SOUTH AUSTRALIA

AR93 – ARROWIE BASIN AREA
INVITATION FOR APPLICATIONS

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

April 1993
1. Executive Summary

The Cambrian Arrowsie Basin lies about 400 kms north of Adelaide, capital of South Australia. The broadly east-west basin is transected by the modern Flinders Ranges, where outcrops supplement scattered drillhole intersections to aid basin mapping. Early Cambrian carbonates west of the ranges yielded 26° API crude shows in shallow wells drilled in the 1950’s, but an evident lack of seals and suitable structures there provides little follow-up opportunity. East of the ranges, however, more than 2 km of Cambrian section has been mapped. Only one well has been drilled there as a new field wildcat; it verified the existence of an oil window and recovered trace free oil from an early Middle Cambrian section, but did not intersect the Early Cambrian primary target. Seismic coverage in this area is generally sparse, but is sufficient to show structural and other leads, including one 33 sq km (8 000 ac) prospect-quality structural closure.

The greenfields nature of the basin is eased by the existence of two pipelines across the area, currently transporting gas and liquids from the Cooper Basin to market (Figure 1).

The Government of South Australia has a solid record of support and encouragement for natural resources exploration and development:

- the onshore petroleum exploration and production licensing process is simple and inexpensive
- reasonable work program commitments are expected
- the responsible development of hydrocarbon discoveries is a State priority.

State royalty and Federal taxation structures offer an economically competitive environment for petroleum risk expenditures.

AR 93 covering an area of 18 620 km² in the eastern Arrowsie Basin is available for application.

Applications are invited by Friday 3rd September 1993.

Any enquiries and applications should be addressed to R. Laws, Director Oil Gas and Coal Division, Department of Mines and Energy, South Australia, PO Box 151, Eastwood 5063 South Australia, Telephone (08) 274 7612, Facsimile (08) 373 3269.

The application should be accompanied by a proposed 5 year work program, a fee of $2 000, details of the technical and financial resources of the applicant and a map of the application area (there is no set form for licence applications).
2. Technical Summary

The Arrowie Basin occupies about 48,000 sq km in South Australia’s Mid North. A Cambrian sequence up to 5,000 m thick was deposited in an initial carbonate-dominated shelf/slope/basin environment, evolving after Middle and Late Cambrian tectonism toward clastic-dominated inner shelf/deltaic and eventually redbed environments. Known facies of the lower basin sequence include sabkha evaporites, shallow-water carbonate complexes with well developed stacked moundforms, shelf and slope channel sands and debris flows, and basinal argillites. Early and early Middle Cambrian carbonates have yielded free oil, in trace amounts up to small recoveries of 26° API paraffinic crude.

The western basin area contains extensive shelfal carbonates and some known slope and basinal argillaceous carbonates in a zone without demonstrated structural trap/seal combinations, although with small amounts of oil recovered from a number of shallow wells. The central basin area initially had thick sedimentary fill, but has been tectonically evented and eroded in the modern Flinders Ranges fold belt; it is presently held under a Petroleum Exploration Licence. AR 93 covers the presently unlicensed eastern Arrowie Basin and contains about 2,300 m of preserved Cambrian section. It has been tested by only one petroleum-exploration wildcat (1982), which did not intersect the primary Early Cambrian carbonate target but demonstrated the presence of an oil window, recovered highly saline waters and reported a free oil trace from early Middle Cambrian rocks.

About 2,400 line kms of pre-1988 seismic in the eastern basin area show a number of structural and stratigraphic leads and at least one prospect-quality mapped closure, to justify further exploration for hydrocarbons. Large areas of the eastern basin remain covered only by 1970 and older vintage regional lines.

The eastern Arrowie Basin underlies a desertic region, with little vegetation and only low-relief dunes and alluvial fans bordering Lake Frome, a large ephemeral playa lake. A large part of the area falls within Lake Frome Regional Reserve into which exploration access is readily obtainable.
FIG. 1 ARROWIE BASIN LOCATION
3. Geologic Background

Underexplored Cambrian sequences are widespread in SA and have yielded numerous oil shows. Such shows range from indigenous oil in Early Cambrian playa-lake and marine subtidal carbonate sediments of the Officer Basin (northwestern SA), in Early and early Middle Cambrian shelfal carbonates of the Arrowie Basin (east central SA), and in Middle to Late Cambrian dolomites and limestones underlying the Cooper Basin (northeast SA), to proven Permian oil that migrated into other Cambro-Ordovician carbonates and clastics beneath the Cooper Basin. Whereas Early Palaeozoic rocks underlying the younger Cooper Basin are known only from scattered well intersections, those of the Officer and Arrowie basins are known from both wells and outcrop, and some basin geometry can reasonably be interpreted.

