March 2004 ISSUE No. 73

AUSGEO news

Acreage open to bids

naturally GAS RICH

Petroleum Open Day 1 April

PP 255003/00048

Also: Oil province hunt, source rock studies, new map for rail buffs

AUSGEO News
March 2004 Issue no. 73

Editor Julie Wissmann

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CONTENTS

The Petroleum Open Day on April 1 is immediately after APPEA 2004 in Canberra. It will be held at Geoscience Australia's headquarters.
See the proposed program at www.ga.gov.au

Australia is naturally gas rich, but our oil production is expected to fall by 40 per cent over the next decade. We need some major new oil discoveries.

Geoscience Australia contributes by providing vital geological and seismic data to help reduce exploration risk.

Photo: Natural gas plant © Australian Picture Library/ RF

This month Canberra is hosting the annual conference of the Australian Petroleum Production and Exploration Association. The APPEA conference is an opportunity for petroleum industry professionals to get to know more about what Geoscience Australia and other parts of the Australian government can and are doing for the industry.

The theme of this year's conference, 'Contributing to our nation' underscores the importance of the petroleum industry to Australia, particularly in economic and energy security terms. This importance has been recognised by government and demonstrated in the 2003 budget decision which allots $61 million over four years to Geoscience Australia's petroleum program.

The funding is to provide the pre-competitive information to support industry's search for a new oil province. The funds will maintain Geoscience Australia's core petroleum program and initiate a vital new phase of data acquisition and the preservation of the data archive.

I am happy to announce that this new initiative is now well under way. The first marine surveys have just returned from sea—one from dredging the frontier basins off the south-west margin, and the other has been critically assessing techniques for identifying active petroleum systems in the Timor Sea. As well, the remastering of deteriorating seismic tapes onto new, stable media has begun. The articles in this issue of AusGeo News describe these new programs in more detail and outline our plans for the future.

The outcome of the new data acquisition program is the eventual offering of new prospective areas in the annual release of offshore petroleum acreage. The 2004 release will be announced by the Minister at the APPEA conference. The areas available for bidding are outlined in this issue.

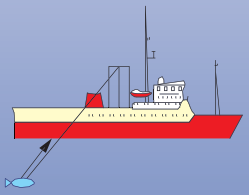
In future years we hope to offer new and further opportunities for investment in frontier and other basins underpinned by critical geoscience information that reduces risk and demonstrates petroleum prospectivity.

Geoscience Australia has a booth at the APPEA conference, and a number of our researchers are presenting papers in the technical program. Our Petroleum Open Day immediately follows the conference. The Open Day will provide an informal atmosphere in which to discuss industry issues with people from Geoscience Australia, the Department of Industry, Tourism and Resources, and the Department of Environment and Heritage.

There will also be an opportunity to review the options for the 2004–2007 petroleum program, and to see the results of current projects. Industry input is essential for our planning of the new data acquisition campaign, so I encourage your contributions to the discussions now and in the future. The dredge samples fresh off the boat from the Bremer and Denmark sub-basins will be on display, as will be our 3D theatre and world-class petroleum data and core repository.

I would like to take this opportunity to welcome APPEA delegates to Canberra and I encourage you to visit Geoscience Australia while in town.

Comment



Neil Williams

NEIL WILLIAMS
CEO Geoscience Australia

Frontiers in oil province HUNT

Australia's oil production is expected to fall by 40 per cent over the next 10 years and this will seriously affect our energy self-sufficiency unless there are major new discoveries.

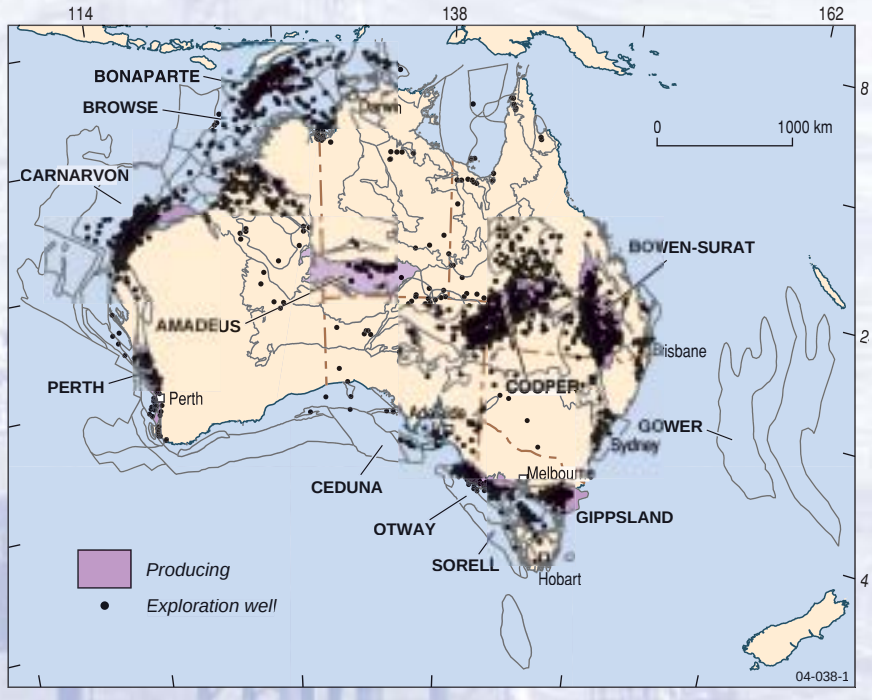
Australia is handling this situation in a number of ways. Existing oil provinces that may have further potential are being re-examined, and new techniques to locate oil using satellite technology are being tested. But the solution is thought to lie in under-explored areas offshore.

Australia has comparatively few petroleum exploration wells—less than eight thousand wells in an area of more than 12 million square kilometres—and it has some un-drilled frontier basins that could contain oil (figure 1).

Companies considering oil exploration in Australian territory look for geological and seismic data to reduce exploration risk. Geoscience Australia provides this vital data.

The Australian Government has allocated $61 million to Geoscience Australia over four years to provide basic geological information that encourages petroleum exploration investment.

$36 million is for the core petroleum program, and $25 million is for new data acquisition and data preservation and archive.



▲ **Figure 1.** Australia has less than eight thousand petroleum exploration wells in an area of more than 12 million square kilometres, and a number of un-drilled frontier basins.

Stakeholder input

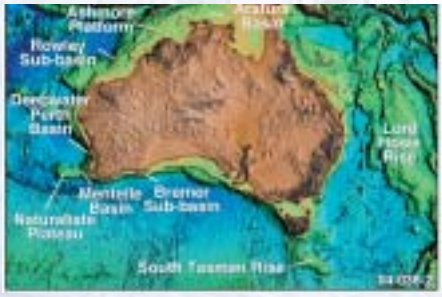
Since the Australian Government allocation, Geoscience Australia has consulted the exploration industry in Australia and overseas about how best to achieve a new oil province.

