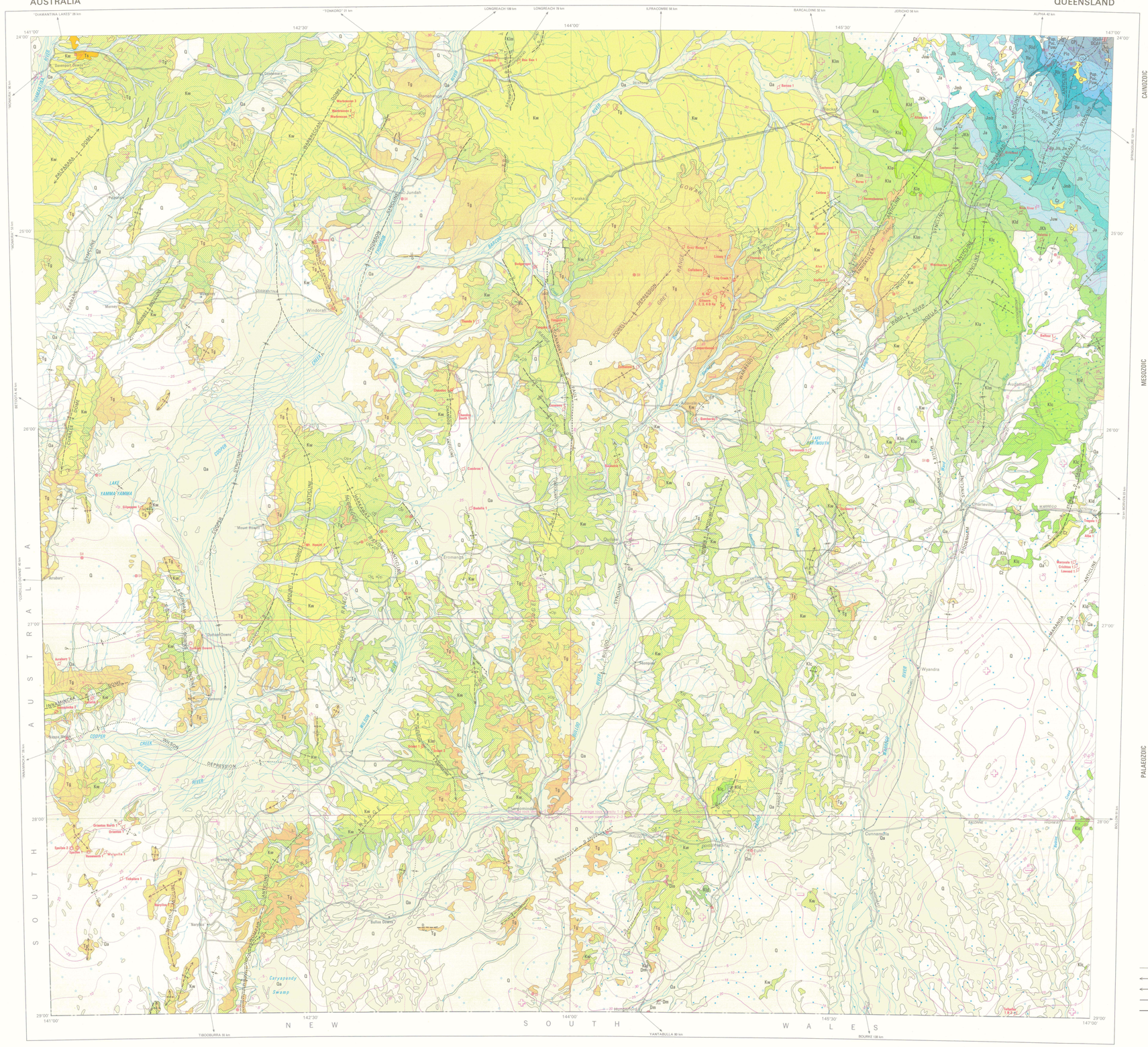

"DIAMANTINA LAKES" 36 km
"TONKORO" 21 km
LONGREACH 106 km
LONGREACH 78 km
ILFRACOMBE 56 km
BARCALDINE 52 km
JERICHO 56 km
ALPHA 42 km
141°00'
142°30'
144°00'
145°30'
147°00'
24°00'
25°00'
26°00'
27°00'
28°00'
29°00'
NORMAN 30 km
NORMAN 15 km
BEDOUT 40 km
TOMAHAWK 28 km
CORDILLO DOWNS 48 km
SPRINGVALE 20 km
CLONCURRY 90 km
TIBOOBURRA 55 km
YANTABULLA 80 km
BOURKE 130 km
S O U T H A U S T R A L I A
N E W S O U T H W A L E S
Eromanga Basin
Cooper Basin
Galilee Basin
Adavale Basin
Drummond Basin
Thomson Fold Belt
Diamantina River
Cooper Creek
Wilson River
Barcoo River
Thomson River
Lake Yamma Yamma
Lake Hope
Lake Dunn
Lake Machattie
Lake Bulloo
Lake Nappamerri
Lake Koonchera
Windorah
Quilpie
Eromanga
Charleville
Cunnamulla
Tambo
Augathella
Mitchell
Jundah
Stonehenge
Yaraka
Blackall
Isisford
Longreach
Winton
Jundah Downs
Arrabury
Naryilco
Tibooburra
Sullies Downs
Catyspaddy Swamp
Mount Howitt
Mt. Howitt 1
Diamantina 1
Kyabra 1
Kyabra Creek 1
Kyabra Creek 2
Kyabra Creek 3
Kyabra Creek 4
Kyabra Creek 5
Kyabra Creek 6
Kyabra Creek 7
Kyabra Creek 8
Kyabra Creek 9
Kyabra Creek 10
Kyabra Creek 11
Kyabra Creek 12
Kyabra Creek 13
Kyabra Creek

