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Contents

ISSUE 85 MARCH 2007

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AUSGEO news
ISSUE 85 MARCH 2007

CEO *comment*

Neil Williams – CEO Geoscience Australia

This issue of *AusGeo News* features a wide range of articles covering petroleum prospectivity studies, mineral exploration and contributions to the mitigation of the effects of natural hazards.

A major program for Geoscience Australia is identifying the prospectivity of offshore frontier basins, in the quest for a new oil province. The article on assessing prospectivity in offshore frontier basins utilises case studies from the southern Australian Margin to demonstrate how integrated basin analysis is being used at a regional scale to assess petroleum prospectivity in these areas.

There is also a report on the marine survey conducted last year in the Central North West Shelf. The survey involved sampling within areas of potential hydrocarbon migration and seepage to the seafloor.

New geoscience datasets developed during the Tanami-North Australia Project will provide a better understanding of the evolution and metallogenesis of this area. For mineral explorers the most important result from the Tanami deep seismic survey was the correlation of the position of known mineral fields with the surface projection of crustal-penetrating shear zones on the seismic section.

There are several reports relating to the mitigation of natural hazards. We can now refine our estimates of earthquake ground-shaking at a given distance from an earthquake rupture and this provides the potential to rapidly assess earthquake impact for disaster response.

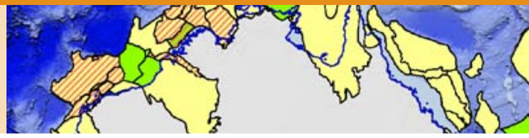
Geoscience Australia staff with GIS expertise contributed to the emergency response to the severe Victorian bushfires between December 2006 and January 2007. During this assignment Geoscience Australia staff developed an innovative method to show critical information in a 3D visual environment. During the bushfire emergency period, Geoscience Australia's Sentinel bushfire monitoring system experienced a major load as emergency managers and communities used it to source information. Sentinel is the internet based mapping tool which provides timely information on the location of bushfires throughout Australia.

New products reported on in this issue include; new geophysical datasets covering areas in Western Australia, the Northern Territory, Queensland and New South Wales, a major price reduction in Synthetic Aperture Radar (SAR) products and the Near-Pristine Estuaries database.

As always, we appreciate your feedback and encourage you to use the online rating mechanism below each article.

AUSGEO news
ISSUE 85 MARCH 2007

Assessing *prospectivity in offshore frontier basins*



Frontier basin studies identify new exploration opportunities

Barry Bradshaw

Recent increases in global demand for hydrocarbons, declining production from mature provinces, and high oil prices are driving a new phase of international exploration for petroleum resources in frontier basins. These are often data-poor areas where the basin geology is poorly understood, making prospectivity and exploration risks difficult to evaluate.

> "Vast frontier areas in offshore Australia remain unexplored and offer the potential for discovery of significant new provinces to maintain our energy security"

Most exploration companies manage these risks by developing an international portfolio of opportunities, and highgrading areas with evidence of a world-class petroleum system together with pool sizes greater than 250 million barrels (mmbbl) oil equivalent.

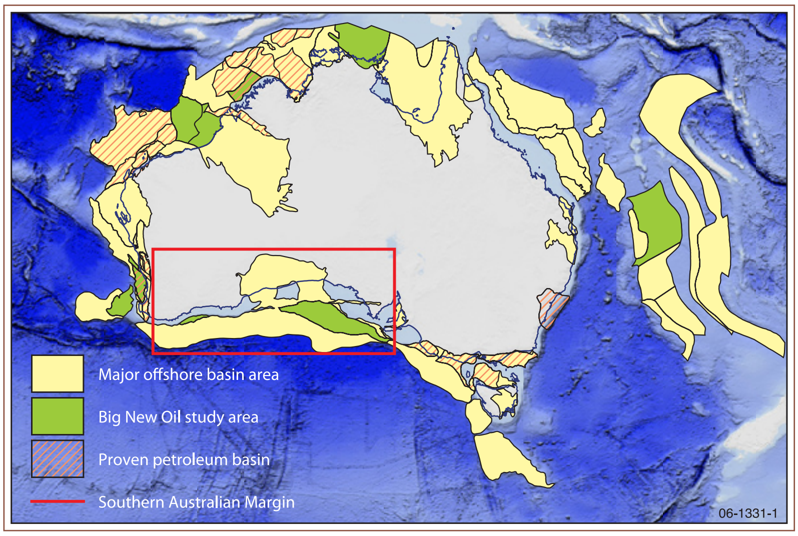


Figure 1. Australia's major offshore basin areas, highlighting proven petroleum basins, and frontier basins studied under Geoscience Australia's Big New Oil Program. The southern Australian margin study area is outlined by the red rectangle.

Australia's offshore frontier basins

Australia remains underexplored for hydrocarbon resources, with only about 8000 wells drilled. Most offshore exploration has been in basins with proven potential: the Gippsland, Bass and Otway basins in southeast Australia; the Perth Basin on the southwest margin; and the Northern Carnarvon, Browse and Bonaparte basins on the northwest shelf (figure 1). Seven major oil fields were discovered in the offshore Gippsland and Northern Carnarvon basins from 1960 to 1990 (Foster 2006). Until recently, numerous smaller discoveries in the Northern Carnarvon and Bonaparte basins have maintained our oil reserves. Vast frontier areas in offshore Australia remain unexplored and offer the potential for discovery of significant new provinces to maintain our energy security.

Since 2003, the Australian Government has funded a geoscientific program of data acquisition that aims to identify and promote new exploration opportunities in key offshore frontier basins (figure 1). Geoscience Australia's role in the Big New Oil Program has been to acquire new datasets and apply integrated basin analysis to model petroleum systems and plays at a regional scale. The datasets underpinning these studies vary according to such factors as regional geology, exploration history, sea-floor geomorphology, and budget constraints.

Two case studies from the southern Australian deepwater margin demonstrate how integrated basin studies are used to assess the petroleum prospectivity of frontier basins at a regional scale.

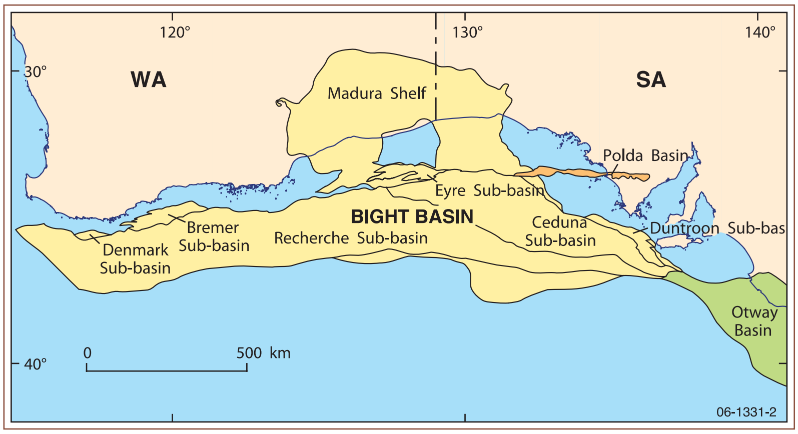


Figure 2. Location of the Bight Basin along the southern Australian margin, with component sub-basins.

Southern Australian frontiers

Geoscience Australia's study of southern Australian frontiers has focused on the Bight Basin. This major extensional system comprises a series of Middle Jurassic–Cretaceous depocentres that developed during the break-up of Australia and Antarctica (figure 2). Most of the basin is formed by the very large Recherche and Ceduna sub-basins, with a series of smaller half-grabens around the main rift basin margin, including the Bremer and Denmark sub-basins in the west, and the Eyre and Duntroon sub-basins in the east. The main depocentres extend over water depths between 100 and 5000 metres, and are relatively unexplored. Only 10 wells have been drilled, all in the eastern part of the Bight Basin.

"case studies from the southern Australian deepwater margin demonstrate how integrated basin studies are used to assess the petroleum prospectivity"

Bremer Sub-basin

The Bremer Sub-basin is a half-graben system located in the western part of the Bight Basin (figure 2). Until recently, exploration was limited to a regional seismic grid acquired in 1974. This showed the presence of potentially prospective structures for trapping hydrocarbons; however, the absence of subsurface geological data from wells and the deepwater setting (100–4000 metres) discouraged further exploration.

Geoscience Australia began a study of the Bremer Sub-basin in 2004 to determine whether it contained suitable geological conditions to generate and trap hydrocarbons and to identify further exploration opportunities. A major challenge was building a geological framework, without any well data, that would allow petroleum systems and plays to be modelled to support a new phase of exploration.

An integrated basin study was undertaken using 1300 kilometres of new seismic data and several hundred rock samples obtained by dredging submarine canyons that cross the continental slope and incise up to two kilometres into the basin fill (figure 3). Results from the Bremer Sub-basin Study are documented in Blevin (2005) and Bradshaw (2005).

The stratigraphy of the Bremer Sub-basin was determined by linking dredge

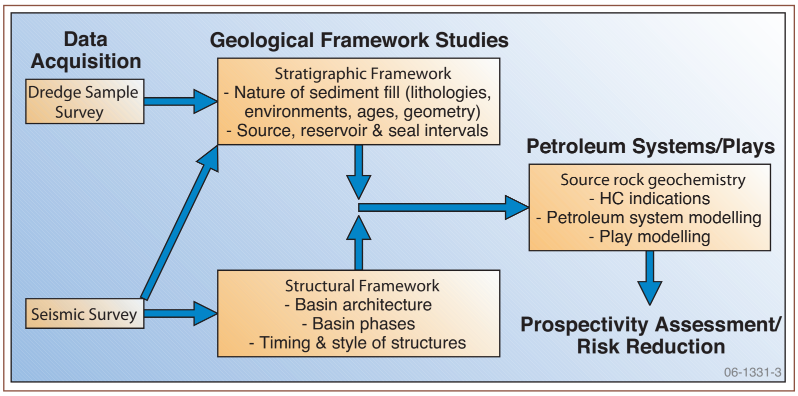


Figure 3. Summary of the integrated basin analysis workflow used in the Bremer Sub-basin study.

samples—analysed for age, palaeoenvironment and lithofacies—with interpreted seismic sequences and facies. This stratigraphic framework was further refined using genetically related depocentres from the eastern Bight and southern Perth basins as geological analogues. Potential source, reservoir and seal rocks were identified within a series of three fluvial–lacustrine cycles beginning in the Late Jurassic and continuing through until the Valanginian (see *AusGeo News 81*). Further analysis of dredge samples from these fluvial–lacustrine strata provided quantitative data confirming the presence of rocks with source, reservoir and seal potential.

"Trap preservation is the main exploration risk for this play type, with many faults showing evidence of a later phase of reactivation."

A structural framework study was undertaken using seismic reflection and refraction data to determine whether these potential source intervals are buried deeply enough to have generated hydrocarbons and, if so, the timing of generation and expulsion and the presence of suitable traps.

Structural mapping highlighted a large potential source kitchen in the central part of the sub-basin, containing 4 to 9.5 kilometres of strata (see *AusGeo News 81*). Potential traps were generated during a period of upper crustal extension that began in the Valanginian and continued until the Aptian. These include fault block traps associated with a major intrabasinal fault system in the central sub-basin area, and large anticlines that formed in the hanging wall of the rift-border faults from smaller eastern and western depocentres.

Results of the structural and stratigraphic framework studies were integrated to model petroleum systems and plays. Petroleum systems were modelled by generating a series of pseudo-wells in each depocentre, constrained by depth conversion of seismic interpretations and source rock analysis from dredge samples. One-dimensional burial history modelling of pseudo-wells indicates favourable timing of hydrocarbon expulsion from Late Jurassic to Early Cretaceous source intervals relative to trap generation in the central sub-basin area, where fault blocks have the potential to trap 250 mmbbl of oil (P_{50} estimate; see *AusGeo News 81*). Trap preservation is the main exploration risk for this play type, with many faults showing evidence of a later phase of reactivation.

Smaller depocentres in the eastern and western parts of the sub-basin contain large anticlines with the potential to trap 500 mmbbl of oil (P_{50} estimate), and may have favourable timing to be charged from Middle Jurassic source rocks (see *AusGeo News 81*). However, hydrocarbon charge is the main exploration risk for this play type because only small potential source kitchen areas are present.