An integrated program of seismic acquisition, geological sampling and oil-seep detection was proposed, along with a portfolio of potential projects (figure 2).

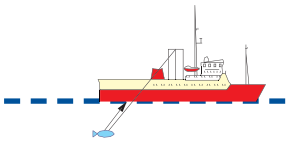
One of the preferred deep-water frontiers was the Bremer Sub-basin and there was interest in the shallow-water Arafura Basin. The Lord Howe Rise was viewed as a longer term prospect. It is too large to ignore and new data for the area could radically change perceptions of its petroleum potential.

Even though frontier basins are Australia's best chance of finding substantial new oil provinces, stakeholders stressed the need to continue efforts in existing exploration areas.

Part of Geoscience Australia's program therefore involves regional overviews and analysis of petroleum systems in proven provinces, and providing access to the data.



▲ **Figure 2.** Potential project areas for Geoscience Australia in the search for a new oil province



First phase

In February, Geoscience Australia began acquiring data in the Bremer and Denmark sub-basins off Western Australia between Albany and Esperance (figure 3). The geophysical and sampling survey is in water depths of 100 to 4500 metres.

A large number of dredge samples and new high-speed seismic data will provide important information about the petroleum geology of the area, the evolution of the sub-basins, and rifting between Australia and Antarctica about 100 million years ago.

At this stage, the petroleum potential can only be inferred. The sub-basins have not been drilled, and until this survey no rocks had been dredged from the seabed.

Both sub-basins appear to be thick enough to have generated oil, providing there is the right combination of petroleum source and reservoir rocks. If these conditions prove true, based on seismic-section interpretations, the Bremer Sub-basin has large geological features that could have trapped the hydrocarbons.

A dozen deep canyons, called the Albany Canyons, provide the ideal dredge sites. These slice 1000 metres deep into the sediment pile and occur where the sub-basins cross the continental slope.

If successful, the first dredge samples will be on display at Geoscience Australia's Petroleum Open Day on April 1 (following the 2004 APPEA conference).

Seep detection

As Earth's crustal plates bump and grind, cracks or faults form allowing hydrocarbons to seep to the surface. Around Australia, ocean generally covers the seeps and water pressure restricts their flow. But some surfaces as gas or an oil slick which can quite quickly evaporate.

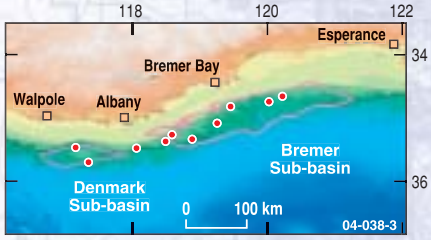


Figure 3. Possible dredge sites in the Bremer and Demark sub-basins

Geoscience Australia has begun locating natural hydrocarbon seepage around Australia. A combination of approaches is being used including remote sensing, conventional geological interpretation, and marine surveys to acquire water column and seafloor samples for geochemical analysis in Geoscience Australia's laboratories.

The first marine survey, around the Ashmore Platform and Yampi Shelf region is in March. Current knowledge of the region, its shallow-water setting and petroleum potential, make it an attractive location to survey.

Previous work around the Cornea area of the Yampi Shelf provided evidence of hydrocarbon seepage. A range of seep detection and sampling tools will be tested in this area and then the survey will focus on the Ashmore Platform using the understanding gained on the Yampi Shelf.

Potential seepage areas have been identified from remote sensing data—a combination of Synthetic Aperture Radar and Landsat satellite imagery, as well as Airborne Laser Fluorescence—and from interpreting features in seismic lines and sub-bottom profiles. The features that suggest seepage include seabed faults, pockmarks, mounds, and changes to sediment since it was deposited (hydrocarbon-related diagenetic zones or HRDZs).

Sub-bottom profiles, side-scan sonar, swath-mapping and fluorometer data will be collected during the survey to better target sampling sites.

Information sharing

Differentiating natural oil slicks from other phenomena requires careful assessment, particularly when using remote sensing tools and satellite imagery to map differences in the sea surface. A number of things can cause slicks or change the surface tension of the ocean, including passing ships or coral spawning.

Geoscience Australia recently hosted a science–industry workshop on the remote sensing of natural oil seeps. Australian as well as international consultants and researchers presented and discussed different remote sensing techniques and their geological integration. The workshop has been extremely useful for evaluating potential survey sites around Australia.

Another valuable workshop delivered by Michael Abrams, leader of a large, multi-client study on surface geochemistry calibration for the Energy and Geoscience Institute, University of Utah has resulted in a new partnership for Geoscience Australia.

The two agencies will be collaborating on methods of seep analysis and detection.

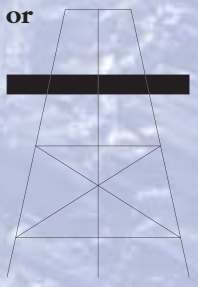
Forward program

Geoscience Australia has identified study areas in the south-west region, North West Shelf and the Lord Howe Rise, and scoped a preliminary program of data acquisition up to 2007. These will be modified with survey results and stakeholder input. Further industry–government workshops will be held on an as-needs basis.

The surveys will help determine whether a suitable geological history has occurred to form large oil accumulations and whether oil is still present. The targeted areas range from shelf depths to deep water.

Data acquisition will be linked to the Australian Government's annual release of petroleum exploration acreage. Explorers can study the results and judge the prospectivity of acreage for themselves as the data will be free via the web or at the cost of transfer.

For more information phone Marita Bradshaw on +61 2 6249 9452 or e-mail marita.bradshaw@ga.gov.au



MORE GAS, LESS OIL
in forecast update

The medium-term forecast for the discovery of hydrocarbons in the Browse Basin was recently updated by Geoscience Australia.

In the next 10–15 years, Geoscience Australia expects that seven gigalitres (46 million barrels) of oil, 119 billion cubic metres (4.2 trillion cubic feet) of gas and 18 gigalitres (115 million barrels) of condensate could be discovered in the Browse Basin (table 1).

This discovery forecast was calculated using Geoscience Australia's resource assessment program, AUSTPLAY.

It is not an estimate of the basin's ultimate potential.

The previous Browse Basin assessment released in 1998 forecast that 62 gigalitres (391 million barrels) of oil and 93 billion cubic metres (3.3 trillion cubic feet) of gas could be discovered.

It reflected the optimism associated with finding oil in the Cornea Field in 1996–1997, which has dimmed with subsequent exploration activity. On the other hand, the previous gas assessment proved to be pessimistic, with the subsequent discovery of gas at Brecknock South, Crux and Argus alone exceeding the forecast.

Table 1. Summary of Geoscience Australia's medium-term assessment for the Browse Basin (GL gigalitres, mmb million barrels, bcm billion cubic metres, tcf trillion cubic feet)

		Mean	P_{10}
Oil	**GL**	**7.3**	**23.9**
	mmb	**46**	**150**
Gas	**bcm**	**118.6**	**338.5**
	tcf	**4.2**	**12.0**
Condensate	**GL**	**18.3**	**51**
	mmb	**115**	**321**

Forecast uncertainties

The drilling forecast for the next 10–15 years strongly influenced the assessment, even though predicting future drilling activity is complex.

