

SPATIAL INFORMATION FOR THE NATION

AUSGEO *news*



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RISK
going digital

ON TRACK FOR Australia



Also: Antarctic surveys completed, geoscience tools for viticulture, AIMR on-line...

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Maps, signs of their times. In this issue we briefly trace how mapmakers aided the discovery of Australia and show how Geoscience Australia continues a long tradition of mapmaking by adapting the latest technology to create very useful, yet beautiful images of the Australian region.

Geoscience Australia prepared the front cover's central image from the direct broadcast data of a NOAA satellite (see page 9). The satellite sensor collects this data over a 2399-kilometre swath, 14 times a day from an altitude of 833 kilometres.

In April this year, a dedicated NOAA antenna was installed at Geoscience Australia's ACRES facility near Alice Springs to collect data from the day- and night-time passes of three NOAA satellites (numbers 12, 15 and 16). Each of these satellites normally traverses the Australian region twice during the day and twice at night.

The globe on the front cover and opposite is a view of Australia from Galileo, courtesy of NASA Photo Gallery. The satellite is Landsat-7.



The Australian Geological Survey Organisation (AGSO) and Australia's national mapping agency (AUSLIG) have merged to form Geoscience Australia. The merger maximises the knowledge, skills and output of two respected agencies, and makes Geoscience Australia the custodian of a wide range of national data collections that are strategically important to Australia.

For most of you the merger simply means that you can call one place—Geoscience Australia—for all your spatial data needs, whether they are topographic maps, satellite imagery, and geodesy information, or geophysical data and geological maps. For us, it means a few changes including bringing staff from different sites together into our Symonston headquarters.

Our organisation is a world leader in high-quality geoscience information. We have input into government decisions relating to resource use, management of the environment, and the safety and well-being of Australians.

Our activities cover three broad areas: onshore Australia, offshore Australia and spatial information.

Onshore activities focus on enhancing mineral exploration and environmental land-use planning. They involve research into regional geology and mineral systems, and the production of geoscientific maps and databases.

This year we again play a major role in the Commonwealth Government's pre-commercial oil exploration program. Our petroleum geologists identify potential hydrocarbon areas and new prospective basins in Australia's offshore territories to entice global investment in Australian petroleum exploration.

Our other offshore activities involve mapping the outer limits of Australia's jurisdiction under the United Nations Convention on the Law of the Sea, and studies of the marine environment and 'health' of coastal waterways.

The whole organisation carries out spatial information activities, and we are very focused on putting substance into our slogan 'spatial information for the nation'.

In this issue of *AusGeo News* we provide a glimpse of the sorts of spatial information we hold in our national data collections, and how our spatial data are used. I hope that you will contact the staff listed and talk with them about the variety and depth of work carried out by Geoscience Australia in our three research divisions (Minerals and Geohazards, Petroleum and Marine, and National Mapping).



Comment



GEOSCIENCE AUSTRALIA
headquarters
149° 9' 30" east
35° 20' 38" south



NEIL WILLIAMS
CEO Geoscience Australia



DISCOVERY

traced through

MAPPING

history

Mapmakers aided the discovery of the world and its riches. Throughout European history they have adapted the latest technology to create beautiful images while providing the best available perspective of the Earth. Geoscience Australia continues this long, valued tradition.



National Library of Australia

Ptolemy calculated that the Earth must be round. He came up with this wild idea in the second century by working out the coordinates of thousands of points on the Earth's surface. Three centuries later, Macrobius agreed that the Earth indeed was round but he thought there had to be four continents. At the time, most people believed the Earth was flat and there were only three continents: Asia, Africa and Europe, which were surrounded by oceans.

In the eighth century the idea of another continent stirred the imagination of a monk called Beatus, who wrote about a great southern land where strange creatures called Antipodeans lived. But it would be many centuries before the great southern land would be mapped and its governments would be involved in revealing its riches.

Even as late as the 1400s, world maps were based on conjecture. Few people had access to these meticulously hand-drawn charts, which were valued as much for entertainment as their artistic merit.

Technology though changed their role forever, and took their circulation beyond European courts and monasteries. With the printing press, more people had access to maps. And as information about the world was added and circulated, maps were highly sought after for news of other lands. They were prized for navigation and exploration and for conquest and trade.

Great southern land

Portuguese navigators who sailed south of the Equator realised the value of maps. They tried to keep maps of their journeys secret because of the untapped trade potential they found. But by the mid-1500s, information from Portuguese maps had leaked to rivals.

German maps began incorporating Asian islands, and new maps (and expeditions) from neighbouring nations soon followed. But the most prolific generators of data from southern waters were the Dutch merchants. They met other sea-faring people such as the Javanese, who had been creating nautical charts.

Everything the Dutch merchants found was recorded and ended up on the drafting tables of mapmakers in Holland in the world's first major map publishing houses. Artistic skill was melded with the science and mathematics of mapmaking. All sorts of imagined animals were drawn in the map margins. Some maps were even decorated with gold.

When the National Library of Australia brought the 'Treasures from the world's greatest libraries' exhibition to Canberra last year, maps from the 1600s were placed among other rare items such as the Dead Sea Scrolls. The collection included a very rare first edition atlas with a hand-drawn world map showing the imaginary Terra Australis Incognita, and the beginnings of a map of Australia in the Mar di India sheet (figure 1).

The Dutch started working out the shape and size of Terra Australis in the early 1600s, most likely because of Dutch East India Company interests and contacts. In 1605, Jansz was commissioned to discover and chart unknown southlands. By 1623, Carstensz had named parts of Cape York Peninsula.

From the 1600s to the 1800s various European explorers including the French and English charted the coastline and added to the map of Terra Australis. European settlement, migration and inland exploration provided further geographical details (figure 2).

Strategic value

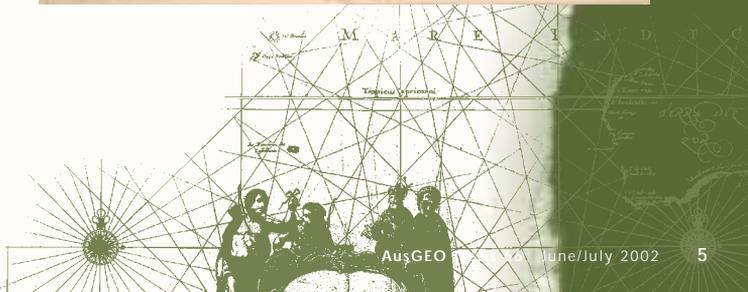
Throughout the 1900s, surveyors, geologists and cartographers built the picture of Australia using whatever technology was available: compass, theodolite and star observations, wireless time signals, aneroid readings (to determine altitude) and, by the 1930s, aerial photography. Australia's federal and state governments were behind much of this work, realising that maps underlie a nation's development and progress.

In 1910 the Commonwealth Government set up a Lands and Survey Branch (eventually called AUSLIG). But it wasn't until the 1940s and the wartime demand for strategic minerals that the government realised it needed maps showing the extent and location of Australia's minerals. The Minerals Resources Survey (forerunner to the Australian Geological Survey Organisation or AGSO) was established to find, map and evaluate mineral deposits required for the Allied war effort, minerals that were in short supply, or materials that had been imported but could no longer be obtained from overseas. The Survey investigated sources of dozens of resources such as oil, gas, coal, sulphur, fertiliser minerals, iron ore, asbestos, tin, bismuth, mercury and manganese.



▲ **Figure 1.** The sea atlas of the water world (De zee-atlas ofte water-waereld, 1659, by Hendrick Doncker), Mar di India sheet, reproduced with permission of the National Library of Australia

▼ **Figure 2.** Map of New South Wales 'from the best authorities and from the latest discoveries' published in England in March 1825. The map shows place names, landforms, waterways and unexplored areas, with an inset map of New Holland or Australia at 1:40 million scale. Reproduced with permission of the National Library of Australia



By the mid-1960s there was a complete air photo coverage of Australia, a series of topographic maps at 1:250 000 scale was nearly completed, and there was a steadily growing series of geological maps at the same scale that showed the potential mineral riches.

Because of the shared ground and strategic nature of AUSLIG and AGSO work, the Commonwealth Government last year merged the two agencies into one organisation called Geoscience Australia to continue the long tradition of mapmaking to aid resource assessment, exploration and trade—but in a digital age. And unlike the 1500s when map information was a state secret, the Commonwealth Government has decided that anyone can access its basic mapping data (or fundamental spatial information), which will be free on-line.

Patch work

Australia is a vast land and for mapping purposes, the continent traditionally has been divided into small areas or tiles. These areas were surveyed over many years with a variety of instruments that were not calibrated alike. Because of survey differences, there are problems when the tiles have to be stitched together to make maps of large regions or the entire continent.

Like Ptolemy, Geoscience Australia's geophysicists came up with a wild idea to apply mathematical solutions to their geographic problem. Through a series of equations that are computing intensive, Geoscience Australia has been sequentially re-scaling and levelling mismatched tiles and joining them in a seamless way.

Eventually Geoscience Australia will produce a 'seamless' database that is continually updated, from which users can print all sorts of maps of Australia (mineral specific, geological, topographic, and even 3-D). Users will be able to select a region of any size, customise the display, and add their own layers to the base data. They will be able to download data to their own system and print maps at their choice of scale. Sometime in the future, Geoscience Australia maps might even be printed on demand at a local kiosk.

Digital revolution

The first steps towards a digital revolution have been taken. Earlier this year, Geoscience Australia's Global Map Data Australia 1M was released free on-line. This is a 1:1 million scale dataset of Australia that consists of vector and raster layers of administrative boundaries, drainage, transportation, population centres, elevation, vegetation, land-use and land-cover themes (figure 3).

In three months, more than 2500 licences were granted to download the data. The data are being used for route planning, map production, navigation and positioning, environmental monitoring, exploration, demographic analysis, asset and facilities management, and emergency and disaster response.

One element of mapmaking that hasn't changed since Ptolemy's day is the use of reference points and coordinates. But there have been problems applying a consistent coordinate system worldwide. As a consequence, the coordinates on maps produced in different places (even in Australia) over the years don't tie up.

'Why don't my maps match?' is one of the most common questions posed to Geoscience Australia mapping staff.

Australia has adopted the international standard for its datum and changed its geographic coordinate system (now called the Geocentric Datum of Australia or GDA94) to bring geographical coordinates in line with satellite data. GDA94 uses the Earth's centre of mass as its reference point. This resulted in a one-off leap of about 200 metres to the north-east for all Australian coordinates in January 2000. The use of consistent coordinates brings map users one step closer to being able to combine map data from multiple sources, and the internet is the ideal medium.

As Geoscience Australia's mapmakers adapt their skills to internet delivery, and the line between cartography and information technology is increasingly blurred, they are still to some extent artisans. There will always be an element of interpretation in deciding how to depict features and combine colour, line and typography that will make sense to people and be appealing. Even in the digital age, a touch of artistry is needed to create maps that people want and enjoy.