Figure 2 shows a chronostratigraphic chart with geologic summary of the Arrowie Basin, and a stratigraphic-sequence correlation over >700 km between the Officer and Arrowie basins to illustrate the regional influence of episodic sea-level changes. Although deposition may originally have extended between the basins, as suggested by drilling in intervening structural lows, these ancient basins differed. Regional reconstructions show that the Arrowie Basin lay closer to the edge of a sinuous continental palaeomargin than did the Officer Basin. The effects of mid and Late Cambrian tectonism (associated with accretion of microcontinental fragments in areas east of the Arrowie) appear less pronounced in the Officer Basin, and the early Arrowie Basin shows a generally more pervasive marine influence.

The Arrowie Basin initially straddled a regional eastward promontory on a generally north-south palaeocontinental margin. Deeper basinal environments then existed both north and south of the Arrowie shelf area, where shallow marine shelf and ramp deposits of the basal Hawker Group accumulated. Following an episode of widespread (but not complete) subaerial exposure, differential subsidence continued and a shelf-slope break developed with deepwater embayments encroaching upon the shelf. On the shelf margin grew extensive archaeocyath-calcimicrobe reefs, and debris flows containing shelf limestone megaclasts accumulated in slope environments. A second episode of broad subaerial exposure preceded the influx of the first significant sand wedge into the basin, followed by resumed growth of large reef complexes that then rimmed the northern basin area. These stacked bioherms are known in outcrop to reach >300 m width and ~100 m thickness. Earth movements soon thereafter began to differentiate the basin by isolating some portions, and volcanism (evidenced by tuff within clastics) may have commenced in areas east of the basin. Overall shoaling began; further clastic influxes occurred, channel incisions are known from rock exposures and interpreted in seismic data, and evaporites developed in some areas as Hawker Group deposition terminated.
Deposition of shallow-marine shales, silts, sands and thin carbonates soon resumed (Billy Creek Formation). It was followed by the last important carbonate phase of Arrowie Basin fill, with further development of small bioherms and ooid shoals (Wirrealpa and Arona Creek Limestones). However the northern open-marine connection was broken, and would not be resumed. The overlying Lake Frome Group comprises mostly red beds as clastics with occasional thin carbonates, and represents the final phase of Arrowie Basin deposition. The basin was deformed by Cambro-Ordovician tectonism, and today is in part obscured by Mesozoic and Tertiary cover.

There is an evident rhythm of sea-level rises and falls during the Early and Middle Cambrian, expressed in both Arrowie and Officer basins (Figure 2). These events contributed significantly to the complexity of facies developments in the Arrowie Basin.

The preserved remnants of the Arrowie Basin occupy an area of ~48 000 sq km, trending broadly east-west across the northern end of the Flinders Ranges. These low ranges, formed by Tertiary reactivation of Cambro-Ordovician and older structural trends, expose sediments of the Arrowie Basin and its largely late Precambrian substrate and effectively divide the modern basin into western, central and eastern portions (Figure 3):

* The western portion (~13 000 sq km) is represented by generally thin carbonate-shelf deposits fringing the stable Gawler Craton to the west, with some deeper-water facies developed marginal to the Flinders Ranges. The strongest oil shows in the basin are from vuggy dolomitised limestones (lower Wilkawillina Limestone of the Hawker Group) in this marginal zone.

* The central portion (~15 000 sq km), broadly coincident with the Flinders Ranges, may originally have been filled by more than 5 000 m of sediments in a depression expressing the terminal phase of the older, north-south trending Adelaide Trough. Oil staining of Wilkawillina Limestone is known within the ranges.

