Preview

Australian Society of Exploration Geophysicists

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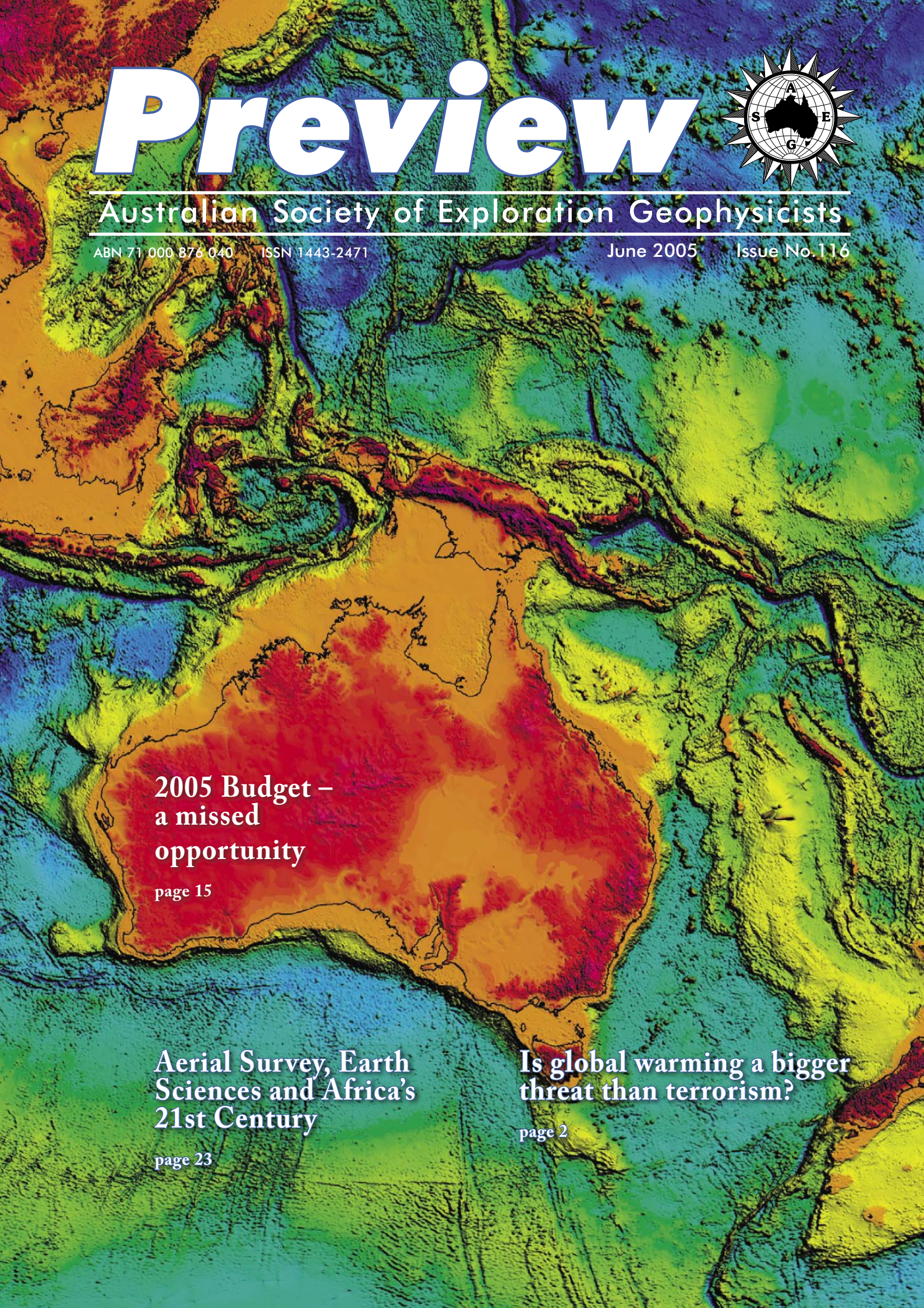

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Image of bathymetry on the front cover provided courtesy of Geoscience Australia.

Is global warming a bigger threat than terrorism?

The state of play

Global warming and climate change are here to stay, as a key politico/economic issue. From the annual World Economic Forum held at the Swiss alpine ski resort of Davos, to the Australian Institute of Physics Conference held in Canberra at about the same time (see Preview, April 2005), the impact of global warming has been high on the agenda.

Over the last ten years or so the question of whether warming is taking place is being replaced by questions such as:

- How much warming will there be?
- What effect will this have on life on Earth? And
- What should we do about it?

At the Davos meeting, scientific, government and industry experts said that the danger from global warming is probably the biggest single threat the Earth is facing.

For example, Sen. John McCain (Rep., Arizona) said that he considered the danger to be "the greatest threat to our globe that we've ever experienced" and advocated the use of nuclear power as a possible option.

David King, chief scientific adviser of the Office of Science and Technology of the UK, said that global warming was the biggest threat of this century, even bigger than terrorism.

"The amount of evidence coming in is remarkable," King said. "Every week, about two articles in major scientific journals offer information indicating climate change."

The evidence is indeed widespread. It includes an increase in average global temperatures of about 0.6°C in the last 150 years, melting of the Arctic ice sheet, retreats of glaciers word-wide (particularly on the Antarctic peninsula), rise in sea levels and the European heatwave of 2003, which reportedly caused 31,000 deaths. Clearly, if this trend continues the effects will be catastrophic.

Furthermore, it is now clear that the burning of fossil fuels is the dominant cause the current global warming.

In Australia, average temperatures have also increased significantly (see Figure 1), over the last 50 years (particularly in the values of nightly minimum temperatures) and the rainfall pattern has changed significantly as well (see Figure 2).

One could therefore argue that, by comparing the number of terrorist attacks in Australia over the last 50 years with the effects of climate change as demonstrated with droughts and higher temperatures, David King is right.

What action should we take?

The experts at Davos proposed the following action points:

1. Urgent action at international and national levels to reduce carbon emissions.
2. Development of strict international regulatory frameworks for emissions monitoring.
3. Expansion of the Group of 8 to include key developing economies, particularly China, India and Brazil, and the creation of a climate change task force.

As can be seen, these proposals are mainly words. Detailed actions did not seem to get a mention, probably because the nuts and bolts actions to achieve the goals are just too hard to achieve.

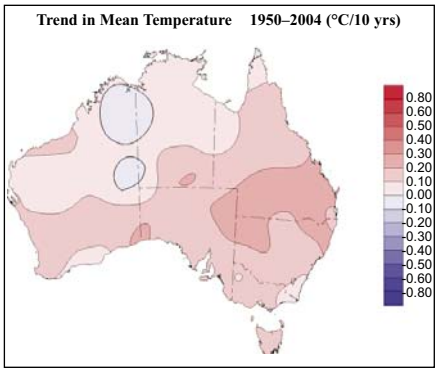

Fig. 1. Trends in mean temperature since 1950 in °C/10 yr. Note that in southern Queensland and northern New South Wales the mean increase over this period is over 1°C. Diagram provided courtesy on the Bureau of Meteorology.

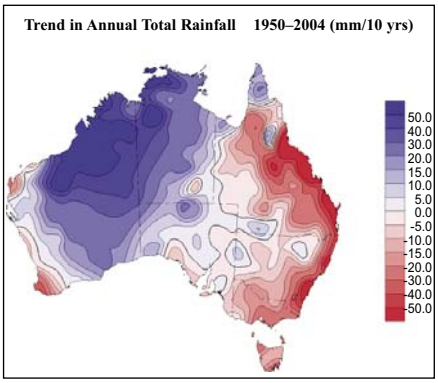

Fig. 2. Trends in total rainfall since 1950 in mm/10 yr. Note the significant changes in the southwest of WA and along the east coast. Diagram provided courtesy on the Bureau of Meteorology.

The global demand for fossil fuels, particularly petroleum, continues to rise, while the known reserves are not keeping pace. Nuclear alternatives are, at present, politically unpalatable, and the Hydrogen Economy (HE) is simply not a viable option in the foreseeable future. There are major problems with the **production** of hydrogen, the **storage** of hydrogen and its **use**. Research breakthroughs in each of these three areas will be essential if HE is to get anywhere.

In other words there are no easy answers.

The Australian Climate Group (AGC) (http://www.iag.com.au/pub/iag/sustainability/publications/climate/intro.shtml) proposed the following actions in 2004 to lower the risk that climate change will reach dangerous levels. These were:

1. ***Reduce***: Australia's political leaders must work with business and the community to take immediate action to cut our greenhouse gas emissions by 60% by 2050.
2. ***Trade***: Establish market mechanisms to trade greenhouse gas emissions, providing the business sector with a powerful tool to meet reduction targets.
3. ***Act***: All Australians to take responsibility for their own role in reducing greenhouse gas emissions by using energy more wisely.
4. ***Adapt*****:** Put in place measures to minimise the impacts of climate change, from building improvements to deal with more intense storms, to investing in new agricultural industries, which require less fresh water.
5. ***Innovate***: New business opportunities must be developed and implemented as the rest of the world moves to low carbon energy futures.
6. ***Lead***: A leadership role must be taken to identify and implement solutions to reduce the impacts of human-induced climate change. As one of the wealthiest and best-educated nations in our region, we can share our innovations and technologies with nations of the Asia Pacific.

What action is being taken?

As far as one can tell, the Australian Government has done very little to reduce greenhouse emissions, and has not acted upon any of the ACG's recommendations. In fact it can be argued that with the abolition of the Australian Greenhouse Office in the 2005/6 Budget (see *Eristicus* in this Preview), it has reduced its commitment to climate change issues.

However, there will be a significant talkfest in Melbourne during November this year, in the form of Greenhouse 2005.

Greenhouse 2005: Action on Climate Change (http://www.greenhouse2005.com) is billed as the largest climate change conference held in the Southern Hemisphere this year. It is being organized by CSIRO, the Australian Greenhouse Office and the Bureau of Meteorology.

Australian and overseas scientists will be addressing how industry and government can respond to climate change research at this meeting.

The plan is to "draw together the current knowledge of climate change to present as complete a picture as possible of the known impacts of climate change in Australian cities and the natural environment, and how we need to proceed to respond to these changes," according to CSIRO Climate Director, Bryson Bates.

However, it is unlikely that the meeting will result in any concerted actions by governments. What we do know is that we will have access to more words; be presented with more evidence for climate change, and at $770 for Early Bird registrations, the words will have to be good.

Finally , I will leave the reader to think about the answer to the question: Is global warming a bigger threat than terrorism?

David Denham

ASEG-EEGS Agreement signed

A cooperation agreement between the ASEG and EEGS was signed at the SAGEEP 18th Annual Meeting in Atlanta, USA on April 6, 2005.

EEGS is the Environmental and Engineering Geophysical Society in the USA and SAGEEP (Symposium on the Application of Geophysicists to Engineering and Environmental Problems) is their annual conference and exhibition.

ASEG President Howard Golden was unable to attend SAGEEP and asked long-standing ASEG member Richard (Dick) Irvine to represent the ASEG at the signing ceremony (pictured). The agreement is similar to others between the ASEG and fellow professional societies and aims to advance the common goals and objectives of each society, in recognition of the mutual interests of their members.

Norm Carlson, President of EEGS, on the left, and Dick Irvine representing the ASEG signing the ASEG-EEGS Agreement at the 18th SAGEEP Annual Meeting in Atlanta, USA on April 6, 2005.

Of particular interest to ASEG members, members of each society can attend conferences of the other society at member's registration rates and also purchase publications at members' rates.

EEGS vision is to champion the development and appropriate use of environmental geophysics and has a membership of approximately 650 members.

SAGEEP is internationally recognized as the leading conference on the practical application of shallow geophysics. It has an average attendance of approximately 400 and includes an exhibition, which this year had 39 exhibitors. Technical papers ran in three parallel sessions over three days and there were also pre and post-conference workshops and a demonstration of geophysical equipment. The technical papers ran the gamut of groundwater, environmental, engineering, archaeological, cavity detection and UXO geophysics.

ASEG members with interests in these areas are encouraged to join EEGS and attend the annual SAGEEP conferences – the next will be held near Seattle from April 2-6, 2006. Further details are available on the EEGS website: www.eegs.org.

2005

16-17 August
Central Australian Basins Symposium (CABS) 2005
Theme: Minerals and petroleum potential
Venue: Alice Springs (details TBA)
Contact: Greg Ambrose, Northern Territory Geological Survey
Email: greg.ambrose@nt.gov.au

4-7 September
Near Surface 2005
11th European Meeting of Environmental and Engineering Geophysics of the Near Surface Geoscience Division of the EAGE
Venue: Palermo, Sicily
Website: http://www.eage.nl

13-16 September
South African Geophysical Association
9th Biennial Conference and Exhibition
Theme: More out of our Depth
Venue: Cape Town International Convention Center SA
Web site: http://www.sbs.co.za/saga2005/

2005

17th September
SEG 75th Anniversary Dinner and Ball
Burswood Resort and Casino, Perth
Contact www.aseg.org.au/wa/seg_party

19-23 September
22nd International Geochemical Exploration Symposium
Sponsors: The Association of Exploration Geochemists
Theme: From Tropics to Tundra
Venue: Sheraton Hotel, Perth, WA
Website: www.promaco.com.au/conference/2005/iges

6-11 November
SEG International Exposition & 75th Annual Meeting
Venue: Houston, Texas, U.S
Website: www.seg.org

2005

13-17 November
GREENHOUSE 2005: Action on Climate Change
Main sponsors: CSIRO, AGO and BOM
Venue: Carlton Crest Hotel, Melbourne
Website: http://www.greenhouse2005.com

5-9 December
2005 AGU Fall Meeting
Venue: San Francisco, California, U.S.A.
Website: www.agu.org/meetings

2006

7-10 May
2006 APPEA Conference
Venue: Gold Coast Convention & Exhibition Centre, Qld
Deadline for receipt of Abstracts: 1 September 2005
Website: http://www.appea.com.au/conference/CallforPapers2006.pdf

12-15 June
68th EAGE Conference & Exhibition
Venue: Vienna, Austria
Contact: http://www.eage.org/conferences/

2-7 July
The Australian Earth Sciences Convention 2006
ASEG, in collaboration with GSA;
ASEG's 18th International Conference and Exhibition, and GSA's 18th Australian Geological Convention
Venue Melbourne, Vic.
Website: www.earth2006.org.au

1-6 October
SEG International Exposition & 76th Annual Meeting
Venue: New Orleans, Louisiana, U.S.
Contact: http://seg.org/meetings/calendar

2007

18-22 November
ASEG's 19th International Conference and Exhibition
Venue: Perth, WA
Contact: Brian Evans [Brian.Evans@geophy.curtin.edu.au]

Inco Building the World's Leading Nickel Company

Inco to be Platinum Sponsor of 2006 Conference

Inco has agreed to be the Platinum Sponsor of the ASEG-GSA's Australian Earth Sciences Conference.

Through most of its 100 years, Inco was a North American company that brought its nickel to the rest of the world. Today, it is a truly global company, mining in two hemispheres and operating on four continents.

It is now the second-largest integrated nickel producer in the world (behind Russia's Noril'sk Nickel) with a market capital of US$ 8.13 billion. It is also a significant producer of copper, precious metals, and cobalt. The company has operations in 14 countries, including mines in Canada and Indonesia and nickel refineries in Canada, the United Kingdom, Japan, Taiwan, and South Korea. Inco realized gross revenues of $4.3 billion in 2004, delivering 251,882 Mt of nickel, 124,884 Mt of copper, and 2.5 million oz of precious metals during the year.