For more information about topographic maps and satellite imagery of Australia phone Dan Jaksa on +61 2 6201 4310 or e-mail daniel.jaksa@ga.gov.au. For geological and geophysical maps of Australia contact the Geoscience Australia Sales Centre. ☒



Figure 3. Global Map Data Australia 1M consists of eight layers of information: four vector boundaries (drainage, administrative boundaries, population centres and transportation), plus four raster layers (elevation, land cover, land use and vegetation).



National Library of Australia

TOPOGRAPHIC map series update *almost* complete

Geoscience Australia has the Australian continent totally covered with its 1:250 000 scale topographic maps and the latest update has included many more features.

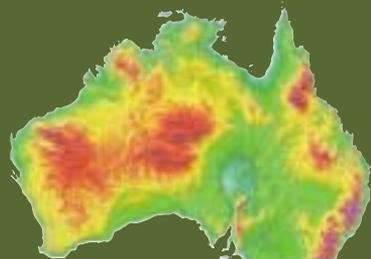
Topographic maps represent the Earth's natural and artificial features at a reduced scale. They show the locations of mountains, rivers, roads, railways, vegetation and many other features. Structures such as rail lines and bridges and some natural features such as rivers and parks are simplified in shape or represented as symbols. Features such as mountain ranges are represented using contours and colour shading.

Topographic maps are produced by establishing the exact location of features in an area (their latitude, longitude and height above sea level). These are known as reference points, which are combined with air photos or satellite imagery to produce a topographic map.

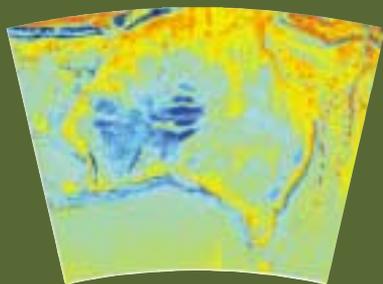
Geoscience Australia's GEODATA TOPO-250K was specifically designed as a base layer for a geographic information system (GIS), following extensive user consultation. The latest version (series 2) has 95 feature classes in five themes: hydrography, infrastructure, relief, vegetation and reserved areas. This detail far exceeds the next available national topographic data coverage, the Global Map 1M, which has 20 feature classes.

Series two is due for completion in 2003. There are 513 tiles in the new series (see figure 1). After each GEODATA TOPO-250K tile is updated, the information also becomes available in two graphical formats: the popular, printed 250K NATMAPs and the digital NATMAP RASTER 250K.

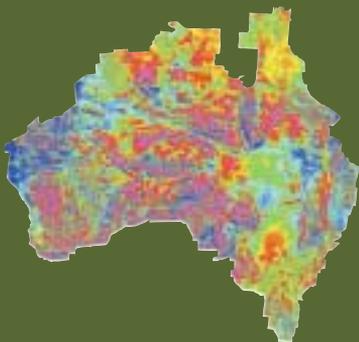
A standard printed map covers an area of one and a half degrees of longitude by one degree of latitude, or about 150 kilometres from east to west and 110 kilometres from north to south. A few coastal areas and capital cities have a larger coverage. For many rural and outback areas of Australia, Geoscience Australia's 250K NATMAPs are the most detailed topographic maps available.



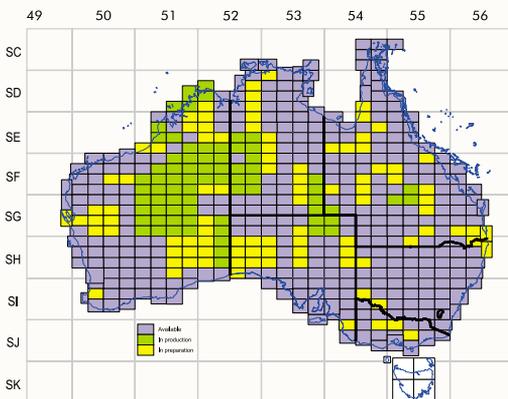
Elevation



Gravity anomaly



Magnetic anomaly



▲ Figure 1. TOPO-250K series 2 should be completed next year.

The GEODATA TOPO-250K tiles retail for \$108 each, with discounts for bulk orders. The data's national consistency is quality assured with rigorous production and independent quality testing. At \$9.25 for a paper map and \$99 for a complete set of RASTER 250K, the graphical products offer professional and private users easy access to detailed topographic information about Australia.



◀ **Figure 2.** TOPO-250K series 2 over Kangaroo Island, showing infrastructure and vegetation themes



▲ **Figure 3.** TOPO-250K series 2 over Kangaroo Island, showing hydrography and relief themes



▼ **Figure 4.** TOPO-250K series 2 over Kangaroo Island, showing all themes

Table 1. Features in the TOPO-250K series 2

Aboriginal area reserve	Aerial cableway	Aircraft facility	Bench mark
Bore	Breakwater	Building	Built-up area
Canal	Cave	Cemetery	Cliff
Contour	Conveyor	Crater	Cutting
Dam	Distorted surface	Embankment	Fence
Ferry route	Foot track	Ford	Foreshore flat
Forest	Forestry reserve	Gas well	Gate
Horizontal control point	Hypsometric area	Island	Jetty
Lake	Land subject to inundation	Landmark	Levee
Lighthouse	Locality	Lock	Mainland
Mangrove	Mangrove flat	Marine swamp	Mine
Nature conservation reserve	Offshore rock	Open-cut/mining area	Orchard
Park	Pine plantation	Pinnacle	Pipeline
Power line	Prohibited area	Railway	Railway bridge
Railway causeway	Railway station	Railway tunnel	Rainforest
Rapid	Reef	Reservoir	Road
Road bridge	Road causeway	Road tunnel	Rocky outcrop
Saline coastal flat	Salt evaporator	Sand	Sand dunes
Sand ridge	Sea	Sea wall	Seismic line/cleared line
Settling ponds	Spillway	Spot elevation	Spring
State border	Stock grid	Storage tank	Swamp
Water supply reserve	Water tank	Watercourse	Waterfall
Waterhole	Waterpoint	Wharf	Windbreak
Windpump	Wreck yard		

Continuous PICTURE possible with SATELLITE images



SATELLITE IMAGERY AVAILABLE FROM GEOSCIENCE AUSTRALIA

- **LANDSAT:** The Landsat-7 sensor has six spectral bands at 30-metre resolution, a panchromatic band with 15-metre resolution, and a higher resolution thermal band of 60 metres.
- **SPOT:** SPOT 4 has a multispectral mode with a pixel size of 20 metres and a panchromatic mode with a pixel size of 10 metres. SPOT 5 was launched in May. SPOT-LITE is a detailed series of SPOT panchromatic satellite images of Australia that can be accessed through the Geoscience Australia web site.
- **TERRA:** Available free on-line from Geoscience Australia for the first seven days after acquisition. The MODIS sensor on the TERRA satellite has a swath width of more than 2000 kilometres, and spatial resolution of 250–1000 metres. Data are used for a variety of broadscale land, ocean and atmospheric applications.
- **NOAA:** Available free on-line from Geoscience Australia for the first seven days after acquisition. The USA's National Oceanic and Atmospheric Administration (NOAA) series of satellites carries the advanced very high resolution radiometer sensor (AVHRR). The sensor is a five- or six-channel (depending on the model) scanner, sensing the visible, near-infrared, and thermal infrared portions of the electromagnetic spectrum at about 1.1 kilometre resolution.
- **RADARSAT:** This satellite has the unique capacity to acquire data in any one of a possible 35 imaging modes. Its synthetic aperture radar (SAR) sensor can operate in a variety of the modes. It has a resolution of 10–100 metres.
- **ERS:** ERS-2 has 30-metre resolution and includes a SAR sensor.



Hundreds of kilometres above the Earth, satellites are continuously imaging the planet and updating data as they repeat their paths. The digital measurements are transmitted to recording stations on Earth (such as Geoscience Australia's ACRES facility near Alice Springs) and processed into pictures. Various countries own the satellites that are orbiting the Earth.

Through the Australian Centre for Remote Sensing (ACRES), Geoscience Australia processes and distributes images taken over the Australian region from satellites such as Landsat, TERRA and NOAA (United States), SPOT (French), RADARSAT (Canadian) and ERS (European). It has archived 23 years of satellite imagery of the Australian continent.

Satellite sensors measure reflected and emitted energy. They take measurements actively (by sending out a radar signal and recording the reflectance) and passively (by recording the reflected sunlight from the Earth's surface). Visible, infrared, thermal and microwave radiation are measured.

Satellite imagery is used to monitor land-use changes, survey soil types, predict crop yields, explore for minerals and oil, manage water resources, and monitor natural disasters and assess the effects of floods and bushfires.

A catalogue of archived satellite imagery is available from the Geoscience Australia web site (www.ga.gov.au).

'Remote sensing' by satellite is the basis of most Earth observations nowadays. This term refers to a method of gathering data where there is no contact between the instrument (satellite or plane) and the object being studied or observed (the Earth).

For more information phone Gypsy Bhalla on +61 2 6201 4232 or e-mail gypsy.bhalla@ga.gov.au

SATELLITE IMAGES crucial to estuary audit

Satellite imagery is proving essential to 'the big picture' of land use and environmental impacts in Australia, and Geoscience Australia is one of many organisations that rely on the images for their research.

For example, Geoscience Australia relied heavily on satellite imagery when the National Land and Water Resources Audit commissioned an inventory on the condition of Australia's estuaries and coastal waterways two years ago.

Measurements taken from Landsat satellite imagery allowed Geoscience Australia's Urban and Coastal Impacts (UCI) project to rapidly and consistently appraise the geographical features of more than 900 estuaries around Australia.

Geoscience Australia processed dozens of satellite images that had estuarine features. Hard copies of these Landsat Thematic Mapper scenes were then combined with other reference materials such as air photos and topographic maps to help geomorphologists and sedimentologists interpret and define the physical dimensions and characteristics of the estuaries. These data were captured into a GIS (geographic information system) and used by the UCI project to quantify the physical forces (wave, tide and river energies) that form and affect the functioning of these coastal features.

The UCI project also used aerial photographs ranging in scale from 1:5000 to 1:80 000 to interpret the facies (the sedimentary layers). The facies boundaries were mapped onto hard copies of 1:15 000 and 1:50 000 scale Landsat images. Digital versions of the boundaries were added to the GIS.

The UCI project has also been studying the sedimentary layers of some 405 Australian modified estuaries and coastal waterways, to assess the abundance and integrity of habitats. This work continues, with the UCI project planning a national inventory on mangroves, salt marshes, saltflats and intertidal flats. These are key habitats for State of Environment Reporting, and the inventory will be used as a baseline for habitat monitoring and management.