Current permit drilling commitments were used as a starting point. The problem is permit drilling commitments extend a maximum of six years from the date the exploration permit is granted. As well, drilling commitments in the later stage of a permit life generally have a lower expectation of actually being drilled.

The current assessment (table 1) is based on a forecast drilling model of 16 wildcat wells expected to be drilled in the next 10–15 years.

An alternative model based on the number of wells to be drilled to meet current permit commitments (21 wells) produces an outcome of 215 billion cubic metres (7.6 trillion cubic feet) of gas and 29 gigalitres (180 million barrels) of condensate. The oil outcome does not change because the modifications occur in the pure gas assessments.

This alternative drilling model was considered too optimistic based on permit drilling commitments for outer areas, and so the number of modelled wells was reduced for the current assessment.

Assessment units

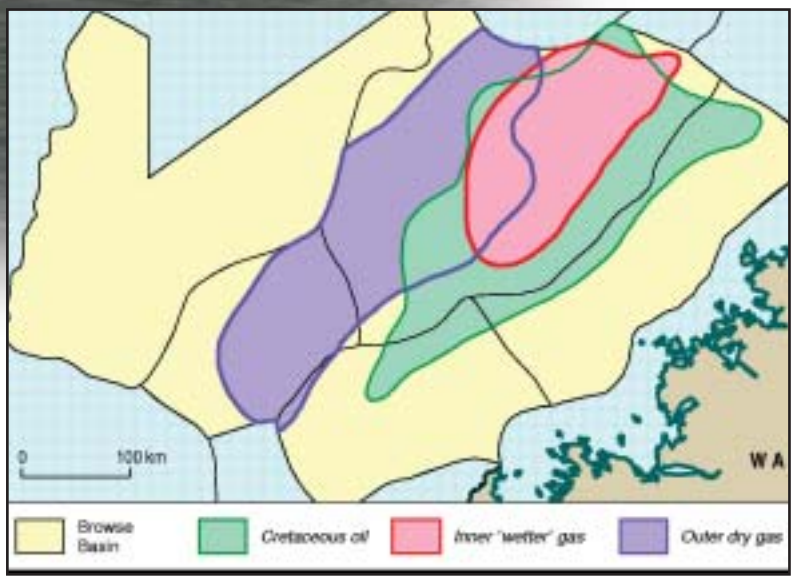
Three assessment units were defined for the Browse Basin: an outer dry-gas area, an inner 'wetter' gas area, and a Cretaceous oil assessment unit (figures 1 & 2).

The outer dry-gas area comprises accumulations where condensate–gas ratios are generally less than 20 barrels of condensate per million cubic feet of gas. These include Scott Reef, Brecknock, Brecknock South and Argus gas accumulations, and the deeper Middle Jurassic Plover Formation gas reservoir of the Brewster accumulation.

In the inner 'wetter' gas area, condensate–gas ratios are greater than 20 but less than 70 barrels of condensate per million cubic feet of gas. It includes the Crux accumulation and the shallower Late Jurassic/Early Cretaceous Vulcan Formation gas reservoir of the Brewster accumulation.

The Cretaceous oil assessment unit comprises parts of the Caswell Sub-basin and the Yampi Shelf. These two distinct structural regions required different sets of input parameters to be properly assessed.

▲ **Figure 1.** Location of the Browse Basin



▲ **Figure 2.** Assessment units for the Browse Basin

USGS assessment

The United States Geological Survey included the Browse Basin in its world petroleum assessment in 2000.

Its discovery forecast for the Browse Basin was 168 gigalitres (1055 million barrels) of oil, 569 billion cubic metres (20.1 trillion cubic feet) of gas and 148 gigalitres (934 million barrels) of condensate.

The current Geoscience Australia and USGS assessments clearly differ.

The main difference is the timeframe for the forecasts; Geoscience Australia's assessment is for a 10–15 year period, while the USGS assessment is for a 30-year period.

Geoscience Australia has adopted the USGS gas–condensate assessment as the ultimate potential for the Browse Basin, but it believes the oil forecast is overly optimistic and is probably influenced by the Cornea oil discovery.

Other updates

Geoscience Australia is currently assessing the potential of the Dampier Sub-basin. Updated assessments for the remainder of the Carnarvon Basin and the Gippsland Basin will occur in future years.

The Bonaparte Basin assessment and the AUSTPLAY program were presented and discussed at the Timor Sea Geoscience Symposium in Darwin in June last year.

For more information about Geoscience Australia's resource assessment program phone Andrew Barrett on +61 2 6249 9502 or e-mail andrew.barrett@ga.gov.au

EVENTS calendar

compiled by Steve Ross

AAPG 2004
American Association of Petroleum Geologists
18 to 21 April
Dallas, Texas
Contact: AAPG Convention Department, PO Box 979, Tulsa Oklahoma 74101-0979 USA
phone +1 918 560 2679
fax +1 918 560 2684
e-mail convene@aapg.or

Coast to Coast '04
Coastal CRC
19 to 23 April
Grand Chancellor Hotel, Hobart
Contact: Conference Design, PO Box 342, Sandy Bay, Tasmania 7006
phone +61 3 6224 3773
fax +61 3 6224 3774
e-mail mail@cdesign.com.au

Spatial Data Forums
Geoscience Australia
Canberra 21 May, Adelaide 25 May, Perth 27 May, & Brisbane 11 June
Contact: Andrew Beer, Geoscience Australia, GPO Box 378, Canberra ACT 2601
phone +61 2 6249 9034
fax +61 2 6249 9937
e-mail andrew.beer@ga.gov.au

17th Geophysical Conference & Exhibition
Australian Society of Exploration Geophysicists & Petroleum Exploration Society of Australia (NSW Branch)
15 to 19 August
Sydney Convention Centre
Contact: Conference Action, PO Box 576, Crows Nest NSW 1585
phone +61 2 9437 9333
fax +61 2 9901 4586

PESA 2nd Eastern Australasian Basin Symposium
Petroleum Exploration Society of Australia
19 to 22 September
Adelaide
Contact: Rob Bulfield, SAPRO Conference Management, PO Box 187, Torrensville SA 5031
phone +61 8 8352 7099
fax +61 6 8352 7088
e-mail scm@sapro.com.au

Submerged SLICE of Australia target of sea voyage

An important piece of the tectonic jigsaw of the south-west Pacific will be probed by Geoscience Australia during a sea expedition in May this year.

