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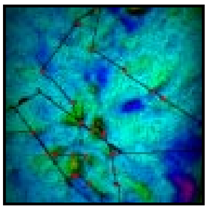
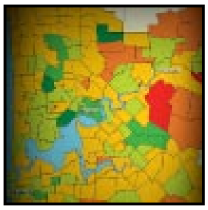




Comment

This issue of *AusGeo News* features a wide range of articles covering emergency management issues for natural hazards. It also includes features on Australia's uranium resources and mineral exploration, recent marine surveys in the Coral Sea region, and information on new products.

The article on natural hazard risks in Perth reports on the results of a major four-year study conducted by Geoscience Australia in collaboration with federal, state and local government agencies. This was the most rigorous natural hazard risk assessment ever undertaken for Perth, and some of the conclusions were unexpected. Another article discusses the remapping of the Karijini National Park area in Western Australia as the first product of a pilot mapping program focussing on emergency management information requirements.

As we enter the bushfire season, I am pleased to report that the Sentinel bushfire monitoring system now has a permanent home at Geoscience Australia after nearly three years as an R&D demonstrator project. Sentinel is an internet based mapping tool designed to provide timely information on the location of bushfires to emergency service managers throughout Australia. Two other articles highlight the importance of post-disaster data collection and Geoscience Australia's role in developing and piloting post-disaster surveys. These studies improve our knowledge base of the costs and major factors that influence a community's vulnerability and risk to hazard events. Geoscience Australia is also doing fundamental research that will contribute to a better understanding of the potential for major earthquakes and tsunamis. There is also an article on geodetic measurements of permanent ground displacements from last year's Indian Ocean earthquake and tsunami which show clear indications of where stress has been released along the Sumatran coastline.

Australia's rich endowment in uranium resources is assessed in a feature that points out the importance and dominance of the giant Olympic Dam deposit. This article also highlights the importance of uranium-rich felsic igneous rocks as sources of uranium for ores deposited by low-temperature hydrothermal processes in other rock types. Another article draws attention to the recent survey of global non-ferrous mineral (excluding iron ore, coal) exploration budgets by the Metals Economics Group of Canada that shows that Australia's share of world mineral exploration budgets has fallen to a new low despite increased levels of exploration both in Australia and globally. Australia's competitive position in world mineral exploration and the impediments to expansion of mineral exploration in Australia have been the focus of the Minerals Exploration Action Agenda.

There is also a report on the marine survey conducted early this year over the Mellish Rise and the Kenn Plateau in the Coral Sea off Queensland. The region is geologically complex with the basement rocks being a mixture of continental and younger basaltic (sea-mount type) rocks. The information obtained from these studies will add to our understanding of the breakup and seafloor spreading history of the Southwest Pacific. In related news, Geoscience Australia has just released a new high-quality national bathymetric grid covering 41 million square kilometres of the Australian region (and surrounds). This new dataset should be particularly useful to decision-makers managing Australia's marine environment.

It is a great honour for our organisation that three of our current projects were recognised at the 2005 Australian Safer Communities Awards ceremony held at Parliament House on December 1. The Cities Project Perth, the Collaborative 100 000 Scale Mapping Pilot for Emergency Management and the Scenario Modelling for the Assessment of National Catastrophic Disaster Capability projects, received 'Highly Commended' awards in the Pre-Disaster Category (National Significance). As outlined above, this issue includes reports on the first two of these projects.

Finally, I extend to all readers of *AusGeo News* best wishes for the festive season and the new year.

NEIL WILLIAMS
CEO Geoscience Australia

NATURAL HAZARD RISK:
Cities Project Perth

Good decisions need good data—the Cities Project Perth report will give decision makers high-quality information about natural hazard risk.

Miriam Middelmann and Trevor Jones

Is the land I want to buy in Perth likely to be flooded? Will my office building withstand storms or earthquakes? How much of the Perth coastline will erode in the next 50 years? Until the Cities Project Perth report, very little information was available to local councils, engineers or administrators to help answer such basic questions.

Cities Project Perth has created and analysed an enormous amount of data on sudden-onset natural hazards in the most rigorous natural hazard risk assessment ever undertaken for the Perth region. The report is now the primary resource for emergency managers, risk managers, land use planners and other officials responsible for reducing natural hazard risk in the most densely populated area of Western Australia (WA).

Permanent urban settlements in WA began with European settlement in 1829, but scientific data has been collected for a much shorter period. Records of events over such a short time are not a reliable guide to future impacts from natural disasters. Cities Project Perth examined past events, gathered new data, and developed predictive models to provide scenarios for rare but probable high-impact events not seen in the historical record. The completion of this body of research enables us to make some very well-informed estimates.

Increased knowledge highlights risk

The study provides new information about important risks to Perth and the surrounding areas. The results show that Perth could experience an extremely rare earthquake, a highly damaging cool season storm, or higher flood levels than previously modelled or experienced.

The earthquake source zone east of Perth is larger than previously thought, placing more wheatbelt communities at higher risk. While wheatbelt earthquakes occur some distance from Perth, they have caused significant insurance losses in the city. This new knowledge will be included in the next revision of the earthquake loadings standard for Australian buildings.

The report estimates that potential losses from earthquakes in WA are considerably higher than historical losses, partly because most residences are unreinforced double brick, which is vulnerable to earthquake damage. The rare but high-impact nature of earthquake risk in the Perth region indicates that the most effective means of mitigation are appropriate building design and construction standards, combined with adequate insurance.

Cool season storms and tropical cyclones, often accompanied by bushfires, have historically caused the highest natural-hazard insurance losses in southwest WA. The report indicates that these storms will continue to pose a threat to the region.

Wind hazard is highest for coastal areas, including the lower reaches of the Swan River, and the region running north–south along the top of Darling Scarp, where historical losses have occurred. New wind-hazard maps produced by the project collate essential information that could be used to improve building construction and design guidelines. By highlighting the areas exposed to greater risk, the maps are also a valuable guide for emergency managers.

A model was developed for assessing flood hazard, providing new information on flooding in the Swan–Canning river system. Eight flood scenarios identify flood-prone areas, providing information on area and depth of inundation and flow velocity, and how these may change during a flood event. This information may contribute to better land use planning, appropriate development controls for the future, and improved emergency response and recovery planning.

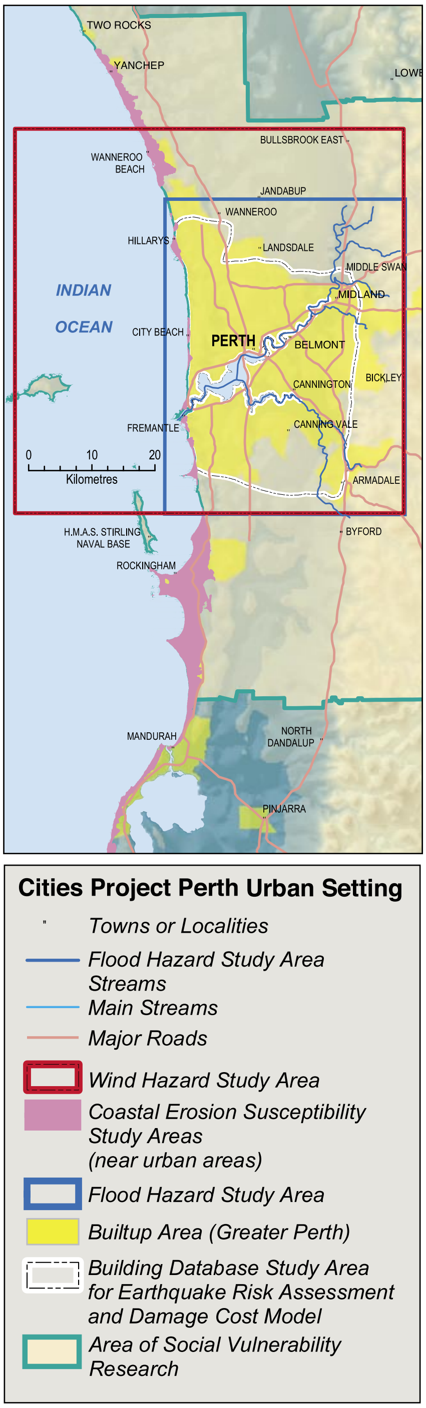


Figure 1. Study area—greater metropolitan Perth.

The southwest WA coastline is susceptible to erosion caused by long-term sea level rise. Modelling suggests that the shoreline of Swanbourne Beach could recede by as much as 130 metres over the next century—significantly more than earlier estimates. Fortunately, the Swanbourne seafront doesn't have many buildings. Further investigations in developing areas such as the Bunbury to Mandurah coastline, which are potentially susceptible, would improve our understanding of future impacts from sea level rise.

Tsunamis generated by earthquakes in the subduction zone offshore of Indonesia could endanger Northwest Shelf oil and gas infrastructure (a considerable part of the WA economy). Tsunami research initiated by the WA Government and Geoscience Australia will shed further light on the tsunami hazard along the state's coastline. This research will prioritise areas of coastline to be monitored by the Australian Tsunami Warning System.

On a brighter note, Australian Bureau of Statistics data indicates that WA has a strong community network, which will greatly assist long-term recovery from a natural disaster.

Figure 2. Coastal erosion on Perth's beaches (photo courtesy of *The West Australian*).

Guarding against complacency

With this new level of risk assessment, it is reassuring that Perth has so far enjoyed a relatively benign environment. In the city's short history, no truly catastrophic natural events have affected it—in the past hundred years, no natural disaster has killed more than five people or caused insurance losses worth more than $100 million.

Other cities and regions in Australia have not been so fortunate. Darwin was flattened by cyclone Tracy in 1974; the Brisbane–Ipswich–Gold Coast region was flooded in 1974; Brisbane was buffeted by storms again in 1985; and Newcastle suffered the 1989 earthquake. Fires have been catastrophic in Hobart (1967), South Australia and Victoria (Ash Wednesday, 1983), and Canberra (2003).

The Cities Project Perth report provides a perspective by comparing the cost of natural disasters and transport accidents in the Perth region. Aircraft crashes have killed a significant number—29 people died in the 1950 crash of a DC-4 near York, 100 kilometres east of Perth—and shipwrecks off the WA coast were regular events in the nineteenth century, causing great loss of life and incurring high economic cost.

Events like the Indian Ocean tsunami and Hurricane Katrina in the United States show that we need to plan for unexpected, rare and extreme disasters, as well as the more likely lesser ones.

Risks of environmental impact and economic loss are rising due to a higher population and denser settlement in the Perth region, but recent losses of life in natural hazard events have been much fewer than in the early days of the Swan River settlement. Improved warning systems and better emergency management response, land planning and building codes have reduced life-threatening risk. Reduced risk, however, is not 'no risk'. The report makes recommendations for action and for gathering further information to improve the models and enable more accurate projections.

Although estimates of the cost of potential natural disasters are important inputs for decision makers responsible for allocating expenditure on risk reduction, such estimates are difficult to achieve. Apart from loss of human life, estimates of loss are traditionally based almost entirely on total insurance claims. Available data suggests annualised losses of approximately $15 million from natural hazards in southwest WA, but this figure is considered an underestimate.

A collaborative approach

Cities Project Perth is the latest in a series of studies of Australian cities. The studies took a unique, all-hazards approach to understanding risk by incorporating measures of vulnerability, resilience and probability of occurrence.

Before the project began, discussions were held with government agencies in WA to define the needs of the research, as described in the final project brief:

The goal of [the] Cities Project is to ascertain the vulnerability of Australian urban communities to the effects of geological and meteorological hazards (collectively referred to as geohazards), thereby providing emergency managers and planners with information and decision support tools that will aid in the mitigation of geohazards. The objective of the WA Cities Project is to improve the methodology, develop decision support tools and generate information to assist in the mitigation of geohazards.

A unique feature of this project is the partnership developed between Geoscience Australia and a range of organisations. There was extensive cross-jurisdictional collaboration between national, state and local government agencies. Cities Project Perth participants were Geoscience Australia, the Fire and Emergency Services Authority of Western Australia (FESA), the Bureau of Meteorology (BoM), the Western Australian Land Information System (WALIS), and the Western Australian departments of Planning and Infrastructure (DPI), Environment (DoE), and Land Information (DLI). Local government has also been a key partner of Geoscience Australia's cities projects. Several local governments, including the cities of Perth, Wanneroo, Joondalup and Swan directly contributed data or advice on hazards and community vulnerability.

Figure 3. Fremantle Railway Bridge destroyed by the July 1926 floods (photo courtesy of The Battye Library 54902P).

FESA offered Geoscience Australia office space and resources in the project, and greatly assisted research and stakeholder interaction. BoM contributed expert meteorological input to the project and provided data from its automatic weather stations for the severe wind analysis.

DPI gave expert advice on the implications for planning policy of the risks exposed by the project. DPI's close relationship with the WA Planning Commission has effectively transmitted results from the project into WA planning policy.

WALIS and DLI are playing leading coordination roles in ensuring that the Cities Project Perth databases will continue to be maintained, improved and made available to users through the WA Shared Land Information Platform (SLIP). DLI provided many spatial databases to the project at its beginning, including 'Lands' GIS coverages and extracts from the WA Valuer-General's database, laying the foundation for the spatial analysis of community safety.

Close collaboration with DoE enabled the development of a new model for assessing flood hazard, and expansion of the mapping to include the more extreme flood events. DoE has taken ownership of the model and will use it when the department reviews flooding in the Swan River system after the next major flood.

This pooling of expertise and resources developed more than a dozen databases, models and maps which are not only the backbone of this study but can assist further investigation. While the original information applies to Perth, the models and processes are also applicable worldwide. For example, the building cost models provide cost per square metre estimates for replacing Perth's built environment after earthquake damage, and can be applied to other hazards.

The project is attracting considerable interest in Australia and internationally. It recently won an Emergency Management Australia Safer Communities Award in WA and was recognised at the 2005 Australian Safer Communities Awards ceremony held at Parliament House on December 1. The Project, as well as two other Geoscience Australia projects, received a 'Highly Commended' award in the Pre-Disaster Category (National Significance).

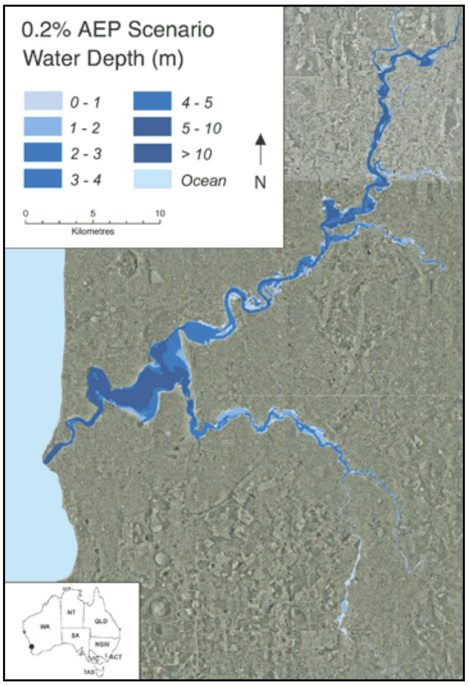


Figure 4. Flood inundation mapping for the 0.2% annual excedance probabilities (AEP) scenario showing maximum water depth contours.