* The eastern portion (~20 000 sq km) comprises two sub-basins separated by the Benagerie Ridge, which by about Middle Cambrian time became emergent as a consequence of diastrophic movements accompanied by some distant volcanism. West of the ridge lies AR 93 covering the Moorowie "Syncline" (sub-basin), where ~2 300 m of Arrowie Basin sediments thin onto the ridge by onlap and truncation; east of the ridge is the Yalkalpo "Syncline" (sub-basin), where packages of Early to mid-Cambrian sediments thicken again to the east but the upper Arrowie Basin sequence (Lake Frome Group) appears condensed to absent. Depositional settings initially ranged from inner shelf to upper slope, later replaced by redbed environments. Free oil traces and migrated asphaltic bitumens are reported from mid-Cambrian limestones of the lowest redbed sequence in the Moorowie Syncline, showing its potential for petroleum generation and entrapment.
FIG. 2B OFFICER AND ARROWIE BASINS STRATIGRAPHIC SEQUENCE CORRELATION
The Moorowie Syncline is now structurally bounded to the west by the Flinders Ranges, which at least partly overthrust the syncline, and to the east by the Benagerie Ridge where deepseated basically normal faults active both in and before Cambrian time underwent some reactivation during the Tertiary. A few such faults may reach near surface, being marked by mound springs when Mesozoic aquifers are breached. The Moorowie Syncline is bounded to the north by an upfaulted basement high apparently largely devoid of Cambrian cover, principally by erosion, and to the south by basement outcrops that represent depositional limits of the Arrowie Basin.

Trending for more than 100 km north-south through the Moorowie Syncline is a set of faults termed the Poonauna Fracture Zone, which has been a focus of post-1982 seismic acquisition. These faults have been interpreted as originally normal faults, active during Early to mid-Cambrian time, probably then defining a series of half-grabenal depressions. Reverse movements, perhaps with an element of transpression, resulted in gentle eversion by early Late Cambrian time. Some of the faults show later reactivation, but fault throws overall rarely exceed ~30 msec. Within and about this fault set is a number of seismically identified structural leads, and a mapped prospect (the Poverty Lake structure) with 33 sq km (8 000 ac) closure at mid-Cambrian level.
4. Exploration History

During the 1950's twenty shallow wells were drilled by Santos at Wilkatana, just west of the Flinders Ranges in the Arowie Basin (Figure 3). These wells pursued without commercial success a series of strong oil shows in vuggy dolomitised limestones of the lower Wilkawillina Limestone. Several of the wells recovered live oil, a 26° API paraffinic crude, and/or waxy residues. Later analyses suggest the oil is derived from an argillaceous rather than carbonate source rock; and notwithstanding its waxy character, it shows an anoxic-marine algal source affinity. A number of unsuccessful wells has since been drilled to follow-up the Wilkatana shows along the western side of the Flinders Ranges, including one in 1982 that virtually twinned Wilkatana-1. Petroleum Exploration Licence 41 is current over the northern ranges portion of the Arowie Basin.

The eastern portion of the Arowie Basin was held under licence by Delhi/Santos from 1954 until its final surrender in 1988. They acquired some 2,000 line kms of seismic data in total. All used explosive sources, except for 350 kms of Vibroseis in 1986 and 1987, the last two surveys conducted. By the early 1970's the first 800 kms of regional seismic had shown the Poontana Fracture Zone, with associated rollovers, and the form of the Moorowie Syncline. By 1982 a further 380 kms had defined several leads and prospects in part of that syncline. A 1984 survey of 633 kms identified other leads there, and provided the first regional coverage in the Yalkalpo Syncline. Three subsequent surveys totaling 570 kms were aimed principally at developing leads and prospects in the south-central Moorowie Syncline. Seismic grids generally exceed 4 x 4 kms, and large areas remain covered only by regional dynamite lines of 1970 or older vintage.

Some gravity and aeromagnetic data also have been acquired over the area, and results have been incorporated in regional maps.

