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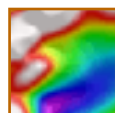
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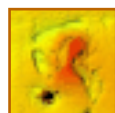
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CEO comment



Dr Chris Pigram – A/g CEO Geoscience Australia



In the 2010–11 Federal Budget handed down on 12 May, the Australian Government announced that Geoscience Australia will receive additional resources of \$65.3 million over the next four years. This additional funding will strengthen the agency’s role in relation to carbon capture and storage, support the Government’s response to climate change and assist the agency in delivering its current work program. The Government has also announced a strategic review of Geoscience Australia which will be completed in time for consideration in the 2011–12 Budget.

Two other important recent events for Geoscience Australia, reported on in this issue, were the Ministerial release of the *Australian Energy Resource Assessment* in March and the release of the Southwest Margin Data Package in Perth in April.

The *Australian Energy Resource Assessment* is a major report which examines the nation’s identified and potential energy resources ranging from fossil fuels and uranium to renewables. It concluded that Australia has an abundant and diverse range of energy resources including black and brown coal, uranium; and both conventional and coal seam gas resources as well as one of the best renewable energy resource bases in the world in geothermal, wind, solar, ocean and bioenergy. The Minister for Resources and Energy, The Hon. Martin Ferguson AM MP, said that the assessment ‘would provide fundamental information for policy debates over the next couple of years’. The assessment was undertaken jointly by Geoscience Australia and the Australian Bureau of Agricultural and Resource Economics at the request of the Department of Resources, Energy and Tourism.

The Data Package includes pre-competitive seismic reflection data and seafloor mapping acquired by Geoscience Australia during surveys of the Southwest Margin off Australia’s western coast in 2008–09. The data will enable explorers to assess the petroleum potential of these frontier areas as well as providing base data for future acreage releases and the assessment and management of marine habitats. During the release, the Minister for Resources and Energy, The Hon. Martin Ferguson AM MP, said that the data will ‘create opportunities for Australia’s petroleum exploration and the possibility of new oil and gas discoveries to supply Australia’s and Western Australia’s energy needs in the future’.

This issue includes details of the exploration areas being offered in the 2010 release of Offshore Acreage for petroleum exploration. The Westralian Superbasin, along the North West Shelf (the Bonaparte, Browse, Roebuck and Carnarvon basins), features prominently in this year’s release. These intensively explored areas are complemented by a new frontier area off southwestern Australia (the Mentelle Basin) and two

areas in the Ceduna/Dunroon Sub-basins in the eastern part of the Bight Basin.

The frontier Mentelle Basin also features in an article on the recent assessment of the potential petroleum prospectivity of the basin by Geoscience Australia scientists. The assessment included the interpretation of existing seismic data, including data acquired by Geoscience Australia in 2008–09, and analysis of gravity and magnetic data.

There is also a report on the application of geophysical methods for mapping Australia’s offshore areas, such as the continental margin. The use of magnetic survey datasets for mapping these environments provides a cost-effective means of mapping large areas of offshore geology. Another article outlines how Geoscience Australia researchers are using high resolution still photographs collected during marine surveys for biodiversity assessment in deep sea habitats.

This issue also includes a report on the 2010 revision of the Australian Geomagnetic Reference Field and its predicted annual changes over the Australian region during the period to 2015.

New opportunities for offshore petroleum exploration

2010 Acreage Release offers blocks in producing regions and in frontier areas

Thomas Bernecker

Each year, the Australian Government formally releases new offshore exploration areas at the annual Australian Petroleum Production and Exploration Association (APPEA) conference. The 2010 release of offshore petroleum exploration areas was announced on 17 May in Brisbane by The Hon. Martin Ferguson AM MP, Minister for Resources and Energy.

This year, 31 areas in five offshore basins were released for work program bidding. Closing dates for bid submissions are either six or twelve months from the release date, that is, 11 November 2010 or 12 May 2011 respectively, depending on the exploration status in these areas and the extent of available data. The 2010 Release Areas are located in Commonwealth waters off the Northern Territory, Western Australia and South Australia, and include intensively



explored areas close to existing production as well as new frontier basins (figure 1). The Westralian Superbasin along the North West Shelf, comprising the Bonaparte, Browse, Roebuck and Carnarvon basins, continues to feature prominently in the 2010 Release. These areas are complemented by a new frontier area in offshore southwestern Australia (Mentelle Basin) and by two areas in the Ceduna/Duntroon sub-basins in the eastern part of the Bight Basin, off South Australia.

Bonaparte Basin

The Bonaparte Basin is predominantly offshore and covers an area of approximately 270 000 square kilometres on Australia's northwest continental margin. The basin contains up to 15 000 metres of Phanerozoic marine and fluvial sediments and is structurally subdivided into several Paleozoic and Mesozoic sub-basins and platform areas. Several proven petroleum systems for both oil and gas are known to exist in the basin (Barrett et al 2004). For 2010, three Release Areas have been gazetted within the Petrel Sub-basin and two areas within the Vulcan Sub-basin (figure 2).

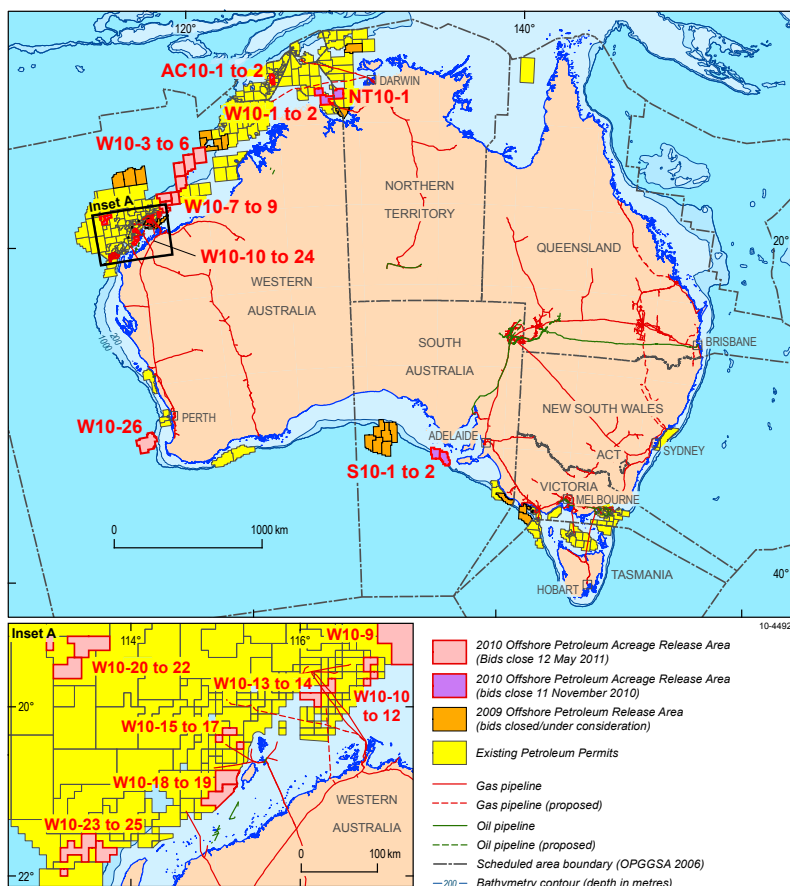


Figure 1. Location map showing the 2010 Offshore Petroleum Acreage Release Areas.

Release Areas NT10-1, W10-1 and W10-2 are located in the Joseph Bonaparte Gulf, about 400 kilometres southwest of Darwin, in water depths ranging from 10 to 40 metres. The three areas are in the vicinity of the Petrel, Tern and Blacktip gas accumulations (figure 2). Gas from Blacktip is piped to Darwin via the onshore plant near Wadeye and the Bonaparte trans-territory pipeline. This pipeline connects to an existing pipeline, transporting gas from the Amadeus Basin to Darwin.

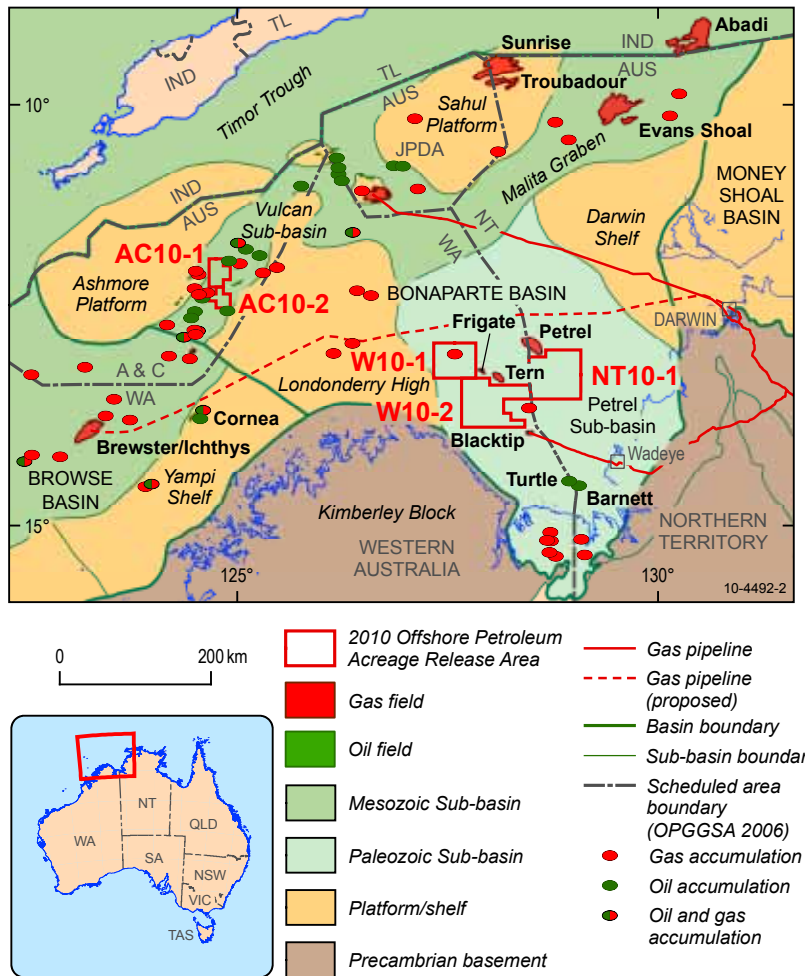


Figure 2. Structural elements map of the Bonaparte Basin showing location of the 2010 Release Areas and petroleum accumulations.

At least two Permian petroleum systems are considered viable in the central Petrel Sub-basin and it is the wide distribution of salt and related tectonism that dominates exploration play types. The key exploration uncertainties in the 2010 Release Areas appear to be the absence of a proven oil-prone system in the central Petrel Sub-basin, and the small number of suitably sized trap closures for economic gas accumulations. However, the overall prospectivity of the three Release Areas is highlighted by the distribution of commercial gas accumulations in Upper Permian and Lower Triassic sandstones, of which Blacktip has been put into production. Plans for future

gas developments in the Petrel Sub-basin have been developed, and any new discovery could potentially be commercialised within a short timeframe.

Release Areas AC10-1 and AC10-2 are located approximately 650 kilometres west of Darwin in the Timor Sea, within Australia's Territory of Ashmore and Cartier Islands (figure 2). Both Release Areas lie in the central Vulcan Sub-basin on the continental shelf where water depths are generally less than 200 metres. The Vulcan Sub-basin is a proven hydrocarbon province containing producing and decommissioned oil fields in addition to oil and gas discoveries that are presently undeveloped. Recent discoveries in the area include Padthaway (2000), Audacious (2001), Katandra (2004) and Vesta (2005). Currently, oil is produced from the Jabiru, Challis-Cassini and Puffin fields, while the Montara, Skua and Swift-Swallow accumulations will have a linked development. Accumulations in the sub-basin generally range between 10 and 50 million barrels (MMbbl) or 1.6–7.9 million cubic metres (Mm³) and are produced via subsea wellheads and tiebacks to Floating Production Storage and Offloading (FPSO) vessels.

The main exploration targets in the Vulcan Sub-basin are sandstones in the Upper Triassic Challis and Nome Formations, fluvio-deltaic sandstones of

the Middle Jurassic Plover Formation, Oxfordian shoreface/barrier bar sandstones of the Montara Formation, Tithonian submarine fans of the upper Vulcan Formation and submarine fans of the Upper Cretaceous Puffin Formation. The Cretaceous and Tithonian sandstones generally have excellent to good reservoir qualities respectively, whereas reservoir quality is assessed as good to locally poor within the intersected Middle Jurassic and Triassic sections.

Rowley Sub-basin, Roebuck Basin

The Roebuck Basin, located between the Browse and Carnarvon basins, covers approximately 160 000 square kilometres on the central North West Shelf. It contains the Bedout and the Rowley sub-basins in which sediments disconformably overlie the Paleozoic intracratonic succession of the Oobagooma Sub-basin (figure 3),

an offshore extension of the Fitzroy Trough. The four Release Areas (W10-3 to W10-6) extend across the central part of the Rowley Sub-basin which is a westward-thickening upper Paleozoic–Mesozoic depocentre (or area of thickest deposition).

Well control is limited to nine wells in the entire Roebuck Basin, none of which was commercially successful. The only significant hydrocarbon shows were recorded by Phoenix 1 and Phoenix 2 in the northern Bedout Sub-basin (figure 3). The coaly Triassic Locker Shale and parts of the Keraudren Formation are considered the source rock intervals for the gas occurrences in the Phoenix wells. Potential reservoirs occur at several stratigraphic levels including sandstones within the Permian Grant Group, shoreward facies of the Triassic Keraudren Formation and Locker Shale, as well as sandy deltaic facies in the Lower Cretaceous. The Keraudren Formation and the Locker Shale also provide intraformational seals.

Several stratigraphic plays have been proposed for exploration in the Rowley Sub-basin and encompass Triassic onlap and Jurassic fluvio-deltaic complex plays. For these, hydrocarbon charge is proposed to be derived from either intraformational or underlying source rocks (Smith et al 1999). In addition to stratigraphic plays, there is potential for various structural traps developed along several largely untested fault trends within the sub-basin.

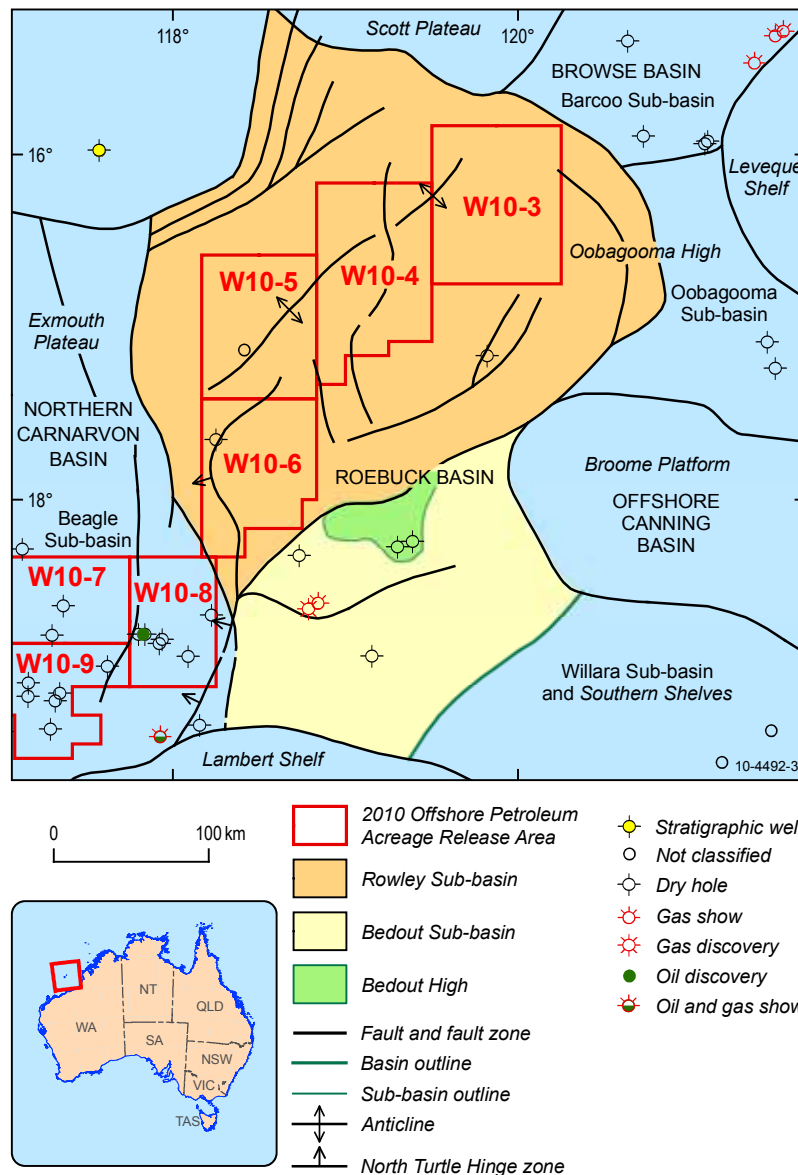


Figure 3. Structural elements of the Roebuck Basin (after Smith et al 1999).

