THE OFFER

Four new petroleum exploration licences (PELs) in the Cooper and Eromanga Basins are being offered by the South Australian Government on the basis of work program bidding (Figures 1 and 2).

The release comprises four blocks with a minimum total area of 9000 km² at this stage. The areas of blocks CO2010-A and CO2010-B are fixed and will not change. However any additional acreage relinquished within zones C and D before 10 February 2011 (i.e. one month before the close of bidding) will be added into blocks CO2010-C and CO2010-D respectively. For example a minimum 391 km² area (less the area of any Petroleum Production Licences (PPLs) or Petroleum Retention Licences (PRLs) granted during the licence term) is expected to be relinquished from PEL 111 (straddling zones C and D) around mid 2010.

Maps of each block are included in Appendix 1. The areas of each block and exploration to date are summarised below:

<table>
<thead>
<tr>
<th>Block</th>
<th>Minimum Anticipated Area (km²)</th>
<th>Wells</th>
<th>2D seismic (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2010-A</td>
<td>3658</td>
<td>-</td>
<td>811</td>
</tr>
<tr>
<td>CO2010-B</td>
<td>2522</td>
<td>-</td>
<td>1047</td>
</tr>
<tr>
<td>CO2010-C</td>
<td>2399</td>
<td>2 + 1 in PEL111</td>
<td>5833 (+ 1717 in PEL111)</td>
</tr>
<tr>
<td>(Zone C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2010-D</td>
<td>391 (max)</td>
<td>-</td>
<td>3805</td>
</tr>
<tr>
<td>(Zone D)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Previous exploration data and reports are readily available from PIRSA in digital format on removable hard drives, including:

- well completion reports
- GIS datasets including wells, seismic, tenements, pipelines
- seismic survey shot point location data
- seismic survey reports and archive stack data (SEGY format)
- digital well logs (DLIS/LIS format)
- velocity survey check shot information
- structure maps and datasets
- PEPS database with production, well, seismic and engineering data
- company prospectivity reports

www.petroleum.pir.sa.gov.au
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Cooper Basin Acreage Release • CO2010-A, B, C and D

Figure 1

Cooper and Eromanga Basins, South Australia

PETROLEUM LICENCES

Petroleum tenements
- Exploration licence (PEL)
- Exploration licence application (PELA)
- Production licence (PPL)
- Production licence application (PPLA)
- Retention licence (PRL)
- Retention licence application (PRLA)
- Acreage release block
- Acreage release zone

PEL 111 – minimum 390 km² to be relinquished prior to close of bid

Petroleum pipelines
- Pipeline licence (PL) – gas
- Pipeline licence (PL) – gas and liquids
- Pipeline licence (PL) – liquids

Discoveries 2002 – 2009
- Oil
- Gas

- Cooper Basin subcrop limit
- Coongie Lakes control zone – no access

Datum GDA 94 - Projection MGA Zone 54

Discoveries 2002 – 2009
- Oil
- Gas

Figure 1
Figure 2

Cooper and Eromanga Basins, South Australia
TOP CADNA-OWIE DEPTH IMAGE with SOUTH AUSTRALIA and QUEENSLAND TENEMENTS

South Australian tenements
- Acreage release zone
- Acreage release block
- PEL 111 – minimum 300 km² to be requisitioned prior to close of bid
- Exploration licence (PEL)
- Exploration licence application (PELA)
- Production licence (PPL)

Queensland tenements
- Petroleum exploration permits
- Petroleum lease – granted
- Petroleum lease – application

Petroleum wells
- Oil
- Gas
- Geothermal
- Dry
- Proposed or currently drilling

Government of South Australia
Primary Industries and Resources SA

Datum GDA 94 - Projection MGA Zone 54
INTRODUCTION
The Cooper Basin is a Permo-Carboniferous to Triassic intracratonic basin located 800 km north of Adelaide, extending into southwest Queensland (Gravestock et al., 1996). It is overlain by the prospective Jurassic to Cretaceous intracratonic Eromanga Basin which extends over much of central-eastern Australia (Cotton et al., 2006). The Cooper and Eromanga Basins collectively contain up to 3700 m of predominantly fluvial, glaciofluvial, lacustrine and deltaic sediment with some Cretaceous marine sediments (Figure 3). Targets are 1200–3700 m deep. The Cooper and Eromanga basins lie unconformably over early Palaeozoic marine sediments of the Warburton Basin and Mid-Carboniferous Big Lake Suite granite, which is currently being evaluated as a source of geothermal energy (e.g. Wyborn, et al., 2004; Wyborn, 2008).

The Cooper Basin and overlying Eromanga Basin remain Australia’s largest and most mature onshore hydrocarbon province (Figure 1), supplying major south-eastern Australian gas markets for over 40 years and producing oil for over 27 years. The Cooper Basin Liquids Project (1980–84) was initiated to market the oil and existing gas liquids. A liquids pipeline links Moomba to a processing plant and storage and export loading facilities at Port Bonython.

