

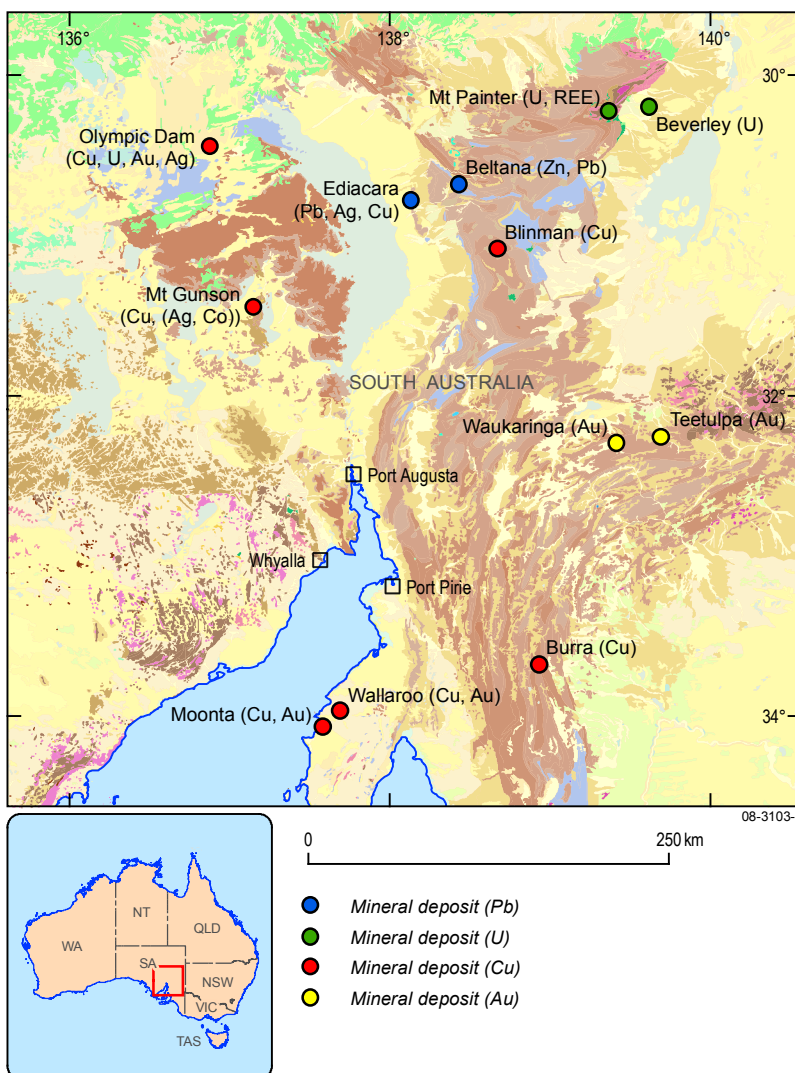
## New surface geology dataset for South Australia

Seamless digital surface geology of South Australia at 1:1 million scale is now available from Geoscience Australia. The dataset was primarily compiled from 1:250 000 scale digital geology maps covering the state and recent mapping by the Department of Primary Industries and Resources, South Australia. It is edge-matched to previously released datasets of the geology of the eastern states and the Northern Territory and includes a consistent nation-wide classification of regolith materials.

The surface geology of South Australia is dominated by regolith including sand plains, dunes, lake sediments, and colluvium around prominent topography. Exposed bedrock is intermittently and widely distributed with the intervening regions often covered with only a thin regolith veneer. This bedrock is of diverse age, ranging from recent Cainozoic sediments, to Archaean gneiss and greenstone in the Gawler Craton.