The main exploration uncertainty appears to be effective hydrocarbon generation. However, widespread distribution of oil inclusions in the Roebuck Basin, including in East Mermaid 1, may be indicative of paleo-oil columns and evidence of petroleum generation within the Rowley Sub-basin. It is therefore possible that the application of new concepts to these Release Areas may translate to exploration success.

Northern Carnarvon Basin

The Carnarvon Basin is the southernmost province of the Late Paleozoic to Cenozoic Westralian Superbasin that underlies the northwestern continental margin of Australia from the Exmouth Plateau in the south to the Arafura Sea in the north. The northern offshore Carnarvon Basin contains about 15 000 metres of mainly Mesozoic sediments dominated by deltaic to marine siliciclastics and shelf carbonates. The basin is one of Australia's most explored and prospective and has ready access to established oil and gas exploration, production and support infrastructure (figure 4). The Australian Energy Resource Assessment (Geoscience Australia and ABARE 2010) shows that more than half of Australia's demonstrated resources of conventional gas (94 out of 164 trillion cubic feet or Tcf) are in the Carnarvon Basin as well as more than 40 per cent of the remaining oil (crude, condensate) and LPG. The 2010 Release Areas (figure 5) are located in the Beagle Sub-basin (three areas), Dampier Sub-basin (five areas), Barrow Sub-basin (five areas), Exmouth Plateau (three areas) and Exmouth Sub-basin (three areas).

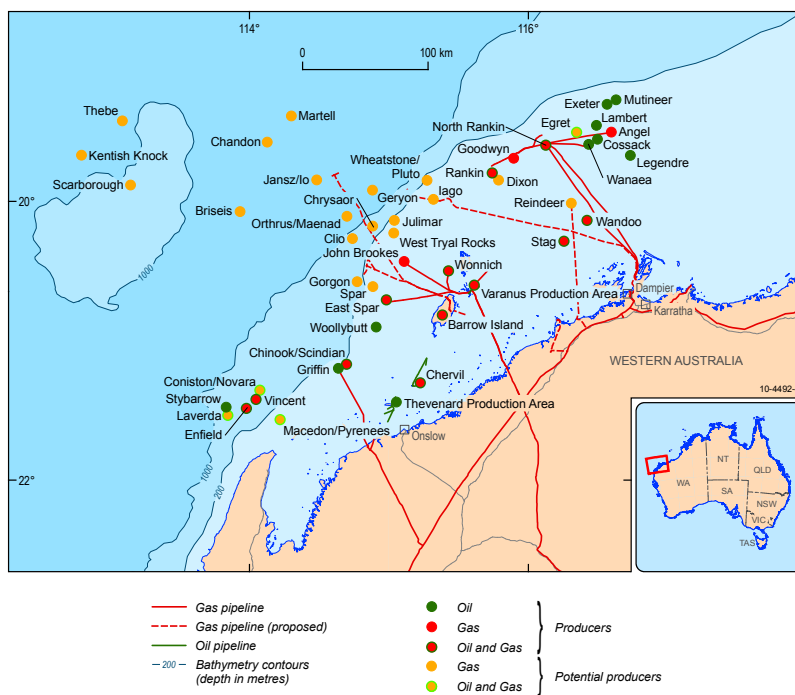


Figure 4. Oil and gas accumulations, production infrastructure and pipelines in the Northern Carnarvon Basin

Beagle Sub-basin

The Beagle Sub-basin is located between the Dampier Sub-basin to the southwest, and the Rowley and Bedout sub-basins of the Roebuck Basin, to the northeast and east, respectively (figure 5). Although previously considered as part of the offshore Canning Basin, close chronostratigraphic similarities with the Dampier Sub-basin sequences support its inclusion in the northern Carnarvon Basin framework.

Release Areas W10-7, W10-8 and W10-9 are located between 140 and 300 kilometres north-northeast of Dampier. Water depths across the areas deepen gradually from 50 metres in the southeast up to 1000 metres in the northwest. Exploration in the Beagle Sub-basin began in 1965 with regional seismic, gravity and magnetic surveys. Drilling started in 1971 and 25 wells have been drilled since then. No commercial accumulations of hydrocarbons have been encountered, and Nebo 1 (figure 5) drilled in 1993, is the only significant discovery.

The discovery of oil in Calypso Formation sandstones at Nebo 1 demonstrated the presence of an active petroleum system within the southern Thouin Graben of the Beagle Sub-basin. The dominant exploration play types for the Beagle Sub-basin are tilted fault-bounded sequences within, and along, the trans-tensional Triassic-Jurassic horsts. Basin floor sands developed after Late Jurassic break-up along the edges of elevated horsts may

also represent valid plays. Structural highs hosting Upper Jurassic reservoir sandstones are also a proven play type developed within the troughs (Nebo 1 within the Thouin Graben). For these, the regionally extensive Lower Cretaceous Muderong Shale/Forestier Claystone would act as the main sealing facies. Although regional tectonic reactivation is likely to have impacted on fault-seal integrity and may have affected the configuration of migration pathways, the fact that a proven petroleum system is in operation, should encourage explorers to have a closer look the Beagle Sub-basin.

Dampier Sub-basin

The Dampier Sub-basin contains a late Paleozoic to Cenozoic sedimentary succession over 10 kilometres thick that is dominated by Triassic to Lower Cretaceous sediments. Thick successions of Jurassic oil-prone sediments underlain by faulted gas-prone Triassic sediments occur in the deeper depocentres. The five areas included in the 2010 Release lie in relatively shallow water (around 100 metres) and are located close to major oil and gas accumulations on the Rankin Platform (figure 5) and to the commercial Angel, Wanaea, Cossack and Legendre fields. To date, more than 200 exploration and

development wells have been drilled in the Dampier Sub-basin with a technical success rate of 41 per cent. Three wells are located within the release areas: Patriot 1 and Pleiades 1 in Release Area W10-10, and Dampier 1 in Release Area W10-14.

Hydrocarbon accumulations in the Dampier Sub-basin occur at multiple stratigraphic levels from the Triassic to the Cretaceous, commonly as stacked pay sections. The main hydrocarbon source rocks occur within the Lewis and Kendrew troughs. Two proven petroleum systems are recognised on the basis of geochemical studies (Boreham et al 2001; Edwards et al 2007): a gas-prone system sourced from Triassic to Middle Jurassic fluvio-deltaic sediments and an oil-prone system sourced from Upper Jurassic marine sediments.

Exploration plays are quite diverse in the Dampier Sub-basin and mainly involve drape anticlines, such as Wandoo and Stag, and horst structures, such as Wanaea, Cossack, Mutineer and Egret. The potential for stratigraphic traps has long been recognised within the Dampier Sub-basin (Barber 1994) and related plays can now be tested with the application of improved 3D seismic technologies and third-order sequence stratigraphic analysis. Although the Dampier Sub-basin is a prolific hydrocarbon province, several exploration uncertainties need to be recognised. For instance, the entrapment and preservation of oil and gas accumulations

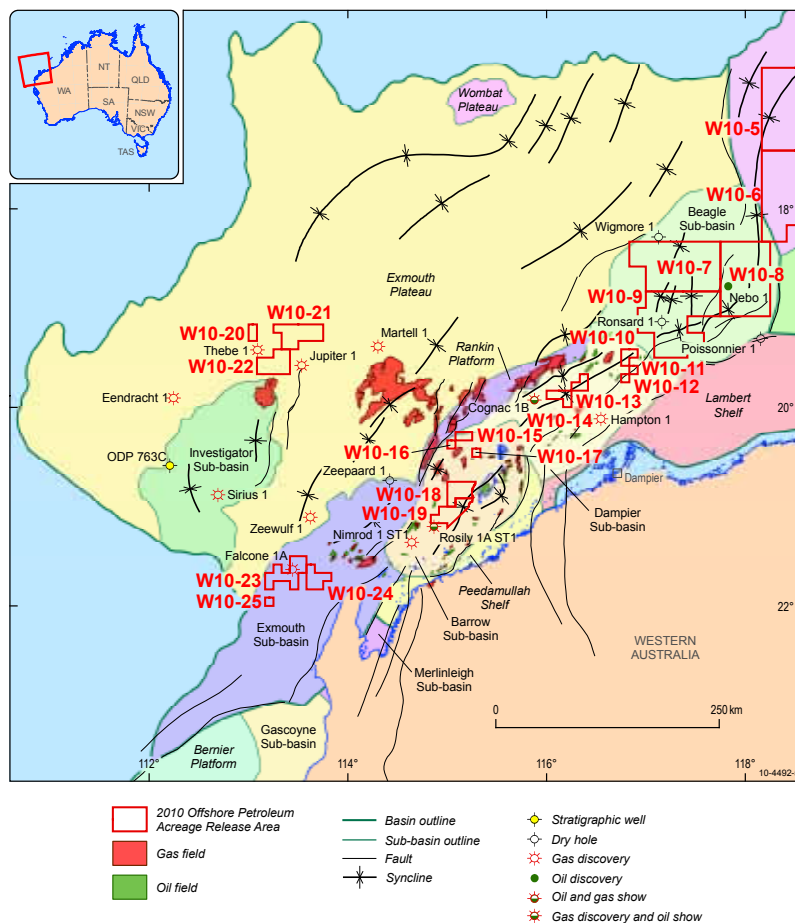


Figure 5. Structural elements of the Northern Carnarvon Basin and adjacent basins showing the 2010 Release Areas, oil and gas accumulations and selected wells.

varies across the sub-basin and diagenetic overprints in deeply seated reservoirs are known to affect permeabilities, as identified in Lynx 1A. However, the success rates in this part of the Carnarvon Basin highlight the Dampier Sub-basin as a prime exploration province.

Barrow Sub-Basin

The Barrow Sub-basin, located southwest of the Dampier Sub-basin (figure 5) has been actively and continuously explored since the 1960s. Oil was found in several zones in Cretaceous sediments in Barrow Island wells drilled in 1964, and production facilities have been established on Varanus Island. Release Areas W10-15 and W10-16 are located in the northeast-trending Tryal Rocks Terrace, which contains the John Brookes gas field, while Release Areas W10-17, W10-18 and W10-19 are located over the western edge of the Barrow depocentre.

The oil and gas fields that surround Release Areas W10-15 to W10-19 demonstrate that the area is highly prospective. There are proven plays at Triassic, Middle–Upper Jurassic, Lower Cretaceous and Paleocene levels. Within the Barrow Sub-basin, oil has accumulated primarily in the Barrow Group and the Windalia Sandstone Member of the Muderong Shale, within the post-breakup megasequence. The Lower Cretaceous Barrow Group has excellent reservoir characteristics, and Upper Cretaceous and middle Miocene faulted anticlines provide structural traps.

Gas charge appears to be pervasive throughout the region containing the Release Areas so that trap geometry, reservoir occurrence and quality are the main uncertainties. Overpressuring has been identified within the thick Jurassic section and within parts of the Cretaceous Barrow Group and is likely to be related to the presence of gas-generating organic matter at depth (He and Middleton 2002). Such zones of overpressure are an exploration uncertainty and a drilling hazard. Despite those uncertainties, the Barrow Sub-basin remains one of the most successful hydrocarbon provinces not only along the North West Shelf, but within Australia's offshore area.

Exmouth Plateau

The Exmouth Plateau is a deep-water marginal plateau that represents the western structural element of the Northern Carnarvon Basin. Most of the plateau is underlain by 10 to 15 kilometres of generally flat-lying or block faulted, tilted Lower Cretaceous, Jurassic, Triassic and older sedimentary section. These sediments were deposited during the periods of extension that preceded the break-up of Australia and Argo Land in the Middle Jurassic, and then Greater India in the Early Cretaceous.

Release Areas W10-20, W10-21 and W10-22 are located in deep water (900 to 1200 metres) about 300 kilometres off the coast of Western Australia, on the central portion of the Exmouth Plateau (figure 5). Gas production facilities are currently being developed for the nearby Chevron-operated Gorgon and Jansz–Io fields, and Woodside-operated Pluto field. ExxonMobil and BHP Billiton are currently examining development options for the Scarborough and Thebe fields. The super-giant Jansz–Io gas field, giant Scarborough gas field, and the Jupiter 1 and Eendracht 1 gas discoveries, together with the recent gas discoveries in the Chandon 1, Thebe 1 and 2, Martell 1, Glencoe 1, Nimblefoot 1, Briseis 1 and Kentish Knock 1 wells, demonstrate that the deep-water central Exmouth Plateau is prospective for large gas accumulations. All these discoveries are attributed to a widespread regional gas system sourced from the Triassic succession.

The main exploration play types involve rotated, high-relief Triassic fault blocks associated with drape features and deeper intra-Triassic cross-fault traps. Upper Triassic (Rhaetian) pinnacle and patch reefs, such as those intersected in the Ocean Drilling Program holes on the Wombat Plateau on the northern margin of the Exmouth Plateau, have also recently been identified on new 3D data across parts of

the central Exmouth Plateau. They represent a potential new play in the region that has yet to be tested. Given that a proven hydrocarbon system has already been established across the central Exmouth Plateau, continued success relies on the identification of additional valid traps with access to charge from the gas-prone Mungaroo source. 3D seismic and AVO technology (see *AusGeo News* Issue 84) are thus key exploration tools that are likely to contribute to continued exploration success on the deep-water Exmouth Plateau.

Exmouth Sub-basin

Along with the Barrow, Dampier and Beagle sub-basins, the Exmouth Sub-basin formed as a series of northeast–southwest-trending, *en echelon* structural depressions during the Pliensbachian to Oxfordian. The pre-rift section in the Exmouth Sub-basin consists of a sequence of Permian and Lower to Middle Triassic sediments. The Locker Shale was deposited in shallow shelf environments during a widespread Early Triassic marine transgression which is recognised all along the western Australian margin from the Bonaparte Basin to the Perth Basin. Release Areas W10-23, W10-24 and W10-25 are located in the western Exmouth Sub-basin and Release Areas W10-23, W10-24 and W10-25 lie approximately 20 to 85 kilometres offshore from North West Cape on the Western Australian coastline (figure 5) where water depths rapidly increase to over 1000 metres.

Two petroleum systems are prospective in the Release Areas. The extensive Locker/Mungaroo–Mungaroo/Barrow petroleum system, which has sourced some of the giant gas fields in the Northern Carnarvon Basin, was proven with the discovery of gas in the Mungaroo Formation at Falcone 1A. Accumulations of the productive Dingo–Barrow petroleum system of the Exmouth Sub-basin lie about 20 to 30 kilometres to the northeast of the Release Areas. The Triassic sedimentary succession has proven potential for mature source facies, including possible organic-rich units in the Lower Triassic (marine Locker Shale equivalents) and Upper Triassic (deltaic Mungaroo Formation facies and marine equivalents). The Upper Jurassic Dingo Claystone is the principal source for oil in the Exmouth Sub-basin.