PLATE B2

CENTRAL EROMANGA BASIN

PERSPECTIVE SUBSURFACE CORRELATION

QUEENSLAND

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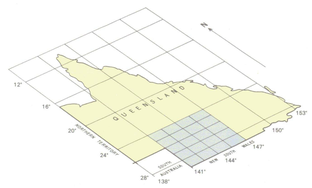
Geology 1968–72 by B. R. Senior
Compilation 1972 by B. R. Senior and M. Nancarrow
Digitising 1972 by Preliminary Map Section BMR
Computer programme 1972 by S. Henley
Cartography by Geological Branch BMR
Drawn 1973 by R. Swoboda, J. Mason
Printed 1974 by Mercury-Walch Pty. Ltd., Hobart, Australia

Bibliographic reference: B. R. Senior 1974. Geology of Central Eromanga Basin. Bur. Miner. Resour. Aust. Bull. 167.8

Maps are available separately

Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T.

LOCALITY MAP



HORIZONTAL SCALE
1:1 000 000
(Front corner only)

VERTICAL SCALE
V/H = 15
(Front corner only)

0
500 m
1000 m
1500 m
2000 m
2500 m
3000 m

COOPER BASIN SEQUENCE

MESOZOIC	TRIASSIC		
	MIDDLE TO UPPER TRIASSIC		
	LOWER TO MIDDLE TRIASSIC	Rbx	NAPPAMERRI FORMATION
	LOWER TRIASSIC		
PALAEOZOIC	PERMIAN		
	UPPER PERMIAN		
	LOWER TO UPPER PERMIAN	Plg	GIDGEALPA GROUP
	LOWER PERMIAN	Plm	MERRIMELIA FORMATION
	UPPER CARBONIFEROUS TO LOWER PERMIAN	CPj	JOE JOE FORMATION

GALILEE BASIN SEQUENCE

combined on section

R	
Rm	MOOLAYEMBER FORMATION
Rk	CLEMATIS SANDSTONE
Rld	GUNDA BEDS
Rl	REWAN FORMATION
P	
Pcw	BLACKWATER GROUP
Pac	BLACK ALLEY SHALE
Pwa	PEAWADDY FORMATION
Plo	COLINLEA SANDSTONE
CPj	JOE JOE FORMATION

ADAVALE BASIN SEQUENCE

PALAEOZOIC	UPPER DEVONIAN TO LOWER CARBONIFEROUS	DCk	BUCKABIE FORMATION
	MIDDLE DEVONIAN	Dme	ETONVALE FORMATION
		Dmc	Couladdi Dolomite Member
		Dmb	Boree Salt Member
		Dml	LOG CREEK FORMATION
		Dmk	Bury Limestone Member
		Dmg	GUMBARDO FORMATION
	SILURIAN		
	ORDOVICIAN		
	LOWER PALAEOZOIC		
	PRECAMBRIAN AND CAMBRIAN		