The Gawler Craton is located in the central part of the state and hosts several important mineral deposits including iron oxide-copper-gold deposits at Olympic Dam and Prominent Hill, historic copper production from Moonta –Walleroo, gold at Challenger, and iron deposits in the Middleback Ranges west of Whyalla. The world's largest uranium deposit occurs at Olympic Dam in the eastern Gawler Craton. Uranium was also mined at Radium Hill and Mount Painter in the Palaeo- to Mesoproterozoic Curnamona Craton located in the central eastern part of the state, and is currently extracted from Cainozoic sediments at the nearby Beverley Deposit. There has been historic production of copper and other base metals from many deposits throughout the Neoproterozoic to Cambrian Adelaide Fold Belt and adjacent Cambrian Kanmantoo Fold Belt.

The new digital data puts these mineral deposits and many others in their regional geological context. It also supports the development of regional exploration models which are necessary to effectively explore regions under cover. The digital geology data are intended for use at 1:1 million scale and have a spatial accuracy of approximately one kilometre. Geological unit attributes include the stratigraphic name, the Australian Stratigraphic Unit Database number, lithological description, and maximum and minimum ages. Summary attributes



**Figure 1.** Geology of the Flinders Ranges region, north of Adelaide.



including lithology group and lithology type provide additional flexibility for analysing the geological polygon data. Outcropping and selected buried faults are also represented in the dataset.

The data are available as a free download, or on CD which can be purchased through the Geoscience Australia website for \$99.00.

### **Related articles/websites**

Surface geology of South Australia, 1:1 million scale (free download)  
[www.ga.gov.au/products/](http://www.ga.gov.au/products/)

Geoscience Australia Sales Centre (for purchase on CD)  
[www.ga.gov.au/oracle/agsocat/](http://www.ga.gov.au/oracle/agsocat/)

## **Revealing Proterozoic mafic-ultramafic magmatism in Australia**

Geoscience Australia in collaboration with the State and Territory geological surveys has recently released a detailed web-based map that shows the location, age, and correlations of Proterozoic mafic-ultramafic igneous rocks across the Australian continent. The new colour map *Australian Proterozoic mafic-ultramafic magmatic events* consists of two sheets which are available in pdf and jpeg formats through the Geoscience Australia website.

A 1:5 000 000 scale map showing the continental distribution of 30 magmatic events that range from the Early Palaeoproterozoic (~2455 million years (Ma), ME 1) to the Early Cambrian (~520 Ma, ME 30) is the main feature of Sheet 1. The newly-defined magmatic event series (ME 1–ME 30) is based on several hundred age measurements, over 90 per cent of which are derived from recent Uranium-Lead (U-Pb) dating of zircon and baddeleyite.

Solid geology digital maps with state/territory and regional coverages were synthesised to produce a national presentation of mafic-ultramafic rock units, and regional rock packages that include coeval mafic-ultramafic igneous rock components. Colour-coding of rock units by their age of magmatism provides a visual cue to the spatial and temporal correlations of magmatic units at both province and continental scale. Their relationship to the evolution of the continent is shown with an overlay of the Australian Crustal Elements dataset. The detail in the new map extends to isolated occurrences of dated magmatic units and a commentary describing relevant rock relationships.

The second sheet includes a large format Time–Space–Event Chart which shows the presence and correlation of the 30 magmatic events across 28 Australian crustal provinces. Those events known to be mineralised in Australia are highlighted, and six of the magmatic events are shown to be coeval with major nickel-copper ± platinum-

### **For more information**

phone Alan Whitaker on  
+61 2 6249 9702

email [alan.whitaker@ga.gov.au](mailto:alan.whitaker@ga.gov.au)

### **To order copies of the CDs**

phone Freecall 1800 800 173  
(in Australia) or  
+61 2 6249 9966

email [sales@ga.gov.au](mailto:sales@ga.gov.au)