On the basis of the first gravity and magnetic surveys, three wells of less than 500 m depth were drilled at Cootabarlow on the Benagerie Ridge in 1949. Initial petroleum-exploration drilling in the eastern Arowie Basin was for stratigraphic control. Delhi/Santos drilled three Moorowie Syncline wells in 1968, each to ~2 500 ft (~800 m) depth, to assist interpretation of regional seismic (Lake Frome 1, 2 and 3). During the 1970's the SA Department of Mines and Energy drilled four stratigraphic wells about the Benagerie Ridge as part of its Statewide exploration-assistance program (Bumbarlow 1, Mudguard 1, Yalkalpo 1 and 2), and later mineral-exploration wells (MU-2, BWM-1A, WK-1 and 2) have expanded stratigraphic control.
Only one petroleum new-field wildcat has been drilled in the area: Delhi/Santos Moorowie 1, drilled to 10 650 ft (3 246 m) in 1982. That well tested a small (~1 000 ac) closure proximal to the Flinders Ranges fold belt. It penetrated 237 m of Mesozoic and Tertiary cover, and 1991 m of Arrowie Basin sediments, overlying more than 1 000 m of unmetamorphosed late Precambrian sediments. The Arrowie section is interpreted as largely post-Hawker Group in age; only ~40 m of section is ascribed to a shallow-water, partly evaporitic facies of the Oraparinna Shale (Figure 2) and the well thus did not test equivalents of the Wilkatana and outcrop oil-show sequences known to the west. Nonetheless, traces of free oil were reported in fresh carbonate cuttings from the lowest Lake Frome Group. Lab analysis later described migrated asphaltic bitumens in cuttings from that interval. A DST also recovered highly saline gas-cut water from the Wirrealpa Limestone.

Following relinquishment of the area by Delhi/Santos in 1988 and a subsequent licensing round, the Moorowie Syncline was taken under Petroleum Exploration Licence 47, awarded in 1990 to Anzoil NL. The new licensee undertook no new data acquisition and the licence was surrendered in early 1993.
5. Petroleum Source/Reservoir and Seal Potential

Source

Most drilling in the lower Arrowie Basin prospective sequence (pre-redbeds of the Lake Frome Group) has intersected organically-lean shelfal carbonates. More basinal shaly rocks are known from outcrop and some subsurface penetrations, but deep weathering of outcrop sections has degraded accurate analysis of their petroleum generation potential. Hard evidence to properly identify regional source-rock intervals therefore is sketchy. As in most under-explored basins with petroleum shows, source potential must here be assessed by integrating scattered hard data with geologic interpretations, underpinned by the reality of the oil shows.

Table 1 summarises the few available source-rock data; refer to Figure 2 for formation/sequence names and their depositional settings. Rock extracts have pristane/phytane ratios and δ¹³C values indicating algal-cyanobacterial origins. Rock-Eval and elemental analyses suggest preservation of gas-prone Type III or essentially non-generative Type IV kerogens, but micritised bituminite at Wirrealpa/Moodlatana levels in Moorowie 1 implies the prior existence of some oil-prone Type II kerogens there. The best evidence of oil sources remains the 26° API paraffinic crude from Wilkatana.

Table 1

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<td>max.</td>
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<td>0.31</td>
<td>0.09</td>
<td>13</td>
<td>320 *</td>
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</table>

* migrated

The highest TOC contents are reported from four of the seven available samples of Sequence 1.3, representing the Parara Limestone and Orparinna Shale within late transgressive and highstand tracts (Figure 2). At that time the Arrowie Basin appeared barred on the north from open-marine circulation, and it seems possible that intrashelf anoxic environments then developed. No geochemical data exist on unweathered Parara highstand, Nepabunna or Midwerta samples from Sequence 1.2, and large areas of the Moorowie and Yalkalpo sub-basins encompassing interpreted palaeoenvironments conducive to the preservation of organic matter remain unsampled.
Maturity

Estimation of source rock maturity in pre-Devonian rocks must rely on symptoms other than the degree of coalification of plant macerals. In the Moorowie Syncline, organic geochemical studies have used aromatic maturity parameters from chromatography/mass spectrometry of rock extracts to calculate equivalents of vitrinite reflectance. By this means, the Wirrealpa Limestone in Moorowie 1 and Lake Frome 1 is estimated to lie within the lower oil window (VR_{oak} = 1.11-1.16%); and the Orparinna Shale in mineral-exploration well BWM-1A farther southwest, marginal to the Benageri Ridge, is also estimated to be within the lower oil window (VR_{oak} = 1.16% ave.).