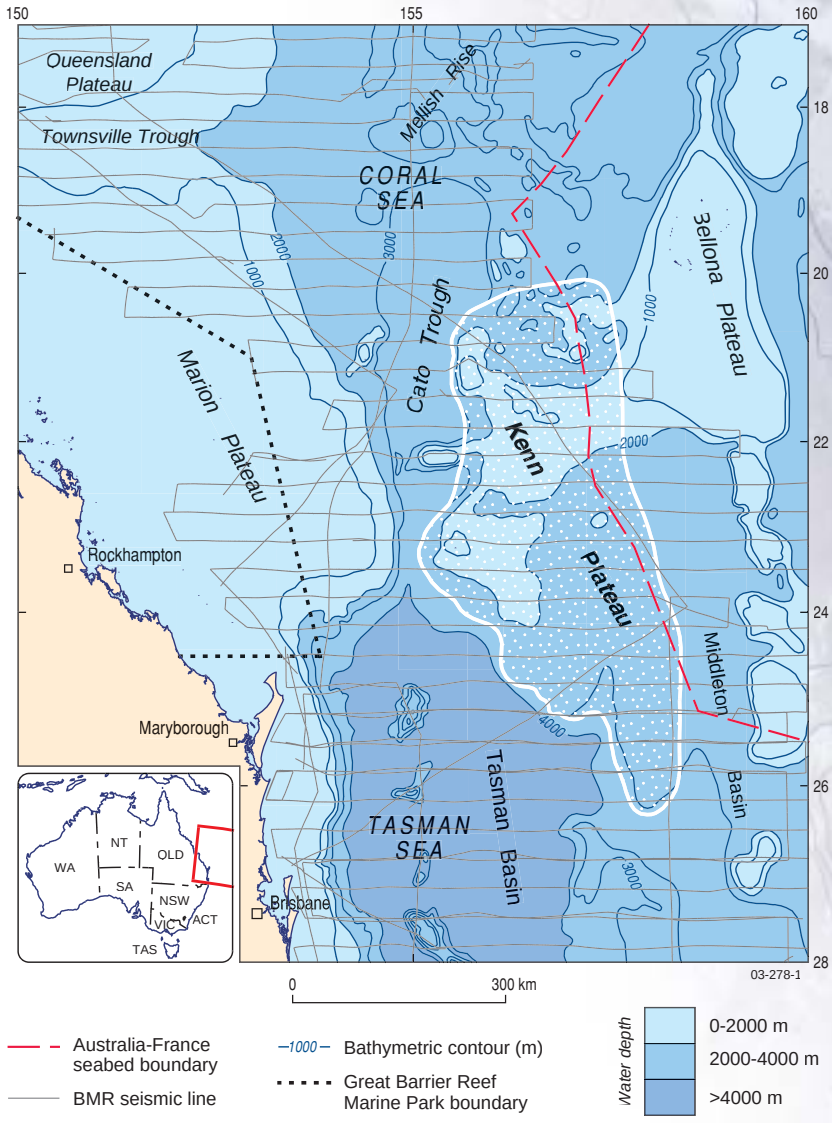
The Kenn Plateau expedition is the first stage of an investigation into remote and poorly understood plateaus that lie off Australia's north-east margin.

The Kenn Plateau is a large, submerged continental block that rifted 63–52 million years ago from what is now southern Queensland.

It is a submarine plateau separated from the Marion Plateau by the 3000-metre-deep Cato Trough. The Bellona Plateau lies to the north-east and the Middleton Basin to the south-east (figure 1).

Table 1. Scientific questions for the Kenn Plateau expedition

- The nature and distribution of acoustic basement (continental and/or volcanic?);
- The nature and tectonic styles of the plateau's margins to help constrain plate tectonic hypotheses;
- The geometry and age of the rift basins, and the nature of their sediments;
- The controls on the initiation and development of east Australian carbonate platforms since the early Miocene;
- The nature and ideally the age of several Cainozoic volcanic pedestals, assumed to be parts of the Tasmantid volcanic chain;
- The nature of modern sediments on this remote marginal plateau and their potential influence on benthic habitats.



▲ **Figure 1.** The submarine Kenn Plateau lies at the junction of the Coral Sea and Tasman Sea. Its geology is the focus of an upcoming expedition on the *Southern Surveyor*.

The Australian part of the Kenn Plateau is about 100 000 square kilometres in area, of which about 40 000 square kilometres (half the area of Tasmania) is in water shallower than 2000 metres. The plateau is shallowest along its north-western margin and generally deepens to the south-east.

It is a rare area that lies at the junction of the Coral Sea and Tasman Sea, between seafloor-spreading terrains to the south, and ridge propagation and other terrains to the north.

The Kenn Plateau is being targeted initially because of its setting, and because of a buried sedimentary succession more than two kilometres thick that should answer some questions about the geology of the greater Lord Howe Rise region.

Seismic profiles of the region are generally of low quality, and there are very few sediment or rock samples from the plateau. It is presumed to contain rift basins younger than 65 million years old.

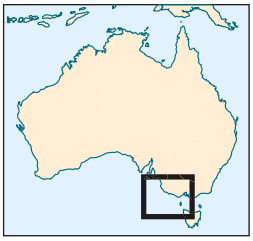
The *Southern Surveyor* will be used for the expedition. A program of shallow, high-speed seismic, bathymetric and magnetic profiling will establish the plateau's framework and setting. The research program will also include dredging and coring to obtain rocks and sediments.

The program addresses several themes in Australia's Ocean Policy and Marine Science and Technology Plan. Scientific questions being probed by the expedition are outlined in table 1.

The expedition should greatly improve understanding of the geologic evolution and geographic history of the Kenn Plateau, as well as its long-term resource potential, which is currently believed to be small.

For more information phone Tony Stephenson on +61 2 6249 9472 or e-mail tony.stephenson@ga.gov.au

Otway source rocks probed for *liquids* potential

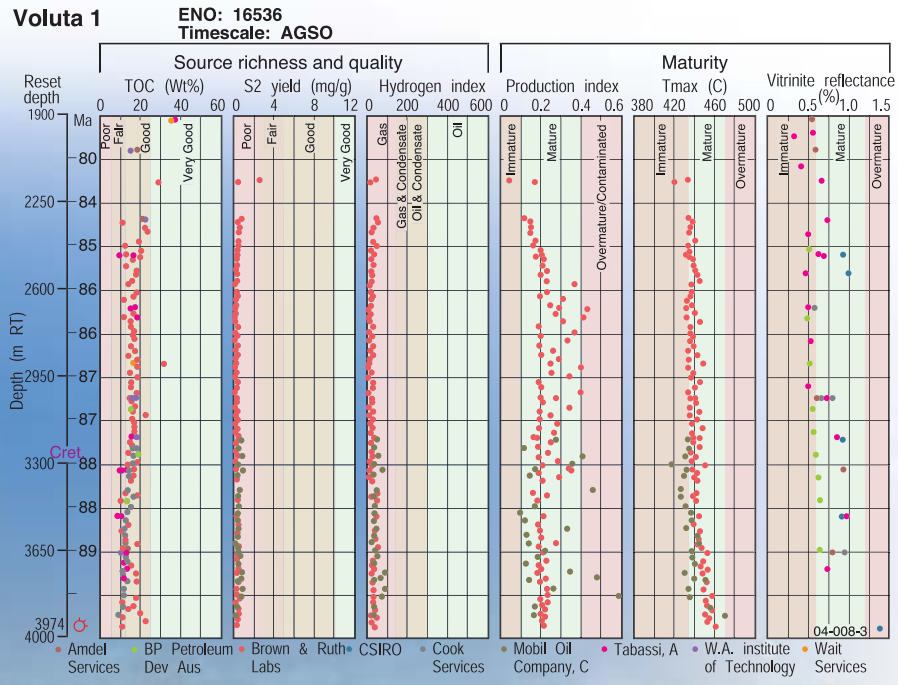


The Otway Basin in south-east Australia is becoming a major commercial gas province. Sub-commercial oil occurrences suggest the basin also has liquids potential.