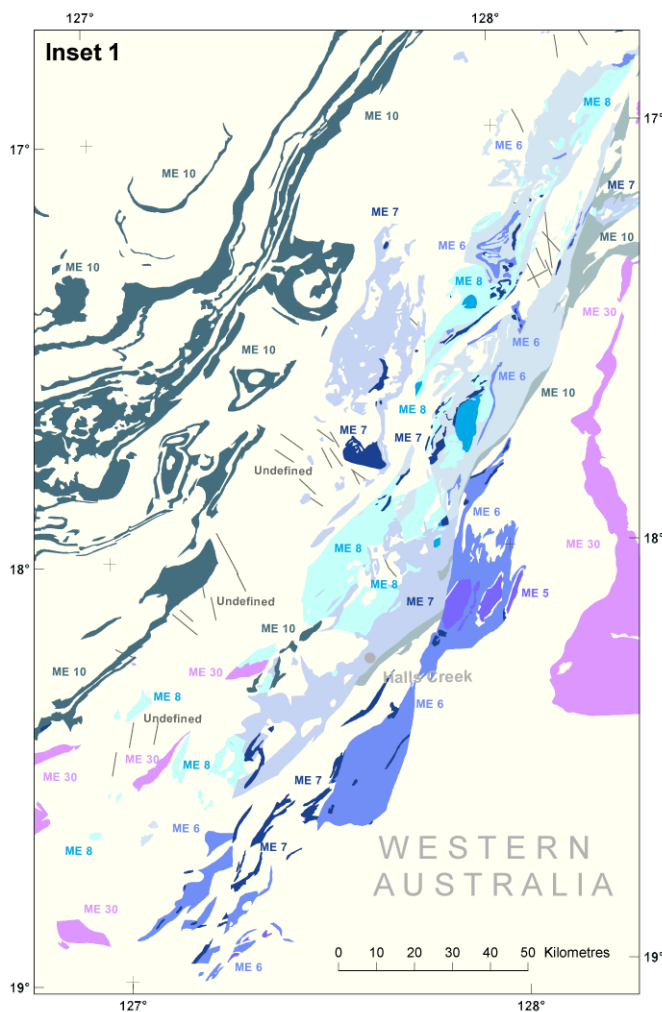
group element deposits in other continents, such as ~2440 Ma Penikat in Finland, ~1918 Ma Raglan, ~1880 Ma Thompson, and ~1850 Ma Sudbury in Canada, ~1403 Ma Kabanga in Tanzania, and ~827 Ma Jinchuan in China.

Sheet 2 also includes two maps at 1:10 000 000 scale. The first map shows the locations of Australian nickel-copper-chromium-vanadium-titanium and platinum-group element mineral deposits and occurrences overlain on a composite of Proterozoic and Archaean mafic-ultramafic rock units. The second map shows the geographic extent of five magmatic events which are designated Large Igneous Provinces which are characterised by exceptionally large volumes of mafic-dominated magma emplaced over short geological periods of a few million years or less.

The new national map is the final component of the Proterozoic magmatic event

map series. It revises and supersedes the earlier maps of Western Australia and Northern Territory–South Australia. The geological and geochronological basis of the map series is summarised in an accompanying Geoscience Australia Record 2008/15 *Guide to using the 1:5 000 000 map of Australian Proterozoic mafic-ultramafic magmatic events* by DM Hoatson, JC Claoué-Long, & S Jaireth. The Record includes individual time-slice maps of Australia for each of the 30 Proterozoic magmatic events.

The new national map focuses attention on the extent and volume of certain magmatic systems, and associations with mineralisation. The locations of mafic-ultramafic rock units, correlations across the continent, and the relationship of magmatism to the evolving crustal structure of the continent, are all prominent. The new map and Record will be of interest to explorers searching for nickel, platinum-group elements, chromium, titanium, and vanadium, as well as providing fundamental resources for understanding the dynamic evolution of the Australian continent.