Over 1,800 exploration and development wells have been drilled and over 75 633 km 2D and 8 830 km2 3D seismic recorded. Total cumulative product sales to end June 2009 includes: 4.878 Tcf of gas, 73.48 mmboe of condensate, 145.8 mmbbl of oil and 76.4 mmboe of LPG. Annual petroleum production and the value of sales since 1970 are shown in Figure 4. Oil production was declining until 2002 when new discoveries caused a resurgence of drilling activity and exploration success, while gas sales peaked in 1989 and have been declining since 1998.
Exploration drilling has produced a steady stream of discoveries since the discovery of gas in 1963 as indicated by the world class exploration success rates (Figure 5). While drilling hiatuses correlate with oil price crashes, the steep increases in the oil discovery success rate are linked to improved seismic acquisition and processing, more 3D seismic acquisition, testing new play types (e.g. the Jackson discovery in 1981 and the Strzelecki-3 oil discovery in 1978) and also to new companies entering the basin and reinvigorating exploration. In contrast, the gas discovery success rate curve is smoother because the commodity price has not been as variable as the oil price, and long term contracts dominate the market.

PETROLEUM GEOLOGY
The Cooper Basin unconformably overlies flat lying to compressively deformed Cambro-Ordovician Warburton Basin strata and Carboniferous granitic intrusives. The unconformity is mapped as the Z seismic horizon (Figure 6). The intracratonic Cooper Basin represents a Late Carboniferous to Triassic depositional episode terminated at the end of the Middle Triassic with regional uplift and erosion. Three major troughs (Patchawarra, Nappamerri and Tenappera) are separated by structural ridges (Gidgealpa–Merrimelia–Innamincka (GMI) and Murteree) associated with the reactivation of NW-directed thrust faults in the underlying Warburton Basin (Figures 6 and 7). These troughs contain up to 2 500 m of Permo-Carboniferous to Triassic sedimentary fill overlain by as much as 1 300 m of Jurassic to Tertiary cover.
Cooper Basin
The Late Carboniferous to Early Permian succession consists of basal glaciofluvial clastics and proglacial outwash deposits, overlain by thick coal measures (peat swamp), floodplain, lacustrine and high sinuosity fluvial facies. Uplift and erosion at the end of the Early Permian resulted in a depositional break and Late Permian to Early Triassic fluvial and floodplain facies were deposited on the unconformity surface. Deposition in the region was terminated at the end of the Early Triassic with slight but widespread deformation, regional tilt and erosion. The top of the Permian section is mapped as the P Seismic Horizon.

Eromanga Basin
The Jurassic–Cretaceous Eromanga Basin can be divided into three sequences — lower non-marine, marine and upper non-marine. Exploration is concentrated on the productive lower non-marine sequence, which consists of basal high-sinuosity fluvial and floodplain deposits, overlain by extensive and thick low-sinuosity fluvial sandstones. Two intervening floodplain and lacustrine units occur within this sand package, which is overlain by extensive lacustrine and shoreface facies, deposited in a large lake which extended throughout the Cooper Basin region. This lower non-marine sequence is overlain by Early Cretaceous marine shales that form a regional seal, and Late Cretaceous non-marine deposits. The top Cadna-owie Formation (Early Cretaceous) is mapped as the C Seismic Horizon (Figure 7).

Lake Eyre
Tertiary to Recent fluvial to lacustrine deposits of the Lake Eyre Basin unconformably cover the Eromanga Basin. The unconformity at the top of the Eromanga Basin is often difficult to distinguish in wells and seismic.

SOURCE ROCKS
Cooper Basin
Numerous producing wells and significant gas and oil shows in wells in the Cooper Basin area indicate that sufficient mature source rocks are present and have generated hydrocarbons. Permian coal measures and shales have high Total Organic Carbon (TOC) content and represent the main hydrocarbon source for Cooper Basin oil and gas accumulations. They are dominated by Type III kerogens derived from higher plant assemblages.

Oils and condensates are typically medium to light (30–60° API) and paraffinic, with low to high wax contents. Most Permian oils in Permian reservoirs contain significant dissolved gas and show no evidence of water washing. Gas composition is closely related to maturity/depth with drier gas occurring towards basin depocentres although there is strong geological control on hydrocarbon composition.

The Patchawarra Trough contains the bulk of the oil and wet gas reserves consistent with local source rocks being in the ‘oil window’, while the hot Nappamerri Trough (40–50 °C/km), underlain in part by granite, is over mature and contains mainly dry gas. Permian source rocks have average TOC and S2 pyrolysis yields of 3.9% and 6.9 kg/t, respectively (excluding coals).
Cooper Basin Acreage Release • CO2010-A, B, C and D

Figure 6

Cooper and Eromanga Basins, South Australia
TOP BASEMENT DEPTH IMAGE with STRUCTURAL ELEMENTS

Acreage release zone
Acreage release block
Cooper Basin permian edge
Cooper Basin subcrop limit

Cooper Basin

Cooper and Eromanga Basins, South Australia
TOP BASEMENT DEPTH IMAGE with STRUCTURAL ELEMENTS

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Cooper Basin
Cooper Basin Acreage Release ● CO2010-A, B, C and D

Cooper and Eromanga Basins, South Australia

TOP CADNA-OWIE DEPTH IMAGE
with STRUCTURAL ELEMENTS

Figure 7

Cooper Basin aerial photography with structural elements.
Locally, the Toolachee Formation is the richest source unit. The Patchawarra Formation is considered the other major source unit, especially the lower shales and coals. The lacustrine Murteree Shale is a gas-prone source rock with good to very good TOC content (1.7 to 4.7%).