The proven traditional Triassic fault block play, which hosts most of the hydrocarbon reserves in the Northern Carnarvon Basin, extends into the Release Areas. Mungaroo Formation sandstones in fault-block traps are sealed by either the Dingo Claystone or intraformational seals. The gas accumulation at Falcone 1A, within Release Area W10-23, is an example of this play type. Barrow Group sandstones sealed by Muderong Shale or interbedded claystone units in stratigraphic and structural traps are the other targets. The oil and gas fields in the Exmouth Sub-basin are examples of these play types.

Mentelle Basin

The Mentelle Basin is a large (36 400 square kilometre) frontier basin on the southwest Australian margin located approximately 120 kilometres from Bunbury. It lies to the west of the Perth Basin which has shared tectonic and depositional histories. The 2010 Acreage Release comprises one large block in this offshore frontier (figure 1). As part of Geoscience Australia's Offshore Energy Security Program, new seismic data was acquired in 2008–09 to improve the understanding of the major sequences and structural elements. The results of the Mentelle Basin study, including the assessment of the hydrocarbon prospectivity, are described in the article by Borissova et al in this issue.

Bight Basin

The Jurassic–Cretaceous Bight Basin is a large, mainly offshore basin situated along the western and central parts of the continental margin of southern Australia, in water depths ranging from less than 200 metres to over 4000 metres. The basin contains five main depocentres—the Ceduna, Duntroon, Eyre, Bremer and Recherche sub-basins. The Release Areas S10-1 and S10-2 are located in the easternmost part of the Bight Basin, covering large parts of the Duntroon Sub-basin and minor parts of the Ceduna Sub-basin (figure 6).

In nearly 50 years of exploration in the offshore Bight

Basin, less than 100 000 line-kilometres of seismic data have been acquired and only 10 petroleum exploration wells have been drilled. The majority of these wells were drilled in water depths of less than 250 metres along the margins of the basin, where the source rock quality of mid- to Upper Cretaceous marine deposits has been reduced by the influx of terrigenous organic matter into proximal depositional facies. Prior to the drilling of Gnarlyknots 1A in 2003, most exploration drilling in the Bight Basin was focused around the inboard margin of the Ceduna Sub-basin or in the half-graben systems of the Eyre and Duntroon sub-basins. Seismic and sequence stratigraphic interpretation, as well as biostratigraphic and sedimentological studies, indicate that most wells penetrated the proximal parts of the Cretaceous depositional systems. Therefore, organic geochemical data from the wells provides information about the source rock potential of these proximal facies.

rocks that have the potential to generate hydrocarbons (Totterdell et al 2008; Boreham 2009). Most data on reservoir rocks in the Bight Basin are from wells in the Duntroon Sub-basin and southeastern Ceduna Sub-basin. Reservoir quality across the basin varies from poor to excellent and is dependent on paleoenvironmental conditions and depth of burial.

One of the key risks identified prior to the most recent exploration phase was the possible lack of an effective source rock and thus adequate hydrocarbon charge. This risk has been significantly reduced by the sampling and identification of a high quality marine source rock of Cenomanian to Turonian age (Totterdell et al 2008) and the identification of a number of encouraging bright amplitude anomalies on seismic sections. Given the under-explored status of the Duntroon and Ceduna sub-basins, both 2010 Release Areas offer opportunities to pursue current exploration concepts.

In summary, the 2010 Offshore Acreage Release offers a wide variety of block sizes in shallow as well as deep water environments. Area selection has been undertaken in consultation with industry and the state and Northern Territory geoscience agencies. This year's Acreage Release caters for the whole gamut of exploration companies given that many areas are close to existing infrastructure while others are located in frontier offshore regions.

“This year’s Acreage Release caters for the whole gamut of exploration companies...”

The thick Jurassic to Cretaceous succession in the Ceduna and Duntroon sub-basins contains a number of source intervals consisting of marine and non-marine carbonaceous shale, coal and oil shale. They were deposited in a variety of lacustrine, deltaic and marine environments and form good to excellent quality potential source



Figure 6. Structural elements of the eastern Bight Basin showing 2010 Release Areas and wells drilled.



For more information on the 2010 release areas

phone Tom Bernecker on +61 2 6249 9239
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To book into the 2010 Acreage Release Data Room visit

Offshore Petroleum Acreage Release Data Room
www.ga.gov.au/about-us/facilities/acreage-release-data-room.jsp

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Related articles/websites

2010 offshore petroleum exploration areas (Department of Resources, Energy and Tourism)
www.ret.gov.au/Documents/par/index.html

Data supporting the 2010 acreage release (Seismic data is available in GeoFrame™, Kingdom and Landmark™ formats)
ausgeodata@ga.gov.au

Associated well data
biu@ga.gov.au

AusGeo News 84: Reprocessing shows AVO potential for petroleum exploration
www.ga.gov.au/ausgeonews/ausgeonews200612/index.jsp

AusGeo News 98: First acreage release in frontier Mentelle Basin
www.ga.gov.au/ausgeonews/ausgeonews201006/mentelle.jsp

First acreage release in frontier Mentelle Basin

Significant potential to become new petroleum province



Irina Borissova, Barry Bradshaw, Chris Nicholson, Danielle Payne and Heike Struckmeyer

The Australian Government's 2010 release of offshore petroleum exploration areas included, for the first time, a large exploration block in the frontier Mentelle Basin. This large sedimentary basin (36 400 square kilometres) is located about 150 kilometres to the west of Cape Leeuwin. It lies beneath the Yallingup Shelf and the Naturaliste Trough, a bathymetric saddle, separating the Australian margin from the Naturaliste Plateau (figure 1). Water depths range from 500 to 1500 metres on the continental slope to almost 4000 metres in the central part of the Naturaliste Trough.

breakup on the southwestern margin (Coleman et al 1982; Storey et al 1992).

More recent analyses of existing seismic data and sampling results from this margin (Beslier et al 2004) have shown that the basin is underpinned by continental crust (Borissova 2002; Direen et al 2007). The sedimentary successions in the Mentelle Basin are likely to be of similar age to those in the adjacent southern Perth Basin, (Bradshaw et al 2003) and the basin is potentially prospective for hydrocarbons.

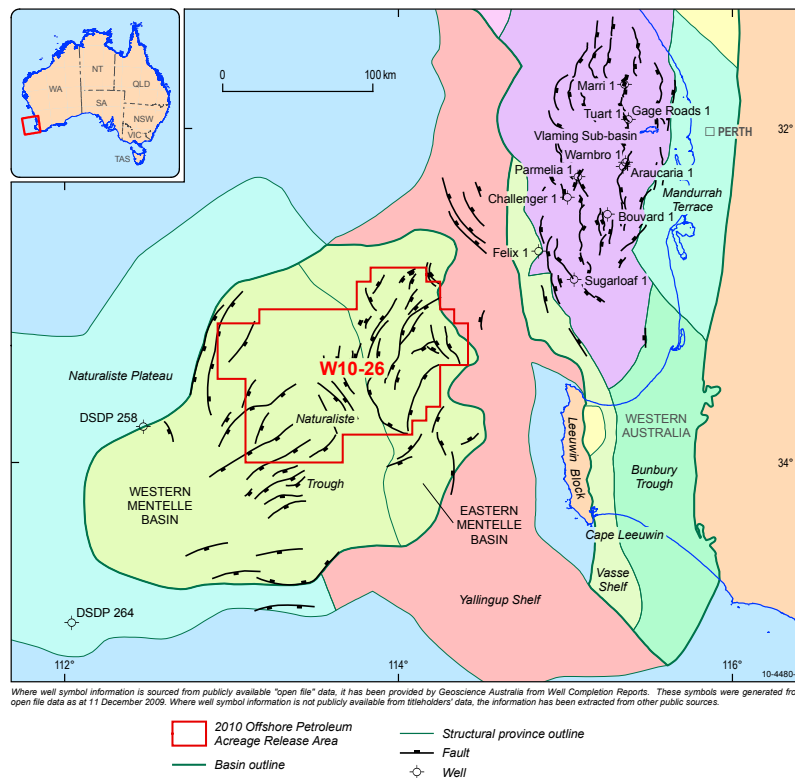


Figure 1. Regional setting and major structural elements of the Mentelle Basin and the Vlaming Sub-basin.

Seismic data collected by Shell in 1973 showed the presence of thick sedimentary successions in the basin, however there has been no follow-up exploration. This lack of interest was because of the deep water depths and the prevailing geological interpretation of the Naturaliste Plateau and the Naturaliste Trough. They were seen as oceanic features that formed as a result of volcanism during the

Recent data acquisition

Because of this new understanding and industry's increased interest in deep-water exploration, Geoscience Australia acquired 1060 kilometres of seismic data across the Mentelle Basin in 2004 (seismic survey 280: figure 2). Interpretation of this dataset (Borissova et al 2006) confirmed the presence of a very large depocentre (or area of thick sediments in a sedimentary basin) with up to ten kilometres of sediments in the deep-water part of the basin. It also confirmed several significant depocentres with up to eight kilometres of sediments in the shallow part of the basin. The analysis also

showed that the structural complexity of the basin could not be resolved with the previous sparse seismic grid.

To complete an assessment of the petroleum prospectivity of this frontier basin, Geoscience Australia acquired an additional 2570 kilometres of industry-standard seismic data in 2008–09 (GA seismic survey 310; Foster et al 2009) as well as gravity and magnetic data. Together with the existing data, this new dataset created a regional seismic coverage with 10 to 20 kilometre line spacing (figure 2).

A team of Geoscience Australia scientists undertook an assessment of the petroleum prospectivity of the Mentelle Basin between August and November 2009. This study included seismic interpretation combined with analysis of gravity and magnetic data. Correlations with the South Perth Basin stratigraphy led to the development of a tectonostratigraphic framework and petroleum systems model for the basin (Borissova et al 2010).

Interpretation of the new data

Based on the interpretation of the new seismic data, the Mentelle Basin can be divided into two key structural domains with different fault and depocentre geometries: the western and eastern Mentelle basins (figures 1 and 2). In the northern part of the western Mentelle

and over most of the eastern Mentelle Basin, major structural elements correlate with the north–south trending Permian to Jurassic rift system of the Perth Basin. This contrasts with the southern part of the western Mentelle Basin which displays similarities to the northeast–southwest trending Jurassic to Early Cretaceous rift basins of the southern Australian margin.

Analysis of the seismic, well (DSDP 258) and sampling data (figure 2) as well as comparisons with the stratigraphy and petroleum systems elements in the adjacent Perth Basin, revealed a multi-phase history of extension and volcanism in the Mentelle Basin (Borissova et al 2010). Initial rifting in the Mentelle Basin occurred in the Early Permian, followed by thermal subsidence during the Triassic to Early Jurassic. However, Permo–Triassic depocentres containing sedimentary successions up to seven kilometres thick are preserved only in the eastern Mentelle Basin. The second stage of rifting in the Middle Jurassic to Early Cretaceous led to accumulation of very thick sedimentary successions in half-graben depocentres of the western Mentelle Basin (up to nine kilometres of syn-rift strata).

Early Cretaceous continental breakup on the south-western margin was accompanied by extensive volcanism. In the western Mentelle Basin, multiple overlapping lava flows and volcanoclastic sediments form

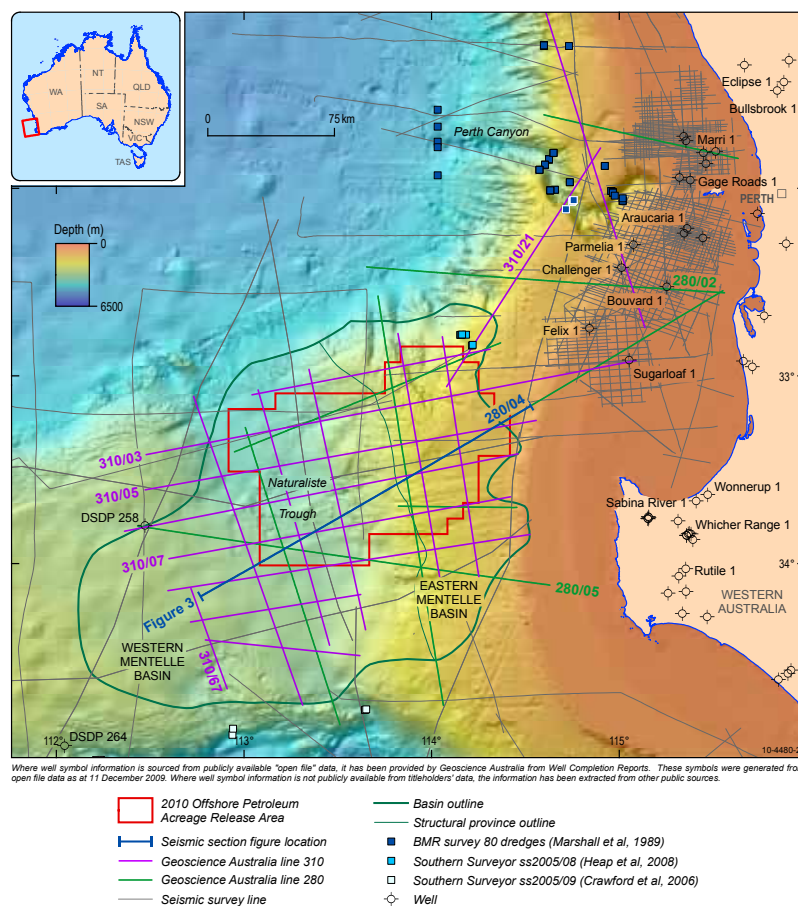


Figure 2. Location of seismic lines, wells and dredge sampling sites in the Mentelle Basin region.

a thick syn-breakup volcanic succession up to one kilometre thick. During the thermal subsidence that followed the breakup, several tectonic events in the surrounding region led to fault reactivation, structuring and renewed igneous activity. In the Paleocene the western Mentelle Basin started to collapse with a hinge developing along the boundary with the eastern Mentelle Basin. The onset of fast spreading in the Southern Ocean in the mid-Eocene had a profound impact on the Mentelle Basin, causing reactivation of many faults and partial inversion of the western Mentelle Basin, massive slumping, and some volcanism. The next structuring event occurred in the Miocene. Compressional anticlinal structures formed during this time are possibly related to the collision between the Australian and Eurasian plates.

Potential petroleum prospectivity and play types

Petroleum prospectivity assessment of the Mentelle Basin (Borissova et al 2010) confirmed significant potential to become a new petroleum province. The basin is likely to contain multiple source rock intervals associated with coals and carbonaceous shales, as well as regionally extensive reservoirs and seals within fluvial, lacustrine and marine strata. Petroleum systems modelling indicates that potential source rocks are thermally mature and started to generate during the Early to Middle Jurassic in the eastern Mentelle Basin and during the Early Cretaceous in the western Mentelle Basin. Some source rocks probably continued to generate and expel hydrocarbons after breakup, charging existing and newly-created traps. A wide range of play types have been identified in the Mentelle Basin (figure 3), including faulted anticlines and highside fault blocks, sub-basalt anticlines and fault blocks, drape and forced fold plays, and a large range of stratigraphic and unconformity plays.

In the western Mentelle Basin the main potential plays include highside fault blocks and sub-basalt anticlines. Highside fault blocks (Play Type 1, figure 3) which developed during the syn-rift phase form potential structural traps, where these blocks have favourable location and timing to be charged from the Middle Jurassic to Lower Cretaceous coals and lacustrine mudstones. Fluvial sandstones of the same age are likely reservoirs. Sub-basalt anticlines (Play Type 2, figure 3) are structural traps that formed during the breakup which incorporates Lower Cretaceous fluvial reservoirs sealed by thick syn-breakup volcanics. A number of potential plays formed after the breakup (Play Type 3, figure 3). Lower Cretaceous marine sandstone, including turbidite units, are likely to form good reservoir intervals, while overlying marine mudstone are potential regional seals. Trap types include:

- dome structures and forced folds which originated during Cretaceous to Cenozoic igneous events
- inversion anticlines that formed during the Cenozoic margin flexure and subsidence
- drape structures.