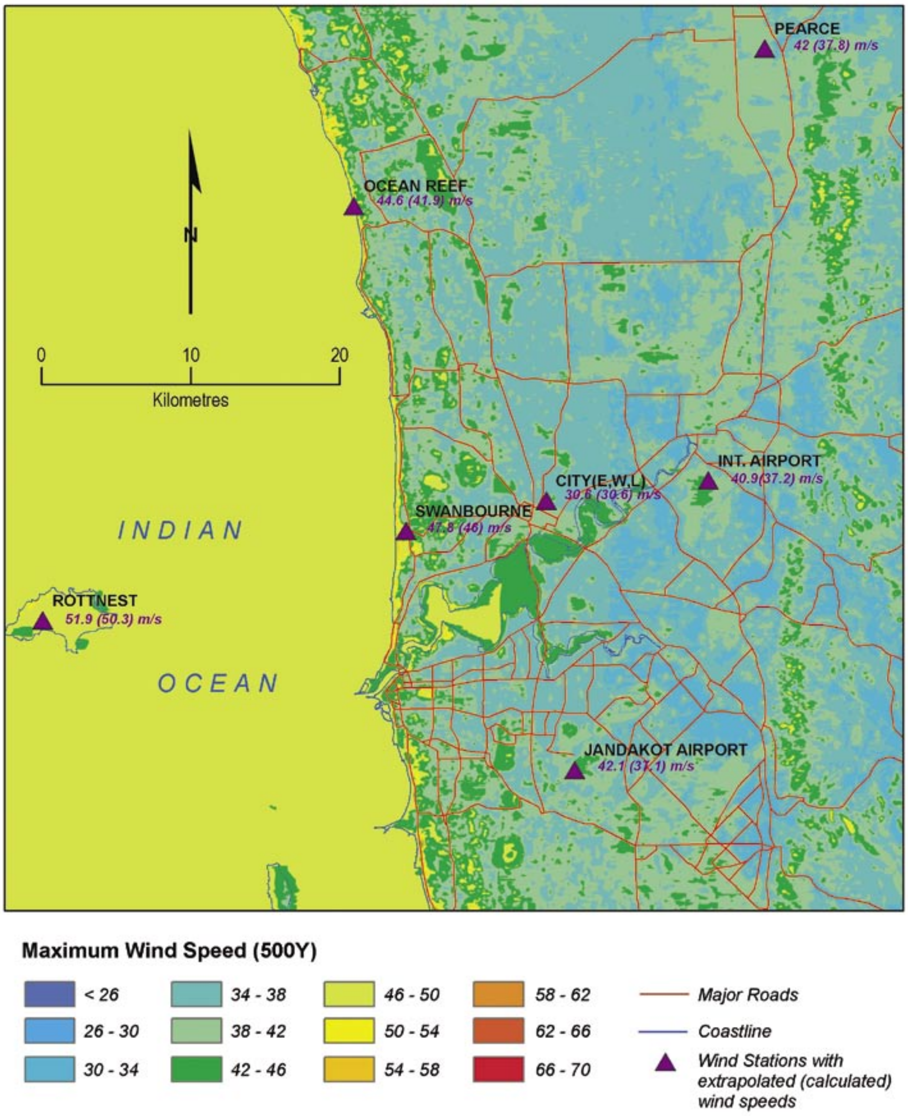
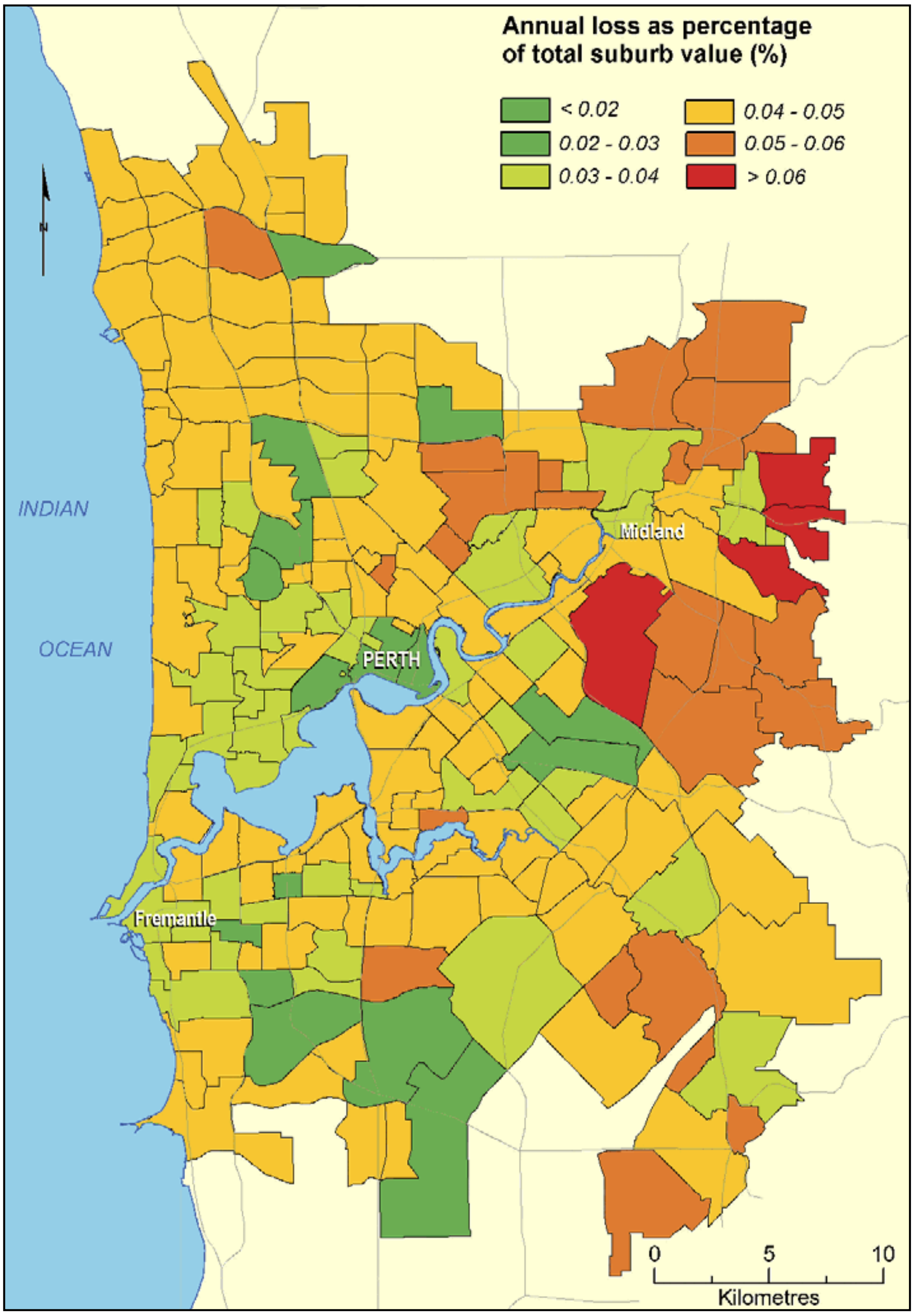


Figure 5. Maximum non-directional wind speeds with a 1 in 500 likelihood of being exceeded in any one year at any particular location (return period of 500 years). Wind speeds are expressed as 3-second maximum gusts in units of metres per second.



▲ **Figure 6.** Annualised earthquake losses at suburb level in the Perth study region. Losses are expressed in terms of total value of buildings and their contents.

The report (approximately 350 pages) can be downloaded from Geoscience Australia's website at www.ga.gov.au/urban/projects/nrap/perth.jsp. Previous Cities Project reports can also be downloaded from www.ga.gov.au/urban/projects/nrap/index.jsp.

A summary brochure and the comprehensive report on CD are also available for cost of postage from Geoscience Australia's Sales Centre at www.ga.gov.au/sales, or email (mapsales@ga.gov.au).

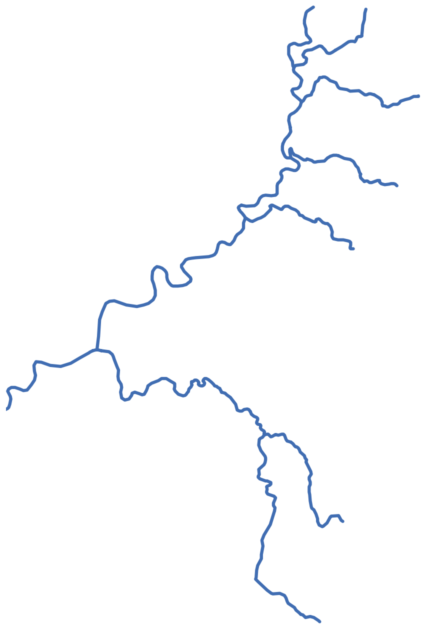
For more information phone Trevor Jones on +61 2 6249 9559 (email trevor.jones@ga.gov.au)

Acknowledgment

We would like to thank Karen McVicker (freelance writer) for her help in putting together this article

Further information on collaborators and partners may be found on their websites, at the following links:

State/local government	Website
Fire and Emergency Services Authority of Western Australia (FESA)	www.fesa.wa.gov.au
Bureau of Meteorology	www.bom.gov.au
Western Australian Department for Planning and Infrastructure (DPI)	www.dpi.wa.gov.au
Western Australian Department of Environment (DoE)	www.environment.wa.gov.au
Western Australian Department of Land Information (DLI)	www.dli.wa.gov.au
Western Australian Land Information System (WALIS)	www.walis.wa.gov.au
City of Perth	www.cityofperth.wa.gov.au
City of Wanneroo	www.wanneroo.wa.gov.au
City of Joondalup	www.joondalup.wa.gov.au
City of Swan	www.swan.wa.gov.au



Why Australia has so much URANIUM

Australia's vast resources of uranium amount to a staggering 40% of the world's total identified resources of uranium recoverable at low cost.

Ian Lambert, Subhash Jaireth, Aden McKay and Yanis Miezitis

Uranium mining in Australia began in 1954 at Rum Jungle in the Northern Territory and Radium Hill in South Australia. The first mining of uranium for electricity generation in nuclear reactors began in 1976, at Mary Kathleen in Queensland.

Australia is now the world's second largest producer. In 2004, Canada accounted for 29% of world production, followed by Australia with approximately 22%. Australia's output came from three mines: Ranger, which produced 5138 tonnes of U_3O_8 (11% of world production), Olympic Dam (4370 t, 9%) and Beverley (1084 t, 2%).

Exports have increased steadily to a record level of 9648 tonnes of U_3O_8 in 2004, valued at A$411 million.

Australia's uranium sector is based on world-leading resources and high and increasing annual output. Our resources are generally amenable to low-cost production with minimal long-term environmental and social impacts.

Around 85 known uranium deposits, varying in size from small to very large, are scattered across the Australian continent (McKay & Miezitis 2001). After five decades of uranium mining, Australia still has the world's largest uranium resources recoverable at low-cost (less than US$40/kg U, or US$15/lb U_3O_8). In April 2005, these remaining low-cost resources amounted to 826 650 t U_3O_8 (= 701 000 t U), or roughly 40% of world resources in this category. Australia's total remaining identified resources in all cost categories amount to 1 347 900 t U_3O_8.

Australia's initial in-ground resources of uranium (total resources before mining, without taking account of extraction and processing losses) amount to 2.4 million t U_3O_8. The distribution of initial in-ground uranium resources among the main types of deposits is summarised in Figure 1.

Types of uranium deposits

Approximately 89% of Australia's initial in-ground resources occur in two main types of deposits:

Hematite breccia complex deposits—approximately 70% of resources occur in Proterozoic hematite granitic breccias at Olympic Dam in South Australia, the world's largest uranium deposit. Broadly similar hematite breccia mineralisation is being evaluated elsewhere in the same geological province at Prominent Hill (very low uranium grade) and at Mt Gee in the Mount Painter Inlier of the Curnamona Province. These are examples of 'iron oxide copper gold deposits' with higher uranium contents than most deposits of this type.

Unconformity-related deposits—about 19% of resources are associated with Proterozoic unconformities, mainly in the Alligator Rivers field in the Northern Territory (Ranger, Jabiluka, Koongarra).

Other significant resources occur in:

Sandstone uranium deposits—about 4.4% of resources, mainly in the Frome Embayment field, South Australia (Beverley, Honeymoon) and the Westmoreland area, Queensland.

Surficial (calcrete) deposits—about 3.5% of Australia's uranium resources, mostly in the Yeelirrie deposit in Western Australia.

The remaining resources are mainly in metosomatite and volcanic (caldera-related) types of deposits.

Initial in-ground tonnage and grade relationships for Australian deposits are presented in Figure 2, based on Geoscience Australia's OZMIN 2005 database. This shows that:

- The hematite breccia mineralisation at Olympic Dam is characterised by a very large tonnage of low-grade uranium (~0.05% U_3O_8). Uranium is produced as a co-product with copper and gold. Other examples are much smaller.
- Calcrete mineralisation is in medium to large tonnage deposits of low grade.
- Sandstone deposits are of relatively low tonnage but generally higher grades (> 0.1% U_3O_8) than the above types.
- Unconformity-related uranium deposits exhibit a wide range of ore tonnages and grades (generally between 0.1% and 1.8% U_3O_8). By way of comparison, in Canada's major uranium region—the Athabasca Basin—there are deposits of similar style and grade located just below the unconformity, but the McArthur River and Cigar Lake deposits, which straddle or extend just above the unconformity, are much higher grade (up to 26% U_3O_8) (Cuney 2005).

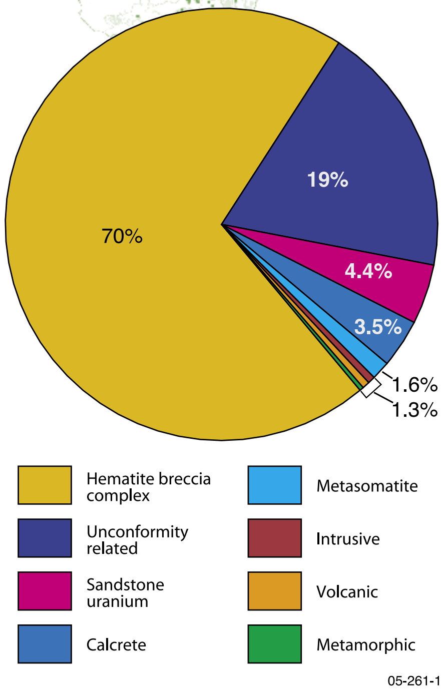


Figure 1. Distribution of Australia's initial in-ground uranium resources (t U_3O_8), by type of deposit. (Source of data: OZMIN 2005).

Exploration—past, present and future

As market prices for uranium fell from 1980 onwards, uranium exploration activity declined in Australia and overseas. By 2003, only five companies were actively exploring for uranium in Australia, and the 17 active projects were confined to areas adjacent to known deposits, mainly western Arnhem Land (NT), Frome Embayment and Gawler Craton–Stuart Shelf (SA).

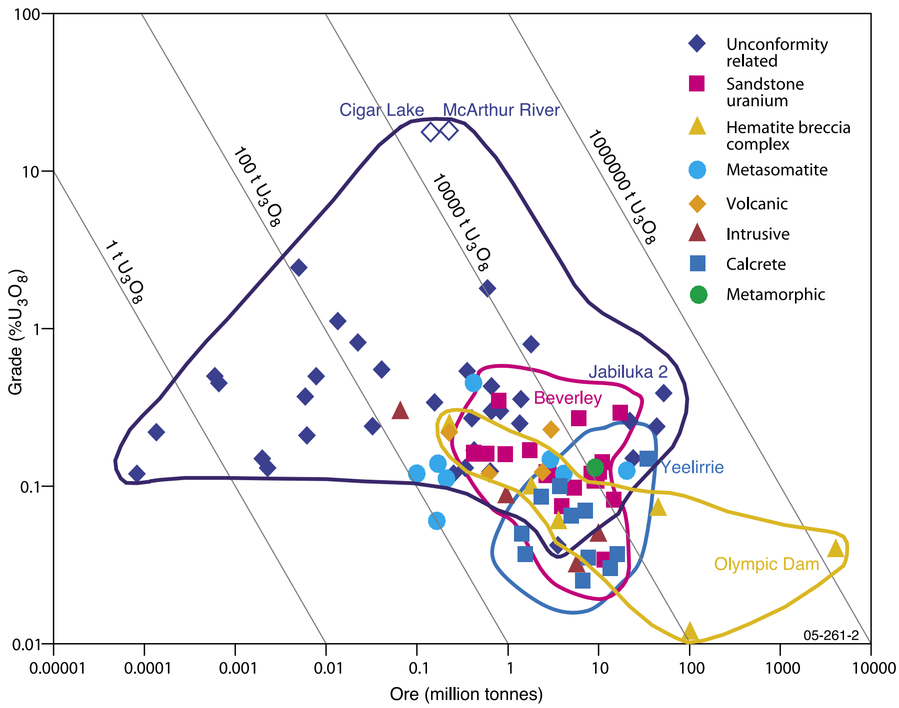
Over the past two years, spot market uranium prices have trebled from around US$10/lb U_3O_8 in early 2003 to US$33/lb U_3O_8 in late 2005. Responding to these price rises, uranium exploration expenditure in Australia doubled from $7 million in 2003 to $14 million in 2004. Exploration has continued to increase dramatically during 2005, with about 70 companies exploring for uranium in more than 280 projects, but the current level of expenditure is a small fraction of peak levels of more than $105 million (constant 2003 dollars) reached in 1980. The increase in expenditure that culminated in the 1980 peak was in large part due to the oil shocks of 1973 and 1979, strongly resembling the current situation of high crude oil prices and rising uranium exploration expenditure.