Together, the petrographic and geochemical evidence supports coals and associated dispersed organic matter as the effective source rocks capable of generating gas and minor oil, albeit in low yields. At maturity levels between 0.7–0.95% Ro, initial generation from the richer facies has led to partial filling of reservoirs with wet gas and oil. There is a sharp onset of significant hydrocarbon accumulation when the source reaches a maturity of 0.95% Ro.

Thin, laterally discontinuous coals represent the best source rocks of the upper Nappamerri Group, whilst shales tend to be organically lean. The lower Nappamerri Group is coal-poor, contains kerogen that tends to be oxidised, and any source rocks are humic-rich and gas-prone.

**Eromanga Basin**

In the Eromanga Basin, the Poolowanna and Birkhead formations contain organic-rich shales that are oil-prone (Type II/III kerogen) and maturity ranges from 5-0.7% Ro. Lateral migration from these source areas has also been postulated. The Murta Formation is interpreted to have potential to generate light paraffinic crude oils, even at maturity levels as low as 0.50–0.55% Ro. It contains Type II/III kerogen however the best Murta source facies contain telalginite and indicators of bacterial precursors occur.

The marine sequence and upper non-marine sequence are immature for hydrocarbon generation over much of the basin (< 0.45% Ro). Both Permain and Mesozoic source rocks have contributed to oil accumulations in the Eromanga Basin. Each Eromanga oil accumulation needs to be considered in terms of its juxtaposition to potential source kitchens, to assess the likelihood of Permain and/or Mesozoic sources (McKirdy et al., 2005).

**RESERVOIRS AND SEALS**

**Cooper Basin**

Multi-zone high-sinuosity fluvial sandstones form poor to good quality reservoirs in the Cooper Basin sequence. The main gas reservoirs occur primarily within the Patchawarra Formation (porosities up to 23.8%, average 10.5%; permeability up to 2500 mD) and Toolachee Formation (porosities up to 25.3%, average 12.4%; permeability up to 1995 mD). Shoreface and delta distributary sands of the Epsilon and Daralingie formations are also important reservoirs. Oil is produced principally from low-sinuosity fluvial sands within the Tirrawarra Sandstone (porosities up to 18.8%, average 11.1%; permeability up to 329 mD). Towards the margin of the Cooper Basin, oil is also produced from the Patchawarra Formation and from Merrimelia Formation fluvial channel sands in the Malgoona Field.

The Callamurra Member of the Arrabury Formation is conventionally regarded as a regional seal, but nevertheless contains economic oil and gas reservoirs in some areas and is a leaky seal in others. Low sinuosity fluvial sandstones of the Paning and Wimma Sandstone members form economic oil and gas reservoirs, and high-sinuosity fluvial...
sandstone of the Tinchoo Formation reservoirs oil. As yet, there have been no economic oil or gas fields discovered in the Cuddapan Formation in South Australia.

Intraformational shale and coal form local seals in the major reservoir units. Beneath the Daralingie unconformity are two important early Permian regional seals — the Roseneath and Murteree shales. The Roseneath Shale is the top seal of the Epsilon Formation, and the Murteree Shale seals the Patchawarra Formation. A younger regional seal is provided by the Triassic Arrabury Formation.

**Eromanga Basin**

The principal Eromanga Basin reservoirs are good to excellent reservoir quality Hutton and Namur braided fluvial sandstones (porosities up to 25%, permeability up to 2500 mD). Oil is also reservoired in fair to excellent quality sandstones in the Poolowanna and Birkhead formations, McKinlay Member and Murta Formation. The Wyandra Sandstone Member of the Cadna-owie Formation forms a significant oil reservoir in Queensland; however, the only significant accumulation in SA occurs in the Aldinga Oil Field. Seals consist of intra-formational siltstones and shales of the Poolowanna, Birkhead and Murta formations in the Cooper region.

**TRAPS**

**Warburton Basin**

The Warburton Basin remains under-explored, yet has all the required ingredients of a valid hydrocarbon system: oil and gas shows and flows, reservoir, seal, traps and access to proven mature source rocks via down dip migration pathways from the Eromanga and Cooper basins (Sun and Gravestock, 2001). Hallmann et al. (2006) present evidence for small amounts of migrated Warburton Basin oil in Permian reservoirs. Locally, Permian oil has migrated into Warburton Basin reservoirs on the basin margin and gas has migrated into fractured Ordovician reservoirs fringing the Allunga Trough. Overlying Merrimelia Formation glaciolacustrine shale would form an effective seal.