Combined structural–stratigraphic traps (Play Type 4, figure 3) are likely to occur along the hinge zone separating the eastern and western Mentelle basins. This is where Lower Cretaceous fluvial sandstones

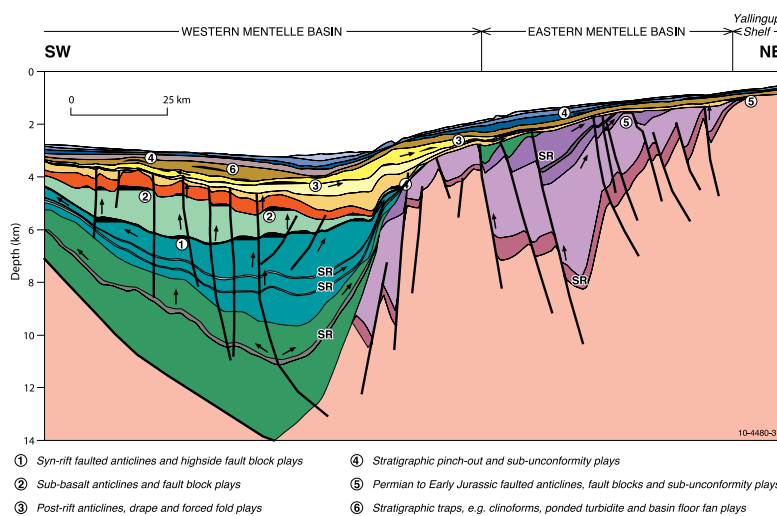


Figure 3. Conceptual play diagram for the Mentelle Basin.



onlap on basement or pre-rift strata. This trap type has favourable location and timing for charge from syn-rift source rocks in the western Mentelle Basin, and may be a significant exploration play.

In the eastern Mentelle Basin potential trap types include faulted anticlines, highside fault blocks, and sub-unconformity traps (Play Type 5, figure 3). Reservoirs are likely to be present throughout the pre-breakup succession and Lower Permian coals should provide mature source rocks. Potential stratigraphic traps (Play Type 6, figure 3) occur within post-rift strata, both in the eastern and western Mentelle basins. These traps include turbidite sandstones sealed by slope mudstones within prograding shelf-slope wedges and ponded turbidite sandstones encased in slope mudstones.

Summary

New data collected during the Geoscience Australia seismic survey 310 in 2008–09 enabled an assessment of hydrocarbon prospectivity of the frontier Mentelle Basin and resulted in the first release of exploration acreage in this basin. Sustained efforts by Geoscience Australia in advancing the geological knowledge of frontier basins have provided explorers with a new target in offshore Australia.

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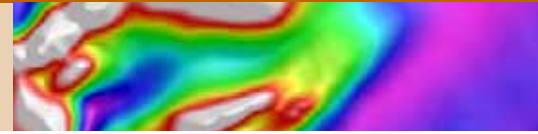
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Potential field methods prove effective for continental margin studies

Another option for offshore geology mapping

Michael Morse



Remote geophysical data acquisition tools, such as gravity and magnetic surveys, have proved very successful in mapping the underlying geology of the Australian continent. Similarly, these geophysical methods can also be applied in Australia's offshore areas for mapping the continental margin using marine vessels (surface and submarine) and aircraft. The use of airborne magnetic surveys in these environments provides a cost-effective means of mapping large areas of offshore geology. These datasets greatly contribute to the assessment of the petroleum potential of offshore basins through providing an understanding of regional geology, basin architecture, and crustal discontinuities, as well as showing the distribution of igneous rocks. Two simple potential field methods that have proven effective in the offshore environment are the Upward Continuation Residual (UCR; Jacobson 1987) and the Analytic Signal (AS) Phase (Tilt) filters (Nabighian 1972, 1974; Miller and Singh 1994). These filters

are readily available in common commercial and open-source geophysical data processing packages. The UCR and AS methods have been extensively and successfully applied to basin studies carried out by Geoscience Australia in the Capel and Faust basins off eastern Australia, the Bight Basin in the Great Australian Bight, and basins off southwestern Australia (Morse, Gibson and Mitchell 2009). This paper uses examples from the deepwater Otway Basin and the Sorell Basin off western Tasmania.

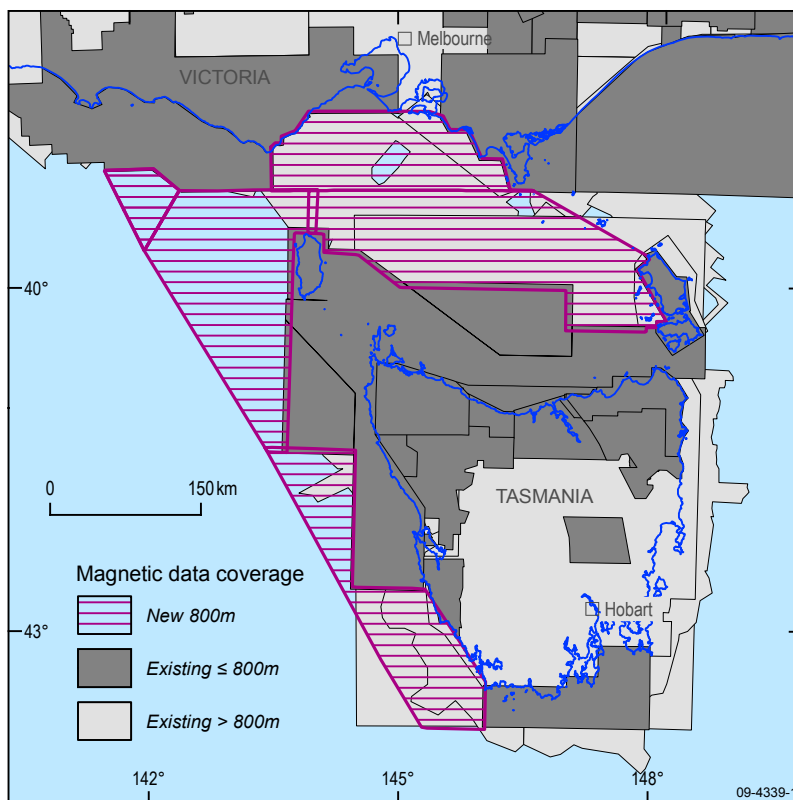


Figure 1. Recent aeromagnetic acquisitions across the Bass, southern Otway, and Sorell basins and Torquay Sub-basin.

Otway Basin and the Sorell Basin

The geology and petroleum potential of the western Tasmanian offshore basins is poorly understood. To improve explorer understanding of these basins, aeromagnetic data was acquired by Geoscience Australia and Mineral Resources Tasmania in 2008 as part of a cooperative National Geoscience Agreement project. Geoscience Australia's contribution was provided as part of its Offshore Energy Security Program. The survey acquired 141 234 line kilometres of high quality aeromagnetic data with a line spacing of

800 metres across the Bass, southern Otway and Sorell basins and Torquay Sub-basin (figure 1). The aim of this survey was to acquire new aeromagnetic data to help delineate the structural architecture of the basins and underlying basement, and the distribution of igneous rocks. These data filled gaps in the existing aeromagnetic coverage of the area between Tasmania and mainland Australia. It provided fresh insights into basement structure and the structural controls on basin architecture and sedimentation patterns during the breakup of Gondwana and separation of Australia from Antarctica. The UCR and AS filter methods discussed below were used to analyse these data in combination with seismic and geological data.

Benefits of the Upward Continuation Residual filter

The Upward Continuation Residual (UCR) filter manipulates the magnetic and gravity data to enhance the shallower source anomalies by minimising the dominant large deep source anomalies.

The UCR method provides a robust method of frequency separation in potential field data (Jacobson 1987) that is locally adaptive and produces a visualization of the data that is arguably more geologically interpretable than a fixed frequency or band-pass filtered image.

The method also provides a more interpretable image than total horizontal derivative methods. The UCR method is based on the upward continuation filter which calculates the potential field that would have been recorded at a higher level above the source. Calculating the potential field at this higher level filters out the anomalies of smaller and shallower sources from the original data (figure 2a), and results in a smoother, longer wavelength for the potential field dataset (figure 2b). The useful high frequency signal (figure 2c) can be accessed by subtracting the upward continued signal from the original data, where the upward continuation dataset is acting as a nonlinear, locally adaptive long wavelength filter.

The resultant data effectively images anomalies from shallower sources. In the case of continental margin areas, this method removes the dominant effect of the thinning crust (shallowing Moho) and enhances basins and other upper crustal density features (figure 2). As with all filtered data grids, some artefacts of the process—such as edge effects—remain and need to be considered when interpreting the results.

The UCR filter approach can also be used to separate small amplitude short wavelength anomalies from magnetic signals dominated by high amplitude anomalies to extract source signals from within the sedimentary basin (figures 3a, 3b).

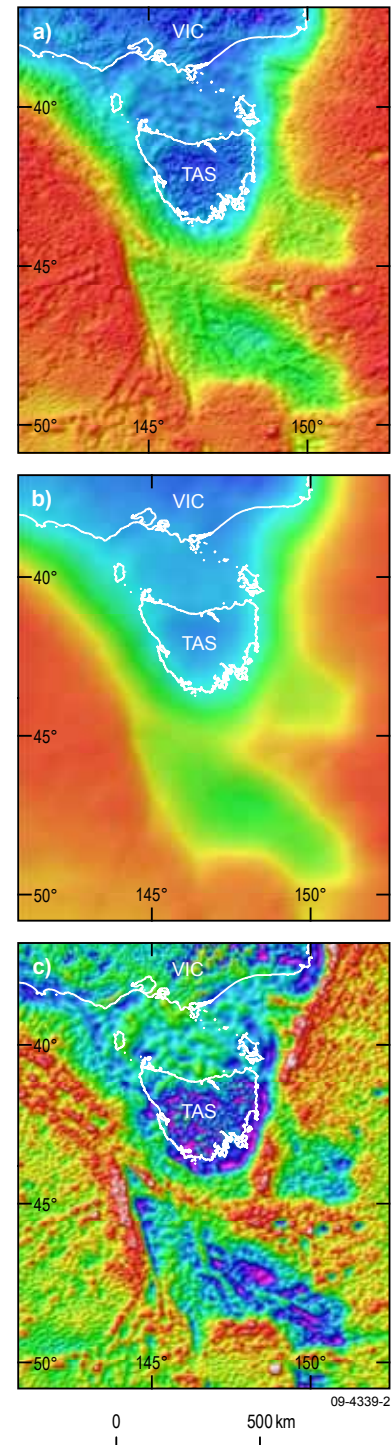


Figure 2. Upward continuation residual filter applied to Bouguer gravity anomaly data for southeastern Australia. The Bouguer gravity anomaly grid at sea level (0 metres; shown at figure 2a) minus the Bouguer gravity anomaly data calculated at 25 kilometres (figure 2b) gives a filtered residual grid of the Bouguer gravity that images the high frequency content of the original data (figure 2c).

Mapping potential field data

Analytic signal phase filters provide a simple method to map the estimated positions of magnetic source bodies (Miller and Singh 1994). The analytic signal of magnetic or gravity field data is an alternative mathematical representation of the data (Nabighian 1972, 1974). It can be used instead of the Reduce to the Pole (RTP) filter to locate magnetic anomalies over source bodies, and in low latitudes is more stable than the RTP filter. The analytic signal has two parts, amplitude and phase. In two-dimensional cases the analytic signal has a number of attractive properties that simplify the interpretation of the magnetic field. In three-dimensional cases this simplification does not occur but the analytic signal is still a useful approach to retrieving geological information from the geophysical signal.

The combination of the analytic signal's amplitude and phase data provides a powerful alternative means to visualise potential field data. This combination proved useful in mapping the fabric of the magnetic data over the deepwater Otway and the Sorell basins and clearly displays the structural fabric of the western Tasmanian margin (Morse et al 2009).

The analytic signal phase data can be used to directly map the approximate position of the anomaly source bodies. Miller and Singh (1994) showed that the analytic signal phase is positive over source bodies and negative otherwise. A geographic information system (GIS) layer of the approximate source body positions can be produced by:

- Calculating the analytic signal phase of the gridded potential field.
- Converting the resultant grid into a binary grid: +1 for positive phase values and -1 for negative phase values.
- Using a raster-to-polygon utility to convert the positive areas to polygons.

Where there are shallow sources, the polygons will tightly map the lateral extent of the source bodies. For deeper sources the source body polygons will be wider, and the deeper the source body the wider the polygon. The method is therefore dependent on the quality of the gridded data used.

The advantage of this method is that it objectively determines the source positions from the magnetic anomaly data with more detail than can be manually interpreted. Figure 4a shows how this method extracts geological detail that could not be manually extracted from the data. Given the limitations of this method, the polygons produce a map that correlates with the known geological features and allows these geological features to be confidently mapped offshore (figure 4b). This method extracts one of the essential information attributes of the magnetic anomaly data—the location of the magnetic source bodies—and provides geological information that can be integrated

with other geological datasets (figures 4a, 4b).

The potential field methods described above are just two of a number of methods used to interpret potential field geophysical data. They have proven useful in Geoscience Australia's frontier basin studies and show how geological information can be extracted from geophysical datasets in studies of the continent's southern margins.

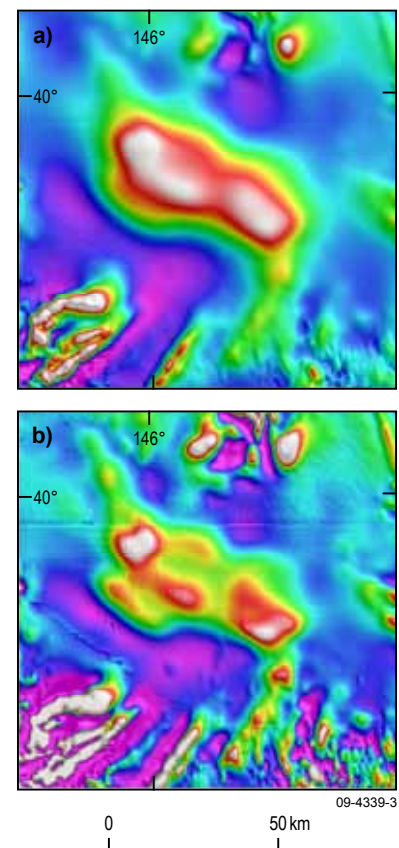


Figure 3. Visualisation of detailed structure of the large total magnetic intensity anomaly located in the middle of the Bass Basin (figure 3a). The UCR filter (0 metres minus 500 metres upward continuation) shows that this large anomaly is made up of a number of separate anomalies which correlate with shallow sills imaged in reflection seismic data (figure 3b).