Studies of the organic petrology of cuttings from Moorowie 1 show extensive micritisation of ?laminite at Wirrealpa levels, and fluorescence and reflectance of vitrinite-like macerals suggest that the oil window for algal/bacterial organic matter (i.e., VR_{o} = 0.5-1.33%) spans the interval 1300-2030 m in Moorowie 1 (lower Lake Frome Group almost to base Billy Creek Formation, Figure 2). Extrapolated BHT's in this well were 66°C (155°F) at 1710 m and 120°C (250°F) at 3250 m depths.

Reservoirs

There is no systematic quantitative study of Hawker Group potential reservoirs, mainly due to a lack of suitable unweathered samples. Qualitative indicators include known vuggy and fracture porosity in the Wilkawillina Limestone from Wilkatana and other wells west of the Flinders Ranges, with reported visual porosity estimates of 15%; and visual estimates of 20% moldic porosity in thin ooid grainstones interbedded with Orparinna Shale in Yalkalpo 2, on the eastern margin of the Benageri Ridge. Comparable ooid/poloid grainstones are in BWM-1A on the western ridge margin. MU-2 in the southern Yalkalpo Syncline cored a very thin karstic surface at lower Wilkawillina level, suggesting that widespread exposure events might contribute to porosity enhancement.

Exposures of extensive middle and upper Hawker Group archaeocyathan-cyanobacterial bioherms, which at least in some areas grew on recently-recognised ancestral tabulate-coral bases, commonly show porosity occlusion by early diagenetic marine and burial cements. However pervasive dolomitisation has developed fracture and intercrystalline porosity in mapped bioherms, and similar reefs in the subsurface would offer reservoir potential. The largest individual bioherms known in outcrop are ~40 m thick and ~75 m wide, but their stacking leads to mapped complexes up to ~100 m thick and >300 m wide.

Moorowie 1 GLOBAL log analysis shows only 4-8% porosity in upper Hawker Group sandy dolostones that are capped by ~7 m of anhydrite, although that analysis may be an underestimate.
Channel sands at near-top Hawker Group levels are known from outcrop in the Flinders Ranges, and a 36 m-thick equivalent comprising silts, fine sands and occasional grits was intersected in Yalkalpo 2. The channel fill includes generally well rounded and cross-beded quartzo-feldspathic sands, but these are tight in outcrop due to calcite matrix. Such channels lie above, and sometimes incise, the Parara and Orparinna rocks of Sequence 1.3 that constitute the best known source rocks (Table 1). Exposures show northward transport of sediment within these channels. Seismic data in the northern Moorowie Syncline have previously been interpreted to show northward-trending channel features at top Hawker Group levels; although other interpretations of those features are possible it is uncertain whether Cambrian caprocks exist to create a play in this area.

The Wirrealpa Limestone, immediately underlying the Lake Frome Group, shows no demonstrable reservoir properties in outcrop and was proved tight by a DST in Lake Frome 2 stratigraphic well. However vuggy oolites cored near the base of the Wirrealpa in Moorowie 1 yielded 1500 ft recovery of SGCMW (with 1 400 ft SGCM) in DST 2, from 6 004 to 6 043 ft (1 830-1 842 m). This saline water recovery (total dissolved solids 142 000 ppm; Rw = 0.1 @ 70°F) demonstrates some effective Wirrealpa porosity and permeability. Water inflows from this interval continued throughout drilling, raising final mud salinity to 36 000 ppm. In the northern part of the Moorowie sub-basin seismic data can be interpreted to show possible carbonate moundforms at a Wirrealpa or perhaps top Hawker Group pick, but there is no demonstrable pre-Mesozoic seal over such features (Figure 5B) in this area although they may be suitably sealed elsewhere in AR 93.

Widespread clastics of the Lake Frome Group include reservoir-quality sands, with up to 13.7% porosity and 37 md permeability measured. There is a reported trend of increasing secondary porosity with depth in Lake Frome 2 stratigraphic well, where DST 1 1 595-1 726 ft (486-526 m, Moodlataana Formation) recovered 120 ft mud, 230 ft MW and 1 000 ft red MW with total dissolved solids of 75 000 ppm.