The report to the National Land and Water Resources Audit on the condition of Australia's estuaries and coastal waterways was published last year as Geoscience Australia record 2001/07.

Coastal waterway mapping

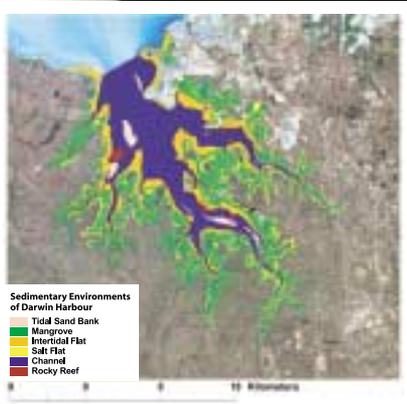
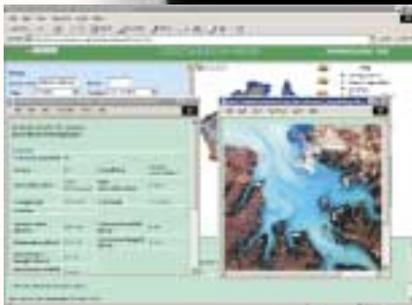
The UCI project classifications for 974 of Australia's estuaries and coastal waterways are provided in the OzEstuaries database (see figure 1). A description of one waterway in the database follows.

Darwin harbour (figure 2) is situated on the northern coast of the Northern Territory and opens into Clarence Strait. Annual rainfall over the 1990 square kilometre catchment is strongly seasonal (ca.1535 mm), most of which falls during the summer monsoon between December and March.

The harbour has been modified by humans and contains residential, industrial, aquaculture and port activities. The surrounding catchment is partially cleared of native vegetation for grazing and horticulture.

Darwin harbour is a tide-dominated estuary that is characterised by a series of north-west-trending drowned river valleys cut into the underlying bedrock. The main channels of the harbour are funnel-shaped and taper landward from the mouth. Extensive areas of intertidal habitats (figure 2) fringe the channels. These features are typical of tide-dominated estuaries in Australia with large spring tidal ranges (i.e. >4 m). The tidal range in the upper parts of funnel-shaped, tide-dominated estuaries can be significantly amplified, resulting in elevated water levels and strong tidal currents inside the estuary.

▼ Figure 1. Classifications for 974 of Australia's estuaries and coastal waterways are provided in the OzEstuaries database.



▲ Figure 2. Darwin harbour

Six key sedimentary habitats occur in the Darwin harbour estuary, which is typical of tide-dominated estuaries in the Northern Territory. Mangroves and salt marsh/saltflats dominate. These regions are potential sinks for fine particles from the catchment and offshore sources. Large, elongate tidal sand banks have developed in the wide main channels of the harbour in response to the strong tidal currents.

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or e-mail david.heggie@ga.gov.au**



DIGITAL DATA BEST



if much is at risk

If analysis is complex and spatially linked, switch to a digital mode advises Lisa Buckleton from Geoscience

Australia's Cities project team—even if the problems of data inconsistency, price and access are still being worked out.

Paper maps are essential visualisation and communication aids for emergency responders. During this year's January bushfires in New South Wales, Geoscience Australia provided more than 3000 paper maps and satellite images of bushfire-affected areas in just over a week to fire, police and emergency workers. But paper maps lack flexibility. The information cannot be manipulated like digital data.

Spatially enabled information is crucial not only to disaster response, but also to risk assessment, management and avoidance (land-use planning). Technology for storing, analysing and displaying spatial information—known as a GIS (geographic information system)—greatly increases the sophistication of the analyses that can be performed on data. This technology allows all kinds of data to be synthesised and integrated, and presented graphically as maps and models. A GIS allows maps to be customised, and speeds map creation. It is fundamental to risk and disaster analyses because of the complexities involved.

Risk-GIS

In the aftermath of the September 11 attacks on New York last year, a GIS helped decision-makers with disaster relief/response efforts. But a GIS for assessing disasters is only as good as its data, which must be accurate, current and suitable, as well as comprehensive.

For six years, Geoscience Australia's Cities project has been examining multiple hazards (e.g. earthquakes, floods and landslides) and the risks to Australian urban communities. The project has been building a 'Risk-GIS' with this data and is including other essential information such as a community's social and structural vulnerability to various disasters. Examples of data being included in the Risk-GIS are:

- physical characteristics of the natural environment (e.g. bathymetry, topography, vegetation coverage, geology and depth to ground water);
- physical characteristics of the built environment (building materials and construction, road materials and construction methods, water and gas pipe materials);
- administrative details (land-use planning, the location and capabilities of emergency response facilities, hospitals, schools, power stations, water supplies and food retailers);
- community characteristics (26 demographic, social and economic parameters primarily extracted from census data);
- historical event data (frequency, size and impact of previous hazard events); and
- aerial photography.



Great detail is necessary. For flood or storm-surge modelling, for instance, contour data of a half-metre accuracy or better is preferred to properly assess the extent of the hazard. An example of the detailed visualisation that can be created with the Risk-GIS is shown in figure 1.

Post-disaster information

Reliable, detailed information about actual events is also vital. The Risk-GIS must include hazard-related observations (e.g. meteorological or geological data), physical damage, and the cost to repair or replace buildings and other infrastructure. Much of the information can be obtained readily by field teams visiting disaster areas soon after the events (with pre-formatted, palm-top computers) and collaborating with insurers, local officials, and engineers regarding damage and repair costs.

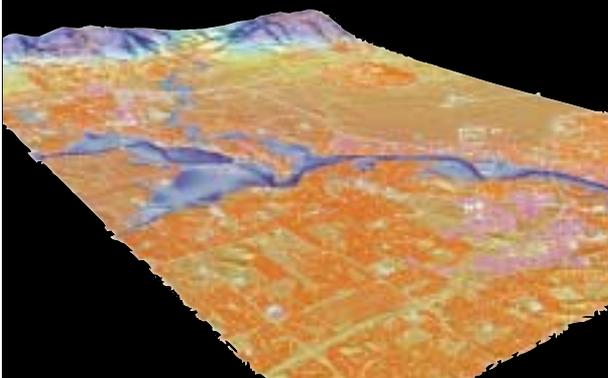
Pre- and post-disaster surveys have been undertaken by the Cities project in earthquake-affected areas. These surveys, in Newcastle and Dubbo in Australia and Gujarat in India, used state-of-the-art digital field data acquisition units (each consisting of a Compaq palmtop computer with ArcPad and database software, a Garmin 12 differential GPS receiver, and a digital camera). These units allow efficient and robust data collection that can be integrated into GIS databases and fed directly into the vulnerability and risk analysis processes.

Information is also needed on the long-term economic and social impact of disasters. Direct and indirect costs provide the basis for tracking the 'true' price of past disasters. This information is vital for improving loss-estimation models.

Risk models

An earthquake risk map of Newcastle, New South Wales, is an example of how the Risk-GIS integrates information and can be used to demonstrate the potential impact of future natural hazard events on a community (figure 2). The map shows the average, annualised risk in terms of building damage and the total direct cost of repair. The predicted concentration of damage in the central business district is consistent with the pattern of damage observed in the 1989 Newcastle earthquake, and demonstrates the vulnerability of this area to future earthquakes.

▼ Figure 1. Swan River flood event, 1:100 years, integrating orthophotos and surface maps



▲ Figure 2. Newcastle earthquake risk map compiled from data held in the Risk-GIS

Risk modelling can be used to set research priorities and to develop disaster scenarios for emergency response and urban planning. It is also useful for educating the community, and evaluating risk acceptance thresholds for stakeholders.

Access and quality

All levels of government in Australia, various agencies and universities, as well as some private companies have data that should be part of the Risk-GIS. But the format and quality of data vary and not all data are in the public domain.

Structured databases exist for earthquake, tsunami, storm surge, and landslide hazards, as well as meteorological hazards. Data that Geoscience Australia gathers as part of its national responsibilities (table 1) are accessible for risk modelling, as is historical hazard data compiled by organisations such as the Bureau of Meteorology. But most data have been collected for other purposes and do not necessarily meet risk assessment requirements.

Much effort is often required to modify or 'value add' the data. For example, many utility providers (electricity, water, sewerage and gas) store their spatial data in 'dumb' graphic format rather than as 'intelligent' attributed GIS data. The required attributes are commonly stored in a separate database with no link to the graphics. Connecting the attributes to the graphics requires significant resources.



▲ Photo: Field equipment used by Geoscience Australia's Cities project for pre- and post-disaster surveys

Table 1.
Geoscience Australia's national responsibilities for hazards

- detecting and reporting earthquakes
- monitoring and reporting nuclear explosions
- monitoring changes in the Earth's magnetic field (in the Australian region)
- detecting space debris
- managing the national geodetic global positioning satellite (GPS) network
- cooperating with the Bureau of Meteorology and Emergency Management Australia in the development of the Australian tsunami alert system (ATAS)

Other issues that have an impact include the pricing regimes of some organisations, copyright and licence conditions, and data confidentiality problems (due to commercial sensitivities), mostly regarding infrastructure data. (This is greatest where the utilities are fully privatised.)

It is becoming a little easier to obtain the requisite data, partly because data-gathering methods are now much more efficient. Field data-capture techniques are more economical and more accurate. Remotely sensed imagery (collected using planes or satellites) is now more precisely positioned and of a higher resolution, includes a wider range of frequencies (with better frequency discretion), and is cheaper than ever before. Basic data such as cadastre and road networks are better positioned spatially and sub-metre-accuracy surface data (e.g. contours and digital elevation) are now available.

But more needs to be done to remove barriers to the production of high-quality risk assessments for Australian communities.

Government initiatives

The Commonwealth Government has implemented several initiatives to boost the growth of Australia's spatial information industry, which should help those building a comprehensive, up-to-date Risk-GIS. These include:

- Establishment of the Commonwealth Office of Spatial Data Management;
- A policy of cost-free public access to the Commonwealth Government's fundamental spatial data;
- The GeoInsight program (a \$2 million grant to Technik) for a technology transfer and skill development program for Australian emergency-management agencies;
- The Australian Disaster Information Network (AusDIN) project, which has the potential to provide a comprehensive, strategic, and technical framework for hazard, vulnerability, and risk studies;
- The amalgamation of two Commonwealth agencies AUSLIG and AGSO (into Geoscience Australia), which considerably strengthens the new, internet-based, public-information access system.