Inco Exploration is focused on nickel and is directed from Inco's research facility in Mississauga, Ontario, by vice-president Nick Sheard (past ASEG President), Bob Bell, Director, Exploration Australia and two other directors. The company has a strong technical services organization based in Inco's main mining centre of Sudbury, Ontario, which provides global project generation initiatives together with geological, geochemical, geophysical, petrophysical services and data management. Inco conducts exploration for both sulphide and laterite nickel globally and is committed to all facets of exploration from grassroots, brownfields and in-mine exploration. Currently exploration is being conducted in Canada, Australia, Brazil, Finland, Indonesia, New Caledonia and China.

In 2004 Inco has had considerable success by adding 60 Mt of reserves and resources to its sulphide and laterite operations in Canada, Indonesia and New Caledonia.

Australia is increasingly becoming a major focus of Inco's grassroots exploration, with Terry Crabb (current ASEG President) recently being appointed as Exploration Manager of Inco Resources (Australia). The company's exploration has been primarily for nickel sulphides but this has expanded recently to nickel laterites with the signing of an agreement with Heron Resources on their extensive laterite holdings in the Kalgoorlie area. In addition to the Heron option, Inco has option/joint ventures with Helix Resources Limited and FraserX Pty Ltd in Western Australia and in South Australia with PlatSearch NL and Landmark Stone Pty Ltd. In addition to these ventures, Inco has acquired a 100% interest in several properties in New South Wales, Victoria, and South Australia. It is conducting grassroots and generative nickel sulfide exploration throughout Australia this year.

Inco is pleased to be able to sponsor this conference and exhibition, which is a partnership between GSA and the ASEG, and which will clearly demonstrate the value of integrating geology and geophysics into competent exploration programs. Inco Exploration believes that a successful exploration program is based on integration and benefits from partnerships; we are looking forward to continuing our partnerships and seeking new ones in order to become more successful in Australia.

Student Essay Awards in Magnetics

2nd Student Essay Awards in Magnetics, Toronto, Canada. April 15, 2005. A group of companies is pleased to be sponsoring the 2nd Essay Award Program in Magnetics. For those not familiar with the program, undergraduate and graduate earth science students can qualify for financial and professional software awards by writing a short essay of between 800 to 1200 words. A description of the program including rules, some suggested essay topics, and examples of last year's winners is at www.gemsys.ca/m agnetic_essays.htm.

"The 2nd Essay Awards follow in the footsteps of our first award program," remarked Dr. Ivan Hrvoic, President, GEM Advanced Magnetometers. "We were pleased with the quality of the papers and the interest in magnetics demonstrated throughout last year's program. Our partners are very enthusiastic about the 2nd awards program."

The Essay Awards are intended to 1) help encourage the understanding of magnetic methods in resource exploration, near surface geophysics and other fields, and 2) to assist students through financial and software support. Essays are welcomed from around the world and this year, the organizers have altered the end date to early October so that students from south of the equator can qualify more easily.

Awards are determined by an independent group of international experts recognized for their work with magnetics and in teaching. This year's judges are repeating their roles from last year:

- Dr. Derek Fairhead, Leeds University, UK
- Dr. Bill Morris, McMaster University, Canada
- Dr. Michal Ruder, Wintermoon Geotechnologies, Inc. USA

GEM Advanced Magnetometers, Encom Technology, GISCO, Allied Associates Geophysical Ltd., Geostudi Astier s.r.l., and Terraplus Canada provided funds or software to facilitate the Essay Awards in Magnetics.

SEEGrid roadshow underway

Showcasing interchange of government geoscience data to minerals industry

Successful minerals exploration relies on continuous access to current and quality assured geospatial information, regardless of jurisdictional or geographic boundaries. However, the issue of poor data interoperability (or interchange) is widely recognised as a barrier to effective use of existing data held within government geoscience agencies. There are no formally endorsed data interchange standards, and the relatively fragmented nature of the mining software market further exacerbates the problem.

A collaborative project between CSIRO, Geoscience Australia and Social Change Online (with support by AUSIndustry) has just completed a test bed for real-time data interoperability between data housed in ACT, SA and WA. A further AUSIndustry grant has been obtained to showcase this test bed and to extend the test bed to all remaining states. The key objective of the project is to raise awareness of what interoperability offers and drive a consensus view towards the adoption of data interoperability standards.

Technology diffusion workshops

The SEEGrid Roadshow project will run a series of executive briefings and technology diffusion workshops in each capital city to promote the benefits of interoperable services to a broad spectrum of organizations within the industry, public and academic sectors.

Executive briefings will deliver a generic overview of interoperable services, what they are and highlight their benefits to Industry in terms of real capacity to save resources.

Technology diffusion workshops will give a technical demonstration of how the initial test bed was deployed and implemented across three states and two jurisdictions.

What will you learn from participating?

- What are interoperable geospatial services?
- What benefits can interoperable services bring to your organisation?
- How can you maximise the value of your digital geospatial assets?
- How can these services be deployed within your organisation and between your collaborators?
- The critical need for standards.
- How communities have been established to develop these standards.
- What is the current state of play of these services in the Government Geoscience sector?

How can you participate?

Roadshow sessions will be held in all Australian capital cities:

There is **no cost to participate** in the sessions, but places are limited so registration is essential. To register, contact Petra Bowling on Ph (08) 6436 8625, Fax (08) 6436 8555 or petra.bowling@csiro.au or visit the website: **www.seegrid.csiro.au**.

The schedule is as follows:

— Perth 30th May (both) Canberra 1st July (both)

— Adelaide 9th June (both), Darwin July (both), Hobart 16th June (both), Sydney July (both), TBA – visit www.seegrid.csiro.au, Brisbane 22nd June (Executive Briefing), Brisbane 23rd June (Technology Workshop), Melbourne 26th July (both).

SEG 75th Anniversary

In 1930 the Society of Economic Geophysicists was established in Houston, USA. The following year it was re-named the Society of Petroleum Geophysicists, and annual conventions were held from the outset. In 1936 it became the Society of Exploration Geophysicists and the first issue of the journal Geophysics was published in the same year. Curiously the first paper published was *Black magic in geophysical prospecting* by L.W. Blau.

Although the SEG is now based in Tulsa, Oklahoma, the non-U.S. participation and membership grew to the point when in the mid-1990s it exceeded the U.S. membership and conference presentations. Geophysical conferences are now co-sponsored throughout the world by the SEG, and the Global Affairs Committee is one of its largest and most important sub-committees of the SEG organization. SEG publications such as Geophysics and The Leading Edge are a major resource, as are the SEG Distinguished Lecturer Program (DISC), and it's Continuing Education Programs.

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Due to the Diamond Anniversary of the SEG this year, celebrations are being held across the globe during 2005. In Australia, a sub-committee of the Australian Federal Executive is holding a 75th Anniversary Celebration Dinner at the Burswood Resort and Casino in Perth on the 17th of September. The idea is to reflect briefly on the development of geophysics, in the USA and in Australia, to recognise the current status of the profession of Geophysics and its role in exploration, while at the time having a great social night.

The ball includes a three course meal, all drinks, dancing, prizes (including two return economy class tickets courtesy of Singapore Airlines to anywhere on their global network) and giveaways through out the night.

Full details are available on the ASEG web site at www.aseg.org.au/wa/seg_party

Come help us celebrate 75 years of geophysics!

Australian Earth Science Convention 2006: Resourcing Our Future

The Organising Committee is pleased to announce the official First Call for Abstracts and Opening of Registration for the Australian Earth Sciences Convention to be held in Melbourne, 2nd – 6th July, 2006.

The Convention combines the key elements of the Geological Society of Australia's 18th Australian Geological Convention and the Australian Society of Exploration Geophysicists' 18th International Conference and Exhibition.

We are delighted to announce that the Convention is supported by Platinum Sponsor – Inco Resources (Australia) Pty. Ltd. Other sponsors to date include Gold Sponsor – Victorian Department of Primary Industries.

The Organising Committee for the 2006 AESC is representative of both the Geological Society of Australia and the Australian Society for Exploration Geophysicists. We have therefore developed an integrated program to cover the spectrum of geoscience disciplines and involve inter-disciplinary perspectives to many scientific and industry themes and issues. The convention will include daily plenary presentations by eminent national and international scientists on topical issues, followed by a comprehensive program on scientific research and industry themes. In addition, delegates will have a choice of participating in many interactive workshops and field trips. The overall program represents the greatest opportunity yet for academic and government researchers and educators, and industry and government professionals to get together to address significant geoscientific issues.

The Convention will host:

- A range of pre- and post- convention tours and workshops
- A three-day trade exhibition showcasing all aspects of exploration, mining, government and academia
- Four-days of research, technical and industry symposia, organised into the following major streams:
  - Mineral Resource Geoscience
  - Energy Resource Geoscience
  - Environmental and Engineering Geosciences
  - Geodynamics of Earth's Evolution
  - Resourcing Geoscience
  - Innovation in the Geosciences
- Social occasions, including a sumptuous Convention Dinner with entertainment

Key Dates

- Second Call for Abstracts: September, 2005
- Abstract Submission Deadline: 15th December, 2005
- Early Bird Registration Deadline: 28th February, 2006
- Australian Earth Sciences Convention: 2-6 July 2006

For more information visit the website: www.earth2006.com.au or contact:
The Meeting Planners
91-97 Islington St, Collingwood, Vic., 3066
Tel: (03) 9417 0888 Fax: (03) 9417 0899
Email earth2006@meetingplanners.com.au

Workshops and Excursions

Workshops and field trips are currently still being developed. The program to date is:

Mineral Resources

- Victorian Minerals Industry Exploration Workshop
- Gold in Victoria – 3-day fieldtrip
- Fluid flow modelling

Other Possibilities

- *(Gold) Mining-geology in Victoria*
- *VIMP data release*
- *Metallogenic evolution of LFB (student trip)*
- Victorian mineral-sands deposits
- Magnetic interpretation

Energy Resources

- La Trobe Valley brown-coal fields

Other Possibility

- *Victorian Oil and Gas workshop*

Environmental and Engineering Geoscience

- Landscape Evolution (regolith)

Other Possibilities

- *Environmental Geoscience*
- *Shallow Seismic Refraction Methods*

Geodynamics of Earth's evolution

- Newer Volcanic Province, western Victoria field trip
- Lachlan Fold Belt, Victoria field trip
- Melbourne Geology field trip
- Permian glacial deposits of Victoria field trip

Other Possibility

- *Potential field inversion modelling*

Resourcing and innovation

- Victorian heritage
- Fluid Inclusions (workshop)

For more details and online registration, visit www.earth2006.org.au

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Workshops and Excursions

Workshops and field trips are currently still being developed. The program to date is:

Mineral Resources

- Victorian Minerals Industry Exploration Workshop
- Gold in Victoria ~3-day fieldtrip
- Fluid flow modelling

Other Possibilities

- *(Gold) Mining-geology in Victoria*
- *VIMP data release*
- *Metallogenic evolution of LFB (student trip)*
- Victorian mineral-sands deposits
- Magnetic interpretation

Energy Resources

- La Trobe Valley brown-coal fields

Other Possibility

- *Victorian Oil and Gas workshop*

Environmental and Engineering Geoscience

- Landscape Evolution (regolith)

Other Possibilities

- *Environmental Geoscience*
- *Shallow Seismic Refraction Methods*

Geodynamics of Earth's evolution

- Newer Volcanic Province, western Victoria field trip
- Lachlan Fold Belt, Victoria field trip
- Melbourne Geology field trip
- Permian glacial deposits of Victoria field trip

Other Possibility

- *Potential field inversion modelling*

Resourcing and innovation

- Victorian heritage
- Fluid Inclusions (workshop)

For more details and online registration, visit www.earth2006.org.au

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New Executive elected at AGM

At the 2005 AGM of the ASEG, held on 2nd May, 2005 in Perth, the first Executive under the new constitution was elected (see page 10).

Terry Crabb takes over as President from Howard Golden and James Reid is now President-elect. There is also a new position – States' Representative, which is filled by Don Sherlock of WA. Jenny Bauer, John Watt, Lisa Vella and Koya Suto continue to serve in the same posts they held in the last EC and Howard Golden takes over from Kevin Dodds as Past President, responsible for international affairs.

So that members get know a little more about their new leaders, we have included below short biographies of Terry Crabb and James Reid.

Terry Crabb - ASEG President

Terry graduated from Adelaide University in 1972 with a BSc in Geology and Geophysics, completing his studies whilst in Arizona working on an IP crew for Phelps Dodge, exploring the SW USA looking for copper.

Terry then travelled the world whilst employed by Geoterrex (Sydney and Ottawa) and Uriran (Teheran), before returning to Perth to join Geosearch and then ECS in geophysics management roles.

Adelaide beckoned, and Terry joined the SADME (now PIRSA) in 1983, as a Principal Geophysicist, and during the following 13 years held positions as Chief Geophysicist, Inspector Petroleum, Manager Information Services, Controller Computing Services and commenced studying for an MBA.

From 1984 through 1987, Terry was active on the Federal Executive of the ASEG as Treasurer and Secretary and worked closely with *Exploration Geophysics* legend, editor Don Emerson, under the Presidencies of Reg Nelson and Bob Smith.

During 1996 and 1997 Terry was based in Toronto as Chief Geophysicist, Airborne, with Scintrex before returning to Perth as CEO of Australian Geophysical Surveys in late 1997. Over the next three years AGS developed into a competitive airborne geophysical survey company, and Terry managed to complete his MBA.

With the demise of AGS during the resources slowdown, and the absorption of most of the Airborne Geophysical Contractors by Fugro, limited opportunities in the Geosciences in 2000 saw Terry join SMS Management and Technology in Canberra as a business management consultant. During this time he maintained his association with the ASEG, joining the Federal Executive in 2002 and becoming Chair of the Publications Committee in 2003.

Terry is currently back in Perth as Exploration Manager of Inco Resources (Australia) Pty Ltd as they ramp up exploration in Australia under Nick Sheard's guidance as Inco's Vice-President of International Exploration.

Terry is a member of the ASEG, SEG, PESA, and is a fellow of the Aus IMM. He recently joined the Cottesloe Golf Club and is a long-standing member of the Perth Hash House Harriers.

James Reid - President-elect

James Reid graduated with an Honours degree in Geophysics from the University of Sydney in 1991, and an MSc from the same institution in 1994. After brief stints with Geoterrex and Placer Pacific Ltd he returned to university and obtained a PhD in Geophysics (airborne electromagnetics) from Macquarie University/CRC AMET in 1999.

Since 1999, he has been a lecturer in Geophysics at the University of Tasmania.

His main research interests are in electromagnetic methods, and their application to exploration and environmental problems. He is a member of the ASEG, SEG and EEGS.

ASEG welcomes new Corporate Member

Multiwave Geophysical Company has joined the ASEG as a new Corporate Member for 2005. The ***Multiwave Geophysical Company ASA*** was founded on 1st July 1998. It was formed to fill the perceived need to better image known reservoirs and identify previously unknown resources. It has also developed techniques to increase both known reserves and recovery rates of these.