The basin's oil families are well understood through detailed carbon isotope and biomarker studies, and potential source rocks have been identified in a range of Late Jurassic to Cretaceous (150–65 million year old) lithostratigraphic units.

But the effective source rocks for oil and gas are yet to be identified and this requires integrating source-rock characteristics with the geochemistry.

Geoscience Australia is studying the basin's oil-source correlations to learn more about the spatial variations in petroleum potential, condensate–gas ratios, gas–oil ratios, and maturation.



▲ **Figure 1.** Geochemical log of source and maturity parameters based on Rock Eval and vitrinite reflectance data, which can be generated on-line from Geoscience Australia's web site.

Organic geochemistry study

Key offshore and onshore wells as well as a regional grid of conventional and deep-seismic data are currently being interpreted. This work will provide a time-series for source-rock development.

Well logs, geochemical plots and web-based geochemical profiles have been reviewed to select new and existing samples of potential source rocks. A total of 169 sediments from 32 onshore and 15 offshore wells were chosen for more detailed study.

New vitrinite reflectance and fluorescence analyses based on the Newman technique were also carried out on samples from four key offshore wells (Mussell-1, Troas-1, Trumpet-1 and Voluta-1). Kerogen-specific VRF analyses are critical for accurate burial history modelling and determining maturation.

On-line data

The primary resource for organic geochemical data for the Otway Basin is Geoscience Australia's ORGCHEM database. Users can access open-file information in the database via the web.

They can build geochemical profiles of Rock Eval (S2, HI, PI and Tmax) and vitrinite reflectance (VR) data for most offshore exploration wells (figure 1). After submitting an initial well query, a downhole profile of geochemistry results can be generated by clicking the 'Graph' option under the 'OrgChem' header.

Sample ages are automatically estimated using Geoscience Australia's STRATDAT database (figure 1).

Preliminary results

The study will not be completed until June, but there are some preliminary results:

- Potential source rock intervals through time can be determined using the estimated ages (Ma) at the top and base of the samples. The onset of coal deposition at around 115 million years is clearly marked by increases in total organic carbon (TOC) concentrations (figure 2).
- Most Early Cretaceous (135–97 Ma) potential source rocks offshore are predominantly gas prone (HI<300 mg hydrocarbons/g TOC) with only minor liquids potential. Potential source rocks commonly enter the maturity window (VR > 0.65%) for petroleum generation between 2200 and 3400 metres depth in offshore wells (figure 3).
- Vitrinite reflectance (VR) datasets vary greatly in quality and consistency (figure 1). VRF analyses help constrain existing VR data and are important for burial history modelling.

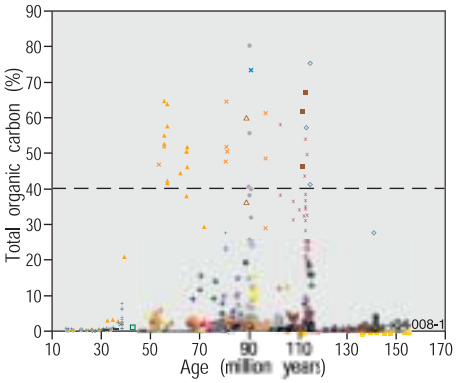


Figure 2. Age profile of total organic carbon for offshore wells in the Otway Basin

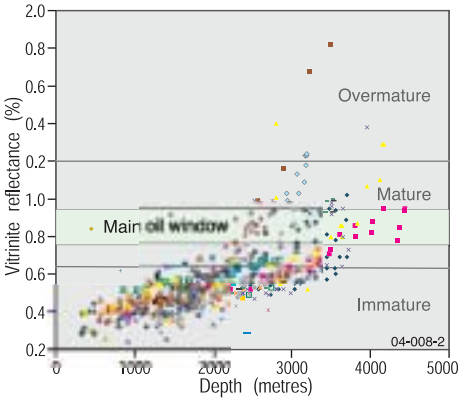


Figure 3. Maturity profile of vitrinite reflectance versus depth for offshore wells in the Otway Basin

Argonaut 1A	Crayfish A 1	Mussel 1	Triton 1
Breaksea Reef 1	Discovery Bay 1	Nautilus A 1	Triton 1 ST1
Bridgewater Bay 1	Eric The Red 1	Neptune 1	Tross1
Chama 1	La Bella 1	Nerita 1	Troas 1 ST1
Champion 1	Loch Ard 1	Normanby 1	Trumpet 1
Clam 1	Minerva 1	Pecten 1	Voluta 1
Conan 1	Minerva 2A	Prawn 1	Whelk 1
Copa 1	Morum 1	Snail 1	

Final results of the study will be presented at the Eastern Australian Basin Symposium II in Adelaide in September 2004.

For more details phone Chris Boreham on +61 2 6249 9488 or e-mail chris.boreham@ga.gov.au

NEW TOOL splits petroleum populations

Oil and gas samples from the Otway Basin reveal a lot about their heritage when analysed with Geoscience Australia's new tool.

The GC-IRMS, or gas chromatography-stable isotope ratio mass spectrometer, analyses carbon isotopes ($^{13}C/^{12}C$), and last year a new capability for analysing hydrogen (D/H) was added.

This addition has returned some interesting findings about the Otway gases and oils and the value of hydrogen isotope analysis in tracing petroleum family history.

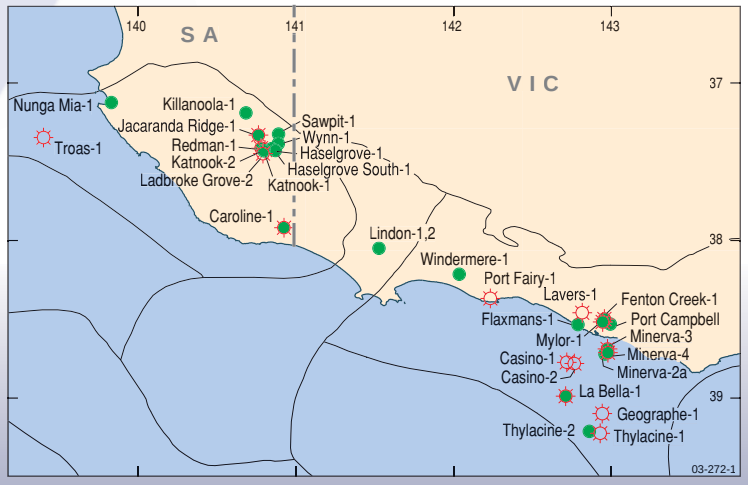


Figure 1. The analysed gas and oil were sampled from these locations in the Otway Basin.

