DEPARTMENT OF
~~NATIONAL RESOURCES~~
NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1980/32

CENTRAL EROMANGA BASIN PROJECT, PROGRAM PROPOSALS, 1980-1982

by

P.L. Harrison, S.P. Mathur, F.J. Moss, J. Pinchin,
and B.R. Senior

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ABSTRACT

BMR proposes to carry out a multidisciplinary geoscientific regional investigation of the central part of the Eromanga Basin and of the underlying Adavale, Cooper and Galilee Basins in order to determine the petroleum resource potential, and to assist in efficient and comprehensive exploration of the area which may lead to the discovery of oil and gas.

The basins are large by world standards and yet there are many parts which are relatively unexplored and many facets of their geological histories which are not clearly understood. The study will involve reviewing fragmented information obtained from regional geological work and petroleum exploration activity, and further surveys to build up a comprehensive account of the depositional, structural, and thermal histories of the basins.

Existing seismic data will be reviewed and new data acquired in critical areas. Information from well sections and logs will be combined with the seismic stratigraphic information as a basis for basin-wide lithofacies correlation studies. Palynological data, and information from fully cored stratigraphic holes to be drilled later in the program, will also assist in these studies. LANDSAT imagery and photogeological data will be studied to assist in identifying structural features and their extensions. Information on sub-basement rocks and structures which may have influenced basin development will be obtained from studies of the gravity and magnetic fields, from deep crustal seismic reflection and refraction, and from magnetotelluric surveys. The results will be integrated to determine the structural and depositional history of the area.

Further information on the source rock potential and thermal history of the rocks will be obtained from a review of source rock data, analysis of further samples from critical well sections using the Pyrolysis method, and from geothermal gradient field measurements. Hydrological data will be reviewed, samples will be taken in deep water bores for analysis of hydrocarbon content, and studies made of the possible importance of faults and fault-induced folds as potential hydrodynamic petroleum traps. The potential petroleum resources of the area will be assessed.

The regional work proposed will be done over a three year period; however, the results of research projects will be published as they become available.

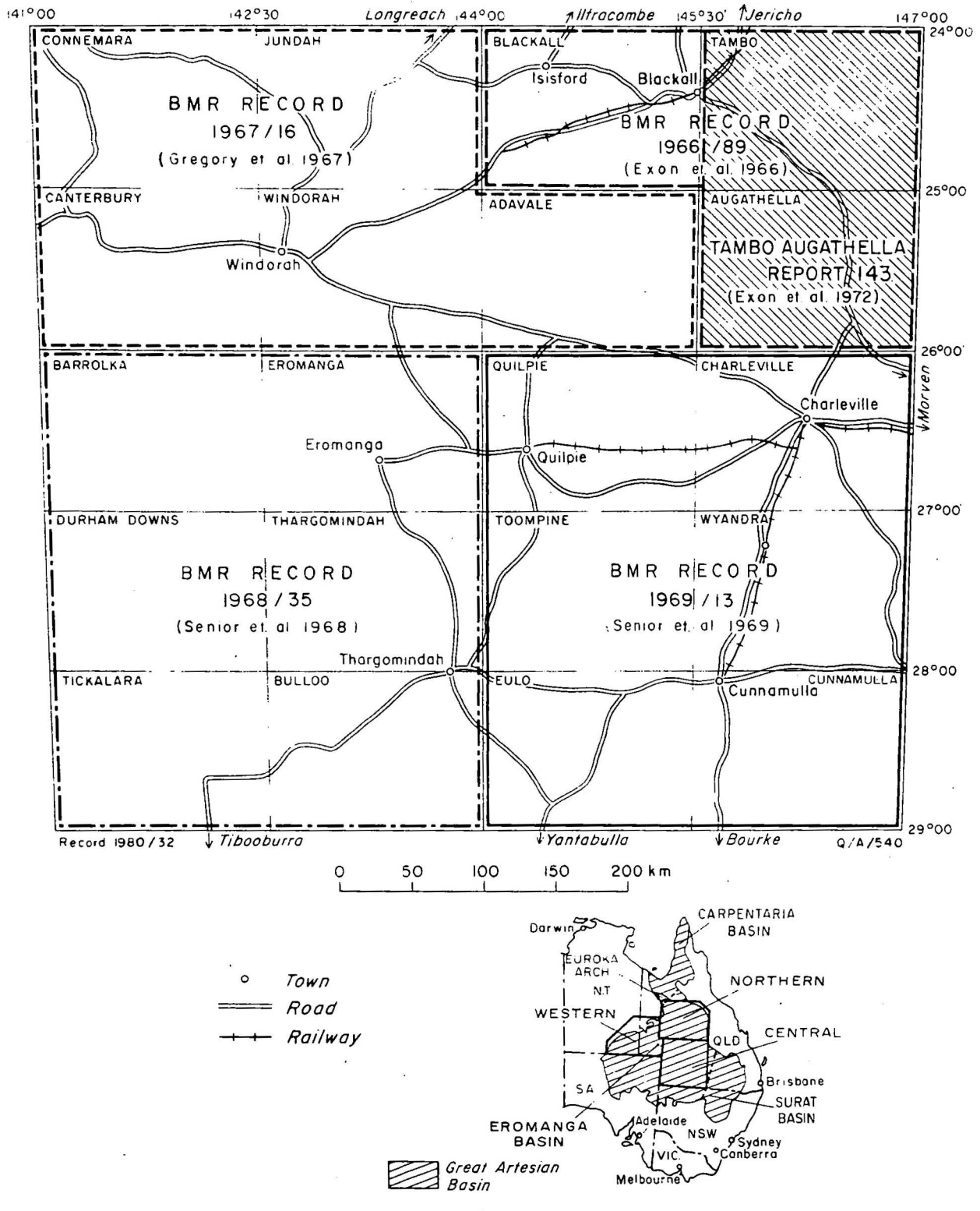

Fig.1 Location map & key to Explonatory Notes, BMR Report & Record Series (unpublished) in the central part of the Eromanga Basin (from Senior & others, 1978)

INTRODUCTION

Australia faces a decreasing ability to meet its requirement for oil, with forecast local production meeting about 45 percent of demand in 1984-1985. Australia is moderately well-endowed with natural gas, but it is likely that demand for gas for markets in the eastern States will exceed existing supplies before the year 2000.

A major role for the Bureau of Mineral Resources (BMR) is to promote and assist petroleum exploration. In part fulfilment of this role, BMR proposes to undertake a major study of the central part of the Eromanga Basin of Queensland which will be called the "Central Eromanga Basin Project". The main objective will be to carry out fundamental multidisciplinary geoscientific regional investigations of the Eromanga and underlying sedimentary basins, which will enable the petroleum resource potential to be determined, and assist efficient and comprehensive exploration of the area.

The geographical setting of the area (Fig. 1 & 2) is given in Appendix 1.

A review of existing information will be made to determine gaps in the knowledge of the area and the work required to fill these gaps and satisfy the objective. It is expected that new or more detailed information will be required on the structure of the deep crust and its relationship to basin evolution, nature and timing of tectonic events, the environments of deposition, location and nature of facies changes, distribution and characteristics of source rocks, burial history, heat flow and geothermal gradient, and distribution of unconformities.

Techniques which may be used to obtain information necessary to achieve the objective include: geochemistry; photo-geology; well-log analysis and stratigraphic correlations; sedimentology; palaeontology and palynology; gravity; magnetics; seismic, including deep seismic sounding; magneto-telluric; electrical; electromagnetic; heat flow; palaeomagnetism; and fluid dynamics.

REGIONAL GEOLOGY AND PETROLEUM PROSPECTS

The area contains four potentially hydrocarbon-bearing basins, each separated by unconformities and containing rocks of Middle Devonian to Late Cretaceous age (Table 1). The Adavale and Cooper Basins are entirely concealed; units of the Galilee and Eromanga Basins crop out in the northeast.

Basement consists of probably non-prospective Lower Palaeozoic and earlier Warburton Basin rocks in the west; and schist, quartzite, strongly folded clastics, granite, porphyry and basalt elsewhere.

The prospective sequences are described below:

Adavale Basin and Warrabin Trough

The Middle Devonian to Lower Carboniferous Adavale Basin consists of volcanics, marine sandstone, limestone, dolomite, and evaporites; overlain by continental, vari-coloured sandstone, shale, and siltstone. Structurally it consists of a central, fault-bounded basin and the Quilpie, Cooladdi and Westgate Troughs (Fig. 3). The main basin contains up to 6700 m and the troughs up to 5000 m of sedimentary rocks.

A north-trending basement horst (Canaway Ridge) separates the western edge of the Adavale Basin from a more westerly area of poorly known Devonian and Carboniferous sedimentary rocks called the Warrabin Trough. The western and northern margins of this trough are unknown.

The Adavale Basin sequence was deposited on the western edge of the Tasman Geosyncline. Acid volcanics and volcanogenic sediments of the Gumbardo Formation accumulated in the Middle Devonian and were followed by a marine transgression in which sandstone and carbonate of the Log Creek Formation, and the Bury Limestone Member were laid down. Uplift and partial erosion followed prior to a second marine transgression in which the Cooladdi Dolomite Member of the Etonvale Formation was deposited. The sea then regressed in the northeast forming a shallow evaporitic basin (Boree Salt Member of the Etonvale Formation). Eventually the basin consisted of low-lying flood-plains and saline lakes in which vari-coloured sand, silt, and mud of the Buckabie Formation were deposited. The Adavale Basin was uplifted and eroded with sedimentation recommencing in the late Carboniferous (Galilee Basin).

Petroleum exploration was directed towards finding structural closures within porous and permeable beds in the Log Creek Formation. Sixteen exploration wells were drilled resulting in the discovery of a medium-sized, as yet non-commercial, gas-field at Gilmore in which 5 appraisal wells have been drilled. Present-day interest is centred on the carbonate rocks and the possibility of petroleum accumulations in reef structures.

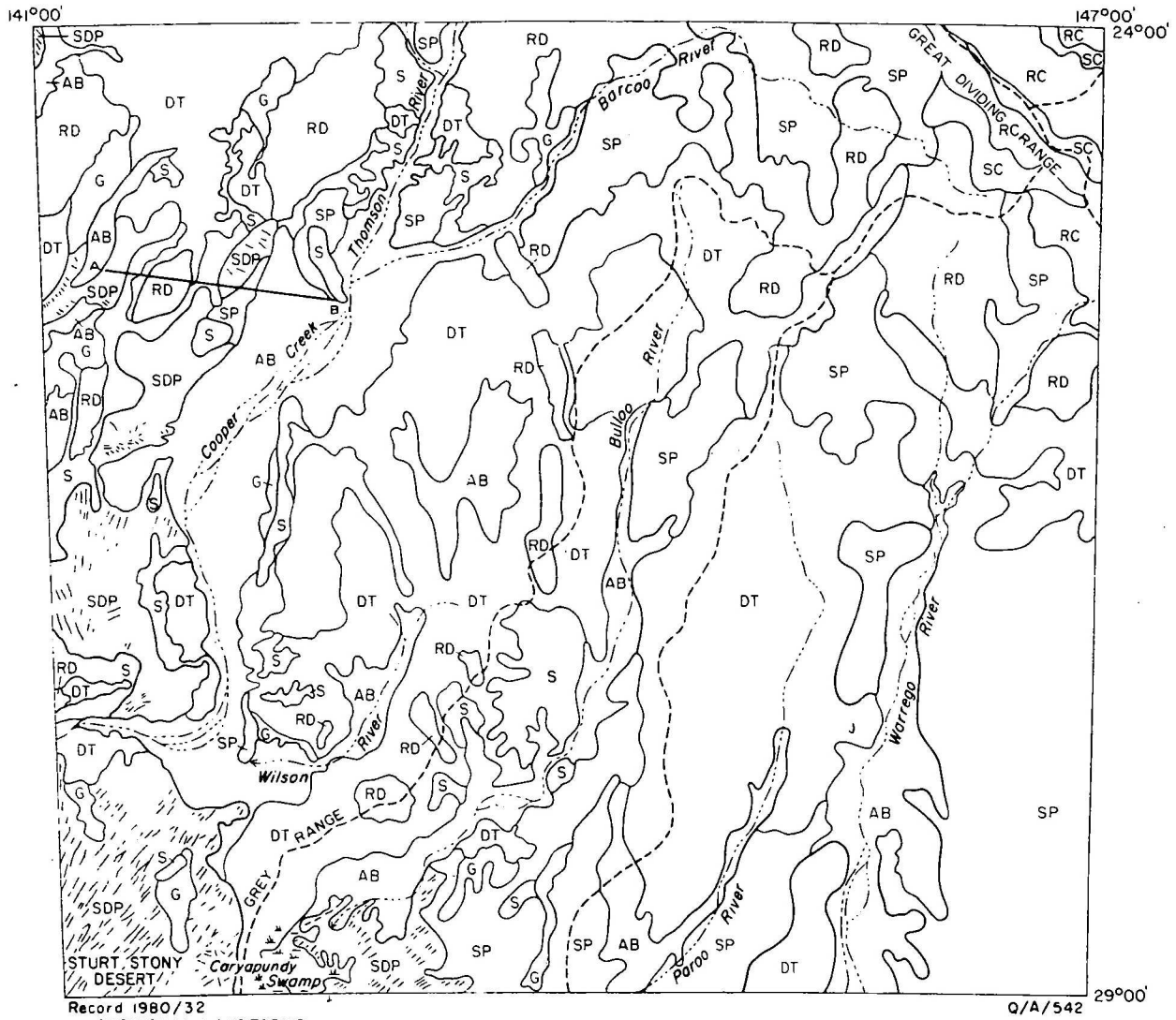

Fig.2 Physiographic sketch map and diagrammatic section showing relation between landscape type and weathered Cretaceous rocks, Tertiary quartzose rocks and younger alluvia (from Senior & others, 1978)