Multiwave is today a modern upstream oilfield service company, with focus on seismic acquisition services, ranging from 2D towed streamer to highly advanced se… acquisition (using both P- and S… addition ***Multiwave*** is the exclusive … partner to EMGS AS in their … ElectroMagnetic SeaBed Logging te… The company's head office is in Berg… local offices in London, Houston and Si… ***Multiwave*** has, during its relatively short … made significant achievements and is t… world-wide approved seismic service provider to the offshore upstream community.

In October 2000 the Company issued new shares through … e placement whereby … nd Rieber Shipping … olders in ***Multiwave***. … s today the largest … *itwave*.

… the Chairman of … is the CEO.

… mation visit their website at http://www.multiwave.no.

Obituary

Willem Frederick Verhoeff: 1930 - 2005

Will Verhoeff was born in Holland, obtaining a Diploma in Marine Engineering from the Marine School at Flushing. At the age of 19 he joined the Merchant Navy, and ended up in Western Australia in 1954.

He joined the BP oil refinery at Kwinana, south of Perth, as a Mechanical Fitter and an Instrument Technician. Will completed a Diploma in Applied Physics at Perth Technical College. He joined the staff of Perth Technical College as a technician in the Department of Mathematics and Physics in 1961, rising to the position of supervising technician. He continued on through the institutional transitions from Perth Technical College to the Western Australian Institute of Technology and then to Curtin University of Technology, in the Departments of Applied Physics and then Exploration Geophysics. During those years, he studied Exploration Geophysics part time.

Will contributed greatly to the development of physics and geophysics instrumentation in the 1960s and 1970s by constructing equipment which was either not readily available or prohibitively expensive, such as pulse height analysers (gamma spectrometry) and electrical and electromagnetic prospecting equipment. Where suitable transformers were not available, he wound them himself. In the mid-1970s, Will became a skilled Fortran programmer. He was responsible for building and maintaining the WAIT Geophysics Program Library, contributing much of the software himself. His more notable software contributions involved Hilbert Transforms of magnetic survey data and Gosh Filters in electrical work.

In his younger days, Willem was an active sportsman (Rugby and Water Polo). A first grade player for the Palmyra Rugby Union Football Club in the WARU, he later took responsibility for the sport as Secretary of the Palmyra Club (1967-70), delegate to the WA Rugby Union and editor of the Palmyra Club newsletter for over ten years. He served a term as the President of the WA Junior Rugby Union, and took a guiding role in the formation of the WAIT Rugby Union Football Club, serving as its secretary at one stage. In 1972, Will was elected Life Member of the Palmyra Rugby Union Football Club.

Willem Verhoeff was a foundation member of the Curtin University Department of Exploration Geophysics, when it was established as a university department in its own right in 1990. In those days, participation in Exploration Geophysics at Curtin was more an act of faith than of financial wisdom. Will was an enthusiastic participant. He had a very strong grasp of the laws of physics and the way in which geophysical instruments responded to the physical properties of the rocks and sediments of the Earth. He took the initiative and applied for and received a grant for the establishment of a Physical Properties Laboratory for the study of rock properties.

After his active sporting career came to an end, Will became an enthusiastic philatelist. His specialist field was 'Children', and his elaborate collection took a surprisingly artistic form. This became his life-long hobby, and his extensive collection included many complete annual sets of Australian stamps.

After his retirement in 1995, Will continued active participation in the affairs of the Department of Exploration Geophysics as Honorary Research Associate, though at a slower and more leisurely pace.

Willem Frederick Verhoeff will be fondly remembered for his common sense, his sense of humour, and his generous and enthusiastic participation in Western Australian Rugby Union and Exploration Geophysics at Curtin University.

By Norm Uren
April 2005

New Members

The ASEG welcomes the following new members to the Society. Their membership was approved at the Federal Executive meetings on the 30th March and 27th April 2005.

Christopher Hugh Adams
RMIT University *Vic*

Amanda Jane Davies
RPS Energy *WA*

Luke Bartel Gardiner
Beach Petroleum *SA*

Jayson Robert Gregg
Golder Associates *QLD*

Sam Howman
University of WA *WA*

Alexander Ronald Kaiko
Tap Oil Ltd *WA*

Rachel Maier
Adelaide University *SA*

Simone Mercer
Flinders University *SA*

Clarke Martyn Petrick
Arid Zone *NT*

Galen John Pettigrew
University of Tasmania *TAS*

Steven Pickering
SPM Pty Ltd *WA*

Jennie Powell
Curtin University *WA*

Ahmed Salem
Nuclear Materials Authority *Egypt*

Marco Felice Scardigno
Adelaide University *SA*

David Benjamin Spence
Adelaide University *SA*

Chidambaram Sridhara *India*

Julianna Joy Toms
Curtin University *WA*

Claybon Mark Wallis
Australian School of Petroleum *SA*

Monique Anne Warrington
Santos Ltd *SA*

Anthony David Weatherall
Veritas DGC Australia *WA*

Keiiti Aki 1930-2005

Keiiti Aki, who was born in Japan in 1930 died in May this year. It appears that Aki fell and banged his head on a pavement in Réunion. It was thought to be a mild bump but he developed a haematoma on the brain and died a few days later.

Keiiti Aki received his PhD from the University of Tokyo in 1958 and worked as a post-doc at Caltech in the early 1960s. He taught at MIT from 1966 until 1984, when he joined the University of Southern California. At USC he occupied the Keck Chair, Department of Earth Sciences, until he retired in 2000.

In 1995, Aki moved to La Réunion (a French island in the Indian Ocean), which served as a small-scale laboratory for earthquakes in volcanic systems and for predicting volcanic eruptions.

He was probably best known as co-author for the volumes of ***Quantitative Seismology*** written with Paul Richards of Columbia University, which have been in print for over 20 years. These have been ***the*** standard in seismology teaching and advanced research since 1980. Today, it is required reading for advanced classes in seismology and geophysics, and has been the most frequently cited book in seismology since its publication.

His work in seismology covered a very broad field including:

- Pioneering work in ***seismic tomography*** using teleseismic and local earthquake data, analysis of coda waves as scattered waves from small-scale heterogeneities in the lithosphere, frequency dependence of seismic attenuation in the lithosphere, detection of non-linear soil response in strong ground motion, and discovery of the fault-zone guided waves;

- He made major advances in the ***predictive understanding of earthquakes,*** linking geodynamic models and non-linear dynamics models; and

- The invention of the concept of the ***seismic moment***, the first scaling law of seismic spectra, the first interpretation of near-fault strong motion by a propagating dislocation model, developing models of heterogeneous fault zone based on the barrier concept, modelling volcanic tremor sources, and detection of scale dependence in earthquake phenomena.

He was the 10th recipient of the Medal of the Seismological Society of America and was probably the most widely cited seismologist of the latter half of the 20th century.

In recognition of his global impact, the American Geophysical Union and European Geosciences Union awarded Aki their highest honours:

The William Bowie in 2004 and Beno Gutenberg medal in 2005, respectively.

A very sad loss

By David Denham, Koya Suto and John McDonald

New South Wales – by Naomi Osman

At our March meeting Carina Simmat, our Student Liaison Officer, gave an interesting talk on mine-scale 3D borehole radar imaging. She spoke on the uses of borehole radar in the mining environment, with many hard rock mining examples, and tackled the interpretation challenges that borehole radar faces. In April, Adam Wheatley, spoke about the Earth Resources Foundation (ERF). He described the activities of the ERF and in particular those to do with geophysics. ERF also has a wider role in explaining to school students earth processes, such as salinity of land and water and global warming. His talk prompted a great deal of discussion and debate about what can be done to attract high school students to the Geosciences.

On the 9th March 2005, two of our members Mike Smith and Steve Collins attended the Science Meets Parliament day in Canberra. Steve spoke with Martin Ferguson, the Shadow Minister for Primary Industries, Resources and Tourism and both met key advisors, discussing topics ranging from incentives to stimulate mineral exploration in Australia to technical innovation, skills development and the training of young geoscientists.

In other news, Ted Tyne, formerly Director of the Geological Survey of NSW, has accepted the position of Director, Minerals at PIRSA in Adelaide. NSW Branch wishes him well in his new position and we know that the SA Branch will benefit greatly from his presence.

South Australia – by Selina Donnelley

2005 began for the South Australian Branch of the ASEG with a well-known speaker from PIRSA, Andrew Shearer, who presented to us some interesting initiatives by the South Australian Government. The SA Government is keen to encourage exploration, and Andrew presented a talk entitled "PACE - The Premier's Initiative for Accelerating Exploration in SA". Andrew's talk coincided with the AGM, and we had 32 people present for the voting in of a mostly new committee. Selina Donnelley (Santos) was elected as President, Tania Dhu (Adelaide University) will continue as Secretary, and Dave Cockshell (PIRSA) was re-elected as Treasurer.

In March, the SA Branch invited an international speaker to the monthly technical meeting. Mark Tingay from the Geophysics Institute in Karlsruhe, Germany presented an interesting talk on *The World Stress Map* to a group of about 25 people.

The SA Branch hosted a technical meeting on April 17th by Huw Edwards of PGS Reservoir Australia. Huw gave a talk entitled *Creating a Step Change in our Understanding of the Regional Geology of the North West Shelf using Mega Survey Data*. Huw presented examples from around the world – including the North Sea, where PGS have integrated a swath of 3D surveys into a single 18,500 km2 survey. This enables much easier regional scale interpretation and understanding for explorationists. PGS merge, normalise and interpret publicly available 3D datasets and then perform attribute analysis on a large scale, presented using a satellite viewer, for handling the large volumes of data involved. As a result, new areas of prospectivity are defined, and the understanding of regional deposition and geological structures improved. Huw presented an interesting talk concentrating on the Australian North West Shelf to a large group of professionals and students. In addition, the SA Branch welcomed PGS Reservoir as sponsors for monthly SA technical meetings.

We also welcome our other sponsors for technical meetings in 2005: PIRSA, Schlumberger, Santos, Cooper Energy, Australian School of Petroleum, Minotaur Resources, Petrosys, Zonge Engineering, Beach Petroleum and Stuart Petroleum.

We welcome new members and interested persons to come along to our technical meetings, usually held on a Wednesday night at the Duke of York Hotel at 5:30pm. Please contact Tania Dhu (tania.dhu@adelaide.edu.au) or Selina Donnelley (Selina.donnelley@santos.com) for details.

Western Australia – by Anita Heath

The 2005 office bearers for the WA Branch are:

	President:	Don Sherlock
	Secretary:	Juliana Toms
	Treasurer:	Ben Hall

Ground water was the theme of the last technical evening on 11th May. The guest speaker was Niels Christensen, Professor at the University of Aarhus in Denmark, who presented at the Irish club at 6 pm. He attracted a healthy crowd which he kept interested for an hour! Niels is currently taking an absence of leave for a year and is working for CSIRO, modelling the EM response to CO2 sequestration. He was editor-in-chief of the Journal of Applied Geophysics from 1998 to 2002.

The ASEGWA are celebrating the SEG's 75th Anniversary on 17th September with a dinner. The SEG notable speaker is Norm Uren. Tickets will cost $85 per head. It should be a night to remember thanks to the major sponsors.

Gold Sponsor: Chevron Texaco

Silver Sponsors: Worsley Parsons GPX
Geosoft Australia Veritas DGC
Woodside Energy Total Depth

Singapore Airlines have donated two return economy tickets to anywhere on their global network to be given as a prize at the dinner. If you are interested in attending please contact Megan our Social Coordinator on Tel: (618) 9382 4307.

This year's SEG/EAGE Distinguished Instructor Short Course (DISC) will be held in Perth at the ARRC on Tuesday, 23rd August. It will be a one day workshop on the ***Insights and methods for 4D reservoir monitoring and characterisation*** to be given by Rodney Calvert, who is currently with Shell in Houston. The objective of the course is to ensure that participants go away with a basic understanding of the issues leading to success and failure, and the methods to ensure success.

It is aimed at anyone interested in understanding 4D and its potential, and is suitable for managers who must make the important decisions, for reservoir engineers who want to understand the results, for seismologists who have to get the results, and for anyone else who would like to learn how to remotely track subsurface processes in 3D as they happen. For more information contact Anita Heath on Tel: (618) 9367 3827.

DISC lecturer Rodney Calvert

ASEG thanks the following organisations for their sponsorship and support of DISC 2005: Statoil, ENI SpA, Total, Shell, Veritas and BP.

2005 Budget – a missed opportunity

One might have expected, in another year of plenty built on the ephemeral resources boom, that some of the gains may have been invested in long-term infrastructure projects to improve Australia's efficiency and effectiveness. But as we all now know, this did not happen. The $2 billion for water has been committed, but the way the States and the Commonwealth are arguing about the details of the package it could be some time before this money starts to flow. Instead, for the most part we get the short term tax cuts and the implementation of the scatter-gun election promises.

As a result the total Commonwealth funding for Science and Innovation as a percentage of GDP has fallen to below 0.6% of GDP in 2005/6 – the lowest level in two decades (according to FAST's media release of 19 May).

Despite the modest increases in R&D in Backing Australia's Ability, Commonwealth investment is projected to fall to 0.597% of GDP in 2005/06 – down from 0.66% in 2003-04 and 0.62% in 2004/5. Even as a percentage of total Commonwealth expenditure (2.76%) the number has dropped in the last three years.

Although most of the science and technology spending had been foreshadowed in last year's Backing Australia's Ability II program and in the 2004 election campaign, there were a few unexpected bright spots. One of these was the funding to set-up ***The Australian National Tsunami Warning System.*** This will contribute to an Indian Ocean Tsunami Warning System (IOTWS) and will integrate with the existing Pacific Tsunami Warning Centre to facilitate warnings to the South West Pacific region.

The cost to the Government of this system is $68.9M over four years. It will be jointly operated around-the-clock by Geoscience Australia (GA) and the Bureau of Meteorology (BoM), with Emergency Management Australia (EMA) handling the public awareness and disaster response aspects of the system.

GA's share of the $68.9M is $21.2M, the BoM's share is $40.4M, and EMA's is $7.3M. AusAid will also be providing $2M each to GA and the BoM for overseas technical assistance and training to build in-country capacity.

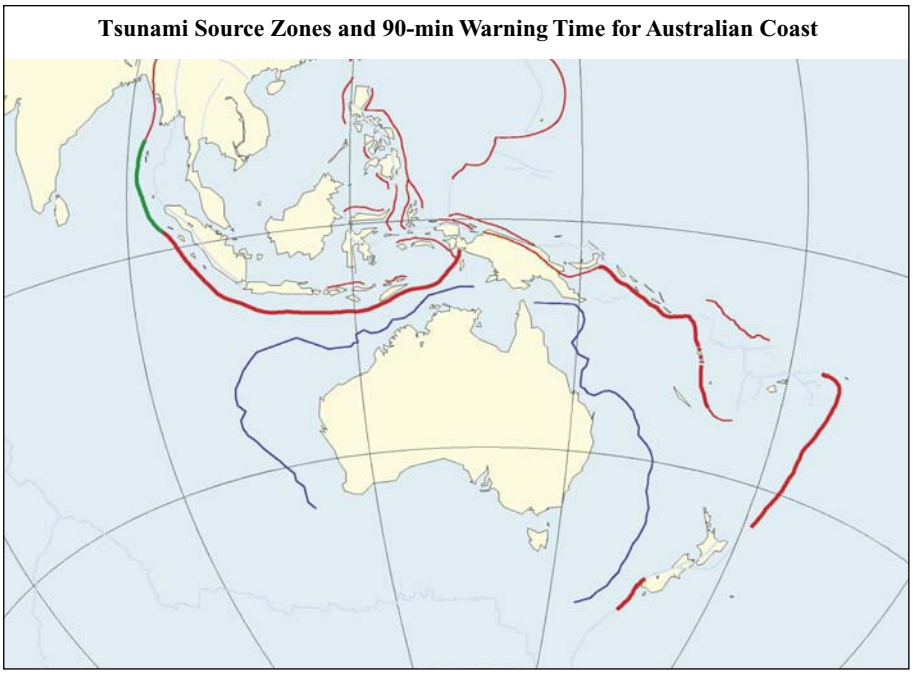

Fig. 1. Map of the active subduction zones in the Australian region (red lines), the plate boundary that ruptured during the 2004 Boxing Day earthquake (green line) and the 90 minute iso-chron for tsunamis to reach the Australian coasts. In other words when the tsunami reaches the blue line it will hit the coast in 90 minutes. (Diagram provided courtesy of GA).