Geoscience Australia used results from the Bremer Sub-basin study to support the release of two designated frontier permits in 2005. The permits (WA-379-P and WA-380-P) were subsequently awarded to Plectrum Petroleum plc, which bid an $80 million indicative exploration program. This included the acquisition of 3500 kilometres of new seismic data and an option to drill two wells in a secondary exploration program.

Eastern Bight Basin

The eastern part of the Bight Basin is one of the most prospective deepwater frontier basins in offshore Australia. Of particular interest to petroleum explorers is the Ceduna Sub-basin, which contains at least 15 kilometres of sedimentary section. Though still a frontier region, the eastern Bight Basin has had several phases of exploration, including drilling campaigns by Shell (1960s to mid 1970s), Esso Australia (1979–1983), BP (1980s), BHP (early 1990s) and Woodside Petroleum (current).

"The eastern part of the Bight Basin is one of the most prospective deepwater frontier basins in offshore Australia."

Geoscience Australia undertook an integrated basin study of the eastern Bight Basin between 1998 and 2004, using regional seismic and well data. Petroleum system and play models from these studies predict favourable geological conditions to generate and trap hydrocarbons in thick mid to Late Cretaceous deltaic and marine sediments within the Ceduna Sub-basin (Blevin et al 2000, Totterdell et al 2000, Struckmeyer et al 2001).

Only 10 wells have been drilled in the eastern Bight Basin. No commercial hydrocarbons have been discovered, with the most significant result to date being an oil show at Greenly-1. Most wells have been drilled around the landward margins of the rift system in water depths between 70 and 260 metres where the source rock quality of mid to Late Cretaceous strata is reduced by large amounts of terrigenous organic matter associated with proximal depositional environments.

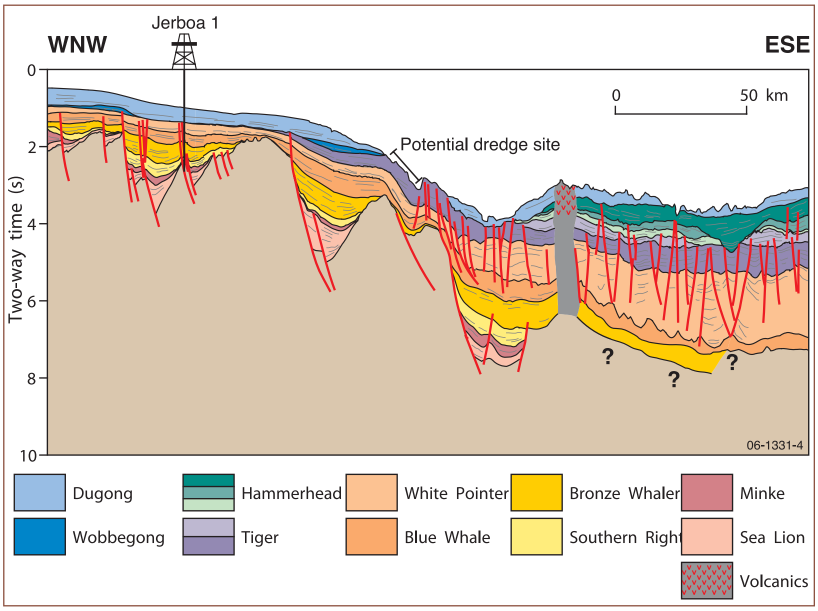


Figure 4. Location of planned dredge sampling site at the boundary between the Ceduna and Eyre sub-basins, where an interpreted source rock interval from the Turonian to Santonian age Tiger Supersequence is exposed at the seafloor.

In April 2003, Woodside Petroleum and joint venture partners drilled Gnarlyknots-1A in 1316 metres of water to test the petroleum systems within more distal Late Cretaceous depositional systems. However, because of adverse weather conditions, the well was abandoned at the top of the Tiger Supersequence, some 1500 metres above the planned completion depth, and encountered oil indications within proximal sand-prone deposits (Tapley et al 2005). Although a valid trap is yet to be tested in the Ceduna Sub-basin, one of the key uncertainties for explorers is whether a viable petroleum system is present.

Some indications of an active petroleum system have previously come from:

- hydrocarbon seep studies using synthetic aperture radar (SAR) and airborne laser fluorosensor (ALF) data (Struckmeyer et al 2002)
- geochemical studies of asphaltite strandings along the southern margin (Boreham et al 2001)
- fluid inclusion studies of wells (Ruble et al 2001).

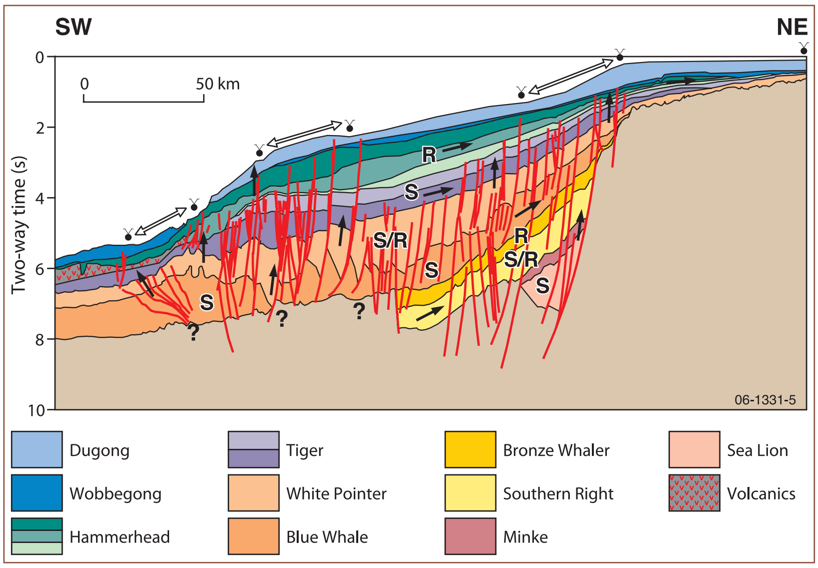


Figure 5. Natural hydrocarbon seep model for the Ceduna Sub-basin published by Struckmeyer et al (2002). Arrows show the three regions of interpreted hydrocarbon seepage that will be surveyed and sampled.

Marine survey

To reduce the hydrocarbon charge risk for explorers, direct physical evidence for high-quality source rocks and/or an active petroleum system in the Ceduna Sub-basin are needed. To obtain this, Geoscience Australia is currently undertaking a marine survey using the National Research Facility, the RV *Southern Surveyor*.

> "This will be the first time that these technologies have been used in water depths greater than 1000 metres"

The survey has two objectives:

- Dredge sample areas where seismic data indicate that source rock intervals are exposed on the seafloor in the distal parts of the Ceduna Sub-basin (figure 4). Rock samples obtained from the survey will be geochemically analysed for their source rock quality.
- Test for an active petroleum system by investigating and sampling potential natural hydrocarbon seepage sites. Existing seismic, SAR and ALF data indicate that seepage is most likely to occur in three broad areas of the Ceduna Sub-basin (figure 5): along faults that extend to the seafloor near the landward margins (100 to 1100 metres water depth); where growth faults extend to the seafloor around the southern and southwestern edges of the Ceduna Terrace (1600 to 2700 metres); and above shallow shale ridges at the basinward margin of the sub-basin (3000 to 4500 metres).

The tools that will be used to detect and sample seeps have been developed and applied on the northern Australian margin by Geoscience Australia's Seeps and Signature Project (see *AusGeo News 81*). This will be the first time that these technologies have been used in water depths greater than 1000 metres.

This survey of potential seep sites, together with targeted dredge sampling of source intervals, aims to demonstrate that a viable petroleum system exists in the Ceduna Sub-basin.

Conclusions

Case studies from the southern Australian margin show that assessing the petroleum potential of frontier basins requires development of our geological knowledge so that petroleum systems and plays can be modelled at a regional scale. Geoscience Australia employs integrated basin analysis using all available datasets to model regional petroleum systems and plays in frontier areas. However, each frontier region has unique challenges in terms of the complexity of basin geology, the availability of existing datasets, and budget constraints on the acquisition of new datasets. Innovative approaches are therefore often necessary to acquire key datasets. Good quality regional seismic lines comprise the essential data for our integrated basin studies, given that well data is often sparse or absent in frontier basins.

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Related websites/articles

AusGeo News 81

The Bremer Sub-basin—a new deepwater petroleum opportunity

www.ga.gov.au/ausgeonews/ausgeonews200603/bremer.jsp

The northern Arafura Basin—a shallow water frontier

www.ga.gov.au/ausgeonews/ausgeonews200603/arafura.jsp

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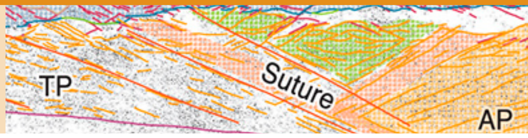
AUSGEO news
ISSUE 85 MARCH 2007

New *model for Tanami gold mineralisation*

Deep Seismic Survey establishes architecture of major Proterozoic gold province



Bruce Goleby, Patrick Lyons and Dave Huston

Identification of a major suture between the Tanami and Aileron provinces and recognition that mineral deposits in the region are associated with major crustal-penetrating shear zones and/or anticlinal stacks are two fundamental results from the Tanami Seismic research project.

"ore deposits are all located within the more complexly deformed zones...(and) have a direct association with structural anomalies"

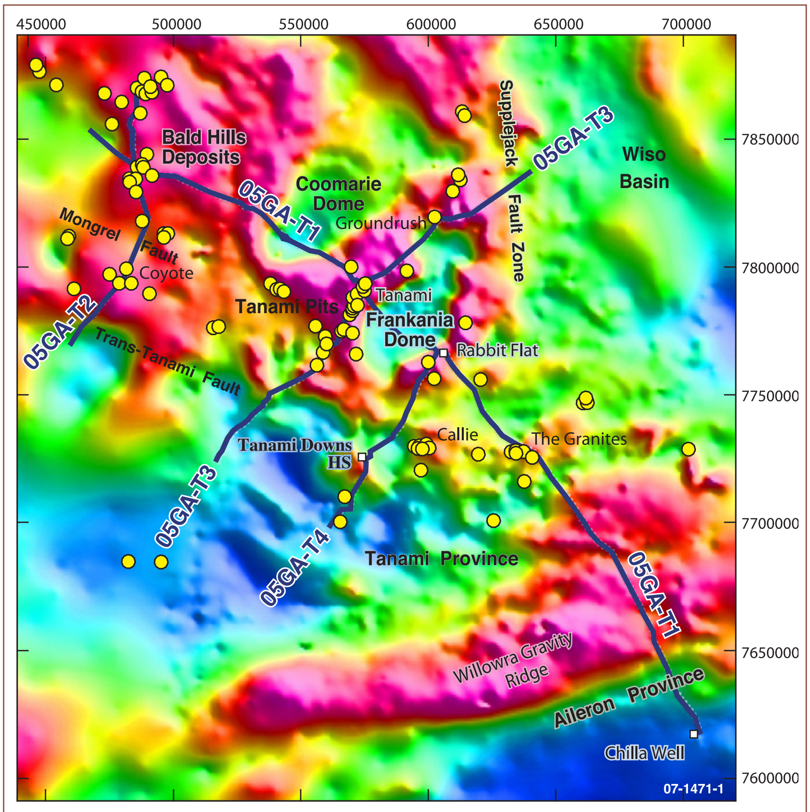


Figure 1. Location of the Tanami region, northern Australia, showing location of the four Tanami traverses (05GA-T1 through to 05GA-T4). Locations of mine sites and deposits are shown as circles.

The suture spatially corresponds to the Willowra gravity ridge (figure 1) and has a classic crocodile form (Meissner 1989). It separates the northwest-dipping structural grain of the Arunta–Aileron province crust in the south from the southeast-dipping structural grain of the Tanami crust in the northwest. The collision between the Tanami and Aileron crusts is interpreted to have occurred prior to ~1840 Ma, as rocks of the overlying ~1700 Ma Tanami–Lander package blanket this suture.

The correlation of the position of known mineral fields with the surface projection of crustal-penetrating shear zones on the seismic section is remarkable (figure 2) and has profound implications for explorers.

Crust-penetrating structures are observed extending from near-surface to the Moho boundary. Where these structures intersect upper crustal Tanami Group rocks, the seismic data shows a dramatic increase in deformation associated with the complexity of secondary structures related to the crustal-scale shear zones (figure 3).