For more information
phone **Lisa Buckleton** on
+61 8 9323 9815 or e-mail
lisa.buckleton@ga.gov.au ✉

EVENTScalendar

Compiled by Steve Ross

■ Australian Science Festival

Australian Science Festival Ltd

17 to 25 August

Canberra

Contact: Australian Science Festival,
PO Box 193, Civic Square ACT 2608

phone +61 2 6205 0588

fax +61 2 6205 0638

www.sciencefestival.com.au

■ Applied Structural Geology for Mineral Exploration & Mining Symposium

Australian Institute of Geoscientists

22 to 25 September

WMC Conference Centre, Kalgoorlie

Contact: Jocelyn Thompson, Australian
Institute of Geoscientists,

PO Box 606, West Perth WA 6872

phone +61 8 9226 3996

fax +61 8 9226 3997

e-mail aigt@aig.asn.au

■ Earth Science Week

Australian activities coordinated by
Geoscience Australia

13 to 19 October

Educational and scientific institutions
across Australia

Contact: Jeanette Holland,
Geoscience Australia, GPO Box 378,
Canberra ACT 2601

phone +61 2 6249 9731

fax +61 2 6249 9990

e-mail jeanette.holland@ga.gov.au
www.ga.gov.au/education/esw

■ Mining 2002 International Convention & Trade Exhibition

Mining 2002

30 October to 1 November

Carlton Crest Hotel, Brisbane

Contact: Mining 2002, PO Box 607, West
Perth, WA 6872

phone +61 8 9485 1166

fax +61 8 9481 8023

e-mail abbie@verticalevents.com.au

www.mining2002.com.au

■ e-future: Into the mainstream

Institution of Surveyors Australia & the
Australasian Urban & Regional
Information Systems Association (AURISA)

25 to 30 November

Convention Centre, Adelaide

Contact: Hartley Management Group,
PO Box 20, Kent Town SA 5071

phone +61 8 8363 4399

fax +61 8 8363 4577

e-mail efuture@hartleymgt.com.au

www.hartleymgt.com.au/efuture

Rare ground, where fiction is FACT

The shadowy land of Mordor sketched in Tolkien's 1950s book, *Lord of the Rings*, is not a myth.

Mordor is 68 kilometres north-east of Alice Springs in the middle of Australia rather than in Middle-earth, and it is a wild place for dingoes and camels instead of Tolkien's hobbits and dark lords.

Mordor is an extraordinary area that the geology fraternity has kept quiet about for 30 years.

A team of government geologists and field hands mapped Mordor in 1972-3. At the time, locals called the place Spring Pound, probably because it is said to have an unusual spring that comes and goes.

Bureau of Mineral Resources geologist Alan Langworthy was the ringleader when it came to officially naming the place. He suggested Mordor because of the remarkable similarity between the area's geological features and the Mordor map published in *Lord of the Rings*.

Mordor Pound (also called Mordor Igneous Complex) is a region of low relief surrounded by sheer cliffs of sandstone and conglomerate. The cliffs form a distinctive rectangular pound that is open-ended to the south-west.

Location precision *amazing*



Figure 1.

'Where in the world are you?'

Whether you are in Ulaanbaatar,

Ushuaia or in rugged terrain miles from
anywhere, Geoscience Australia's on-line

GPS (global positioning satellite) service, AUSPOS, generates ultra-precise
positions from the world's most remote locations within minutes.

In the 16 months that AUSPOS has been operating, it has been accessed
from every continent and has supplied users with more than 10 000 accurate
coordinates.

AUSPOS data are being used to measure glacial movement in Antarctica,
position oil rigs on Australia's North West Shelf and Bass Strait, and
coordinate pastoral leases on mainland Australia. Pacific island nations use
AUSPOS to accurately determine positions for their remote islands.

For field work, AUSPOS saves a lot of time and equipment. Previously,
surveyors and geologists needed at least two GPS receivers and a high level
of computational ability. With AUSPOS, they set up only one GPS receiver,
record six to 12 hours of signal, download the data to a computer and
submit a RINEX file to AUSPOS on-line. The 24-hour service returns highly
accurate positions within minutes.

The ability to calculate accurate coordinates can be attributed to the
Australian Regional GPS Network (ARGN), which is part of the International
GPS service. The ARGN is made up of 15 GPS receivers in geologically
stable areas in Australia and Antarctica (see figure 1).

Right: The Landsat-7 satellite image shows the uncanny resemblance between Mordor Pound in the Northern Territory and Tolkien's mythical Mordor.



Left: Sketch of Mordor from plate 4, *Maps of Middle-earth*, in JRR Tolkien's *The Lord of the Rings, part 3: Return of the King*, published by Allen & Unwin.



To enter Mordor, one must follow a rugged four-wheel-drive track that passes through a gap in the cliffs called Wild Dog Pass (Cirith Gorgor in Tolkien's tale). In the valley floor there are conical hills of black rock. One is called Mount Doom because it resembles its namesake in Tolkien's book.

The rocks of Mordor Pound are ultramafics and some unusual rocks called shonkinites. Like the original Mordor, they would have been forged in a very hot environment where, according to Tolkien's description, 'great steam and smoke belched... and all about it the Earth gaped'.

The rocks are unusually rich in potassium, aluminium, rubidium, strontium and barium. They surfaced as molten rock from deep in the Earth's crust, but were not extensively contaminated by country rocks. They have not

undergone the degree of deformation and alteration that is normally expected of such old rocks.

Geoscience Australia geologists determined that Mordor rocks are 1.13 billion years old. But there are opposing views on the order in which the major rock groups were emplaced (ultramafics, shonkinite, then syenite, or whether the ultramafic bodies postdate the felsic bodies).

Minerals of economic interest may be associated with the rocks, including nickel, copper, platinum-group elements, diamonds, uranium and rare-earth elements.

Further information about the geology of Mordor Pound can be found in Geoscience Australia record 2001/39 (see product news page 28). 

with Australia's on-line GPS

Figure 1. (Far left) The Australian regional GPS network comprises 15 permanent geodetic GPS receivers on the Australian and Antarctic continents, which contribute to the International geodetic framework.



Anyone, anywhere in the world, at any time, can use AUSPOS. It is a free service that many countries are accessing, including New Zealand, East Timor, Malaysia, Mongolia, Tuvalu, Tonga, South Africa, Finland, Sweden, Spain, the United States, Canada, England and Ireland.

South Pacific network

Geoscience Australia is helping to set up a similar GPS network in the south Pacific as part of an AusAID-funded project. Twelve GPS stations are being combined with tide gauges to enable Pacific island nations to monitor climate and sea level changes.

The most recent GPS station was opened on Papua New Guinea's Manus Island (the largest island in the Admiralties group) on May 3.

Tide gauge records collected over long periods indicate a rise in global sea level of 10 to 30 centimetres over the past century. However, there are large discrepancies in the rate of change indicated by different tide gauges. These differences are thought to be mainly caused by earthquakes, tides, volcanic activity and vertical land motion resulting from glacial rebound, tectono-physics, subsurface fluid withdrawal and sediment consolidation.

The GPS network is used to establish the absolute height of the tide gauges and determine horizontal and vertical crustal movement (through geodesy, which is measuring the position and movement of the Earth). Under the AusAID project, local people are being trained to use the GPS network and decipher tide-gauge signals to monitor absolute sea-level variations.

Above: Photographs taken at the May 3 opening of the latest GPS station on Manus Island (2° below the Equator).

Left: Bob Twilley of Geoscience Australia's Geodesy program. **Centre:** Stephen Pokawin, Governor of Manus Provincial Government

Measurements taken in the south Pacific should provide a better understanding of the causes that may accelerate a change in mean sea level, and should contribute reliable scientific data to the current debate about whether sea-level changes are related to global warming.

For more information phone John Dawson on +61 2 6201 4344 or e-mail john.dawson@ga.gov.au 

Call for research proposals for EXPERIMENTS & IN 2003 & beyond

Submissions by **AUGUST 12, 2002**

The Australian National Seismic Imaging Resource (ANSIR) seeks bids for research projects for experiments in 2003 and beyond.

ANSIR is Australia's major national research facility in the earth sciences. It was created to encourage and assist world-class research and education in the field of seismic imaging of Earth. It operates a pool of state-of-the-art seismic equipment suitable for experiments designed to investigate geological structures from environmental and mine scale through to continental scale. ANSIR is operated jointly by Geoscience Australia and the Australian National University.

ANSIR equipment is available to all researchers on the basis of merit, as judged by an Access Committee. ANSIR provides training in the use of its portable equipment, and a field crew to operate its seismic reflection profiling systems. Researchers have to meet project operating costs.

Details of the equipment available, access costs and likely field project costs, as well as the procedure for submitting bids for equipment time are available on the web at: <http://rses.anu.edu.au/seismology/ANSIR/ansir.html>. This web site also shows an indicative schedule of equipment for projects that arose from previous calls for proposals.

Over the next year, controlled source equipment will be used on both sides of the continent. People interested in proposing piggy-back experiments should contact the ANSIR Operations Manager for details of the scheduled experiments. The long-period portable instruments are in heavy demand; potential users are urged to submit bids at the earliest opportunity. Spare capacity on short-period portable instruments in 2003 is anticipated.

Researchers seeking to use ANSIR in 2003 and beyond should submit research proposals to the ANSIR Operations Manager by August 12, 2002.

Enquiries should be directed to:

- **Mr Tim Barton** (for projects requiring ANSIR's seismic reflection equipment), ANSIR Operations Manager, GPO Box 378, Canberra ACT 2601. Tel. +61 2 6249 9625 or e-mail tim.barton@ga.gov.au
- **Prof Brian Kennett** (for projects requiring ANSIR's portable seismic recorders), Research School of Earth Sciences, Australian National University, Canberra ACT 0200. Tel. +61 2 6215 4621 or e-mail brian.kennett@anu.edu.au ☞



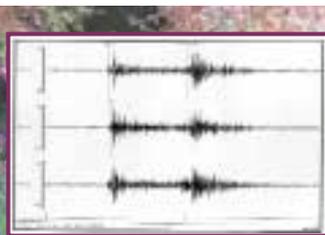
Certain *ring* for earthquake **ALERT**

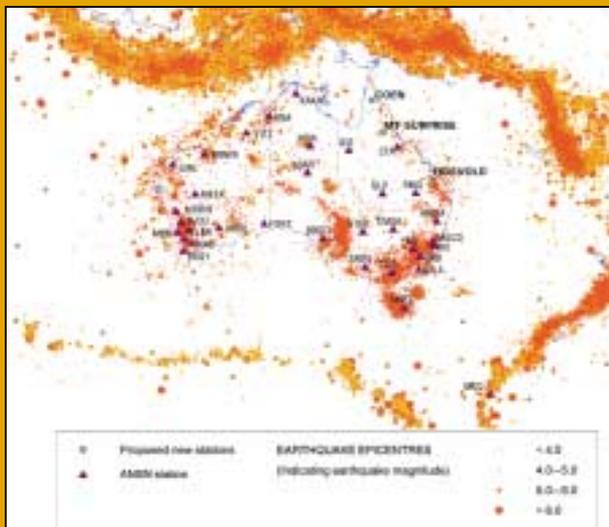
There is a safety ring around Australia to monitor ground motion and feed into research on the causes and effects of earthquakes. Geoscience Australia builds and maintains this ring of seismographic stations for the Commonwealth Government.