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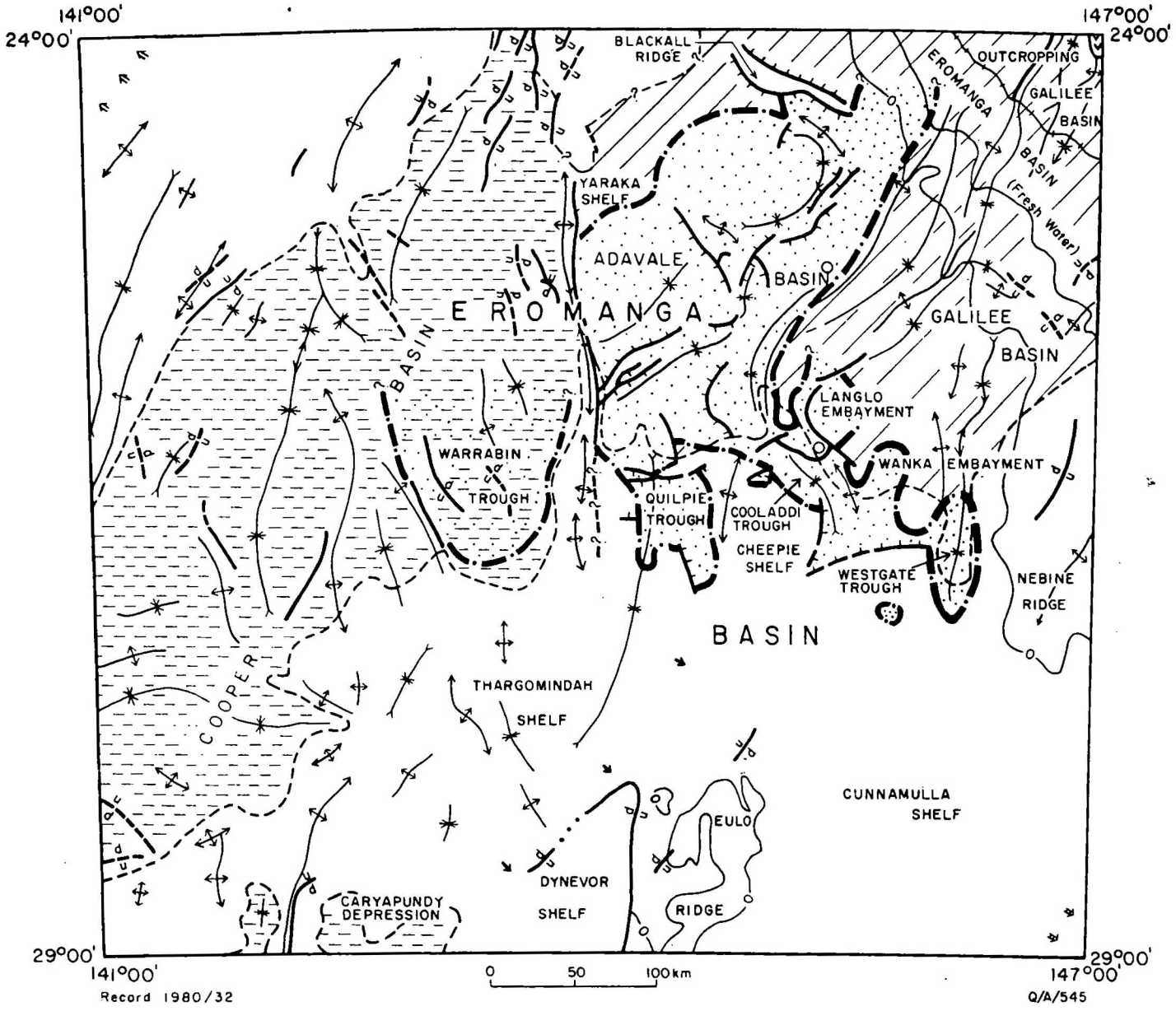


Cooper Basin

Adavale Basin (overlain by Galilee)

Outcrop margin of Eromanga Basin

Zero structure contour on base of Rolling Downs Group (datum M.S.L.)

Anticline axis with plunge direction

Syncline axis with plunge direction

Monocline

Fault cutting Eromanga Basin and older rocks

Thinning of Eromanga Basin rocks towards the Boulia Shelf

Galilee Basin

Outcropping Drummond Basin

Thinning of Eromanga Basin rocks towards Dynevor, Cunnamulla Shelves and Eulo Ridge

Thickening of Eromanga Basin rocks towards the Surat Basin

Concealed truncated margin of Permo-Triassic Cooper and Galilee Basins

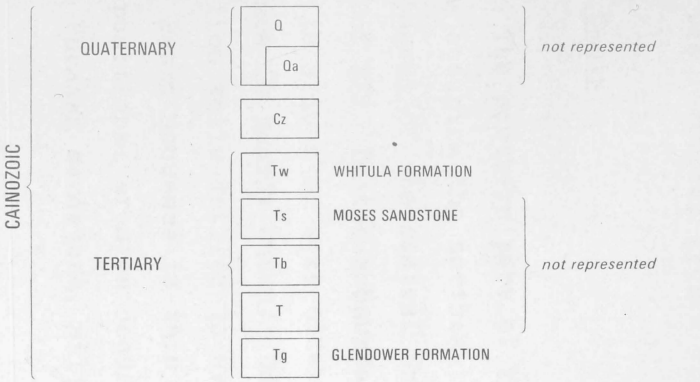
Fault cutting pre Eromanga Basin rocks

Margin of Adavale Basin and equivalents

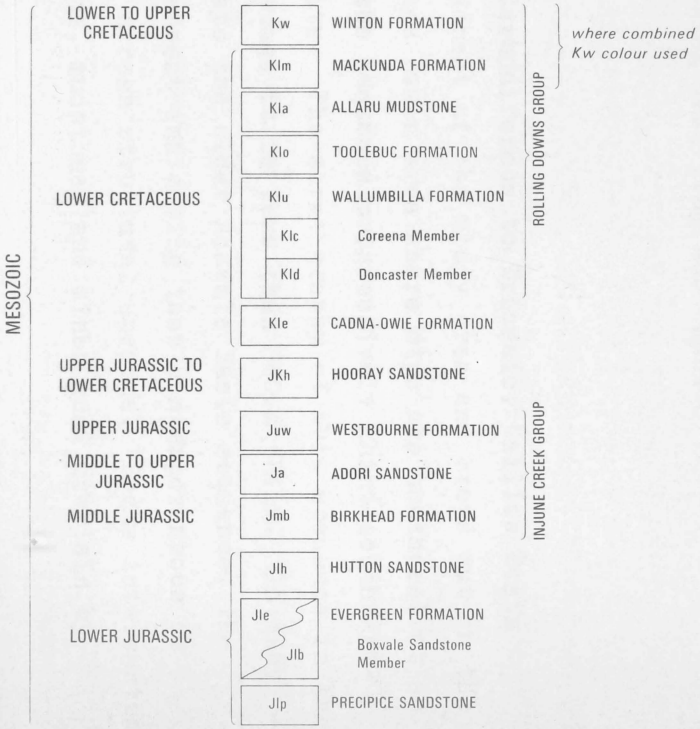
Fault cutting Adavale Basin rocks

Salt diapir in Adavale Basin rocks

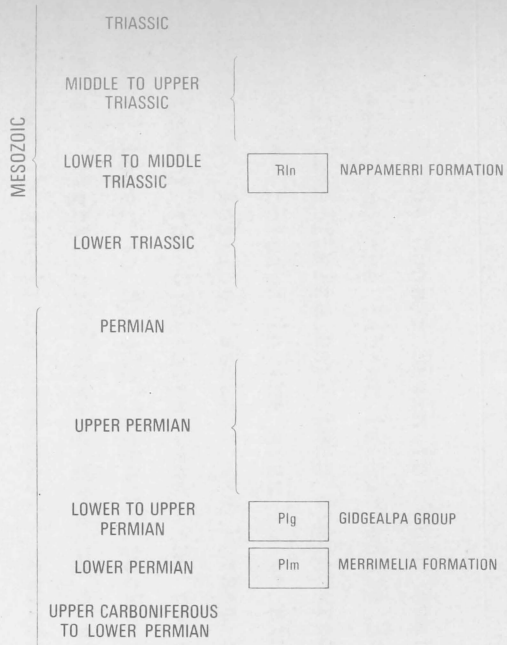
Fig. 3. Structural sketch map (from Senior & others, 1978)



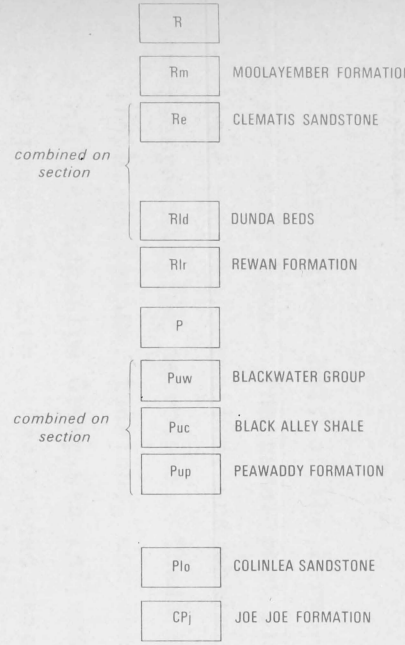
EROMANGA BASIN SEQUENCE



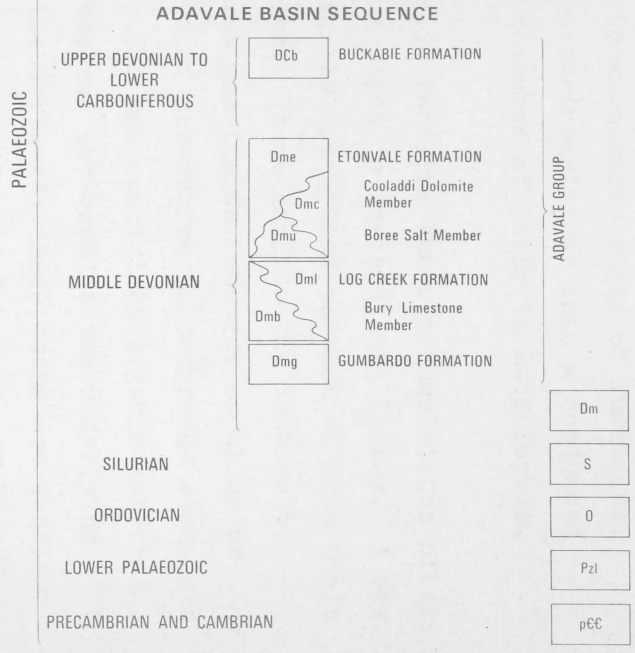
COOPER BASIN SEQUENCE



GALILEE BASIN SEQUENCE



ADAVALE BASIN SEQUENCE



DRUMMOND BASIN SEQUENCE

Table 1

Stratigraphy (from Senior & others 1978)

Cooper Basin (Queensland)

The eastern half of the Permo-Triassic Cooper Basin lies within the proposed study area. The basal part of the sequence consists of probable glacigene rudites, arenites, and shale of the Merrimelia Formation which are non-prospective for petroleum. These rocks are conformably overlain by sandstone, siltstone, mudstone, and coal of the Gidgealpa Group. The distribution of the Gidgealpa Group was influenced by periodic contemporaneous movement along structural axes. Facies and thickess variations are particularly prevalent in the Queensland portion, making basin-wide correlation of individual formations difficult. The sequence merges northeastwards into a condensed sequence (< 100 m thick) of unnamed coal measures of Early to Late Permian age.