Known ore deposits are all located within the more complexly deformed zones and therefore have a direct association with structural anomalies, including through-going thrust faults, associated pop-up structures and ramp anticlines. The seismic sections show several additional structurally anomalous areas that might be considered to have mineral potential.

Tanami Province crust

The Tanami Group (consisting of the Dead Bullock, Killi Killi and Mt Charles formations) has variable thickness across the province and exhibits dramatic changes in seismic reflectivity. It is thickest in the northwest part of traverse 05GA-T1, between the Bald Hills deposits and the Mt Fredricks region, where it is interpreted to reach a maximum thickness of 10 kilometres (3.5 seconds two-way time (TWT); figure 2). From this area, towards the southeast, there is a gradual, though variable, thinning of the Tanami Group to a point south of 'The Granites' where it thins rapidly to a depth of 3 kilometres (1 second TWT).

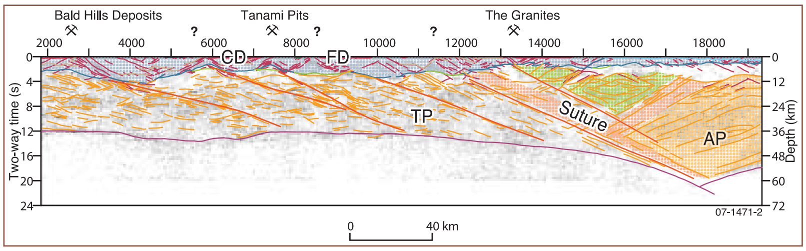


Figure 2. Schematic diagram showing main features of the Tanami traverse 05GA-T1. CD—Coomarie granite, FD—Frankenia granite, TP—Tanami Province, AP—Aileron Province.

Farther south, the structural style changes from one dominated by antiformal stacking to another dominated by 'thin-skinned' thrusting. At this point it becomes difficult to distinguish the Killi Killi and Dead Bullock formations, thus, only the base of the Tanami Group is delineated here. This change also corresponds to the change from mapped outcrop of Killi Killi Formation to mapped outcrop of the Lander Rock package.

The Tanami Group supercrustals are characterised by domains of less complex reflectivity patterns, juxtaposed against areas of complex deformation showing southeast, northeast and northwest dipping thrust faults with associated hanging wall anticlines. Several of these thrust faults appear to link with crustal-penetrating structures. Along-profile variations within the seismic character of the lower parts of the inferred Dead Bullock Formation suggest the possibility of the existence of discrete depocentres into which early sediments of the Dead Bullock Formation were deposited.

There is a marked change in structural character near or below the base of the Tanami Group. This change is inferred to represent a décollement surface that corresponds in places to the unconformity between the Tanami Group and its Proterozoic–Archaean basement, and elsewhere to a surface that runs within the basement material.

The seismic data indicate that Frankenia granite attains a maximum thickness of just over a kilometre. The seismic image indicates that the Coomarie and Frankenia Domes are not domes, as previously thought, but are underlain by inward-dipping reflections. This suggests that the granites are flanked by antiformal thrust stacks. Although this was investigated, it was extremely difficult to identify additional buried granite bodies of cross-sectional area and seismic character similar to those imaged at the surface.

The Supplejack Fault Zone, the inferred eastern boundary to the Tanami Province (Crispe et al, in press), is imaged as a zone of linked structures that extend to the mid-crust. The character of seismic reflectivity on both sides of this zone are not significantly different, suggesting that the Tanami region extends farther east, under the Wiso Basin.

The youngest deformation structures—such as the 'Trans-Tanami Structure' (Tanami Fault) and the Mongrel Fault—are not imaged as major structures on the seismic profile, but as uppermost crustal structures that link to deeper structures. The three-dimensional seismic grid provides a well-constrained geometry to the late structures and suggests a change in this deformation style within the upper crust, north and south of the Trans-Tanami Structure.

The regional seismic section 05GA-T1 (figure 2) shows the presence of a series of crustal-penetrating structures that extend from the surface to the Moho boundary. Several of these structures are interpreted as fundamental to the evolution of the Tanami Province and the establishment of the current architecture of the region. All link the mid-crust to 'thin-skinned' structures within the uppermost crust.

One of the major crustal-penetrating structures separates the Tanami Province from the Aileron Province. This suture corresponds with a marked thickening of the crust of the Tanami Province, from approximately 42 kilometres near 'The Granites' mine, to over 60 kilometres in the southeastern part of the traverse. This thickening of the crust in the southeast coincides with changes in the regional gravity field that define the east-northeast-trending Willowra gravity ridge (figure 1).

Mineralisation constraints

The onset of the Halls Creek–Tanami orogeny was important for ground preparation within the Tanami Province. It produced thrusts that contributed to the plumbing system of the ~1800 Ma Tanami gold event and might have been associated with lode-gold systems. At about 1800 Ma, convergence from the northwest switched to convergence from the south, and brought about the formation of the giant Callie deposit. The northward convergence opened older meridional structures, particularly in between the Coomarie and Frankenia granites. The major mineralising event occurred at the end of the Stafford event at 1803–1791 Ma and is currently interpreted to relate to the shift from convergence on the northwest margin of the North Australian Craton to convergence along its southern margin (Huston 2006).

"…thickening of the crust in the southeast coincides with changes in the regional gravity field"

At the scale of the seismic data, lode gold deposits are associated with antiformal thrust stacks nested on thrust systems which usually transect the whole of the Tanami Group (figure 3). Some of the thrust systems are, in turn, nested on thrusts transecting the Proterozoic–Archaean basement. The Tanami–Aileron collision is presumed to have been a north–south collision, based on its spatial correspondence with the Willowra gravity ridge, and it may have established a fundamental control on all subsequent deformations.

The Tanami survey

AusGeo News 84 presented a summary of the results from the six-year collaborative study into the Tanami region and its surrounds. It documented some of the major changes the project had made to our understanding of the geological make-up and mineral potential of the North Australia Craton. A key component of the Tanami collaborative project was the acquisition of 720 line-kilometres of deep seismic reflection data (figure 1) to establish the architecture of this major Proterozoic gold province and to define the deep geological structure in regions of known mineral deposits.

Participants in the Tanami deep seismic research project were Geoscience Australia, the Northern Territory Geological Survey, the Geological Survey of Western Australia, Newmont Exploration, and Tanami Gold NL. Results from the Tanami deep seismic research project were presented at the Tanami Seismic Workshop held in June 2006 in Alice Springs.

Details on the acquisition of the Tanami Seismic Survey have been presented previously (see *AusGeo News 79*). Among the

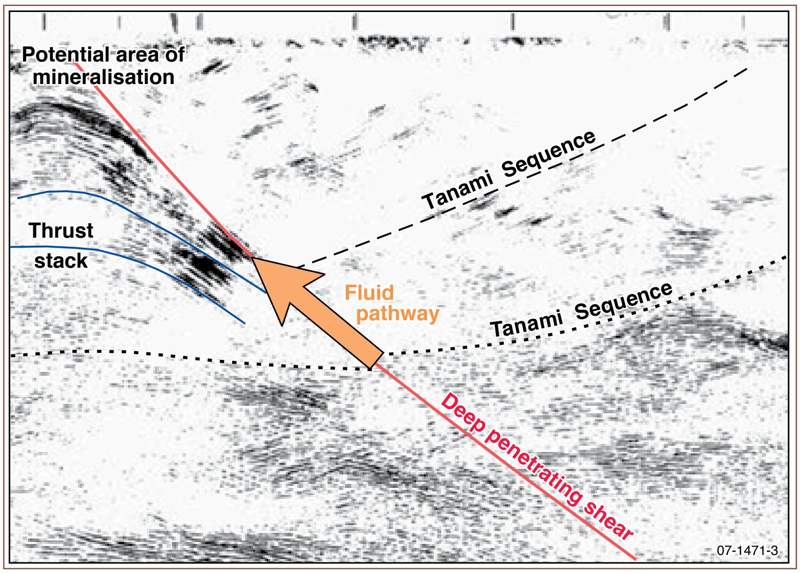


Figure 3. Schematic representation of potential areas selection strategy as indicated by the seismic reflection results. Figure oriented left to northwest.

more significant data obtained during the survey was information on the geometry of faults in the area, the thicknesses of the Tanami Group, the relationships of the various rock layers and mineralisation to crustal-scale structures, and the character of the Tanami–Arunta (Aileron) boundary.

The regional traverse 05GA-T1 (figure 1) from the Bald Hills region in the northwest to the Chilla Well region in the southeast produced excellent images of the crustal architecture along this profile. Traverses 05GA-T2, 05GA-T3, and 05GA-T4 are three cross-traverses that provide three-dimensional control on whole-of-crust architecture within the province.

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www.ga.gov.au/minerals/research/regional/nap/NAP_home.jsp

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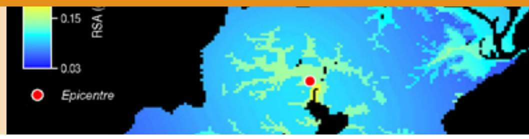
On *shaky ground? Understanding earthquake ground-shaking in Australia*

New prediction equations and Australia's first site-response model to aid earthquake disaster planning



Andrew McPherson and Trevor Allen

The devastating 1989 Newcastle earthquake, which claimed 13 lives and caused over $800 million in insured losses, showed that Australian communities are not immune to the effects of earthquakes.

New ground-motion prediction equations integrated with the first site-response model for Australia can refine our estimates of earthquake ground-shaking, providing the potential to rapidly assess earthquake impact for disaster response.

Predicting the level of ground-shaking at a given distance from an earthquake rupture depends on three key elements:

- the magnitude and frequency content of the earthquake source
- how earthquake energy decays as it propagates through the Earth's crust
- how near-surface regolith modifies the observed ground motions.

> "The new equations are based on numerical simulations... These numerical methods have particular utility in stable continental regions such as Australia"

For a specific earthquake (e.g. Newcastle 1989) the first of these are estimated from the recorded seismograms. The second of these elements are modelled using ground-motion prediction equations, while the third is represented by a site-response model. The combination of these two models provides a fundamental tool for assessing earthquake hazard.

The acquisition of high-quality Australian earthquake ground-motion data, and the development of improved numerical simulation techniques and the first national-scale Australian site-response model, now permit Australian-specific earthquake hazard analyses.

Ground motion

New ground-motion prediction equations have been derived for the southeastern Australian crust, obviating or reducing the need to invoke analogues from other settings, such as eastern North America (ENA). The new equations are based on numerical simulations, calibrated by data recorded from small-to-moderate sized Australian earthquakes. These numerical methods have particular utility in stable continental regions such as Australia, where records from larger magnitude earthquakes are simply not available to develop predictive ground-motion models for large earthquakes.

The new ground-motion prediction equations are based on recorded data from southeastern Australia (SEA) where, due to the development of much of the nation's infrastructure and higher than average earthquake activity, the seismograph network is well developed. Earthquake source and seismic wave travel path parameters are used to simulate ground-motions over a magnitude range of M 3.0 to 7.5, with the resulting simulated data regressed to obtain model coefficients.

Site response

Regolith, the layer of weathered rock, unconsolidated sediments and/or soils that overlies fresh bedrock, can contribute significantly to the modification (amplification or de-amplification) of earthquake ground-motions. Modelling and predicting the potential impact of earthquakes on the built environment therefore requires an understanding of how the regolith behaves during an earthquake.

A first-generation national-scale site classification map based on modified US National Earthquake Hazard Reduction Program site classes has been developed for Australia (figure 1). The map uses surficial geology and other available geoscientific data at a variety of scales to identify and group regolith materials into classes likely to exhibit a similar response to earthquake ground-shaking. The paucity of data available in Australia to quantify this physical behaviour means that geology has to be used as a proxy for shear wave velocity—a key variable for modelling the potential response of structures at the surface. Accordingly, shear wave velocity values for mapped Australian geological units are inferred from available relationships between measured shear wave velocity and geological materials in California.

For areas of Australia where local-scale geophysical and geological data are available, more detailed site classification and site response assessment can be achieved. However, in the absence of these data, the national site classification map now provides a first-pass estimate of regolith site amplification anywhere in Australia.