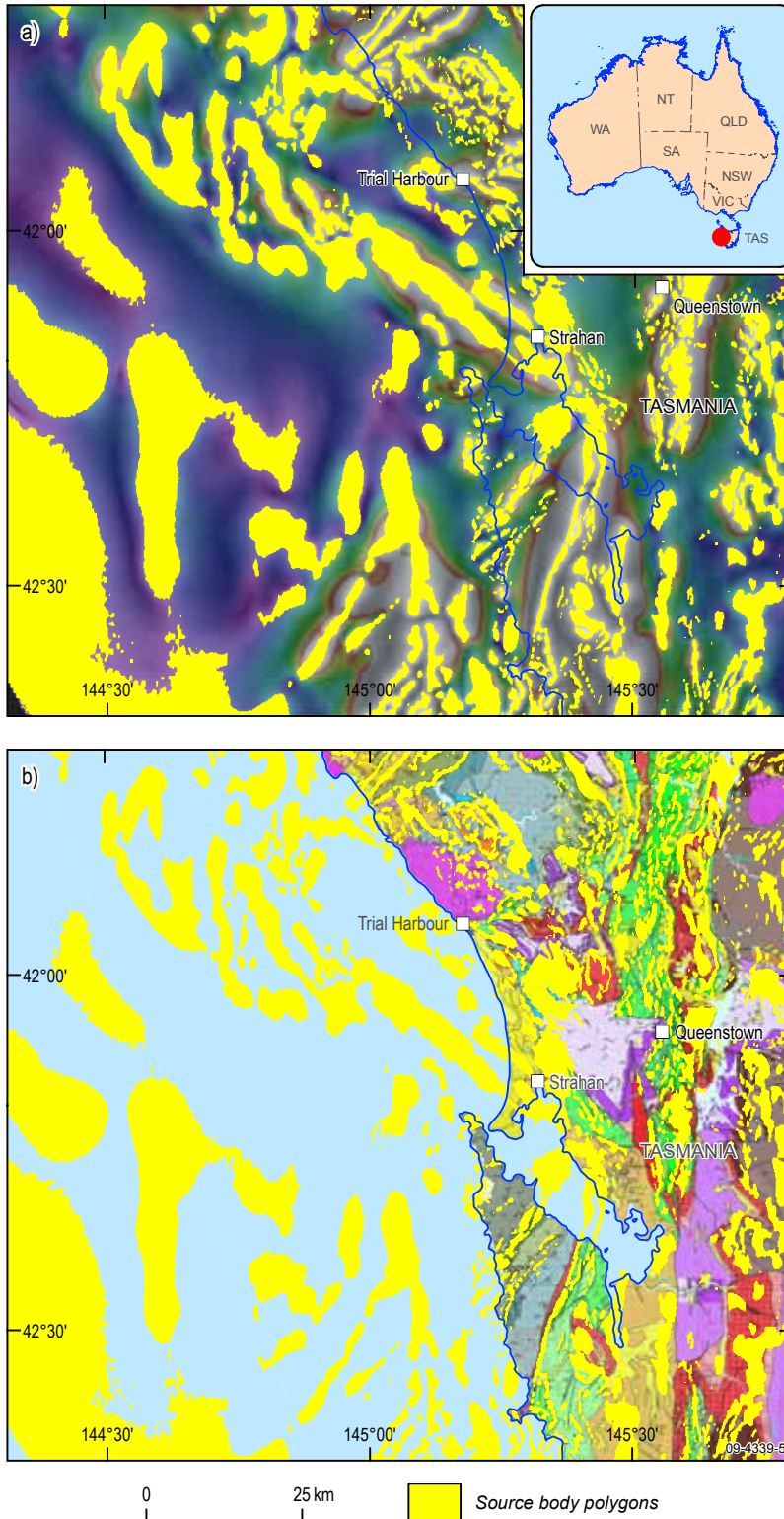


Figure 4. Strahan Sub-basin, western Tasmania: a) source body polygons from analytic signal phase on the analytic signal map; b) source-body polygons on the Tasmania 1:250 000 scale geology map.

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Estimating biodiversity with deep sea images

Towards a more comprehensive characterisation of the seafloor

Rachel Przeslawski and Kate Dundas

Australia's marine jurisdiction is almost 14 million square kilometres. Geoscience Australia acquires geological, geophysical and ecological data to better understand the jurisdiction. These regional pre-competitive datasets, collected as part of the Offshore Energy Security Program, are available to assist the activities of Australia's offshore oil and gas industry, and the management of the marine zone.

“At first glance, these habitats seem barren, but they are actually teeming with life.”

Seabed Mapping and Characterisation Project staff are currently working on the identification of representative seabed habitats. These studies will be used to characterise seabed environments for the purpose of defining Australia's little-known deep sea diversity. Among the variety of tools and techniques used to identify substrate type and characterise the biota of the seafloor are underwater video and still photography. The images collected to date show that most of the deep sea is characterised by soft sediment plains in which very few animals are seen.

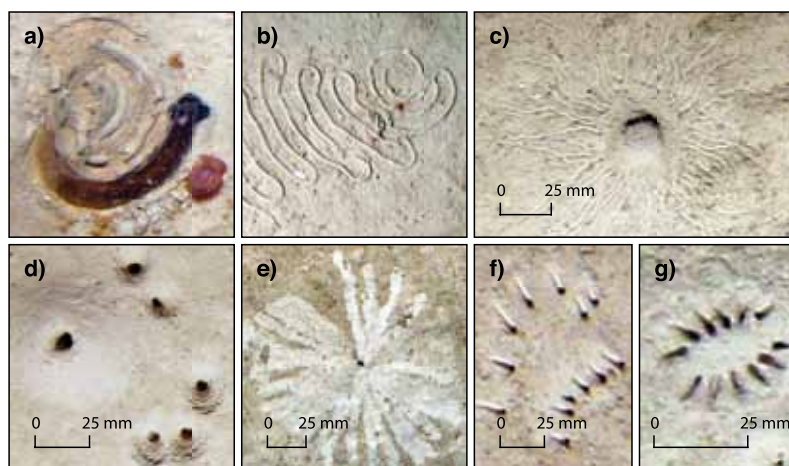


Figure 1. A sample of the types of *lebensspuren* identified from still images: a) acorn worm spiral with the animal forming the feature; b) acorn worm switchback; c) rayed mound; d) burrow cluster; e) large rosette; f) matchstick feature; g) ovoid pinnate. Scale bars are 25 millimetres. Note: scale could not be determined for images from the western margin (a, b) because of lack of size reference points on the camera.

Deep sea diversity

At first glance, these habitats seem barren, but they are actually teeming with life. Previous biological sampling of the seafloor using boxcores has suggested that the deep sea may harbour greater species abundance and diversity than shallow water areas, and in some areas may even be comparable to biodiversity hotspots such as tropical coral reefs (Grassle and Maciolek 1992).

However, most of these deep sea animals are rarely seen because they are generally small and infaunal, meaning that they spend most of their lives within the sediment. During feeding and burrowing these animals move through the soft sediment and form a range of features, including starbursts, spirals, and spaghetti-like tracks (figure 1). These features are known as *lebensspuren*, which refers to any type of sedimentary structure produced by a living organism. *Lebensspuren* have been shown to be useful surrogates for the biodiversity of larger animals in subtidal systems (Widdicombe et al 2003), but no similar research has yet been conducted in deeper waters. High resolution still photographs are



often collected in conjunction with video footage during surveys but, to date, have rarely been used for habitat or biodiversity analysis of deep sea habitats. They offer a means to use *lebensspuren* as a proxy for

biodiversity assessment in deep sea habitats which are normally quite difficult to quantify with video. This facilitates a more comprehensive characterisation of the seafloor across deep sea plains.

The study

Still images collected on the eastern and western Australian margins were analysed for *lebensspuren* (figure 2). The study areas were based on marine reconnaissance surveys undertaken by Geoscience Australia: Survey GA0427 (TAN0713) on the eastern margin and Survey GA2476 on the western margin (figure 2). These areas were chosen because they represent different geomorphic and geological settings; two parameters that may affect the abundance and type of biota in the sediments. The aims of the study were to:

- catalogue the different types of *lebensspuren*
- quantify the diversity of *lebensspuren* as a potential proxy for deep-sea biodiversity
- evaluate whether the quantification of *lebensspuren* from still images is an appropriate technique for broadly quantifying biological activity and diversity in the deep sea.

The latter assessment was based on the detection of known biological relationships between environmental variables and biodiversity, as well as the

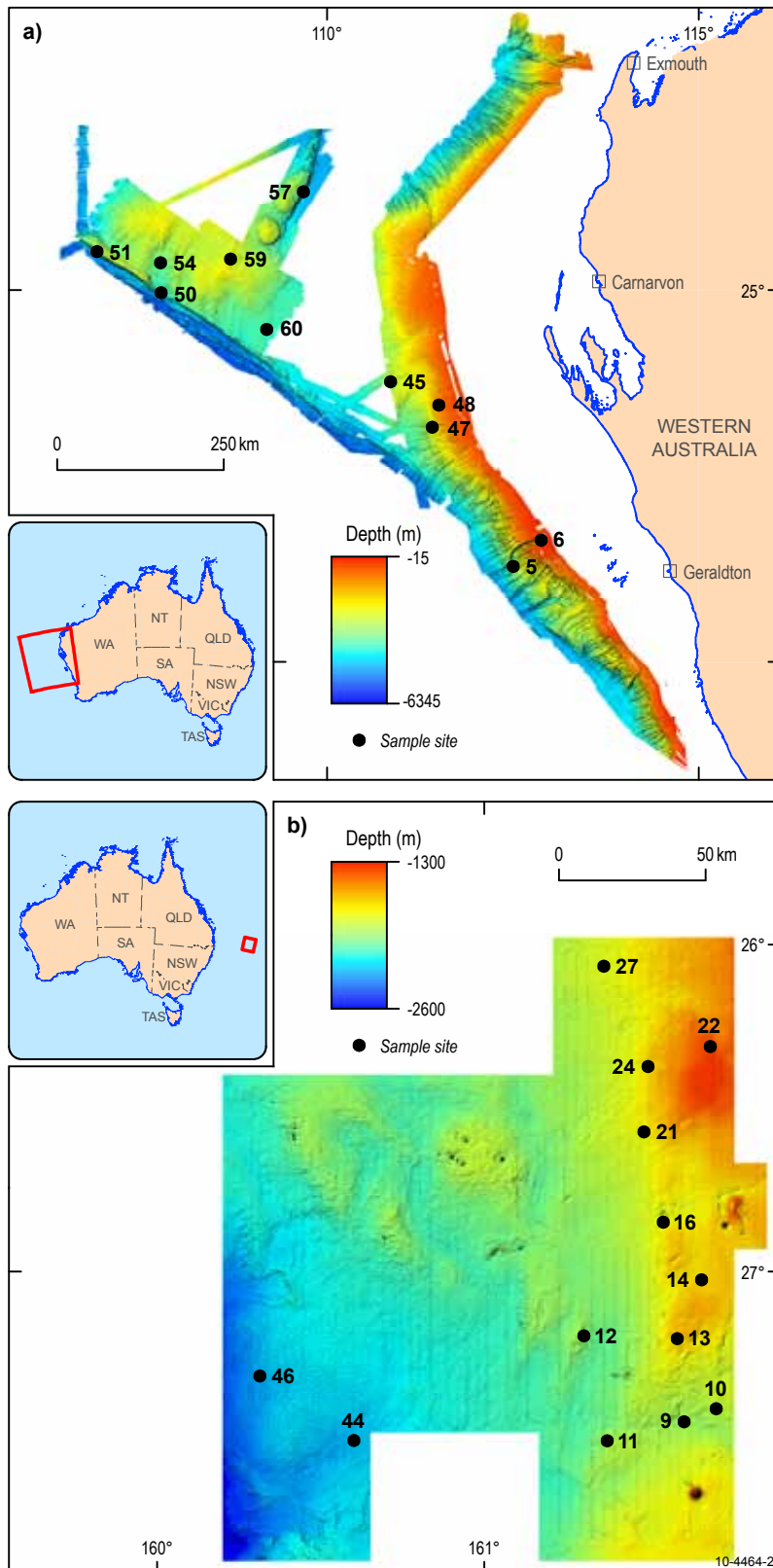


Figure 2. Survey areas for the eastern and western margins, including stations (locations) from which still images were analysed.

expected biological differences between the eastern and western Australian margins.

For each region, selected still images were examined, and the different types of *lebensspuren* were recorded. Since very common features were difficult and time-consuming to count, only their presence or absence was recorded. The types of *lebensspuren* were named, classified according to the likely mechanism of formation (such as feeding, dwelling, waste), and compiled into a directory (Dundas and Przeslawski 2009).

Lebensspuren were then correlated with environmental data collected concurrently during the survey to identify any significant relationships. In both the eastern and western margins, the *lebensspuren* were analysed with depth and sediment properties (such as percentage mud or carbonate). At selected stations on the eastern margin, *lebensspuren* were also analysed with geochemical parameters (such as extractable metals, measures of organic freshness, carbon and nitrogen expressed on carbonate-free basis).

A total of 46 different types of *lebensspuren* were recorded from the eastern and western margins, some of which are shown in figure 1. Very few organisms were directly observed forming *lebensspuren* (figure 1a) which highlights a major difficulty when observing these animals in traditional video and image analysis.

Multivariate analyses confirmed significant regional differences in *lebensspuren* abundance and types between the eastern and western margins, with the eastern margin showing higher *lebensspuren* abundance and diversity. *Lebensspuren* were significantly correlated to depth and freshness of organic matter, with more types of *lebensspuren* associated with shallower depths and sediments with high organic freshness (figure 3). Depth accounted for 22 per cent of the variation in *lebensspuren* types among stations (locations) while organic freshness accounted for 70 per cent. Mud and carbonate content were also significantly related to *lebensspuren* but were confounded with depth.

Overall, the method of using still images to quantify *lebensspuren* as a proxy for deep seafloor biodiversity warrants further use and research. Clear geographic differences were seen in *lebensspuren* assemblages, and these differences were associated with environmental factors such as depth. These patterns parallel known biological patterns, thus suggesting that quantification of *lebensspuren* may be suitable for

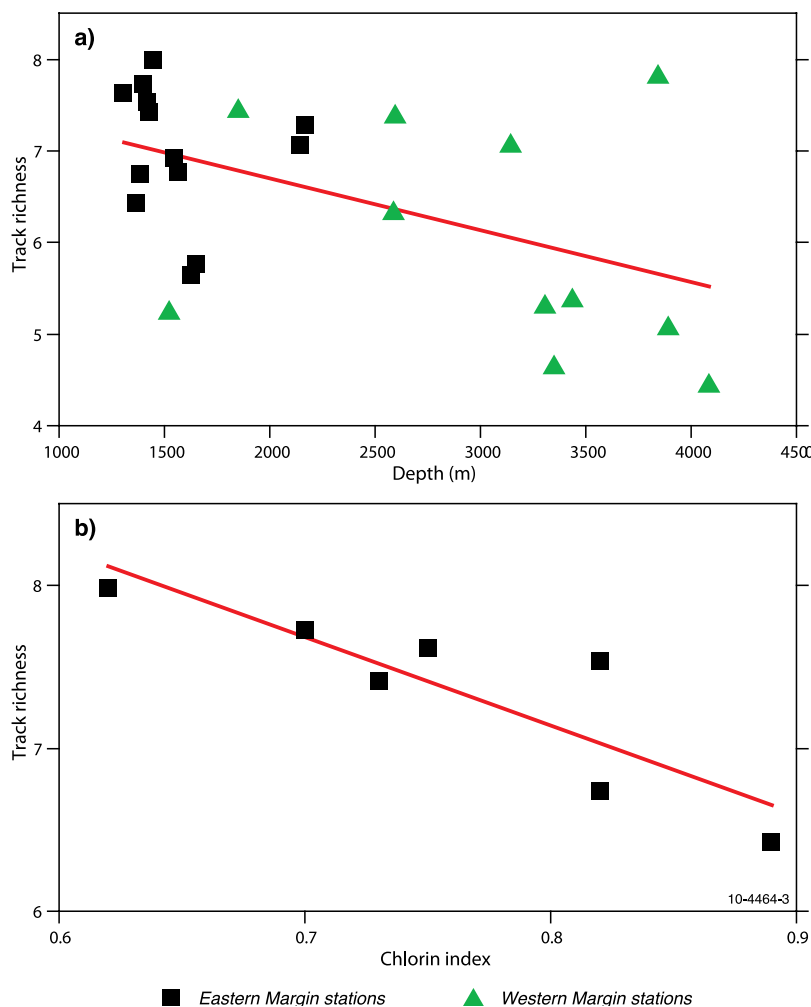


Figure 3. Relationships between *lebensspuren* track richness and a) depth and b) chlorin index, a measure of products from degraded chlorophyll. Dark squares are eastern margin stations while green triangles are western margin stations.



broad-scale comparisons of biological diversity among deep sea sites. The advantages and disadvantages of using video and still images to collect biological data indicate that optimal results are likely to be obtained when biotic and abiotic samples are collected concurrently with deep-sea video and still imagery.