The Cooper Basin in South Australia contains known accumulations of oil and gas, and the latter is currently being piped to Adelaide and Sydney. A few smaller gas fields have been discovered in the Queensland portion of this basin which is included in the area to be studied. These include the Roseneath, Wolgolla, Epsilon, Wackett and Durham Downs gas-fields. Source rocks occur throughout the Gidgealpa Group and consist of non-marine carbonaceous rocks and coal. Lower to Middle Triassic rocks for the most part lack organic material and are tight, effectively forming a widespread cap rock to the underlying dominantly gas-prone sequence. Towards the northeast these rocks are sandier with shale interbeds. In this area one show of oil of 3.8 barrels of 53 API gravity was recovered from a drill stem test from AOD Chandos 1.

Galilee Basin

The southern part of the Carboniferous to Triassic, Galilee Basin sequence occupies the northeast quadrant of the study area and crops out in the far northeast of the central Eromanga Basin area where dips are southwest at an average of 4°. In the subsurface the sequence progressively thins southwestwards with a loss of some older units. The stratigraphy of this sequence in the subsurface is poorly known. On average it is less than 500 m thick. In many exploration wells drilled to evaluate the older Adavale Basin sequence, the Galilee Basin sequence is thin or absent indicating that contemporaneous or post-depositional erosion occurred across structural upwarps. Rocks intersected include Permian sandstone, siltstone, mudstone, and minor coal overlain by

Triassic quartzose to sublabile sandstone and mudstone. The sequence appears to be partly contemporaneous with the Cooper Basin sequence, and both sequences are interconnected across the northernmost part of the Canaway Ridge.

The hydrocarbon potential of this sequence is not known in the central Eromanga Basin area. As discussed previously, the sequence is thin in structures that have been drilled to date, but seismic evidence shows some thickening towards synclinal axes. The carbonaceous rocks and coal seams may have source rock potential. This sequence is thought to be in hydraulic continuity with the Eromanga Basin sequence, and any hydrocarbons generated in the Galilee Basin may have migrated under the influence of the prevailing southwest movement of groundwater in the former basin. Hydrocarbon entrapment is theoretically possible under these conditions (see Senior & Habermehl, 1980).

Eromanga Basin

The Eromanga Basin consists of an essentially conformable sequence of Early Jurassic to Late Cretaceous age. Most units crop out in the northeast, elsewhere the youngest unit lies close to the surface.

The Jurassic sequence, 500 to 1200 m thick, consists mainly of continental quartzose arenite interbedded with carbonaceous siltstone, mudstone, and minor coal measures. A basal marine or paralic unit, as yet unnamed, may occur within the deepest part of the basin coincident with the Thomson and Cooper Synclines and Wilson Depression (Plate 1). The preserved Cretaceous sequence is 500 to 1800 m thick in the central Eromanga Basin region, the thickest accumulations coincide with the previously mentioned synclinal structures. The mainly marine Early Cretaceous sequence consists of labile arenite interbedded with montmorillonite-rich siltstone, mudstone, and claystone. Similar rocks occur in the Late Cretaceous sequence but were deposited in paralic, lacustrine, and fluvial environments.

By the beginning of 1980, about 75 petroleum exploration wells had been drilled in the central part of the Eromanga Basin, but less than twenty were designed to test the Eromanga sequence. A significant number were drilled in areas where the rocks are immature (Table 2); and apparently no account was taken of the major role played by basin-wide groundwater movement in the migration and entrapment of petroleum in siting any of the wells.

Discovery of gas, in economic quantities within Jurassic rocks at Namur 1 in South Australia, and in subeconomic quantities in Wackett 1 in Queensland, has led to a revival of interest in the Eromanga Basin sequence. Jurassic rocks have also yielded significant quantities of oil (Poolowanna 1, Strzelecki 3, and Dullingari North 1). Source rock and maturity data (Table 3) show that the sequence is marginally mature to mature and contains fair to very good source rocks for oil. Habermehl and Senior (1980) have recently reviewed the petroleum prospectivity of this basin in relation to hydrodynamic trapping mechanisms.

STRUCTURAL SETTING

Structures affecting the Eromanga Basin and underlying Galilee, Cooper and Adavale Basins are shown in Figure 3 and Plate 1.

The dominant structural trend is northeast, modified in places by a northerly component. The Adavale Basin and the Warrabin Trough are bounded by north or northeast-trending faults or fault-associated basement highs. The Canaway Fault which forms the western margin of the Adavale Basin also partly separates the Galilee Basin from the Cooper Basin. To the west of the Canaway-Stormhill Fault system, the dominant structural trend is northwards.

In the western half of the region, movements of basement horsts give rise to asymmetric surface anticlines within the Eromanga Basin sequence, or to faults. All faulting and folding in the Eromanga Basin sequence reflects stronger deformation either in underlying basin systems or in the basement. The positions of the axes of the Cooper and Adavale Basins approximately correspond to synclines within the Eromanga Basin.

Deformation within the Adavale, and nearby Drummond Basin, sequences increases in intensity eastwards, and is the result of folding, faulting, and overthrusting, which occurred during the Late Carboniferous Kanimblan Orogeny. Further deformation, along pre-existing trends during the Cainozoic, led to additional movement along some faults and folds in the younger Galilee and Eromanga Basin sequences.

Most known folds and some faults were identified during reconnaissance geological investigations using sparse field data, standard photo-interpretation techniques and information from seismic surveys (Senior & others, 1978). During later studies (Senior, 1977; Senior & Habermehl, 1980) further linear features were identified using 1:50 000 scale aerial photographs and LANDSAT imagery for the western part of the central Eromanga Basin. It was found that in general all but the thickly alluviated tracts, commonly coincident with

synclines, contain linear features and that several coincide with faults delineated by seismic surveys. In places lineations "extend" seismically determined faults for considerable distances.

PREVIOUS GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS

Geological mapping

Systematic geological mapping of the Central Eromanga Basin was carried out by BMR and the Geological Survey of Queensland from 1964 to 1968. Twenty 1:250 000 series geological maps and explanatory notes were completed and published by the end of 1972. Syntheses of information from these surveys were presented by Exon & Senior (1976) and Senior & others (1978). A special study of the geology and geomorphology of the western part of the area reported by Senior (1977) indicated that information on the development of landforms in response to weathering and tectonic setting led to a better understanding of the evolution of this region. A method of dating weathered rocks from the area using palaeomagnetism was pioneered by Idnurm and Senior (1978). The subtle expression of landforms and associated structure interpreted from LANDSAT imagery and aerial photographs, together with a more accurate picture of groundwater flow, led to the development of the hypothesis by Senior and Habermehl (1980) regarding possible migration and entrapment of hydrocarbons within this region. Discovery of oil and gas within Eromanga Basin rocks mainly outside the area gave the impetus for further research into this hypothesis.

The results of previous work are of recent origin, and the relatively simple surface geology does not warrant further detailed geological mapping work at present. In addition to the 1:250 000 series of geological maps there is a synthesis of the geology at 1:1 000 000 scale and a special geology and geomorphic map of the Haddon Corner area at 1:250 000 scale. The subsurface geology of the region is presented in BMR Bulletin 167 of the region (Senior & others, 1978) in a series of structure contour and isopach maps at 1:1 000 000 scale.

Hydrogeology

The central Eromanga Basin forms part of the hydrogeological Great Artesian Basin, a multi-aquifer confined groundwater basin (Habermehl, 1980). Flow directions are west to southwest (Fig. 4) in the main Jurassic-Lower

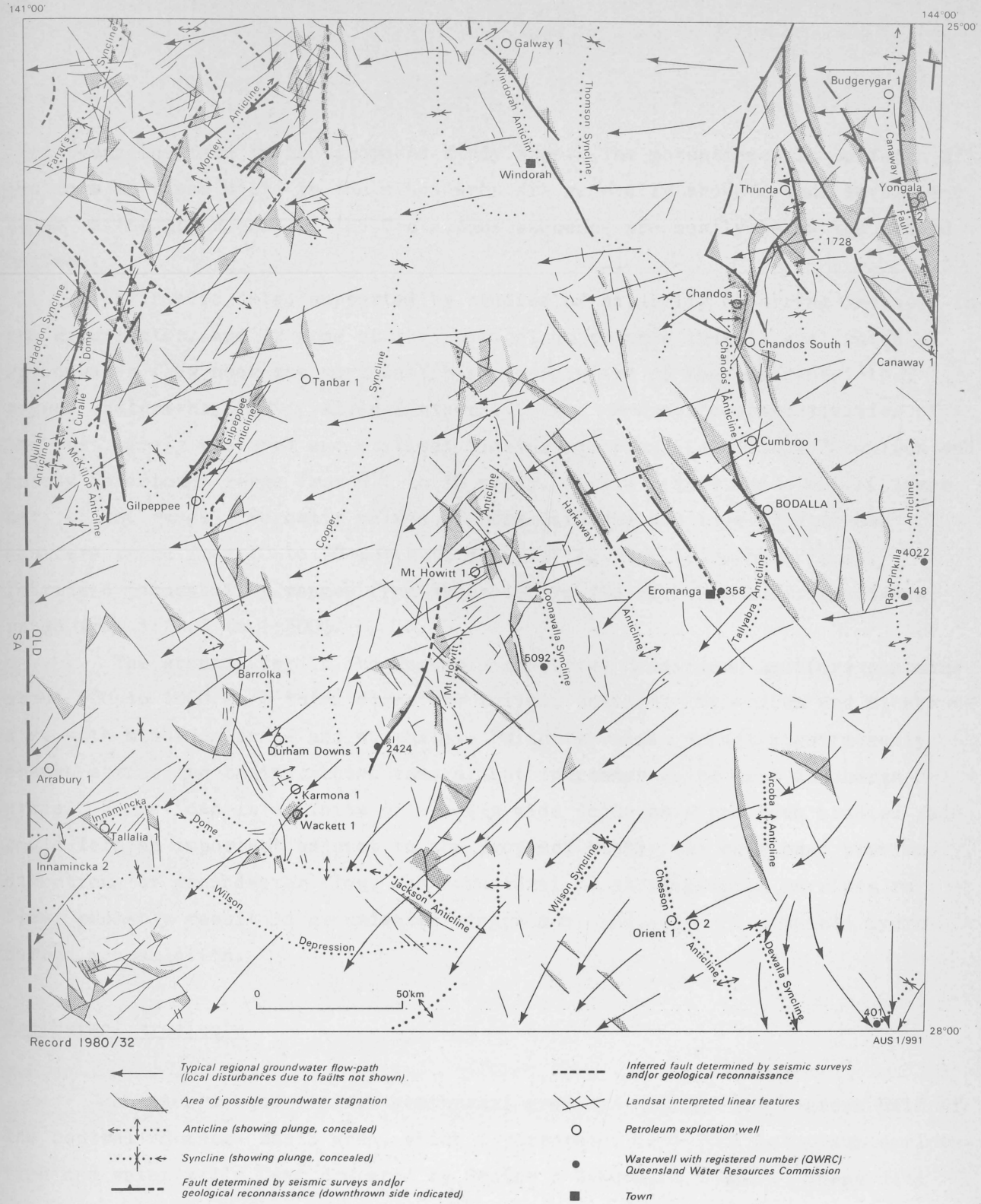


Fig. 4 Regional groundwater flow in the Great Artesian Basin (from Senior & Habermehl, 1980)

Cretaceous aquifers in the proposed study area. The potentiometric surfaces of aquifers in these units in the study area are generally above ground level, and those in the upper part of the Cretaceous sequence are mostly below the ground surface.