ADAVALE GROUP

Dm	
S	
O	
Pzl	
pCC	

EROMANGA BASIN SEQUENCE

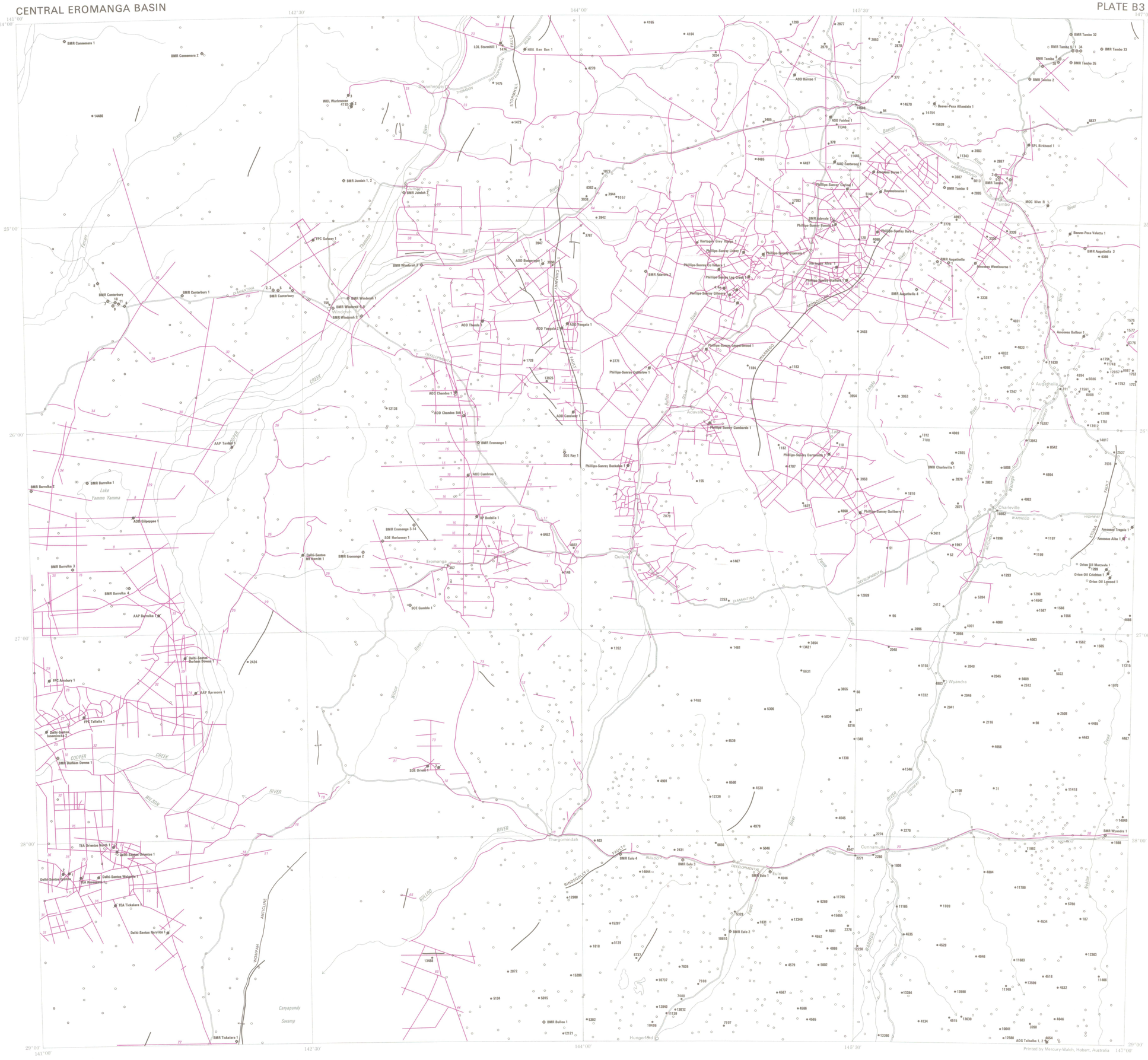
CAINOZOIC	QUATERNARY	Q	not represented
		Qa	
		Cz	
	TERTIARY	Tw	WHITULA FORMATION
		Ts	MOSES SANDSTONE not represented
		Th	
		T	
		Tg	GLENDOWER FORMATION
MESOZOIC	LOWER TO UPPER CRETACEOUS	Kw	WINTON FORMATION where combined Kw colour used
	LOWER CRETACEOUS	Klm	MACKUNDA FORMATION ROLLING DOWNS GROUP
		Kla	ALLARU MUDSTONE
		Klo	TOOLEBUC FORMATION
		Klz	WALLUMBILLA FORMATION
		Klc	Coreena Member
		Kld	Doncaster Member
		Kle	CADNA-OWIE FORMATION
	UPPER JURASSIC TO LOWER CRETACEOUS	Jkh	HOORAY SANDSTONE
	UPPER JURASSIC	Jow	WESTBOURNE FORMATION INJUNE CREEK GROUP
	MIDDLE TO UPPER JURASSIC	Jo	ADORI SANDSTONE
	MIDDLE JURASSIC	Jmb	BIRKHEAD FORMATION
		Jth	HUTTON SANDSTONE
	LOWER JURASSIC	Jm	EVERGREEN FORMATION
		Jm	Basalt Member
		Jbl	Bowale Sandstone Member
		Ja	PRECIPICE SANDSTONE