Modelling the Newcastle 1989 earthquake

Using the M 5.4 Newcastle 1989 earthquake as a scenario, we demonstrate:

- differences in calculated 'hazard on rock' using an ENA ground-motion model versus the new SEA ground-motion model
- the significance of resolving earthquake hazard with and without the incorporation of site response information.

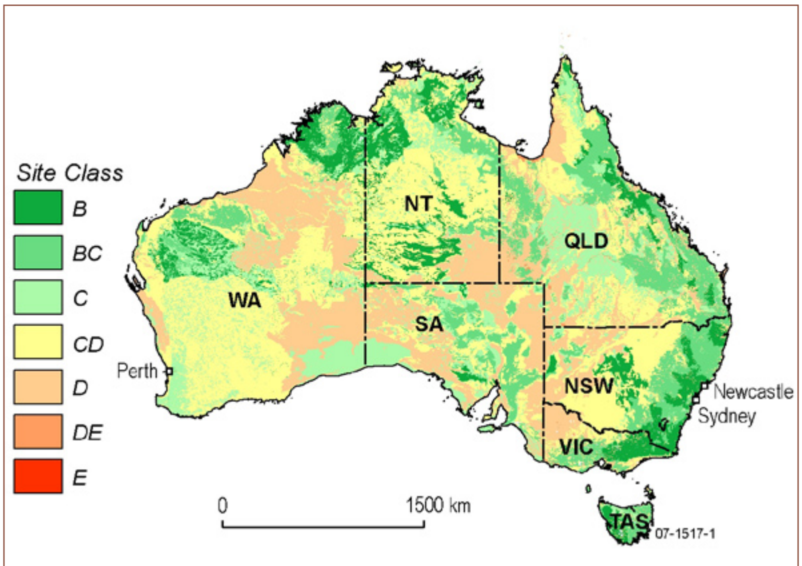


Figure 1. First-generation national site classification map of Australia based on modified US National Earthquake Hazard Reduction Program site classes.

Until recently, predicting earthquake ground-motions in Australia relied on the application of models from elsewhere—mainly the United States. Australia's first ground-motion model that considers different frequencies of earthquake wave energy has been developed using data from SEA, an area previously assumed by many to be analogous to the tectonically stable intra-plate setting of ENA.

Recent comparisons of recorded ground-motion data from ENA and SEA indicate that this assumption may hold true for distances less than 100 kilometres from a fault. However, following reinterpretation of ground-motion data from ENA, new ground-motion equations developed in the United States are now predicting higher attenuation for sites in this distance range.

The new SEA model compares favourably against new ENA models, demonstrating similar low-frequency ground-motions at short distances from the earthquake rupture. The SEA model, however, predicts lower levels of high-frequency energy and peak ground acceleration relative to the new ENA model (figure 2).

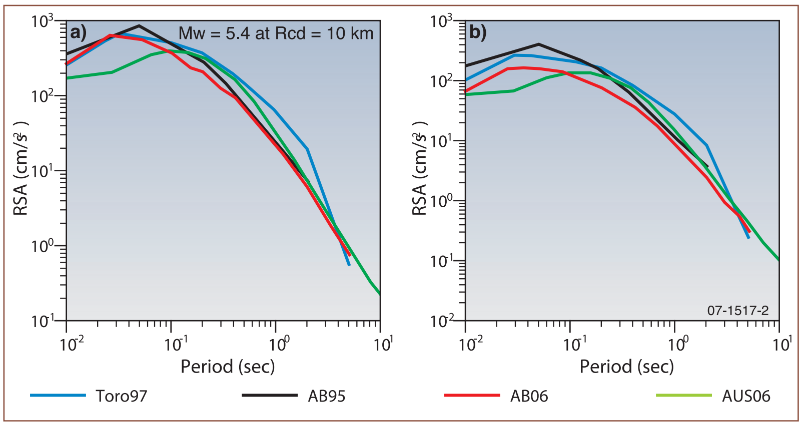


Figure 2. Comparison of the new SEA (AUS06) model against several North American ground-motion attenuation models. Estimated response spectral accelerations (RSAs) are calculated over a range of periods of ground-shaking at (a) 10 and (b) 20 kilometres. The new SEA model demonstrates lower ground-motions over most periods relative to pre-2006 models, and compares favourably with the latest ENA model (AB06) at longer periods, but with lower levels of short-period (and peak ground acceleration) motion.

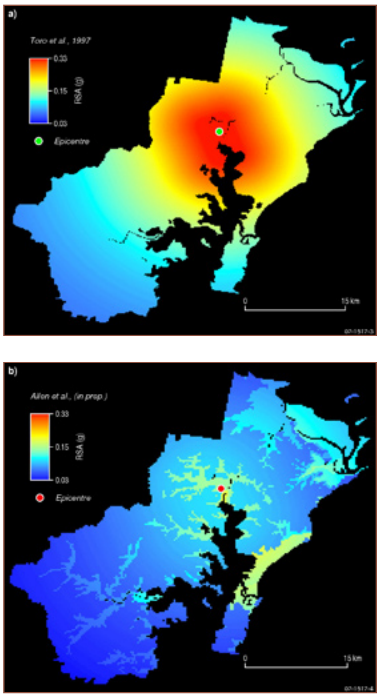


Figure 3. Comparison of earthquake hazard model output for the Newcastle region showing (a) previous capability employing an ENA attenuation model; and (b) present capability for SEA, employing the new southeast Australian ground-motion model in combination with the new national site response model.

Then and now: the current Australian earthquake hazard model

Figure 3 demonstrates our capabilities before and after the development of Australian-specific ground-motion prediction equations and the national site response model. Figure 3a compares modelled earthquake ground-shaking potential employing the ENA ground-motion attenuation model of Toro et al (1997) against the latest revision of the Australian hazard model (figure 3b) for a scenario earthquake in the Newcastle region.

The SEA ground-motion prediction equations predict significantly lower ground-motions than those produced using the ENA model, and also demonstrate the significance of incorporating regolith site response into earthquake hazard assessment.

The addition of modelled site response information significantly enhances our ability to predict spatial variation in strong ground-shaking, a key factor in understanding and modelling the distribution of damage and loss. Despite allowing for increased amplification due to site response, we predict lower overall ground-shaking.

Conclusion

A comparison of SEA and ENA ground-motion prediction equations demonstrates the importance of recording and modelling Australian-specific earthquake data. We observe that the SEA attenuation model predicts significantly lower ground-motions than the first generation of ENA attenuation models (e.g. Toro et al 1997). The application of a national-scale site response model that provides broad-scale characterisation of the potential response of the regolith to ground-shaking anywhere in Australia further refines our estimates of earthquake hazard.

Products from this current methodology for earthquake hazard assessment in Australia are of particular interest to emergency managers involved in disaster planning, and have possible implications for revision of the Australian Building Code and earthquake loading standard. They also have significant potential application in decision-support tools for rapid post-event assessment of earthquake-affected areas for prioritisation of emergency response.

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Reference

Toro GR, Abrahamson NA & Schneider JF. 1997. Model of strong ground motions from earthquakes in central and eastern North America: best estimates and uncertainties. Seismological Research Letters 68(1):41–57.

Australian Government
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No *evidence of seepage in Central North West Shelf*

Hydrocarbon seepage survey downgrades prospectivity

John Kennard

In May–June 2006, RV *Southern Surveyor* surveyed the central North West Shelf, off the Western Australian coast near Broome, to improve our understanding of the petroleum prospectivity of the offshore Canning and Roebuck basins. This frontier exploration region is located between the proven hydrocarbon provinces of the Carnarvon Basin to the southwest and the Browse Basin to the north.

The aim was to identify sites of natural hydrocarbon seepage, which can provide direct evidence for an active petroleum system within the subsurface. As hydrocarbon seepage sites can support highly diverse ecosystems due to nutrients, biogeochemical cycles and changes in sediment substrate, they may also be associated with palaeo-reefs or modern reefs.

Sample sites identified

Areas of potential hydrocarbon migration and seepage to the seafloor were initially identified from existing seismic, remote sensing (synthetic aperture radar), bathymetry and echo-sounder data. During the survey, multibeam swath bathymetry, 12 and 120 kHz echo-sounder, 120 kHz side-scan sonar, 1.5 kHz sub-bottom profile and fluorometric data were acquired across 18 potential hydrocarbon seepage sites on a 300 to 1500 metre line spacing (figure 1; Areas 1 to 11 and X1 to X5).

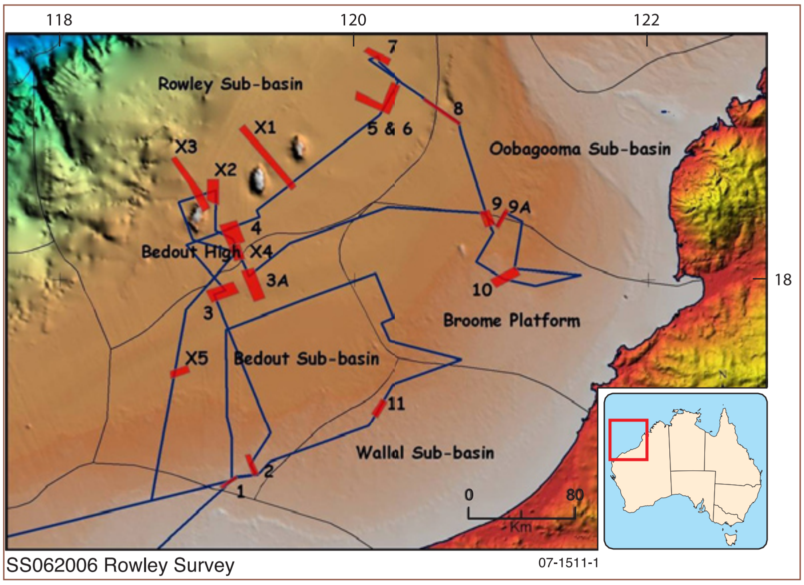

Figure 1. Ship track and surveyed areas, central North West Shelf.

Sampling sites within each mapped area were selected by integrating all survey data. Sediment grab, gravity core (4 to 6 metre recovery), vibro-core (up to 4.7 metre recovery) and dredge samples were collected for follow-up sedimentological, headspace gas and biomarker analysis. Seafloor video footage, conductivity–temperature–depth water column profiles and water samples were also acquired.

Identified features of interest include shallow and near-seabed seismic amplitude anomalies, shallow faults, erosional escarpments and sinkholes, an extensive ~40 metre thick pelagic ridge, megadunes (5 to 8 metre relief), dunes (2 to 4 metre relief), pockmark fields and plume-like water column features.

Active fluid escape from the seabed was documented at Area 9, where a series of oolitic megadunes are pierced by clusters of crater-shaped pockmarks approximately 2–15 metres in diameter. Video footage indicates that the pockmarks are commonly lined with nodular concretions (figure 2), and in one instance active venting of a cloudy fluid was observed from the pockfield.

Petrological, geochemical and biomarker analyses of the nodular concretions indicate that they are cemented by acicular aragonite that precipitated from fluids of normal marine chemistry. Similarly, biomarker and headspace analyses of sediments recovered from all surveyed potential seepage sites show no evidence of thermogenic hydrocarbons, although several core samples contain high amounts of CO_2 (20 000–232 000 parts per million in the headspace gas) probably generated by modern biogenic processes.

Faults produced Miocene and modern reefs

Sub-bottom profiles indicate that the Mermaid Fault Zone, a major deep-rooted northeast trending wrench zone along the inboard edge of the Rowley Shoals reefs, comprises a network of anastomosing strike-slip faults that extend to within a few metres of the seabed (figure 3). Transpressional (left-lateral) faulting and associated folding and uplift along this zone are thought to have initiated Miocene reef growth and subsequent build-up of the present-day Rowley Shoals.

Figure 2. Pockmark lined with nodular concretions (108 metres water depth).