Hydraulic data, supported by studies of naturally occurring isotopes in the groundwater, and by some of the chemical data, show that lateral rates of groundwater flow near the northeast basin margin are of the order of 1 to 5 m/year (Habermehl, 1980; Airey & others, 1979). Hydraulic conductivities of the most widely explored and utilised flowing aquifers (Cadna-owie Formation and Hooray Sandstone) range from 0.1 to 10 m/day, with a predominance in the lower part of the range. Porosity values of most Jurassic and Lower Cretaceous aquifers range from 10 to 30 percent, diminishing with increasing depth, intrinsic permeability ranges from about 100 to 400 md. Hydraulic gradients range from 1:2000 to 1:3000.

The groundwater in the Jurassic and Lower Cretaceous aquifers contains about 500 to 1000 mg/l total dissolved solids, dominated by sodium and bicarbonate, with minor chlorate and sulphate. Salinity values do not significantly change across the basin, though some slight increases occur near discharge areas. Variations in salinity on a basin-wide scale have not been studied and could form an important adjunct to the proposed study. As mentioned previously, directions of groundwater flow, and structural or stratigraphic barriers to flow, probably result in groundwater stagnation, and sites of possible hydrocarbon accumulation.

Geothermal gradients

An uncorrected minimum geothermal gradient map for the western half of the central ERomanga Basin area, which incorporates data from petroleum exploration and water wells, was prepared by Senior & Habermehl (1980). These data show that a large portion of the area has above average geothermal gradient (33°C/km for continental areas); high values (over 50°C/km) occur above shallow basement shelves (Thargomindah and Dynevor Shelves), and adjacent to major faults. Regional trends indicate gradual gradient increases towards the Diamantina Slope and towards the Wilson Depression. Polak & Ramsay (1977) and Polak & Horsfall (1979) attribute local high gradients to upward migration of hot artesian water along fractures. Increasing geothermal heat is thought by Kantsler & others (1979) to be a post-Cenomanian phenomena, and may have

coincided with a period of gentle folding and faulting following the Late Miocene (Senior & Habermehl, 1980). The high temperatures probably produced an increase in maturity of potential hydrocarbon source rocks.

Source rock analysis

Thirty-five petroleum exploration wells in the central Eromanga Basin area have been sampled for source rock analysis (Table 4). All cored intervals have been analysed but no work has been attempted on analysis of drill cuttings. The maturity and source rock potential of the Eromanga Basin and part of the Cooper Basin in Queensland have been described briefly by Senior & Habermehl (1980). That of the other pre-Eromanga Basins have not been evaluated although results of some analyses are on file within the Petroleum Exploration Branch, BMR.

Gravity surveys

Reconnaissance, and some detailed, gravity coverage has been obtained over the central Eromanga Basin area by BMR and by petroleum exploration companies. The surveys and their references are listed in Table 4.

Regional gravity data (Fig. 5) show good spatial correlation with the structure of the various sedimentary basins as defined by other geophysical and geological information. The gravity lows, marked A to E in figure 4, (lower than -200 $\mu m/s^2$) correspond with the areas of thicker sedimentary rocks within synclinal depressions or troughs, whereas the higher gravity values (higher than -200 $\mu m/s^2$) correspond with the areas where the sedimentary rocks are thin, and conceal ridges within the basins. Additionally, the deeper parts of the gravity lows (lower than -300 μ/s^2) broadly correspond with the areas containing concealed Devonian-Carboniferous sedimentary rocks of the Adavale Basin and the Warrabin Trough. On this basis, gravity lows in other areas within the central Eromanga Basin region indicate Permo-Triassic sediments in A, and Devonian-Carboniferous below the Permo-Triassic sedimentary sequence in areas B, C, D and E. No seismic or bore hole information is available in area A; however, in areas B, C, D and E, scanty seismic data support this interpretation.

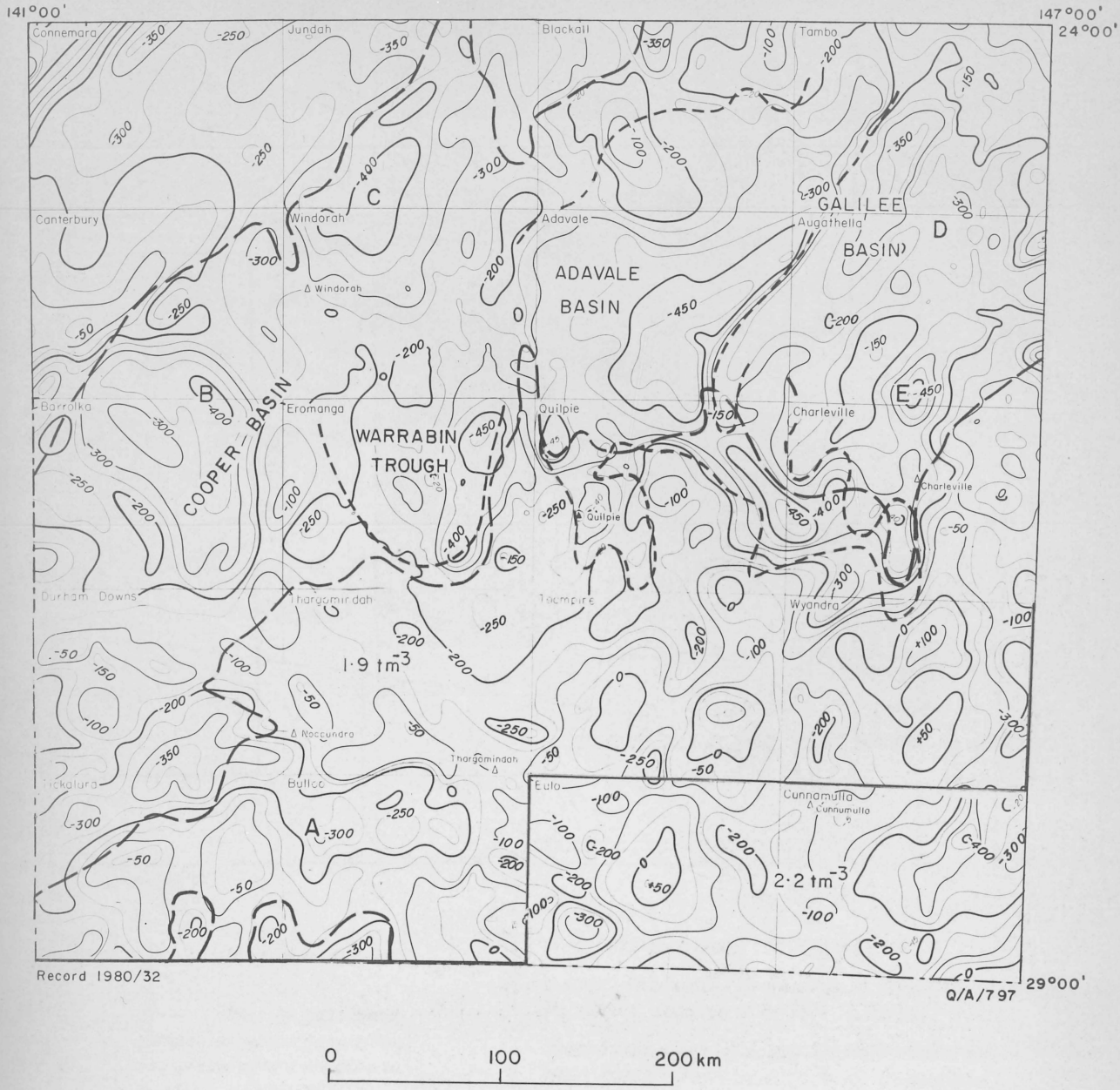
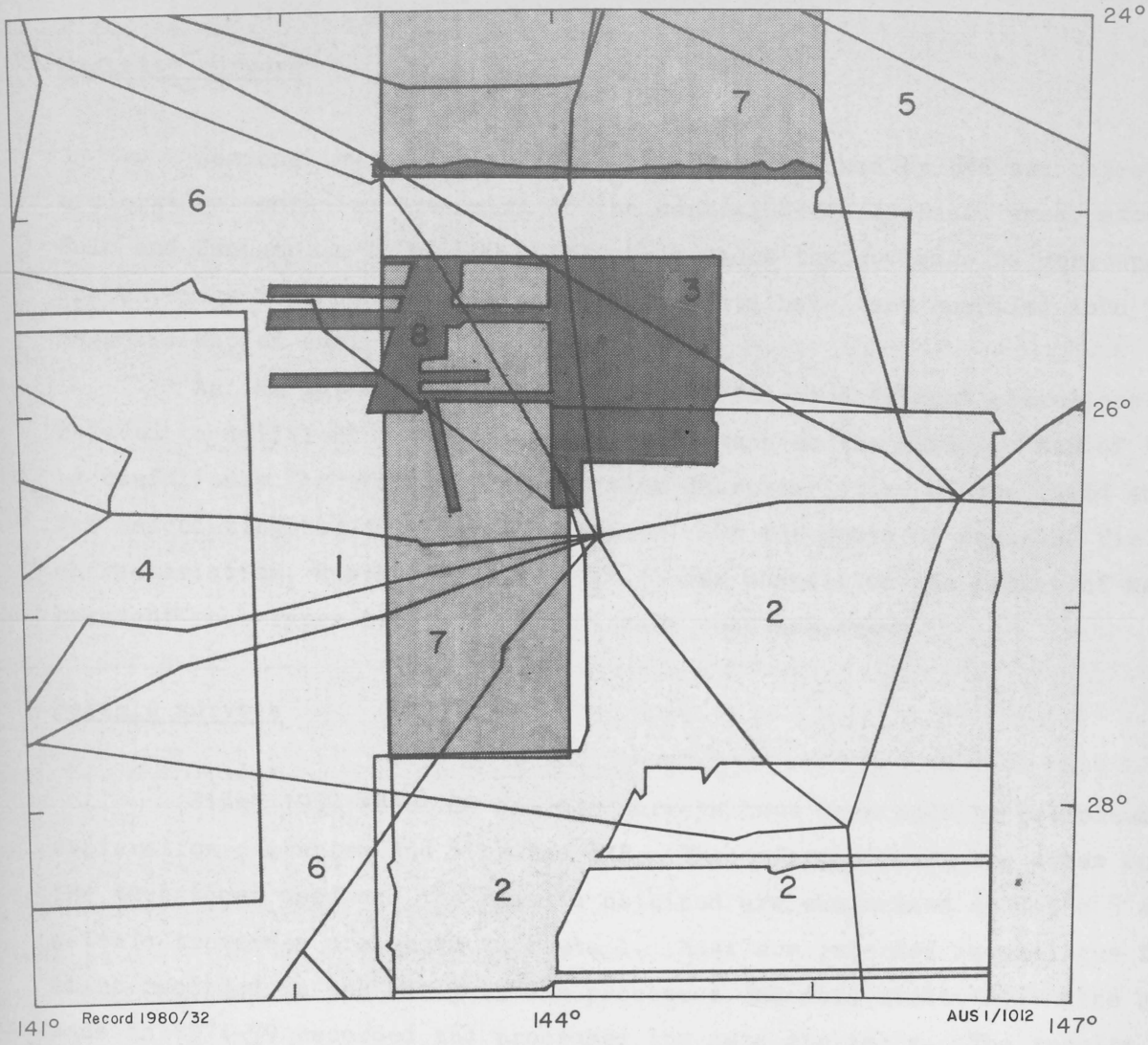


Fig.5 Bouguer gravity anomaly contour map



Surveys flown by or for BMR

Surveys flown by subsidised companies and organisations who made data available to BMR on restricted or unrestricted basis

Area covered by both of the above

0 100 200 km

1 *Great Artesian Basin 1958 BMR 60/14*

2 *Quilpie - Charleville - Thargomindah Phillips Petroleum Company 62/1704 (subsidy)*

3 *Jundah - Windorah - Blackall Adavale - Augathella 1960 Phillips Petroleum Company Queensland Mines Department*

4 *Innamincka - Betoota - SA Delhi Australian Petroleum 62/1709 (subsidy)*

5 *Tambo - Augathella 1962 Magellan Petroleum Corp. 62/1703 (subsidy)*

6 *Cooper Creek 1963 Delhi Australian Petroleum 63/1705 (subsidy)*

7 *Central Great Artesian Basin 1962 BMR 69/33*

8 *East Windorah 1974 XLX NL 74/220 (subsidy)*

Fig. 6 Aeromagnetic coverage

Magnetic surveys

Regional aeromagnetic data have been obtained by BMR and petroleum exploration companies over most of the central Eromanga Basin area, except in Eulo and Cunnamulla 1:250 000 sheet areas where the coverage is very sparse. The coverage is shown in Figure 6; these data have been compiled into the Magnetic Map of Australia (BMR, 1976).