**Cooper Basin**

Anticlinal and faulted anticlinal traps have been relied on as proven exploration targets but potential remains high for discoveries in stratigraphic and sub-unconformity traps, especially where the Permian sediments are truncated by the overlying Eromanga Basin succession. Economic oil and gas are reservoired in the Nappamerri Group, paradoxically regarded as a regional seal to the Cooper Basin.

Structural growth during the Permian and Jurassic and differential compaction played an important role in trap formation and fill, as well as strongly affecting reservoir properties. Anticlinal, fault, sub-unconformity truncation, structure–stratigraphic (e.g. channel fairway facies draped on structural nose) and stratigraphic pinchout traps are also proven plays.

**Eromanga Basin**

Trapping mechanisms within the Eromanga Basin are dominantly structural (anticlines with four-way dip closure or drapes over pre-existing highs) with a stratigraphic component (e.g. Poolowanna Formation, Hutton–Birkhead transition, intra-Birkhead channel sands, McKinlay Member and Murta Formation). Seals consist
of intraformational siltstones within the Poolowanna, Birkhead and Murta Formations. The Birkhead-Hutton petroleum system is the most productive in the Eromanga Basin.

Stacked oil pay in the McKinlay/Namur, Hutton and Birkhead occurs around the Cooper basin region. The Eromanga Basin also contains rare gas accumulations, where Permian gas has migrated upwards along faults and been trapped higher in the section (e.g. Namur Gas Field).

**EXPLORATION POTENTIAL**

The number of oil discoveries in the South Australian part of the Cooper Basin reached 112 at the end of 2009 (Figure 5). Extensive areas on the flanks of the Cooper Basin and in the broader Eromanga Basin remain under-explored.

In the core Cooper province, Cooper Basin oil and gas exploration and Eromanga Basin oil exploration has typically focused on four-way dip-closed anticlines. 3D seismic is an extremely useful tool for prospect delineation in the Eromanga Basin. However, potential also exists for as yet overlooked discoveries in even shallower pools such as the Cadna-owie Formation and the Coorikiana Sandstone. Seismic processing has shown that the structural configuration at Coorikiana level can be independent of the older structural framework. Stratigraphic plays are a proven play concept in the Cooper Basin, and recent Eromanga Basin discoveries on the western flank of the Cooper Basin may have a stratigraphic component.

Significant unconventional gas potential remains in the Cooper Basin, in the form of gas in low permeability reservoirs (tight gas), shale gas and coal seam gas. Huge volumes of gas exist in low-permeability rocks in deeper gas fields. The Nappamerri and Patchawarra Troughs of the Cooper Basin are also considered to have large potential for shale gas. The shale gas potential of the Nappamerri Trough is being actively pursued in the Beach Energy operated PEL 218. Beach Energy has estimated potential gas-in-place in the SA and Qld Nappamerri Trough of 20-100Bcf/km², and Santos is already producing shale gas from one of its wells. In the southern Cooper Basin Strike Energy plan to explore the relatively shallow Permian section to assess the coal seam gas and underground coal gasification potential of the Permian coals. Thick coal seams in the Early Permian Patchawarra Formation may be a future target for deep coal seam gas.

The region is also being explored for geothermal energy (e.g. Wyborn et al., 2004).

**CO2010-A, CO2010-B – Frontier Blocks**

Blocks CO2010A and CO2010-B (figures 11 and 12, Appendix 1) are considered frontier acreage. The blocks are located in the northernmost part of South Australia, abutting Queensland. No wells have been drilled in the blocks and most of the seismic was acquired in the 1960s. SEGY data is available for three regional lines that cross the blocks (79-QAG, 79-QAM and 84-TKA) and the line ends of a detailed 2D survey to the east. The nearest wells are Haddon Downs 1 located near the eastern boundary of CO2010-B, and Putamurdie 1, located near the south-eastern boundary of CO2010-A.
Whilst the Cooper Basin edge is mapped to cross the eastern part of CO2010-B, the Patchawarra Trough and Arrabury Trough hydrocarbon kitchens lie a minimum 50 to 60km to the south of CO2010-B, and considerably further from CO2010-A. However Eromanga Basin source intervals may provide oil charge if sufficient source rock volumes and maturity are present.

The best source rocks in the Jurassic-Cretaceous sequence of the western Eromanga Basin are the coals and carbonaceous shales of the Birkhead Formation, organic-rich shales and siltstones of the Murta Formation and the highly carbonaceous shales of the Poolowanna Formation (Michaelsen and McKirdy, 1996). All these units contain varying quantities of Type II/III (oil/gas-prone) and Type II (oil-prone) organic matter. The Murta Formation is not present in blocks CO2010-A and CO2010-B; however mature Poolowanna Formation and Birkhead Formation source rocks are anticipated in the blocks as described below.

At Haddon Downs 1, Rock-Eval analysis over a carbonaceous siltstone at the base of the Poolowanna Formation (18m cuttings sample) returned a potential yield of 11 kg hydrocarbon/tonne of rock. At Putamurdie 1, Birkhead Formation core samples selectively sampled for dark argillaceous lithologies were determined to be Type II/III source rocks with good generative potential.