Early uranium discoveries relied extensively on airborne radiometric surveys. The 1960s and early 1970s saw extensive testing of surficial radiometric anomalies. This progressed to more sophisticated approaches, often based on conceptual geological modelling, which led to major discoveries at Jabiluka and Olympic Dam. In more recent exploration, airborne electromagnetic surveys have been used to locate palaeochannels in the vicinity of the Beverley and Honeymoon sandstone uranium deposits in South Australia, and to locate potentially mineralised graphitic rocks in the search for unconformity-style deposits.

Given the paucity of modern exploration, there is significant potential for additional uranium deposits to be found in Australia, including:

- unconformity-related deposits, including high-grade deposits at and immediately above the unconformity, particularly in Arnhem Land in the Northern Territory but also in the Granites–Tanami region (Northern Territory–Western Australia), the Paterson Province (Western Australia) and the Gawler Craton (South Australia)
- hematite breccia deposits, particularly in the Gawler Craton and Curnamona Province of South Australia, and the Georgetown and Mount Isa Inliers of Queensland
- sandstone-hosted deposits in sedimentary strata in various regions adjacent to uranium-enriched basement
- carbonatite-related rare earth–uranium deposits in Archaean cratons and Proterozoic orogens.

Despite the fact that there has only been one notable uranium discovery since 1980—the unconformity-related Kintyre deposit in 1985—Australia's low-cost resources have continued to increase through the delineation of additional resources at known deposits, particularly Olympic Dam.



Why so rich in uranium?

Spatial and temporal relationships between uranium deposits and unmineralised uranium-enriched rocks from across the continent have been studied in an attempt to explain why Australia has such a high proportion of the world's known uranium resources. This study was based on Geoscience Australia's extensive OZCHEM database (www.ga.gov.au/gda/index.jsp).

Of approximately 22 000 rocks in the OZCHEM database analysed for uranium, over 2700 have 10 ppm U or more (at least four times crustal average and more than twice the average for felsic igneous rocks). These uranium-enriched samples are mainly granitic and felsic volcanic rocks, but include a small proportion of associated gneisses and sedimentary samples. Their distribution is indicated in Figure 3. It is a significant observation that all known uranium deposits exhibit clear spatial relationships with uranium-enriched bedrocks. This observation holds true at regional to local scales.

Figure 4 shows the ages of uranium mineralisation in relation to the ages of the uranium-enriched granitoid intrusives and associated felsic volcanics, which were clearly emplaced during major magmatic events during:

- the late Archaean (2.69–2.65 Ga) (Champion & Sheraton 1996)
- the Palaeo-Mesoproterozoic. (~1.9–1.5 Ga)
- in eastern Australia, the Silurian to the Permian (0.43–0.25 Ga).

Of these intervals, the Proterozoic produced the greatest volumes of uraniferous igneous rocks. These are widespread in South Australia, the Northern Territory and parts of Western Australia and Queensland in regions of high geothermal gradients (Howard & Sass 1964, Etheridge et al 1987). The uranium-enriched felsic igneous rocks are mainly highly fractionated and/or have alkaline affinities. Most felsic igneous rocks contain uranium in accessory minerals such as zircon and monazite, but the uranium-enriched examples appear to be characterised by significant proportions of uraninite, which is relatively readily leached under low-temperature oxidising conditions.

Figure 2. Logarithmic plot of U_3O_8 grade (weight %) versus initial mineral resources (Mt) for Australian uranium deposits. Two major unconformity-related uranium deposits in Canada are also plotted (as open symbols). The diagonal lines show tonnes of contained U_3O_8.

These observations support the conclusion that the large number of uranium deposits and prospects across Australia reflects the extensive emplacement of uranium-enriched felsic rocks in three main periods of igneous activity. While some uranium deposits appear to have formed during these widespread thermal events, most formed from uranium-enriched source rocks by subsequent low-temperature processes.

In the case of Olympic Dam, mineralisation is of similar age to felsic igneous activity. Together with the close spatial association, this supports the view that the uranium was concentrated during hydrothermal activity resulting from this igneous-thermal event (Oreskes & Einaudi 1990, Reeve et al 1990, Reynolds 2000). Olympic Dam's combination of huge tonnage and recoverable uranium grades make it unique among known iron oxide Cu–Au deposits, leading to speculation about its genesis. A number of coincident factors may have been involved:

- high palaeogeothermal gradients
- vast volumes of generally uranium-enriched granitic rocks emplaced at shallow crustal level, and intruding coeval felsic volcanics
- generation of a maar volcanic setting
- overprinting of relatively reduced (magnetite-stable) alteration by hematite-stable oxidised and uranium-bearing fluids, with precipitation of uranium resulting from reduction by mixing with ascending fluids or by reactions with pre-existing sulphide-bearing magnetite alteration.

Some small intrusive and volcanic-style uranium deposits also have temporal association with felsic host rocks, including the intrusive-style Crocker Well deposit in Mesoproterozoic granitoids in South Australia and the Ben Lomond volcanic-style deposit in Carboniferous rhyolitic tuffs in northeastern Queensland (McKay & Miezitis 2001).

More generally, the uranium mineralisation is considerably younger than the spatially related igneous rocks. This is the case for the calcrete, sandstone and unconformity-related deposits, which appear to have formed as a result of uranium mobilisation from older uranium-enriched source rocks under low-temperature oxidising conditions, and precipitation by redox reactions. The high-grade deposits are likely to reflect relatively more efficient oxidation–reduction systems.

In particular:

- There is a clear spatial relationship of the Cainozoic calcrete-type uranium deposits in the western part of the continent, including the large Yeelirrie deposit, with the uranium-rich Archaean felsic rocks in the northern part of the Yilgarn Craton. The probable source rocks are approximately 2.6 billion years older than the uranium deposits.
- Sandstone uranium deposits are the most widely distributed type of uranium deposit in Australia and range in age from Neoproterozoic for the Westmoreland group of deposits in Queensland (Ahmad & Wygralak 1990) to Cainozoic for those of Honeymoon and Beverley in the Frome Embayment, South Australia. The Mulga Rock sandstone deposit in Western Australia was sourced from uranium in the Archaean basement to the west (Fulwood & Barwick 1990). Those in the Frome Embayment are derived from the adjacent exceptionally uranium-rich Proterozoic felsic rocks and perhaps from pre-existing uranium mineralisation (Curtis et al 1990).
- Unconformity-related uranium deposits, which formed in the late Palaeoproterozoic to late Neoproterozoic, are variably younger than the spatially associated Palaeoproterozoic to late Archaean felsic igneous rocks. In uranium fields such as in the Alligator Rivers – Arnhem Land region, available geochronological data provides evidence for several ages of mineralisation. This implies several episodes of transport and deposition of uranium, presumably triggered by tectonic activity, and resetting of ages through overprinting events.

It is interesting that no significant uraniferous deposits have been found in Late Archaean–Palaeoproterozoic conglomerates in Australia, which do not have the high proportions of quartz pebbles that are characteristic of the major gold–uranium bearing conglomerates of the Witwatersrand in South Africa, and to a lesser extent the uranium-bearing Elliott Lake conglomerates at Canada. This probably reflects the absence of major and relatively rapid uplift and erosion of fertile Archaean crustal blocks in Australia.

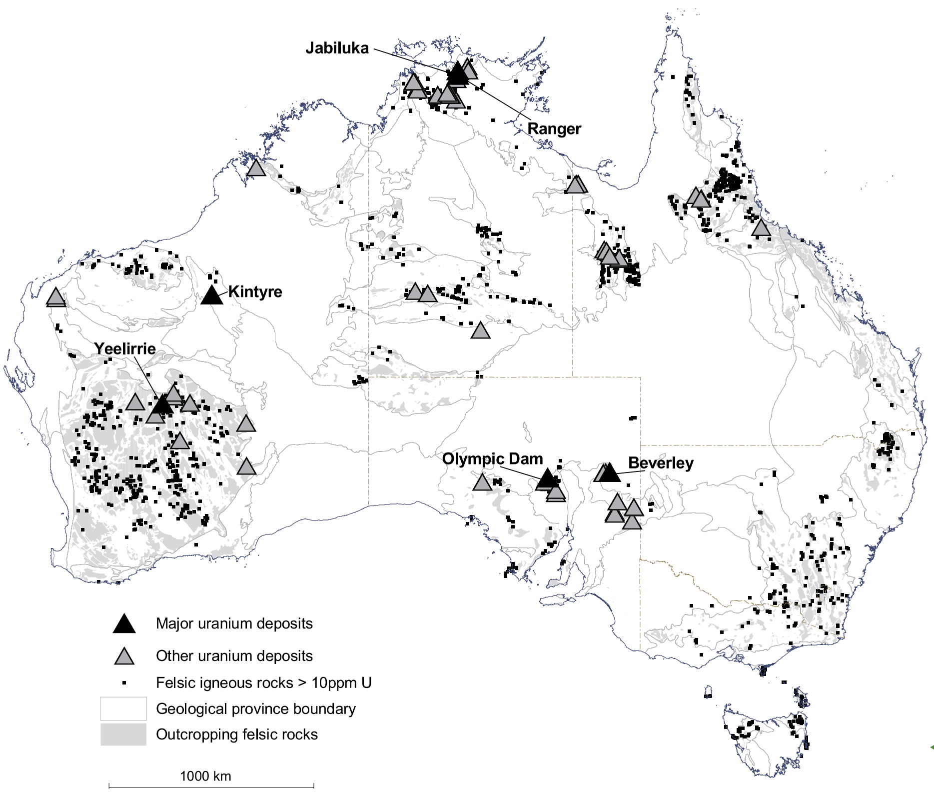


Figure 3. Australian uranium deposits in relation to occurrences of felsic igneous rocks known to have at least 10 ppm uranium.

Australian mineral exploration *update*

Global mineral exploration grows, but our share falls again

Mike Huleatt and Lynton Jaques

A recently released survey of world non-ferrous mineral exploration budgets for 2005 shows that the total budget increased for the third consecutive year to almost US$5.1 billion, 38% higher than in 2004. This was only slightly less than the US$5.2 billion achieved in 1997 at the peak of the last exploration boom (figure 1). The survey, by Canadian company Metals Economics Group (MEG), included over 1400 companies with exploration budgets exceeding US$100 000.

The MEG 2005 survey shows that Australia's share of global exploration budgets fell to a new record low of 13%. This is a 30% fall from about 19% in 1999 and is well below our 19–20% historic average. While the 2005 global mineral exploration budget rose by 38% over 2004, the overall Australian budget rose by only 17%.

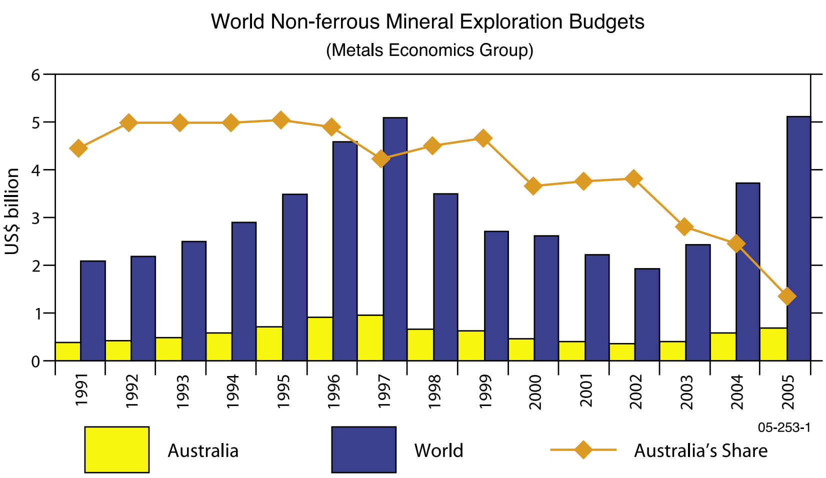
On a regional basis, Australia was again ranked fifth of seven after Latin America, Canada, Africa and the Rest of the World (figure 2). Canada remained the leading nation for the third year running, having displaced Australia from that position in 2002 and widened its lead in the 2005 survey.

The decline in Australia's share of world mineral exploration reflects the fact that minerals exploration is a global business in which Australia competes with other countries that also have rich mineral endowments.

Gold exploration budgets again exceeded those for base metals in dollar terms but base metals exploration budgets showed the greatest dollar increases in 2005. Copper exploration budgets increased substantially but the real standouts are the zinc exploration budget which increased about 90% and the nickel exploration budget which increased by almost 65%.

Late-stage exploration continues to be important in the current exploration cycle as companies work to bring projects to production to take advantage of the current high metals prices. The total budget for late-stage exploration (including feasibility work) was slightly higher than total grassroots exploration budgets.

According to the MEG survey, approximately 59% of the 2005 exploration budgets of Australian-based companies was for mineral exploration in Australia. The survey included 266 Australian-based companies with non-ferrous mineral exploration budgets of more than US$100 000 that were exploring in Australia. Budgets for Australian exploration were strongly directed to gold (US$331.4 million, 54%) which was 2% higher than in 2004.



◀ **Figure 1.** Global non-ferrous metal exploration budgets for 2005 together with Australian non-ferrous metal exploration budget and Australia's share of global mineral exploration budgets for the period 1991 to 2005. Source: Metals Economics Group Corporate Exploration Strategies.

Australian mineral exploration increases

Australia Bureau of Statistics (ABS) data for the 2004–05 financial year shows total mineral exploration expenditure of $1028.3 million. This is a 28% increase on 2003–04 figures and 49% on the low point of 2001–02, but is still 25% below the 1996–97 peak in real terms.

The steady rise in expenditure (figure 3) has been driven by a marked increase in demand for minerals, notably from China, and high metal prices—with most at or near 15 to 20-year highs. Improvements in the global economic market and high prices for mineral commodities have resulted in substantial improvement in the economic performance of the resources sector.

Spending increased in all jurisdictions except Victoria, where a minor fall occurred. Western Australia was the leader, attracting $606 million, an increase of 30% on 2003–04. It was followed by Queensland where spending rose by 32.9% to $166.4 million and New South Wales where spending rose by 45.7% to $73.6 million. Spending in South Australia rose by 60.4% to $66.9 million and in the Northern Territory (up by 30.8%) to $55.6 million. Tasmania recorded a 10.7% increase to $8.5 million. Victorian exploration spending fell by 3.7% to $51.5 million.