As the aeromagnetic data were recorded at different elevations and reduced to different datums, a compilation such as the Magnetic Map of Australia is useful only for studying the relative characteristics of the field and not for calculating the depth to the sources. On the basis of magnetic field characteristics, Rumph (1978, Fig. 11.1) has postulated the extent of major basement rock types below the sedimentary rock sequences.

Seismic surveys

Since 1959 about 80 seismic surveys have been made by petroleum exploration companies and 5 by the BMR. The information on the areas surveyed, the techniques used and the results obtained are summarised in Table 5 and the seismic traverses are shown in Plate 1. Most are recorded in analogue form; eight recorded in the early 1970's processed the data digitally. Nine surveys made in 1974-79 recorded and processed the data digitally. The results from all surveys show that the quality of data obtained has improved with developments in the recording and processing equipment, and techniques. The 1978 surveys by Aquitaine in the Adavale Basin area show the best quality of data obtained so far, especially from the pre-Eromanga sedimentary basins.

The earlier, poorer quality data are useful in mapping the thickness and structure of the Jurassic-Cretaceous Eromanga Basin, and Permian-Triassic Cooper and Galilee Basins sedimentary rocks down to the strong reflector 'P' near the top of Permian. The analogue methods were only partially successful in investigating either the Devonian-Carboniferous, Adavale Basin sedimentary rocks below 'P' or the basement. As a result, the nature and extent of Adavale Basin sequence is, in places, only poorly known. The 1978 Aquitaine surveys suggest that modern digital techniques of recording and processing are most effective in mapping the extent, thickness and structure of the Adavale Basin and equivalent troughs.

SPECIFIC PROBLEMS

There are many gaps in our knowledge of the depositional and structural history of the central Eromanga Basin area, and its potential petroleum resources. The Eromanga Basin and the basins below are large by world standards and yet there are many parts which are relatively unexplored. These include important geological features such as concealed basin boundaries, major faults and fault-induced structures.

Also within the known regional framework there are many unresolved problems. Specific problems already recognized are tabulated below; other problems may become apparent as further studies are made in the area.

Adavale Basin and Warrabin Trough

1. The identity and distribution of Devonian-Carboniferous rocks within the Westgate, Cooladdi and Quilpie Troughs and the distribution of these rocks in the Warrabin Trough are not well defined.

2. The nature of the sedimentary sequence along the northwest margin at the edge of the Yaraka Shelf, is virtually unknown. Improved reservoir characteristics could occur in the Log Creek Formation, which in this area may relate to the former depositional margin of the basin.

3. The evaporites sequence, and the salt diapirs which occur along the faulted eastern margin with local thickening to within 1000 m of the surface, are not well known despite known petroleum entrapment in such structures in other parts of the world.

4. The structure, Devonian stratigraphy and depositional environment of the Adavale Basin east of the Pleasant Creek Arch is largely unknown. Existing seismic and drill data suggest a thick marine sequence, but there is very little seismic coverage, and no seismic sections provide information on the deeper parts of the sequence. In addition folding and faulting is more intense towards the east, making interpretation more difficult there.

5. The importance of the Pleasant Creek Arch, and other structural highs, to Devonian deposition is unknown, and the overall depositional history of the central part of the Adavale Basin has not been resolved. Isopach maps indicate an arcuate pattern of deposition from the Bury/Stafford area to the Dartmouth/Quillberry trend, whereas general facies changes appear to be from west to east.

Cooper Basin (Queensland)

6. Little is known of the nature and thickness of Cooper Basin sediments in the Thomson Syncline.

7. The nature and thickness of the sedimentary sequence along the axis of the basin are ill-defined.

8. Cooper Basin rocks may be present in the Caryapundy Depression in the south.

9. The structural and stratigraphic relationships between the Cooper and Galilee Basins, where they are connected across the northern part of the Canaway Ridge, are not well understood and need to be investigated.

10. Structural relationships are not well understood where there are large gaps in seismic coverage around the concealed basin margins. In places the Cooper Basin sequence is faulted against basement highs, and elsewhere there is evidence of onlap. Embayments along the southeastern margin resulting from block-faulted growth structures could be of interest in exploring for petroleum accumulations in structural or stratigraphic traps.

Galilee Basin

11. The stratigraphy of the Galilee Basin sequence in the central Eromanga Basin area is poorly known. It is generally less than 500 m thick in the area.

Eromanga Basin

12. Information is required on the distribution of Lower Jurassic rocks; rocks of this age were found only in one well within the Cooper Syncline. These rocks are probably equivalent in age to the prospective Evergreen Formation and Precipice Sandstone Formation of the Surat Basin and to the Lower Jurassic, unnamed sequence encountered in Poolowanna 1.

13. The overall thickness and extent of source rocks within the Eromanga Basin sequence is poorly known.

14. The hypothesis of minor faults forming structural and stratigraphic barriers to groundwater flow, resulting in groundwater stagnation and possible traps for hydrocarbons needs to be investigated.

PROGRAM

The project will be a multidisciplinary investigation which will aim at determining:

- The geological history of the central Eromanga Basin area.
- The nature, thickness and distribution of sedimentary rocks, including source, reservoir and cap rocks within the area.
- The thermal history of the sedimentary sequence.
- The structural deformation of the area and its timing with respect to petroleum generation and migration.
- The various petroleum prospecting plays relevant to the area.
- An assessment of the potential petroleum resources.

Regional work will be planned, over a three-year period, to obtain basin-wide stratigraphic correlations, to study the properties of the rocks, and to investigate the structural relationships of the basins. Studies of regional geological and geophysical information, LANDSAT data, drill cores and cuttings, and wireline logs will be made. Further geological and geophysical surveys will be required particularly where new and improved techniques and surveys can provide information to fill gaps in understanding the geology of the area.

A major part of the program will involve recording regional seismic reflection and refraction traverses and detailed gravity traverses across the main structural elements of the basin tying between some of the principal wells. Seismic stratigraphic information, with geological control from well sections, and wireline logs will enable lithofacies correlations to be attempted. This information together with that obtained from analysis of deep crustal reflection and refraction information obtained on key traverses will be used to provide the basic framework for determining the structural and depositional history of the area. Information from new magneto-telluric, high-sensitivity aeromagnetic, electrical, electromagnetic, and other surveys and studies may also assist in refining the picture.

Source rock and maturation data from wells in the most prospective areas will be reviewed, and new maturation studies will be undertaken on drill cuttings from critical sections in the wells, using the "Pyrolysis" method. New information on geothermal gradients will be obtained from field measurements in deep holes drilled on the key traverses.

The results of particular investigations may be published as tasks are completed. The information obtained will be integrated with other pertinent information progressively to provide a better understanding of the central Eromanga Basin area and its potential petroleum resources.

To assist in planning studies and surveys the area is split here into two parts:

(1) West of the Canaway Fault including the Thomson and Cooper Synclines and the underlying Warrabin Trough.

(2) East of the Canaway Fault including the Adavale Basin and associated troughs.

Broad outlines of the work proposed in these areas are given in Table 6. Details of studies, surveys, staff and their involvement are given in the BMR Program documentation.

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Note: References are also given in Figures 1 and 5, Tables 2, 3 and 5 and Plate 1 to BMR Records, Reports and Bulletins, Petroleum Search Subsidy Act Files, State Government, company and other published and umpublished reports. Full reference details for these are included in BMR Bulletin 167, (Senior & others, 1978). Unpublished reports are available for study at the BMR, Canberra and the Geological Survey of Queensland.

APPENDIX 1
GEOGRAPHICAL SETTING

The central Eromanga Basin is taken as the area from 24° to 29°S and from 141° to 147°E; it includes twenty 1:250 000 Sheet areas (Fig. 1).

Relief is very subdued (Fig. 2); elevation ranges from 60 m above sea level in the southwest to about 500 m in the northeast. Extensive alluviated plains of the Channel Country are separated by interfluves of dissected plateaus. 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. The most strongly dissected country is in the northeast along the Great Dividing Range, and landforms in this area feature numerous cuestas and strike ridges.

Riverine plains widen to the south, where they consist of alluvial flats dissected by a complex of braided stream 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 these merge imperceptibly eastwards into flat sandplain and monotonous scrub-covered, red, sandy-soil plains.

Sealed and unsealed roads and station tracks provide access to all but the sand dune country in the southwest. The basin is transected east to west by the sealed Diamantina Developmental and Bulloo Developmental Roads. The Western Railway which terminates at Quilpie, and the Southwestern Railway which terminates at Cunnamulla, service the eastern half of the area. TAA provide regular air services to several towns within the region.

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TABLE 2

HYDROCARBON OCCURRENCE WITHIN, OR IN HYDRAULIC CONTINUITY WITH, THE EROMANGA BASIN SEQUENCE

(Senior and Habermehl, 1980)

Petroleum exploration well name and number	Hydrocarbons	References
DSVAT Wackett 1	Gas at 2 200 MCFD from Hutton Sst and 100 MCFD from Injune Creek Group	BMR data
AOD Budgerygar 1	Minor gas shows in Hutton Sst	Cadart, 1969
AOD Chandos 1	3.8 barrels 53 gravity oil in DST from the Triassic	Laing & Benedek, 1966
AOD Cumbroo 1	Trace of oil in Permian	Campe, 1969
DS Mount Howitt 1	Minor shows in Jurassic and in Nappamerri Formation	Delhi-Santos, 1966
+SOE Scout 2 (Canaway Downs)	Grease, methane and nitrogen from Winton Formation	GSQ, 1960-65
+SOE Scout 3 (Gumbla)	Grease and numerous gas shows of hydrogen, methane and inerts within Winton Formation	GSQ, 1960-65
+SOE Harkaway Scout 1	Numerous gas shows/hydrogen and methane in Winton Formation	GSQ, 1960-65
SOE Orient Scout 1	Numerous gas shows (hydrogen, inerts and methane) mainly from Hooray Sst	GSQ, 1960-65
SOE Orient Scout 2	Gas show in Allaru Mudstone?	GSQ, 1960-65
DFS Betoota 1	Yellow fluorescence, oil stain and gas from Injune Creek Group and Hutton Sst	Harrison & others, 1961
Water well		
*7311 (Tallyabra)	Oil of vaseline-like consistency and inflammable gas in Winton Formation	Cameron, (undated)
*357 (Eromanga Town)	Methane and inert gas probably from Winton Formation	GSQ, 1960-65
*358 (Eromanga Town)	Carbon dioxide and methane from Winton Formation and Hooray Sandstone	GSQ, 1960-65
*3950 (Lynfield)	Methane in Winton Formation	GSQ, 1960-65
*1728 (Bulgroo)	Inflammable gas at 800 psi from Allaru mudstone and wax in Injune Creek Group	GSQ, 1960-65

+ Percussion drill holes which failed to penetrate the entire Eromanga Basin sequence.

* Water well number refers to Registered Number of Queensland Water Resources Commission. These water wells were completed in aquifers no older than the Hooray Sandstone.