Petroleum systems

Previous geochemical studies of the Otway Basin focused mainly on the oils and oil stains. These studies suggest, with varying levels of confidence, that the Otway hosts one of the largest number of petroleum systems of any basin in Australia. Up to five different oil populations have been identified.

The Otway oils are thought to be sourced from a range of depositional environments: from fresh to saline lacustrine, to fluvio-lacustrine and peat swamp, to marine. Potential source rocks are of Late Jurassic to Late Cretaceous age (150–65 million years).

Changes in depositional setting and source-rock character are closely linked to the basin's development (from initial rifting to thermal subsidence).

Gas isotopes

The analysed natural gases and oils (including condensates) show the Otway petroleum systems are strongly compartmentalised. Most hydrocarbons are recovered from the Early Cretaceous Pretty Hill Formation in the western Otway Basin or from the Late Cretaceous Waarre Sandstone in the eastern Otway Basin (figure 1).

The hydrogen isotopic composition of individual C_1–C_5 hydrocarbon gas components is plotted in figure 2a. Two populations of natural gases are clearly seen with large hydrogen isotopic separations of 90‰ or more between populations.

The wide isotopic separation probably reflects the different climatic and hydrological conditions which had an impact on the hydrogen isotopic composition of water during the Early Cretaceous.

Carbon isotopes also differentiate the two gas populations, although at much lower isotopic resolution (figure 2b). The isotopic compositional differences are also evident in the individual *n*-alkanes from oils and condensates.

Gas–oil correlation

The extended (C_{2+}) *n*-alkane D-isotopic profile for representative gas–oil pairs indicate two significant populations in the Otway (figure 2c). The western Otway gas–oil population is isotopically light (depleted in D) compared with the eastern population.

Carbon isotopes do not offer the same clear distinction of oils (figure 2d). Nevertheless, the natural gases show a strong isotopic association with their respective oils, especially for D (figure 2c). This suggests that they were generated together from the same source.

The gases, oils and their effective source rocks also have a strong stratigraphic and geographic relationship, inferring mainly short- to medium-migration distances from source to trap.

Next step

Hydrogen isotopes provide a more concise picture than carbon isotopes of the genetic relationships between gases and oils, and clearly distinguish two main populations in the Otway.

Further testing is required to see if these D-isotope results are influenced by the higher susceptibility of hydrogen to isotopic exchange in the geological environment. This aspect is being clarified through conventional bulk carbon isotopic and biomarker studies, and an analysis of the hydrogen isotopic composition of the source organic matter.

The results of the Otway studies will be presented at the Eastern Australian Basin Symposium in Adelaide in September.

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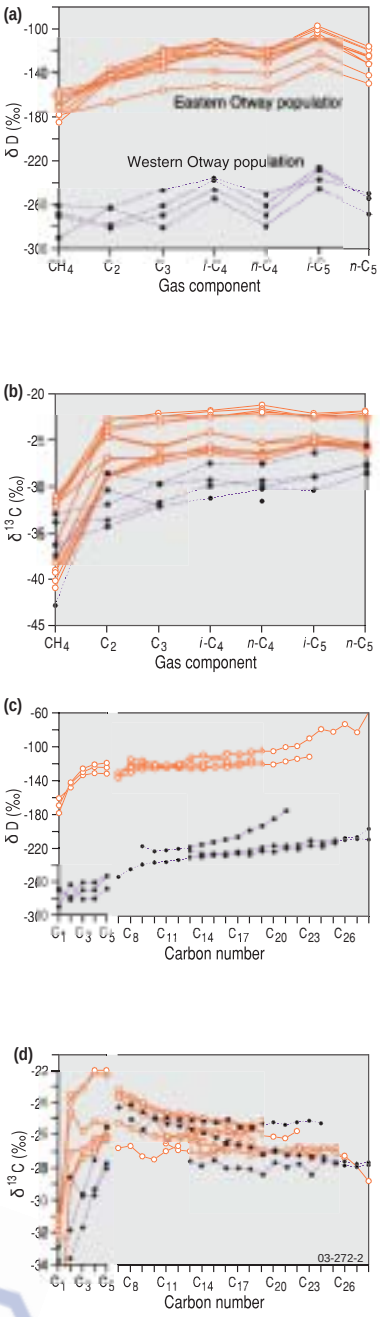

Figure 2. Gas components from the Otway Basin showing **(a)** hydrogen isotope values and **(b)** carbon isotope values, and gas and oil individual *n*-alkane components for which hydrogen isotope values **(c)**, and carbon isotope values **(d)** are shown. The open and solid symbols represent the eastern and western Otway Basin, respectively.

Gas chromatography-stable isotope mass spectrometer used in hydrogen isotope analysis

Electoral boundaries review

Locating electoral boundaries requires mapping expertise, which has Geoscience Australia involved in a review of ATSIC electoral boundaries.

Voting in the Aboriginal and Torres Strait Islander Commission (ATSIC) elections is based on zones, regions and wards—the boundaries of which crisscross the country. There are 16 zones divided into 35 regional councils, which may be sub-divided into wards.

The *Aboriginal and Torres Strait Islander Commission Act (1989)* requires elections to be held every three years. Voting is not compulsory, but more than 53 000 votes were recorded in the election held in 2002.

Under the Act a panel is convened after each election to seek and review comments about the election. The panel considers submissions and, if necessary, visits communities to discuss issues. The process takes three to four months.

The Act requires Geoscience Australia to nominate a member to the five-person panel because of its mapping expertise. Its representative is Bill Hirst (with assistance from Peter Richardson).

The other panel members are three indigenous people appointed by the Minister and a representative of the Australian Electoral Commission.

The panel recently completed two reports to be presented to both houses of parliament. One report outlines suggested changes to the electoral system and the other recommends changes to the electoral boundaries. The boundaries report will be available for public comment, so there may be new submissions.

An augmented panel with a Geoscience Australia representative will be appointed in March/April to consider the report's comments. A final boundaries report will then be prepared. This will complete the process required by the ACT—that is until the after next ATSIC election.

Dog Fence *mapped*

The entire, dog-legged wire fence that winds 5400 kilometres across South Australia and into southern Queensland is finally being surveyed, and will feature on Geoscience Australia's 1:250 000 topographic maps.

Geoscience Australia geographer Brian Polden says that prominent geographic features can be sparse in remote areas.

'A conspicuous fence is an important landmark for mapping', he says.

The Dog Fence was built in the late 1800s by graziers and governments to keep dingoes away from sheep, although some sections along the New South Wales border were originally rabbit proof fences.