Source rock maturity has been an issue for the western Eromanga Basin away from the Poolowanna Trough. However at Haddon Downs 1 the Tmax vs HI cross plot for Poolowanna Formation source rocks suggests that the unit is in the oil generation window.

Given the likely presence of mature source rocks in the Jurassic section, one exploration uncertainty is volume of organic rich source rocks to generate enough oil to charge migration pathways to potential hydrocarbon traps.

Very little is known about the Warburton Basin to the west of the Cooper Basin due to the paucity of well intersections. However maps made by the BMR Palaeogeographic Group1 display an interpretation of the Ordovician Larapintine seaway extending across the Amadeus Basin into the Warburton Basin (Veevers, 2000), suggesting that equivalents of the organic-rich Horn Valley Siltstone may have been deposited in the Warburton Basin. Lower to Middle Ordovician quartzites and shales were intersected in Pandieburra 1 and lithologically similar rocks were intersected in Putamurdie 1. The shales in Pandieburra 1 were described as black with an organic appearance, and gave off a kerosene-like odour when heated.

The steep dips (60 and 70°) recorded in the Warburton Basin sequence at Putamurdie 1 and Pandieburra 1 indicate significant deformation. However if less deformed areas can be defined on seismic, then the Ordovician section of the Warburton Basin would provide an attractive target for shale gas plays, or may be a potential source rock for the overlying Eromanga Basin sequence.

1 The Bureau of Mineral Resources (BMR) is now Geoscience Australia
CO2010-C (Zone C)

CO2010-C (Figure 13, Appendix 1) currently comprises four separate areas.

The two southern areas of CO2010-C (relinquished from PEL 101) straddle the Patchawarra Trough and a small portion of the Packsaddle Ridge. These areas are surrounded by Cooper Basin gas fields/discoveries, including Verona, Beanbush, Napowie, Merindal, Bookabourdie, Coonatie, Lamdina, and Cuttapirrie. Gas has been produced from multiple pay zones in the Cooper Basin sequence at Bookabourdie (Nappamerri Group, Tirrawarra Sandstone) and Coonatie (Epsilon Formation, Nappamerri Group, Patchawarra Formation, Tirrawarra Sandstone and Toolachee Formation).

Oil pools have been discovered above the Cooper Basin gas accumulations in the overlying Eromanga Basin sequence. For example at Bookabourdie, an oil pool was discovered in the Birkhead Formation, and at Cuttapirrie, an oil pool was discovered in the Poolowanna Formation.

In addition to the conventional hydrocarbon accumulations, there is potential for unconventional gas plays in the southern areas of CO2010-C. The Early Permian sequence in the Patchawarra Trough has the necessary elements for a Basin Centred Gas System – humic, gas-prone coal beds, R, > 0.6% to initiate thermal gas generation, low porosity and permeability reservoirs interbedded with the source rocks and gas shows (Law, 2002). At Wimma 1, located in the centre of the Patchawarra Trough just outside the block, overpressured gas sandstones with poor reservoir properties were encountered in the Early Permian section.

The two northern areas of CO2010-C lie on the Deramookoo Shelf, Mt Howie Ridge and Birdsville Track Ridge. These areas have minimal seismic coverage and no wells, lying 15 to 20 km from the edge of the Early Permian Gidgealpa Group source rocks of the Patchawarra and Arrabury troughs. The nearest oil pools lie 15 to 20 km to the south and southeast, marginal to the Patchawarra and Arrabury troughs. These oil pools are reservoired in the Triassic Tinchoo Formation (Keleary, Telopea, Tarragon and James), Jurassic Poolowanna Formation (Keleary) and Jurassic basal Birkhead/Hutton (Tarragon, Keleary and Cleansweep). The nearest gas discovery, Kiwi 1, is reservoired in the Triassic Callamurra Member of the Nappamerri Group.

Pandieburra 1, located approximately 20km west of the northern area, encountered fluorescence in fine grained sandstones of the Poolowanna Formation. In addition trace amounts of hydrocarbon were detected by gas chromatography of the trapped air above a water sample from a DST over the zone. The well was drilled in 1963 as a crestal test of a large interpreted closure (250 sq miles!) defined by seismic lines acquired in 1961 and 1962.

Given the considerable distance of the northern areas from the Early Permian kitchens, alternative source rocks should be considered. The Late Permian Toolachee Formation overlies Pre-Permian basement to the north and west of the Arrabury Trough, and organic rich sediments and coals in this unit provide a potential hydrocarbon source close to the block boundaries. In the overlying Eromanga Basin sequence the coals and carbonaceous shales of the Birkhead Formation and the highly carbonaceous shales of the Poolowanna Formation are also
potential source rocks (Michaelsen and McKirdy, 1996). Hydrocarbon geochemistry studies suggest that many of the oils reserorved in the Eromanga Basin have been generated in situ, and have not migrated from deeper source rocks in the Cooper Basin (Michaelsen and McKirdy, 1996).