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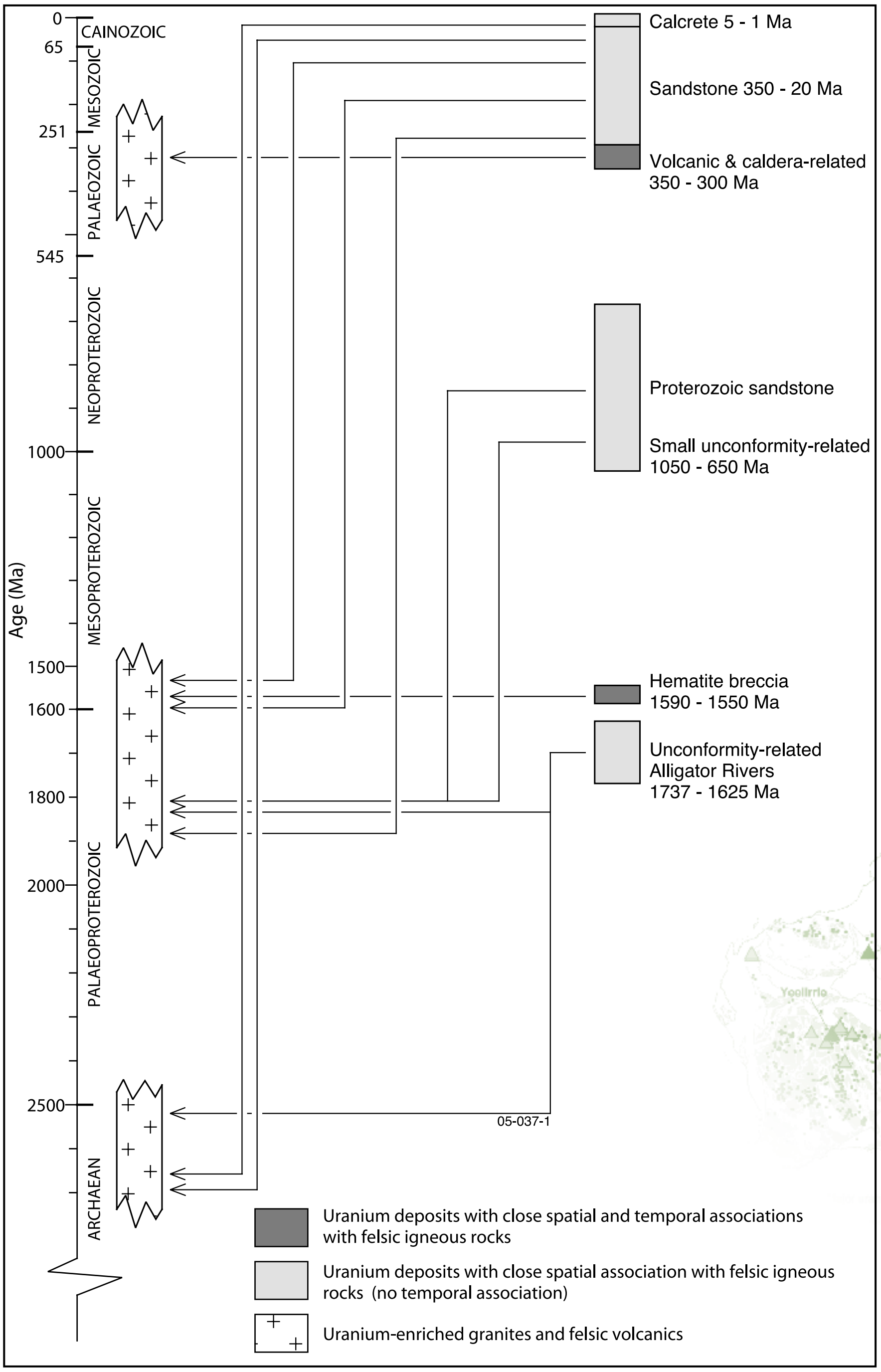

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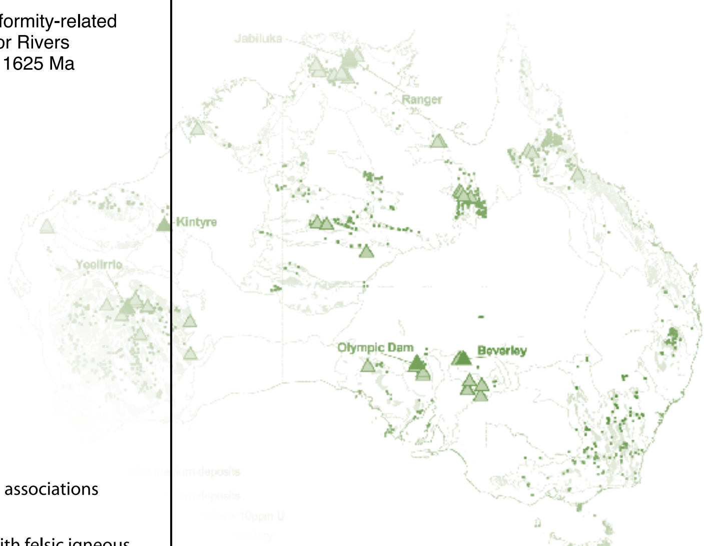

Figure 4. Ages of uranium deposits and uranium-enriched felsic igneous rocks. Lines link each deposit type to the age of its probable source rocks.

Gold

The strong growth in exploration expenditure in 2004–05 is encouraging but gold exploration has remained flat (declining in real terms) over the past two years. This trend is of concern because:

- for the past 20 years gold has comprised more than half Australia's mineral exploration expenditure
- the resource life for gold is lower than that of any other commodity except diamond.

ABS reported gold exploration spending for 2004–05 was $391.7 million, a reduction of $5.4 million over 2003–04. Western Australia was the focus of gold exploration with $259.6 million (66% of total spending).

Other metals

Copper exploration spending for 2004–05 was $71.3 million, an increase of $33.5 million (89%) over 2003–04. An increase in spending in South Australia of 139% to $32.7 million saw that state become the principal target for copper.

Exploration for nickel in 2004–05 rose by 88% to $158.6 million with all but $9.9 million spent in Western Australia. In contrast to the strong growth reported in nickel and copper exploration, spending on zinc, lead and silver exploration rose by only $1.5 million to $31.2 million.

ABS reported that spending on exploration for iron ore more than doubled in 2004–05 to $138 million, of which $136.9 million was spent in Western Australia and $0.9 million in the Northern Territory.

In 2004–05, ABS reported that exploration drilling totalled 6.78 million metres, an increase of 1.1 million metres (19%) from 2003–04. Of that total, 2.78 million metres was drilled in search for new deposits, accounting for 41% of all exploration drilling (a substantially smaller share than the 47% recorded the previous year).

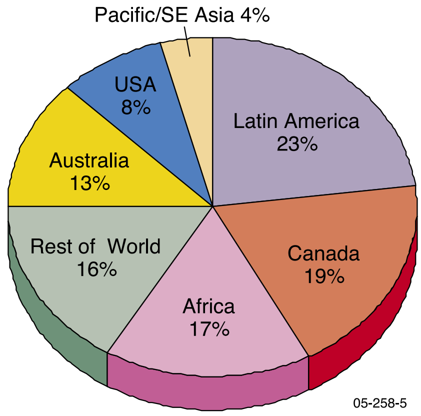

Figure 2. Distribution of world non-ferrous metal exploration budgets in 2005, as reported by the Metals Economics Group.

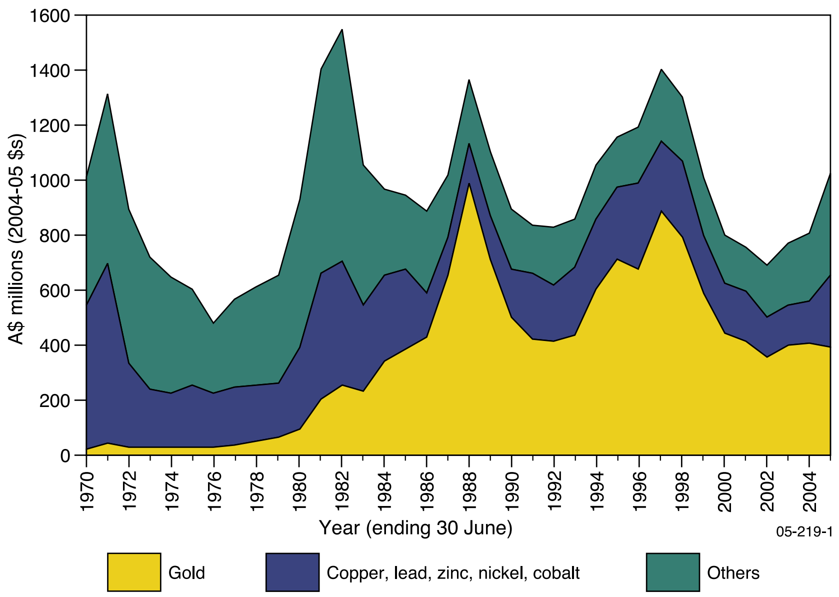

Figure 3. Australian mineral exploration expenditure 1970–2004 in constant 2004–05 dollars, based on Australian Bureau of Statistics data deflated by the Consumer Price Index.

Favourable outlook for exploration

Mineral exploration in Australia continued to recover in the past year; however, as illustrated by the MEG data, it is growing at slower rate than in many other parts of the world. Persistent high gold and metal prices and continuing strong demand for metals and bulk mineral commodities such as iron ore and coal, particularly from China, are driving the growth.

In the longer term, demand for base metals and bulk commodities will primarily depend on the rate and extent of economic growth in China, the strength of the US economy and the impact of high oil prices on the international economy.

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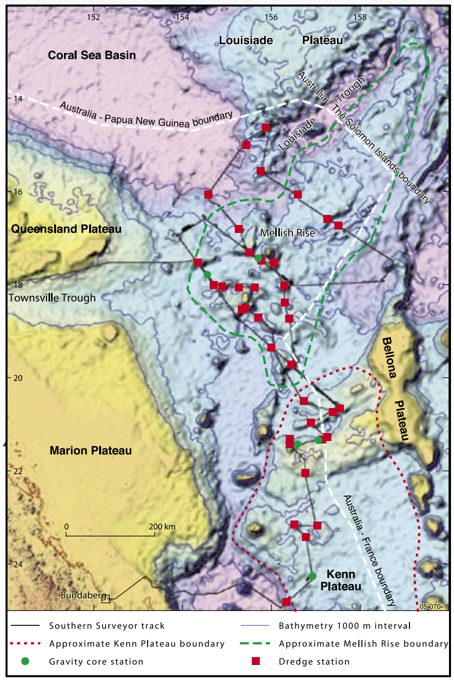
The Mellish Rise — A BIG PIECE OF THE CORAL SEA GEOLOGICAL JIGSAW PUZZLE

Geoscience Australia's contribution to understanding one of the least known parts of Australia's marine jurisdiction.

George Bernardel and Jim Colwell

In January–February 2005, Geoscience Australia used the National Facility research vessel *Southern Surveyor* to study the Mellish Rise and adjoining Kenn Plateau in the Coral Sea, east of Queensland (figure 1). Ship time was provided by the Steering Committee of the National Facility *Southern Surveyor*. The voyage was led by Dr Neville Exon of Geoscience Australia, who led an earlier survey to the Kenn Plateau in May 2004 (see *AusGeo News 75* at www.ga.gov.au/ausgeonews/archive/200410.jsp).

The shipboard team consisted of a core of Geoscience Australia technicians and scientists supported by scientists from the Geological Survey of Queensland, the Australian National University and the University of Sydney. CSIRO provided technical support, and P&O Australia provided the vessel's crew.



▲ **Figure 1.** Location of the Mellish Rise and Kenn Plateau in the Coral Sea, showing the track of the *Southern Surveyor* and the locations sampled. The background image shows regional bathymetry. The Mellish Rise comprises probable rifted continental and oceanic fragments.

Regional setting

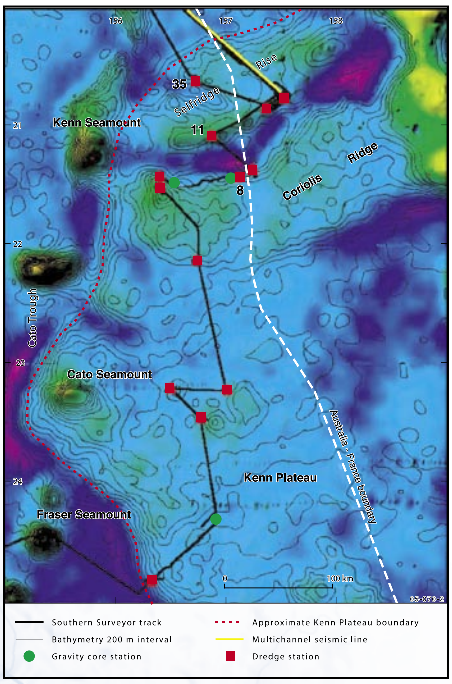
Most of the work was undertaken on the Mellish Rise, a large, complex, northeast-elongated, dissected block. It is believed to have separated from the Australian continental margin as a result of extension between the Australian, Lord Howe Rise and Louisiade Plateau crustal elements from about 52 to 62 million years ago.

The Mellish Rise's northwest margin is separated from the Louisiade Plateau by the Louisiade Trough, which may have been the prolongation of a Townsville Trough rift system before evolving into an arm of a triple junction developed between the rise and Marion Plateau (figure 1). The arcuate south-eastern margin, bordering the Kenn and Bellona Plateaus, may have formed as a strike-slip fault between the triple junction to the west and the seafloor-spreading system along the Rise's eastern margin.

Lying mainly in water depths between 500 and 3000 metres, the Mellish Rise's total area is about 200 000 km^2, of which about 150 000 km^2—an area twice as large as Tasmania—is under Australian jurisdiction. The eastern part of the Rise is French (New Caledonian) territory, and the northern section is Solomon Islands territory (figure 1).

Acquisition program

Previous geophysical surveys over the Coral Sea, largely undertaken as part of the Continental Margins Program by the former Bureau of Mineral Resources in the early 1970s, did not include rock sampling to enable dating and determination of the nature of the sedimentary strata and basement rocks. The latest survey (figures 1 to 3) acquired 40 dredge hauls of rocks (14 over the Kenn Plateau and 26 over the Mellish Rise), ~1200 km of multichannel seismic profiles, ~2000 km of magnetic profiles and ~7000 km of multibeam sonar data (i.e. ~18,000 km^2 of seabed coverage). The dredging of the Mellish Rise largely completes the geological sampling of all major plateaus off Australia, at least to reconnaissance level.



▶ **Figure 2.** The complexity of the Kenn Plateau area is evident in this map of the Earth's gravity field recorded from satellites and ship surveys. Details of the *Southern Surveyor* Ĉ survey are shown, including the positions of three key dredge sites.

Complex dissected area

The Mellish Rise and Kenn Plateau form a complex area (figures 1 to 3). The seismic and multibeam data show that the rise is much like a dissected plateau, largely formed of irregularly shaped highs separated by valleys. The highs are fault-bounded basement blocks crowned in places by seamounts (for example, Mellish Reef in figure 3). Seismic profiles show that the valleys are characterised by several thick sequences, with the upper sequence thin across the highs.

The sequences in the valleys appear to comprise at least three packages: Late Cretaceous – Early Palaeocene (100–60 Ma), Late Palaeocene – Eocene (60–34 Ma) and Oligocene and younger (33–0 Ma). Several phases of tectonism are interpreted. The oldest package is related to rifting and subsequent break-up of the east Gondwana margin. The transition from the middle to youngest package is related to the onset of a period of compression from the east in the Eocene (~ 40–45 Ma).

Volcanic edifices such as the seamount underlying the Mellish Reef (figure 3) are probably part of the Tasmantid seamount chain, which was formed 30–35 million years ago and extends southward down the east Australian margin to east of Tasmania.

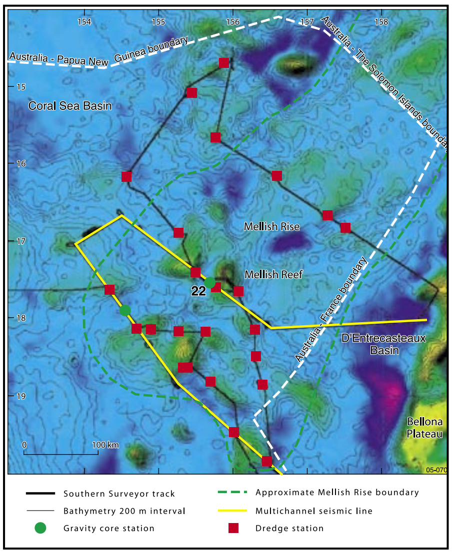


Figure 3. The complexity of the Mellish Rise is evident in this map of the Earth's gravity field recorded from satellites and ship surveys. Details of the *Southern Surveyor* survey are shown, including the position of a key dredge site (dredge 22).

Dredge information

Many types of rocks were dredged and sediment cores taken during the survey. The cores recovered mainly calcareous and foram nanno ooze. The 40 dredges (figure 1) sampled a diverse suite, including mostly siliciclastic sediments, calcarenites, felsic volcanic rocks, volcaniclastic rocks, basalts, dolerites and ubiquitous manganese crusts.

The Coriolis Ridge was sampled by dredge 8 (figure 2), which brought up sandstone and revealed a volcanic terrain supporting continental felsic volcanics. This demonstrates a continental origin for Kenn Plateau basement. Further to the north, at dredge sites 11 and 35 (figure 2) on the Selfridge Rise, just beyond the southern edge of the Mellish Rise, hauls including metamorphic quartzite and hard quartz-rich sandstone rocks further support a continental origin for the plateau and, probably, the adjoining Mellish Rise.

Typical volcanic seamount rocks and capping reefal rocks, such as basalt and calcarenite, were dredged from the seamount hosting the Mellish Reef in the centre of the Mellish Rise (dredge 22 on figures 3 and 4). If the basaltic material can be dated, this may provide the most northerly and oldest date for the Tasmantid seamount chain.

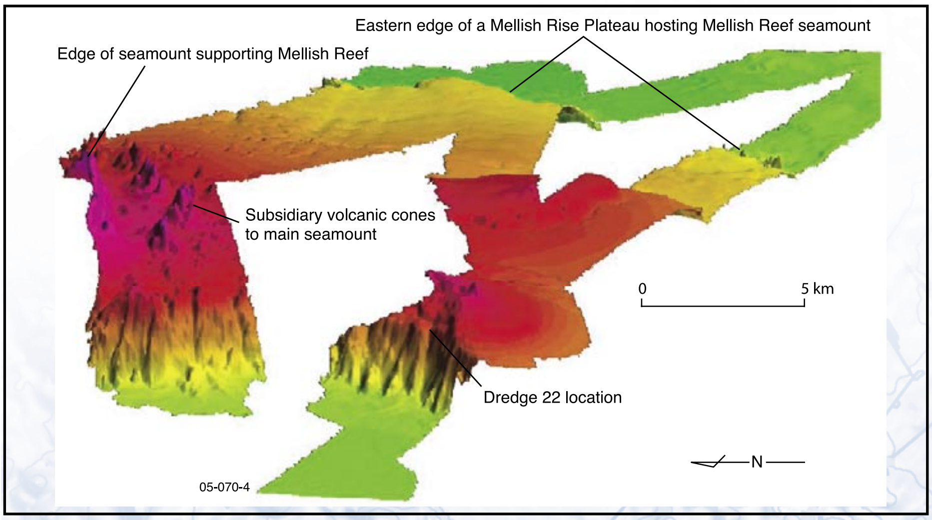


Figure 4. Example of seafloor multibeam sonar coverage south of the Mellish Reef. The site where rocks from dredge 22 were obtained is shown.