**Figure 1.** Part of the new 1:5 000 000 scale Australian Proterozoic mafic-ultramafic magmatic events map.

**For more information**

phone Dean Hoatson on  
+61 2 6249 9593

email dean.hoatson@ga.gov.au

**Related websites/articles**

Australian Proterozoic Mafic-Ultramafic Magmatic Events Map (Sheet 1 of 2)

[www.ga.gov.au/image\\_cache/GA11507.pdf](http://www.ga.gov.au/image_cache/GA11507.pdf)

[www.ga.gov.au/image\\_cache/GA11511.jpg](http://www.ga.gov.au/image_cache/GA11511.jpg)

Australian Proterozoic Mafic-Ultramafic Magmatic Events Map (Sheet 2 of 2)

[www.ga.gov.au/image\\_cache/GA11506.pdf](http://www.ga.gov.au/image_cache/GA11506.pdf)

[www.ga.gov.au/image\\_cache/GA11510.jpg](http://www.ga.gov.au/image_cache/GA11510.jpg)

Part 1. Proterozoic Mafic-Ultramafic Magmatic Events Map: Western Australia

[www.ga.gov.au/image\\_cache/GA8798.pdf](http://www.ga.gov.au/image_cache/GA8798.pdf)

[www.ga.gov.au/image\\_cache/GA8797.jpg](http://www.ga.gov.au/image_cache/GA8797.jpg)

Part 2. Proterozoic Mafic-Ultramafic Magmatic Events Map: Northern Territory and South Australia

[www.ga.gov.au/image\\_cache/GA10636.pdf](http://www.ga.gov.au/image_cache/GA10636.pdf)

[www.ga.gov.au/image\\_cache/GA10645.jpg](http://www.ga.gov.au/image_cache/GA10645.jpg)

*AusGeo News 84:* New map for nickel explorers

[www.ga.gov.au/ausgeonews/ausgeonews200612/productnews.jsp#product2](http://www.ga.gov.au/ausgeonews/ausgeonews200612/productnews.jsp#product2)

*AusGeo News 87:* New map for nickel and platinum explorers

[www.ga.gov.au/ausgeonews/ausgeonews200709/productnews.jsp#product1](http://www.ga.gov.au/ausgeonews/ausgeonews200709/productnews.jsp#product1)

## Review of Australia's thorium resources

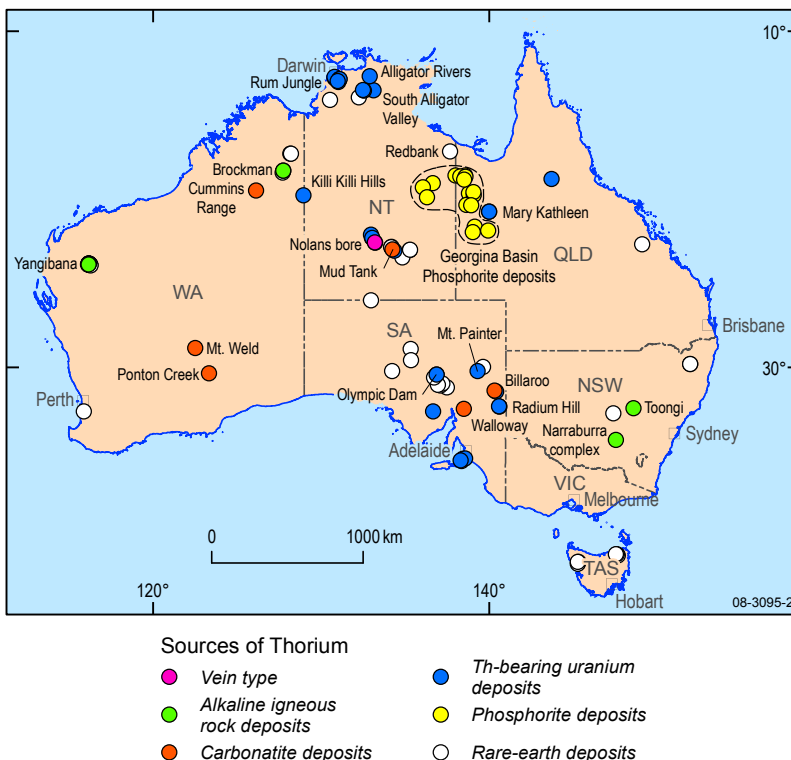
This review provides an enhanced understanding of geochemical processes controlling the distribution of thorium in the Earth's crust and the status and distribution of Australia's thorium resources. It is an output from Geoscience Australia's Onshore Energy Security Program (OESP) and can be downloaded through Geoscience Australia's website. The OESP is delivering pre-competitive data packages and scientifically-based assessments to attract investment in exploration for onshore energy resources such as oil, gas, uranium, thorium and geothermal energy.