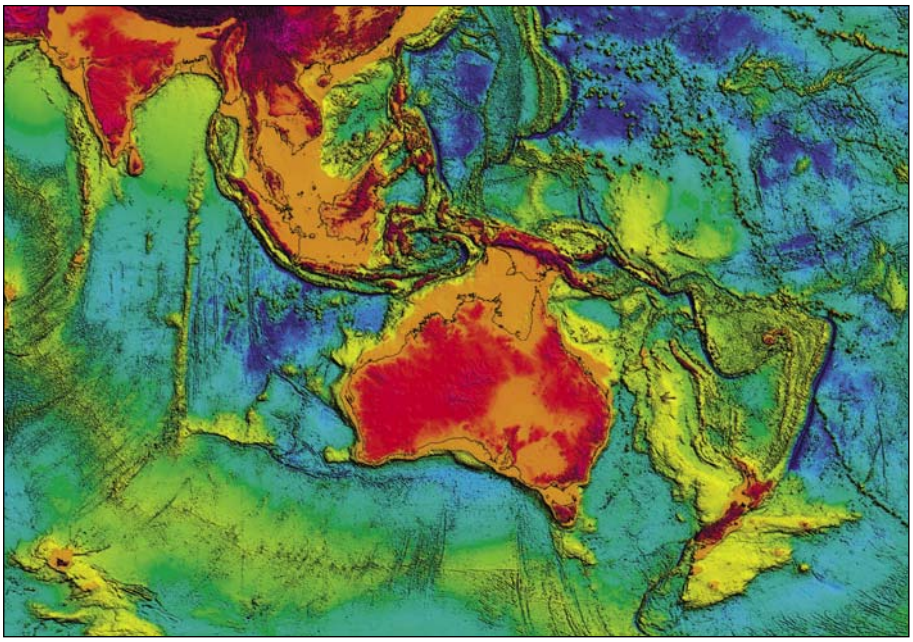

Fig. 2. Image of the detailed bathymetry in the Australian region. The complexity of the ocean floor is well illustrated. (This diagram was provided courtesy GA).

GA's $21.2M is for the updating of Australia's seismic monitoring capability, and the development of an around-the-clock operations and analysis centre.

The BoM's $40.3M is for new and upgraded sea-level gauges and Deep-Ocean Assessment and Reporting of Tsunamis (DART) buoys, and for the enhancement of their around-the-clock operations and analysis centre.

EMA's $7.3M is for public and institutional awareness education and training.

The purpose of the Australian National Tsunami Warning System is to:

- Reduce loss of life in the event of a tsunami affecting the Australian coast,
- Mitigate tsunami risks for operations at sea and in coastal waters, and

• Reduce the impact of tsunamis on essential infrastructure in our coastal regions.

The initiative will also allow Australia to continue to play a leading diplomatic, scientific and technical role in international efforts to establish a durable and effective Indian Ocean tsunami warning system. It also demonstrates the Australian Government's strong commitment to assist our Pacific Island neighbours address their tsunami threat[1].

Figure 1 indicates the areas where earthquakes can generate tsunamis that could impact on theAustralian coast. The red lines indicate the subduction zones; the green line indicates the extent of the plate boundary that ruptured on Boxing Day 2004; and the blue line indicates the 90 minute travel-time locus for any tsunami to reach the Australian coast. Figure 2 shows the detailed bathymetry in the Australian region.

For the system to work effectively, it is necessary to locate all shallow earthquakes with magnitudes of 6 or greater associated with the 'red' zones and and determine whether these will. This all has to be done before any 'wave' reaches the blue line. Then, whatever warnings are necessary have to be issued by the EMA and its state couterparts and acted upon by the local communities.

The technical challenge is non-trivial.

The second surprise was $46.3M commitment from 2005-06 (including $7.0 million capital funding) to establish an ***intercontinental airlink between Australia and Antarctica***. This will improve access to Australia's Antarctic research stations and is long overdue.

At the same time as these new initiatives are being funded, the government increased the efficiency dividend for all Departments and agencies (including CSIRO, ARC, and GA) to 1.25% (from 1.0%). This will result in a reduction in funds of ~$400,000/year for 07/08 and 08/09 for CSIRO and ~$341,000 over four years for the ARC. All agencies are supposed to manage these cuts by increased productivity.

Agency	Appropriation from Australian Government in $M[2]				
Year	2003/04	2004/05	2005/06	2006/07	2007/08
CSIRO	569	577	594[3]	608	627
ARC	414	482	557[4]	568	581
NH&MRC*	360	426	457	*	*
DSTO	294	287	320	309	307
CRC Program	202	194	208	190	*
BoM	197	191	207[5]	213	220
ANSTO	206	154	138[6]	129	121
Geoscience Australia	96	102	105[7]	111	104
Australian Greenhouse Office	73	45	44	#	#
Antarctic Division	85	87	101[8]	103	102
AIMS	22	22	23	24	24

* Forward estimates not available.

Incorporated into the Department from 2005/06

[1] The text was taken from post-budget releases by ministers and briefings by GA's CEO.

[2] For more information see: http://www.dest.gov.au/NR/rdonlyres/20B8A026-A27D-4933-A6F6-7BCA28D418E3/5515/S_I_Budget_Tables_200506.pdf

[3] As per triennial funding agreement, plus $68M for new buildings in Perth, Melbourne and Canberra.

[4] ARC funding increases to $557M in line with BAA 1 commitments.

[5] Increase due to tsunami warning system and replacement of aging met stations.

[6] Includes $20M for new OPAL reactor.

[7] Increase for tsunami warning system.

[8] Increase due to Antarctic airlink.

There was also an amalgamation of several previously 'independent' agencies in the Department of Environment and Heritage. These include the Antarctic Division, which is now one of the 'Outcomes' in the Department, and the National Oceans Office and the Australian Greenhouse Office, which no longer exist and have been amalgamated into the Department

The table below provides a summary of how the main science agencies funded by the Commonwealth fared.

Garrett stays – Batterham goes

Geoff Garrett reappointed as CSIRO CEO

Geoff Garrett has been reappointed as the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Chief Executive until 31 December 2008.

Dr Garrett was appointed as CEO in January 2001 and has led the organization through challenging times since then. He has helped transform CSIRO in that period, with the main initiative being the establishment of the National Research Flagships program.

This has focused CSIRO's research activities into six priority areas, which are aligned to the National Research Priorities.

This initiative aims to build new industries, broaden the skill base of the Australian workforce, encourage innovation, sharpen our international competitive edge and make the most of complex new technologies.

He has also been instrumental in strengthening CSIRO's links with industry and in particular to broaden its revenue base, so that it will soon be earning 40 percent of its operating budget from external earnings.

Robin Batterham stands down

After two full three year terms as Australia's Chief Scientist (starting in May 1999), Dr Batterham has decided not to seek reappointment for a third term. He will go back to a full time position with Rio Tinto, with whom he is currently engaged on a part time basis.

Dr Batterham was instrumental in encouraging investments in science and raising science awareness among the broader community.

He worked with the Australian Government to transform science and innovation investment, particularly through the Backing Australia's Ability package which will result in $8.3 billion in funding over the period 2001-2011.

From 1988, Dr Batterham has held senior positions in Technology Development with CRA Limited, now Rio Tinto Limited. During this time, he developed a processing route for what is now recognised as the world's largest economic zinc mineralisation.

His energy and enthusiasm for science will be sorely missed, but he will probably get to play the organ of Scot's Church in Melbourne more often.

We await with interest the appointment of his successor and more importantly, whether he/she will be full-time or part-time in the position.

Australian Geoscience Council's submission to Parliamentary Committee

The Australian Geoscience Council has just made a submission to the Parliamentary Standing Committee on Science and Innovation. It contains an excellent review of some of high impact geoscience innovations that have been developed in Australia and also eight recommendations for the Committee to consider. The Executive Summary is reproduced below. We will include a summary of the innovation examples in the August issue of *Preview.*

[9] To view the complete submission see the website: www.aig.asn.au/agc/

Executive Summary[9]

The resource industry in Australia is characterised by sustained innovation to meet competitive pressures within the country and internationally. Creative geoscience is typically funded at the margin of financial capacity and is subject to constant re-assessment of the merits of the research. It involves industry, government and universities in a strategic partnership each with particular roles.

The resource sector continues to create new wealth for Australia with long lead times. Unlike other business sectors, the industry generates new money which did not exist before the discovery, delineation and development of our natural resources. This capability, together with the high resource endowment of our geological terranes, has led to the continued delivery of superior export earnings for Australia.

The Australian Geoscience Council encourages government support for innovation in this highly productive sector. Specifically, we advocate government action to implement the recommendations of the Strategic Leaders Group of the Minerals Exploration Action Agenda, established by Minister Ian Macfarlane in 2002 to address the recent decline in mineral exploration investment in Australia. Australia's share of the global investment dollar for resource exploration has steadily declined in recent years; action must be taken now to arrest this trend.

We therefore recommend the following actions by government:

R1: Government and the Australian Research Council encourage partnerships between industry, universities and government research institutions that foster the undertaking of research of immediate relevance to the resources industry.

R2. Intellectual property rights are granted to the performing organisation while ensuring that individual researchers or research teams can share in the rewards.

R3: Government develops a national program to support the development of best practice commercialisation capabilities in universities and scientific institutions.

R4: Government develops a national program to improve science teaching capability and to attract highly qualified students into the study of science and engineering.

R5: The Government introduces an Australian flow through share scheme for specified exploration expenditure for resource exploration and extends the concept to companies with a research commercialisation focus.

R6: The Government increases the funding for the acquisition of precompetitive geoscience by Geoscience Australia to attract mineral exploration investment to the unexplored part of Australia's mineral provinces that exist beneath the un-prospective weathered surface cover.

R7: CSIRO in partnership with industry and with appropriate universities expands its capability to develop new techniques and technologies to facilitate the new frontier of mineral exploration under cover.

R8: Government develops criteria for assessing publicly funded research which will ensure that the innovation system is able to support and engage strategic sectors of the economy, including the resources sector.

ASEG Research Foundation

Project results

The ASEG Research Foundation provides grants to support students at the BSc (Hons.), MSc and PhD levels. The grants are paid directly to the relevant Australian University departments to cover field or laboratory expenses associated with the project. In this issue we summarise the work of Damian Leslie when he was undertaking his PhD at Curtin University from 2001-2004.

Student: Damian Leslie*
Host Institution: Curtin University
Supervisors: Bruce Hartley† and Kevin Dodds**
Project Title: ***A Geophysical Application of Time Reversal***

Project Summary

This research investigates a technique of detecting changes in the subsurface, possibly caused by extraction of oil and gas from reservoirs, using phase conjugation of continuous acoustic signals. This technique can equally be applied as an alternative to conventional seismic surveying methods.

The time-reversed acoustics (TRA) method presents a novel imaging solution to problems where conventional techniques fail. It has been developed as an experimental tool with applications in medical imaging and treatment, non-destructive evaluation of materials and underwater communications (Fink, 1997; Fink, 1999). The application of TRA to image changes in homogeneous and heterogeneous media has been investigated in this research. Time-lapse measurements record the effects of a virtual source situated at the time-dependent change in the subsurface. The TRA method provides an innovative means of focussing energy back at the virtual source (Figure 1).

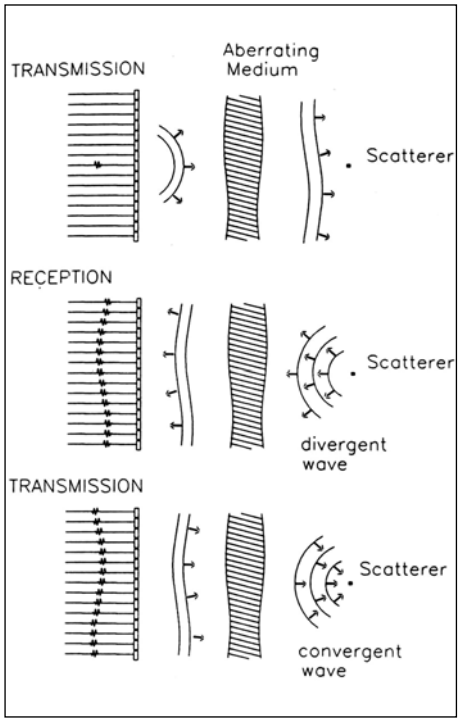

Fig. 1. The three-step sequence for focusing energy onto a target using time-reversed acoustics (after Prada et al., 1994).

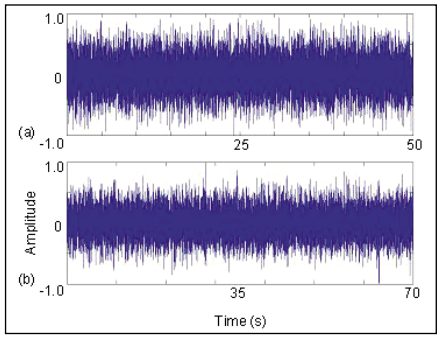

Fig. 2. The signals transmitted from (a) source A and (b) source B are illustrated for one repeat length.

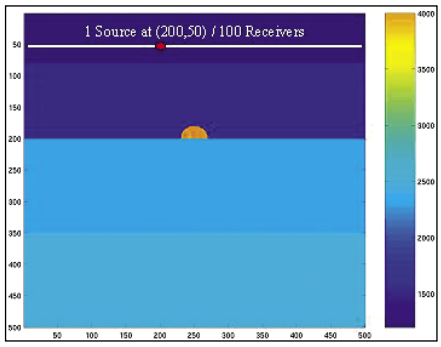

Fig. 3. Signals A and B are propagated through the model, with the velocity of the dome structure varied between soundings.