Further analysis

An excellent understanding of the geological composition and evolution of the Mellish Rise and Kenn Plateau region is expected to be gained from the interpretation of seismic profiles and seafloor morphology, petrological examination, and nannofossil and foraminiferal evaluation of the sedimentary rocks now underway. These studies will provide insight into the nature of the basement rocks underpinning the Mellish Rise, which is probably a mixture of older continental rocks and younger oceanic basaltic volcanics. The information gained will enable further refinement of the complex break-up and seafloor-spreading history of the southwest Pacific in current tectonic models. Information on seafloor morphology and sediments will also contribute to future marine planning for the area.

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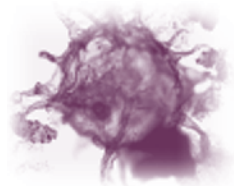
The *'New'* EDIACARAN PERIOD



The latest geological time scale includes a newly identified period named after a locality in South Australia.

Kath Grey (Geological Survey of Western Australia), John Laurie (Geoscience Australia) and Jim Gehling (South Australian Museum)

The geological time scale has been developed by geoscientists over the past two centuries to describe and understand the history of the Earth.

Its foundation is an international standardised system of time intervals whose names commonly derive from words associated with the areas where they were first defined.

The Cambrian Period took its name from Cambria, the Roman name for northern Wales, while Jurassic is derived from the Jura region of northern Switzerland. Similarly, the new Ediacaran Period is named after the Ediacara Hills in the northern Flinders Ranges in South Australia.

Figure 1. Professor Guy Narbonne (Queen's University, Canada), at left, and Dr Jim Gehling (SA Museum) at the Ediacaran Global Stratotype Section and Point at the base of the Nuccaleena Formation, in Enorama Creek, Flinders Ranges. The toe of Professor Narbonne's left boot is just above the marker denoting the base of the Ediacaran. Dr Gehling is leaning on the explanatory sign.

The Earth thaws

The Ediacaran Period is the first period-level interval of geological time to be created in the Standard Global Chronostratigraphic Scale for well over 100 years. It covers an interval of about 88 million years from the end of the Marinoan glaciation about 630 million years ago to the beginning of the Cambrian Period about 542 million years ago.

As befits a period with such a well-known South Australian name, its base is defined by a Global Stratotype Section and Point (GSSP) at the base of the Nuccaleena Formation, immediately above the Elatina diamictite in the Enorama Creek section of the Flinders Ranges (figure 1). The GSSP was officially unveiled by the South Australian Premier, Mike Rann, on 16 April 2005.

This level in the rock succession marks the termination of the Marinoan glaciation. The Marinoan was the last truly global glaciation of the Neoproterozoic and, at its peak, saw continental glaciers reach sea level in tropical latitudes. It was so severe and widespread that some researchers consider that the entire planet froze (the 'Snowball Earth' hypothesis).

This glaciation, which began near the end of the appropriately named Cryogenian Period, is represented in the Flinders Ranges by the Elatina Formation and correlative units. The subsequent abrupt deglaciation led to the deposition of a peculiar carbonate unit termed a 'cap dolostone' which, in the Flinders Ranges, is found in the base of the Nuccaleena Formation. Cap dolostones like that in the Nuccaleena have been recognised around the globe immediately above the last of the Neoproterozoic glacial deposits.

Figure 2. Representatives of the Ediacara biota.

New life, new system

The Ediacaran is perhaps most famous for its association with the Ediacara biota (figure 2), a peculiar group of organisms, many of which are of uncertain affinity. Although they had previously been found in other places around the world, their significance only began to be understood when they were discovered in the Ediacara Hills by Reg Sprigg in 1946 (Sprigg 1947).

They mark the first appearance of large, architecturally complex organisms in Earth history. Although there has been a great deal of debate about their relationships, current evidence suggests that the Ediacara biota included a mixture of stem- and crown-group radial animals, stem-group bilaterian animals and perhaps representatives of other eukaryotic kingdoms.

The Association of Australasian Palaeontologists recently published 'Ediacaran Palynology of Australia' (Grey 2005; figure 3) with support from the Virtual Centre for Economic Micropalaeontology and Palynology and the Geological Survey of Western Australia.

Using a diverse palynoflora, one of us (Grey) has developed the first biostratigraphic scheme for the Ediacaran of Australia. Indeed, it is the first continent-wide biostratigraphic study of such a long interval of Proterozoic time published anywhere in the world.

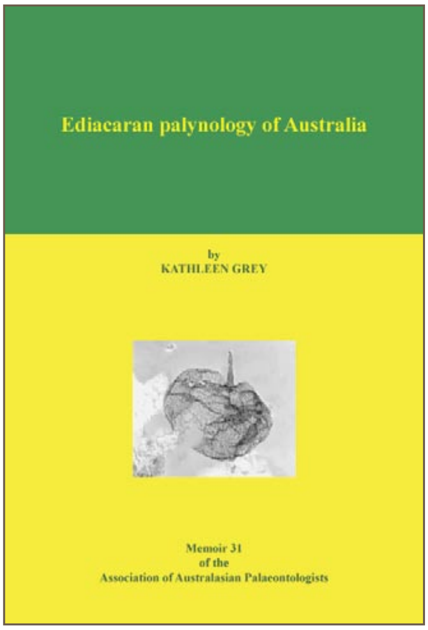
The scheme of five assemblage zones—based on the ranges of over 60 species of the problematic single-celled organisms called acritarchs (see figure 4)—allows rock successions in the Adelaide Rift Complex and the various remnant basins of the Centralian Superbasin to be correlated more precisely than has previously been possible.

There is much potential for further subdivision and more precise correlation as these acritarch assemblages become better documented. The assemblages also show promise for global correlation because some of the species identified in Australia are also known from coeval successions in China, Siberia and northern Europe.

Ediacaran assemblages in the Centralian Superbasin and Adelaide Rift Complex are taxonomically diverse, with two palynofloras and five assemblage zones recognised (figure 4). The older palynoflora, the Ediacaran Leiosphere-dominated Palynoflora, contains only one assemblage zone. It is succeeded by a younger Ediacaran Complex-Acanthomorph-dominated Palynoflora, which contains four assemblage zones. These zones are demonstrably independent of lithology and can be recognised across the Adelaide Rift Complex and the Officer and Amadeus basins, despite taphonomic and palaeoenvironmental influences.

The large Neoproterozoic acanthomorph acritarchs, which are between 200 and 900 µm in diameter and which form a significant component of these diverse Ediacaran assemblages, are poorly represented in samples prepared using standard palynological preparation techniques. They are particularly vulnerable to fragmentation because of their large size and fragility.

As a consequence, an improved palynological preparation technique—described by Grey (1999)—had to be developed for this study. This produced greatly increased yields of microfossils from horizons that were seemingly barren or had only limited yields using standard techniques. The improved method has increased yields from Ediacaran sediments and allowed the development of this detailed biostratigraphic scheme.

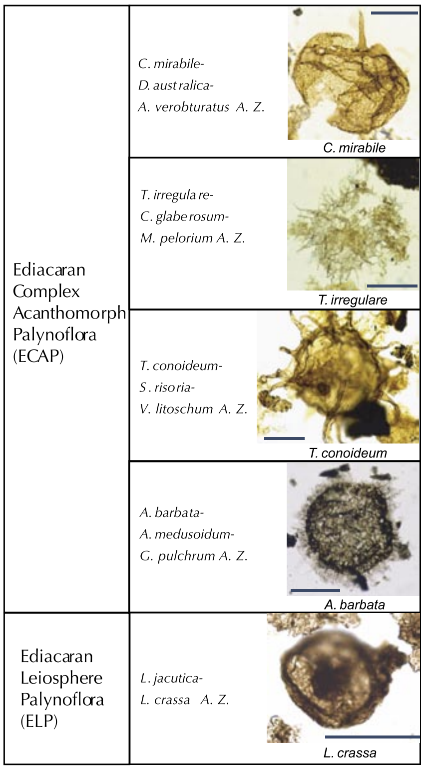


▲ **Figure 3.** Front cover of 'Ediacaran Palynology of Australia' (Grey 2005).

An evolutionary shock?

The marked and rapid increase in abundance, size, morphological complexity and taxonomic diversity of life forms during the Australian Ediacaran shows that it was a period of major evolutionary change. Observed biotic changes are radical, and the position of this important transition matches a short-lived negative $\delta^{13}C_{org}$ excursion that approximates to the debris layer from the Acraman impact event. The $\delta^{13}C_{org}$ is used as a measurement of the ratio of Carbon isotopes in the organic material in the rock.

This impact was of a meteorite estimated to be about 4.8 kilometres across, which left a crater about 90 kilometres in diameter centred on Lake Acraman in South Australia. Debris from the impact is spread over a radius of at least 560 kilometres, but it was so large that it would have had a global effect. The following marked positive $\delta^{13}C_{org}$ excursion corresponds to the acanthomorph acritarch diversification. The evidence for a relationship between the Acraman impact event and this dramatic diversification is largely circumstantial, and requires further investigation.



▲ **Figure 4.** Ediacaran biostratigraphic scheme of assemblage zones (AZ) from Grey (2005), with illustrations of some of the eponymous acritarchs. Scale bars are 100 µm in length.

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Copies of *Ediacaran Palynology of Australia* are available from the Geological Society of Australia (www.gsa.org.au/publications.html)

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CRUSTAL DEFORMATION from the SUMATRA–ANDAMAN EARTHQUAKE

Geoscience Australia's analysis of the largest earthquake since the beginning of modern space geodesy.

Minghai Jia

The Global Positioning System (GPS) and a global network of receivers now enable detection of ground motion at the millimetre to centimetre level before, during and after earthquakes.

GPS data from the global network of more than 200 sites is routinely analysed for various research purposes, including the monitoring of global sea level, climate change, and crustal deformation in Southeast Asia, Australia, the South Pacific and Antarctica.

Long-term GPS time series analysis shows that the Australian and Indian plates move towards Sumatra–Andaman at velocities of five centimetres and four centimetres per year, respectively.

To assess the Sumatra–Andaman earthquake, Geoscience Australia used Bernese GPS Processing Software Version 5.0 to analyse data from more than 250 GPS sites, including the 200 global GPS sites and 50 local GPS sites in the region, including sites in Australia, Malaysia, Thailand, Indonesia, the Philippines, China, India and the Maldives.

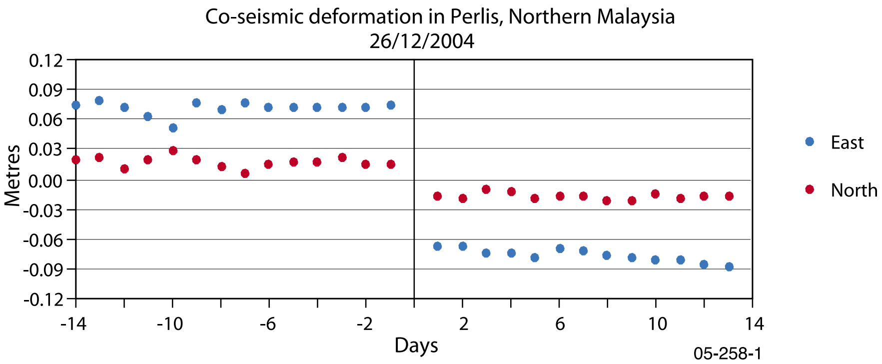
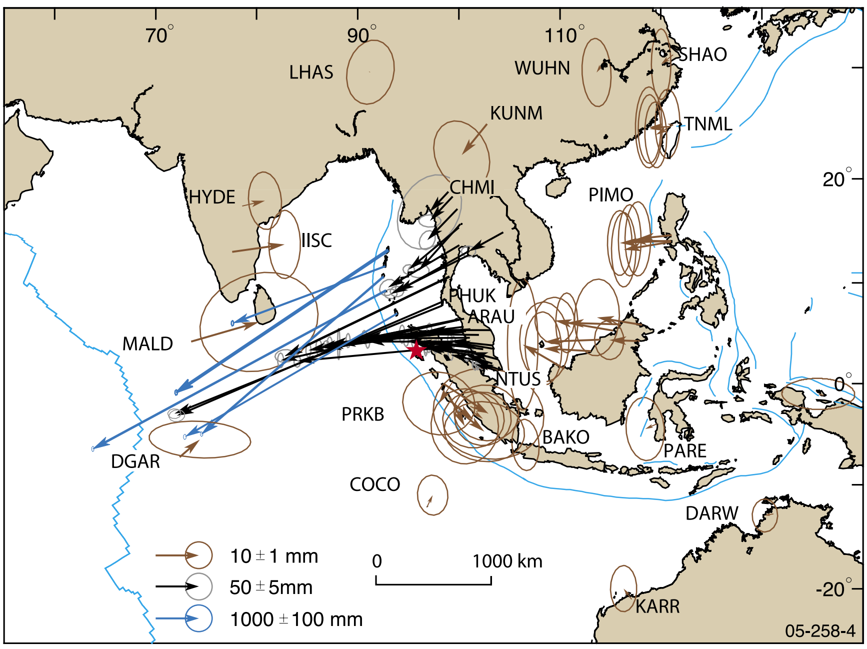


Figure 1. Co-seismic deformation at GPS site ARAU (Perlis, northern Malaysia).



Co-seismic deformation

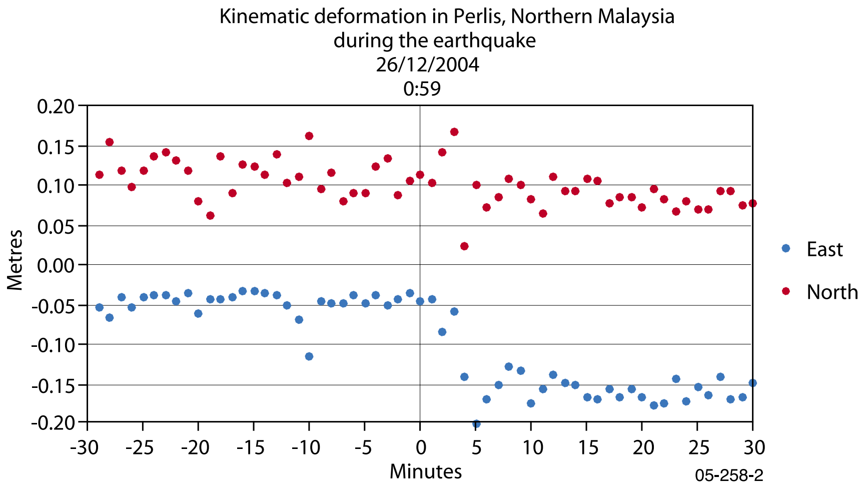
Co-seismic displacements were computed from two combined seven-day solutions—one before and one after the earthquake. Displacements of the sites were calculated as the difference between the two solutions. As an example, Figure 1 shows the co-seismic deformation at GPS site ARAU (Perlis, northern Malaysia). Displacements of 15 centimetres in the east and three centimetres in the north occurred at the site.

The displacement field and error ellipses for all GPS sites in the earthquake region are shown in Figure 2.