DRUMMOND BASIN SEQUENCE

DCd	DRUMMOND GROUP
DCs	SILVER HILLS VOLCANICS

CENTRAL EROMANGA BASIN

PLATE B3



SEISMIC SURVEYS IN THE CENTRAL EROMANGA BASIN

REF NO	YEAR OF SURVEY	ABBREVIATED TITLE	REFERENCE
		ALLIANCE OIL DEVELOPMENT	
1	1962	Alpha	AOD, 1963a
2	1963	Bulgroo	AOD, 1963c
3	1965	Trinidad	AOD, 1964a
4	1965	Chandos	AOD, 1966a
5	1966	Regleigh	AOD, 1966b
6	1968	Coorajah	AOD, 1968
7	1969	South Chandos	AOD, 1969a
8	1969	Yamma Yamma	AOD, 1969b
9	1969	Booranghoop	AOD, 1970a
10	1970	Harkaway	AOD, 1970b
		AMERICAN OVERSEAS PETROLEUM COMPANY	
11	1963	Blackall–Mitchell	Amoseas, 1963a
12	1963	Tambo	Amoseas, 1963b
13	1965	Augathella	Amoseas, 1965
14	1968	Ravensbourne	Amoseas, 1968
		BRITISH PETROLEUM DEVELOPMENT	
15	1966	Thylungra	B.P., 1966
16	1966	Tallyabra	Farley, 1967
		BUREAU OF MINERAL RESOURCES	
17	1959	Quilpie–Eromanga	Bigg-Wither and Morton, 1962
18	1962	Thargomindah–Noccundra	Lodwick and Jones, 1964
19	1961	Westbourne	Bigg-Wither and Davies, 1964
20	1962	St. George–Eulo	Davis and Lodwick, 1966
21	1962–63	Thargomindah–Noccundra	Davis and Robertson, 1966
		CLARENCE RIVER BASIN OIL	
22	1964	Olive River	Clarence River Basin Oil Exploration Co NL, 1964
		CONORADA PETROLEUM CORPORATION	
23	1961	Stonehenge	Conorada Petroleum Corp., 1961
		DELHI AUSTRALIAN PETROLEUM COMPANY AND SANTOS LIMITED	
24	1962	Orientos–Clifton Hills	Delhi-Santos, 1962a
25	1962	Innamincka–Mt. Gason	Delhi-Santos, 1962b
26	1963	Diamantina–Mt. Gregor Range	Delhi-Santos, 1963b
27	1964	Cooper Creek	Delhi-Santos, 1965c
28	1965	Strzelecki–Cooper	Delhi-Santos, 1965d
29	1966	Eromanga–Frome seismic and gravity	Delhi-Santos, 1966b
30	1967	Cooper Basin seismic and gravity	Delhi-Santos, 1967
31	1971	Dunjeroo	Delhi-Santos, 1971
		FLINDERS PETROLEUM NL	
32	1970	Cooper Creek central	Flinders, 1970a
33	1971	Sandy Creek	Flinders, 1971
		FRENCH PETROLEUM COMPANY (AUSTRALIA) LIMITED	
34	1960	H addon Downs Seismic	(unpublished)
35	1966	Windorah–Wolgolla seismic and gravity	FPC, 1966
36	1967	Tickalara seismic and gravity	FPC, 1967
		HARTOGEN EXPLORATION	
37	1971	Cootabynia	Hartogen Exploration, 1971
38	1973	Mt. Edinborough	Hartogen Exploration, 1973
		LONGREACH OIL LIMITED	
39	1969	Thomson River	Longreach Oil Ltd, 1969
		MARATHON PETROLEUM AUSTRALIA	
40	1963	Ruthven	Marathon, 1964
41	1964	Barcoo	Marathon, 1965
42	1964	Wooroolah	Musser, 1964
43	1967	West Blackall	Marathon Petroleum Aust, 1967
		NEW SOUTH WALES OIL AND GAS	
44	1969	Hamilton Gate refraction	NSW Oil & Gas, 1970
		PHILLIPS PETROLEUM AND SUNRAY DX OIL COMPANY	
45	1961	Adavale	Hier and Spivey, 1961
46	1961	Jundah–Yaraka–Blackwater–Langlo	Hier and Fjelstul, 1961
47	1962	Charleville North	Fjelstul, 1962
48	1959–60	Quilpie–Thargomindah–Charleville	Hier and Spivey, 1962
49	1962	Gumbardo	Fjelstul and Beck, 1962
50	1963	Toompine–Wyandra	Phillips-Sunray, 1963a
51	1963	Quilberry Creek	Fjelstul and Beck, 1963a
52	1963	Gowan Range	Fjelstul and Beck, 1963b
53	1963	Highfields	Fjelstul and Tallis, 1964a
54	1963	Gilmore	Fjelstul and Tallis, 1964b
55	1964	Log Creek	Fjelstul and Rhodes, 1965a
56	1965	Stafford	Fjelstul and Rhodes, 1965b
57	1965	Leopardwood	Fjelstul, Rhodes and Tallis, 1965
58	1965	Mt. Watson	Rhodes and Fjelstul, 1965a
59	1965	Strathconen	Rhodes and Fjelstul, 1965b
60	1965	Powell Creek	Tallis and Fjelstul, 1965a
61	1965	Rockwell	Tallis and Fjelstul, 1965b
62	1965	Adavale Basin Detail	Fjelstul and Rhodes, 1966
63	1966	Bride Creek	Phillips-Sunray, 1966a
64	1966	Yaraka	Phillips-Sunray, 1966b
65	1966	Bulloo Downs	Phillips-Sunray, 1966c
66	1965	Lake Dartmouth	Tallis and Fjelstul, 1966a
67	1963	Pleasant Creek	Fjelstul, Tallis and Beck, 1963
68	1965	Listowell	Fjelstul, Rhodes and Collins, 1966
69	1966	Panhandle	Fjelstul, Tallis and Beck, 1966
70	1961–65	Carlow-Hope Creek	Slanis and Netzel, 1967
71	1965	Lissoy	Slanis and Netzel, 1967
72	1967	Welford	Phillips-Sunray, 1968
		SMART OIL EXPLORATION	
73	1959	Grey Range	SOE, 1962b
74	1963	Eromanga	SOE, 1963a
75	1965	Tinderry	SOE, 1965
		TOTAL EXPLORATION	
76	1970	Epsilon	TEA, 1970

2149 — *Wireline logged water bore with registered number, QIWSC Records*

ADO Chandos 1 — *Petroleum exploration well*

BMR Windorah 1 — *BMR shallow stratigraphic hole*

47 — *Seismic lines with reference number*

DATA AVAILABILITY

DISTRIBUTION OF SEISMIC SURVEYS, WIRELINE LOGGED WATER BORES, PETROLEUM EXPLORATION WELLS AND BMR SHALLOW STRATIGRAPHIC DRILL HOLES

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

STRUCTURE CONTOURS ON BASE OF ROLLING DOWNS GROUP

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

— –100 — Structure Contours, intervals 50 and 100 metres
Datum, Mean Sea Level

Water bore
Petroleum exploration well
} Data control points

Basement outcrop

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CENTRAL EROMANGA BASIN

PLATE B5

ISOPACH MAP OF THE WALLUMBILLA FORMATION

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

— 300 — Isopach, 20 metres interval

• Wireline logged water bore

244 Petroleum exploration well

Figures denote thickness of Wallumbilla Formation in metres

Boundary accurate

Boundary approximate

UPPER PART OF WALLUMBILLA FORMATION TRUNCATED AND MOSTLY CONCEALED BELOW CAINOZOIC SEDIMENTS

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CENTRAL EROMANGA BASIN

PLATE B6

TOOLEBUC FORMATION GAMMA-RAY ANOMALY

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

0
30
60m

Approximate Intensity

0 100 200API

NP Not present

• 1474 Water bore with registered number

Mt Howitt 1 Petroleum exploration well

Limit of Toolebuc Formation (accurate)