The fence begins near Ceduna, then meanders north and east, and ends near the Queensland border town of Goondiwindi.

It is almost two metres high and thought to be one of the longest built structures in the world. China's Great Wall is 6700 kilometres long.

The Dog Fence is known by various names including Dingo Fence, Wild Dog Fence, Vermin Proof Fence, and Buffer Fence. It is sometimes confused with Western Australia's famous Rabbit Proof Fence (or State Barrier Fence).

In New South Wales it is generally called the Border Fence because it follows the border with South Australia and Queensland.

Vermin proof fences are vital in the management of dingoes and feral pests in rural areas. Ironically, on the 'protected' side of the fence, the numbers of kangaroos, emus and some feral animals have increased without dingoes.

The whole Dog Fence will be mapped using the latest global positioning systems. But it will take time to record and check the coordinates for every corner and bend in the fence.

Satellite images will help to fix the position of the Dog Fence because the imagery can easily detect strips of cleared vegetation around the large fence.

Field verification and other information from the states with the Dog Fence will be used in conjunction with Geoscience Australia satellite imagery and map data to ensure that the fence is mapped as accurately as possible.

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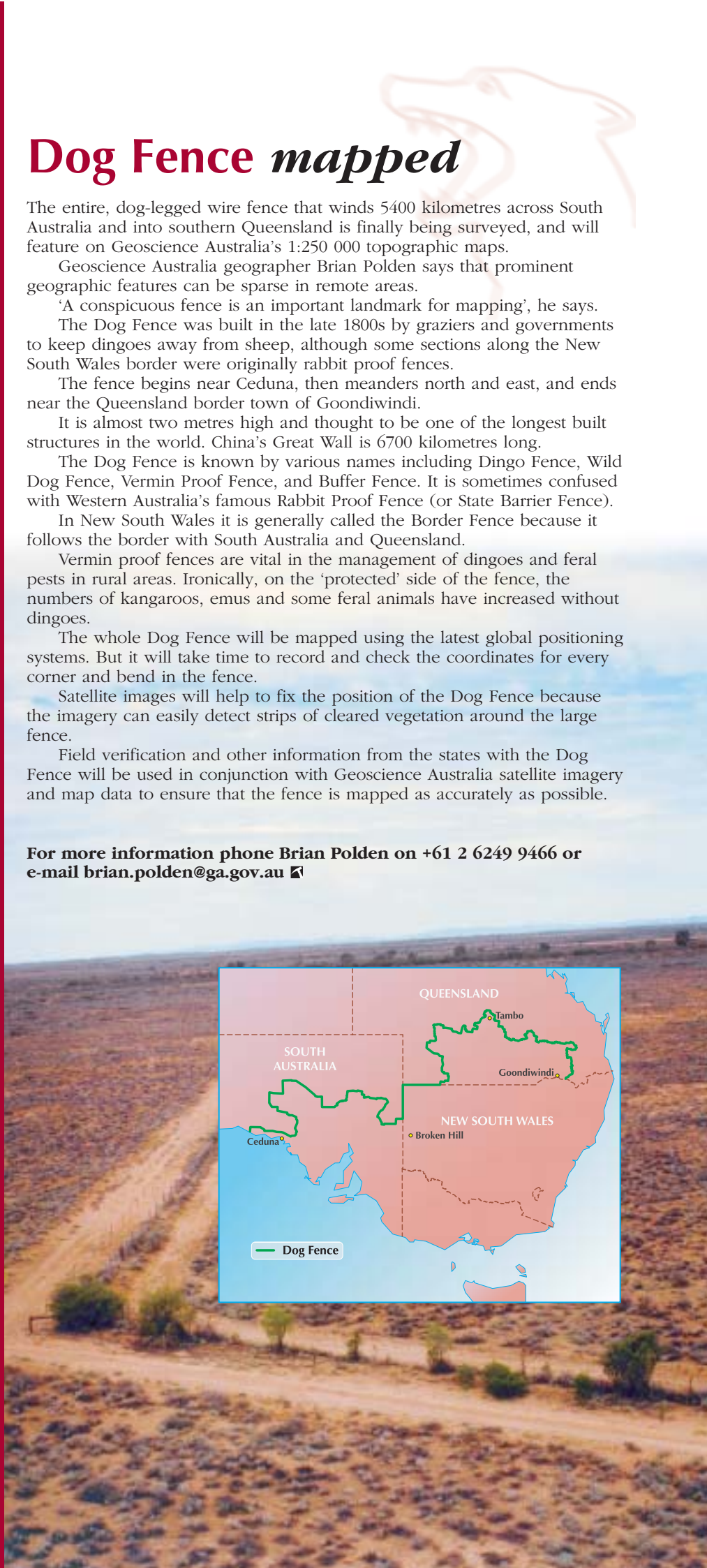
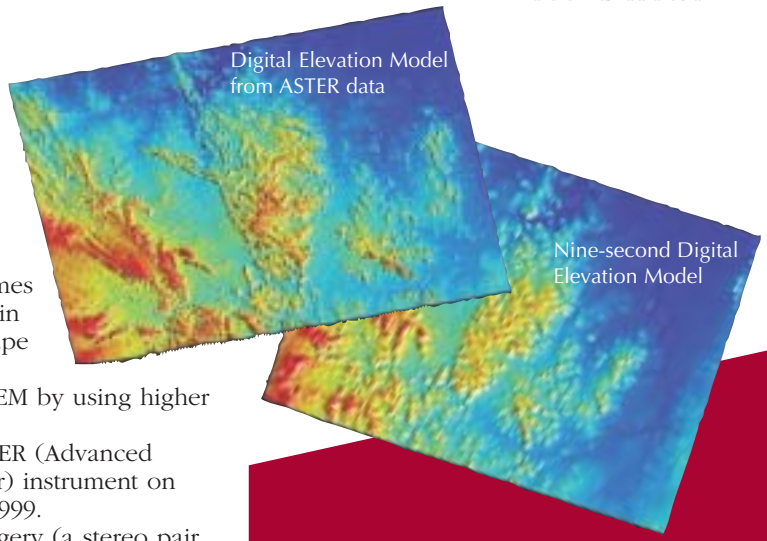


Improved national DEM



The nine-second Digital Elevation Model is the highest resolution, nationally consistent DEM of Australia. Sometimes this resolution does not provide enough detail about terrain variations, particularly for studies into soil salinity, landscape evolution, and catchment management.

Geoscience Australia plans to improve the national DEM by using higher quality satellite data.

A potential source is the stereo imagery from the ASTER (Advanced Spaceborne Thermal Emission and Reflectance Radiometer) instrument on board the Terra spacecraft launched into Earth's orbit in 1999.

ASTER acquires near-simultaneous stereo pairs of imagery (a stereo pair covers a 60-kilometre square of the Earth's surface). This is an important benefit compared with stereo pairs collected on different dates, where ground cover conditions may have changed between acquisitions.