**CO2010-D (Zone D)**

Zone D (Figure 14, Appendix 1) captures part of the north-western margin of the Patchawarra Trough in the Cooper-Eromanga Basin, and the Eromanga Basin sequence west of the Permian sub-crop edge. Most of PEL 111 falls within Zone D. PEL 111 currently expires on 13 July 2010 and a minimum 391km² area (less the area of any PPLs or PRLs granted during the permit term) must be excised on renewal.

The Snatcher and Charo oil fields and the Warhawk 1 oil discovery lie with the area of PEL 111. The three oil pools occur in intra-Birkhead Formation channel sands on anticlinal features on or immediately west of the Permian sub-crop edge. Charo 1 (PPL 177), drilled in 1984 was the first intra-Birkhead oil discovery in the area. However, the intra-Birkhead channel play was not further pursued in the area until 2007 with the drilling of Charo 2 in PPL 177, and later Warhawk 1 (PEL 111) in 2008 and Snatcher 1 (PEL 111) in 2009. All these wells were sited on 2D seismic. 3D seismic surveys (Charo – 2008 and Mollichuta - 2009) have since been acquired to better image the Birkhead Formation channels systems and better define structural closures.

Elsewhere in Zone D, the Callabonna (1990), Growler (2006), Wirraway (2007) and Tigercat (2008) oil pools also occur in intra-Birkhead Formation channel sands on or near the Permian sub-crop edge. Similarly the discovery wells were sited on 2D seismic and 3D seismic surveys have since been acquired.

Significantly, gas peaks, hydrocarbon fluorescence and an oil recovery from the basal Birkhead Formation in Hoolendinnie 1 suggest that oil has migrated at least 20km from the Permian sub-crop edge, if it is Permian sourced. Alternatively Michaelsen and McKirdy (1996) have argued that the Charo and Callabonna oils have a Jurassic source affinity on the basis of specific biomarker ratios. If the Eromanga Basin oils are sourced from intraformational source rocks then oil prospectivity is independent of the Permian subcrop edge.

**INFRASTRUCTURE AND TRANSPORT**

A total of 5 240 km of pipeline has been laid to gas markets in South Australia, New South Wales and Victoria and to the liquids load out facility at Port Bonython. Gas from individual wells passes via field gathering systems (flowlines) to satellite stations which separate gas, free water and condensate. Evaporation ponds are used for water disposal. The essentially water-free gas and condensate pass to the Moomba treatment plant through trunklines. Crude oil is transported by either pipeline or truck to the Moomba plant which was designed to process 25.4 x 10⁶ m³ (902 mmcf) of raw gas and 6000 kl (42 000 bbl) of condensate and crude oil per day. Nine oil and 11 gas satellites are currently in operation. Since January 2009, the Queensland to South Australia/New South Wales (QSN) Link Pipeline between Ballera (Qld) and Moomba has transported sales gas sourced...
from coal seam methane reserves in south-eastern Queensland directly into the Moomba to Adelaide Pipeline. A connection directly into the Moomba to Sydney Pipeline is also possible.

The new entrant Cooper Basin explorers have secured access to Moomba facilities operated by Santos Ltd. Oil is trucked from the Acrasia, Sellicks, Aldinga, Christies and Worrior fields to Moomba. Condensate, LPG, crude and some ethane are transported as a cocktail from Moomba via a pipeline to Port Bonython where they are separated and exported. At least one party has attained an agreement for third-party gas to be processed at Moomba (Smegsy 1, operated by Great Artesian Oil and Gas in 2005).

The township of Innamincka lies southeast of the release areas, 65 km NE of Moomba. It offers a hotel, general store, and light-aircraft airstrip, and is accessible by good quality roads. The causeway at Innamincka provides the major crossing point for the Cooper Creek, which in times of flood is impassable by vehicle.

Accommodation and support facilities are located at the Moomba Production Facility, operated by the Cooper Basin Joint Venture, and not open to the general public. Access is by arrangement with the operator. The full range of support services are located at the Moomba camp including, logging, wireline, fracture stimulation, cementing, transport, fuel supply, aviation (including helicopter) and emergency services. There is a sealed airstrip at the Moomba Production Facility.

LAND ACCESS

National parks and reserves

Some of the current gazettal areas lie within the Innamincka Regional Reserve, in the core of Australia’s arid region (Figure 8). Regional Reserve is a reserve classification under the National Parks and Wildlife Act 1972 that specifically accommodates multiple land use. A PEL application incorporating any portion of the Innamincka Regional Reserve will be referred to the Minister for Environment and Conservation and the views of such Minister are required to be taken into account when granting the PEL. In the case of Petroleum Production Licences within the Innamincka Regional Reserve, approval must be obtained from the Minister for Environment and Conservation. Failing such Minister’s approval, the issue is referred to the Governor for decision.