Limit of Toolebuc Formation (approximate or concealed)

Printed by Mercury-Walch, Hobart, Australia

ISOPACH MAP OF THE MACKUNDA AND WINTON FORMATIONS

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

—300— Isopach, 100 metres interval

Outcrop margin (accurate)

Outcrop margin (approximate or concealed)

MACKUNDA FORMATION OUTCROP

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PLATE C1

GEOLOGY OF THE NORTHWESTERN EROMANGA BASIN

QUEENSLAND, NORTHERN TERRITORY

1977

SCALE 1:1 000 000

0 20 40 60 80 100 KILOMETRES

Lambert Conformal Conic Projection, standard parallels 22°23' and 25°16'

Published by the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T., and the Geological Survey of Queensland, issued under the authority of the Minister for National Resources

Topographic base compiled by the Bureau of Mineral Resources, Geology and Geophysics, from 1:250 000 Planimetric Series of the Division of National Mapping, Department of National Resources and the Royal Australian Survey Corps

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Geology by officers of the Bureau of Mineral Resources and the Geological Survey of Queensland (mainly 1:250 000 scale regional mapping)

Compiled by A. Mond, B. R. Senior, G. Matveev, R. Swoboda

Gravimetry by Geophysical Branch BMR

Cartography by Geological Branch BMR

Drawn by Leigh-Mardon Pty Ltd, Melbourne

Printed by Mercury-Walch Pty Ltd, Hobart, Australia

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LOCALITY MAP



EROMANGA BASIN

1. Northwestern (Bull 167 part C)
2. Northern (Bull 167 part A)
3. Central (Bull 167 part B)

Reference

CAINOZOIC

QUATERNARY

- Qa — *Alluvial sand and gravel, lacustrine silt, clay; some salt*
- Qs — *Aeolian sand; minor alluvial sand and gravel along rivers*

TERTIARY

- T — *Argillaceous sandstone, siltstone, sandy mudstone, some gypsum, minor ferruginized sediments; unnamed limestone*
- Th — HORSE CREEK FORMATION: *Chalcedonic limestone, some claystone*
- Ta — AUSTRAL DOWNS LIMESTONE: *Chalcedonic limestone*
- Tn — NORANSIDE LIMESTONE: *Limestone, red calcareous silty sandstone, chalcedony*
- Tc — WAITE FORMATION: *Argillaceous sandstone, siltstone and conglomerate; chalcedonic limestone*
- Ts — MT COLEY SINTER: *Siliceous sinter, chalcedony*
- Tm — MARION FORMATION: *Quartzose sandstone, sandy siltstone*
- Tv — SPRINGVALE FORMATION: *Silicified clay, chert, limestone*
- Tr — ETINGAMBRA FORMATION: *Quartzose sandstone, conglomeratic sandstone, conglomerate; some kaolinitic siltstone*
- Tg — GLENDOWER FORMATION: *Quartzose sandstone, sandy conglomerate, quartz pebble conglomerate, minor siltstone, silcrete*
- *Chemical weathering (kaolinized, silicified and ferruginized sediments) profile. Information available only east of 139°30'*

EROMANGA BASIN SEQUENCE

MESOZOIC

ROLLING DOWNS GROUP

LOWER TO UPPER CRETACEOUS

- Kw — WINTON FORMATION: *Labile sandstone, siltstone, mudstone, calcareous in part; some coal, limestone; minor intraformational conglomerate*
- Klm — MACKUNDA FORMATION: *Labile sandstone, siltstone, mudstone, calcareous; carbonaceous, glauconitic in part; some cross-stratification, burrows common*
- Kla — ALLARU MUDSTONE: *Mudstone, siltstone, carbonaceous, calcareous in part; some limestone; glauconite; minor evaporite*

LOWER CRETACEOUS

- Klq — TOOLEBUC FORMATION: *Siltstone, limestone, coquinite*
- Klu — WALLUMBILLA FORMATION: *Mudstone, siltstone, commonly calcareous, carbonaceous; pyritic in part; minor glauconitic labile sandstone; some gypsum*
- Kla — CADNA-OWIE FORMATION: *Interbedded quartzose to sublabile sandstone, minor labile sandstone, siltstone, mudstone (section only)*

UPPER JURASSIC TO LOWER CRETACEOUS

- JKq / JKh — GILBERT RIVER FORMATION / HOORAY SANDSTONE: North-eastern part (JKq) *Quartzose to sublabile sandstone, commonly pebbly, cross-bedded* Eastern part (JKh) *As above, with minor claystone and siltstone* Western part (JKh) *Quartzose sandstone, pebbly sandstone, high angle cross-stratification*

LOWER TO UPPER JURASSIC

- Jh-Js — INJUNE CREEK GROUP (Js) AND HUTTON SANDSTONE (Jh): *Sandstone, siltstone, conglomeratic sandstone, coal (section only)*

COOPER BASIN SEQUENCE

LOWER TO MIDDLE TRIASSIC

- RSs — NAPPAMERRI FORMATION: *Sandstone, shale and siltstone, micaceous in part (section only)*