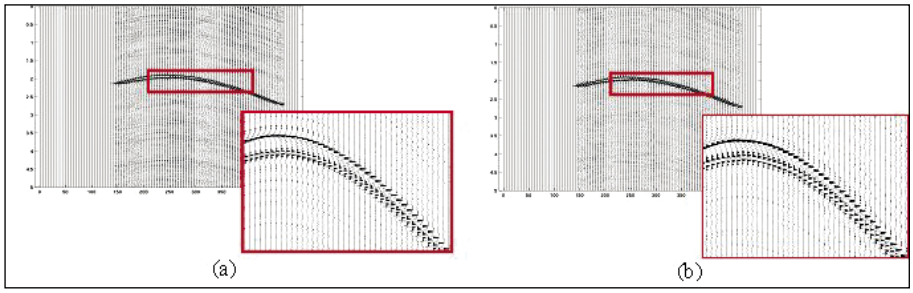

Fig. 4. The independent traveltime determinations for the zone of change generated from the crosscorrelation of the measured signal with reference signals (a) A and (b) B.

A signal generation and processing algorithm was developed to overcome observed limitations in heterogeneous media and permit continuous monitoring of the subsurface. This 'fixed-frequency prospecting' method transmits signals constructed from the superposition of continuous sinusoids with preferred frequency and phase characteristics. These low-power, random and uncorrelated signals (Figure 2) are conditioned in such a way as to exhibit many desirable qualities when transmitted into a model (Figure 3). These include the ability to separate the individual contributions from multiple sources (Figure 4), traveltime recovery techniques independent of the similarity between the transmitted and received signals, and velocity-independent imaging of the zone of change (Figure 5). At a fundamental level, the fixed-frequency prospecting technique

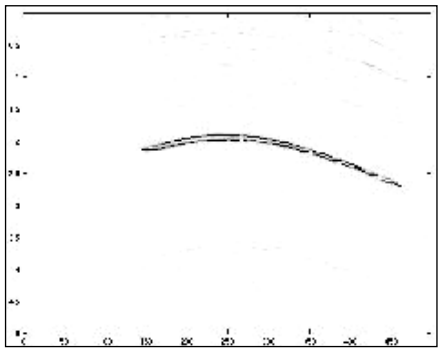

Fig. 5. Velocity model independent imaging of the time-lapse change from fixed-frequency prospecting.

provides an alternative perspective into the process of concentrating energy with methods of time reversal.

The method is based on measurements of the response of the subsurface to continuous

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acoustic signals at a number of fixed frequencies. Changes in the subsurface will result in changes in amplitude and phase of the returned signals. These changes are all that are required to identify alterations in the subsurface. Without knowledge of the subsurface velocity field, time images of the changes can be produced from the superposition of reconstructed continuous signals. If the velocity field is estimated from conventional processing flows, the changes can be imaged in depth by back-propagating the changed signals through the subsurface velocity model. Alternatively, if the changes in the subsurface can be predicted or modelled, the changes in the returned signal can be used to improve the velocity model of the subsurface. Back-propagating the changed response as a continuous signal produces high-amplitude intensity in the areas where changes have taken place.

The current attitude to time-lapse monitoring involves the processing of entire vintages of seismic data and subtraction of the depth images. The possibility of continuously monitoring reservoir depletion suggests an alternative philosophy: the direct measurement of changes to track fluid migration with production.

The methodology exploits lock-in amplifier concepts that detect amplitude and phase of fixed frequency signals against a reference signal. Lock-in amplifier operation can be simulated from digitised data provided that the reference signal phase is also recorded. Lock-in amplifiers are capable of extracting signal from noise in ratios of at least 10^6:1. Integration of signal can be made over extended periods and monitoring of the signal can be continuous. All this means that the source signal does not have to be of high power, so that it may be compact and fixed in position.

Finally, the developments outlined in this research are applicable to many other disciplines beyond geophysics. These include medical imaging with ultrasound, communications and non-destructive evaluation of materials.

References

Prada, C., and Fink, M., 1994, Eigenmodes of the time reversal operator: A solution to selective focusing in multiple-target media: Wave Motion, **20**, 151-163.

Fink, M., 1997, Time-reversed acoustics: Physics Today, **50**, 3, 34-40.

Fink, M., 1999, Time-reversed acoustics: Scientific American, **November**, 67-73.

ASEG Research Foundation thanks 2004 supporters

On behalf of the ASEG Research Foundation I would like to thank the 60 people that made voluntary contributions of between $10 and $100 when they paid their annual membership dues in 2004. The total amount contributed came to just under $1000. In the context of the Foundation this is a significant amount of money and could support an honours project for one year. The list below names all the Donors. Of these Roger Clifton, Peter Fullagar and Amanda Panting contributed $50 or more.

The ASEG Research Foundation was set up to provide enabling financial support for field or laboratory work associated with worthwhile research projects in exploration and related geophysics, carried out as part of honours and post graduate studies in Universities. The Foundation has been in existence now for some 16 or so years and during that time a considerable number of projects have received financial support. The outcome of these projects has been a steady stream of publications in Exploration Geophysics.

The Foundation's support of projects however doesn't only result in worthwhile research outcomes in exploration geophysics, more importantly it is a clear contribution that we as professional geophysicists can make in the development of talented new professionals for our industry

Peter Annan
Peter Atkinson
Barry Bourne
Richard Carter
Graeme Chapman
Roger Clifton
John Coffin
Maurice Craig
Roger Deakin
John Denham
Graeme Drew
Barry Drummond
Mark Duffett
Ernest Eadie
Samuel Elstadt
Gary Fallon
Thomas Forrest
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Shanti Rowlison
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Jill Slater
Edgar Stettler
Jonathan Sumner
Venkateswararao Tammireddy
Richard Turner
Sergio Vieira
Robert Weeden
Jonathon Whellams
Terry White
Anthony Yeates
Toshiyuki Yokota

At the beginning of each year the Foundation requests worthwhile proposals from Australian universities and these are evaluated and ranked by technical committees of experienced geophysicists in the fields of mining and petroleum exploration geophysics. In the recent round, support was awarded to one project in petroleum and three in mining geophysics. A fourth worthwhile mining project is under consideration but is beyond our current means.

The existence of the Foundation currently relies on funding from three principle sources: corporate memberships; ex gratia contributions from the ASEG Federal Executive and importantly the generosity of individual members of the ASEG. Over the past few years with the fall off in the number of corporate members, funding for the foundation has been under pressure. The support of the ASEG and its individual members has been a key factor in the continuance of its work.

Once again thank you to the 2004 Foundation supporters and I remind all the ASEG members that an excellent time to be generous is on the annual membership dues form, bearing in mind that all contributions are tax deductible.

Phil Harman
Chairman, ASEG Research Foundation

90 Years Ago - some pioneering field trips

(Part II)

Edward Kidson, his observers and some more camels

Edward Kidson's 1914 expedition along the Canning Stock Route (see *Preview 115*) was not the first nor the only geophysical expedition in Australia where camels have been the mode of transport, for in 1912 Kidson had, with his assistant F.W. Cox, travelled and observed from Oodnadatta to Daly Waters along the old overland telegraph line (Figure 1 and 2) and then later, in 1914, Alec Kennedy, one of Kidson's observers made two forays into remote desert areas of South Australia as did the South Australian Government Astronomer George Dodwell when he joined the geologist Robert Lockhart Jack on a historic expedition to the remote Everard and Musgrave Ranges. Travel by camel may not have been the preferred mode of transport in 1914 but it was essential for any remote work (Figure 3).

Kidson's helpers

In the period 1911-1915 a number of geophysical observers were employed in Australia by the Carnegie Institution of Washington, Department of Terrestrial Magnetism (CIW/DTM) to measure and map, amongst other things, the earth's regional magnetic field, i.e., declination, inclination and intensity. In addition to Edward Kidson, the first observers were Fred Brown, Eric Webb, Alec Kennedy, F.W. Cox and W.C. Parkinson (Figure 4). There were to be other DTM observers in the following years and all were to carry out pioneering geophysical field surveys. Kidson received great co-operation and observational assistance from the various state government astronomers, including Pietro Baracchi and J.M Baldwin in Victoria and George Dodwell in South Australia. The Adelaide academic, Professor Kerr Grant also became involved when he assisted Dodwell with a number of field observations.

The DTM had supplied Kidson with the then state-of-the-art equipment. He had observatory standard theodolite-magnetometers (and in 1914 the newly invented earth inductors), compass declinometers, observatory standard dip circles, chronometers and watches, thermometers, barometers and cameras – he was very well equipped. By 1914, in addition to his own party on the Canning Stock Route, he also had three other field parties operating in Australia.

To Innamincka, Cordillo Downs and Birdsville

In mid-1914 Alexander (known as *Alec*) Lorimer Kennedy, the DTM geophysical observer and previously a "magnetician" on Mawson's Antarctic 1912-13 expedition led a camel party from Farina, north of Leigh Creek on the Adelaide - Alice Springs telegraph line. The route went up the Strzelecki Creek to Innamincka and Cordillo Downs, then across to Birdsville and back down the Birdsville Track to Hergott Springs (Marree) -a trip of over one thousand kilometres (Figure 5).

For this trip Kennedy had engaged an Afghan camel driver with five bull camels and the journey along the Strzelecki Creek went very well - with plenty of feed and numerous wells and waterholes – however things came to a sudden halt when the camels wandered off during the first night at Innamincka and after a fruitless seven day search it was "by good fortune, we found three strange [sic] camels in the bush country, with which I decided to continue the journey, although it necessitated abandoning some of the supplies and only allowed us one camel for riding". Kennedy's travel after Innamincka was slow as a consequence, at walking pace, and with scanty feed it became more frustrating when they were then held up by nine days of continuous rain! Kennedy, despite these inconveniences, made geophysical and meteorological observations throughout the trip.

On reaching Hergott Springs on the 5th July a message was relayed by telegraph that the

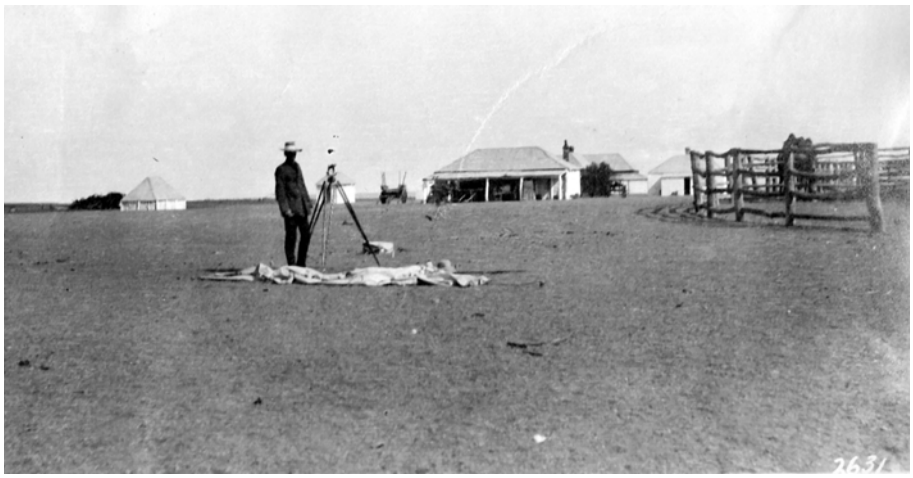

Fig. 1. Kidson's magnetic station site at Charlotte Waters NT showing meat house at left and blacksmith's shop at right. 8th June 1912. Courtesy CIW/DTM-GL Library photo #2631.

Fig. 2. Mag station at Charlotte Waters NT 8th June 1912. The camel train of Mr. F.H. Marsh of Oodnadatta in the background enroute to Alice Springs. Kidson's camp in the foreground. Courtesy CIW/DTM-GL Library photo #2632.

camels had already made their own way home to Farina from Innamincka (360 km as the crow flies).

Non-magnetic "gibbers"

Kennedy made observations (declination, inclination and intensity) at twenty-four regularly spaced stations on the trip and in his report he noted the average time per station was 3.7 days and the average cost was US$27.07 per station.

In his reports Kennedy mentioned the effect of geology at each of his observations, albeit briefly, and his final summary for this trip read - "The great part of the area traversed is a lower and upper cretaceous deposit of sand, sandstone, quartzite, jasper, etc. There are extensive areas of land covered with desert sandstone boulders, locally known as 'gibbers', which consist mainly of sandstone indurated by siliceous infiltrations. Most of the 'gibbers' are red, coated with oxides of iron, the outcome of arid conditions. These oxides apparently have little effect on the magnetic conditions".

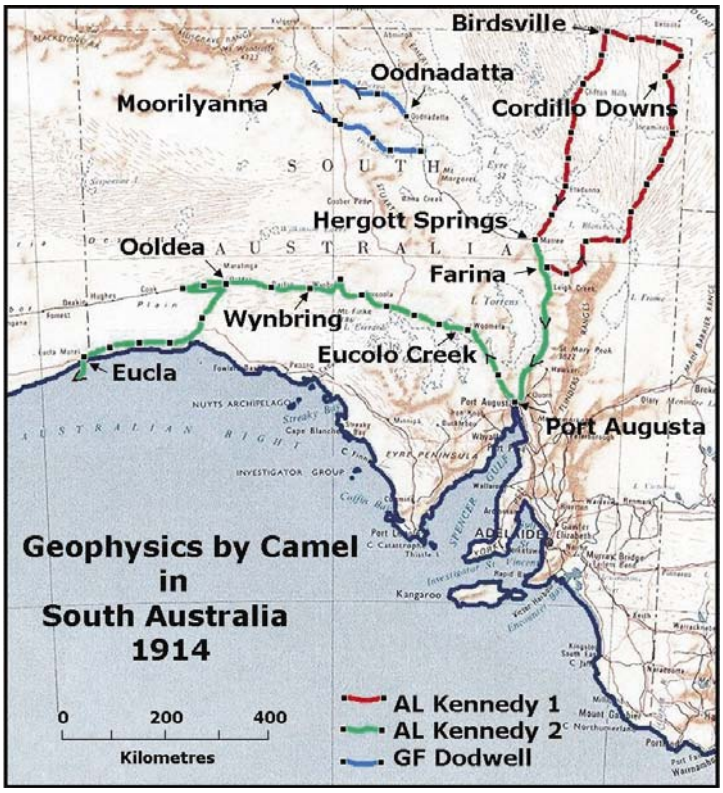

Fig. 3. Kennedy and Dodwell's South Australian expedition routes and magnetic station locations.

By "caravan" to the Nullarbor

Immediately after this expedition to the north-east corner of South Australia, Kennedy, under instructions previously issued by Edward Kidson (who was at that time on the Canning Stock Route) organised another "caravan" – Kennedy's description - that was to ambitiously make magnetometer observations all the way from Port Augusta to Kalgoorlie along the then partly surveyed and constructed transcontinental railway line – a long and difficult trip. Before his departure Kennedy, assisted by the government astronomer George Dodwell, calibrated his magnetometer by reoccupying a known Port Augusta observation site. It was typical of all the DTM observers to make great effort to ensure the accuracy and calibration of their measurements.

The camels for the trip west, all twelve of them, were initially described by Kennedy as "a fine strong lot" and had been driven all the way from Hergott Springs by the Adelaide based camel driver Tom Dare – over 300 km. On the 19th August 1914 Kennedy, with his friend the engineer F.M. Best, Tom Dare and the camels, departed Port Augusta and despite being given experienced advice **not** to attempt the trip due to the serious drought conditions they proceeded (Figure 6).

No water on the Nullarbor

The expedition should never have continued and was under extreme stress from the start, with lack of feed and water and then the discovery that only four of the camels were tamed pack animals, the rest being wagon camels – a big difference! The condition of the camels, most of which were very unruly, deteriorated quickly and reached crisis point at Tarcoola, where it was found there was no water - none at all! All of the water at the time was being carted in (by camel) at US$4.50 per 100 gallons.