The Commonwealth Government began the seismographic network 45 years ago (following the International Geophysical Year) by establishing three stations. The National Seismographic Network now comprises 30 stations around Australia and three stations in Antarctica. A further 32 instruments in major population centres monitor ground motion (for the Commonwealth-State/Territory Urban Monitoring Program).

The network records earthquakes within the Australian region, as well as larger earthquakes around the world. It also monitors nuclear explosions, and some stations are part of a worldwide network that was set up to verify compliance with the Comprehensive Nuclear Test Ban Treaty.

The digital data recorded by the network stations are telemetered in near-real time to Canberra, where they are analysed and stored in Geoscience Australia's database of Australian and global earthquakes. Geoscience Australia operates a 24-hour, seven-day-a-week earthquake alert system.





▲ **Figure 1.** Australian national seismographic network stations, proposed new stations, and earthquakes recorded by the network in the Australian region

Alert system

The alert system automatically analyses earthquakes detected by the network, and calculates their location and magnitude. If an earthquake is potentially damaging, an alert is sent to an on-call duty seismologist, who verifies the event and notifies Emergency Management Australia. EMA relays a warning to relevant local authorities.

Another important function of the network is detecting earthquakes that could generate tsunamis around Australia and particularly the south-west Pacific region. If such an event occurs, EMA is immediately notified so that local authorities and/or the Pacific island nations that could be affected are prepared.

Other uses

Information derived from the network's data is used for advice to the building, resource and insurance industries, to other government agencies, the media, and the general public. Geoscience Australia scientists use the data in their research to estimate and model the risk posed by earthquakes to Australian communities. The models are one of the measures being used to improve building codes.

The network also provides data to support global earthquake hazard research. Data is regularly exchanged with international agencies such as the International Seismological Centre and the United States Geological Survey. These agencies maintain comprehensive databases of global earthquake data and publish and distribute international bulletins of seismic activity.

Network upgrade

Geoscience Australia is currently upgrading the network to improve the coverage and quality of data. With improved coverage, Geoscience Australia will be able to detect and locate lower magnitude events in a wider area of the continent. (In some places, the network cannot locate earthquakes of magnitudes lower than 3.5.)

The bandwidth and dynamic range of many of the stations will be enhanced to support critical research into the source and wave-path characteristics of Australian earthquakes. This research is important for estimating the ground shaking caused by earthquakes and the potential damage to buildings and infrastructure in Australian towns and cities.

For more details phone Bill Greenwood on +61 2 6249 9787 or e-mail bill.greenwood@ga.gov.au



HOW GOOD IS THE NATIONAL SEISMOGRAPHIC NETWORK?

Remember the Landsat-7 satellite image of smoke from a fireworks explosion in the hills of Perth on March 6 (printed on page 24 of *AusGeo News* 65)? That image was captured an hour after the explosion.

The National Seismographic Network recorded the explosion as it happened, triggered the alert system, and telemetered the data shown opposite in near-real time to the on-duty seismologist, Andrew Owen, in Geoscience Australia's headquarters for analysis and verification. ☑



ANTARCTIC

Marine geophysical surveys completed off ANTARCTICA

After 93 days at sea, the seismic survey vessel *Geo Arctic* berthed in Durban, South Africa, on April 12 completing a series of the most thorough geoscience surveys ever carried out off Antarctica. The voyage was the culmination of two years' work to acquire data along a segment of the Australian Antarctic Territory (AAT) that is about the same length as the Australian margin between Brisbane and Perth.

Geoscience Australia carried out the work for the Commonwealth Government, which requires a large quantity of geophysical data to define the shape of the AAT continental margin and its underlying geology. The data are required by the government if it decides to lodge a submission delineating the 'extended continental shelf' off the AAT, with the United Nations Commission on the Limits of the Continental Shelf.

In the first season (2000/01), the ice-strengthened survey vessels *Polar Duke* and *Geo Arctic* carried out two surveys off the AAT. The *Polar Duke* acquired about 3500 kilometres of high-speed seismic data and a similar amount of bathymetry data during a 58-day survey that was concentrated on the continental slope in water depths greater than 1000 metres. The *Geo Arctic's* 102-day voyage surveyed the deeper water 'outboard' of the *Polar Duke* lines. It acquired more than 10 500 kilometres of high-quality, deep-seismic data.

Filling in the gaps

In the survey design, a series of seismic lines with an average separation of 90-95 kilometres was planned along the margin of Antarctica. These lines were to extend from the continental slope in water depths of about 1000 metres to the deep ocean at around 4500 metres depth.

In the first year of surveying, the *Geo Arctic* recorded every second of the planned lines along the 5500 kilometre length of the AAT margin. This approach was adopted to acquire data from the entire margin in the first season that could then be used to minimise the work required in the second season. Thirty-two lines were recorded, at an average length of more than 330 kilometres each. Eighteen refraction sonobuoys were also successfully deployed for information on the velocity structure of the crust. Many of the lines provided full transects of the continental margin in areas where previous data were sparse or non-existent.





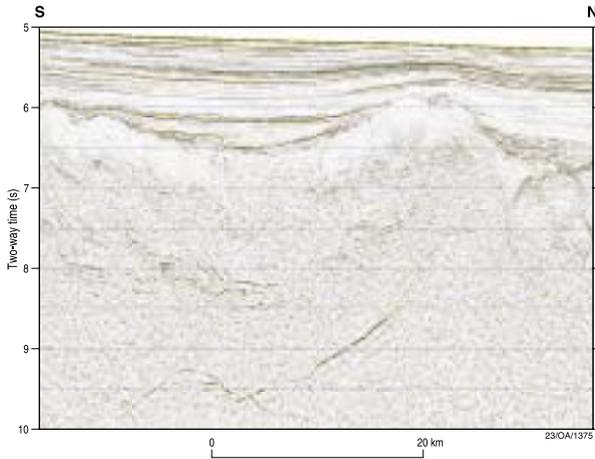
In the season just completed (2001/02), the intention was to shoot all the in-fill lines and to extend first-season lines that interpretation had shown were not long enough. A further 41 lines (almost 9600 kilometres in total) of good-quality data were recorded. Ninety refraction sonobuoys also were deployed, about 80 of which will provide important information about the nature of the crust.

Quick processing

On-board processing of the seismic data was an important aspect of the latest *Geo Arctic* survey. This facility allowed survey plans to be modified on-line, which was critical to maximising the efficiency of operations. The rapid turn-around in processing data also meant that detailed interpretation of the first season's data could occur, while the second season's survey was still under way.

Interpretation of data from the first season is well advanced. Along with conventional interpretation of the reflection seismic data, substantial effort is going into modelling the refraction seismic and potential field (gravity and magnetic) data. This mix of interpretations will lead to a better understanding of a large part of the Antarctic margin that previously was not possible.

The first-pass interpretation is being undertaken by Geoscience Australia. Students at the universities of Sydney and Oxford are also using some data in doctoral studies. The data will become available to the international scientific community in accordance with the terms of the Antarctic Treaty and under the auspices of the Scientific Committee on Antarctic Research.



▲ **Figure 1.** Part of a seismic line from the deep-water margin of George V Land, Antarctica, acquired during Geoscience Australia's latest survey on the *Geo Arctic*. The sediments in the top of the section were deposited during the separation of Australia and Antarctica during the past 80 million years. In this section the sediments are about 1500 metres thick. The reflectors in the bottom of the section come from the crust at a depth of about 14 kilometres.

International relevance

Geoscience Australia's surveys off the AAT represent a huge leap in the amount of geoscience information available for offshore Antarctica. The work provides the international science community with 20 000 kilometres of deep-seismic, gravity and magnetic data, and 3500 kilometres of high-speed seismic data, as well as almost 100 sonobuoy refraction stations.

While the data can be used to determine the outer limit of the 'extended continental shelf', the information is also fundamental to an understanding of Antarctica and its role in the global climate system, and will be useful for environmental management planning.

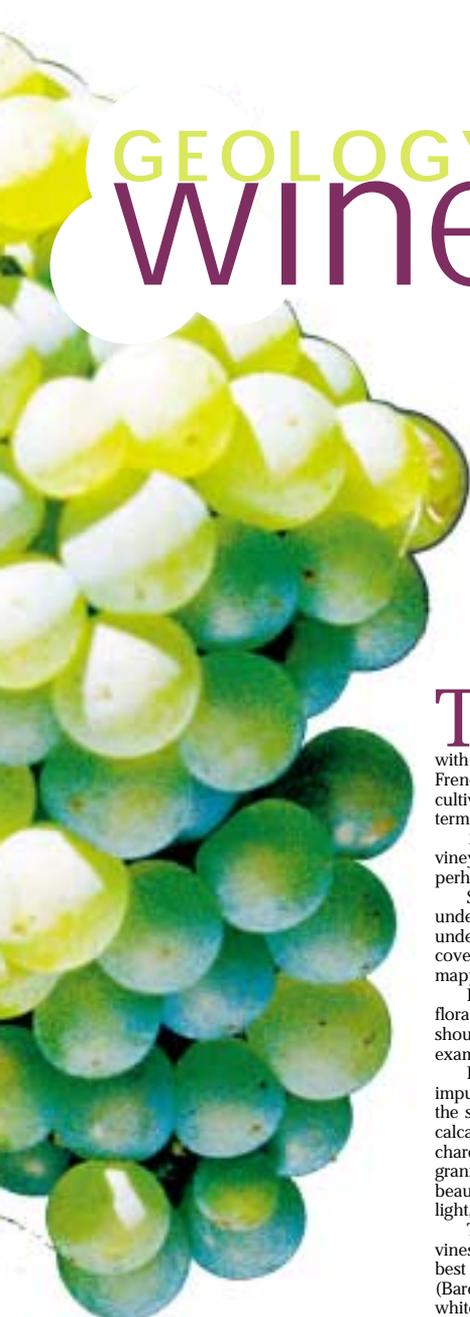
Survey origins

In December 1999, the Australian Ministers for Foreign Affairs, and Environment and Heritage announced that the government would carry out work that would enable it to prepare a submission delineating the 'extended continental shelf' off the AAT. It is the area of seabed/subsoil jurisdiction beyond the 200 nautical mile Exclusive Economic Zone, as defined by Article 76 of the United Nations Convention on the Law of the Sea.

The Australian Antarctic and Southern Ocean Profiling project was set up, under the management of the Department of Finance and Administration in consultation with the Australian Antarctic Division, to acquire and interpret data that would underpin any such submission. The clients for the project are the Department of Foreign Affairs and Trade and the Attorney General's Department. Technical aspects of the work are largely the responsibility of Geoscience Australia. The surveys were carried out using an experienced geophysical contractor (Fugro Geoteam AS, Norway) in accordance with permit guidelines issued by the Australian Antarctic Division and Environment Australia.