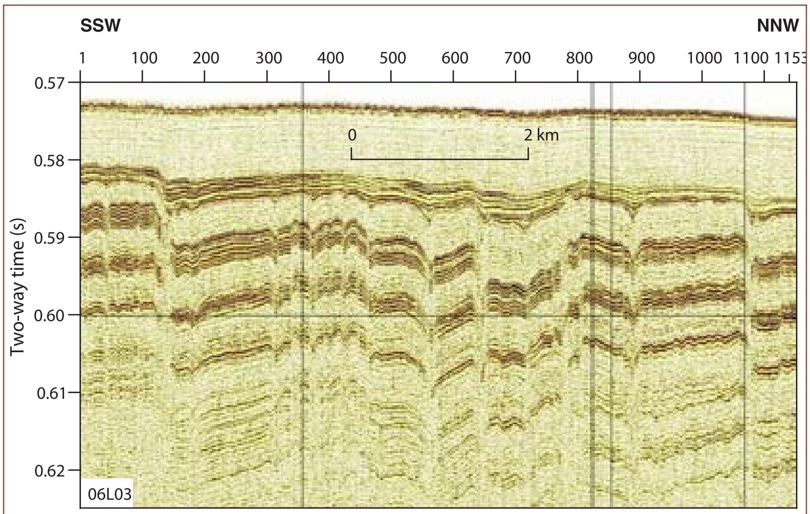

Figure 3. Sub-bottom profile showing network of strike-slip faulting, Area 6, Mermaid Fault Zone. Verical thickness about 40 metres.

The survey tested several promising potential hydrocarbon migration-seepage pathways in the region, but did not find any evidence of a currently active petroleum system. This finding, in conjunction with the lack of exploration success in the region, especially the recent deepwater Whitetail-1 (2003), Wigmore-1 (2003) and Huntsman-1 (2006) wells in the deepwater Rowley Sub-basin, downgrades the petroleum prospectivity of these parts of the central North West Shelf and reorders their priority in relation to other frontier areas in offshore Australia.

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AUSGEO news
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Fighting *fire with GIS*

Geoscience Australia helps Victorian firefighters battle blazes

Alexander von Brandenstein & Andrew Beer

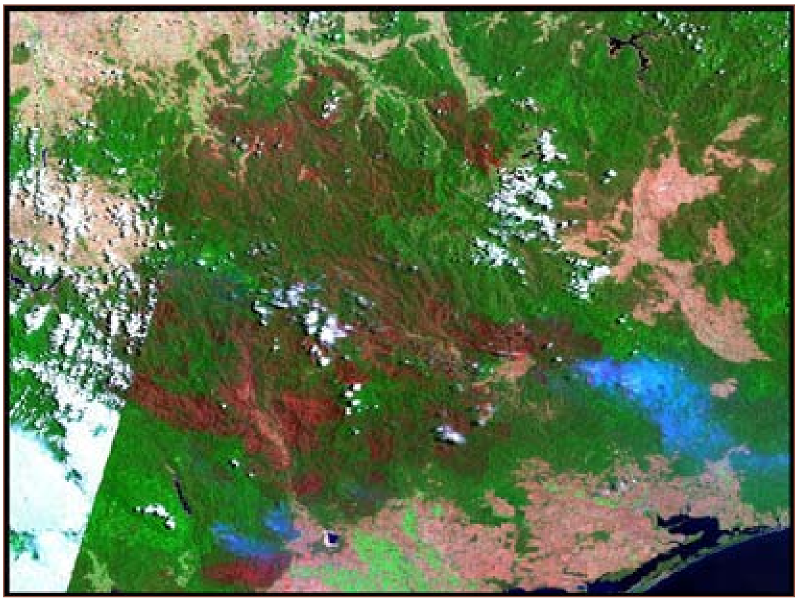

Figure 1. Landsat satellite image showing the extent of burnt areas in eastern Victoria at 3 January 2007.

Every summer, bushfires are a fact of Australian life. Recent fires in eastern Australia have devastated communities and infrastructure, and destroyed vast areas of bushland. The greatest impact was in Victoria, and in large tracts of New South Wales and South Australia.

In early December 2006, Victoria experienced summer thunderstorms that started many fires in the east and north of the state. By 11 December, around 4000 firefighters had been deployed to fight 13 blazes. A major fire in northeast Victoria had already burned 250 000 hectares of bushland and destroyed several buildings, including the famous Craig's Hut which featured in the iconic Australian movie *The Man from Snowy River* (figure 1). By 18 December, 18 houses had been lost in Gippsland, and a man had died after falling from a trailer while fighting fires.

Key Geoscience Australia role

Because of these and other bushfires, Emergency Management Australia (EMA) invoked the Commonwealth Disaster Plan, which provides a framework for the Australian Government to assist state and territory government agencies when resources are limited.

EMA asked Geoscience Australia to provide GIS mapping experts to work in conjunction with the Victorian Country Fire Authority and the state's Department of Sustainability and Environment.

Staff with relevant expertise from Geoscience Australia volunteered to help and committed to work during the Christmas – New Year period. They worked in two 12-hour shifts per day at either the Incident Command Centre in Benalla or at the Integrated Fire Agency Coordination Centre in Traralgon.

Local incident management commanders and section commanders needed maps to plan the strategic placement of strike teams and some 35 aircraft fighting the fires. The GIS officer on duty had to update and maintain data on strategic control lines, containment lines, incident management team (IMT) boundaries and the fire area (derived using remote sensing).

Geoscience Australia staff at the Traralgon centre worked IMTs to identify and establish new fire control lines. They constantly updated and maintained strategic control lines, containment lines and IMT boundaries. Fire activity updates arrived in many forms: handwritten notations on topographic maps, GPS coordinates and, occasionally, GIS-compatible files from other IMT mapping teams. These data were updated, sent to IMTs and published as paper maps (figure 2).

Liaison the key

The team liaised with the incident controller to determine the location of consolidated control lines and to prepare for further burning-off operations when weather and fuel moisture permitted. Team members also contacted mapping staff in the Emergency Coordination Centre in Melbourne. Mapping experts at the centre received raw line-scan data and airborne multirole solid state active array radar (AMSAR) data flown just hours before, which needed to be orthorectified and then digitised.

During the assignment, Geoscience Australia staff developed a method to show fire areas, containment lines, strategic control lines, fire station locations, IMT boundaries and sector areas in a 3D visual environment. Daily briefings at the Integrated Fire Agency Coordination Centre in Traralgon included 3D presentations derived from this innovation. The briefings gave decision makers a better understanding of the terrain in which they were deploying strike teams.

Figure 2. Geoscience Australia volunteers contributed to the emergency response through regular updating of fire-growth maps overlain on Landsat satellite imagery.

Fire growth in real time

Fire-growth presentations to the meetings demonstrated a methodology that showed the growth of the fire over several days using images exported from specialised GIS software and loaded into a PowerPoint presentation. The converted GIS files were also loaded onto laptop computers so that decision makers could easily view and interrogate areas of interest using 3D functionality.

After the successful initial demonstration, staff prepared a similar presentation for a Victorian Cabinet meeting on 22 January 2007.

The collaboration of Victorian and Australian government agencies produced invaluable support during a difficult and resource-intensive time for emergency managers. This work demonstrated that these agencies can work together effectively to share expertise and data.

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Related websites

ACRES imagery of Victorian bushfires

www.ga.gov.au/acres/whatnew.jsp#firejan

in brief

Operations Hub in action for Australian Tsunami Warning System

The Operations Hub for Geoscience Australia's new Australian Tsunami Warning Centre (AusTWC) was officially opened on Friday 1 December 2006 by the Minister for Industry, Tourism and Resources The Hon. Ian Macfarlane, MP.

The AusTWC is part of the Australian Government's response to the December 2004 Indian Ocean tsunami. 'This Operations Hub is a step towards increasing Australia's capability to respond effectively in the face of another natural disaster,' Mr Macfarlane said.

Fig 1. Minister Macfarlane and guests viewing monitors showing details of earthquake activity following the opening.

The Australian Tsunami Warning Centre is part of the Australian Tsunami Warning System, a collaborative project involving Geoscience Australia, the Bureau of Meteorology, Emergency Management Australia, and the Australian Agency for International Development (AusAID). The program is coordinated by the Department of Foreign Affairs and Trade.

The AusTWC's Operations Hub will detect earthquakes in the region and examine details such as magnitude, location, depth along with other seismic characteristics to determine whether or not they are likely to cause a tsunami. This data will be used in conjunction with the Bureau of Meteorology's tide gauge data, and Geoscience Australia and the Bureau of Meteorology will work together to determine whether a tsunami warning should be issued.

The Australian Tsunami Warning Centre will operate continuously 24 hours per day 7 days a week monitoring 39 Australian seismic stations and 71 overseas stations at any time and will share its information with other countries in the region.

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Related websites/articles

Australian Tsunami Warning System
www.bom.gov.au/oceanography/tsunami/atws_summary.shtml

in brief

Sentinel system closely watched

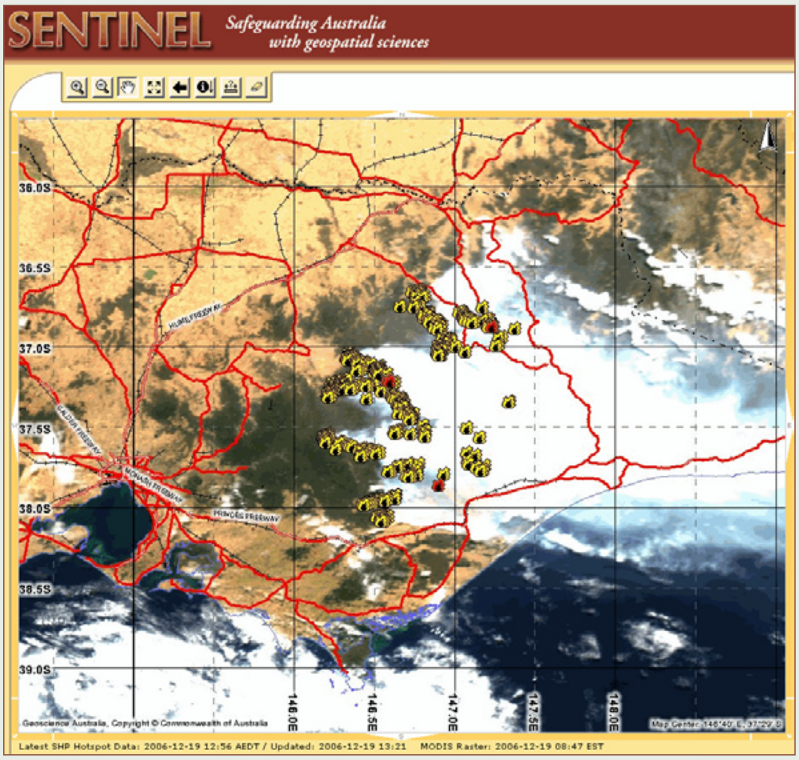

Fig 1. Sentinel download showing fire distribution at 19 December 2006.

There was unprecedented demand for information from Geoscience Australia's Sentinel bushfire hot-spot detection system during the December-January period as members of the public and emergency managers accessed the website seeking information about the location of fires.

The number of Sentinel users and volumes of data produced from the site increased rapidly in early December as forest fires raged in Victoria's Eastern Highlands and East Gippsland. During December 2006 Sentinel was used by over 40 000 unique visitors and provided over 180 Gigabytes of data, far exceeding any previous use. The usage levels for January were only slightly lower.

To manage this level of demand and possible slower access for users a 'Current Overview' page was put into service and a number of data layers were removed from the site. Emergency managers were able to access these layers using a password provided by Geoscience Australia.

Other improvements include the availability of some meteorological data following a new cooperative agreement between Geoscience Australia and the Bureau of Meteorology. Information such as wind speed and direction indicators, weather-watch radar, and isohyets are now available on Sentinel as trial layers.

Geoscience Australia is also testing hot-spot detection using the Advanced Very High Resolution Radiometer (AVHRR) satellites operated by the National Oceanic and Atmospheric Administration. If testing is successful, this would mean an increase in the daily hot-spot satellite cover from four 'overpasses' to six, thereby giving all users even more up-to-date information.

The Sentinel bushfire monitoring service is an internet based mapping tool which was developed by CSIRO Land and Water, Department of Defence and Geoscience Australia in 2003. The operational management and development of Sentinel was moved to Geoscience Australia in December 2005.