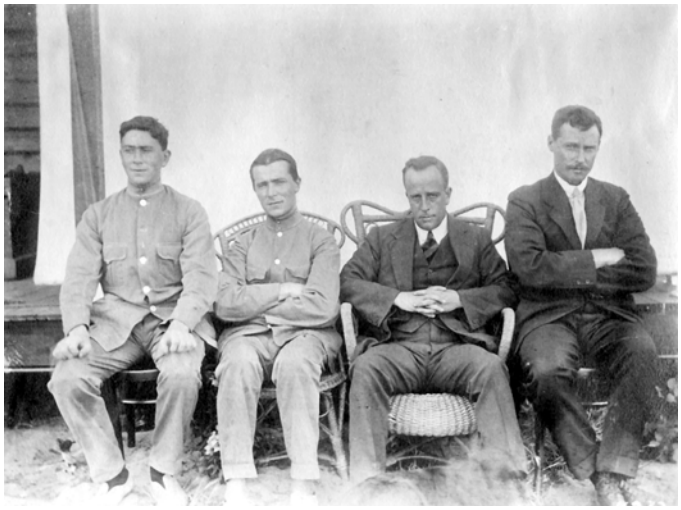

Fig. 4. Some CIW/DTM "magneticians", left to right: Fred Brown, W. C. Parkinson both in DTM uniform, Edward Kidson and Alec Kennedy. Courtesy CIW/DTM-GL Library photo #4732.

Fig. 5. Some gibber plains at Cordillo Downs, South Australia. Station buildings in the background and Kennedy's observation tent in foreground. 28th May 1914. Courtesy CIW/DTM-GL Library photo #4684.

Fig. 6. Kennedy's expedition travelling along Eucolo Creek, South Australia after passing the then construction railhead circa 29th August 1914. Courtesy CIW/DTM-GL Library photo #4699.

Kennedy, with some deviations to native wells for water, continued on with the expedition as far as Ooldea Bore but it became impossible when it was found the next known water along the partly surveyed route was 340 km away at Bore No.4 in Western Australia. The expedition was not capable of crossing such a stretch without water (Figure 7).

At Ooldea, Kennedy "availed himself of" Mr T.R. Nealyon of Fowler's Bay (a supplier to the railway surveyors) and using his motor vehicle for transport, observed two stations further out into the Nullarbor (Figure 8) but Kennedy was to have no choice other than to abort the travel along the railway route. He was forced to backtrack with the camels south from Ooldea to the coastal overland telegraph line at White Well and from there travel west to Eucla, observing a number of mag stations along the way.

Despite Kennedy's plans to find alternate ways to finish his observations to Kalgoorlie, Edward Kidson (then back in Perth) called it all off on the 10th October 1914 and Tom Dare was immediately instructed to return to Hergott Springs with the camels, a long haul of about one thousand kilometres.

Kennedy went on to make a series of repeat observations out the back of the Eucla pub while awaiting his embarkation to Perth, not

departing from there until the 8th November on the supply steamer *Eucla* (which arrived only once every three months). He reported to Kidson in Perth on the 15th Nov 1914 where they were to compare and calibrate their systems.

An expensive trip

Kennedy, in his final report to the CIW/DTM, calculated the average field expenses for the thirty or so observations he had made from Port Augusta to Eucla was US$113.50 per station and that was really expensive! It should be mentioned his report also briefly commented on both the geology and the magnetic environment encountered on the Nullarbor:

"The country is magnetically disturbed between Gilbert's Well and Ooldea. The geological formation is pleistocene and pliocene sands, limestone, etc., overlying granites and gneisses, which outcrop in various places. Mount Christie, about 20 miles north-west of Wynbring Rock-Hole, is known as a magnetic hill. Between Ooldea and Eucla there is less disturbance, the country being mainly the Miocene and Eocene limestones of the Nullarbor Plain."

Fig. 7. F.M. Best filling camel tanks from the remote Wynbring Rockhole, circa 16th September 1914. Courtesy CIW/DTM-GL Library photo #4717.

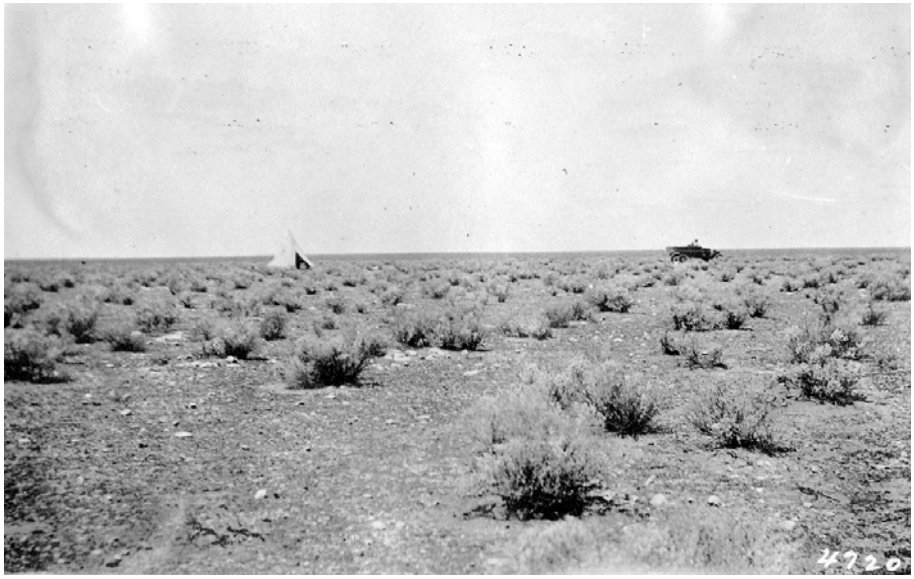

Fig.8. Kennedy's "Bore B" magnetic station on the Nullarbor Plain. Mr. T. R. Nealyon's motor vehicle at the right. 26th September 1914. Courtesy CIW/DTM-GL Library photo #4720.

Alec Kennedy was to resign shortly thereafter from the DTM and along with a number of his compatriots, including Kidson and Webb, and like most of their generation, went off to war.

It is with gratitude I again thank the Carnegie Institution of Washington, DTM-Geophysical Laboratory Library for access to their Australian records and photographs and in particular thanks go to their librarian, Shaun Hardy, for his continued interest and co-operation.

References:

Bauer, L. A., and Fleming, J. A., 1915, Researches of the Department of Terrestrial Magnetism, Volume II, Land Magnetic Observations 1911-1913 and Reports on Special Researches.

Bauer, L. A., Fleming, J. A., Fisk, H. W., and Peters, W. J., 1921, Researches of the Department of Terrestrial Magnetism, Volume IV, Land Magnetic Observations 1914-1920.

Kidson, Isabel M., 1941, Edward Kidson O.B.E. (Mil), M.A., D.Sc., F.Inst.P., F.R.S.N.Z. late Director of Meteorological Services in New Zealand.

Aerial Survey, Earth Sciences and Africa's 21st Century

By Colin Reeves[1]

Email:
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Introduction

In 2002 Exploration Geophysics in ITC[2] became an 'expiring chair'. If there is anyone who came simply to watch me expire, then I hope they will be disappointed! Forty minutes is, in any case, a generous allowance for a last breath.

I have chosen for my title *Aerial Survey, Earth Sciences and Africa's 21st Century*. This deserves some explanation. When, in 1982, ITC (at that time the International Institute for Aerial Survey and Earth Sciences) advertised a chair in exploration geophysics with an emphasis on airborne survey methods it showed a degree of relevance and enlightenment in the affairs of the developing world that merited my close attention. I set out the ambitions I had to match the honour of my appointment in my inaugural address (Reeves, 1984). As things turned out, it also provided, for the next 20 years a vehicle for my professional enthusiasm and a catalogue of activities that the world can evaluate. It is in the nature of things that times change and now is clearly a good time to move on. Neither the 'aerial survey' nor the 'earth sciences' are any longer items the institute chooses to advertise in its title. We have not yet solved the problems of Africa, however, and this is what I want to address in some detail today. It is timely because there are many initiatives in 2005 to address these problems, such as the G7, the G8 and the Make Poverty History campaign. 'Africa is a place plagued with problems … so embedded and widespread that no continent, no matter how rich, could tackle them on its own. And Africa is not rich.' (Blair, 2005).

But let me start at the beginning

When I was very small, I struggled to understand a conundrum. As a family we were not rich and times were tough in post-war Britain. But after a while we had an old car and even, eventually, a television set. As I built up an awareness of the wider world in which I found myself, I enjoyed finding my older sister's National Geographic magazines and looking through them, probably even before I could read the words. In Africa, I noticed, the children appeared to have much less than I did. Most of them appeared not even to have clothes. What sort of world was it where I had clothes and they did not? Why was I the lucky one?

Decades later, I found a quotation from the infamous Cecil Rhodes that summarises this rather neatly:

'To be born British is to win first prize in the lottery of life.'

I hope that you, like me, find this shamefully lacking in political correctness. But the awful truth is that **the average person in Africa was better off financially when I was a child than he or she is now, 50 years later – by a factor of two!**

Africa in need

Africa is 22% of the world's land area, is home to 12% of the world's population, yet generates and consumes only 2% of the world's electricity and attracts less than 1% of the world's foreign investment. From an economic point of view, if it ceased to exist, most people would hardly notice. The media, however, remind us of a menu of civil war, famine and deprivation that pricks us into action or at least awakens our conscience. 49 % of Africans live on less than one dollar a day; 1 in 3 is undernourished and 28 million suffer from HIV/Aids. Deaths from war and preventable diseases in Africa amount to an Asian tsunami every few weeks. And the continent contains some truly majestic unspoilt places that need preserving from the ravages of farmers, foresters and poachers if they are to remain for future generations to see and appreciate.

Poverty, particularly desperate poverty, is probably the greatest enemy of the environment. Who can blame anyone desperate to feed a family for actions that are environmentally unfriendly? And proper care of the environment is a luxury that even some of the world's richest nations seem reluctant to afford. Everything we cannot grow is ultimately 'borrowed' from the earth – and it gets returned either as carbon dioxide or in pretty poor shape such as dirty water, toxic waste and so forth. This is not the topic for today, however. Environmental care costs the money that there is never enough of. How can we generate the wealth that will be necessary to give better

[1] This is an edited text of Colin Reeve's Valedictory Address, given at ITC on 3 March 2005. It has been published with the permission of ITC.

[2] ITC was founded in Delft in 1950 as the International Training Centre for Photogrammetry and Aerial Photography - a Netherlands contribution to global post-war reconstruction through the technology of map-making. Over 15,000 foreign students, mostly at postgraduate level from Africa and SE Asia, have now followed year-long courses. In 1972 a new main campus was established in Enschede where (after several name changes) the emphasis is now on GIS and satellite imagery applications. The last of the ITC activity in Delft ceased in 2004.

Fig. 1. Botswana Geological Survey Headquarters, Lobatse, in 1973. The Cape-to-Cairo road is on the left, the Cape-to-Cairo railway out of shot to the right.

Fig. 2. The new buildings for the National Geological Information Centre on the same site, June 2001.

standards of living to those most desperately in need?

A solution for poverty – the lesson of Botswana

When I first went to Africa in 1969 to work for the Geological Survey of Botswana (Figure 1), that country was the fourth poorest country in the world. Many people wore rags and the entire national telephone directory was the size of a very small school exercise book.

Even four years after independence, the first piece of government stationery I saw was grandly headed with 'Bechuanaland Protectorate' – crossed out and 'Botswana' written in, in blue crayon. In the 35 years since then it has become the richest country per capita on the continent and a rare African success story. At independence (1966) there were no secondary schools, only *mission* hospitals and less than 20 km of sealed road in the entire country, the size of France (Young, 1966). Now they have the schools, hospitals and roads that they need and new Geological Survey buildings (Figure 2).

This is the difference that real, rapid development can make. Not that they have solved all their problems, of course, but at least they have the luxury of some national wealth with which to ***tackle*** the new ones. I am able to give you some human dimension to this because, a few years ago, I was invited back to help celebrate the Geological Survey's 50th anniversary. Here, resplendent in retirement (Figure 3), are some of the field hands I

Fig. 3. Some of the field-hands who worked in the early 1970s return to the Geological Survey to celebrate its 50th anniversary in 1998.

had worked with during long months in the Kalahari in the early 1970s. More important, their children were making sound progress and substantial careers after a good education.

The source of Botswana's wealth, in a word, is diamonds. The credit for finding and developing the diamonds must go to De Beers, but the national economic success must be credited to the Botswana Government for its wise handling of the politics and economics. In turn, credit should go to the Geological Survey of Botswana for maintaining the national geoscience data infrastructure that made – and continues to make – Botswana a good place to explore. And invest.

As the Geological Survey's first geophysicist, it was an important part of my own professional education to discover, after the first week on the job, that I had exhausted the supply of background reading on the geology of Botswana. I can tell you that, when your main problem is lack of data – or geo-ignorance, let me call it – geoinformation management doesn't rank very highly as a potential occupation. Very simple geological questions that I directed at long-serving geologists all seemed to meet the same routine answer: "We don't know". A large part of this ignorance was due to the fact that 70% of the country is covered with the Kalahari sand that totally obscures the solid geology. Eventually, John Hepworth, survey director for most of my five years in Botswana, came with a better answer: "You're our geophysicist. It's your job to go and find out!" As a result, the first national gravity coverage of the country was carried out and, soon after, Canadian government financial support was secured for the first aeromagnetic survey. A good impression of the 'derring-do' style of getting things done in the field at this time is given by Chris Scholz in his book, *Fieldwork* (Scholz, 1997).

The greatest compliment that has been paid to the importance of these early, 'amateur' surveys is that they have all been replaced by modern, professional coverage to the highest standards in more recent years. Once the value of regional geophysical coverage to geological reconnaissance is realized, it is a very small step further to realize that only the technologically most sophisticated coverage is good enough. And that coverage should be repeated as the survey technology improves.

Canada, Australia, Africa

All the projects I have undertaken in the 30 years since I left Botswana have been variations on this same theme. I can't mention them all today and I have been very fortunate that my students have taken me – in their research projects, if not in the flesh – to many different countries. But I cannot miss mentioning the reinforcement my ideas I received during the two years I spent in Australia, 1991-3, on special leave from ITC. Geophysical mapping from the air has been high on the agenda in Australia since the Bureau of Mineral Resources Geology and Geophysics was founded in 1946. The first magnetic anomaly image of the whole of Australia appeared from my group there in 1993 and has already gone into its fourth edition. Through modern web-access, it has become one of the foundations of the continent's excellent geological information infrastructure (www.ga.gov.au).

I had already learnt the importance of aeromagnetic coverage to the mapping of whole continents during my time in Canada,

1976-83. Canada first set the pace for systematic geophysical mapping of their territory – a little, but not much, larger than Australia – in the 1950s and 1960s. What is not coincidental, I am sure, is that it is now from Canada and Australia, the two 'giant' countries in terms of solid-mineral investment worldwide, that 80% of the current investment capital in Africa's mineral potential comes. Even so, you should remember that Africa is almost twice the size of Australia and Canada *combined* but still attracts less than half the investment in mineral exploration (see table below). In other words, only about a quarter as much per square kilometre, as the wide open spaces of Canada's tundra and Australia's outback. Even this is far better than the situation in 1990 (see http://www.e-sga.org/news6/art1.html) when Africa accounted for less than 5% of the global expenditure. In this sense Africa has benefited from globalisation in the last fifteen years. But Africa has ten times the population of Canada plus Australia and there is clearly still room for improvement.