Thorium can be used as a nuclear fuel, through breeding to uranium ( $^{233}\text{U}$ ). Several reactor concepts based on thorium fuel cycles are under consideration, but much development work would be required before the thorium fuel cycles can be commercialised. At present thorium fuels are used to varying degrees in some research reactors in India and Russia. Tests are being undertaken in Russia on the use of thorium fuel in conventional nuclear reactors and India is

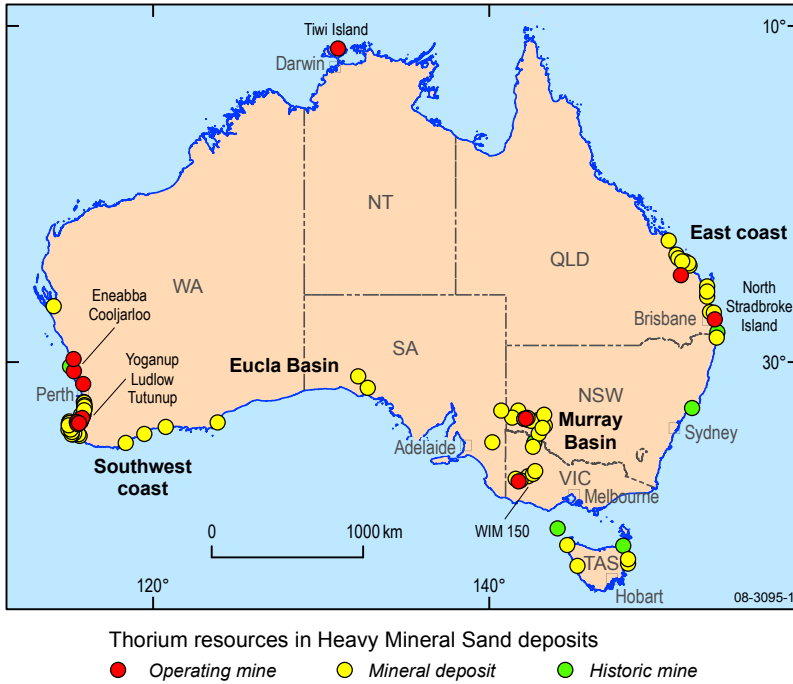
currently developing a thorium-fuelled Advanced Heavy Water Reactor.

There has been no widespread exploration for thorium in Australia. However, thorium is known to be widely distributed across Australia in a number of different geological settings (figure 1). Australia contains about 19 per cent of the world's identified thorium resources. Most of them are held in the monazite component of heavy mineral sand deposits that are mined for their ilmenite, rutile, leucoxene and zircon content (figure 2). Australia's thorium resources in heavy mineral sand deposits could amount to about 364 000 tonnes. Other significant sources of thorium include the Nolans Bore deposit (with about 53 300 tonnes of thorium) in the Northern Territory and the Toongi zirconia project (with about 35 000 tonnes of thorium) in New South Wales.

Thorium occurs in nature either within minerals or as a tetravalent ion. The large, highly charged  $\text{Th}^{4+}$  ion has a marked tendency to form complexes with other ions in solution. The major ones of interest are with chloride, fluoride, nitrate, sulphate and carbonate ions.



**Figure 1.** Location of Australia's thorium-bearing mineral deposits and occurrences excluding those related to heavy mineral sand deposits (Data is from the Australian Mines Atlas).



**Figure 2.** Location of Australia's mineral sand deposits including names of operating mines and selected historical mines. (Data is from the Australian Mines Atlas).