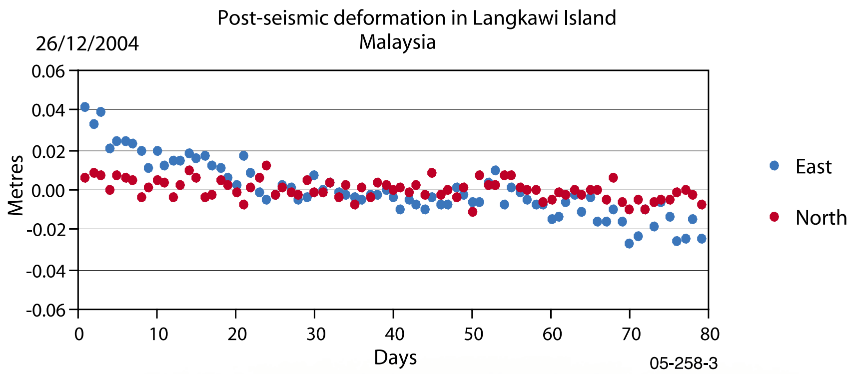
The displacement detected by GPS varies with location. Displacements vary from three to six metres in the Andaman and Nicobar Islands, indicated by the blue arrows. The black arrows show displacements at sites in Thailand, Malaysia and Sumatra. Almost 28 centimetres displacement was detected at GPS site PHUK (Phuket Island, southern Thailand near northern Malaysia), decreasing gradually towards the north and south.

Displacements reduced to two centimetres at the NTUS site (Singapore) and three centimetres at the CHMI site (northern Thailand). Deformation of around 10 millimetres was detected at large distances, indicated by brown arrows. Deformations from these sites, except for sites southeast from the epicentre, were also generally towards the epicentre or the great Sumatra fault, even though they were relatively small compared with their error ellipses.

Figure 2. Displacement field for the earthquake region determined by GPS. The red star represents the epicentre, and the green lines show plate and fault boundaries.



▲ **Figure 3.** Kinematic deformation at GPS site ARAU (Perlis, northern Malaysia) during the earthquake, which occurred at about 0:59 on 26 December 2004.



▲ **Figure 4.** Post-seismic deformation at GPS site LGKW (Langkawi Island, northern Malaysia).

The southeast sites seem not to have been impacted by the earthquake, which implies that the stress along the subduction zone plate interface of southern Sumatra was not released. This is the likely reason for the Simeulue–Nias earthquake on 28 March 2005.

The determination of co-seismic deformation is very useful for further investigation of fault slip models and of other seismic features of the earthquake.

Kinematic deformation

Kinematic coordinate solutions, computed from stations near the earthquake every 30 seconds over 30-minute periods before and after the earthquake (0:59, 26 December 2004), show the progression of the rupture.

Figure 3 shows the kinematic deformation of 10 centimetres at GPS site ARAU. Deformation was detected when the surface waves began to hit the site two minutes after the earthquake; four minutes later, positions at the site were relatively stable again.

Earthquake progressions of this type enable scientists to better understand the fault rupture process. In the near future, the determination of real-time deformation may also benefit tsunami warning systems, such as the Australia Tsunami Warning System, by allowing us to make more reliable assessments of the likelihood of tsunami events.

Post-seismic deformation

Using a long-term GPS time series after the earthquake, we can also examine the post-seismic deformation process. As an example, Figure 4 shows the deformation at GPS site LGKW (Langkawi Island, Malaysia), which declined continuously over time after the earthquake. An eastward deformation of more than six centimetres was determined during the 80-day period after the earthquake.

Such post-seismic deformation information from all available GPS sites in the earthquake region can help scientists analyse likely elastic, poroelastic and viscoelastic deformation, and plastic flow of the Earth's crust in the earthquake region, giving a better understanding of crustal relocation and redistribution after the earthquake.

For further information, phone Minghai Jia on +61 2 6249 9045 (email minghai.jia@ga.gov.au)

AFTER THE DELUGE, a post-disaster survey

Geoscience Australia is developing and piloting post-disaster surveys to understand a community's vulnerability.

Mary Milne

New post-disaster surveys will help us to better understand the major factors that influence a community's vulnerability to hazard events and the costs of such events. This effort is a response to the Council of Australian Governments' review, 'Natural Disasters in Australia', which found that only limited socioeconomic and damage data is consistently and comprehensively collected after natural disasters.

Geoscience Australia sent a team to survey businesses and households affected by flooding in northern NSW and southeast Queensland from 28 to 30 June 2005. Two people died in this event, many had to be evacuated, and businesses and residents suffered significant losses and disruption to normal activities.

Major objectives of the survey were:

- to gather data on damage, disruption and costs from flood and storm events across prepared and unprepared communities
- to gather data on the types of preparation that businesses and households carry out, and their effectiveness in reducing losses
- to pilot the business and household surveys (figure 1).

The survey included small businesses in Lismore and Billinudgel, a township two kilometres from the coast, and householders in three of the most severely affected localities on the northern NSW coastline—New Brighton, Ocean Shores and South Golden Beach (figure 2).

Levels of preparedness differed greatly between the surveyed communities, and depended on such factors as previous experience of flood events, warning time and the rate of flood-level rise.

Lismore, with a history of regular flooding, was the most prepared of the surveyed communities. A recently completed levee upgrade protected the city's CBD. Most businesses and households had either lifted or relocated their property, many doing so before official flood warnings were issued. Many surveyed businesses also used the Bureau of Meteorology website to monitor flood-level forecasts and develop evacuation plans.

Although Billinudgel experiences regular flooding, in this event the water rose faster and higher than in previous floods and cut road access to the township, preventing some owners from lifting or moving property.

In general, the surveyed northern NSW coastal communities have not experienced regular flooding. Because this flood reached its peak before sunrise, householders had limited opportunity to prepare for the event, and many surveyed households had not received an official warning.

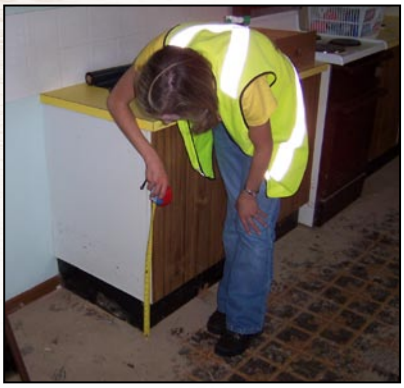
Cost of damage. Surveyed households suffered an average $27 000 in insured losses, including building, contents and vehicle damage. Floor coverings and furniture were damaged even in areas where floodwaters rose to relatively low levels (figure 3).

Surveyed householders reported initial stress over whether their losses were claimable, because insurance covers storm damage but not damage caused by riverine flood. On the coast, the event was classified as a storm, so insured households were able to claim. In Lismore, it was classified as a flood.

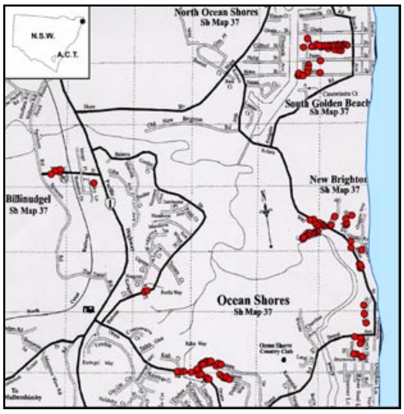
Cost of disruption. All surveyed businesses in Lismore were disrupted by the flood, regardless of whether water entered their premises. Relocating property to restore businesses at a time of limited road access for proprietors, staff and customers resulted in an average of two days of lost trading. Service providers believed that they would not be able to recoup losses; goods providers believed that transactions had merely been delayed by the event.

Recovery period. As a result of their high level of preparedness, small businesses in Lismore were soon back in operation. Even businesses that incurred water damage were operational after a few days.

In contrast, three months after the event, 50 per cent of surveyed households reported that repairs had either not started or were yet to be completed. About 60 per cent of the respondents identified a shortage of tradespeople as the major constraint to recovery.



▲ **Figure 1.** Surveying water depth in residential dwellings.



▲ **Figure 2.** Location of surveyed communities.

▲ **Figure 3**. Damaged household contents.

Geoscience Australia is continuing to collect recovery data for analysis and incorporation into the natural hazard risk models for estimating the socioeconomic costs of natural disasters.

For more information phone Mary Milne on +61 2 6249 9521 (email mary.milne@ga.gov.au)

In Brief

SENTINEL finds a permanent home at Geoscience Australia

The Sentinel bushfire monitoring system has become a permanent feature at Geoscience Australia. After nearly three years as a Research and Development (R&D) demonstrator project, providing assistance to the fire management community, it was decided that Sentinel would eventually be located at Geoscience Australia. The operational Sentinel system was seen as a logical extension to Geoscience Australia's current remote sensing activities.

The Sentinel bushfire monitoring service is an internet based mapping tool. It was designed to provide timely information to emergency service managers on the location of bushfires throughout Australia.

The system was developed by CSIRO Land and Water and the Defence Imagery and Geospatial Organisation (DIGO) in collaboration with Geoscience Australia after the devastating bushfires during December 2001 and January 2002. CSIRO began operating the website as an R&D demonstrator project and Geoscience Australia's remote sensing data acquisition facilities in Alice Springs provided information on potential "hotspot" locations.

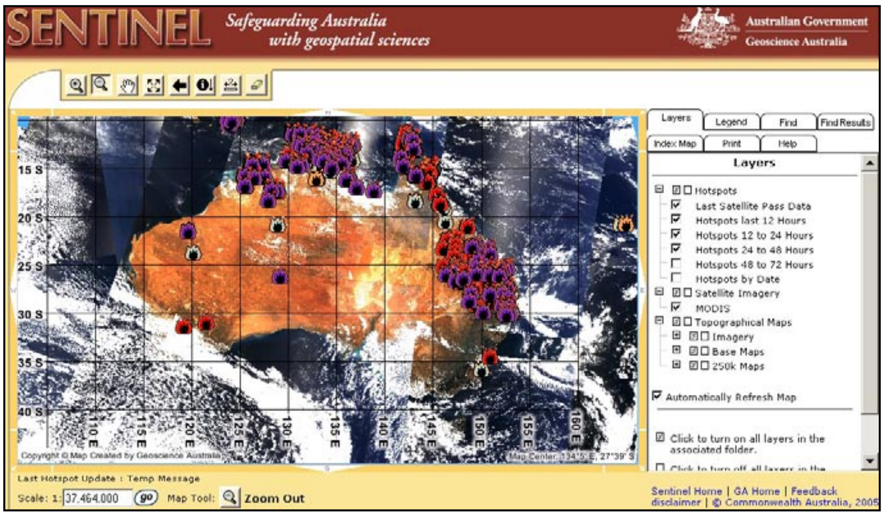
Hotspots from MODIS data

Sentinel hotspots are derived from Moderate Resolution Imaging Spectroradiometer (MODIS) sensors on board Terra (morning pass) and Aqua (afternoon pass) satellites. Images are captured, over a given point at least four times a day, between the two satellites, each with a ground swath of 2330 km and day/night coverage.

MODIS acquires data in 36 spectral bands, two of which are primarily thermal infrared channels at 4 and 11 µm and used for hotspot detection. The algorithm developed by the University of Maryland/NASA detects hotspots if $T_4 - T_{11} \geq 20K$ (10K for night passes) and $T_4 > 320K$ (315K for night passes), where, T_4 and T_{11} represent brightness temperatures in degrees Kelvin derived from MODIS bands 22 and 31 respectively.

Additionally, contextual information such as average background temperature and sun-glint factor is also considered when detecting hotspots.

The accuracy of MODIS data is considered to be superior to Advanced Very High Resolution Radiometer (AVHRR) data when detecting hotspots because it has higher sensitivity and fewer temperature saturation problems.



The new system offers a number of improvements over the original system.

The response time has been reduced when updating hotspot information on the web. Originally taking 60 to 90 minutes after acquisition to process, it now takes 45 minutes for daytime passes and 20 minutes for night passes, resulting in an improved website performance.

The quality of the MODIS colour imagery (500m) has also improved and is now updated within two hours of acquisition. There is also a choice of access from dial-up to broadband internet connection.

MODIS data acquired from the Hobart ground station is now integrated into the web service, which extends the Sentinel hotspot coverage to New Zealand. It also serves as a "backup" for South East Australia and is in addition to the Alice Springs coverage.

The new find/search facility will allow users to find the location of bushfires using the area name or other attributes such as lakes, airports, etc. Users can also search bushfires within a given buffer zone.

The system also supports additional topographic data (250K maps) and offers interoperable web mapping and feature service.

More satellite data and hotspot information from other satellites such as AVHRR will be added progressively by Geoscience Australia. Importantly, both CSIRO and Geoscience Australia's Sentinel web services will run in unison until at least January 2006. Once the operational capability of Geoscience Australia's system has been established, CSIRO will then withdraw its' Sentinel web service.

For more information phone Shanti Reddy +61 2 6249 9647 (email shanti.reddy@ga.gov.au) or visit (sentinel.ga.gov.au)

AUSGEO news
ISSUE 80 December 2005

New KARIJINI NATIONAL PARK MAP

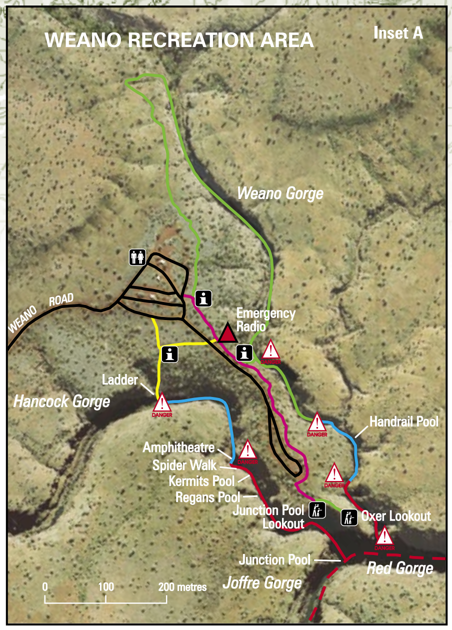
A new map and dataset covering the northern half of the Karijini National Park was launched in Perth on 28 October by the Hon Warren Entsch MP, Parliamentary Secretary to the Minister for Industry, Tourism and Resources together with the Western Australian Minister for Environment and Science, Dr Judy Edwards, MLA.

The Karijini National Park, located in the Pilbara region in the north-west of Western Australia, attracts around 100 000 visitors a year which equates to about 300 visitors a day. Underlying the natural beauty of the area with its sheer gorges, waterfalls and swimming holes is an extremely harsh and fragile environment.

The map is suitable for emergency management command and control, fire management, tourism management and rescue operations as well as visitors to the park. It uses high-resolution satellite imagery and aerial photography to highlight cultural features such as buildings, roads, mining infrastructure, dams and bores, terrain and major tourist sites. The map also provides important information relating to vegetation.

Karijini National Park was one of the areas identified by state emergency management and mapping agencies as being in urgent need of updating as part of the 1:100 000 scale national mapping pilot program being undertaken by Geoscience Australia. The map is the result of collaboration between Geoscience Australia, the Fire and Emergency Services Authority of WA, and the WA Department of Conservation and Land Management together with a number of local government agencies, community groups and local users.

For more information phone Phil Tickle on +61 2 6249 9769 (email phil.tickle@ga.gov.au). To order the map phone Freecall 1800 800 173 (in Australia) or +61 2 6249 9966 (email mapsales@ga.gov.au)



National soil website *launched*

The Australian Soil Research Information System (ASRIS) (www.asris.csiro.au), a product of the Australian Collaborative Land Evaluation Program (ACLEP), was officially launched by the Minister for Agriculture, Fisheries and Forestry, Peter McGauran, at Parliament House on October 12.

The new website, which is publicly available, has been tailored to meet the needs of anyone with an interest in natural resources. It provides the best available information on soil and land resources across Australia in a consistent format.

The system can be used to access information at seven different scales:

- the upper scales provide general descriptions of soil types, landforms and regolith across the continent
- the lower scales provide more detailed information in regions where mapping is completed. Information relates to soil depth, water storage, permeability, fertility, carbon and erodibility with most soil information recorded at five depths
- the lowest scale consists of a soil profile database with fully characterised sites that are known to be representative of significant areas and environments.

Information is displayed using coloured maps, satellite images, tables, photographs and graphs. The online geographic information system allows the user to zoom into a region of interest, produce customised maps and save the results to their computer.

Geoscience Australia's Dr. Colin Pain is a member of the National Coordinating Committee for Soil and Terrain (NCCST), which provides technical assistance and guidance to ACLEP. The national and regional map polygons of landforms and regolith are provided by the CRC Landscape Environments and Mineral Exploration's (LEME) physiographic regions project.

Peter McGauran, MP, Minister for Agriculture, Fisheries and Forestry, launching the new website at Parliament House.

Funding was provided by CSIRO Land and Water, and the Department of Agriculture, Forestry and Fisheries Australia (via the Natural Heritage Trust and National Land and Water Resources Audit). The collaborating state and territory agencies also provided substantial in-kind resources and technical support.