For more details phone the project director Simon Schiwy on +61 2 6215 2576 or e-mail Simon.Schiwy@finance.gov.au. Alternatively, phone Howard Stagg on +61 2 6249 9343 or e-mail howard.stagg@ga.gov.au





GEOLOGY AT ROOT OF wine-grape COMPLEXITIES

For centuries wine-grape growers have been perplexed how the same grapes grown in like areas can produce wines of various qualities.

Geologist and wine-industry consultant, Dr Douglas Mackenzie describes how geoscience tools can be used to explain the differences, and map out areas most suited to viticulture. He provides more detail than the general article about geology and viticulture published in *AusGeo News* 63.

Two thousand years ago the Romans realised that the same wine grapes grown in nearby, apparently similar areas could produce quite different wines. They knew that the differences had something to do with the position of their vineyards and not just the wine makers' skills. French wine producers, through centuries of trial-and-error viticulture (the cultivation and husbandry of grapevines), built on this notion and use the term *terroir* to explain the differences.

Terroir refers to the total natural environment of a vineyard or area of vineyards: the local climate, topography, vegetation, land-use history and, perhaps most importantly, geology and soil.¹⁻³

Soil is directly related in composition, texture and mineralogy to the underlying rocks (or other parent material). Changes in soil composition and underlying geology are commonly reflected in changes in natural vegetation cover (figure 1). Australian geologists use such vegetation patterns as aids in mapping the distribution of rock types.

If geology and soil composition can profoundly affect a mixed natural flora, then a single plant species such as the wine-grape vine, *Vitis vinifera*, should also respond to changes in geology and soil composition. A good example where this occurs is Burgundy in France.⁴

In the Côte de Nuits (northernmost Burgundy), red-brown clays on pink, impure limestone produce the world's best pinot noir. Twenty kilometres to the south-west (the Côte de Beaune), lighter, sandier/siltier soils on calcareous mudstone (marl) and marly limestone produce intense, long-lived chardonnay, but generally less-exalted, more delicate, pinot noir. The sandy, granitic gneiss-derived soils of southernmost Burgundy produce the best beaujolais, made from gamay grapes. Soils overlying younger marls produce light, 'quaffing' gamay wines and modest chardonnay.

The story is similar in Alsace, France, where the best riesling comes from vines on 'sandy' soils formed on sandstone and schist, while pinot gris does best on rich soils formed on marls. In Piemonte, Italy, the best nebbiolo (Barolo) is grown on blue-grey marl, while barbaresco comes from soils on white marl, and nebbiolo d'alba from yellow sandy soils.

Australian examples

In Coonawarra, South Australia, excellent cabernet sauvignon is produced from red clay soils (terra rossa) formed on a relatively sandy part of the Padthaway Formation. Vines grown in the surrounding areas of 'black' clay soils (formed on muddier shallow-marine or lagoonal sediments of the Padthaway Formation) and sandy soils (overlying mottled clays) produce vigorous growth but lesser-quality wines (figures 2-4).



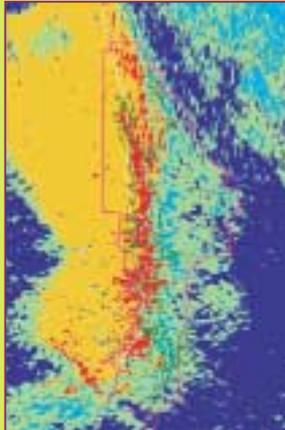
In South Australia's Clare Valley, the best of its renowned rieslings come from vines growing on thin 'red earths' (which contain a calcrete layer and overlie slaty dolomitic siltstone and dolomite) and from vines growing in 'sandy' soils (formed on relatively quartz-rich sedimentary rocks). The best shiraz and cabernet wines come from old vines with their roots deep into thick red clay loams that overlie dolomitic siltstone and slate.

Although the *terroirs* of parts of Australia are understood, there are large areas with the potential for high-quality viticulture still to be explored fully.

Soil composition effects

Many soil factors contribute to vine health and grape/wine flavour, the most obvious being clay content and drainage. Chemical composition, one of the least understood factors, though may hold the key to the subtle effects that *terroir* has on the distinctive regional or local flavours of wines (*typicité*).

France's Institut National de la Recherche Agronomique recently tested this idea in the Loire Valley. The Institut planted cabernet franc vines under identical viticultural conditions and in climatic conditions as closely matched as possible, in several vineyards widely distributed through the Anjou-Saumur area.⁵ Wines made from these vines have consistent inter-vineyard flavour differences. The only significant variables among vineyards are the soils and geology, implying that soil composition is a fundamental cause of wine-flavour differences.



▲ **Figure 1.** (above left) Part of an aerial photograph from the Clare Valley, South Australia, showing pronounced changes in native vegetation from one rock type to another. The thinnest (palest) vegetation cover is over quartz-rich sandstone. The thickest/tallest vegetation is on dolomitic siltstone and slaty siltstone.

▲ **Figure 2.** An image of the Coonawarra area, South Australia, shows the 'raw' gamma-ray spectrometric data in red-blue-green 'false colours'. The terra rossa soil appears as bright green. Other calcareous soils are red to yellow tones.

◀ **Figure 3.** A simple classification of the 'raw' data, showing the terra rossa soils as red; orange = dark calcareous clays; green = sandier soils; pale blue = low-potassium limestone soils; dark blue = very sandy soils and sand.





Trace-element composition of wine varies with its provenance. Multi-variate statistical analysis of 55 Spanish wines using seven elements (Cd, Cr, Cs, Er, Ga, Mn and Sr) produced 86 to 100 per cent discrimination among the three wine-producing areas studied.⁶ On a more local scale, studies in the Okanogan Valley of western Canada showed that concentrations of aluminium, arsenic, cadmium, cobalt, copper and vanadium in wines were perfectly correlated with the locality of the vineyard from which they originated.⁷ It appears that soil chemistry is reflected in wine chemistry—and probably influences wine flavour.

Mapping soil composition

A geophysical tool known as gamma-ray spectrometry is used in geological mapping and mineral exploration. It can be used to map soil and the regolith (the weathered part of the Earth's surface that includes soil and intensely weathered rock).⁸⁻¹⁰

The technique measures weak radiation emitted by naturally occurring radioisotopes—principally potassium, thorium and uranium—from approximately the top 45 centimetres of the land surface. Data are normally represented as a false-colour (potassium concentration by the intensity of red, thorium by green and uranium by blue), geographically corrected image that shows changes in soil composition (figures 5 and 6).

A 'true' soil map is produced by rigorous interpretation of the data, combined with targeted field sampling and/or checking of soil properties, and reference to geological and chemical data. Soils of outstanding vineyards may be mapped and characterised rapidly and accurately using this process.

Site selection and management

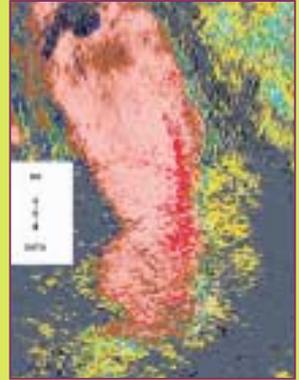
Australian geoscientists use GIS (geographic information system) technology to manage and help interpret multi-faceted data sets. With GIS technology, the soil mapping data described above can be combined with other important *terroir* data to model areas of optimum suitability for viticulture.

The first step in the site selection process is to measure or take ranges for the following:

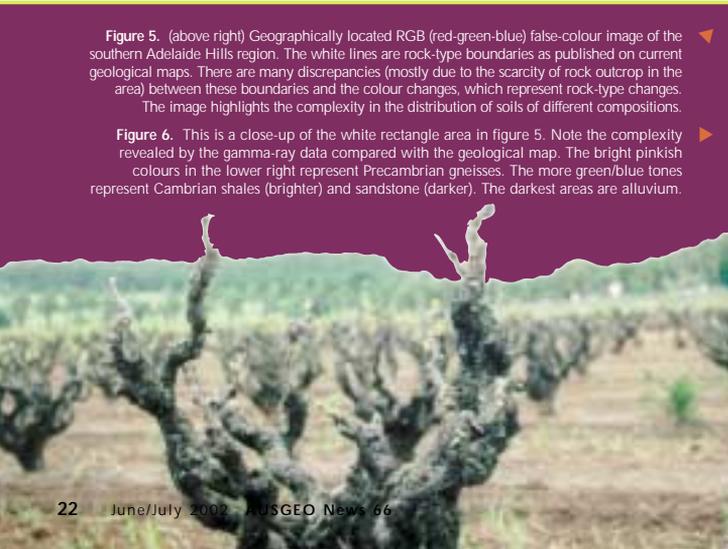
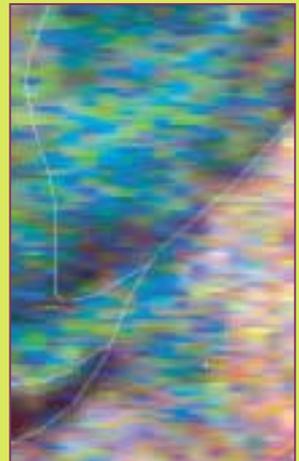
- Topographic factors—elevation, aspect and slope;
- Soil—root-zone depth, composition, drainage properties and parent material;
- Climatic factors—ripening season temperatures, rainfall, cold-air drainage and prevailing winds;
- Water resources—surface and/or ground water;
- Infrastructure—proximity and access to transport and a workforce.