TABLE 3. SOURCE ROCK AND MATURITY DATA FOR THE EROMANGA AND COOPER BASIN SEQUENCES IN SOUTHWEST QUEENSLAND (Senior & Habermehl, 1980)

Lab. No.	Well	Core	Depth (metres)	Age	Formation	Total Extract (ppm)	Alphatic fraction (ppm)	Aromatic fraction (ppm)	Polar fraction (ppm)	Organic C (%)	Reflectance (%) *	INTERPRETATION Maturity index	Hydrocarbon potential
61392	Betoota 1	10	1283	Jurassic	Westbourne Fm	1892	555	625	210	2.00	0.63(85)	M	Very good oil source
61393	"	12	1460	"	Adori Sst	533	41	33	20	0.20	0.76(20)	M	Poor oil source
61394	"	13	1591	"	Birkhead Fm	3281	330	1404	266	4.30	0.95(80)	M	Good oil source
61395	"	14	1746	"	Hutton Sst	105	24	10	43	0.15	0.99(25)	M	Poor oil source
61396	Canaway 1	2	334	Cretaceous	Winton Fm	5357	316	338	654	20.44	0.47(70)	EM	Good gas source
61397	"	3	500	"	Allara Mdst	212	57	26	88	1.45	0.46(70)	EM	Fair oil source
61398	"	6	921	"	Cadna-owie Fm	142	18	12	82	0.25	0.50(68)	EM	Poor oil source
61885	"	7	1091	"	Hooray Sst	190	22	6	31	0.65	0.69(68)	M	Poor oil source
61400	"	8	1212	Jurassic	Adori Sst	1058	69	125	276	1.15	0.49(69)	EM	Fair oil source
61401	"	9	1330	"	Hutton Sst	429	60	49	153	0.45	0.48(66)	EM	Fair oil source
61402	"	10	1416	"	Hutton Sst	6118	118	1645	1700	6.15	0.52(70)	EM	Good-very good oil source
61403	Yongala 1	1	1355	Cretaceous	Cadna-owie Fm	591	47	12	306	0.50	0.58(68)	EM	Fair-good oil source
61404	"	4	1723	Jurassic	Birkhead Fm	414	61	96	122	0.50	0.56(70)	EM	Fair oil source
61405	"	8	2022	Triassic	?	369	10	14	110	0.10	0.59(5)	EM	Poor oil source
61437	Chandos 1	1	1427	Cretaceous	Hooray Sst	505	166	137	183	1.15	0.54(70)	EM	Good oil source
61439	"	7	2171	Triassic	Nappamerri Fm	402	8	19	732	0.15	0.56(10)	EM	Poor oil source
61442	"	10	2369	"	" "	627	148	66	265	0.35	0.70(30)	M	Good oil source (low C)
61441	"	14	2431	Permian	Gidgealpa Fm	26597	203	560	398	21.11	0.83(70)	M	Gas source

Analyses by Dr J.D. Saxby and L. Bruen CSIRO Fuel Research Unit.
Hydrocarbon potential interpreted by Dr K.S. Jackson, Petroleum Technology Section, BMR Canberra.

Lab. No.	Well	Core	Depth (metres)	Age	Formation	Total Extract (ppm)	Hydrocarbons ppm of rock	Hydrocarbons mg/g O.C.	Hydrocarbons % of extract	Organic C (%)	Reflectance (%) *	INTERPRETATION Maturity index	Hydrocarbon potential
01	Galway 1	1	2246	Jurassic	pre-Hutton Sst	3170	215	8	7	2.74	0.72(20)	M	Fair oil source
02	Mount Howitt	1	1284	"	Westbourne Fm	1200	55	14	5	0.39	0.45(21)	EM	Poor oil source
03	"	2	1420	"	Birkhead Fm	4173	485	30	12	1.60	0.54(25)	EM	Fair oil source
08	Cumbroo 1	1	1762	"	"	1473	60	11	4	0.54	0.45(26)	EM	Poor oil source
09	"	1	1767	"	"	4230	790	3	19	25.29	0.65(17)	M	Good gas source Fair oil source
10	"	2	1935	"	Hutton Sst	6673	190	6	3	3.13	0.64(15)	M	Fair oil source
11	"	3	2025	Triassic	Nappamerri Fm	2820	60	4	2	1.42	0.67(14)	M	Poor oil source
12	"	3	2029	"	"	10773	560	2	5	22.47	0.72(19)	M	Good gas source Fair oil source
13	"	4	2156	Permian	Gudgealpa Fm	5350	120	1	2	25.96	?0.76-0.87(24)	M	Good gas source Poor oil source
17	Orientos 1	1	1440	Jurassic	Hooray Sst	?11958	?3415	?1313	29	0.26	?0.51(6)	EM	Poor oil source
18	"	3	1584	"	Westbourne Fm	1623	220	13	14	1.76	?0.56(7)	EM	Fair oil source
19	"	4	1659	Triassic	Nappamerri Fm	430	75	24	17	0.31	?0.57(4)	EM	Poor oil source
20	Thunda 1	1	1879	Jurassic	Injune Creek Group	1753	165	14	9	1.15	0.40(30)	EM	Poor oil source
21	"	2	2108	"	" "	1533	480	5	31	10.40	0.71(25)	M	Good gas source Fair oil source
22	"	2	2115	"	" "	7795	415	13	5	3.24	0.71(28)	M	Fair oil source
23	"	3	2291	Triassic	Nappamerri Fm	-	-	-	-	0.09		M	-
25	Chandos 1	4	1806	Jurassic	Hutton Sst	6153	1010	6	16	16.28	0.71(26)	M	Fair oil source

EM = early mature V.R. 0.4 to 0.6%
M = mature V.R. 0.6 to 1.2%
* number of readings shown in parentheses.

Analyses and interpretation by Robertson Research (Australia) Pty Ltd

TABLE 4 - GRAVITY SURVEYS

Year of Survey	Abbreviated title	Company or Organisation	Reference
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	Seismic traverses central and southern Queensland	BMR	Darby, 1965
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
1968	Northern NSW and southern Qld	BMR	Darby, 1969
1968	Coorajah seismic and gravity	Alliance Oil	Alliance, 1968

TABLE 5 - SEISMIC SURVEYS

Ref. No.	Name of Survey	Year	Subsidy File or BMR Record No.	Oil Company	Type of survey and coverage	Record Quality Eromanga	Record Quality Pre-Eromanga	1:250 000 Map sheets	Recording Comments	Processing Comments	General Comments
1	Alpha	62	62/1634	Alliance	Refraction	-	-	Tambo	-	Not worth reprocessing	
2	Bulgroo	63	63/1513	Alliance	Single	Poor	None	Windorah	Analogue, Gen. Geophys.	Analogue	No pre-Eromanga section.
3	Trinidad	64	64/4553	Alliance	Refr. & Refl.; Single	Fair	Good to fair	Windorah	Analogue NGC 26-SS	Analogue, wiggle trace	Blythesdale & Devonian (?) horizons mapped
4	Chandos	65	66/11106	Alliance	Refraction			Windorah			Confirmed presence of pre-Permian.
5	Regleigh	66	66/11120	Alliance	Refr. & Refl.; Single	Fair	Permian good no deeper info	Windorah	Analogue, National Geophys.	Analogue	Thin Permian; Refr. good control.
6	Coorajah seismic & gravity	68	67/11206	Alliance	Single	Fair to poor	Poor below P	Windorah	Analogue, Dynatronics	Analogue	P horizon mapped; poor data below P.
7	South Chandos	69	60/3048	Alliance	Single	Good to fair	Permian top good poor below	Windorah	Analogue, MS-75	Digital	P horizon mapped; poor data below P.
8	Yamma Yamma	69	69/3021	Alliance	6 fold	Fair to poor	Poor	Barrolka	Analogue, MS-15	Digital	C & P horizons mapped; poor deeper reflections present.
9	Booranghoop	69	69/3073	Alliance	Single	Poor	Poor	Tambo	Analogue, MS-15	Not worth reprocessing	3 short lines only. Thin Galilee section, Adavale thrust faulted.
10	Harkaway	70	69/3058	Alliance	6 fold	Good to fair	Fair to poor	Eromanga	Analogue, MS-15	Analogue, Ray System	Mesozoic, P horizon, Mid-Devonian horizon mapped.
11	Blackall-Mitchell	63	62/1618	Amoseas	Single	Poor	Galilee & Adavale - poor	Tambo	PMR-20	Not worth reprocessing	Galilee section thin; Adavale folded and faulted.
12	Tambo	63	63/1521	Amoseas	Single	-	-	Tambo	-	-	See also Ravensbourne survey.
13	Augathella	65	64/4584	Amoseas	Single	Poor	Galilee - poor Adavale - no information	Augathella	3 hole patterns	Not worth reprocessing	Very poor data.
14	Ravensbourne	68	67/11174	Amoseas	6 fold	Poor	Galilee & Adavale poor to fair	Tambo	3 lines, Thumper	Analogue. Lines AS, AU, BA of Tambo survey (single fold) reprocessed digitally	Adavale quality fair, Mid-Dev. Bury Member mapped
15	Thylungra	66	65/11036	BP	Refr. & Refl.; 6 fold	Good	Poor	Eromanga	NGC26-AA, Techno	Analogue	Blythesdale, Permian and pre-P horizons, mapped.
16	Tallyabra	66	66/11129	BP	6 fold	Good to fair	Fair to poor	Eromanga	Analogue, Automan FM, Geograph	Analogue, McCollum	4 horizons mapped (Transition beds, top & base of Permian & mid-Devonian)
17	Quilpie-Eromanga	59	62/161	BMR	Refr. & Refl.; Single	Fair	Poor	Eromanga Quilpie	T1C, DS7	Analogue	Mesozoic & top Palaeozoic mapped along 4 traverses.
18 & 21	Thergomindah-Noccundra	62-63	64/72 66/177	BMR	Refr. & Refl.; Single	Good to fair	Fair to poor	Tickalara Durham Downs Thargomindah Eulo	TI8000; DS7-7 HTL 7000B	Analogue	C & P horizons related to well; steeply dipping refl. below P(Ord?).
19	Westbourne	61	64/73	BMR	Refr. & Refl.; Single	Poor	Good	Augathella	T1C 621, DS7	Analogue, wiggle trace	Base of Meso.-good refl. only.
20	St. George-Eulo	62	66/144	BMR	Refr. & Refl.; Single	Fair to poor		Eulo Wyandra	TI 8000, DS7	Analogue	Basement mapped at 5700 ft.
22	Olive Downs	64	64/4574	Clarence	Refraction	-	-	Tickalara	Analogue	Analogue	Northerly extension of Warratta Fault checked.