For more information

email sentinel@ga.gov.au

Related websites/articles

Sentinel
http://sentinel1.ga.gov.au/acres/sentinel/index.shtml

AusGeo News 80
Sentinel finds permanent home at Geoscience Australia
www.ga.gov.au/ausgeonews/ausgeonews200512/inbrief.jsp#inbrief1

in brief

New framework marks shift in disaster mitigation

Cyclone Larry in 2006 and the recent Victorian bushfires have again demonstrated the wide-reaching and profound impacts of natural hazards on communities and the environment. A National Risk Assessment Framework for sudden onset natural hazards is currently being implemented across the country. The framework aims to improve our knowledge about natural hazard risk in Australia and support emergency risk management and natural hazard mitigation. The natural hazards covered by the framework include bushfire, earthquake, flood, storm, cyclone, storm surge, landslide, tsunami, meteorite strike and tornado.

The framework has been implemented as part of the Council of Australian Governments (COAG) reforms for natural disaster arrangements in Australia. The COAG report Natural disasters in Australia (High Level Group 2004) advocated a 'fundamental shift in focus towards cost-effective, evidence-based disaster mitigation'. It also pointed out that there was a 'lack of independent and comprehensive systematic natural disaster risk assessments, natural disaster data and analysis.' Other drivers for the framework included:

- the potential impacts of climate change such as changes in the frequency or severity of weather-related natural hazards
- the increasing exposure of Australian communities to natural hazards because of demographic changes and increases in personal assets.

The National Risk Assessment Framework seeks to ensure that consistent and systematic information on risk is produced, and the rigour of risk assessment methods and information is improved where necessary. Consistency is important, as it allows the comparison of risks between different natural hazards and across geographic areas. Consistent information will also contribute to setting priorities for disaster mitigation at all levels from local to national. The framework covers the following risks arising from natural hazards: financial, socio-economic, casualty, political and environmental risk. Each of these risks contributes to the overall impacts of natural hazards on communities.

The framework was prepared through collaboration between government and non-government stakeholders in a series of workshops and meetings convened by Geoscience Australia. It was endorsed by

Figure 1. Damage to pre-1980s dwelling in Innisfail from Tropical Cyclone Larry.

Figure 2. Dwellings constructed after amendments to the *Queensland Building Act* in 1981 withstood Cyclone Larry better. A systematic approach to assessing cyclone risk in other tropical Australian cities will reveal the relative risk from cyclones in each city and areas of higher risk within each city.

the Australian Emergency Management Committee in September 2006. Geoscience Australia's role in the framework is in partnership with the Department of Transport and Regional Services (DOTARS) which manages the Disaster Mitigation Australia Package. The framework is designed for federal, state, territory and local government risk managers as well as risk assessment practitioners, researchers and information managers.

Two national committees have been established to implement the framework and report through the COAG process. The National Risk Assessment Advisory Group is a new Whole-of Governments working group established in September 2006. It includes representatives from each state and territory, the Australian Local Government Association, and Australian Government representatives from the Bureau of Meteorology, Emergency Management Australia, DOTARS, and Geoscience Australia.

The Technical Risk Assessment Advisory Committee is an independent panel of experts established in December 2004 to prepare the framework and to provide expert advice on natural hazard risk relevant to the COAG reforms. This group comprises experts on floods, bushfires, earthquakes and meteorological hazards, as well as experts on climate change, land use planning, insurance and building codes. This range of expertise provides knowledge of the key areas central to the mitigation of natural hazards as well the natural hazards themselves. Geoscience Australia provides the Secretariat for both of these committees.

Current priorities in the framework implementation plan include developing risk assessment guidelines, identifying gaps in our knowledge and setting priorities to increase our knowledge on risk.

References

High Level Group. 2004. Natural disasters in Australia: Reforming mitigation, relief and recovery arrangements, Report to the Council of Australian Governments. Department of Transport and Regional Services, Canberra.

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Related websites

The National Risk Assessment Framework
www.ga.gov.au/urban/

Geoscience Australia participates in National Collaborative Research Infrastructure Strategy (NCRIS)

Geoscience Australia will participate in AuScope, an exciting $42.8 million upgrade of the nation's infrastructure used to support geodetic and geological research. A number of Australian universities, and the geological surveys and spatial agencies in all states and territories were also part of the successful bid. The funding was announced by the Minister for Education, Science and Training, The Hon Julie Bishop MP on 27 November last year.

NCRIS is a $500 million package under the Australian Government's Backing Australia's Ability initiative which is providing $8.3 billion to Australian science over ten years to 2011.

AuScope will allow bridges to be built between the geodetic and geological research communities and practical applications of their science for all Australians. It has a number of elements:

1. $15.8 million has been earmarked by the Australian Government to upgrade the nation's geodetic infrastructure, matched by $50 million in funding and in-kind assistance from GA, the states, territories and participating universities. The upgrade is designed to improve the accuracy of position in Australia by an order of magnitude over the next 10 years. This will be done through upgrades to our Very Long Baseline Interferometry and Satellite Laser Ranging capabilities, highly accurate gravity surveys and almost an order of magnitude increase in the number of fixed global navigation satellite system (GNSS) receivers. There will also be a pool of portable GNSS receivers for campaign measurements in areas thought to be undergoing crustal deformation. The outcomes from this upgrade will be relevant to the Earth sciences, for example through the study of neotectonics and natural hazards, but are expected to have their biggest impacts in the farming, mining, transport, safety, defence and construction industries.
2. The remaining $27 million has been allocated for four main initiatives. It is matched by approximately $30 million in co-investment.
   - The National GeoTransect Program is a major data acquisition program and involves three key components: Earth Imaging and Structure (mostly for seismic and magnetotelluric sounding), Materials and Properties (Virtual Core Library), and Composition & Evolution (including geochemistry and geochronology).
   - AuScope Grid comprising distributed data / information storage hardware, high bandwidth network links, data management protocols, middleware and software. AuScope will also be establishing Grid-enabled access to a range of simulation, modelling, inversion and visualisation tools.
   - AuScope Simulator is a toolkit of simulation, modelling, inversion and data mining tools.
   - The AuScope Earth Model is the integrated knowledge infrastructure component of the AuScope Infrastructure System but is not funded by nor part of NCRIS. AuScope intends to work with the State and Commonwealth government geoscience agencies to plan and build the Earth Model.

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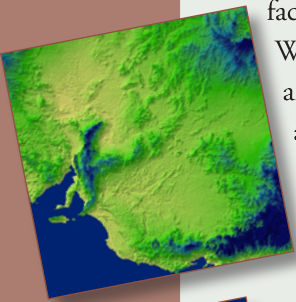
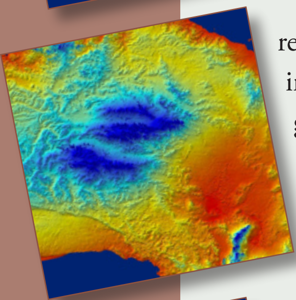
Fig 1. Vibroseis truck which is used to generate a source for seismic imaging of the Earth.

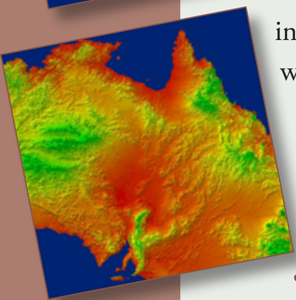
in brief

Towards a New National Elevation Database

Australian government agencies at all levels, the community and industry are driving significant increases in the demand for high quality spatial data. Issues such as climate change, coastal vulnerability, water and natural resource management, emergency management, health and safety issues all require fundamental spatial data at a range of scales to meet specific requirements. Fortunately in some instances a few key datasets, such as elevation data, can help meet a range of needs.







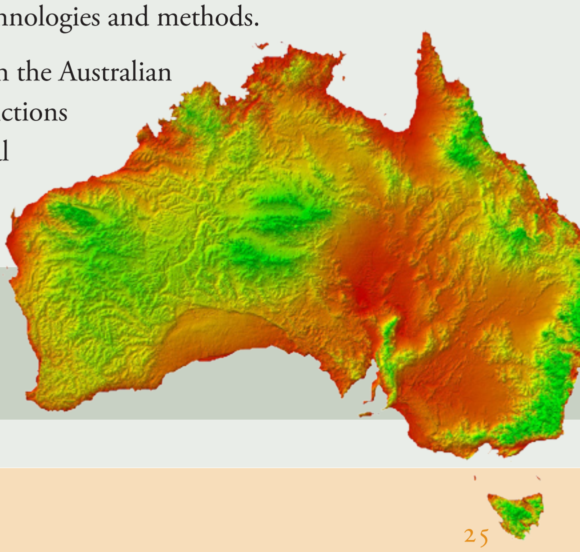
When examining coastal vulnerability, users need to know which areas could be inundated, and other factors such as rainfall in a catchment area which could be susceptible to tidal surge caused by a cyclone. With scientists predicting a sea-level rise during this century, regional planners require information on areas which may be susceptible to inundation. Water resource managers need to know the direction and distribution of water flows through catchments and floodplains for water accounting, agriculture and biodiversity management. Emergency managers need to be able to predict which roads may be cut by flooding, or model the potential spread of a fire. These and similar applications require information displaying the characteristics of the terrain in three dimensions.

In this context elevation data are generally analysed using digital elevation models (DEM) which represent a simulated 'bare earth' dataset which can be displayed and analysed within a geographic information system (GIS). At present there are numerous DEMs held by local, state and federal governments ranging in vertical and horizontal accuracy from +/-25 centimetres and one metre respectively to state-wide DEMs with 10 metre vertical and 25 metre horizontal accuracy, whilst at the national level there is a DEM gridded at 250 metre resolution. Though the local and regional DEM needs are adequate for many significant areas there are also many gaps. Often data is captured using different standards, and duplication of effort also occurs. Licensing and data access are often inconsistent and a lack of coordination can mean that data costs significantly more than if the process was coordinated at the state or national level.

Geoscience Australia has recently initiated a New National Elevation Database Project in conjunction with the Intergovernmental Committee on Surveying and Mapping (ICSM). Though the project is in the early stages of development, recent consultation with a wide range of users has identified a number of requirements which will drive its development. These include the need for:

- very high resolution DEMs with vertical accuracies of approximately 25 centimetres in low-lying coastal areas and floodplains
- seamlessly integrated DEMs which include both topography (land) and bathymetry (water depth)
- a single point-of-truth framework with appropriate consistency in standards, license conditions and access
- a multi-resolution approach which recognises that different areas will have different data requirements
- the database to be dynamic and allow continual improvement rather than a 'snap-shot'.
- opportunities for private industry involvement using a range of technologies and methods.

Over the coming months Geoscience Australia will be working with the Australian and New Zealand Land Information Council (ANZLIC), state jurisdictions and Australian Government agencies to refine user needs and technical and administrative frameworks. A detailed implementation strategy will be developed over the next 12 months.



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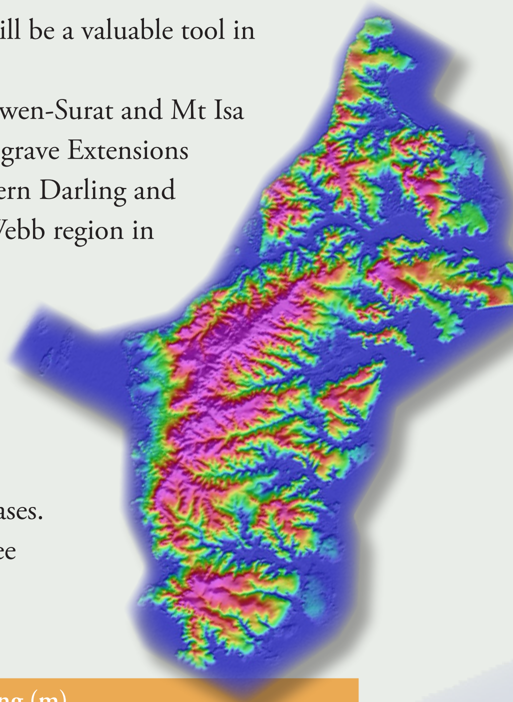
product news

New geophysical datasets released

Datasets from nine new geophysical surveys, released since August 2006, will be a valuable tool in assessing the mineral potential of the respective survey areas.

They include seven airborne magnetic and radiometric surveys in the Bowen-Surat and Mt Isa regions in Queensland, the Tiwi Islands in the Northern Territory, the Musgrave Extensions in Western Australia as well as the Eromanga-Thomson area and the Southern Darling and Murray Basins in New South Wales. The new gravity surveys include the Webb region in Western Australia and part of the Mt Isa region in Queensland.