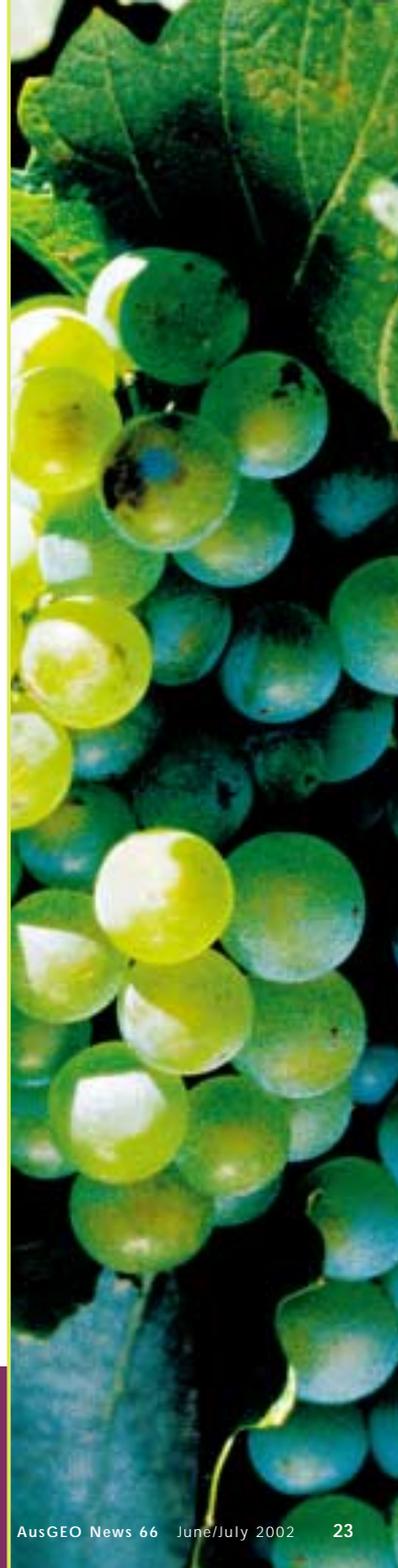
Figure 5. (above right) Geographically located RGB (red-green-blue) false-colour image of the southern Adelaide Hills region. The white lines are rock-type boundaries as published on current geological maps. There are many discrepancies (mostly due to the scarcity of rock outcrop in the area) between these boundaries and the colour changes, which represent rock-type changes. The image highlights the complexity in the distribution of soils of different compositions.

Figure 6. This is a close-up of the white rectangle area in figure 5. Note the complexity revealed by the gamma-ray data compared with the geological map. The bright pinkish colours in the lower right represent Precambrian gneisses. The more green/blue tones represent Cambrian shales (brighter) and sandstone (darker). The darkest areas are alluvium.



▲ Figure 4. A more sophisticated classification of the Coonawarra gamma-ray spectrometric data, showing most of the major classes of soil in the region. The terra rossa soils are depicted in red tones. Note the generally good correspondence with the Penola Land System (white outline) mapped by the South Australian Department of Primary Industries and Resources.





This information in digital form is fed into a GIS program such as ArcInfo or MapInfo. Elevation, slope, aspect, and cold-air drainage can be modelled from digital elevation data normally acquired with the gamma-ray spectrometric data. Variation in soil composition is mapped and classified using the airborne gamma-ray spectrometric data, as described above. Soil 'classes', based on combinations of composition, thickness and perhaps moisture content, are then assigned 'viticultural suitability' ratings.¹¹

Topographic, infrastructure and climatic data are readily available from government agencies such as Geoscience Australia and the Bureau of Meteorology. In most areas, climatic data and water-bore data would need to be augmented by local information to model water-supply potential.

Finally, areas of land would be rated on a map (e.g. by a colour code) according to their potential to produce high-quality wine grapes of a given variety.

The GIS also can be used to design management strategies for the vineyards. For example, soil maps generated using gamma-ray spectrometric data as described above, along with information on actual soil composition, can be used to design programs of soil management so that each 'soil unit' area (area of uniform soil composition, depth, etc.) receives only as much chemical additive as is necessary.

Grapevines appear to perform well and with minimal soil modification if they are planted on soils that best suit each particular variety and clone. After centuries of trial and error to find ideal wine-grape growing regions, Australian geoscience technology can reveal the 'secrets' of *terroir*. The result could be greater production, on a more environmentally sustainable basis, of better quality, more regionally distinctive wines.

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Unexpected pattern in Proterozoic granites

There is a pattern to the mineralisation of Proterozoic granites, which is described in a Geoscience Australia product (record 2001/12) being released in July. The record summarises project work undertaken by Geoscience Australia in collaboration with 20 exploration companies and state/territory geological surveys.

The 'Metallogeny of Australian Proterozoic Granites' project focused on one question: whether Proterozoic granites (and/or their host rocks) with hydrothermal gold, copper, zinc and other mineralisation within five kilometres of their boundaries have any specific characteristics.

Data were compiled on the mineralogy, geochemistry (~7500 analyses), and age of Proterozoic granites and felsic volcanics, as well as the age and mineralogical composition of sediments within five kilometres of Proterozoic granite boundaries for 19 provinces (figure 1).

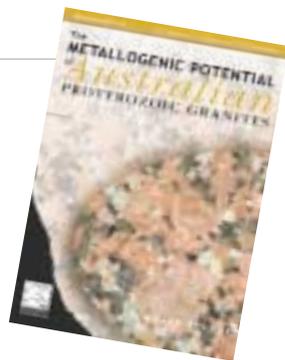
Because the project was investigating a spatial association, whether the metals came from the granite or were leached from country rock was not considered important. The compilation focused on factual data only, therefore because the determination of the tectonic setting was considered highly interpretative, this parameter was not included.

Granite type associations

Nine major associations were identified based on granite type and spatially related mineralisation (figure 2). Overall there is a strong spatial relationship with specific granite types for many commodities.

Unfractionated I- or S-type granites are restite rich and consistently unmineralised. Fractionated I-type granites are either F-poor or F-rich throughout most of their fractionation history. The F-rich granites are often the true rapakivi types and have little mineralisation, presumably because Cl had been fractionated into the granite melt early.

Fractionated F-poor I-type granites can be divided into two classes: oxidised and reduced. The oxidised granites are most commonly associated with Cu-Au deposits and are higher temperature than the reduced class.



There is an unequivocal spatial association between the reduced class and Au-dominant mineralisation with variable amounts of Cu, Sn, W and Bi.

Rare fractionated S-types are commonly associated with Sn mineralisation.

I-type pattern

An unexpected pattern emerged within the five, larger I-type associations. The lower temperature granites are early in the evolution of a province. With time, as the magma temperatures increased, there is a progression from barren granites (e.g. the restite-rich Kalkadoon Association) to the weakly mineralised Nicholson Association, where late vein mineralisation is associated with late fractionation over a narrow range of silica content (~72-77 wt %).

How to FIND AND ORDER SPATIAL DATA

Previous issues of *AusGeo News* described the Commonwealth Government's new spatial data pricing policy and its effects on product delivery. Here are details on how Geoscience Australia has organised its web product listings and how to find what is available for free or as a CD-ROM.

Geoscience Australia's website was recently reorganised to include details on the organisation's range of products and their delivery. To find these details go the Geoscience Australia main web page (www.ga.gov.au) and click on the 'Downloads' link, which will take you to the 'Download Data' page. The listings of available data have been organised into two main groups:

- data currently available for free download; and
- data available on CD-ROM at the marginal cost of transfer (AS99 including GST for a single disk).

Under the new pricing policy a wide range of fundamental spatial data sets are already available free via the internet. On-line access to other spatial data will be provided progressively as the necessary technology becomes available within the custodian agencies. In the interim, products that cannot be accessed on-line are (and will continue to be) supplied on CD-ROM for the cost of transfer.

Free download

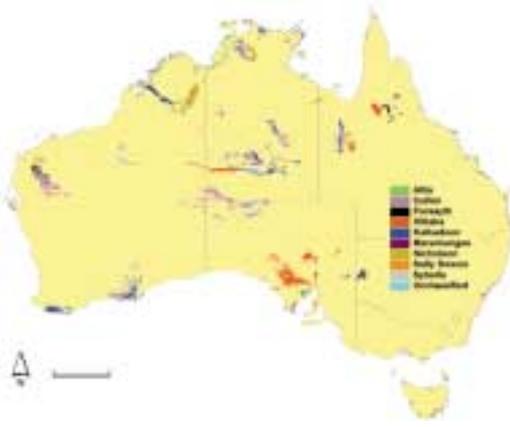
The free group includes geology data for states (Western Australia, Queensland and Northern Territory), national geoscience datasets, and topographic, environmental and satellite data, as well as some publications by Geoscience Australia staff.

The national geoscience datasets are continuously updated and modified. These on-line datasets are typically available in Arcinfo export or Mapinfo formats. The Northern Territory geology data have been upgraded to include the Mapinfo format.

National Mapping Division (formerly AUSLIG) provides access to topographic, satellite imagery and environmental data. These downloads are intended for use in geographic information systems (GIS), computer aided design (CAD) or image processing systems, and require specialist software to view and manipulate the data.

Marginal cost

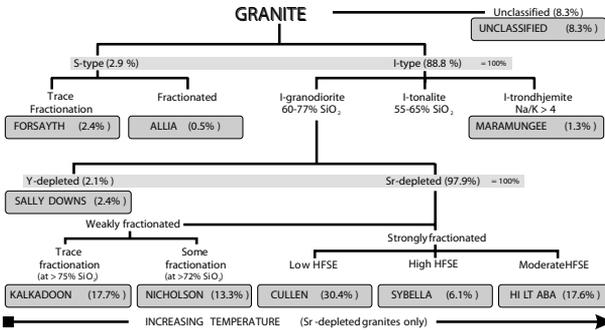
The CD-ROM products are grouped according to the outputs of Minerals, and Petroleum and Marine projects. Due to the volume and common themes, the Airborne Geophysics and Gravity products are listed in separate tables and can be viewed when the link is activated.



The next association is the predominantly Au± base metal endowed Cullen Association. The Sybella Association generally follows and is the only A-type granite in the Australian Proterozoic. It is only weakly mineralised. The Hiltaba Association is generally the youngest major I-type association in this progression. It is spatially related to major Au-Cu mineralisation.

Geoscience Australia record 2001/12: The metallogenic potential of Australian Proterozoic granites comprises a 156-page book and two CD-ROMs (one of pdfs and the other a fully attributed GIS). It is available from the Geoscience Australia Sales Centre for \$99 (includes GST) plus postage and handling.

For further information about project results phone Anthony Budd on +61 2 6249 9574 or e-mail anthony.budd@ga.gov.au



▲ **Figure 1.** (top left) Distribution of Proterozoic granite associations in Australia

◀ **Figure 2.** Summary of the character and relative (by outcrop area) abundances of Australian Proterozoic granite associations

Information about data relevant to Minerals projects and how it is packaged can be viewed by activating the 'Onshore/Minerals' link.

The new screen shows that the minerals datasets are assembled on a regional and national scale. The list of Australia-wide products and mineral provinces appears on top of the page. This is followed by a series of tables that provide details of the CD-ROMs available.

In each table there is information on what products are packaged together, their scale, format and theme, as well as links to the appropriate metadata derived from the Geoscience Australia product database. A link to the sales order form 'Order' appears at the top of each table.

The data relevant to the Petroleum and Marine products are organised along the same lines, with the CD-ROMs assembled into groups reflecting main marine regions.

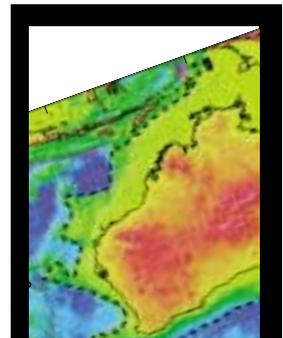
The extent and number of products delivered on a CD-ROM are determined by disk capacity. It is possible that with any single dataset ordered, the client will receive another for free because it was included in that particular package.