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Costing NATURAL DISASTERS in Queensland

The Council of Australian Governments'(COAG) review of Australia's approach to natural disaster management has highlighted the importance of costing disasters as part of a fundamental shift in focus towards cost-effective, evidence-based disaster mitigation. Currently, there are considerable data and research gaps in identifying the total costs of disasters in Australia. At the national and state level, limited cost data are systematically collected and collated by hazard event or location. In addition, little empirical research has been done on the costs to society of different hazard events across jurisdictions (BTRE, 2001).

Geoscience Australia's Risk Research Group has established a pilot project in collaboration with Queensland state agencies to identify and collate existing cost data in order to develop maps, economic tools and models for estimating potential direct costs from natural hazards across jurisdictions. More broadly, the project contributes to COAG Reform Commitments 1 and 2, examining existing data collection systems at the state level and how these can be replicated and modified to facilitate the collection of consistent data for a national risk assessment.

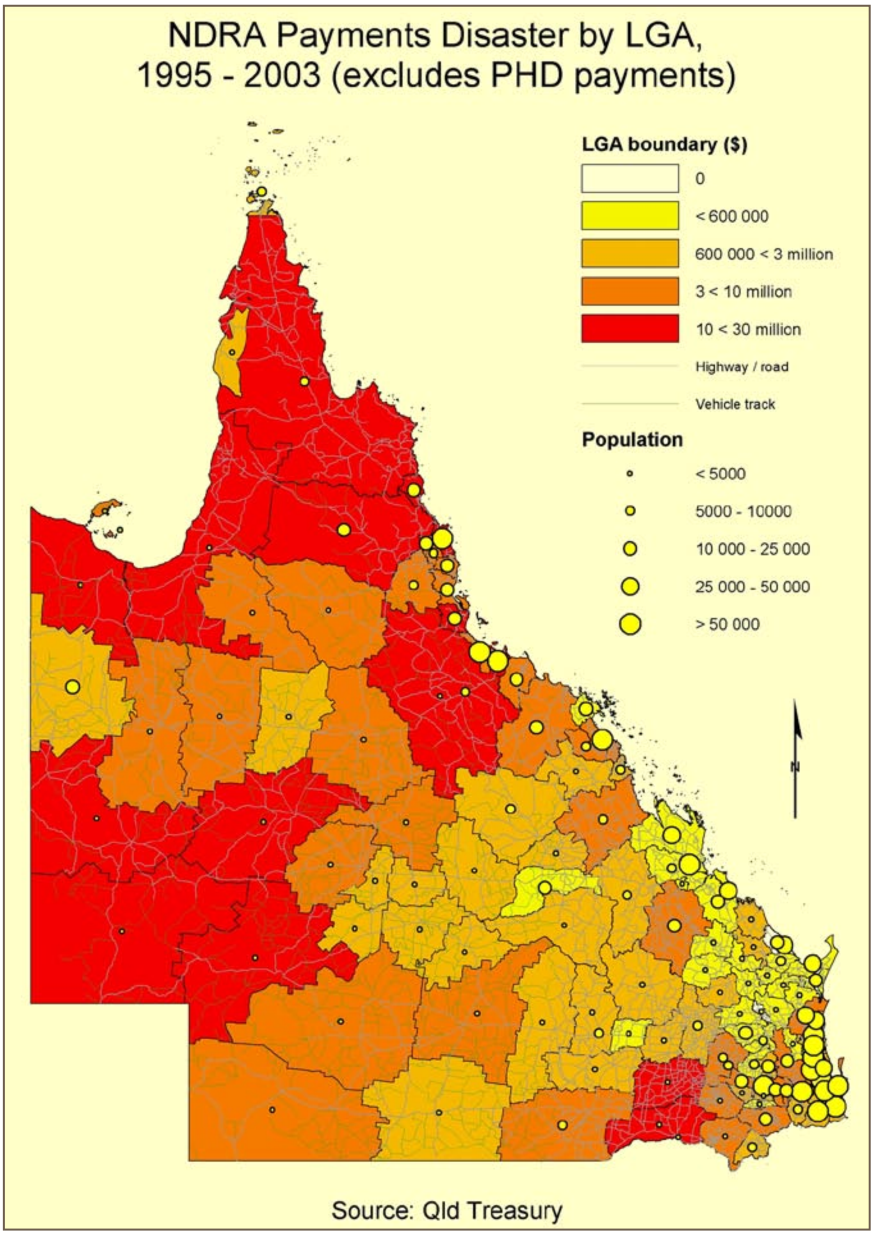


Figure 1. Queensland Natural Disaster Relief Arrangements (NDRA) asset restoration costs by Local Government Area, 1995-2003

The project will provide:

- better understanding of the type of cost data currently being collected at state level and hence the opportunity to more fully understand the type and extent of costs across jurisdictions for incorporation into a national risk assessment framework
- a series of recommendations for cost data collection to ensure a consistent approach across jurisdictions
- a stronger basis for evaluating risk management and mitigation projects and programs
- a stronger basis for allocating resources for disaster management
- the framework for a collaborative process with state stakeholders.

In its first phase, the project has provided a comprehensive historic Natural Disaster Relief Arrangements (NDRA) events database for Queensland along with maps showing the distribution of historical NDRA costs across the State. The database is an integration of three agency data sets, and provides information on the type of hazard event, the location and a breakdown of the major public costs incurred.

A major finding from the review of historical data is that 90 to 95 per cent of the annual claims on NDRA have been spent on recurrent flood damage to road infrastructure in west and north Queensland (see figure 1).

The project has led to a better understanding of the data required to undertake an assessment of the costs of natural disasters in Queensland and how this information can be used to assist in making decisions regarding mitigation spending. It has also examined the existing data collection systems at the state level and how they could be replicated across other states. This provided an insight into how existing systems could be modified to allow for the collection of relevant data to support risk assessment strategies at the national level. The project will conclude in June 2006.

For more information phone Mary Milne on +61 2 6249 9521 (email mary.milne@ga.gov.au)

Related Websites:

Bureau of Transport and Rural Economics:
www.btre.gov.au/docs/reports/r103/r103.aspx

AUSGEO news
ISSUE 80 December 2005

MapConnect:
The next generation of *on-line mapping*

In early 2006 Geoscience Australia will be launching its next generation of on-line mapping applications. 'MapConnect' will allow users to select and download datasets in a standard web browser environment without the need for any additional software. It will also access the most current data utilising user-defined areas, themes and formats.

Initially, MapConnect will be used to access the Topographic 250K Series 3 Geodata, a nationally consistent database and map series that covers the entire nation. Geodata 3 will contain data that has been updated, checked and validated within the last five years. It is optimised for a scale of 1:250 000 and will be used by the spatial information industry, as well as users involved in emergency management, resource management, tourism, education and recreation. All data available through MapConnect will be free of charge under the provisions of the Australian Government's Spatial Data Access and Pricing Policy (www.osdm.gov.au/osdm/spatial_data.html).

MapConnect will be a convenient and user-friendly way to access GeoData 3, allowing users to view the selected data as a map and download their areas of interest in various formats. The user will be able to define their own customised area boundaries or specify standard 1:250,000 scale map tiles. When downloading the data, users will be able to choose a format to suit their use. The dynamic and practical choices available are:

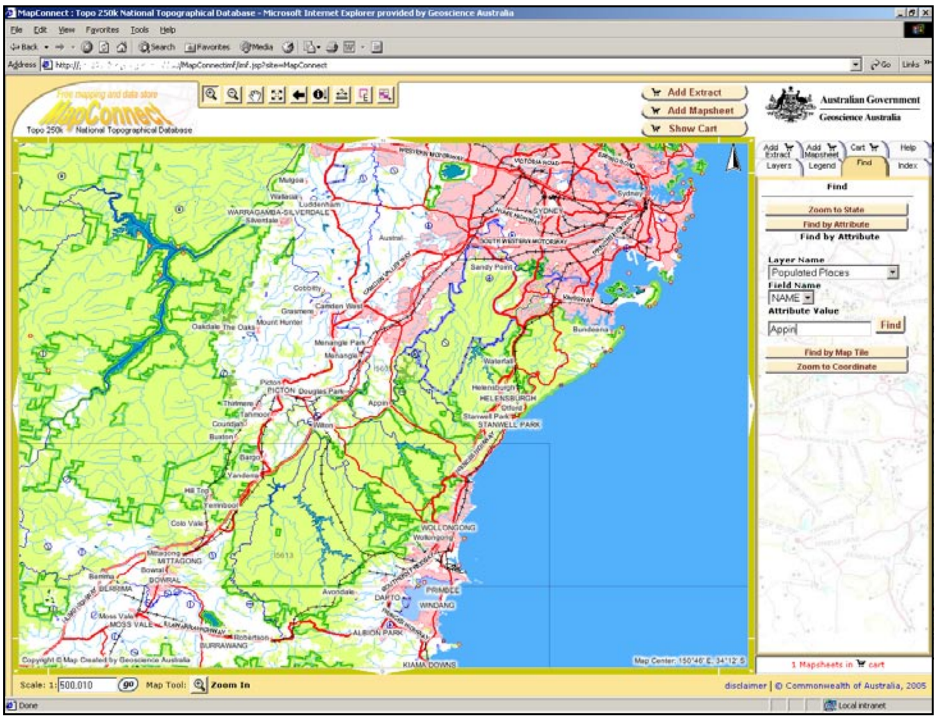
- image formats – ideal for use with GPS navigation systems in vehicle mounted or handheld devices
- GIS formats – attributes and symbology (pGDB, ShapeFile, Mid/Miff & GML formats) that are useful for input into software packages as well as analysis and advanced map production. Data can be selected by theme or as a single file before being compressed for download.
- screen based images – can be simply printed from the map window for use by the general public
- PDF maps – high quality cartographic maps, including legends and scales that can be used by emergency managers or field crew, or incorporated into publications and reports. These maps are in a vector format that allows them to be printed at high resolution or enlarged without loss of quality. Initially these will only be available to emergency management and government agencies.

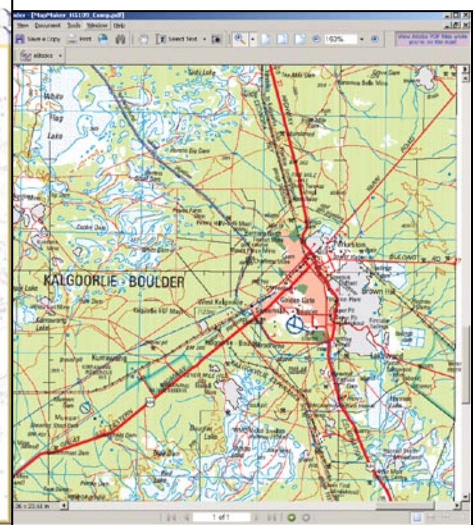
Locating an area of interest will be as simple as entering a place name or map sheet name and zooming into the location. The extent of the download can be selected before choosing preferred formats. The data download is extracted directly from a database to ensure that the most recent data is available to the user. Alternately a data set on DVD covering the whole country is available in a 'seamless' format for the cost of transfer.

Future developments will include the ability to download only that data updated during a specified time frame. This methodology is known as 'incremental updates' and is a national standard specified by the Intergovernmental Committee on Surveying and Mapping (ICSM). It applies only to the GIS formats and reduces the amount of data transferred after the initial download. This also enables advanced users to analyse areas of change during a specified timeframe.

All downloads are registered and licensed with the Office of Spatial Data Management (OSDM) organisation before being downloaded from the Geoscience Australia website (www.ga.gov.au).

For more information phone Tony Hunter on +61 2 6249 9362 (email tony.hunter@ga.gov.au)





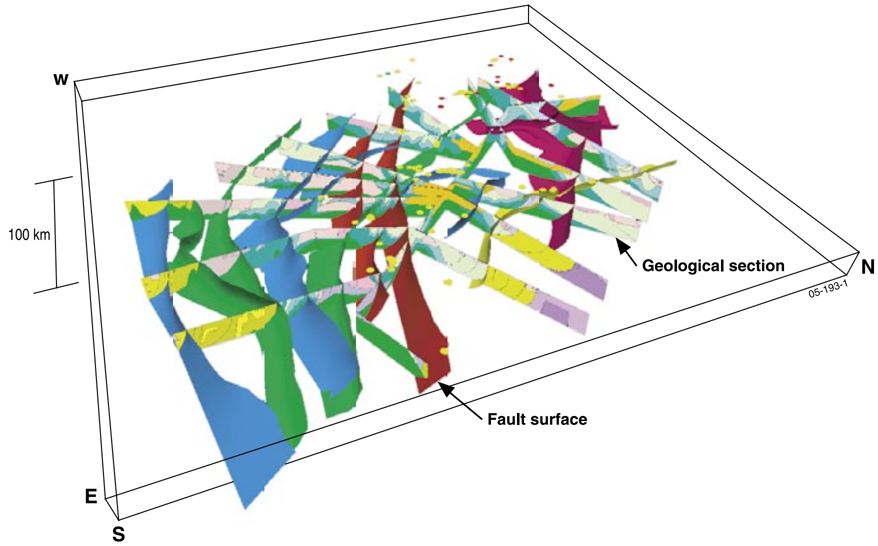
Product News

Latest edition Tanami 3D Geological Model

The third edition of the Tanami three-dimensional (3D) geological model has recently been released and is available through Geoscience Australia's website (http://www.ga.gov.au/map/web3d/tanami/). The Tanami region, one of the major Proterozoic gold provinces in the world, is situated along the border between the Northern Territory and Western Australia.

The 3D model, including 2D datasets (such as geophysical images, solid geology maps, geochronology data, mineral occurrence locations) is displayed in Virtual Reality Modelling Language (VRML), enabling 3D visualisation and manipulation via the web.

The purpose of the VRML model is to assist with visualisation of the three-dimensional distribution of the principal geological elements in the Tanami crust. There are two 3D models of the crust. One shows a series of fault surfaces, which are constructed from geological sections and tested by potential field modelling. The second shows gravity and magnetic inversion surfaces which are generated by inverting gridded gravity and magnetic data into a 3D distribution of density and magnetic susceptibilities (see *AusGeo News 78*).



▲ **Figure 1.** A 'snap shot' taken from the VRML of the Tanami 3D model, viewed from the southeast. The 2D geological sections are shown, with selected fault surfaces and locations of mineral occurrence. The faults are coloured according to the deformation event in which they were most active.

A major feature of this release is the depth to magnetic basement interpretation which consists of four layers. These layers are made up of point depths of magnetic sources within the Tanami basement and a 3D surface of the magnetic basement. This was generated by interpolating between the point depths and a 2D contour representation of the surface. The depth to basement surface simulates the location, in 3D space, and shows the highly prospective Tanami basement rock beneath younger cover sediments.

Other significant features of the third edition include the extension of the 3D modelled faults to the north and west and the inclusion of gravity and magnetic inversion surfaces. Also included is the additional depth to basement layers, the updated seismic acquisition proposal for the Tanami, a preliminary solid geology interpretation for the Western Australia part of the Tanami region and improved navigational features to the VRML web interface.

For more information phone Tony Meixner on +61 2 6249 9636 (emailtony.meixner@ga.gov.au)

Related websites/articles:

Ausgeo News 78 article : www.ga.gov.au/ausgeonews/ausgeonews200506/3dinversion.jsp

Ausgeo News 77 article : www.ga.gov.au/ausgeonews/ausgeonews200509/tanami.jsp

New 3D model: www.ga.gov.au/map/web3d/tanami/

Visual record of Australia from space

A unique visual record of satellite data, showing the progressive changes to landscape and vegetation in Australia over a 32 year period since 1972, is now available. This record which contains several epochs or time frames of satellite data can be obtained from Geoscience Australia (www.ga.gov.au/acres/prod_ser/agosuite.jsp) as well as distributors of Landsat satellite imagery.

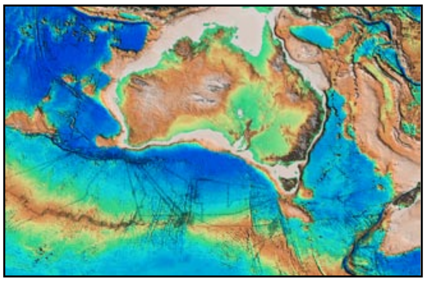
The Australian Greenhouse Office (AGO) originally sourced Landsat satellite imagery data from Geoscience Australia for processing and use in their National Carbon Accounting System for monitoring land clearing and revegetation. Geoscience Australia's remote sensing unit (ACRES) is now distributing this processed data on behalf of the AGO.

The data can be viewed by a data viewer, image analysis software or geographic information system (GIS) software. Users will be able to analyse an area of the continent and compare satellite imagery for different years. The product suite will help land managers and businesses across Australia reduce greenhouse gas emissions and assess factors such as: changes in tree cover and where tree planting has been most effective, which areas should be rehabilitated and the impact of drought or fire.