The average abundance of thorium in the Earth's crust is about 5.6 parts per million (ppm). The upper crust is enriched with an average concentration of 10.5 ppm thorium, while the middle crust has an average of 6.5 ppm, and the lower crust an average of 1.2 ppm. The most important thorium-bearing minerals are monazite, thorianite, thorite, and thoregummite. Other minerals that contain lesser amounts of thorium are allanite, bastnäsite, pyrochlore, xenotime, fluorapatite and zircon. Many of the thorium-bearing minerals are remarkably resistant to oxidation and tend to become enriched in the oxidised zones of mineral deposits.

Geophysical surveys involving radiometric, magnetic, and gravimetric techniques can all be applied to the search for thorium-bearing deposits. However, the lack of penetration of radiometric surveys limits the usefulness of this method in those areas of thick cover which are typical of many parts of Australia. In many places, the deep weathering of the Australian continent has destroyed primary rock lithologies, making recognition of mineralised areas exceptionally difficult. Consequently, stream sediment and other

geochemical surveys may also be used to help identify target areas at both regional and local scales.

Australia has a wide variety of deposits that contain thorium but the geochemical processes that lead to thorium-enrichment are poorly understood at present. More work is required to better understand the role of thorium in the different styles of mineral deposits and to more comprehensively evaluate Australia's total identified thorium resources.

**For more information**

phone Terry Mernagh on  
+61 2 6249 9460

email [terry.mernagh@ga.gov.au](mailto:terry.mernagh@ga.gov.au)

**Related websites/articles**

Onshore Energy Security Program

[www.ga.gov.au/minerals/research/oesp/index.jsp](http://www.ga.gov.au/minerals/research/oesp/index.jsp)

A Review of the Geochemical Processes Controlling the Distribution of Thorium in the Earth's Crust and Australia's Thorium Resources by Terrence P Mernagh and Yanis Miezitis

[www.ga.gov.au/image\\_cache/GA11421.pdf](http://www.ga.gov.au/image_cache/GA11421.pdf)

Thorium Project

[www.ga.gov.au/minerals/research/national/thorium/index.jsp](http://www.ga.gov.au/minerals/research/national/thorium/index.jsp)

## New geophysical datasets released

Datasets from five new geophysical surveys, which will be a valuable tool in assessing the mineral potential of the respective survey areas, have been released since June 2008.

These include data from four new airborne magnetic and radiometric surveys which cover Bass Strait and the offshore area off northwest and southwest Tasmania and the Westmoreland region of Queensland. New gravity data covering the West Musgrave area of Western Australia have also been released.

The data for all surveys were acquired in surveys during 2007 and 2008, conducted and managed by Geoscience Australia on behalf of Mineral Resources Tasmania, the Geological Survey of Queensland and the Geological Survey of Western Australia. The northwest Tasmania offshore airborne magnetic survey was funded by Geoscience Australia.

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

### For more information

**phone** Murray Richardson on  
+61 2 6249 9229

**email** murray.richardson@  
ga.gov.au

### Related websites

Geological Survey of Queensland

[www.dme.qld.gov.au/mines/about\\_us.cfm](http://www.dme.qld.gov.au/mines/about_us.cfm)

Geological Survey of  
Western Australia

[www.doir.wa.gov.au](http://www.doir.wa.gov.au)

Mineral Resources Tasmania

[www.mrt.tas.gov.au](http://www.mrt.tas.gov.au)

**Table 1.** Details of the gravity survey.

Survey	Survey type	Date of acquisition	1:250 000 map sheets	Station spacing, orientation	Stations	Contractor
West Musgrave (WA)	Gravity	May – June 2008	Bentley (pt), Scott (pt), Talbot (pt), Cooper (pt)	2.5 x 2.5 km east – west	4001	Daishsat Geodetic Surveyors