TABLE 5 (continued)

Ref. No.	Name of Survey	Year	Subsidy File or BMR Record No.	Oil Company	Type of survey and coverage	Record Quality Eromanga	Record Quality Pre-Eromanga	1:250 000 Map sheets	Recording Comments	Processing Comments	General Comments
23	Stonehenge	61	62/1568	Conorada	Single	Fair to poor	? No	Jundah	Analogue SIE Fortune		Reconnaissance survey.
24	Orientos-Clifton Hills	62	62/1604	Delhi-Santos	Refr. & Refl.; Single. Velocity surveys in Orientos, Dullingari wells.	Fair to poor	Poor	Tickalara	Analogue	Analogue, should be processed	Strong multiples present. Events not properly identified in report.
25	Innamincka-Mt Gason	62	62/1554	Delhi-Santos	Single	-	-	Durham Downs	Analogue	Analogue, should be processed	Survey to investigate Innamincka Dome. No sections in report (only time - correlation profiles).
26	Diamantina - Mt. Gregor Range	63	62/1655	Delhi-Santos	Single	Fair to good	P horizon good, base Permian poor.	Windorah Canterbury Barrolka Eromanga	Analogue	Analogue	Mapped large anticline in Mt. Howitt area. Permian is about 200 m thick and does not thin over it.
27	Cooper Creek	64	64/4506	Delhi-Santos	Refr. & Refl.; Single, 6 fold offset velocity profiles	Fair to good	Fair to good	Durham Downs	Analogue, FM.	Analogue, would benefit from digital processing	Several lines cross northern edge Nappamerri Trough. 800 m of Permian or more. Hard to pick base Permian.
28	Strzelecki-Cooper seismic & gravity	65	65/4586	Delhi-Santos	Single, offset profiles & Expd. Spreads.	Good to fair	Fair to good	Durham Downs	Analogue	Analogue. Data would improve by digital processing.	Permian thins onto highs. Narrow, deep depression on Line KJ (edge of Nappamerri Trough).
29	Eromanga-Frome seismic & gravity	66	66/11066	Delhi-Santos	Single, 6 fold; offset velocity profiles	Good to poor	Fair to poor	Canterbury Barrolka Durham Downs	Analogue: FM System or AM Techno 451	Analogue	Three structure maps: C, P and base Permian. 2 Isopachs: C-P, thickness. Also probable Cambrian structure in Kallodeina area. Permian thin: ~ 300 m.
30	Cooper Basin seismic & gravity	67	67/11151	Delhi-Santos	Single, 6 fold; Offset profiles to obtain velocities	Fair to poor	Poor to good	Canterbury Barrolka	Analogue, United 1-38, AM Techno 451	Some digital, mainly analogue. Would benefit from reprocessing	Three structure maps: C, P (base Mesozoic) & base Permian. Isopachs C-P & Permian.
31	Dunjeroo	71	71/696	Delhi-Santos	Single, 6 fold	C horizon (Transition Beds) good, P horizon good, shallow events poor, discontinuous	Base Gidgealpa Fair-poor	Tickalara	Analogue PT-100, MR-20. Then PT-800 binary gain-ranging amps + PDR-89 digital recorder	Digital processing by GSI Inc. TVS, TVD	Survey aimed to investigate a possible large structure with thick Permian east of Toolachee gas + condens. field. Two structure maps: P horizon (base of Mesozoic), base of Gidgealpa 2 Isopachs: C-P + Gidgealpa. Defined Brumby structure.
32	Cooper Creek central	70	70/668	Flinders	Single, 3 fold	Fair to poor	Poor	Durham Downs	Analogue, United System	Digital	C, P & base of Permian horizons mapped; deeper refl. suggested.
33	Sandy Creek	71	71/553	Flinders	Refl., Vibroseis, 12 fold	Good	Good to poor	Durham Downs	Analogue; TI 10 000	Digital	C, P & base of Permian horizons mapped; deeper refl. present; Vibroseis results better than explosives results.
34	Haddon Downs seismic	60	-	FPC	Unsubsidized surveys, reports not available						
35	Windorah-Wolgolla seismic & gravity	66	66/11084	FPC	Single	Good	Fair to poor	Canterbury Windorah Barolka Durham Downs Tickalara	Analogue, CGG mag.	Analogue	C, Top & Base of Permian horizons mapped. Thin Permian in Durham Downs, Windorah, Wolgolla areas. No Dev. assumed in Durham Downs, present in Windorah area, absent in Wolgolla area.
36	Tickalara seismic & gravity	67	66/11140	FPC	Single, Offset velocity profiles	Fair to poor	Fair to poor	Durham Downs Tickalara	Analogue	Analogue	Permian thins out in south. C, P & Z (base Permian) horizons mapped.

TABLE 5 (continued)

Ref. No.	Name of Survey	Year	Subsidy File or BMR Record No.	Oil Company	Type of survey and coverage	Record Quality Eromanga	Record Quality Pre-Eromanga	1:250 000 Map sheets	Recording Comments	Processing Comments	General Comments
37	Cootabynia	71	71/626	Hartogen	4 fold	Good to fair	Good	Adavale	Analogue SIE GA33	Digital	Devonian horizon mapped.
38	Mt. Edinburgh	73	73/202	Hartogen	6 fold, 4 fold	Good	Good to fair	Windorah Adavale	Analogue, AM	Digital	Adavale horizon mapped.
39	Thomson River	69	69/3035	Longreach	Single	Fair	No	Jundah	Analogue, Dynatronics		No pre-Eromanga section.
40	Ruthven	63	63/1512	Marathon	Single	Poor	Galilee-Poor Adavale-very poor	Blackall	3 hole patterns	VD section - could be improved, but probably not worth it.	Only one line, very poor.
41	Barcoo	64	64/4575	Marathon	Single, 6 fold	Very poor	Galilee-poor Adavale-very poor	Blackall	Analogue, weathering depth 190 ft	Analogue; wiggle trace	Experimental shooting, upholes and expanded spreads, results available.
42	Wooroolah	64	64/4533	Marathon	Single	Very poor	Galilee-poor Adavale-very poor	Blackall	Analogue, 64 lb/shot	Analogue; wiggle trace. Could be re-processed onto VA records	Deepest horizon mapped - Lower Permian.
43	West Blackall	67	66/11113	Marathon	Single, 3 fold, 6 fold	Very poor	Galilee-poor Adavale-very poor	Blackall		Analogue; wiggle trace	
44	Hamilton Gate refraction	69	69/3085	NSW O & G	Refraction	-	-	Bulloo	-	-	
45	Adavale	61	62/1549	Phillips-Sunray	Single	Poor	Galilee-very poor Adavale-very poor	Adavale	Analogue	Analogue; wiggle trace. Not worth reprocessing	Pre-Mesozoic phantom mapped - discontinuous deeper reflections.
46	Jundah-Yaraka-Blackwater-Langlo	61	62/1558 62/1560	Phillips-Sunray	Single	Fair	Fair to poor	Adavale Augathella	Analogue, MS-15	Analogue; wiggle trace	Adavale Basin outlined; site for Etonvale well selected.
47	Charleville North	62	62/1581	Phillips-Sunray	Single	-	-	Charleville	3 hole patterns 45 lb at 150 ft	Not worth reprocessing	Record sections not seen.
48	Quilpie-Thargomindah-Charleville	59-60	62/1508	Phillips-Sunray	Single	Fair	Fair to poor	Quilpie Charleville	Analogue, MS-15	Analogue; wiggle trace	Reprocessing may improve quality; pre-Mesozoic section present.
49	Gumbardo	62	62/1587	Phillips-Sunray	Single	Fair	Galilee-fair Adavale-poor	Adavale Quilpie	3 holes or single 21 lbs at 100 ft	Analogue; wiggle trace, good reflections, could be improved by reprocessing	3 lines only. 3 hole patterns better than single. Adavale phantom - near base Buckabie mapped.
50	Toompine-Wyandra	63	63/1506	Phillips-Sunray	Single, one regional recon. line	Poor	Galilee-poor Adavale-not present?	Toompine Wyandra	3 holes, 51 lbs at 133 ft	Poor	Shallow sedimentary section.
51	Quilberry Creek	63	62/1612	Phillips-Sunray	Single	Fair to poor	Fair to poor	Quilpie Charleville	Analogue, PMR-20	Analogue	Duricrust problem; lack of Permian section; Dev. horizon mapped.
52	Gowan Range	63	63/1502	Phillips-Sunray	Single	Fair	Fair to poor	Blackall Adavale	Analogue, MS-15	Analogue	Reprocessing may improve quality; Adavale faulted section.
53	Highfields	63	63/1532	Phillips-Sunray	Single	Fair	Galilee-fair to poor Adavale-very poor	Augathella	3 hole patterns 45 lb at 150 lb	Not worth reprocessing	No Adavale mapped - not visible on sections.
54	Gilmore	63	63/1543	Phillips-Sunray	Single	Fair	Galilee-fair Adavale-fair	Adavale	3 holes at 120 ft, 42 lb	Analogue	Mid Dev. Cooladdi and Base Buckabie mapped. Small area only. Report includes a cross section.
55	Log Creek	64	64/4555	Phillips-Sunray	Single	Fair	Galilee-fair Adavale-poor	Adavale	3 holes, 80 lbs at 127 ft	Not worth reprocessing	Small area around well. Mid-Devonian Cooladdi mapped, but questionable as horizon is poor.

TABLE 5 (continued)

Ref. No.	Name of Survey	Year	Subsidy File or BMR Record No.	Oil Company	Type of survey and coverage	Record Quality: Eromanga	Record Quality: Pre-Eromanga	1:250 000 Map sheets	Recording Comments	Processing Comments	General Comments
56	Stafford	65	66/11083	Phillips-Sunray	6 fold	Fair	Galilee-fair to good Adavale-fair to good	Adavale	3 holes at 140 ft, 75 lb	Analogue, could be improved	Small area, Devonian horizons mapped. D anhydrite in Bury 1, Boree Salt Member of Etonvale Fm, D - limestone in Bury 1 - Bury Lst (Limestone facies).
57	Leopardwood	65	64/4558	Phillips-Sunray	Single	Fair	Galilee-fair Adavale-poor	Adavale	3 holes, 143 lbs at 105 ft	Not worth reprocessing	Mid-Devonian (Cooladdi).
58	Mt Watson	65	64/4568	Phillips-Sunray	Single	Fair to poor	Galilee-fair Adavale-poor	Blackall Adavale	3 hole patterns	Not worth reprocessing	Deepest horizon mapped: Base Buckabie/ Devonian D 3 (D 3 - Cooladdi Dolomite in this area).
59	Strathcoman	65	65/4583	Phillips-Sunray	Single	Fair to poor	Galilee-fair Adavale-poor	Blackall	Analogue 3 hole pattern 64 lb		Deepest horizon mapped - near-base Buckabie Fm.
60	Powell Creek	65	65/11035	Phillips-Sunray	Single	Fair	Galilee-fair Adavale-poor	Adavale	3 holes, 90 lbs	Analogue-fair	Mid-Devonian D3 mapped. (Top of Cooladdi Dolomite?).
61	Rockwell	65	65/4576	Phillips-Sunray	Single	Fair	Galilee-fair Adavale-fair	Adavale	Analogue - 3 holes 125 ft, 110 lb	Analogue-fairly good	D3 (Etonvale Carbonate) and a pre-D3 mapped. D3 is more likely to be the Bury Limestone.
62	Adavale Basin Detail	65	65/11003	Phillips-Sunray	6 fold	Fair	Fair to poor	Adavale	Analogue, MS-15	Analogue, VD	Photo reduced section (5cm/s); Devonian sections mapped. (No contour maps).
63	Bride Creek	66	66/11072	Phillips-Sunray	Single - 3 lines, 6 fold - 1 line	Fair	Galilee & Adavale, poor to fair	Blackall Adavale Yambo Augathella	75 lb in 3 holes at 100 ft	Could benefit from reprocessing all lines	Small area surveyed. Single fold almost as good as the 6 fold.
64	Yaraka	66	65/11046	Phillips-Sunray	Single	Fair to poor	Galilee-fair Adavale-very poor	Jundah Windorah	3 hole patterns	Not worth reprocessing	Deepest horizon? Pre-Permian. Poor quality data.
65	Bulloo Downs	66	65/11057	Phillips-Sunray	Single	Good	Very poor	Bulloo	Analogue, MS-15	Analogue	Photo reduced (5 cm/s) sections for Lines 208, 210 only. No useful info. on deeper sed. than Eromanga.
66	Lake Dartmouth	65	65/11005	Phillips-Sunray	Single	Fair	Galilee-fair to poor Adavale-poor	Quilpie	3 holes, 100 lb 120 ft	Analogue-fair	D3 - Etonvale Carbonate mapped in Cooladdi Trough. Now identified as the top of Bury Lst (limestone facies in Cooladdi Trough).
67	Pleasant Creek	62	62/1628	Phillips-Sunray	Single	Fair to poor	Galilee-fair to poor Adavale-very poor	Augathella Adavale	3 hole patterns 45 lb at 150 ft	Not worth reprocessing	Deepest horizon - Mid-Devonian (Cooladdi)? The Bury Limestone is eroded in this area.
68	Listowell	65	65/11024	Phillips-Sunray	Single	Fair	Galilee-fair Adavale-fair to poor	Adavale	3 holes, etc	Analogue-poor to fair	Mid-Devonian, same area as Bride Creek. Line 654 shows deep structure - should be reprocessed and squeezed.
69	Panhandle	66	66/11102	Phillips-Sunray	Single	Fair	Galilee-fair	Windorah Jundah	3 holes, 60 lbs, 120 ft	Analogue-fair	Yaraka Shelf, no pre-Galilee present.
70	Carlow-Hope Creek	61-65	-	Phillips-Sunray	Unsubsidized surveys, reports not available						
71	Lissoy	65	-	Phillips-Sunray	" " " " "						
72	Welford	67	67/11178	Phillips-Sunray	Single, 12 fold	Fair	Galilee?-fair	Windorah	3 holes, 60 lb 120 ft	Analogue; 12 fold is poor and should be digitally reprocessed	Canaway Ridge.
73	Grey Range	59	62/1504	LH Smart	Single	Fair to poor	Poor	Windorah	Analogue, Century	Analogue	Deeper Palaeozoic sediments or thin over anticlines.