Findings from this study will assist in the characterisation of deep sea areas which cover much of Australia's marine jurisdiction. This environment is one in which the biology is difficult to investigate because of the prevalence of small infauna and the logistical constraints associated with sampling in deep waters. The use of still images to quantify *lebensspuren* offers a cost-effective means to analyse data that are normally not assessed during deep-sea surveys. This option should increase the scope of biodiversity analyses and results from this study have been promoted through the Census of Marine Life and several other international research organisations.

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Related websites

AusGeo News 89: Survey of remote eastern frontier basins completed
www.ga.gov.au/ausgeonews/ausgeonews200803/index.jsp

AusGeo News 94: Southwest Margin surveys completed
www.ga.gov.au/ausgeonews/ausgeonews200906/surveys.jsp

AusGeo News 94: Revealing the Wallaby Plateau
www.ga.gov.au/ausgeonews/ausgeonews200906/wallaby.jsp

Census of Marine Life
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- Rocks and minerals
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Monitoring Earth's changing magnetic field

New geomagnetic field models released

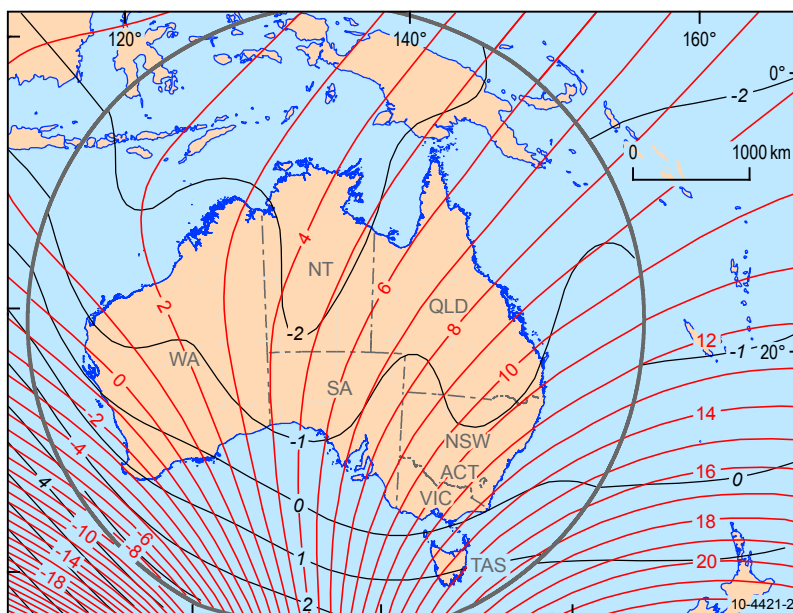
Andrew Lewis

Regional and global geomagnetic models have a wide range of applications in the general community as well as the scientific, industrial and engineering sectors. The Australian regional model is particularly useful for anyone using a compass for navigation—including bushwalkers, mariners and pilots—and other applications such as aligning satellite dishes, telescopes and solar-passive houses. Specialist applications include mineral exploration and drilling, surveying, mapping, research into the global magnetic field and its secular change, and studies of Earth's deep interior, crust, ionosphere and magnetosphere.

The geomagnetic field on or near the surface of the Earth is the sum of magnetic fields which originate from numerous magnetic sources including deep within the planet, through the atmosphere

and into space. Some of these geomagnetic sources vary in complex and unpredictable ways. Geoscience Australia continually monitors Earth's changing magnetic field in the Australian region for modelling, mapping and improving the community's understanding of geomagnetic phenomena.

Because of the dynamic nature of the geomagnetic field, mathematical models of the field need to be updated regularly to ensure they track changes and remain as accurate as possible. Consequently, new revisions of both the global and Australian regional geomagnetic field models are now available from Geoscience Australia.



Declination, Australian Geomagnetic Reference Field model 2010 at 2010.0
— Declination angle (°)
— Annual rate of change of declination ("/year)
— AGRF model area
Contours outside the circle are derived from IGRF-11.

Figure 1. Contours of the magnetic declination in degrees (red) and annual change of declination (black) in minutes-of-arc per year from the AGRF 2010 model at epoch 2010.0. The circular boundary shows the limit of the AGRF model, consequently contours outside the boundary are from the International Geomagnetic Reference Field Model (IGRF-11 at 2010.0).

The Australian Geomagnetic Reference Field model

The Australian Geomagnetic Reference Field (AGRF) is a mathematical model of the geomagnetic field and its predicted annual changes over the Australian region including continental Australia and nearby offshore areas, most of Papua New Guinea and parts of eastern Indonesia. The 2010 revision is a mathematical representation

of the undisturbed geomagnetic main field at epoch 2010.0 and its predicted annual changes during the period 2010 to 2015 (figure 1). The model is the sixth in the series of AGRF models and describes the field originating from internal sources using spherical cap harmonics. The main field is modelled to a nominal minimum spatial wavelength of 1500 kilometres and the annual change to 2000 kilometres.

“Because of the dynamic nature of the geomagnetic field, mathematical models of the field need to be updated regularly to ensure they track changes and remain as accurate as possible.”

Extensive vector geomagnetic survey datasets were used to derive the main field model, including magnetic data from the German CHAMP satellite, high elevation airborne data, and ground based vector survey data across Australia. The main field datasets were updated to epoch 2010.0 using a secular variation model of the Australian region derived from geomagnetic observatory and repeat station data collected over the last 50 years. The secular variation model in the 2010 revision of AGRF is based on a linear extrapolation of the most recent geomagnetic observatory and repeat station data. Based on our knowledge of the past behaviour of the magnetic field, the secular variation model should be appropriate out to epoch 2015.

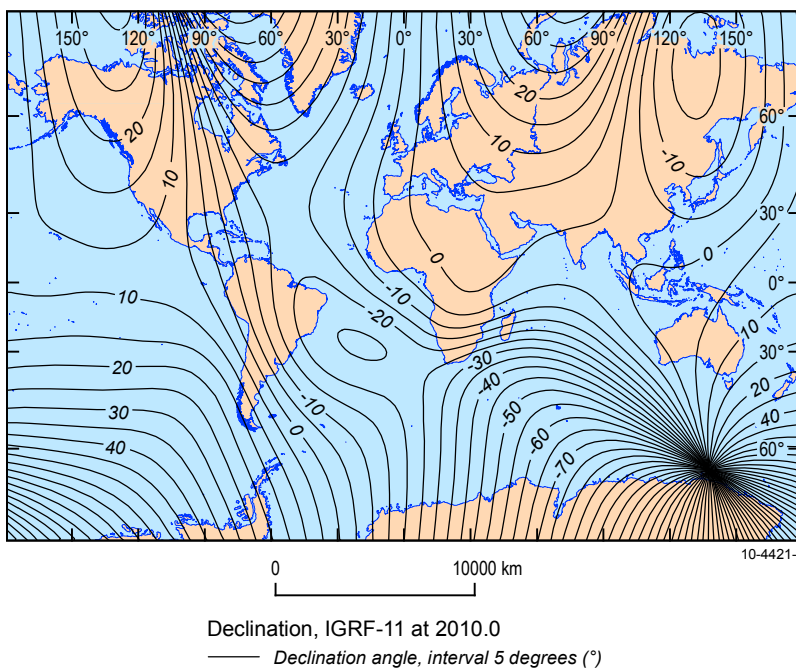


Figure 2. Isogons derived from the IGRF-11 model for epoch 2010.0, the declination contour interval is 5 degrees.

The extensive regional data sets used in developing the AGRF model make it the most accurate available model for the Australian regional magnetic field for the interval 2010 to 2015.

The 2010 AGRF model is based on the recently released eleventh revision of the International Geomagnetic Reference Field, which is a global spherical harmonic model of the geomagnetic field.

An on-line calculator for the AGRF is available through the Geoscience Australia website. Software to evaluate the AGRF at a single point or a grid of points is available on request from Geoscience Australia.

The International Geomagnetic Reference Field

The eleventh generation of the International Geomagnetic Reference Field (IGRF-11) was released by the International Association of Geomagnetism and Aeronomy (IAGA) in late December 2009. This release adds a definitive main field model for 2005.0, a new model for 2010.0 and a secular variation model for the period between 2010 and 2015.

IGRF-11 allows the undisturbed long wavelength geomagnetic field originating from sources internal to Earth to be calculated at any location on, or near, the surface of Earth during the period 1900 to 2015 (figure 2). The spherical



harmonic degree and order 13 coefficients of IGRF-11 have modelled the main field at 2010 to a minimum nominal spatial wavelength of 3000 kilometres. The degree and order 8 secular variation coefficients model the rate of change of the field to a minimum nominal spatial wavelength of 5000 kilometres.

The development of the IGRF is the result of international collaboration between magnetic field modellers and the scientific institutions and government agencies that undertake satellite magnetic surveys and operate geomagnetic observatories.

The full set of spherical harmonic coefficients for IGRF-11 can be downloaded in several formats from the International Association of Geomagnetism and Aeronomy (IAGA) V-MOD web site. There are several online IGRF calculators available, including those at the British Geological Survey and the National Geophysical Data Centre in the United States of America. Links to these websites are provided below. Software to calculate IGRF-11 at a single point or a grid is also available on request from Geoscience Australia.

Related websites/articles

Online calculator for the Australian Geomagnetic Reference Field available through the Geoscience Australia website.

www.ga.gov.au/oracle/geomag/agrfform.jsp

International Association of Geomagnetism and Aeronomy (IAGA) V-MOD website

www.ngdc.noaa.gov/IAGA/vmod/igrf.html

British Geological Survey online IGRF calculator

www.geomag.bgs.ac.uk/gifs/igrf_form.shtml

National Geophysical Data Centre (United States) online IGRF calculator

www.ngdc.noaa.gov/geomagmodels/IGRFWMM.jsp

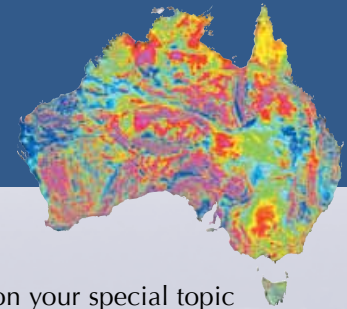
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New petroleum frontiers revealed

The release of new pre-competitive seismic data and seafloor mapping acquired in surveys off Australia's western coast will 'create opportunities for Australia's petroleum exploration and the possibility of new oil and gas discoveries to supply Australia's and Western Australia's energy needs in the future' according to the Minister for Resources and Energy, The Hon. Martin Ferguson AM MP.

The Minister released the Southwest Margin Data Package in Perth on 14 April 2010 (figure 1). The release highlights findings from the Southwest Margin Marine Reconnaissance Survey and the Seismic Survey which were completed in February 2009. The surveys collected about 7300 kilometres of seismic reflection data from offshore frontier basins along Western Australia's coast including the Mentelle Basin, the Zeewyk and Houtman sub-basins within the Perth Basin, the Carnarvon Basin and the Wallaby Plateau. They were also the first marine surveys undertaken since the extension of Australia's maritime boundaries and included the Extended Continental Shelf on the Wallaby Plateau.

The data release included seismic, gravity and magnetic data as well as 11 700 kilometres of reprocessed seismic data collected and processed under Geoscience Australia's Offshore Energy Security Program. The release highlighted the role of the surveys in supporting pre-competitive data to underpin offshore acreage releases, and the Australian Government's Energy Security Initiative which supports industry through the provision of pre-competitive data at cost of transfer.



Figure 1. The Minister for Resources and Energy, The Hon. Martin Ferguson AM MP (centre) with (from left) Dr Peter Moore, Executive Vice President, Exploration, New Ventures, Mergers and Acquisitions, Woodside Energy Ltd, Dr Clinton Foster, Chief of Geoscience Australia's Petroleum and Marine Division, Dr Chris Pigram, Acting CEO of Geoscience Australia and Dr Bruce Goleby, Chief Geophysicist and Group Leader, Geoscience Australia, following the release of the Southwest Margin Data Package on 14 April.

The Southwest Margin Data Package provided a lead-in to the APPEA 2010 Conference in Brisbane from 16 to 19 May 2010. The new knowledge has already been used to provide information on the geology of areas scheduled for acreage release in 2010 in the Mentelle Basin (southwest of Perth). This issue of *AusGeo News* includes two articles on the 2010 Acreage Release Areas.

For more information

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Related articles/websites

Southwest Margins Survey details

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=70291

Southwest Margins Data Package

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=70292

AusGeo News 98: New opportunities for offshore petroleum exploration

www.ga.gov.au/ausgeonews/ausgeonews201006/offshore.jsp

AusGeo News 98: First acreage release in frontier Mentelle Basin

www.ga.gov.au/ausgeonews/ausgeonews201006/mentelle.jsp

AusGeo News 94: Southwest Margin surveys completed

www.ga.gov.au/ausgeonews/ausgeonews200906/surveys.jsp

AusGeo News 94: The geology and deep marine terrains of Australia's western margin

www.ga.gov.au/ausgeonews/ausgeonews200906/marine.jsp

Assessing Australian energy resources

Australia's abundance of energy is a key contributor to Australia's economic prosperity. The Australian energy sector directly accounts for five per cent of gross-industry value-added; 20 percent of total export value; supports a large range of manufacturing industries and provides significant employment and infrastructure. The demand for energy is increasing as Australia's economy and population grows.

A major report on Australia's energy resources was released by the Minister for Resources and Energy, The Hon. Martin Ferguson AM MP, on 1 March 2010. The *Australian Energy Resource Assessment* examines the nation's identified and potential energy resources ranging from fossil fuels and uranium to renewables. The assessment reviews the factors likely to influence the use of Australia's energy resources to 2030, including the technologies being developed to extract energy more efficiently and cleanly from existing and new energy sources. The Minister said that the assessment 'was more than a snap-shot of Australia's energy resources. It is a national prospectus for energy investment and exports. It would provide fundamental information for policy debates over the next couple of years'.

Australia has an abundant and diverse range of energy resources. It has very large coal resources that underpin exports and low-cost domestic electricity production, more than one third of the world's known uranium resources, and substantial conventional gas and coal seam gas resources. These can support Australia's domestic needs and exports for many years to come. Identified resources of crude oil, condensate and liquefied petroleum gas are more limited and Australia is increasingly reliant on imports for transport fuels.

Australia has a rich diversity of renewable energy resources (wind, solar, geothermal, hydro, wave, tidal, bioenergy) with low greenhouse gas emissions. With the exception of hydro and wind energy (which is

growing strongly) many of these resources are largely undeveloped, constrained by the current immaturity of technologies. The expected advances in technology by 2030 will allow them to make a growing contribution to Australia's future energy supply. By this time Australia's energy consumption pattern is expected to change significantly. While fossil fuels (coal, oil and increasingly gas) will continue to dominate the energy mix, renewable energy sources, notably wind, are expected to become increasingly more significant.

The Australian Energy Resource Assessment was undertaken jointly by Geoscience Australia and the Australian Bureau of Agricultural and Resource Economics (ABARE) at the request of the Department of Resources, Energy and Tourism as a contribution to future energy policy. The publication is available for download through the Geoscience Australia website and is also available in printed and CD-ROM formats from the Geoscience Australia Sales Centre.