**Seals**

The best known sealing potential in the basin is offered by the ~7 m anhydrite bed intersected in Moorowie 1 at the top of the Hawker Group. This represents a mid-Cambrian regression that terminated the principal phase of marine deposition within both the Arrowie and Officer basins. Evaporite pseudomorphs in outcropping parts of the upper Orparinna Shale support interpretations that desiccated pans and algal mudflats were spread widely across the Arrowie Basin at end-Hawker Group time, offering ample opportunity for regional seal development.

The Billy Creek Formation, which overlies the Hawker Group, is principally composed of shales, siltstones and tight sandstones with minor carbonates, and is generally assumed to also seal that group. Local seals undoubtedly exist in the Lake Frome Group, but no regional seal is identified.
6. Play Concepts, Prospects and Leads

Play Concepts

Top Hawker Group channel-fill sands have been mapped in outcrop and identified in some stratigraphic-well cores, and on some seismic interpretations there is an area of channels near top Hawker Group topography in the northern Moorowie Syncline. Current data cannot prove any such channel fill to be older than Mesozoic, however, and there is no demonstrable Cambrian seal. These types of high-risk stratigraphic plays could be improved if mapped in combination with seismic structure.

It is also possible to interpret the seismic topography described above as carbonate moundforms developed in a platform/ramp setting, with occasional smaller moundforms spreading northward into a more basinal environment. Although this alternative interpretation also suffers by a lack of demonstrable Cambrian seals, it offers a play that may have considerable value elsewhere in AR 93.

Prospects and Leads

At the southern end of Lake Frome the Demeter/Poverty Lake prospect is a ~33 sq km (~8 000 ac) closure at near top Hawker Group level, within the Poontana Fracture Zone. The prospect (Figures 4 and 5) is adequately controlled by seismic of 1985-87 vintage. It shows some evesion character, with deep Precambrian marker reflections apparently restored toward a baseline, overlain by variable thicknesses of Arrowie sediment packages; relief on deeper reflectors is less than that on the Wirrealpa horizon. The principal risk at this prospect is lack of significant Hawker Group thickness, since current seismic data in the region east of Moorowie 1 well are inadequate to clearly demonstrate the addition in that direction of significant or persistent sediment packages immediately underlying the Billy Creek Formation. Nonetheless, other post-Moorowie 1 seismic interpretations by the industry have favoured thicker Hawker Group preserved west of the Poontana Fracture Zone.

Two other strong leads (Daily/Pasmore River and Lake View) with interpreted closure at top Hawker Group level have been mapped about the southern end of Lake Frome, associated with or west of the Poontana Fracture Zone, and more than 30 weak leads have been identified throughout the eastern basin area.

In view of the generally sparse coverage of 1980's vintage seismic, most of which is 24-fold or less dynamite data that could probably profit from reprocessing, and the otherwise regional nature of low-fold 1970's vintage seismic, there seems ample scope for further exploration in the eastern Arrowie Basin. One exploration well is certainly not a definitive test of such an extensive area, where unfushed Cambrian carbonate complexes with some evidence of oil shows and a demonstrated oil window are supported by regional evidence of oil generation.
FIG. 4 POVERTY LAKE PROSPECT
FIG. 5B  CARBONATE MOUND?

POSSIBLE CAMBRIAN MOUNDFORM

HAWKER GROUP

SADME 93-503
7. Data Package Contents

Exploration companies wishing to purchase the data package for AR 93 are invited to please complete the order form at the rear of the brochure. The contents of the data package are listed below. Additional unpublished reports listed in the bibliography can be ordered, and will be included in the package at extra cost. The cost of the package is $Aust 4 100 including freight charges.

Copies are to be supplied as microfiche where possible. Seismic sections and shotpoint location maps will be supplied as sepias copies. The DME contact persons for enquiries relating to the data package are:

Production/Sales
Mr P Dunne
Document Storage Centre
(08) 379 7244

Geological Interpretations
Dr D Gravestock
Oil, Gas and Coal Division
(08) 274 7633

Geological Data

Geological reports


Published geological maps

1:250 000 Geological series
COPELEY and explanatory notes
FROME and explanatory notes
PARACHILNA and explanatory notes
CURNAMONA
1:600 000 Special series
Adelaide Geosyncline and Stuart Shelf (2nd edition)

Well completion reports

Note: Digital (LIS format) tapes of limited log data are available from the Department of an additional cost of $35/tape plus $30/well for all wells listed. Complete data tapes for petroleum wells can also be purchased from Wiltshire Geological services and Ian Northcott and Associates Pty Ltd.