TABLE 5 (continued)

Ref. No.	Name of Survey	Year	Subsidy File or BMR Record No.	Oil Company	Type of survey and coverage	Record Quality Eromanga	Record Quality Pre-Eromanga	1:250 000 Map sheets	Recording Comments	Processing Comments	General Comments
74	Eromanga	63	63/1554	LH Smart	Refr. & Refl.; Single	Fair to poor	-	Eromanga	SIE GA-33, Mag.	Analogue	5500 ft of Palaeozoic indicated; P deepest.
75	Tinderry	65	64/4559	LH Smart	Refr. & Refl.; Single	Fair	Fair to poor	Eromanga	SIE GA-33, Mag.	Analogue	6500 ft of Palaeozoic indicated.
76	Epsilon	70	69/3027	Total	Single	Good to fair	Fair	Barrolka Durham Downs Tickalara	Analogue; CGG	Analogue	C, P & Z horizons mapped; Z (top of Devt); Reduced (5 cm/s) sections in report.
-	East Lynne	70	70/458	Beaver	Single, 3 fold, 6 fold	Fair	Galilee-good Adavale-fair	Tambo	Analogue, FM	Digitally processed by Digitech	Photo reduced sections 5 cm/s - Lines ELA, ELB, ELE. Adavale section highly faulted - complex tectonics. Galilee is thin.
-	Windeyer	69	69/3067	Beaver	Single	Fair-poor	Galilee-good Adavale-fair to poor	Tambo	Analogue	Analogue, not worth reprocessing	Photo reduced sections 5 cm/s - Lines YA, ZE ... etc. Galilee section thin, Adavale folded and faulted.
77	Clifton	76	-	Sydney University	6 fold						Recorded deep crustal reflections.
78	Wilparoo	79	-	Delhi	6 fold (Geoflex)						Cooper Basin
79	Karmona	74	-	Aquitaine	6 fold						Cooper Basin
80	Windula	74	-	Aquitaine	12 fold (Thumper)			CONFIDENTIAL			Cooper Basin
81	Baryulah	74	-	Aquitaine	12 fold (Thumper)			REPORTS			Cooper Basin
82	Wallaroo	78	-	Aquitaine	6 fold						Adavale Basin
83	Yarran	78	-	Aquitaine	6 fold						Adavale Basin
84	Maruga	78	-	Aquitaine	6 fold						Adavale Basin
85	Coonaberry	74	-	Delhi	6 fold						Cooper Basin

TABLE 6 - PROPOSED WORK 1980-1982

	1980	1981	1982
Review of geological and geophysical information • Proposals for seismic and other investigations. • Reprocess seismic data as required. • Digitise SP and well location data and prepare base maps. • Produce synthetic seismograms for key wells.	Thomson & Cooper Synclines and Warrabin Trough - before July. Adavale Basin and associated troughs - before November.		
Seismic reflection • Record, process and interpret digital CDP data, including deep crustal reflections to 20s, using normal seismic crew for 4 month surveys, covering 400 to 500 km each.	Thomson & Cooper Synclines and Warrabin Trough.	Adavale Basin and associated troughs.	Survey area to be decided.
Seismic refraction • Record, process and interpret deep crustal refraction data along selected 150 km reflection traverses and their extensions in cooperation with seismic reflection survey program.	"	"	"
Gravity • Measure and interpret gravity along seismic and other traverses or grids as necessary concurrently with seismic surveys.	"	"	"
Magnetotellurics • Test possible MT models to determine applicability of method. • Record and model MT data on feasibility survey along selected seismic traverses.	"	"	"
Geothermal • Review geothermal information. • Record geothermal gradients in 20, 100 m deep holes along selected seismic traverses. • Record geothermal information in deep water bores and new stratigraphic holes as required.	"	"	"
		Availability of bores and stratigraphic holes will determine sites	As for 1981
Magnetics • Review applicability of aeromagnetic techniques particularly to investigations of study area. • Record, process and interpret magnetic data in selected areas if suitable high sensitivity techniques are found to be applicable.	1 month office study	Survey techniques and areas to be decided.	

TABLE 6 (continued)

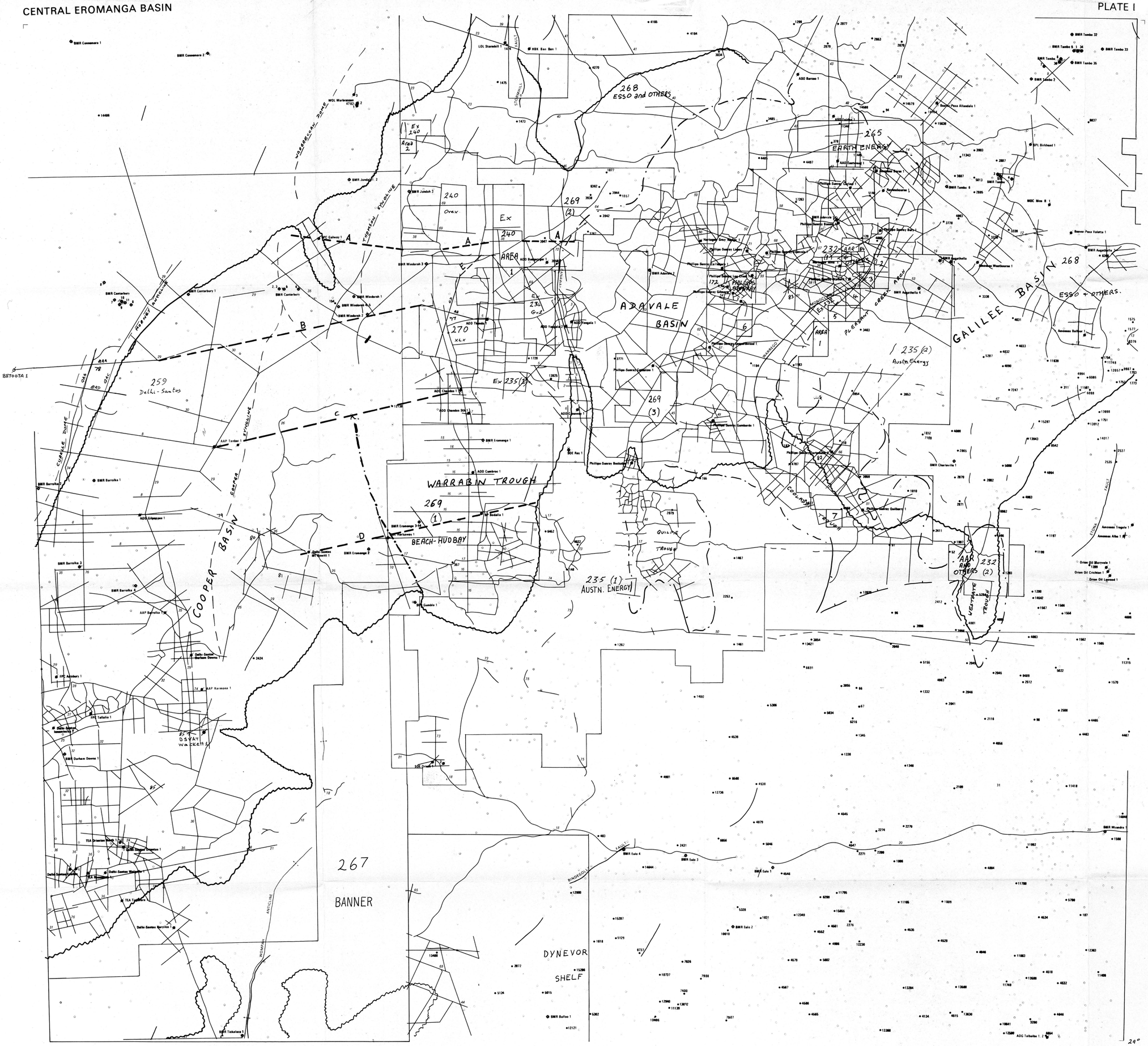
	1980	1981	1982
Electrical and Electromagnetic			
• Develop and assess the use of electrical and electromagnetic methods to investigate the electrical properties of the sedimentary sequences/	1 month office study		
• Conduct soundings along seismic traverses to determine correlation of electrical and seismic marker horizons	Thomson & Cooper Synclines and Warrabin Trough	Sites to be decided	As for 1981
LANDSAT and photogeology			
• Study regional structures particularly in areas of detailed investigations in attempts to determine the importance of faults and fault-induced folds as potential hydrodynamic petroleum traps.	Thomson & Cooper Synclines and Warrabin Trough.	Adavale Basin and associated troughs.	Study area to be decided.
Hydrology and groundwater geochemistry			
• Review hydrological data with particular emphasis on information near structural lineaments. • Collect and analyse groundwater samples for hydrocarbon content, salinity etc.	"	"	"
Source rocks and maturation			
• Review information from prospective areas. • Analyse drill cuttings using "Pyrolysis" method.	"	"	"
Palaeontology			
• Review data, inc. palynological data, in selected areas.		3 month laboratory study.	
• Obtain data from new exploration wells and stratigraphic holes.	Opportunity basis.	As for 1980.	As for 1980.
Basin-wide lithofacies correlations			
• Subsurface facies analysis, in cooperation with GSQ, using seismic stratigraphy, well sections and wireline logs.		Thomson & Cooper Synclines and Warrabin Trough.	Adavale Basin and associated troughs.
• Obtain sidewall cores and cuttings, if possible, from critical sections or new exploration wells to assist in study of lithology and stratigraphy.	Opportunity basis.	As for 1980.	As for 1980.

TABLE 6 (continued)

	1980	1981	1982
Stratigraphic drilling			
• GSQ may have a rig available for drilling 2 holes to 1200 m to test 300 m or more of Jurassic section to obtain new sedimentological, stratigraphic, source-rock and other pertinent information in areas where faults or fault indiced folds may favour hydrocarbon entrapment.		Sites to be decided.	Sites to be decided.
Petroleum resource assessment			
• Analyse pertinent information as it is obtained, integrate with results of related studies to determine critical factors relating to petroleum potential i.e. Source rocks and maturation, reservoir rocks and seal, stratigraphic and structural traps, timing and preservation. • Assess potential petroleum resources.		Continuing basis.	Continuing basis.

CENTRAL EROMANGA BASIN

PLATE I



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	Brigg, Wither and Morton. 1962
18	1962	Thargomindah: Noccundra	Lodwick and Jones. 1964
19	1961	Westbourne	Brigg, 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	Erimanga: 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	Haddon 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	Girwan 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. 1966
		TOTAL EXPLORATION	
76	1970	Epsilon	TEA. 1970

BEAVER

– 1970 East Lynne
– 1969 Windeyer

no reference (Tambo area)

• 2148 Wireline logged water bore with registered number. QIWSC Records

ADD Chandos 1 Petroleum exploration well

BMR Winderah 1 BMR shallow stratigraphic hole

37 Seismic lines with reference number

RECENT SEISMIC SURVEYS (Confidential)

77	1976	Clifton	University of Sydney
78	1979	Wilparoo	Delhi Oil Co
79	1974	Karmona	Aquitaine
80	1976	Windula	"
81	1976	Bangulah	"
82	1978	Wallaroo	Aquitaine
83	1978	Varran	"
84	1978	Maruga	"
85	1974	Coonaberry	Delhi Oil Co

Record 1980/32

267 Authority to Prospect

Ex232 Surrendered or Advertised Area

DISTRIBUTION OF SEISMIC SURVEYS AND DRILLHOLES, BASIN MARGINS, PETROLEUM TENEMENTS AND SEISMIC TRAVERSES PROPOSED FOR 1980

Scale 1:1 000 000

20 10 0 20 40 60 80 100 KILOMETRES

SEISMIC LINES PROPOSED FOR 1980 ———

AUS 1/1010