Airborne Geophysics and Gravity data are currently organised by survey and listed in a table, viewable as:

- list of surveys sorted by project name;
- list of surveys sorted by project number; and
- list of surveys sorted by CD reference number.

Typically there is one survey on a single CD.

For more information phone Barbara Wijatkowska-Asfaw on +61 2 6249 9109 or e-mail barbara.wijatkowska-asfaw@ga.gov.au



Correction: East should be east and west should be west. In figures 1a-c on pages 20-21 in *AusGeo News* 65 we have flipped the labels 'East Tasman Basin' and 'West Tasman Basin'. Thank you to our readers who picked up our error and understood what should have been printed.

Australia's resource status on-line

Good news for those interested in Australia's mineral and energy resources: Geoscience Australia has released *Australia's Identified Mineral Resources 2001* (AIMR) on-line after 51 years in print. There are similar plans for the *Atlas of Australian Resources: Geology and Minerals*, the current version of which is a 60-page collection of maps published by AUSLIG in 1988.

Next year, AIMR data including deposit and mine names will be linked to the web-based atlas, which will be titled the 'National Atlas of Mineral Resources, Mines and Processing Centres'.

Industry picture

AIMR was first published in 1949 as the *Australian Mineral Industry 1948 Review*. In the foreword, the Minister for Supply and Development said, 'The object of the Review is to present a correlated picture of the mineral industry of the Australian Commonwealth and its territories, its ramifications, and its influence on the economy of the nation'.

AIMR continues this important function for Australia's major export industry, with the value of minerals and energy exports forecast to reach \$34.8 and \$25.1 billion respectively in 2002-03 (in total six per cent higher than 2001-02).

AIMR provides an assessment of Australia's known mineral endowment and level of exploration activity. It is used to monitor whether resources are being discovered and developed for production at rates sufficient to maintain Australia's position as a major supplier of mineral commodities. It is sought after for basic research into the mining industry.

National atlas

The National Atlas of Mineral Resources, Mines and Processing Centres will provide a comprehensive, on-line, map view of Australia's mining industry. It will have a GIS (geographic information system) format that is more functional for users than a bound book.

The atlas will show the location of mineral and energy resources, mines and production/processing centres (existing and planned). It will contain satellite imagery and, ultimately, other important thematic coverage (e.g. agriculture, boundaries, climate, environment, geology, population, transport, energy reticulation and water). It will also contain links to jurisdictional legislation, and provide information on mining and processing in terms of regional development, employment and decentralisation.

The atlas will be a huge production. It is being developed by Geoscience Australia with support from the Minerals Council of Australia (\$50 000 plus further 'in-kind' assistance) and federal funding (\$50 000) under the Regional Minerals Program.

'The Minerals Council considers the atlas to be an extremely useful resource for its members, the industry in general, and the broader community with whom the minerals industry interacts', said Dr Kevin Tuckwell, Acting Executive for the MCA in March when plans for an on-line atlas were discussed.



Minister for Industry, Tourism and Resources, Ian Macfarlane stated as he announced federal funding on June 14, that 'the need for an integrated and dynamic atlas of this type is greater now than it has ever been'.

Other organisations such as the Geological Survey of Western Australia will contribute 'in kind' when the basic atlas module is completed.

The atlas will meet the needs of agencies and individuals who seek commodity, technical, trade, employment and value-adding information relating to minerals and mining. It will be ideal for planning, decision-making and risk assessment, particularly as it can be kept up to date.

The easy-to-use, interactive map views can be updated on an annual basis and when there are any new significant developments such as a major discovery or project announcement.

The national atlas project will be launched in July this year at the first Principals' Committee meeting in Canberra (see opposite).

**For more information contact
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or e-mail bill.mckay@ga.gov.au**

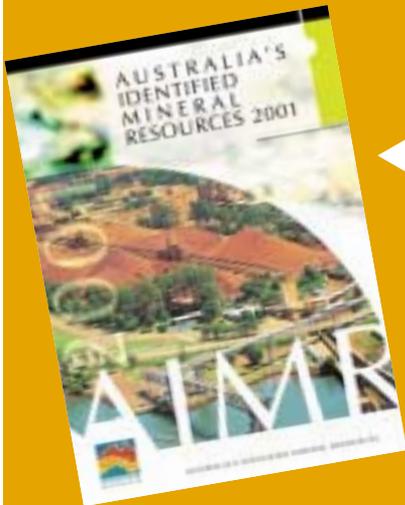
Tantalising thought...

You probably rely on Australian tantalum.

Australia is the world's largest producer of tantalum. AMIR shows that Greenbushes and Wodgina mines, operated by Sons of Gwalia, produced 485 tonnes of tantalum in 2000—which is 77 per cent of world production. The next largest producer was Brazil at 90 tonnes.

Because it is resistant to most acids, tantalum is ideal for chemical manufacturing and in surgery to strengthen or replace bones. But its biggest use is for tiny capacitors in mobile phones, computers and videos.

Capacitors store charge and provide stable current to electronic circuits. Tantalum capacitors are in demand for small electronic devices because they can store very large charges for their size.



Far left: The first edition of AMIR printed in 1949

Left: The 52nd edition of AMIR released on-line in 2002

ANTARCTIC DATASETS *free* on-line



Canadian Space Agency RADARSAT International

NATIONAL ATLAS project *under way*

The National Atlas project will be launched on July 8 in Geoscience Australia headquarters in Canberra at the inaugural Principals' Committee meeting and the project's Management Committee meeting.

The preliminary components of the on-line atlas and their linkages will be demonstrated at the launch (see figures 1 & 2).

The Principals' Committee will endorse project objectives and sign on funding arrangements for 2002-03. The committee comprises Neil Williams (chair and CEO, Geoscience Australia), John Ryan (Deputy Secretary, Department of Industry, Tourism and Resources), Mitchell Hooke (Chief Executive, Minerals Council of Australia) and Bill McKay (chair, Management Committee).

The National Atlas Management Committee members are Bill McKay, Keith Porritt, Neal Evans, Andrew Lucas (GA), Di Stuart (MCA) and Marie Taylor (ITR). This committee will determine the project's priorities and work program for 2002-03. 🗺️

Two datasets that provide place names and information about geodetic markers on Antarctica are now free on-line.

The *Composite gazetteer of Antarctica* includes 34 163 official names which correspond to 17 077 features on the 13.5 million square kilometre island—the most isolated island in the world. Data for the gazetteer were collated by the Programma Nazionale di Ricerche in Antartide (Italy) for the Scientific Committee on Antarctic Research.

The *Geodetic control database for Antarctica* primarily shows the location of geodetic control points, such as astronomical observations, benchmarks and GPS (global positioning satellite) sites in Antarctica. The geodetic information provides an exact position for mapping and geodynamic purposes.

The *Composite gazetteer of Antarctica* and the *Geodetic control database for Antarctica* are two of 12 datasets that are provided free on-line by Geoscience Australia's National Mapping Division.

For more information phone Glenn Johnstone on +61 2 6201 4393 or e-mail glenn.johnstone@ga.gov.au 🗺️



Figures 1 & 2. Screens from a preliminary version of the on-line atlas being demonstrated at the project launch on July 8.

New thoughts on ARUNTA MINERAL POTENTIAL

Geoscience Australia has released an on-line report (record 2001/39) that helps correct a misconception about the mineral potential of intrusive mafic-ultramafic rocks in the Northern Territory's Arunta Province.

Many believe that the Arunta has little mineral potential because of its high metamorphic grade, and a tectonothermal history that spans more than 1500 million years. This is supported by the fact that no major mineral deposits have been found in the Arunta, despite comprehensive government mapping programs from the 1960s to the mid-1990s.

However, most intrusions in the Arunta have not been thoroughly assessed for orthomagmatic or hydrothermal mineralisation, particularly at depth or under shallow cover.

Geologists from Geoscience Australia, in association with the Northern Territory Geological Survey, carried out field work in the Arunta from August to October 2000. The area studied encompasses the Mount Doreen, Mount Liebig, Napperby, Hermannsburg, Alcoota, Alice Springs and Huckitta 1:250 000 map sheets.

Sixteen mafic, ultramafic and alkaline bodies were sampled from a rectangular area, 150 kilometres north-south by 600 kilometres east-west. The intrusions were provisionally divided into western, central and eastern groups on the basis of their metamorphic history, lithology and fractionation. Gradient-enhanced magnetics, gamma-ray spectrometrics and Landsat-5 imagery were used in sample selection.

The results show there are geographical differences in the mineral prospectivity of mafic-ultramafic rocks throughout the Arunta. The western and central intrusions have some potential for Ni-Cu-Co sulphide deposits. The eastern intrusions appear to be more prospective for platinum-group element mineralisation. Most intrusions crystallised in situ and were not tectonically emplaced.



Record 2001/39 summarises the field relationships and mineralisation features of the major mafic-ultramafic intrusions in the Arunta. It makes readers rethink some notions about the prospectivity and resource potential of the intrusions.

Record 2001/39: Field investigations of Proterozoic mafic-ultramafic intrusions in the Arunta Province, central Australia by Hoatson and Stewart is available free on-line (www.ga.gov.au/general/technotes/NAP_results_products.jsp).

For more information phone Dean Hoatson on +61 2 6249 9593 or e-mail dean.hoatson@ga.gov.au



PROMISING RESULTS for automatic grid-merging *software*

Independent datasets were used to test the method. The two available were the AWAGS (Australia Wide Array of Geomagnetic Stations) traverses flown around Australia early in 1990, and data acquired during the Third-order Regional Magnetic Survey of Australia from 1967 to 1975.

Early chapters of the record describe these datasets in detail, including their processing, prior to the comparisons. The record also provides an insight into the long-wavelength (100s to 1000s km) errors in the combined data.

Regional compilations of composite grid data (the Yilgarn in Western Australia, the Curnamona region of South Australia and New South Wales, part of the Northern Territory, and all of Western Australia) were used to compare *Gridmerge* with the test datasets.

The *Gridmerge* program is now part of the geophysical processing software available from Intrepid Geophysics. This software produces better results and is more efficient for combining grid data, compared with earlier methods.

Record 2001/43: Comparisons of total magnetic intensity grids, combined using Gridmerge, with two independent datasets is available at www.ga.gov.au/pdf/RR0050.pdf.

For more information phone Peter Milligan on +61 2 6249 9224 or e-mail peter.milligan@ga.gov.au

There is a new, automatic method to combine large sets of gridded airborne magnetic and gamma-ray spectrometric data into regional compilations, using software (*Gridmerge*) tested and developed in the first instance by Geoscience Australia. Details of the tests are published in Geoscience Australia record 2001/43, which was posted on the web in pdf format at the end of June.