PEDIRKA BASIN SEQUENCE

PERMIAN

- P — CROWN POINT AND PURNI FORMATIONS AND UNDIVIDED ? PERMIAN: *Sandstone, pebbly sandstone, siltstone, boulder, cobble and pebble, conglomerate; minor pyrite, lignite at the top*

PALAEOZOIC

AMADEUS BASIN SEQUENCE

CAMBRIAN TO CARBONIFEROUS

- SC — *Clastics*
- PC — *Clastics, carbonates, evaporites*

GEORGINA BASIN SEQUENCE

- SD — *Sandstone, conglomerate*
- CO — *Carbonates, clastics*
- P — *Clastics, carbonates below Georgina Basin*

PRECAMBRIAN

- Pzt — *Schist, quartzite, feldspathic sandstone, indurated mudstone and shale (section only)*
- pCc — *Sandstone, dolomitic sandstone, breccia and quartzite. Redbeds, sandstone, orthoquartzite (section only)*

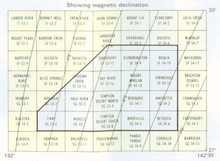
CRYSTALLINE BASEMENT

- pGm — *Gneiss, schist, quartzite, amphibolite, dolerite*
- pGg — *Granite*

- *Geological boundary*
- *Anticline, showing plunge*
- *Syncline, showing plunge*
- *Monocline*
- *Fault*
- *Where location of folds and faults, is approximate, line is broken; where inferred, queried, where concealed, folds are dotted, faults are shown by short dashes*
- *Trend line, airphoto interpretation*
- *Drill hole, ls — stratigraphic hole, SH — scout hole*
- *Petroleum exploration well, dry-abandoned*
- *Water bore (2350 - Reg. No. Qld. Irrig. Water Supply Comm)*
- *Road*
- *Track*
- *Railway*
- *Town*
- *Homestead*
- *Isogal values in milligals*
- *Gravity "high" anomaly*
- *Gravity "low" anomaly*
- *For the calculation of Bouguer anomalies 1·9 g/cm³, 2·2 g/cm³ and 2·67 g/cm³ have been adopted as average rock densities*

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Showing magnetic declination


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MOUNT CAMPBELL SF 53-47
MOUNT CAMPBELL SF 53-48
MOUNT CAMPBELL SF 53-49
MOUNT CAMPBELL SF 53-50
MOUNT CAMPBELL SF 53-51
MOUNT CAMPBELL SF 53-52
MOUNT CAMPBELL SF 53-53
MOUNT CAMPBELL SF 53-54
MOUNT CAMPBELL SF

NORTHWESTERN EROMANGA BASIN

PLATE C2

DATA AVAILABILITY

DISTRIBUTION OF SEISMIC SURVEYS, WIRELINE LOGGED WATER BORES, PETROLEUM EXPLORATION WELLS AND BMR SHALLOW STRATIGRAPHIC DRILL HOLES

Scale 1 : 1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

REF. NO.	YEAR OF SURVEY	SURVEY NAME	COMPANY OR ORGANIZATION	BMR SUBSIDY FILE OR RECORD NUMBER
1	1970	Toko Range	Alliance Oil Development Co. Aust. NL	70/284
2	1965	Simpson Desert 'A'	Amerada Petroleum Corp. of Aust. Ltd	65/11007
3	1966	Simpson Desert North & 'B'	Amerada Petroleum Corp. of Aust. & Exoil (NT) Pty Ltd	66/11087 & 66/11132
4	1966	Simpson Desert 'C'	Amerada Petroleum Corp. of Aust. Ltd	66/11096
5	1964	Kilpatha	Australian Aquitaine Petroleum Pty Ltd	63/1557
6	1966	Perlanna	Australian Aquitaine Petroleum Pty Ltd	66/11085
7	1964	Andado	Beach Petroleum NL	63/1544
8	1964	Hale River Floodout	Beach Petroleum NL	64/4532
9	1964	Dakota Bore	Beach Petroleum NL	64/4542
10	1971	Three Corners	Beach Petroleum NL	71/526
11	1961	Amadeus Basin (southern margin)	Bureau of Mineral Resources	62/167
12	1963	SE Georgina Basin	Bureau of Mineral Resources	65/75
13	1964	SE Georgina Basin	Bureau of Mineral Resources	65/39
14	1965	Southern Georgina Basin	Bureau of Mineral Resources	66/28
15	1960	Great Artesian Basin	Department of Mines, South Australia	61/60
16	1964	Mt Charlotte	Finke Oil Co Pty Ltd	64/4517
17	1965	Finke River	Finke Oil Co Pty Ltd	65/11023
18	1962	Steeles Gap	Flamingo Petroleum Pty Ltd	62/1565
19	1963	Todd River	Flamingo Petroleum Pty Ltd	63/1510
20	1964	Hale River	Flamingo Petroleum Pty Ltd	64/4556
21	1963	Pedirka–Annandale	French Petroleum Co (Aust.) Pty Ltd	63/1514
22	1964	Bedourie	French Petroleum Co (Aust.) Pty Ltd	64/4503
23	1965	Sandringham	French Petroleum Co (Aust.) Pty Ltd	65/4594
24	1960	Simpson Desert	Geosurveys of Australia Ltd	62/1543
25	1964	Northern Simpson Desert	Mercure International Petroleum Pty Ltd	64/4520
26	1960	Springvale–Boulia	Phillips Petroleum Co & Sunray Mid-Continent Oil Co	62/1514
27	1972	Poeppels Corner	Reef Oil NL	72/2645