The spatial resolution (pixel size) of ASTER stereo data is 15 metres, but an ASTER DEM is normally at 30–50 metre resolution to reduce noise.

Geoscience Australia has been using a range of commercial software to assess the quality of ASTER DEMs. The results show that ASTER data could provide DEMs with a Root Mean Squared Error (RMSE) of about 15 metres in undulating terrain and about 20 metres in rugged terrain.

The generation of DEMs from the more advanced applications takes one to two hours on high-performance PCs. The most time-consuming element is the selection of Ground Control Points (GCPs) in the image pairs.

The GCPs are required to improve the planimetric accuracy of the DEMs to about 10 metres (RMSE), and to translate the DEM to a local height datum.

The quality of the DEMs generated by the different software was generally comparable. The main differences were the use of GCPs in DEM generation and geolocation, and options in grid cell size.

Geoscience Australia is also testing the semi-automated use of GCPs in ASTER DEM generation. The results will help determine the best datasets for the improved national DEM.

New satellite data pending

Satellites are crucial to Geoscience Australia's mapping program. It acquires and interprets data from a number of satellites including the Landsat series and NASA's Terra satellite.

Another satellite that interests Geoscience Australia is the Advanced Land Observing Satellite (ALOS) being developed by the Japan Aerospace Exploration Agency (JAXA).

ALOS is a major global geospatial project and is scheduled to be launched from the Tanegashima Space Centre, Japan in the northern summer of 2004. It will be one of the world's largest earth-observation satellites.

ALOS is designed for high-resolution and precise land observation and will contribute to disaster monitoring, resource surveying and mapping via its three main sensors:

- the Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM) composed of three sets of optical systems to measure precise land elevation;
- the Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) to observe coverage of land surfaces; and
- the Phased Array type L-band Synthetic Aperture Radar (PALSAR) that enables day-and-night and all-weather land observation.

Geoscience Australia (ACRES) will acquire and archive raw data from JAXA, and process it for users in the Oceania region.

Vault opening lets data copying begin

Federal Industry Minister Ian Macfarlane opened the vault to one of the world's largest and most comprehensive collections of seismic data in Geoscience Australia's headquarters in February.

The old data tapes were collected by mineral and petroleum explorers over 40 years up to 1990.

The data are stored on 25 thousand one-inch 21-track tapes and 300 thousand half-inch nine-track tapes, some of which are starting to deteriorate.

Access to this data is critical to the resources industry so the data are being remastered onto modern cartridges. It will take up to three years and is part of a $25 million government funding allocation to acquire and preserve vital information for petroleum and mineral exploration.

The data transfer will reduce storage space from a massive 6000 shelf-metres to just 30 and will make it easier and cheaper to share the data across the continent.

The $10 million remastering exercise is being done by three Perth companies. SpectrumData and Guardian Data are copying the tapes, while GeoCom Services will provide quality control.

Marine remnants add to **Darling Basin** history

Interest in the Darling Basin in New South Wales was recently rekindled by the Kewell East-1 stratigraphic well in the Neckarboo Trough. It reached 1224 metres and penetrated a section containing marine microfossils.

Until this find, the few petroleum exploration wells drilled in the basin intersected organically lean continental sediments about 400–350 million years old, suggesting the basin has an unfavourable history for hydrocarbons.

There is now no doubt that 400 million years ago, some of this sprawling 100 000 square kilometre basin was covered by sea, and that sediments deposited during this time could provide petroleum source rocks.

The Moomba–Sydney gas pipeline crosses the Darling Basin (figure 1), adding to its attractiveness for exploration.

Other studies suggest some structures in the ancient rocks that formed before the basin itself, may be worth a closer look for their mineral potential.

Recent studies

Geoscience Australia and the New South Wales Department of Mineral Resources have been interested in the Darling Basin for some time. They have been carrying out seismic studies to better understand the basin's history and some of its poorly defined structures.

The work includes a seismic sequence analysis of the Pondie Range Trough using 1980's vintage BHP profiles, and a 160 kilometre-long deep-seismic reflection transect (figure 1).

The transect extended in a north-easterly direction across the Bancannia Trough (a remnant of the Darling Basin) and the ancient rocks of the Koonenberry Zone (about 1500–500 million years old). It was to investigate basement structures that controlled basin partitioning, and highlight any implications for petroleum or minerals.

Pondie Range Trough

The 420–350 million-year-old Pondie Range Trough comprises a 12 000-metre sedimentary section underlain by a deformed basement (figure 2).

The Early Devonian sediments (about 400 Ma) appear to include marine rocks that are a potential hydrocarbon source. Younger deposits (after ~384 Ma) are less promising.

At that time the sea retreated and continental folding and uplift carried river and lake sediments into the basin. It became dominated by red-beds—layers of sediment deposited on the continent, which are red due to a coating of ferric oxide or hematite.

The traditional targets for exploration such as the Pondie Range structure formed during this period (384–370 Ma) when north-east to south-west compressive stress created various thrusts, anticlines and transpressional structures.

Other, possibly lower-risk exploration options are now more highly rated. These include anticlines unbreached by faulting, and compaction drape anticlines over the flank of the Pondie Range Trough at about 1300 metres depth, and possibly biohermal growths (a mound or reef-like mass of rock built up around the remains of corals, molluscs and other sea creatures).

Bancannia Trough transect

The crustal structure north-east of Broken Hill probably comprises discrete south-west-dipping thrust zones superimposed on an older, deformed north-east-dipping basement. From the Broken Hill Block, a Proterozoic shear (2500–545 Ma) seems to dip under the Bancannia Trough and probably detaches at Moho depths.

Most south-west-dipping thrust zones seem to relate to fault systems mapped at the surface, but they were thought to dip the other way—that is, to the east or north-east, away from Broken Hill.

▲ **Figure 1.** Darling Basin location map showing Pondie Range Trough, Bancannia Trough, the Moomba–Sydney gas pipeline, and the seismic transect

The distribution of blocks and shear zones north-east of Broken Hill, and probably throughout the Darling Basin, is largely due to events that took place 384 to 335 million years ago. The shear zones extend deep into the crust and may have been conduits for mineral-rich brines. These shears, especially around the Koonenberry Zone, should interest mineral explorers.

The largely undeformed Bancannia Trough is probably composed of Darling Basin sediments overlying older (~500–430 Ma) sediments or volcanics. Much younger strata and alluvium veneer the area.

The Bancannia Trough underwent north-east–south-west compression (~384–370 Ma) and both flanks appear to have been overthrust. The anticlines that developed near the margins were eventually inverted and eroded.

By about 350 million years, the climate cooled and the sea retreated even further from the continent. Glacial ice covered areas bordering the basin by 285 million years.

An in-depth look at the structural evolution and resource potential of the Darling Basin has been published as Geoscience Australia record 2003/05.

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▼ **Figure 2.** Interpretation of BHP seismic composite profile HD-101/106/107, showing seismic sequences and the Pondie Range-1 structure