Parts of the Cooper Creek system are also listed as wetlands of international significance under the Ramsar Convention (1971). The Ramsar area overlies, at least partly, blocks CO2010-C and CO2010-D (Figure 8). South Australia’s obligations are to manage the wetlands wisely to maintain their ecological character; this does not necessarily restrict exploration access.
Environmental regulation

One of the key environmental requirements of the Petroleum and Geothermal Energy Act 2000 is the need for all regulated activities to be covered by an approved Statement of Environmental Objectives (SEO), whether in a Regional Reserve or on pastoral leases. The purpose of the SEO is to address all risks associated with activities and to address issues and concerns raised by stakeholders detailed in a supporting document - an Environmental Impact Report (EIR). The SEO is prepared on the basis of the EIR through stakeholder consultation. The SEO also provides an effective mechanism for establishing ‘one-window-to-government’ for the industry by engaging the other agencies in the SEO consultation process.

An SEO does not have to be prepared for every individual activity proposal in the case where a licensee can demonstrate that their proposed activity is covered by an existing approved SEO, such as the current regional Cooper Basin SEOs for drilling and seismic activities, available on this data package.

Heritage and land access

A PEL cannot be granted in the Cooper Basin unless an appropriate land access agreement is in place with the Registered Native Title Claimants, the State Government and the explorer. Industry, the State Government, South Australian Native Title Services Ltd (SANTS) and registered Native Title claimants have been working together to create greater certainty and expedite grant of new PELs through conjunctive Indigenous Land Use Agreements (ILUAs) in the South Australian Cooper Basin (Figure 9). ILUAS now form an alternative to the right-to-negotiate process pursuant to the Commonwealth Native Title Act 1993 in the Cooper Basin.
Cooper Basin Acreage Release  ●  CO2010-A, B, C and D

Figure 9

Cooper and Eromanga Basins, South Australia

INDIGENOUS LAND USE AGREEMENT and REGISTERED NATIVE TITLE CLAIMANTS

Registered Native Title claims
- SC97/3: The Wangkangurru/Yarluyandi Native Title Claim
- SC97/4: Dieri Native Title Claim
- SC98/1: Yandruwandha/Yawarrawarrika Native Title Claim
- SC99/1: Adnyamathanha No.1
- SC08/2: Dieri No 2 Native Title Claim
- Indigenous Land Use Agreement (ILUA)

Petroleum tenements
- Acreage release zone
- Acreage release block
- Cooper Basin subcrop limit

Current tenements not shown

Datum GDA 94 - Projection MGA Zone 54

Government of South Australia
Department of Industry and Resources SA

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Breakthrough native title access agreements via the right to negotiate process for 11 Cooper Basin exploration licence application areas were signed in late 2001, enabling the grant of new Cooper Basin licences. In late 2002 through to early 2003, additional native title access agreements (modelled on the deeds established in late 2001) enabled the grant of an additional 16 licences. All these native title access agreements are:

1. conjunctive, e.g. cover all petroleum licence activities from exploration through to production
2. considered both fair to the native title claimants and sustainable with respect to petroleum exploration, development and production.

These Cooper Basin native title access agreements sustain efficient processes to protect Aboriginal heritage in relation to field operations and provide appropriate benefits to the registered native title claimants. The native title deeds for all South Australian petroleum exploration licenses subject to the right-to-negotiate or ILUA process pursuant to the Commonwealth Native Title Act 1993 are available for public scrutiny from the PIRSA website.

It may be necessary to access adjoining accessible areas to conduct regulated activities relative to the PEL, via an Associated Activities Licence (AAL). The right-to-negotiate or ILUA process will include negotiation for facilitation of appropriate access to such adjacent accessible areas reasonably necessary to conduct such regulated activities, and will also include negotiation for facilitation of access relative to the grant of any ensuing licence for future production and necessary infrastructure development.

For further details of the right-to-negotiate or ILUA process contact Joe Zabrowarny, Manager, Licensing and Royalties, email <joe.zabrowarny@sa.gov.au>, phone (08) 8463 3203.

A number of sites of European heritage significance such as historical buildings, structures and geological monuments may also occur in the area. The majority of sites are small and easily avoided by exploration activities.

Geothermal Exploration Licences
A number of Geothermal Exploration Licences (GELs) coincide with petroleum exploration and production licences in the Cooper Basin region (Figure 10). The GEL licensee must be notified of activities in PELs granted as a result of this acreage release. The GEL licensee may object to the activity and may be able to claim compensation if their activities or resources are affected. Likewise the GEL holder must notify the PEL holder of their activities, and the PEL holder may also object and claim compensation.