● 4621 — *Water bore with wireline log (mainly gamma ray) showing registered number, QIWCS records or Department of Northern Australia records*

● The Dam — *Water bore with drillers lithological log, Queensland sector or wireline log, N.T. Sector*

FPC Mardoora 1 — *Petroleum exploration well*

BMR Hay River 2 — *BMR shallow stratigraphic hole*

11 — *Seismic lines with reference number*

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NORTHWESTERN EROMANGA BASIN

PLATE C3

STRUCTURE CONTOURS ON BASE OF EROMANGA SEQUENCE

WITH MARGINS OF OLDER BASIN SYSTEMS AND "BASEMENT"

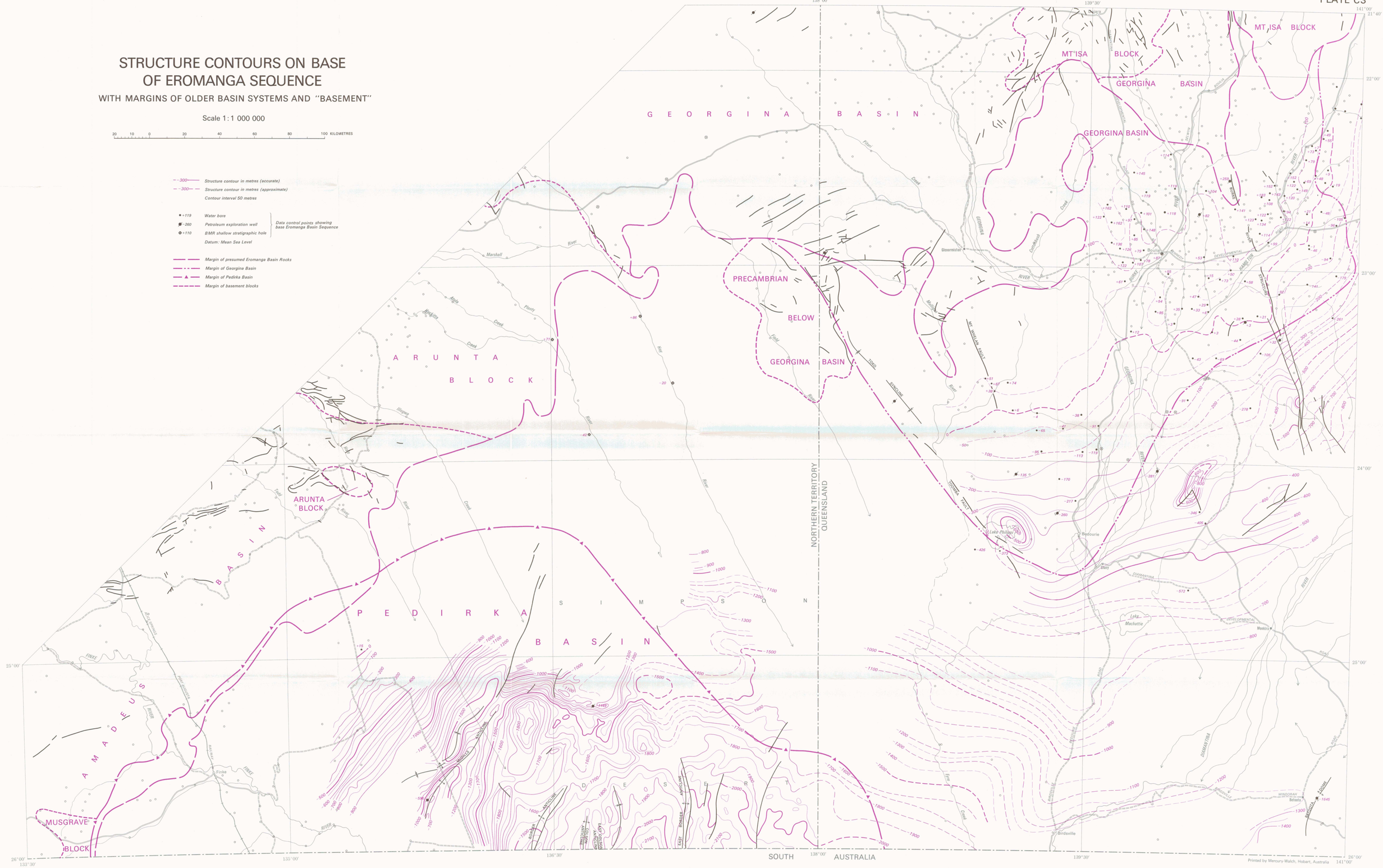
Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

-300- Structure contour in metres (accurate)
-300- Structure contour in metres (approximate)
Contour interval 50 metres

+119 Water bore
260 Petroleum exploration well
+110 BMR shallow stratigraphic hole
Data control points showing base Eromanga Basin Sequence
Datum: Mean Sea Level

Margin of presumed Eromanga Basin Rocks
Margin of Georgina Basin
Margin of Pedirka Basin
Margin of basement blocks



NORTHWESTERN EROMANGA BASIN

PLATE C4

STRUCTURE CONTOURS ON BASE OF ROLLING DOWNS GROUP

Scale 1 : 1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

-300 Structure contour in metres (accurate)

-300 Structure contour in metres (approximate)