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Geophysical Data

Seismic Data

- Computer generated seismic line location map 1:100 000 scale (SEPIA copy).
- Seismic shot point location map 1:50 000 scale (SEPIA copy)
- Seismic sections listed below are chiefly unmigrated full-scale final stacks. Pre 1970 lines are not included.
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<td>1986 Fletcher Arr</td>
<td>86-AHT</td>
</tr>
<tr>
<td></td>
<td>86-AHN</td>
</tr>
<tr>
<td>1987 Mitchell Arr</td>
<td>87-AHN</td>
</tr>
<tr>
<td></td>
<td>87-BBZ</td>
</tr>
<tr>
<td></td>
<td>87-BCB</td>
</tr>
</tbody>
</table>

**Gravity maps**

Bouguer gravity contours 1:250 000
FROME, CURNAMONA

**Magnetic maps**

Total magnetic intensity contours 1:250 000
COPLEY, FROME, PARACHILNA, CURNAMONA
BIBLIOGRAPHY

References


# APPENDIX 1

## ADMINISTRATIVE GUIDELINES FOR PETROLEUM EXPLORATION AND PRODUCTION TENEMENTS

### ONSHORE EXPLORATION GUIDELINES

**Petroleum Act, 1940**

The area to which this Act applies covers all of onshore SA exclusive of Commonwealth Lands; it extends south to the State Territorial Sea Baseline and includes the waters of Spencer and St Vincent Gualls.

<table>
<thead>
<tr>
<th>Title of Tenement</th>
<th>Petroleum Exploration Licence (PEL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Who Can Apply</strong></td>
<td>An individual, a body corporate (ie, a company) or an unincorporated association of persons and bodies corporate (ie, a joint venture involving several persons and/or companies). A foreign corporation applicant must be registered under the provisions of the Corporations Law.</td>
</tr>
<tr>
<td></td>
<td>Where application is made on behalf of a company, the application must be made under the company seal.</td>
</tr>
<tr>
<td><strong>When Application Can be Made</strong></td>
<td>Initial licence - at any time over any area not already under licence.</td>
</tr>
<tr>
<td></td>
<td>Renewal of licence - not less than 3 months before existing licence is due to expire.</td>
</tr>
<tr>
<td><strong>Maximum Area</strong></td>
<td>26 000 km²</td>
</tr>
<tr>
<td><strong>Application Fee</strong></td>
<td>For initial application - $2 000</td>
</tr>
<tr>
<td></td>
<td>For each renewal - $1 000</td>
</tr>
<tr>
<td><strong>Bond (to ensure compliance with licence conditions)</strong></td>
<td>$15 000 minimum. Amount required is specified in letter of offer. Bond may be in the form of cash, cheque or bank guarantee.</td>
</tr>
<tr>
<td><strong>Term of Licence</strong></td>
<td>Initial term - 5 years</td>
</tr>
<tr>
<td></td>
<td>Each renewal (to a maximum of 3) - 5 years</td>
</tr>
<tr>
<td><strong>Annual Rental Payable</strong></td>
<td>Initial 5 year licence term - 24 c/km²</td>
</tr>
<tr>
<td></td>
<td>First renewal (2nd 5 year licence term) - 36 c/km²</td>
</tr>
<tr>
<td></td>
<td>Second renewal (3rd 5 year licence term) - 48 c/km²</td>
</tr>
<tr>
<td></td>
<td>Third &amp; final renewal (4th 5 year licence term) - 60 c/km²</td>
</tr>
</tbody>
</table>

Petroleum Act Reference:

- 6(1)
- 41(b)&(c)
- 6(1a)
- 18(5b)
- 15(1)
- 7(2)
- 13(1)
- 15(2)
- 18c(a)
- 18c(b)
- 18c(c)
- 18c(d)
Minimum Work Commitments

Minimum Expenditure Commitments

Initial 5 year licence term
- first two years - $16 per sq. km per year
- last three years - $24 per sq. km per year.

First renewal (2nd 5 year licence term) -
$100 per sq. km per year.