**Table 2.** Details of the airborne surveys.

Survey	Survey type	Date	1:250 000 map sheets	Line spacing/ terrain clearance/ orientation	Line km	Contractor
Bass Strait (Tas)	Magnetic	Jan – Mar 2008	NA	800 m 90 m east – west	70 856	Thomson Aviation
NW Tasmania Offshore	Magnetic	Jan – Apr 2008	NA	800 m 90 m east – west	43 824	Fugro Airborne Surveys
SW Tasmania Offshore	Magnetic	Jan – Apr 2008	NA	800 m 90 m east – west	26 554	Fugro Airborne Surveys
Westmoreland (Qld)	Magnetic, Radiometric, Elevation	Sep – Dec 2007	Mornington (pt), Cape Van Dieman (pt), Westmoreland (pt), Burketown (pt)	400 m 60 m north – south	60 547	Fugro Airborne Surveys

## New NATMAP Digital Maps widen appeal

Geoscience Australia has recently released *NATMAP Digital Maps 2008* featuring a seamless map which covers the whole of Australia at 1:250 000 scale. This new version of the flagship digital mapping product includes a number of updated maps and a new satellite image of Australia.

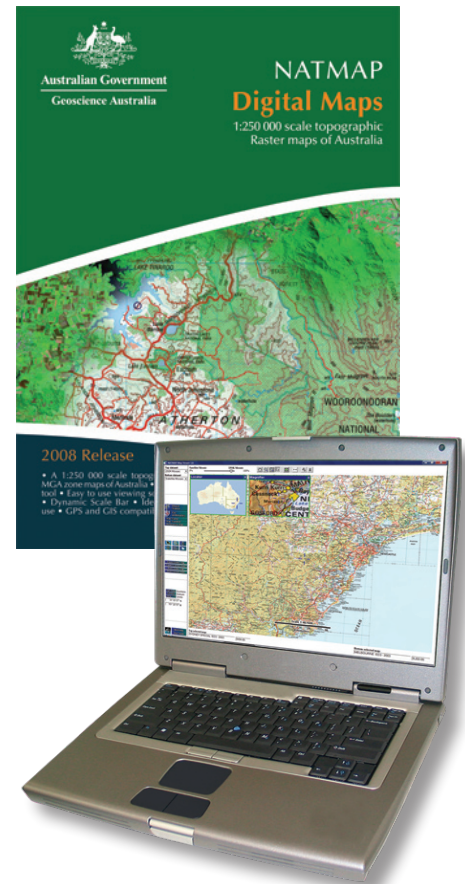
The operating software has been revised to improve its utility. Users can now compare a map with a satellite image of the same area using a new split window tool, or place one map over another with a transparency slide tool. The placename search facility, which is based on the Gazetteer of Australia, has also been updated.

*NATMAP Digital Maps 2008* has a wide variety of professional, emergency management and recreational uses including:

- real-time navigation with global positioning systems (GPS)
- route and adventure planning
- providing backdrops for geographic information systems (GIS), where information is overlaid and analysed (such as emergency response planning)
- map-based presentations
- a convenient and compact storage of maps.

Since the 1:250 000 scale topographic Raster data was included in the Office of Spatial Data Management's Spatial Data Schedule in late 2005, the conditions for commercialisation of the product have been relaxed. Consequently, the licence conditions for *NATMAP Digital Maps 2008* have been clarified to remove any confusion regarding the increased commercialisation potential of the data. However, some of the other data sets included as well as the Viewing software remain proprietary and are not for commercial exploitation.

Though the previous edition of the NATMAP Raster 1:250 000 scale digital maps was available in two versions, the new version is equivalent in resolution quality to the previous 'Premium' version and the price has been reduced to \$99.00. *NATMAP Digital Maps 2008* is supplied on two DVDs and contains all the software needed to use the maps.



### For more information

**phone** Geoscience Australia  
Sales Centre on  
Freecall 1800 800 173  
(in Australia) or  
+61 2 6249 9966  
**email** [mapsales@ga.gov.au](mailto:mapsales@ga.gov.au)