Region	Mineral exploration spending in 2004 ($US millions)	Percentage of global pie
Latin America	773.9	21.8
Canada	695.8	19.6
Africa	571.6	16.1
Rest of the World	546.7	15.4
Australia	521.8	14.7
United States	284.0	8.0
Pacific/SE Asia	156.2	4.4

Worldwide nonferrous exploration spending by region 2004 (1138 companies' budgets totalling US$3.55 billion – see Metals Economics Group website: www.metalseconomics.com).

There is obviously an opportunity. Why is it not being taken up faster? Ten years ago I remember hearing a hard-nosed businessman in minerals comparing Africa and Siberia as places to invest. Trying his best to be positive, Siberia, he said, has the well-trained work force and the efficient infrastructure. Africa has the nice climate.

Objectively, three items determine the attractiveness of any country for mineral investment, given that the geology of Africa is no less attractive than that of, say, Canada or Australia:

1. Political stability and good governance;
2. Fair mining legislation and fiscal regime; and
3. A good geoscience data infrastructure.

The first two items are – however worthy – beyond the scope of the professional earth scientist, except perhaps in a valedictory address! In this sense, politics and diplomacy have a much greater role than earth science in determining Africa's future, as Robert Cooper would, I am sure, agree (Cooper, 2004). 'Finding ways to get badly governed countries to raise their game is, to say the least, notoriously hard (and hugely controversial) for outsiders to do' (The Economist, 2004).

But the geoscience database – or the lack of geo-ignorance – is something that we as scientists should certainly be concerned with. And, having established the importance of aeromagnetic coverage, it is only natural that those looking for worthwhile geoinformation in new territories in Africa pretty soon ask the question: "What is the aeromagnetic coverage like? How easily can I get it?"

The AMMP contribution and its follow-up

In fact, we asked this same question in the 1980s at ITC and eventually, in cooperation with our geophysical colleagues at the University of Leeds in England and at Paterson, Grant and Watson in Toronto, we persuaded sponsors to come up with the US$ 4 million cost of cataloguing, retrieving, digitizing and compiling almost 1000 separate surveys carried out over Africa since about 1950 – AMMP, the African Magnetic Mapping Project! (Barritt, 1993).

This catalogue (Figure 4) is in need of updating because much new survey coverage has been made in the past 13 years – but mostly in the

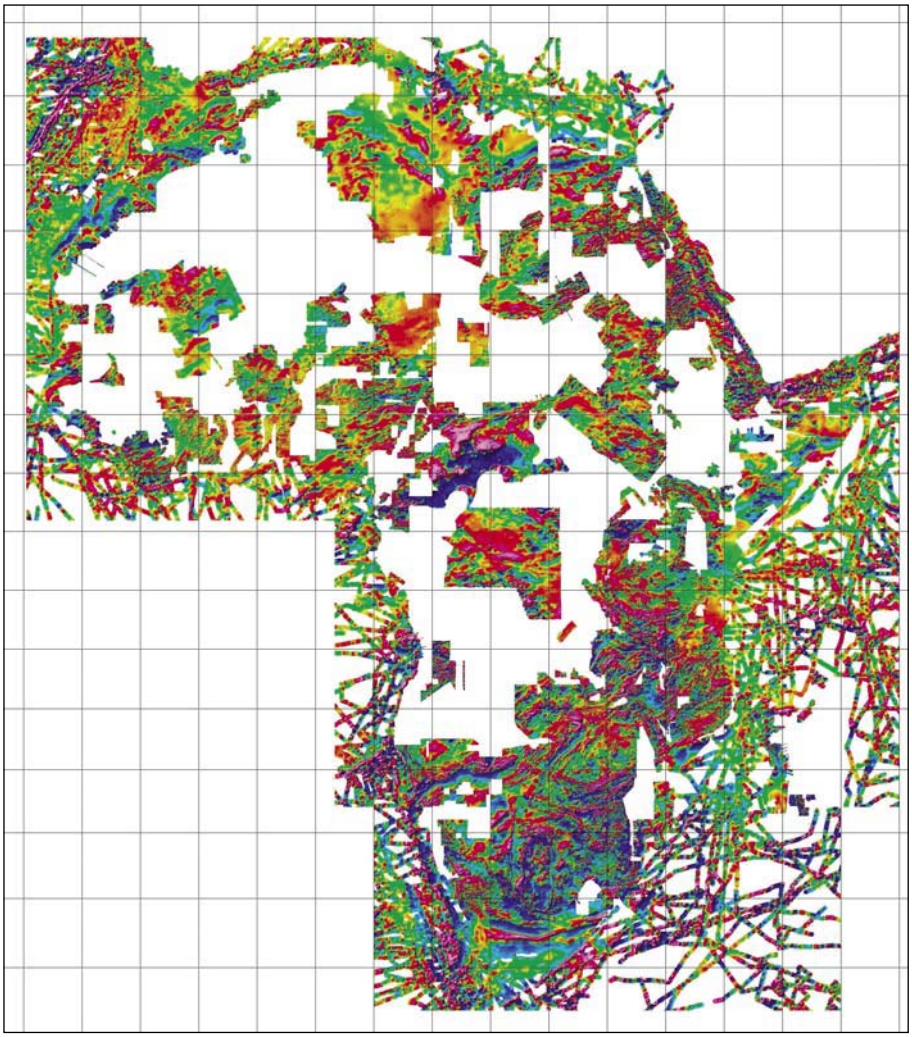

Fig. 4. The aeromagnetic coverage of Africa (1992) (28 Mkm2) still today lacks the completeness that is familiar for Australia (7.5 Mkm2). Courtesy of the African Magnetic Mapping Project.

countries where the importance of this had been established by what we might now call 'first generation' surveys. However, what is still outstanding from first impressions given by this map, is that (1) large areas of Africa remain to be covered, (2) many large areas are covered only with 1960s-70s surveys of technically low specifications that do not offer the resolution possible with modern techniques and (3) other areas are covered by surveys that remain inaccessible to general users, even decades after being carried out. Data ownership is still a major obstacle to good science, particularly where commercial interests or national security are perceived to be at stake.

Aeromagnetic surveys, as we have seen, are the modern precursors to geological mapping. Primary geological mapping has always been in the forefront of initiatives to understand the resource base and inventorise its potential – and hence high on the agenda of national geological survey activities. However, even at the reconnaissance scale of 1:250 000, the task of geological mapping is far from complete. In Africa it is thought that less than half the continent has yet been mapped at 1:250 000 scale and that only half the map sheets surveyed have actually been published (Reedman *et al*., 1998). No basic geological information is therefore available at even reconnaissance scale for three-quarters of the continent – even if you take the trouble to travel to the country of interest in search of the paper maps. In Australia, by contrast, the first pass of this task was completed between about 1948 and 1980. So, while there is certainly more aeromagnetic coverage than geological map coverage in Africa, both items are sadly in need of attention. And, to paraphrase the original concept of where ITC can contribute to international development – 'No development without maps'.

As an illustration of the progress that has been possible using airborne geophysics, Figure 5 shows an area in the NW corner of Botswana, first with a 1979 geological interpretation of the first Landsat satellite imagery and, second, with the 1997 interpretation of the latest generation of detailed airborne magnetometry. To stress that this is not purely an academic exercise, two new kimberlite fields that emerged from this work are highlighted.

If we think about *digital* information on geology, the impact of this revolution is certainly still in the future, but probably not by much. With an eye to its global resource needs, the US has been taking the lead so far, as well as setting a precedent by making the digital data available free of charge. At present the best available USGS digital geology of Africa contains only about one sixth of the megabytes of the similar coverage of the much smaller area of Saudi Arabia, for example. I find it a cause of some current concern that the second significant player in this league and one of the most respected and scientifically logical forces in global geology for decades – UNESCO – has recently decided to abandon much of its basic earth science activity, potentially delivering another victory for geo-ignorance!

But I digress. The point is that many large parts of Africa are, even now, no better off in terms of useful and reliable basic geoscience information than Botswana was 35 years ago. However, the opportunity to repeat elsewhere what has happened in Botswana seems very appealing if, as many politicians seems to think (e.g. Blair, 2005); the time is ripe to make bigger efforts to solve Africa's poverty problems by 2015, or at least in the current century.

African Oil

Let us not concern ourselves only with minerals. While various commentators make different predictions as to what the present century will bring for mankind, it is certain that the world will want oil and gas for at least the next 50 years. It is also certain that it will eventually run out – we are consuming these resources about one million times faster than nature was able to create them (KNAW, 2005). If anyone doubts the importance of motorised transport in the years ahead, they can leave me their car keys when they go home today, or better still, their air tickets for their next holiday. What diamonds did for Botswana, can oil (instead of, or as well as, solid minerals) do for other places in Africa?

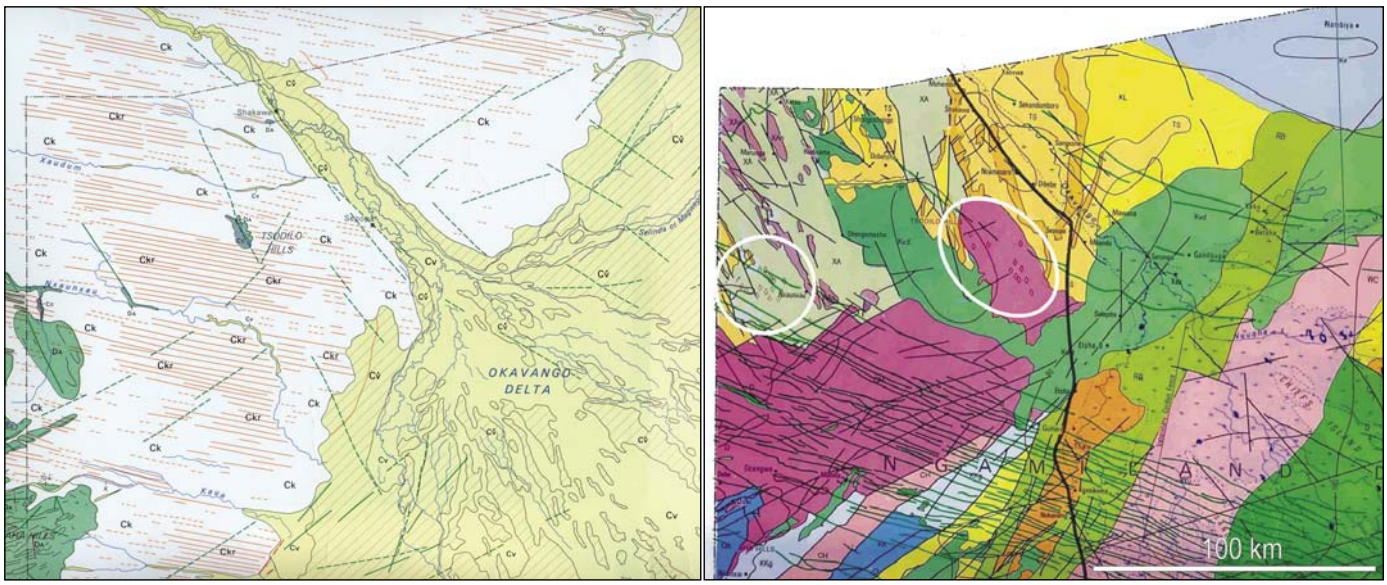

Fig. 5. Top, early Landsat 1 satellite image interpretation of the geology of NW Botswana (1979) showing mostly sand dunes and young sediments of the Okavango inland delta. Below: geological interpretation of high resolution aeromagnetic coverage, 1997. Scale bar 100 km. New kimberlite fields circled. Both courtesy of the Geological Survey of Botswana.

Nigeria has long been the main source of oil in sub-Saharan Africa. It has more recently been joined by other countries such as Angola and Gabon. And what the oil industry can do in terms of – particularly offshore – technology for exploration and production makes rocket science look pretty simple. As exploration moves into deeper waters, the resources of Africa's Atlantic coast promise a new resource bonanza. Angola already satisfies 8% of the United States' enormous thirst for crude oil.

Two new pieces of oil infrastructure in Africa's interior call attention to themselves, namely the pipelines from southern Sudan to the Red Sea, and from Chad to the Atlantic coast in Cameroon. While it takes proven reserves to justify such enormous investments, the pipelines both have excess capacity, so finding and developing neighbouring fields has become very attractive. Geologically, the rift structure hosting the oil is a relic of the time South America broke away from Africa. It is tens of times bigger than the oil-bearing province of the North Sea. In Sudan, one concession area alone is as big as the Netherlands! It is unlikely that what has been found so far is all, or even the best, of what waits to be discovered. Exploration of Africa's east coast, meanwhile, is only now beginning.

So oil revenues for at least some parts of Africa can be virtually guaranteed, provided the diplomatic and political climate can be kept favourable. But oil often brings troubles and creates motives to awaken old hostilities in the sharing of the revenues. The over-simple reaction of the West in Africa (unlike elsewhere) is often simply to leave well alone. For example, there is no longer any western involvement in Sudan's oil patch. It was driven away by public opinion in the West. Sudan now supplies 10% of China's growing thirst for imported oil, a trend that will undoubtedly continue. A much better alternative is for the western countries to remain engaged and strive for a socially responsible outcome and a formula to ensure societal benefits in the countries collecting the revenues. Former Dutch development minister Herfkens argued strongly to maintain this involvement during her time in office. British Prime Minister Blair argues similarly in his article in The Economist as recently as January this year.

Most people, when they think of oil, think of the big western oil companies and perhaps think that they have a capitalistic monopoly on the world's oil resources. In actual fact, nothing could be further from the truth (KNAW, 2005). 70% of the world's oil is in the hands of national oil monopolies owned by governments keen on balancing their national budgets and, in some cases, largely immune to the pressure of shareholders and consumers that at least try to ensure responsible corporate behaviour in the so-called democracies of the west.

An African development model

Prediction, it is said, is difficult, particularly when it involves the future. But what may the future hold for Africa? Africa's 22% of the world's land area is certainly not going to remain unexplored, if only because it contains – probably – 22% of the resources that the world needs. And the world's needs will increase as development in China and India (for example) takes off in a globalised world. What needs to be ensured is that the *people* of Africa get their share of the resulting revenue so that, 50 years from now, they have the basic infrastructure to ensure a standard of living that compares more favourably with the rest of the world. Putting aside the politics and the economics for a while, what can earth science contribute to this?

If the development of Africa's resources is more-or-less inevitable, the strategy, as I see it, should be to ensure a maximum of African involvement in the process. Without this we head towards a new style of economic colonialisation that is not so different from what Rhodes would recognize over a hundred years ago. The globalised world does not need *African* scientists and engineers – it can get such specialists from wherever in the world they cost least. But ***Africa*** needs African scientists and engineers to play their role in this future scenario. How else can a country secure its rightful place at the negotiating table when these exploration and resource development projects are being planned? So it is exactly here that I would place ITC's role in the earth sciences – helping provide Africa with a robust geoscience infrastructure that includes well-trained indigenous specialists. And is it here that I would also hope that the Netherlands aid policy should encourage investment. Making opportunities for intelligent, dynamic young people to see a future in their own countries is clearly an objective that will, eventually, solve many global problems. And Dutch generosity in offering opportunities to students is one that is matched by too few other countries in the western world.