Second renewal (3rd 5 year licence term) -
$125 per sq. km per year.

Third & final renewal (4th 5 year licence term) - $150 per sq. km per year.

Area to be Relinquished on each Renewal

25% of original licence area. This is in addition to any areas voluntarily surrendered during each 5 year licence term.

Fee for Minister’s Consent to Dealings in Licence

$1 000 per transaction (document).

Fee for Inspection of Register

$100

Fee for Copy or Extract from Register

$1 per page

Reg.13(2)

Reg.13(4)

Method of Application

Letter of application addressed to the Director-General, SADME (there is no prescribed form).

Attached to the application should be:

1. full names and addresses of the party/parties making the application, including (where applicable) the percentage interests of the various parties.

2. two copies of a map and description of the area being applied for.

3. a table showing the work intended to be carried out, and the estimated cost of that work, during each year of the five year licence term. (Expenditure estimates should satisfy the minimum expenditure commitments set out in Sections 17 and 18.)

4. particulars of the technical qualifications and expertise available to the applicant party/parties (e.g. qualifications and experience of employees, consultants, etc.).

5. particulars of the financial resources available to the applicant party/parties to carry out the proposed terms and conditions of the licence. (In the case of a company application, this is generally supplied in the form of a copy of the company’s most recent Annual Report.)

6. the $2,000 application fee. Where the application is made on behalf of a company, the application must be made under the company seal.

7(1)(a)

7(1)(b)

18(a)(1)(a)

18(a)(1)(b)

18(a)(1)(c)

18(2)

42(3)

Reg.13(2)

Reg.13(4)

7(1)

7(3)

7(3a)

7(4)

7(4)

7(2)

41(b)&(c)
**Penalty for Non-Payment of Annual Rental Fees**

All fees are payable in advance. If fees are not paid by the due date, a fine of 10% is imposed and in addition, interest accrues at the rate of 6% per annum. If any fee is in arrears for 3 months or more, the licence may be cancelled.

83(1)&(2)

**Licence Variations**

Only on application by the licensee, the Minister may at any time during the term of the licence, vary or revoke a condition of the licence, or attach new conditions to the licence.

17(3)

**Environmental Conditions**

As set out in the Regulations. Any special conditions will be outlined in the letter of offer attached to the licence.

**Surrenders (Partial or Whole of Licence)**

The Act requires the licensee to:

1. apply to the Minister for permission to surrender
2. give 3 months notice in writing
3. pay all outstanding fees
4. pay all outstanding monies and wages to workmen and employees.

Surrenders are only permitted if the licensee has fulfilled all the terms and conditions of the licence up to and including the year in which the application to surrender is lodged.

38(1)
38(1)(a)
38(1)(b)
38(1)(c)

Surrenders are required to lodge all outstanding data on their licences and carry out the cleanup and rehabilitation of their licence areas (where necessary) as a condition of surrender.

38(2a)

Surrenders are effective from the end of the appropriate year of the term of the licence (unless specified otherwise).

38(2b)

**Required Notice for Approval to Undertake Work in Licence Area**

Three months notice is required to arrange necessary clearances with other Government Agencies. This is carried out by SADME on the licensee’s behalf.

**Required Notice of Entry to Landholders**

No risk of damage to land or improvements thereon - 14 days.
Risk of damage to land or improvements thereon - 28 days.

51(1)
51(1)

**Gazettals**

Gazettals occur on:
1. grant of licence
2. surrender of licence
3. cancellation of licence.

6(2)
71(1)

**Suspension and Cancellation**

The Act provides for suspension and/or cancellation for failure to comply with licence conditions.

87(a)(1)

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All monetary amounts are subject to review. Current 1 March 1993.

J00614
To the Director-General  
South Australian Department of Mines and Energy  
PO Box 151  
EASTWOOD  SA  5063

Attention: Oil, Gas and Coal Division

Dear Sir

Re: AR 93

Please provide the AR 93 data package as specified on page 12.

Company ............................................................

Address ............................................................

Contact ............................................................

Telephone .........................................................

Telex ..............................................................

Facsimile ........................................................

Please find enclosed a cheque for $Aust 4 100, made out to the Department of Mines and Energy.

Signed ............................................................

Date    /    /

J00614