Associated Activities Licences
Associated Activities Licences (AALs) are now available under the Petroleum and Geothermal Energy Act 2000. These licences allow explorers to undertake activities or establish facilities (e.g. seismic surveys) in proximity to petroleum exploration, retention and production licences. AALs are typically used to enable the recording of full-fold seismic within a PEL by recording tails of seismic lines outside the licence area.
Cooper Basin Acreage Release • CO2010-A, B, C and D

Figure 10

Cooper and Eromanga Basins, South Australia
GEOTHERMAL LICENCES

Enlargement area

Geothermal well

Geothermal tenements
- Exploration licence (GEL)
- Exploration licence application (GELA)
- Retention licence (GRL)

Petroleum tenements
- Acreage release zone
- Acreage release block
  - Cooper Basin subcrop limit

Datum GDA 94 • Projection MGA Zone 54

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CLIMATE AND LAND USE

Australia’s seasons are opposite to those of the northern hemisphere – the hottest months are January-February and the coldest month is July. At Moomba temperatures can range as high as 48 °C (118 °F) in summer, while overnight temperatures can drop to 2 °C (36 °F) in winter. The Cooper Basin is located in the core of Australia’s arid region. The average annual rainfall in far northern South Australia is 176 mm (7 in), with the heaviest rainfall during December–February.

The northern part of South Australia is sparsely populated and relatively undeveloped due to its remoteness and harsh climate. The main industries are petroleum exploration and development, followed by large pastoral leases producing cattle and tourism.

BIDDING AND AWARD PROCESS

Winning bidders will be selected on the basis of the total five-year work program bid. The work program must be completed within the overall area of the PEL. It must include a statement of exploratory operations the applicant proposes to carry out in the first five-year licence term. It is expected that at least one petroleum exploration well would be included in the program.

Bids will be assessed using the philosophies expressed in “Selecting the Winning Bid”. The specific scoring scheme is detailed in “CO2010 Bid Assessment Policy”. Copies of both documents are included on this CD.

In general, it is important to note that the timing of well drilling and seismic or other data acquisition will be taken into account. Key assessment criteria include:

- The number of exploration wells to be drilled in the PEL and their timing.
- The number of years the applicant is prepared to guarantee the program.
- The extent to which proposed wells are supported by existing or new programmed seismic data.
- The amount and nature of seismic surveying (i.e. 2D versus 3D) to be carried out and its timing.
- Other data acquisition (e.g. gravity, aeromagnetic or geochemical surveys).
- Seismic reprocessing to be carried out.

In frontier areas (i.e. blocks CO2010-A and CO2010-B), proposed wells should be supported by sufficient seismic to define a drillable target.

In addition to the above criteria, where bids are similar, the benefits of the introduction of new explorers into the area may be taken into account. In the case of cascading bids (i.e. multiple or hybrid bids by one applicant or joint venture), only the highest bid will be considered.

The closing date for CO2010-A, B, C and D applications is 4.00pm, Thursday 10 March 2011.

The Minister is expected to announce the winning bidders, together with details of work programs, by May 2011.
REFERENCES


VEEVERS, J.J. (Ed), 2000. Billion –year earth history of Australia and neighbours in Gondwanaland. Published by GEMOC Press, Department of Earth and Planetary Sciences, Macquarie University, NSW.

APPENDIX 1
Detailed maps of CO2010 blocks.

Any vacant acreage in zones C and D will be added into blocks CO2010-C and CO2010-D respectively up until 10 February 2011 (i.e. one month before the close of bidding). For example a minimum 391km² area (less the area of any Petroleum Production Licences (PPLs) or Petroleum Retention Licences (PRLs) granted during the licence term) is expected to be relinquished from PEL 111 (straddling zones C and D) around mid 2010.

Please visit www.petroleum.pir.sa.gov.au for updates.
Cooper Basin Acreage Release • CO2010-A, B, C and D

Figure 11

Petroleum tenements
- Acreage release zone
- Acreage release block
- Exploration licence (PEL)
- Exploration licence application (PELA)

Petroleum wells
- Dry hole
- Dry hole with oil shows
- Gas shows
- Gas well

Petroleum pipelines
- Gas
- Gas and liquids
- Liquids
- Liquid trunkline
- Gas trunkline

Seismic coverage
- 2 dimension
- 3 dimension

Parks with petroleum exploration access
Parks with no petroleum exploration access
Ramsar site

Cooper Basin - South Australia
ACREAGE RELEASE
CO2010-A
Cooper Basin Acreage Release • CO2010-A, B, C and D

Figure 12

Cooper Basin
QUEENSLAND

Parks with petroleum exploration access
Parks with no petroleum exploration access
Ramsar site

Petroleum tenements
- Acreage release zone
- Acreage release block
- Exploration licence (PEL)
- Exploration licence application (PELA)

Petroleum wells
- Dry hole
- Dry hole with oil shows
- Gas shows
- Gas well

Petroleum pipelines
- Gas
- Gas and liquids
- Liquids
- Liquid trunkline
- Gas trunkline

Seismic coverage
- 2 dimension
- 3 dimension

Cooper Basin – South Australia
ACREAGE RELEASE
CO2010-B
Figure 14
CONTACT INFORMATION
Comments, inquiries and applications for exploration licences may be addressed to:

Director, Petroleum and Geothermal Group
Office of Minerals and Energy Resources
Primary Industries and Resources South Australia
Level 7, 101 Grenfell Street Adelaide SA 5000, Australia

Phone
National (08) 8463 3204
International +61 8 8463 3204

Fax
National (08) 8463 4155
International +61 8 8463 4155

Website
www.petroleum.pir.sa.gov.au