For more information or to download a copy visit

www.ga.gov.au/products

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=70142

Australian Energy Resource Assessment

www.ga.gov.au/image_cache/GA16983.pdf

Chile earthquake triggers tsunami warning for Australia

Australia's Tsunami Warning System issued a tsunami warning for sections of Australia's east coast following the fifth largest earthquake ever recorded which occurred off the coast of Chile on 27 February 2010 at 5.34 pm Australian Eastern Daylight Time (6.34 am UTC). The magnitude 8.8 earthquake struck close to the coastal city of Concepción, approximately 300 kilometres south of Santiago. Though significant shaking was felt in Santiago, the capital, damage to infrastructure was limited mainly to towns near the epicentre.

During the week following the main shock, 14 aftershocks that exceeded magnitude six were recorded as well as 169 aftershocks exceeding magnitude five. The aftershocks extend for 700 kilometres along the subduction zone, centred on the location of the main shock, giving an indication of the rupture zone. The earthquake generated a tsunami which had more wide-reaching effects. This was a similar scenario to an event that occurred in 1960 when a magnitude 9.5 earthquake, the largest ever recorded, struck Chile approximately 400 kilometres to the south of the recent event. The 1960 earthquake generated a Pacific-wide tsunami which reached the coasts of Hawaii, Japan and Australia.

The initial assessment of the earthquake gave a magnitude of 8.5 after it was recorded by seismic stations across the Australian National Seismograph Network operated by Geoscience Australia (figure 1). The Joint Australian Tsunami Warning Centre, which is jointly

operated by Geoscience Australia and the Bureau of Meteorology (see *AusGeo News* 96), then issued the warning. Australian emergency managers were then able to prepare for the potential impact that a tsunami could have on the Australian coast.

Consequently, a marine and immediate foreshore threat was put into effect for the east coast between southern Tasmania and central Queensland as well as Norfolk Island and Lord Howe Island. This level of threat warns of potentially dangerous waves, strong ocean currents and the possibility of some localised overflow onto the immediate foreshore. Observations from the tide gauges in the warning zone ranged from 0.5 metres at Norfolk Island to 0.16 metres at Southport, Tasmania. The effects of the tsunami were observed on the tide gauges for several hours after the first arrival. The resulting unusual currents and foreshore conditions validated the marine warning issued by the JATWC.

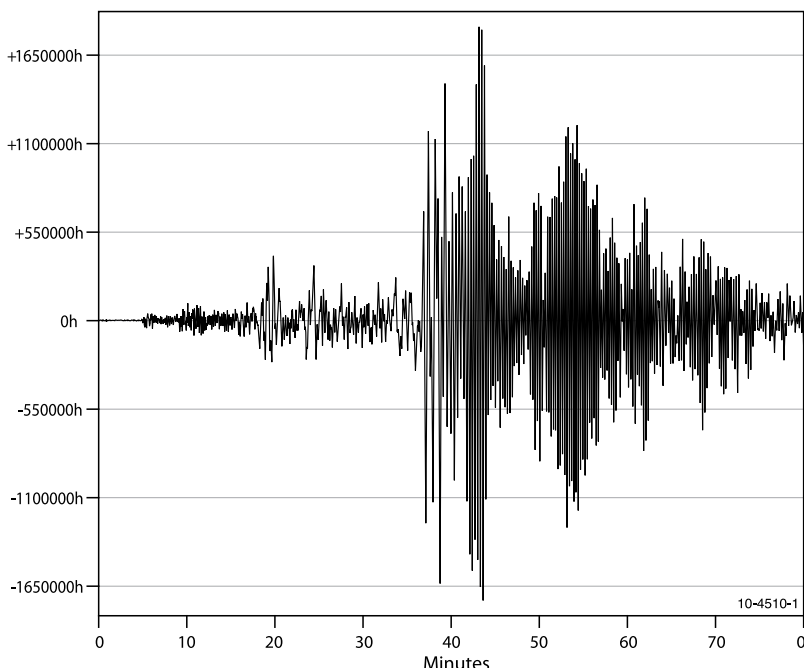


Figure 1. A seismogram of the Chile earthquake as recorded by a seismometer in Canberra operated by Geoscience Australia.

For more information

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Related articles/websites

AusGeo News 96: Tsunami warning system fully operational
www.ga.gov.au/ausgeonews/ausgeonews200912/tws.jsp

New beach information from OzCoasts

Australia has a long and diverse coastline of almost 60 000 kilometres. The Australian coast contains 10 685 beach systems, which occupy half the open coast or about 15 000 kilometres. A new beach database search capability and beach conceptual models are recent additions to Geoscience Australia's OzCoasts website. The website, which was launched in August 2008, contributes to improving natural resource management and the conservation of Australia's coastal zone, estuaries and near-shore environments.

OzCoasts users can search Australian beaches based on name, geomorphic state, and area at a range of scales from local government areas, through Natural Resource Management regions, states or territories, to national coverage. The search produces a report with the location of each selected beach, as well as links to images and descriptions of features and physical characteristics (length, orientation, embaymentisation, number of bars, wave height and period, spring and neap tides and nearest tide station). The beach reports can also be accessed through the Smartline maps in the landform and stability module, by clicking on a line segment (see *AusGeo News* 97).

The beach content was developed by Professor Andrew Short from the University of Sydney who classified the variety of beach systems into three major types. He also contributed to the development of an extensive database on beach hazards and physical characteristics. The conceptual models (figure 1) depict and explain each of the three major beach types found in Australia. These include six wave-dominated, three tide-modified, and four tide-dominated beach states which are a product of wave-tide and sediment conditions, and two states which are fronted by intertidal rocks and fringing reefs (making a total of 15 beach state models). As with estuaries, wave-dominated beaches predominate along the higher energy, microtidal southern coast, while tide-modified and tide-dominated beaches occur most

frequently around the tropical northern coast, as well as some sheltered and mesotidal southern locations. The beach models are found in the Conceptual Models module, alongside similar pictorial illustrations of estuarine function and coastal stressors.

Professor Short's research investigated all Australian mainland beach systems as part of a long-term collaborative project with Surf Life Saving Australia between 1990 and 2004. The database was developed during this time as part of the Australian Beach Safety and Management Program. The new beach search capability complements the estuary search which was developed during the initial phase of the National Land and Water Resources Audit (NLWRA), and provides access to data on approximately 1000 Australian estuaries.

Safety-related aspects of the Australian Beach Safety and Management Program dataset are available through the new Surf Life Saving Australia Beachsafe website.

Related articles/websites

Australian Beach Safety and Management Program, Surf Life Saving Australia Beachsafe website
www.beachsafe.org.au

Relevant publications by Dr Andrew Short, University of Sydney website
www.sup.usyd.edu.au/marine/

Short AD. 2006. Australian beach systems – Nature and distribution. *Journal of Coastal Research* 22(1): 11–27.

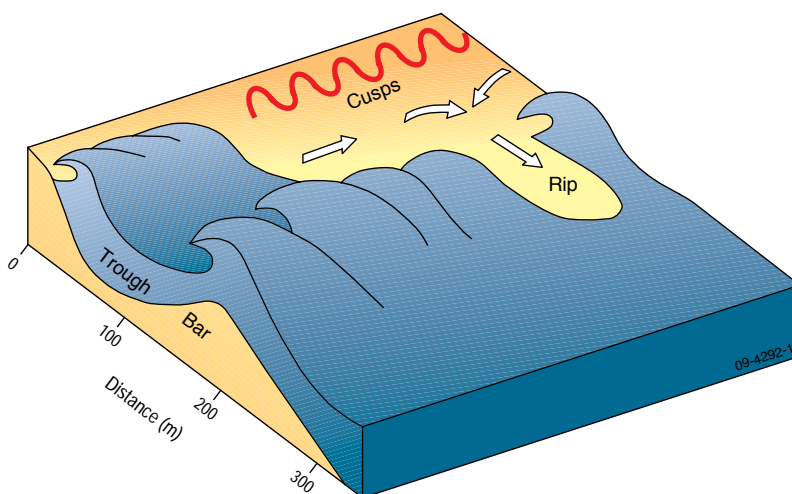


Figure 1. Conceptual model of longshore bar and trough wave-dominated beach showing the offshore bar and trough, with rip feeder currents converging to flow seaward as a rip current (arrows).

First absolute gravity measurements in the Australian Antarctic Territory

Geoscience Australia has recently conducted absolute gravity observations at Davis and Mawson stations in the Australian Antarctic Territory. These observations are the first such measurements undertaken at any of the Australian Antarctic stations to establish accurate gravity reference points for future gravity surveys. They will also enable gravity surveys that have already been conducted in the Australian Antarctic Territory to be tied to the same datum, thus allowing previous and future gravity surveys to be accurately merged and combined.

Gravity reference points (or gravity base stations) have been established at the Australian Antarctic stations in the past but these were done with relative gravity meters. These instruments measure the difference in gravity from one point to another and were used

to measure the difference between a reference point in Australia and the reference points that had been established in Antarctica. Unfortunately the length of time involved in travelling to Antarctica combined with ‘instrumental drift’ was not conducive to accurate readings so the accuracy of these older reference points was compromised.

The absolute gravity meter determines the actual acceleration of gravity by measuring the trajectory of a free-falling object in a vacuum. The surviving gravity base stations at Davis and Mawson were tied to the new absolute base stations using a relative gravity meter (figure 1). Gravity surveys that used these old reference points can now be adjusted to the new absolute datum.

Transport to and from the Antarctic stations was onboard the Australian Antarctic Division’s re-supply vessel RSV *Aurora Australis*, which departed Hobart on 25 January 2010 and returned on 28 February 2010. The ship’s track for this voyage and the location of Davis and Mawson can be seen in figure 2.



Figure 1. Ties between existing gravity base stations and the new absolute gravity base stations were conducted using a relative gravity meter.

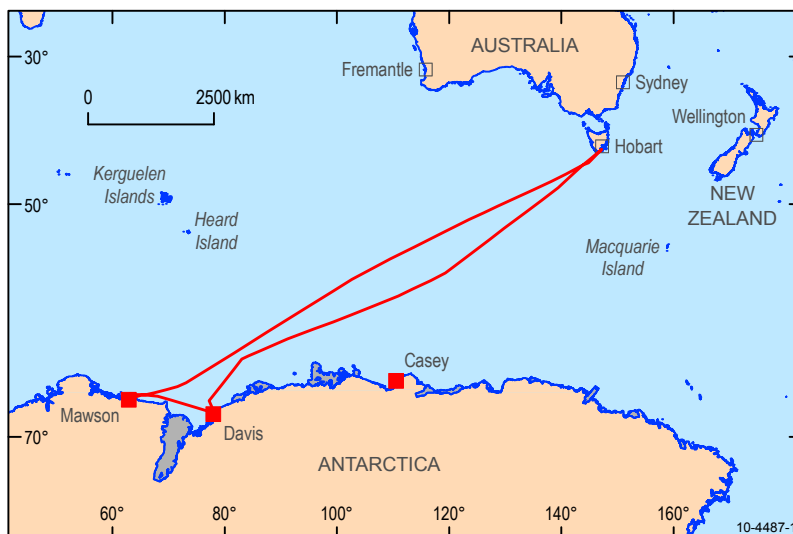


Figure 2. Map showing the location of Davis and Mawson in relation to Australia and the track of the RSV *Aurora Australis* during Voyage 3, 2009–10.

For more information

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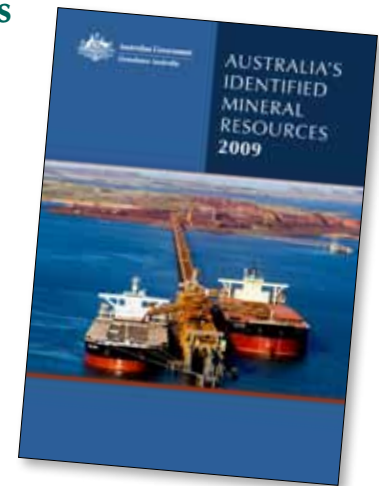
Australia's mineral resources maintain world status

A recent assessment by Geoscience Australia concludes that Australia's mining sector continues to hold the potential to remain the most important export earning sector of the Australian economy for the foreseeable future. This trend is based on the latest annual assessment of Australia's minerals inventory—*Australia's Identified Mineral Resources 2009*. The report shows that Australia's Economic Demonstrated Resources for a number of mineral commodities increased during 2008. These increases mean that production was more than compensated for by the discovery of additional resources.

There have been very few world-class discoveries in Australia in the past two decades and the inventory has been sustained largely through delineation of additional resources in known mineral fields. At December 2008, Australia had the world's largest Economic Demonstrated Resources of brown coal, mineral sands (rutile and zircon), nickel, silver, uranium, zinc, and lead. The country also ranks among the top six worldwide for identified resources of antimony, bauxite, black coal, copper, gold, iron ore, ilmenite, industrial diamond, lithium, manganese ore, niobium, tantalum, vanadium and antimony.

While Australia's resource stocks are healthy overall, the country's position as a premier mineral producer is dependent on continuing investment in exploration to locate high quality resources and to upgrade known deposits to make them competitive on the world market.

The severe world financial crisis in late 2008 has highlighted the fact that a long resource life for a particular commodity does not guarantee that such resources will continue to be exploited in Australia. In an increasingly globalised and competitive commodity market, multinational mining companies continue to search for mineral deposits which will offer attractive returns on investment. Such returns are influenced by the quality of the resources (grade, tonnage and metallurgical characteristics) as well as environmental, social and political factors, land access and the location and scale of competing projects. Increasingly, multinational companies are ranking their individual mineral projects against investment returns from other projects worldwide and this has resulted in a number of recent mine closures in Australia. In the case of nickel, multinational companies have closed sulphide and lateritic nickel mines in Western Australia and Tasmania and consolidated their operations at larger, low cost mining operations, sometimes outside Australia.



A free download of *Australia's Identified Mineral Resources 2009* is available through the Geoscience Australia website and other fundamental data on the minerals sector can be accessed through the *Atlas of Australia's Mineral Resources, Mines and Processing Centres*.

For more information

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or visit

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=69951

Related articles/websites

Australia's Identified Mineral Resources 2009

www.ga.gov.au/image_cache/GA16805.pdf

Atlas of Australia's Mineral Resources, Mines and Processing Centres

www.australianminesatlas.gov.au/

Uranium ore-forming systems of the Lake Frome region, South Australia: regional spatial controls and exploration criteria

Cenozoic basins of the Lake Frome region in northeastern South Australia contain most of Australia's known resources of sandstone-hosted uranium mineralisation. These include the currently operating Beverley uranium mine, and the Honeymoon, Four Mile, Oban, and Goulds Dam deposits. While the known resources are significant, the potential of the region for very large uranium deposits has not been well understood, in part due to limited knowledge of the regional and district-scale geological controls on uranium mineralisation.

A recently released report from Geoscience Australia presents new data and includes a review of geological knowledge of uranium mineral systems in the Lake Frome region. The report, *Uranium ore-forming systems of the Lake Frome region, South Australia*, is intended to provide a revised framework for exploration of major uranium deposits in the region. This new framework is aimed at providing a basis for refined exploration targeting of areas to reduce investment risk for the exploration industry. The report is a product of Geoscience Australia's Onshore Energy Security Program which is delivering pre-competitive data to boost investment in exploration for onshore energy resources including uranium.

The integration of results from this study supports a model of three potential episodes of basin-hosted uranium systems in the Lake Frome region. In this hypothesis, three regional uplift events since the late Mesozoic triggered increases in the gravitationally-driven flow of groundwater through previously deeply weathered uranium-bearing source rocks and into adjacent basins. As a consequence, uranium mineral systems potentially were active during the late Cretaceous to Paleogene, the late Eocene–Oligocene, and the Pliocene–Pleistocene. The model is consistent with known mineralisation hosted by Miocene and Eocene sediments and also predicts potential mineralisation within Mesozoic sediments. Evaluation of the permeability architecture indicates potential for larger uranium systems 'downstream' in the north of the region. The importance of regional fault architecture is highlighted as a control on paleo-fluid flow and on the sites of uranium deposition.