Contour interval 50 metres

•-900 Water bore

•-179 Petroleum exploration well

•+110 BMR shallow stratigraphic hole

Data control points showing base of Rolling Downs Group

Datum mean sea level

Interpreted margin of Rolling Downs Group

NORTHERN TERRITORY

QUEENSLAND

SOUTH AUSTRALIA

S I M P S O N D E S E R T

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NORTHWESTERN EROMANGA BASIN

PLATE C5

TOOLEBUC FORMATION GAMMA-RAY ANOMALY

Scale 1 : 1 000 000

20 10 0 20 40 60 80 100

0
30
60m

Approximate Intensity

0 100 200API

P	Present (anomaly not shown because log not measured in API units)
NP	Not present
4621	Water bore with registered number (solid symbol indicates presence of Toolebuc Formation gamma-ray anomaly)
PS Beantree 1	Petroleum exploration well
	BMR shallow stratigraphic hole
	Limit of Toolebuc Formation (accurate)
	Limit of Toolebuc Formation (approximate)

NORTHERN TERRITORY
QUEENSLAND

S I M P S O N

D E S E R T

SOUTH AUSTRALIA

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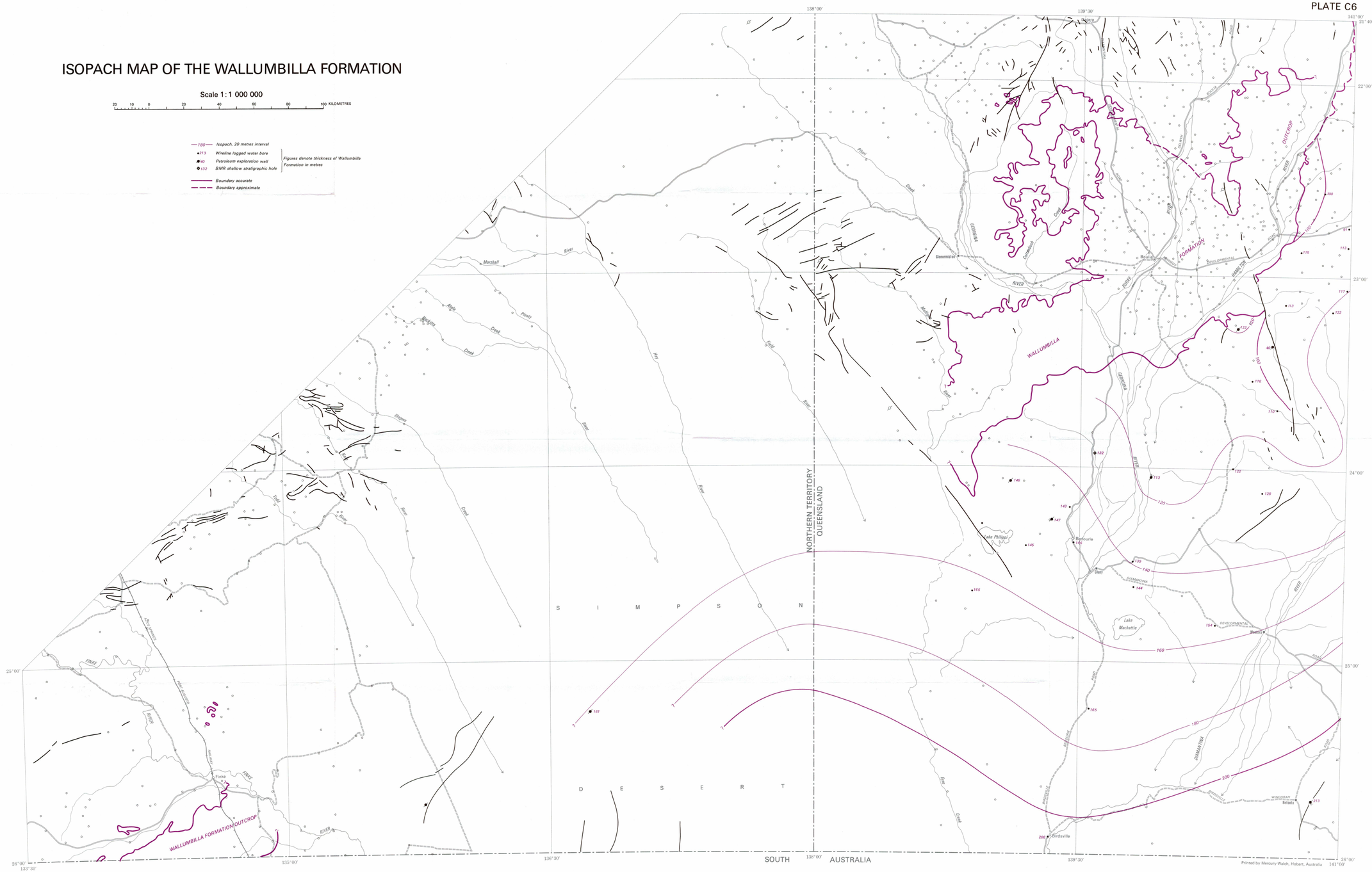
PLATE C6

ISOPACH MAP OF THE WALLUMBILLA FORMATION

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

180 Isopach, 20 metres interval
213 Wireline logged water bore
40 Petroleum exploration well
132 BMR shallow stratigraphic hole
Figures denote thickness of Wallumbilla Formation in metres
Boundary accurate
Boundary approximate



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