The data were acquired in surveys conducted in 2005 and 2006 and, except those in New South Wales, were managed by Geoscience Australia on behalf of the Geological Surveys of Queensland, Western Australia and the Northern Territory. The three surveys in New South Wales were acquired in 2005 and managed by the Geological Survey of NSW.



The datasets have been incorporated into the national geophysical databases. The point-located and gridded data for the nine surveys can be obtained free online using the GADDS download facility.

Table 1. Details of the airborne surveys.

Survey	Survey Type	Date of Acquisition	1:250 000 Map Sheets	Line Spacing (m), terrain clearance (m), orientation	Line Km	Contractor
Bowen – Surat North (Qld)	Magnetic, Radiometric, Elevation	Jan – July 2006	Springsure, Baralaba, Monto, Eddystone, Taroom, Mundubbera, Mitchell, Roma, Chinchilla	400, 80, east – west	169,882	UTS Geophysics
Mount Isa South - West (Qld)	Magnetic, Radiometric, Elevation	April – Aug 2006	Mount Whelan, Bedourie, Machattie, Birdsville, Betoota	400, 80, east – west	140,500	Fugro Airborne Surveys
Tiwi Islands (NT)	Magnetic, Radiometric, Elevation	Oct – Nov 2006	Bathurst Island, Melville Island, Darwin	400, 80, north – south	29,874	Fugro Airborne Surveys
Musgrave Extensions (WA)	Magnetic, Radiometric, Elevation	June – Oct 2006	Musgrave North: Bentley, Scott, Cobb; Musgrave South: Talbot, Cooper	Musgrave North: 400, 60, north – south Musgrave South: 400, 60, east – west	82,094	Fugro Airborne Surveys
Southern Darling Basin (NSW)	Magnetic, Radiometric, Elevation	March – June 2005	Manara, Ivanhoe	400, 60, north – south	18,000	Fugro Airborne Surveys
Murray Basin (NSW)	Magnetic, Radiometric, Elevation	April – Aug 2005	Menindee, Anabranch, Pooncarie Mildura, Balranald	400, 60, east – west	96,000	Fugro Airborne Surveys
Eromanga-Thomson (NSW)	Magnetic, Radiometric, Elevation	Aug – Dec 2005	Urisino, White Cliffs, Yantabulla, Louth	250 & 400, 60, east – west or north - south	166,000	Fugro Airborne Surveys

Table 2. Details of the gravity surveys.

Survey (State)	Survey Type	Date of Acquisition	1:250 000 Map Sheets	Station Spacing / orientation	Stations	Contractor
Webb (WA)	Gravity	Aug – Sept 2006	Webb, Wilson, Ryan, Macdonald	2.5 x 2.5 km east - west	4,103	Daishsat Geodetic Surveyors
Mount Isa Area B (Qld)	Gravity	Sept – Oct 2006	Lawn Hill, Donors Hill, Camooweal, Dobbyn, Mt Isa (western half)	2.0 x 2.0 km east – west on Dobbyn and Camooweal (eastern half); 4.0 x 4.0 km east – west (remainder)	9,857	Fugro Ground Geophysics

Related websites

NT Geological Survey: www.nt.gov.au/dpifm/Minerals_Energy/Geoscience/

Geological Survey of WA: www.doir.wa.gov.au

Geological Survey of Qld: www.nrw.qld.gov.au/science/geoscience/

Geological Survey of NSW: www.dpi.nsw.gov.au/minerals

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New information on Australia's Near-Pristine Estuaries

Around half of Australia's estuaries (that is, 470 out of 974) were classified as 'near-pristine' during the National Land and Water Resources Audit (NLWRA) conducted in 2001 (NLWRA 2002). The NLWRA definition of a near-pristine estuary includes those estuaries with greater than 90 per cent natural vegetation cover in a catchment which has no dams, alterations to tidal flow or aquaculture, and minimal fishing.

Australia's near-pristine estuaries are some of our most valuable natural assets. They are important for:

- **Biodiversity conservation** – because they provide major undisturbed environments for native plants and animals;
- **Management** – because they represent the *benchmark* or *baseline* conditions against which to measure modified estuaries and they also assist in distinguishing between changes caused by human activity and those that occur due to natural cycles of disturbance;
- **Science** – by studying near-pristine estuaries, scientists can learn more about *natural* systems and processes, and the ways in which human activities can impact upon them.

Many countries have only a few or no remaining near-pristine estuaries and therefore lack opportunities for significant biodiversity conservation and scientific research.

Australia's near-pristine estuaries are located away from major population centres in the most remote and inaccessible parts of the coastline, such as across northern Australia and southwest Tasmania. They

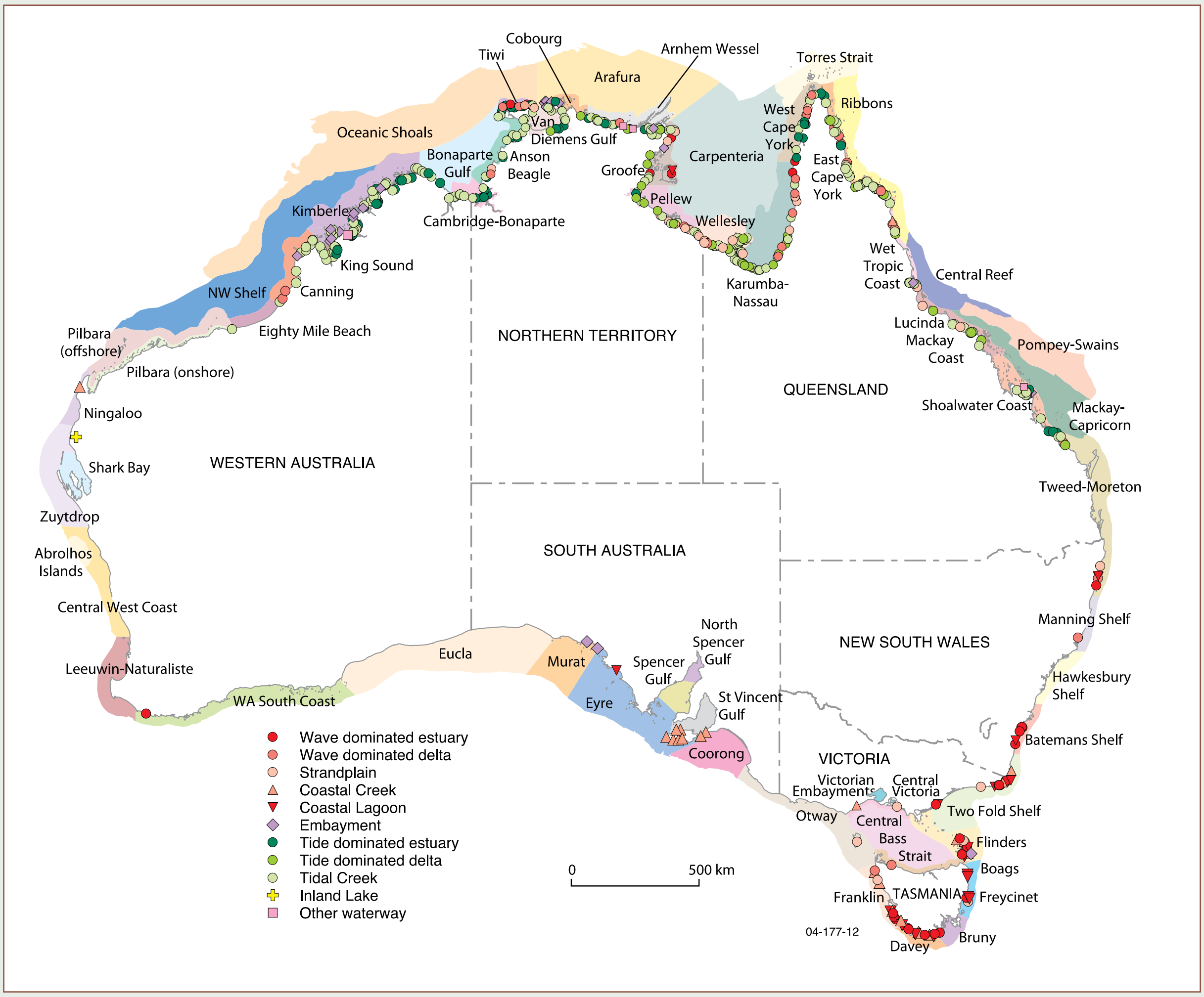

Figure 1. Australia's near-pristine estuaries according to geomorphic type and in relation to IMCRA bioregions (IMCRA 1998). Estuary classification from National Land and Water Resources Audit 2002.

also differ according to the region, for example, estuaries in northern Australia are shaped mainly by tides, whereas in southern Australia they are shaped mainly by waves (Ryan et al 2003). Most near-pristine estuaries in Australia (approximately 65 per cent) fall into tide-dominated classifications.

Geoscience Australia, in collaboration with CSIRO Land and Water and the Coastal CRC, has recently released online resources and information about Australia's near-pristine estuaries through the OzEstuaries and Coastal CRC websites.

The Near-Pristine Estuaries Project page – www.ozestuaries.org/ projects/ pris_est.jsp#geomorphic in OzEstuaries includes a map showing the location and geomorphic type of Australia's near-pristine estuaries (figure 1) in relation to coastal IMCRA bioregions (Interim Marine and Coastal Regionalisation for Australia; IMCRA 1998). Visitors can also zoom in on specific regions to load more detailed maps (figure 2). The webpage also includes an interactive map that can summarise typical pristine characteristics of estuaries by region around the Australian coastline. In showing the estuaries against a backdrop of IMCRA bioregions, these maps can be used to help plan a system of representative marine protected areas.

References

Heap A, Bryce S, Ryan D, Radke L, Smith C, Harris P & Heggie D. 2001. Australian Estuaries and Coastal Waterways: A geoscience perspective for improved and integrated resource management. A report to the National Land and Water Resources Audit, Theme 7: Ecosystem Health. Australian Geological Survey Organisation Record. 2001/07. http://dbforms.ga.gov.au/pls/www/npm.ozest.pubs_reports

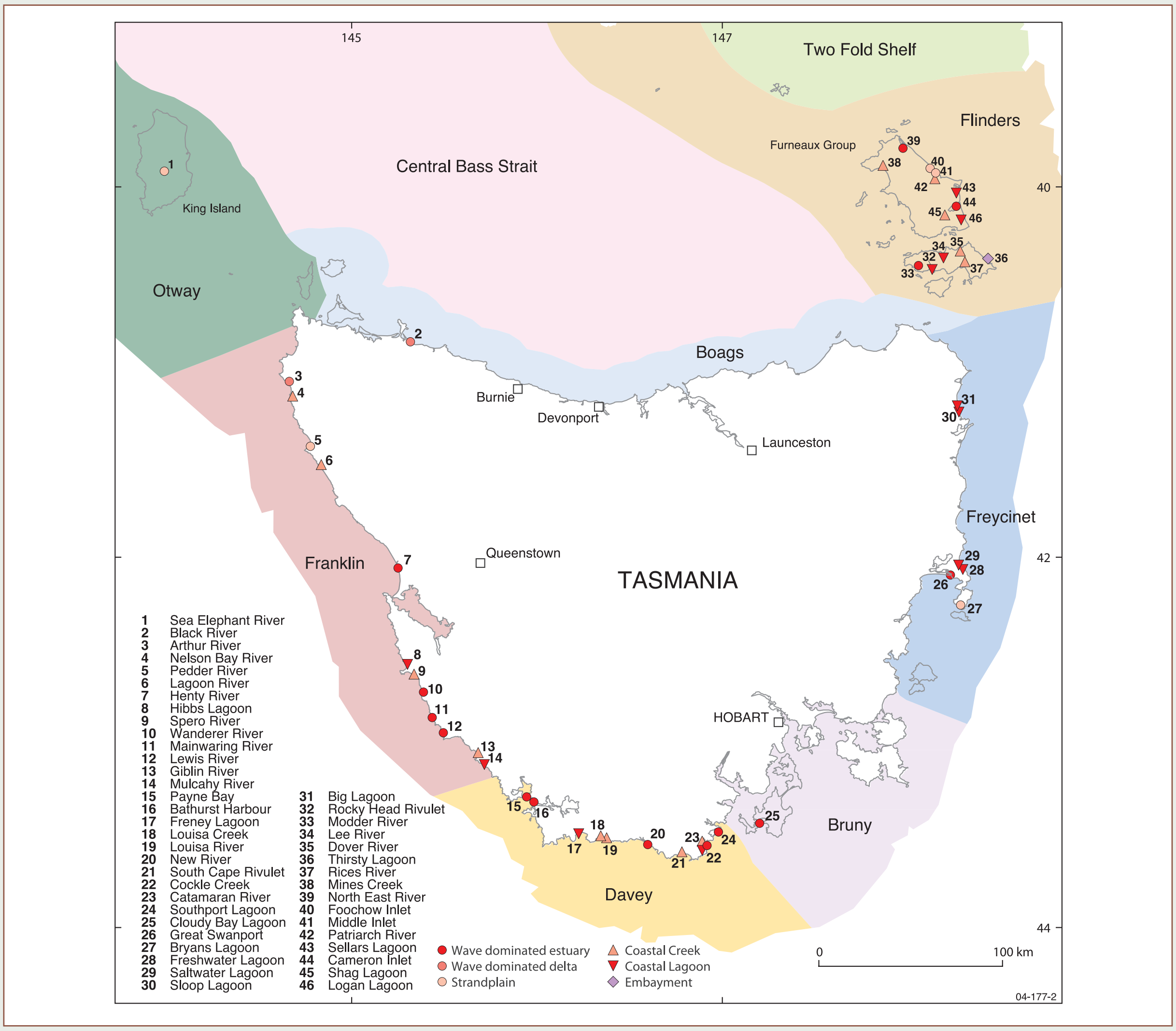

Figure 2. Detailed map of IMCRA regions and near-pristine estuaries of Tasmania.