Using a re-formulation of the 'mineral systems' approach (see *AusGeo News* 95), the report describes the following essential parts of the ore-forming system:

- uranium and fluid sources, with descriptions of lithostratigraphy
- energy and timing in relation to the tectonic evolution
- regional 3D permeability architecture and fluid flow
- chemical gradients and controls on uranium deposition.

The report reviews the geology of uranium deposits in the region and also includes the first published description of the mineralogy of



the Four Mile East deposit. To test the viability of previously published genetic models, the report presents the results of numerical modelling of paleo-fluid flow and mineralising processes. The final chapter synthesises the results and presents alternative ore-forming scenarios along with implications for mineral exploration in the region.

For more information or to download a copy visit

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=6969711-27

Related websites/articles

Uranium ore-forming systems of the Lake Frome region, South Australia (Geoscience Australia Record 2009/40)

www.ga.gov.au/image_cache/GA16103.pdf

AusGeo News 97: Exploring for sandstone-hosted uranium deposits in paleovalleys and paleochannels

www.ga.gov.au/ausgeonews/ausgeonews201003/uranium.jsp

AusGeo News 95: New views of Australia's uranium mineral systems

www.ga.gov.au/ausgeonews/ausgeonews200909/uranium.jsp

New geophysical datasets released

Datasets from five new geophysical surveys which include the Canning and Eucla basins and the Yilgarn Craton in Western Australia and Broken Hill in New South Wales have been released this year.

The data from these new airborne magnetic/radiometric, electromagnetic and gravity surveys provide basic geophysical data which can be interpreted to reveal the sub-surface geology of the survey area. The datasets will be a valuable tool in assessing the mineral potential of the respective survey areas and should stimulate mineral exploration.

The Crossland-Noonkanbah, Naretha and Eucla Coast airborne magnetic and radiometric surveys and South Yilgarn gravity survey were managed by Geoscience Australia on behalf of the Geological Survey of Western Australia. The airborne magnetic and radiometric surveys were conducted under the Western Australian Government's *Exploration Incentive Scheme*.

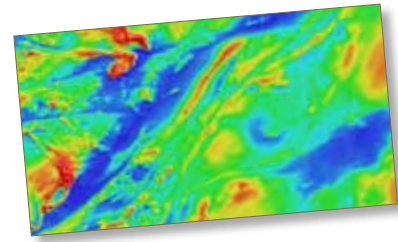
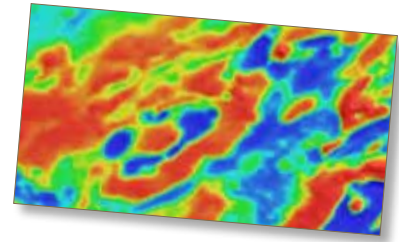


Table 1. Details of the airborne magnetic, radiometric and elevation surveys.

Survey	Date	1:250 000 map sheets	Line spacing/ terrain clearance/ orientation	Line km	Contractor
Crossland - Noonkanbah (East Canning 1) WA	June–December 2009	Lennard River (pt) Noonkanbah (pt) Crossland Dummer (pt)	400 m 60 m north–south	116 700	GPX Surveys Pty Ltd
Naretha (Eucla Basin 3) WA	June–December 2009	Zanthus (pt) Naretha (pt) Balladonia (pt) Culver (pt)	200 m 50 m east–west	123 100	Fugro Airborne Surveys Pty Ltd
Eucla Coast (Eucla Basin 6) WA	June–December 2009	Zanthus (pt) Naretha (pt) Balladonia (pt) Culver (pt)	200 m (onshore) 400 m (offshore) 50 m (onshore) 100 m (offshore) north–south	121 645	UTS Aeroquest Pty Ltd

Table 2. Details of the gravity surveys.

Survey	Date	1:250 000 map sheets	Station spacing/ orientation	Stations	Contractor
South Yilgarn WA	July–December 2009	Lake Johnston Balladonia(pt) Zanthus (pt) Naretha	2500 m east–west	6500	Fugro Ground Geophysics Pty Ltd
Broken Hill NSW	May–October 2009	Broken Hill (pt) Ana Branch (pt) Mildura (pt)	4000 m 1000 m east–west	6999	Atlas Geophysics Pty Ltd

The Broken Hill gravity survey was managed entirely by the Geological Survey of New South Wales and conducted under the New South Wales Government's *New Frontiers* Initiative.

The magnetic, radiometric and gravity data have been incorporated into the national geophysical databases. The point-located and gridded data for these surveys can be obtained free online using the GADDS download facility.

For more information

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Related websites

Geophysical Archive Data Delivery System (GADDS)

www.geoscience.gov.au/gadds

Geological Survey of Western Australia

www.dmp.wa.gov.au

Geological Survey of New South Wales

www.dpi.nsw.gov.au/minerals/geological

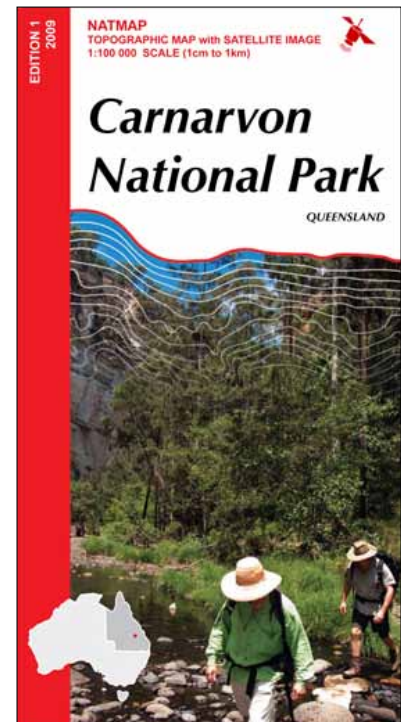
Carnarvon National Park map features in new map

Carnarvon National Park is located in Queensland's central highlands about 700 kilometres northwest of Brisbane. The park has an inviting and rich mosaic of open woodlands, forests and plains and is home to a huge variety of plant and animal species. Sculpted sandstone outcrops, spectacular views from the highest plateau in Queensland and significant Aboriginal rock art sites are all found in the park. It is not surprising, therefore, that Carnarvon National Park is a popular destination for tourists.

The park is the focus of a new multi-scale topographic map recently released by Geoscience Australia. Though the map was originally developed to meet the needs of local emergency and environmental managers, it has also proved a valuable resource for visitors to the area.

The map sheet includes coverage of the Carnarvon Gorge area (showing popular walking tracks) at 1:100 000 scale as well as coverage of the popular southern section of the park at 1:250 000 scale. The reverse side features a satellite image (1:250 000 scale) with overlays showing major roads and visitor facilities as well as three insets highlighting the Salvator Rosa, Ka Ka Mundi and Carnarvon Gorge sections of the park.

The Carnarvon National Park map is one of a number of maps recently released by Geoscience Australia that have been produced as a result of collaboration between the Australian Government and state and territory land management agencies. The map was compiled with assistance from the Queensland Government Department of Environment and Resource Management and the Queensland Fire and Rescue Service. The map is available from the Geoscience Australia Sales Centre and map retailers.



For more information or to order a copy visit

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=68612

ACT Region map updated

A second edition of the ACT Region map was launched in November 2009 by the Australian Capital Territory (ACT) Minister for Police and Emergency Services, Simon Corbell. The new map covers the entire ACT and the immediate surrounding region at 1:100 000 scale. This latest edition provides emergency service workers with critical information to help safeguard the community as well as providing a guide to help local residents and visitors to the region to enjoy its natural beauty.

The map has used the latest in aerial photography acquisition techniques and mapping technologies to ensure that it includes information vital to emergency services activities, such as, prevention, preparedness, response and recovery. Many topographic and cultural features have been updated since the first edition and the map features orthophotography on the reverse side plus an informative narrative panel which provides details about the region's landscapes.

Geoscience Australia collaborated with the ACT Emergency Services Authority to produce the ACT Region map and Geographical Information System (GIS). The maps and datasets were delivered to emergency management workers to assist in planning and operational exercises for the 2009–10 bushfire season. The aerial photography used to identify features during revision and as a reference on the back of the printed map was provided free-of-charge by the New South Wales (NSW) Land & Property Management Authority.

The ACT Region map is part of a cooperative National Topographic Information Coordination Initiative (NTICI) program being undertaken by Geoscience Australia in partnership with state and territory emergency management and mapping agencies. The program operates on the efficient principle of collecting information once and using it many times across all levels of government, industry and the community.

The first detailed ACT Region topographic map was produced in 2004 by Geoscience Australia following the 2003 Canberra bushfires in collaboration with a range of key stakeholders using the best data available at the time. The new edition was developed again by Geoscience Australia in collaboration with various government agencies including the ACT Emergency Services Authority, ACT Planning and Land Agency, ACT Department of Territory and Municipal Services, NSW Department of Lands, NSW National Parks and Wildlife Service as well as emergency service volunteers from the ACT and surrounding NSW region.



For more information or to order a copy visit

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=68755

Close collaboration on carbon capture and storage

Scientists from Geoscience Australia are collaborating with researchers from China on a capacity-building project that focuses on the geological storage of carbon dioxide (CO₂). Known as the China-Australia Geological Storage of CO₂ Project (CAGS) it aims to build expertise and accelerate the development of the technology in both countries.

Geoscience Australia, in conjunction with the Australian Government's Department of Resources, Energy and Tourism, is working in collaboration with the Administrative Centre for China's Agenda 21 in the Ministry of Science and Technology and other partner organisations in China. As part of the Project, Geoscience Australia hosted a technical workshop on geological storage of carbon dioxide in January 2010. The workshop, which was held in Canberra, was attended by more than 60 delegates from China, Australia, the United Kingdom, and the United States (figure 1).

'This is an important project which aims to strengthen the ties between Australian and Chinese researchers for collaboration in the area of geological storage of CO₂,' said Dr Clinton Foster, Chief of Geoscience Australia's Petroleum and Marine Division. The workshop enabled researchers to share their knowledge and experience, and to build valuable networks with representatives across government, academia and industry from both China and Australia.

Presentations and discussions during the three-day workshop covered a wide range of topics including:

- assessing the prospectivity and capacity of geological formations for CO₂ storage
- policy and communication issues
- next steps for geological storage research in China and Australia, and for getting 'storage ready'
- updates on research and CCS projects in China, Australia, the United States, and the United Kingdom.

The visitors also appreciated the opportunity to network while relaxing and enjoying some of the Canberra region's major attractions.

The CAGS Project is one of several supported by the Australian Government through the Asia Pacific Partnership on Clean Development and Climate (APP): it commenced in 2009 and is expected to be completed by the end of 2011. Project activities include technical workshops, research, and other capacity-building activities. In addition to the technical workshop, several Chinese researchers have been sponsored to attend international CCS conferences. Further information about the Project, including presentations and publications, can be found on the CAGS website.

For more information

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Related articles/websites

China-Australia Geological Storage of CO₂ (CAGS) Project
www.cagsinfo.net/



Figure 1. Participants at the CAGS workshop held at Geoscience Australia, Canberra, in January 2010 [copyright Geoscience Australia].



Climate Adaptation Futures	29 June to 1 July
2010 International Climate Change Adaptation Conference Gold Coast Convention Centre, Gold Coast, Qld Contact: Conference Secretariat, YRD (Aust) Pty Ltd, PO Box 717, Indooroopilly, Qld 4068	p +61 7 3368 2422 f +61 7 3368 2433 e nccarf-conf2010@yrd.com.au www.nccarf.edu.au/conference2010
Australian Earth Sciences Convention	4 to 8 July
Geological Society of Australia National Convention Centre, Canberra, ACT Contact: Conference Logistics, PO Box 6150, Kingston, ACT 2604	p +61 2 6281 6624 f +61 2 6285 1336 e aesc@conlog.com.au www.aesc2010.gsa.org.au
AMSA 2010	4 to 8 July
Australian Marine Sciences Association University of Wollongong, Wollongong, NSW Contact: AMSA Conference Organiser, RealEvents	p +61 7 5484 1179 f +61 7 5484 1456 e amsaconf@amsa.asn.au www.amsaconference.com.au
Diggers and Dealers Mining Forum 2010	2 to 4 August
Goldfields Arts Centre, Kalgoorlie, WA Contact: Diggers and Dealers Mining Forum, PO Box 979, West Perth, WA 6872	p +61 8 9481 6440 f +61 8 9481 6446 e suzanne@diggersndealers.com.au www.diggersndealers.com.au
14th Australasian Wind Engineering Society Workshop	5 & 6 August
Geoscience Australia, Symonston, ACT Contact: Bob Cechet, Geoscience Australia, GPO Box 378, Canberra, ACT 2601	p +61 2 6249 9246 e bob.cechet@ga.gov.au www.awes.org
21st International Geophysical Conference & Exhibition	22 to 26 August
Australian Society of Exploration Geophysicists & Petroleum Exploration Society of Australia Sydney Convention Centre Contact: Conference Action Pty Ltd, PO Box 576, Crows Nest, NSW 1585	p +61 2 9437 9333 f +61 2 9901 4586 e asege-pesa2010@conferenceaction.com.au www.asege-pesa2010.com.au
Crustal Architecture and Images SEISMIX 2010	29 August to 3 September
14th International Symposium on Deep Seismic Profiling of the Continents and their Margins Rydges Esplanade Resort Hotel, Cairns, Qld Contact: Dr Bruce Goleby, Petroleum and Marine Division, Geoscience Australia, GPO Box 378, Canberra ACT 2601	p +61 2 6249 9404 f +61 2 6249 9933 e seismix10@ga.gov.au www.earthscrust.org/earthscrust/ Seismix2010/index.htm
15th Australasian Remote Sensing and Photogrammetry Conference	13 to 17 September
Alice Springs Convention Centre, Alice Springs, NT Contact: 15ARSPC Conference Secretariat, 18 Hawthorne Parade, Haberfield, New South Wales 2045	p +61 414 971 349 e info@arspc.com www.15.arspc.com

spatial@gov Conference 2010	5 to 7 October
Australian Spatial Community and CeBIT National Convention Centre, Canberra, ACT Contact: Australian Spatial Community and Hannover Fairs Australia	p +61 2 9280 3400 e info@osdm.gov.au www.cebit.com.au/2010/conferences/spatial-at-gov
Mining 2010 Resources Convention	27 to 29 October
Hilton Hotel, Brisbane, Qld Contact: Vertical Events, PO Box 1153, Subiaco, WA 6904	p +61 8 9388 2222 f +61 8 9381 9222 e info@verticalevents.com.au www.verticalevents.com.au
GROUNDWATER 2010—the challenges of sustainable management	31 October to 4 November
International Association of Hydrogeologists & Geological Society of Australia National Convention Centre, Canberra, ACT Contact: Conference Solutions, PO Box 238, Deakin West, ACT 2600	p +61 2 6285 3000 f +61 2 6285 3001 e groundwater@con-sol.com www.groundwater2010.com
China Mining Congress	16 to 18 November
Ministry of Land and Resources, China Tianjin Meijiang International Convention & Exhibition Centre, Tianjin, China Contact: China Mining Congress & Expo Organising Committee	p +86 10 6446 6855 f +86 10 5885 7006 e info@china-mining.org www.china-mining.org/en/

For more information on Geoscience Australia's involvement in the above events
phone Suzy Domitrovic on +61 2 6249 9571 **email** suzy.domitrovic@ga.gov.au



AESc
australian earth sciences
convention







Education and Careers Evening

Engage with earth science professionals from around Australia, take a walk through the Earth's geological history and take your chances with a lucky door prize! For more information please visit the website: www.aesc2010.gsa.org.au

DATE: <i>Monday, 5 July 2010</i>	VENUE: <i>Geoscience Australia, Symonston, ACT</i>	COST: <i>Free</i>	TIME: <i>4-6 pm</i>
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