The data are available for each epoch in 1:1 million scale tiles or as individual continental mosaics of the Australian landmass.

For more information visit www.ga.gov.au/acres/prod_ser/agosuite.jsp

High resolution view of *Australia's seabed*



Geoscience Australia has recently released a new national high-quality 250m bathymetric data grid of those areas of the Australian water column jurisdiction bounded by 92° E to 172° E and 8° S to 60° S. The data grid has been upgraded with more detailed survey values and national coverage at this resolution (250 metre horizontal cell size) has not been publicly available until now. It was developed by Geoscience Australia in collaboration with the National Oceans Office of the Department of the Environment and Heritage

The dataset consists of data that Geoscience Australia has been collecting routinely from seismic and sampling surveys around the Australian offshore margin since 1963. More recently Geoscience Australia has taken on the role of national custodian for all bathymetry data holdings within the Australian Maritime Jurisdiction. These holdings consist of ship-track bathymetry, swath bathymetry, digitised soundings from hydrographic charts, laser airborne depth sounder (LADS) data and other associated ship-track geophysical measurements. Approximately 10 per cent of the survey data were acquired by Geoscience Australia with the remainder provided by other scientific institutions, oil exploration companies, international data centres and academic organisations.

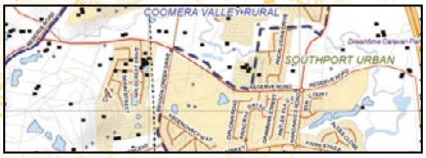
The latest grid covers an area of approximately 41 million square kilometres and comprises a synthesis of approximately 1.7 billion observed data points. These datasets are crucial to proper management and maintenance of Australia's marine jurisdiction and are used by a variety of government agencies and stakeholders, such as the fishing industry, to make informed decisions about its future.

The dataset comes in a variety of formats for all levels of users and includes a comprehensive report detailing the process used to develop the grid.

For more information phone Mark Webster on +61 2 6249 9599 (email mark.webster@ga.gov.au). To order the DVDs phone Freecall 1800 800 173 (in Australia) or +61 2 6249 9966 (email sales@ga.gov.au)

Related Information
www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=63539

Major boost for emergency managers *in south-east Queensland*



Emergency services in south-east Queensland have received a major boost to their emergency management capabilities through the recent revision of 1:25 000 scale (25K) topographic maps for the region. Most of the original maps at this scale are more than 20 years old.

The topographic maps are now available to all Queensland Fire and Rescue Services field staff as hardcopy map books (Atlases) and accompanying DVDs. These are vital tools to help them respond to and manage emergency incidents during the current fire season and beyond.

South-east Queensland is one of Australia's fastest growing areas, and the urban and peri-urban sprawl means critical infrastructure and residents are now closer to high risk zones of bushfire, flooding and storm damage. Impediments such as out-of-date maps have a direct impact on emergency managers' ability to prepare and respond to emergency situations. The risks of using maps that are over 20 years old include possible loss of lives and important infrastructure.

This major mapping initiative would not have been possible without the close collaboration between Geoscience Australia and the Queensland Departments of Emergency Services (DESQ), and Natural Resources and Mines (NRM). Through its pilot program of mapping for emergency management, Geoscience Australia has contributed to the revision of three map books which cover three 1:100,000 scale map equivalent areas. They include the Beenleigh, Murwillumbah and Mt Lindesay areas. Geoscience Australia also played a significant role in the coordination and purchase of the satellite imagery required for the map revision.

Federal and state collaboration is paramount when updating maps for use by emergency services in critical areas such as south-east Queensland. Geoscience Australia's topographic mapping focus over the last 12 months has been developing these collaborative arrangements and pilot projects across Australia—in New South Wales, Victoria and Western Australia. In October this year a new map of the Karijini National Park (Western Australia) was released to the public, to assist emergency service workers manage and respond to emergencies such as flash flooding, and remedy the previously limited mapping of the gorges in the area.

Geoscience Australia's 25K pilot mapping program, including its contribution to the south-east Queensland Atlases, has been a significant catalyst for change in the way federal and state mapping agencies are now approaching their respective mapping programs. There is better and more collaborative decision-making in the areas identified for revision. and the aim is to capture data at the most appropriate scale so it can also be used in smaller scale mapping. More coordinated purchasing of high-cost revision sources, such as satellite imagery, will reduce overall costs to an individual agencies.

For more information phone Philip Tickle on +61 2 6249 9769 (email phil.tickle@ga.gov.au)

Events

BIG NEW OIL *initiative shows results*

Australian Frontier Basins Workshop

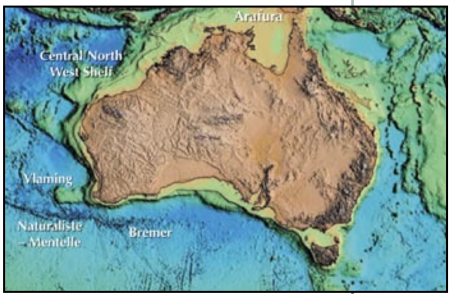
The Australian Frontier Basins Workshop held at Geoscience Australia on 13 and 14 October 2005 was attended by more than 30 delegates from 17 companies and other institutions. They represented all the major Australian and several International petroleum exploration companies as well as a number of the smaller Australian companies. The Albany Port Authority and the Western Australia Geological Survey were also represented.

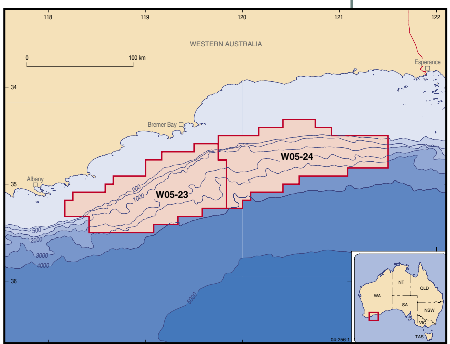
The workshop presented results and discussed petroleum exploration opportunities resulting from the Australian Government's Big New Oil initiative at the half-way point. The 2003-04 federal Budget included $25 million to generate new geoscience data in offshore frontier areas and to preserve Australia's offshore seismic data collection. The initiative is designed to assist the petroleum exploration industry in the search for a new oil province by developing new exploration opportunities and delivering them to the market via the annual offshore Acreage Release. Geoscience Australia is undertaking a program of seismic acquisition, geological sampling and oil seep detection studies in a number of Australia's frontier basins.

Data acquired through the initiative was presented to attendees of the workshop, including interpretation of the new seismic data acquired from the Southwest margin, and results from hydrocarbon seep studies in the Arafura Sea. A highlight was the presentation of results from the Bremer Sub-basin study. The Bremer is the first Australian frontier Sub-basin offered for acreage release as a result of the Big New Oil program. It offers an investment opportunity developed and documented with new data sets and is a designated frontier area for taxation purposes. Bidding closes on the Bremer Sub-basin release areas on the 20th April 2006.

The second day of the workshop was dedicated to other projects within the Big Oil Program, including studies in the Arafura Basin, Offshore Canning Basin and Northern Lord Howe Rise, as well as results obtained from hydrocarbon seeps studies in Northern Australia.

This workshop provided an excellent opportunity for Geoscience Australia to present the results of our work, discuss our forward program with industry and receive their input and feedback.



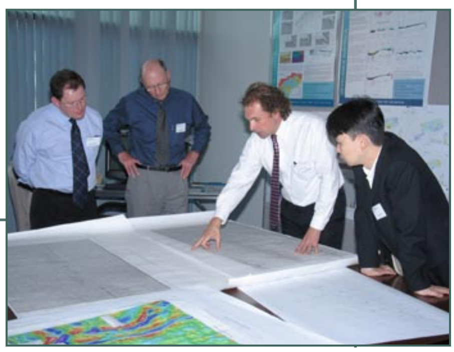


New results from Bremer Sub-basin

Results from a geological sampling survey of the Bremer Sub-basin in February–March 2004 have been documented in Geoscience Australia Record 2005/05, which is now available. This record provides results of the biostratigraphic analysis of 95 rock samples, geochemical analysis of 59 rock samples, and petrographic analyses of selected rocks samples. It also includes a geographic information system (GIS) that provides key spatial data sets, such as the new 250 metre bathymetry grid, and dredge sample locations with analytical results included in the attribute tables.

A CD-ROM containing workshop presentations on the final results of the Bremer Sub-basin study is now available from Barry Bradshaw at Geoscience Australia (Barry.Bradshaw@ga.gov.au).

For more information phone Jenny Maher on +61 2 6249 9896 (email jenny.maher@ga.gov.au). To order the Bremer Sub-basin Record phone Freecall 1800 800 173 (in Australia) or +61 2 6249 9966 (email mapsales@ga.gov.au)

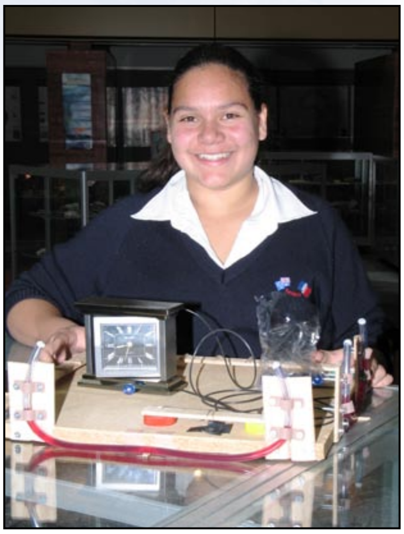


Australia celebrates Earth Science Week 2005

This year's theme was "Geoscientists Explore our Earth" which aimed to promote and explain the role of geoscientists and how their work contributes to the wellbeing of society. Earth Science Week has been celebrated worldwide since 1998 with Geoscience Australia coordinating the Australian celebrations since October 1999. It is now celebrated in every state and territory in Australia.

Australia's National Geographic Channel kicked off the week in dramatic fashion with an epic collection of documentaries showcasing *Savage Earth Week*. The documentaries took a close look at the effectiveness of modern science in averting natural disasters such as earthquakes, volcanoes, hurricanes and tsunamis.

In Sydney, the IMAX theatre thrilled packed audiences with its' new 3D shows *Wild Safari* and *Walking on the Moon*, and had to extend its program schedule to include an extra night.



▲ Winner of the individual category awards

▲ Parliamentary Secretary Warren Entsch (left), ACT Senator Gary Humphries and Geoscience Australia CEO Dr. Neil Williams (back right), with winners from Burgmann Anglican School, Narrabundah College and Telopea High School.

▲ Winners of the group category awards

In the Northern Territory the Geological Survey announced a new scholarship aimed at encouraging young Territorians to undertake university study in the earth sciences.

In Canberra, the National Museum of Australia entertained 11, 540 visitors with 39 performances of the show "Gondwana" which featured a journey through time to explore the origins and creation of Australia's unique prehistoric landscape, populated by dinosaurs, giant beasts and indigenous flora. Australia's amazing prehistory was brought to life using large-scale inflatable plants, spectacular full body puppets, huge projections and a moody, atmospheric musical score.

To mark Earth Science Week Geoscience Australia ran a competition inviting students from local high schools to design and build a simple working model seismometer.

Parliamentary Secretary to the Minister for Industry, Tourism and Resources, The Hon Warren Entsch MP, joined ACT Senator Gary Humphries in presenting prizes to the winners.

Entries were judged by the Project Leader of Geoscience Australia's monitoring network, Bill Greenwood, who was impressed by the standard of entries which he said "demonstrated a good understanding of how earthquakes happened".

The winning entry in the Individual category used a tube filled with liquid that acted as a spirit level, ensuring that the seismometer was on a level surface. Small ball bearings were placed evenly on the periphery of the platform so they fell off when subjected to shaking– the more balls that fell, the more intense the earthquake. A clock on the seismometer stopped ticking when the ball bearings shifted, indicating the time of an earthquake.

The winning Group entry used wood, wire, nails, machine roll paper, a coffee tin (for the paper to roll on to) and a weight to increase sensitivity of the seismometers arm to vibrations. When shaken the horizontal arm holding the pen swayed from side to side generating a seismograph.

Earth Science Week was conceived by the American Geological Institute (AGI) and commenced in 1998. The AGI marked the Week this year with the launch of a free on-line magazine, GeoSpectrum, (www.agiweb.org/geospectrum) which includes a summary of America's Earth Science Week activities.

For more information visit www.ga.gov.au/about/event/index.jsp

Geodetic and oceanographic TECHNOLOGY FOR A DYNAMIC PLANET

The Hon Warren Entsch MP, Parliamentary Secretary to the Minister for Industry, Tourism and Resources opened the Dynamic Planet conference in Cairns on 22 August. In his opening speech, Mr. Entsch outlined the development of the Australian Tsunami Warning System and the need for community preparedness for natural disasters. He was keen to emphasise that this could only be achieved through the collaboration of the global scientific community.

The conference ran for five days and attracted an impressive scientific gathering. Delegates from Geoscience Australia, a major sponsor of the conference, were in attendance along with members from the International Association of Geodesy (IAG), International Association of the Physical Sciences of the Ocean (IAPSO), and the International Association of Biological Oceanographers (IABO).

Dynamic Planet presented a unique opportunity for scientists to come together to present their findings and discuss cross-disciplinary research into the solid earth and oceans. A scientific program called “Monitoring and Understanding a Dynamic Planet with Geodetic and Oceanographic Tools”, again emphasised the need for global collaboration.

Significantly, the conference attracted international interest and around 796 delegates attended from 62 countries. Topics were presented on 27 distinct themes and a total of 812 papers, 495 posters and 317 oral presentations were given. The IAG sessions resulted in 215 posters and 205 oral presentations.

A major highlight of the conference was the Global Geodetic Observing System (GGOS), one of the most significant international initiatives in earth monitoring science. It was developed under the auspices of the IAG and its vision statement is “to achieve a better understanding of geodynamic and global change processes as a basis of Earth Science research” within the central theme of “Global deformation and mass exchange processes in the Earth system”. The GGOS structure is designed to achieve an all encompassing and fully integrated system of instrumentation, observations, reference frames, conventions, constants, processing methodologies, parameters, products and applications.

For more information phone Ramesh Govind +61 2 6249 9033 (email ramesh.govind@ga.gov.au)

Events Calendar 2006

NAPE Expo 2006 –North American Prospects Exhibition
American Association of Professional Landmen
2 & 3 February
Houston, Texas, USA
Contact: AAPL, 4100 Fossil Creek Boulevard, Fort Worth, Texas 76137 USA
phone +1 817 847 7700
email nape@landman.org
www.napeonline.com

PDAC International Convention & Trade Show
Prospectors and Developers Association of Canada
5 to 8 March
Metro Toronto Convention Centre, Toronto, Canada
Contact: PDAC, 34 King Street East Suite 900, Toronto, Ontario M5C 2X8
phone +1 416 362 1969
fax +1 416 362 0101
email info@pdac.ca
www.pdac.ca

AAPG Annual Meeting
American Association of Petroleum Geologists Annual Meeting and Exhibition
9 to 12 April
Huston, Texas
Contact: AAPG Convention Department, PO Box 979, Tulsa Oklahoma 74101-0979 USA
phone +1 918 560 2617
fax +1 918 560 2694
email convene@aapg.org
www.aapg.org

APPEA Conference and Exhibition
Australian Petroleum Production and Exploration Association
7 to 10 May
Gold Coast Convention and Exhibition Centre
Contact: Vicki O’Gorman, APPEA Limited, GPO Box 2201, Canberra ACT 2601
phone +61 2 6247 0960
fax +61 2 6247 0548
email vogorman@appea.com.au
www.appea.com.au

Australian Earth Sciences Convention 2006
18th Australian Geological Convention & Australian Society of Exploration Geophysicists 18th Geophysical Conference and Exhibition
2 to 7 July
Melbourne Exhibition and Convention Centre
Contact: The Meeting Planners, 91-97 Islington Street Collingwood Vic 3066
phone +61 3 9417 0888
fax +61 3 9417 0899
email earth2006@meetingplanners.com.au
www.earth2006.org.au

16th Annual V M Goldschmidt Conference 2006
European Association for Geochemistry, Geochemical Society and Geological Society of Australia
27 August to 1 September
Melbourne Exhibition and Convention Centre
Contact: Tour Hosts Pty Ltd, GPO Box 128, Sydney NSW 2001
phone +61 2 9265 0700
fax +61 2 9267 5443
email goldschmidt2006@tourhosts.org.au
www.goldschmidt2006.org