IMCRA. 1998. Interim Marine and Coastal Regionalisation for Australia: an ecosystem-based classification for marine and coastal environments. Version 3.3. Interim Marine and Coastal Regionalisation for Australia Technical Group, Environment Australia, Canberra. www.deh.gov.au/coasts/mpa/nrsmpa/pubs/imcra.pdf

NLWRA. 2002. Australian Catchment, River and Estuary Assessment 2002, volume 1. National Land and Water Resources Audit, Commonwealth Government, Canberra. http://audit.ea.gov.au/anra/coasts/coasts_frame.cfm?region_type=AUS&region_code=AUS&info=estuaries Data also available at www.ozestuaries.org

Ryan DA, Heap AD, Radke L & Heggie DT. 2003. Conceptual models of Australia's estuaries and coastal waterways: applications for coastal resource management. Geoscience Australia Record. 2003/09. Geoscience Australia, Canberra. www.ozestuaries.org/conceptual_mods/conceptual.jsp

For more information

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Related websites

Near-Pristine Estuaries Project page
www.ozestuaries.org/projects/pris_est.jsp#geomorphic

Several reports on Australia's near-pristine estuaries are also available on the Coastal CRC website www.coastal.crc.org.au/. These include:

- Australia's Near-Pristine Estuaries: Current Knowledge and Management
- Improving Our Knowledge of Near-Pristine Estuaries: Geomorphic habitat mapping and related applications
- An Initial Assessment of Estuarine Geomorphic Habitats as Indicators of Waterway Health

product news

Price drop for Synthetic Aperture Radar (SAR) satellite imagery

Geoscience Australia is pleased to announce a major price reduction in Synthetic Aperture Radar (SAR) products downloaded from the Earth Resource Satellite (ERS). Prices have fallen from over $2000 to $590 as a result of greater pricing flexibility by the satellite operator. The reduced price will increase the attractiveness and utilisation of the SAR data produced by ERS to a wide range of users. In addition, and for a small fee, customers may also place requests for the ERS satellite to acquire data over a particular area in the future.

SAR products have been available from Geoscience Australia's remote sensing unit (ACRES) since 1993. A major advantage of SAR data is its ability to image the Earth through cloud or at night. C-band SAR data is particularly useful in coastal and ocean environments where it has been successfully used in helping to identify oil seeps and slicks, and ship detection.

Geoscience Australia holds a large and comprehensive archive of SAR data covering Australia and New Zealand, including complete continental coverages from the ERS-1 and ERS-2 tandem mission undertaken over nine months in 1995–96. During the tandem mission the orbit configuration enabled global observations, one day apart, from the two satellites. This data is particularly suited for interferometric applications, including subsidence monitoring and Digital Elevation Model (DEM) generation. The ERS-1 and ERS-2 SAR data may also be used for time-series studies with the currently available Envisat ASAR data.

For more information

www.ga.gov.au/acres/prod_ser/ersdata.jsp

European Space Agency (ESA)
www.esa.int/esaCP/index.html

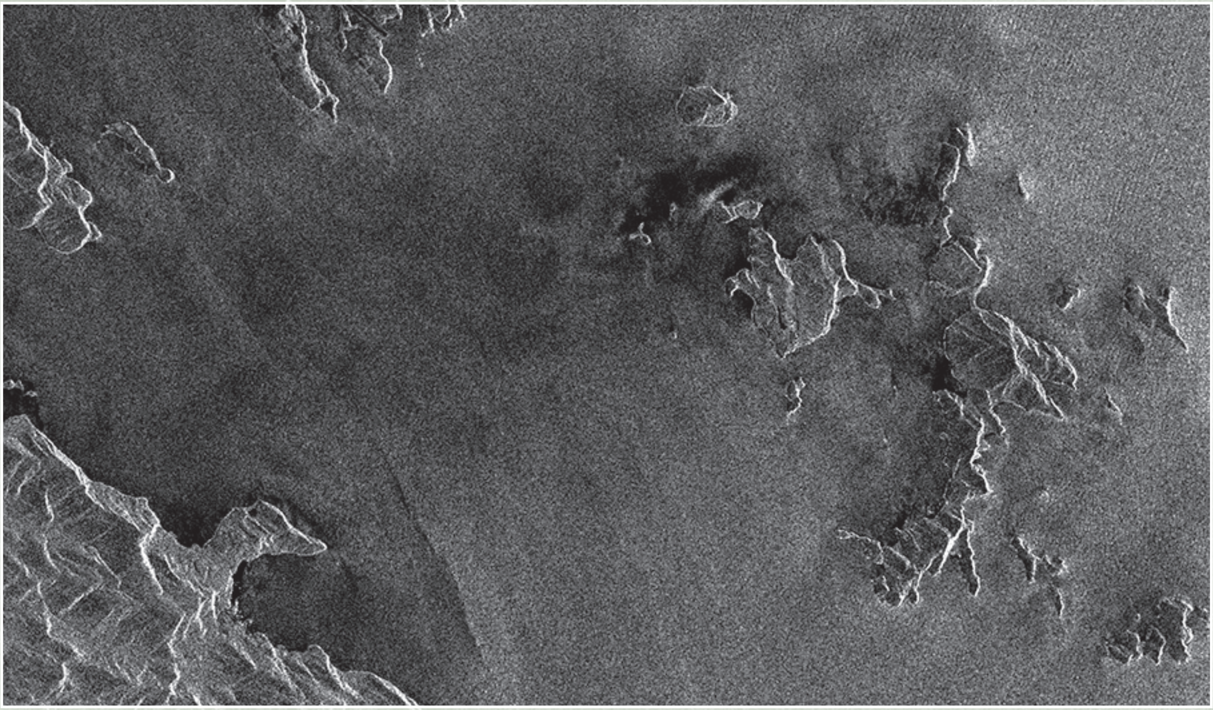

Figure 1. Earth Resources Satellite SAR image over Whitsunday Islands, Queensland © European Space Agency.

China Mining 2006 – A Major Promotion

The China Mining 2006 convention and trade display was held at the Beijing International Convention Center between 14 and 16 November 2006 and attended by more than 2500 delegates. Geoscience Australia and the state and Northern Territory geological surveys exhibited under the banner of Australian Government Geoscience Group in the trade show. This promotion was coordinated by Geoscience Australia and the Geological Survey of Western Australia.

About 70 per cent of attendees were Chinese with the major international participants being Canada (11 per cent) and Australia (6 per cent). Interest from the Chinese delegates was wide-ranging with particular interest in nickel, iron ore, copper, uranium and minor metals. There was strong demand for information on the procedures to gain approval to explore and mine in Australia as well as our general business and regulatory environment.

Prior to the China Mining 2006 convention, an Australian Seminar was held on 13 November. The morning session was organised by Geoscience Australia, the Geological Survey of Western Australia, Invest Australia and the Australian Embassy in Beijing. The morning session covered Chinese investment in the Australian minerals sector with particular reference to exploration. This session was an unqualified success attracting some 280 delegates (virtually a capacity audience) and some lively questioning of the speakers. The afternoon session on Australian investment into China was coordinated by the Australian Embassy and the China International Mining Group.

The Chief of Geoscience Australia's Onshore Energy and Minerals Division, Dr James Johnson, delivered presentations at both the Australian Seminar and the China Mining 2006 convention. His presentation 'Securing the future – Australia's Potential for New Mineral Discoveries' reviewed Australia's record of maintaining a strong mineral resource base which is essential to ensure security of supply to offshore customers. He also highlighted Australia's strong potential for future discoveries to continue adding to the country's resource base providing a strong exploration program is maintained.

For more information

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events

Minerals exploration for the next generation

Approximately 85 senior secondary students visited Geoscience Australia during January as part of the National Youth Science Forum (NYSF) program. During three afternoons of applied learning in the field of gold exploration the students were divided into specialist groups to learn how to analyse real data from the goldfields of Western Australia. They analysed maps showing gravity (relating to density) and magnetic attraction, examined thin-sections of rocks under microscopes, and checked geochemical analysis data. The students also made use of geographic information systems (GIS) to examine and integrate the different types of data.

The exercise was designed to demonstrate how the diverse disciplines of geoscience are combined in mineral exploration and also involved the students in selection of the most likely areas to look for a new gold deposit. It is hoped that this introduction to the problem solving and high-tech nature of minerals exploration together with the opportunity to talk with many of the young scientists in the organisation will inspire some of them to undertake further studies in geosciences.

For more information

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events calendar

EVENTS 2007

APPEA Conference and Exhibition — 15–18 April

1

Australian Petroleum Production and Exploration Association
Adelaide Convention Centre
Contact: Aoife Dooley, APPEA Limited, GPO Box 2201, Canberra ACT 2601
phone +61 2 6247 0906
fax +61 2 6247 0548
email adooley@appea.com.au
www.appea2007.com.au

South Australian Resources & Energy Investment Conference — 30 April–1 May

2

Hilton Adelaide
Contact: Samantha Goulding, Paydirt Media Pty Ltd, PO Box 1589, West Perth, WA 6872
phone +61 8 9321 0355
fax +61 8 9321 0426
email samantha@paydirt.com.au
www.saresourcesconf.com

SSC2007 — 14–18 May

3

Spatial Sciences Institute
Hotel Grand Chancellor, Hobart
Contact: ICMS Pty Ltd, 84 Queensbridge Street, Southbank Vic 3006
phone +61 3 9682 0244
fax +61 3 9682 0288
email ssc2007@icms.com.au
www.ssc2007.com

AMEC Congress 2007 — 7–9 June

4

Association of Mining and Exploration Companies
Perth Convention & Exhibition Centre
Contact: AMEC, PO Box 545, West Perth, WA 6872
phone 1300 738 184
fax 1300 738 185
email pdteam@amec.org.au
www.ameccongress.org.au/

World Conference on Science & Technology Education — 8 – 12 July

5

Sheraton Hotel, Perth
Contact: Elaine Horne & Robin Groves, Convenors, PO Box 244, Mt Hawthorn WA 6016
phone +61 8 9266 2174
fax +61 8 9201 0004
email grovesr@ozemail.com.au
www.worldste2007.asn.au/

AMSA 2007 — 9–13 July

6

Australian Marine Sciences Association
University of Melbourne
Contact: Ms Narelle Hall
phone +61 7 5484 1179
fax +61 7 5484 1456
www.amsa2007.asn.au

19th International Geophysical Conference & Exhibition — 18–22 November

7

Australian Society of Exploration Geophysicists
Perth Convention & Exhibition Centre
Contact: Promaco Conventions Pty Ltd, PO Box 890, Canning Bridge, WA 6153
phone +61 8 9332 2900
fax +61 8 9332 2911
email promaco@promaco.com.au
www.promaco.com.au/2007/aseg