What to do next?

I hope I have stressed sufficiently the need to upgrade the geoscience infrastructure of Africa, and I am sure that this path will gradually be taken up. But now I want to say something about my optimism for GIS applications as a catalyst for this.

It is clear to me that, even with good progress, African geoscience data coverages will not be complete for years to come. In fact, it is probably logical to think that coverages will *never* be complete. It seems axiomatic in every earth science project that the data are always short of the ideal one would wish for. But earth scientists are familiar with the problem of 'playing with less than a full deck'. And earth scientists can come to profound new understanding of the geology of an area with less than a full data set. 'Discovery consists of seeing what everyone else has seen and thinking what no-one else has thought' (Albert Szent-Gyorgi). This is the power of science to make general conclusions – or at least working hypotheses – without first making every conceivable experiment. That is why I think it is very important to mobilise the resources of GIS to assemble what we already know of the geology of the whole of Africa. In this way scientists can use this information to try and understand the processes at work and ask the right questions. Only then can the next costly acquisition of data be targeted on the key areas where the model can be tested most effectively.

But we must work at a continental scale. This cannot be done without proper integration of geological, geophysical and other data from many diverse sources (Figure 6). There are, for example, more than 50 national geological surveys in Africa. It is here particularly that I see GIS as a new tool that can function as a scientific work-bench to assemble and understand better (and *distribute*) what we already know and so bring new knowledge and understanding to African geology. Not least, we should use GIS as a method of teaching, what we know and don't know of earth science, to a new generation of African scientists – not to mention educating a new generation of manager-sceptics who may replace the past two

generations whose legacy is mostly in reduced funding and perpetuation of geo-ignorance in Africa (Reeves, 2001, 2002).

One of my proudest achievements at ITC was the *Gondwana* project which attempted part of this understanding process for the southern continents, starting in 1995. The flagship of this work is the website animation that has now been seen by over 250 000 visitors and been adopted in universities and schools around the world as part of their teaching resources (kartoweb.itc.nl/gondwana).

There is a new initiative in South Africa to promote geophysical education and research in Africa called AfricaArray. I have been honoured by an invitation to take up a small part in this activity, the emphasis being on creating a network – both of geophysical instrumentation and of educational resources – across a large part of the continent that, I am sure, embraces opportunities for much of what I have been talking about today.

On the global scene, the magnetic anomaly map of the world has yet to be drawn, though much of the data necessary to do so already exists. I am flattered to be part of the IAGA team that is charged with carrying this out.

There is a great deal to do. And, as I warned in my inaugural address over twenty years ago, we should not be distracted into doing something else simply because it is easier.

In summary

While humanitarian aid and direct poverty alleviation will remain necessary for some years to come, responsible development of Africa's oil, gas and mineral resources over the coming fifty years could play an important part in bankrolling development of a social infrastructure, commensurate with the need to generate higher standards of living among its people. Oxfam estimates that ***an increase of just 1% in Africa's share of world exports would be equivalent to five times the value of all present aid contributions.***

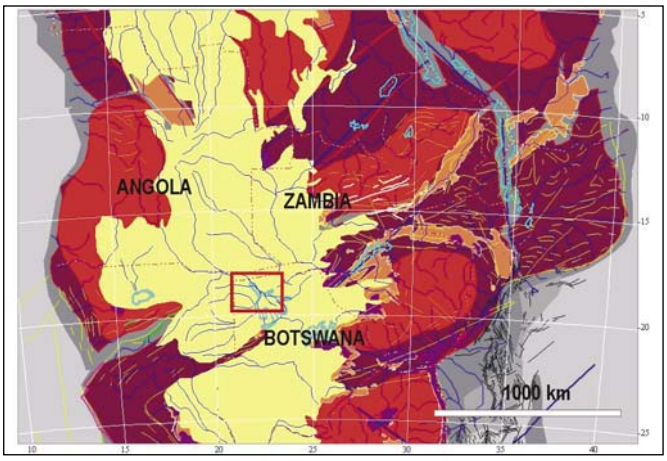

Fig. 6. An interpretation of the crustal elements of central southern Africa from gravity and magnetic data. The sand cover of the Kalahari-Congo basin (yellow) has been re-imposed for effect and the detail area of NW Botswana shown in Fig. 4 is indicated as a red rectangle.

This scenario encompasses the need for resources, the ability to pay for them in the rest of the world and Africa's ability to supply the goods.

Success in terms of Africa's part of the deal will depend on its responsible participation in these events at all levels, including with professional and scientific expertise to represent the positions and interests of the countries involved.

In terms of earth science, the globalised world does not need African earth scientists, but Africa *does,* if it is to maintain this involvement and build – preferably ahead of time – the geoscience data infrastructure that is presently in such poor shape.

The database is needed not only for resource development but also for groundwater and environmental applications.

So, I am returning to a world that I am familiar with where I hope I can still make a useful contribution. But it fills me with sadness that I have somehow failed to bring ITC round to thinking about Africa and the world the way I have described them today. I extend my thanks to all those who supported the Exploration Geophysics programme in ITC over almost 40 years and offer my best wishes to all those ITC alumni who are making a career out of applying what they learnt. I am proud to have been part of your efforts.

References

Barritt, S. D., 1993, The African Magnetic Mapping Project: ITC Journal (Special Issue), 1993-2, 11-199.

Blair, A., 2005, A Year of Huge Challenges: The Economist, 1 January 2005.

Cooper, R., 2004, The Breaking of Nations – order and chaos in the twenty-first century: Atlantic Books.

KNAW, 2005, Fossil Fuels: Reserves and Alternatives – A Scientific Approach. Royal Netherlands Academy of Arts and Sciences, Amsterdam, 2005, 82 pp.

Reedman, A. J., Calow, R. C., and C. Mortimer, 1998, Geological Surveys in Developing Countries: Strategies for Assistance: British Geological Survey Technical Report WC/96/20.

Reeves, C. V., 1984, A crust for exploration, a loaf for development: ITC Journal 1984-3, 171-176.

Reeves, C.V., 2001, 2001 – An Earth Odyssey. KNGMG *Nieuwsbrief*, March 2001, 10-11.

Reeves, C. V., 2002, Geophysical Mapping and International Development, *Preview*, **101**, 22-25.

Scholz, C., 1997, Fieldwork: a geologist's memoir of the Kalahari: Princeton University Press.

The Economist, 2004, Making Poverty History, December 18, 2004, 13.

Young, B. A., 1966, Bechuanaland: Her Majesty's Stationery Office.

The "RAVE" plot: Amplitude vs Depth Cross Plots

By Mick Micenko

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This article provides more information on creating and using the amplitude vs. depth cross plot as shown in the award winning paper at the recent APPEA Conference in Perth (Figure 1).

The cross plot (affectionately named a RAVE plot after the Landmark software package used to create it) is a useful tool in analysing seismic amplitude anomalies and is produced by cross plotting the seismic amplitude of a reservoir horizon against depth to that horizon. Other seismic attributes could be used but in this example amplitude is used because it is believed to be related, at least partly, to hydrocarbon content.

The seismic amplitude map (Figure 2) shows an amplitude anomaly of varying strength which is conformable with structure – the edge of the anomaly is roughly parallel to the depth contours. Structural conformance of amplitude is an indicator of hydrocarbons because an oil-water or gas-oil contact should intersect the top of the reservoir at the same depth across a structure.

The amplitude-depth cross plot can give an indication of the quality of the structural conformance, and the depths to contacts between fluid types can be interpreted at step changes in the amplitude distribution. These step changes are expected because simple modelling of the seismic response in this area has shown that distinct amplitude populations are expected for gas, oil and water filled sandstones. Obviously, if modelling showed no differences between fluid or lithology types then this technique would not work!

In this case the gas-oil contact was predicted only 5 m shallow and the oil-water contact was prognosed correctly.

Reference

Scibiorski, J., Micenko, M., and Lockhart D., 2005, Recent discoveries in the Pyrenees Member, Exmouth sub-basin: A new oil play fairway: APPEA Journal, **45,** 233-251.

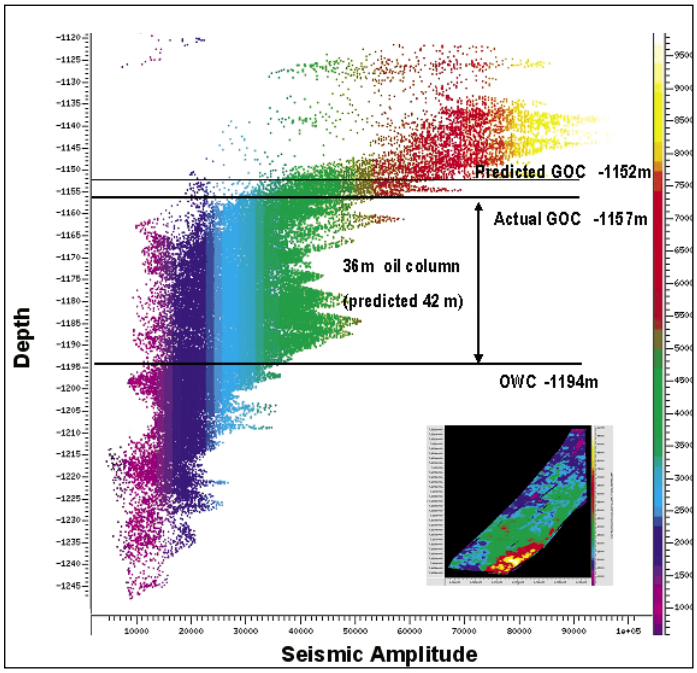


Fig. 1. Cross plot of seismic amplitude of the top reservoir horizon vs depth to the seismic horizon. In this example step changes in amplitude distribution were interpreted to occur at the depths associated with the oil-water and gas-oil contacts in the reservoir. These depths were subsequently confirmed by drilling.

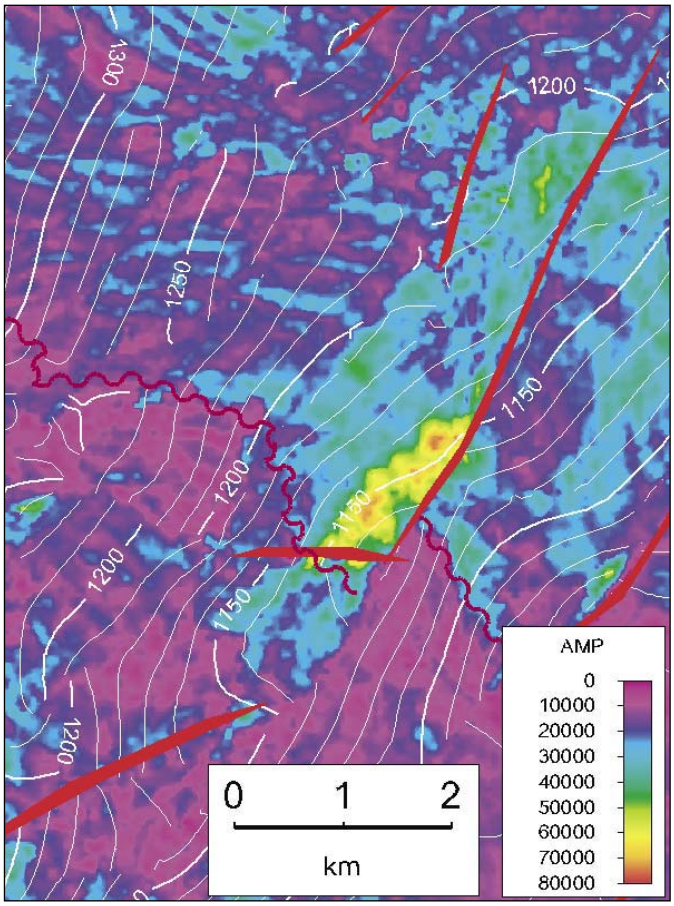


Fig. 2. Prospect map of the top reservoir showing seismic amplitude in colour and depth contour overlay. Changes in amplitude show some conformance to structure suggesting a hydrocarbon fill. The RAVE plot of Figure 1 can give a more accurate depth prediction of fluid contacts (wobbly brown line is approximate limit of a good reservoir).

Geoscience Australia

Major calibration program for Australian gravity stations

A10 Absolute Gravity Measurements at Fundamental Gravity Base Stations

Geoscience Australia is continuing its program of conducting absolute gravity measurements at selected Fundamental Gravity Base Stations. Thirteen base stations will be occupied during June 2005 to add to the 48 stations that were occupied during 2003 and 2004. The locations of these base stations are shown in Figure 1.

These measurements are being made with an A10 portable absolute gravimeter to determine the accuracy and precision of the current Australian Gravity Datum, Isogal84. Figure 2 shows the A10 set up at a Fundamental Gravity Base Station with the vertical gravity gradient being measured alongside using a LaCoste & Romberg model D gravimeter. The vertical gradient measurement is necessary to accurately transfer the gravity value from the sensor height of 76 cm to ground level.

Isogal84 is based on a network of some 900 stations established using relative gravimeters from the 1950's to the present. This network is tied to absolute gravity measurements made at Sydney, Hobart, Perth, Alice Springs and Darwin by a Soviet absolute gravimeter in 1979. The errors in this relative network have been distributed throughout by least squares adjustments of the network. The absolute measurements made by Geoscience Australia will indicate the magnitude and distribution of these errors and provide accuracy estimations for all of the Fundamental Gravity Base Stations.

For further information about these absolute gravity measurements, contact Ray Tracey: ray.tracey@ga.gov.au

FG5 - Second measurement of Precision Absolute Gravity Network

Geoscience Australia has contracted Micro-g Solutions Inc. from USA to measure absolute gravity on 8 sites forming a subset of the Australian Precision Absolute Gravity Network (Figure 3). The survey is planned to commence in mid-May using an FG5 absolute gravimeter which has an estimated measurement accuracy of 2 μGal. A two day measurement is planned at most sites with travel between remote sites by a small charter aircraft. The survey is anticipated to take about five weeks to complete.

Although absolute gravimeters do not need calibration or drift correction, two repeat measurements are planned to check that the FG5 gravimeter has been operating within specifications for the duration of the survey. Repeat measurements are planned at Sydney at commencement and completion of the survey and at Table Mountain Gravity Observatory near Boulder, Colorado USA before and after the instrument travels to Australia. Figure 4 shows the FG5 meter when it was operating in Australia during 2003

An initial measurement was made at the sites forming this network in June 2003. The sites forming this network were selected according to one or more of the following criteria:

- Co-located or near existing geodetic continuous measurement facilities (VLBI, SLR, DORIS or GPS).
- Co-located or near high precision Seaframe tide gauge sites.
- At or near Australian Fundamental Gravity Network (AFGN) stations.

A long-term time series of episodic absolute gravity measurements enables scientific studies on temporal change in gravity from geophysical and environmental induced deformation and mass redistribution in the earth system. These include:

- Vertical crustal motion known as post glacial isostatic rebound originating from reduced loading on the earth's crust following melting of polar region ice sheets.
- Vertical crustal motion originating from tectonic motion during an earthquake.
- Ground surface subsidence originating from removal of water from aquifers.
- Changes in gravity due to a change in mean sea-level.

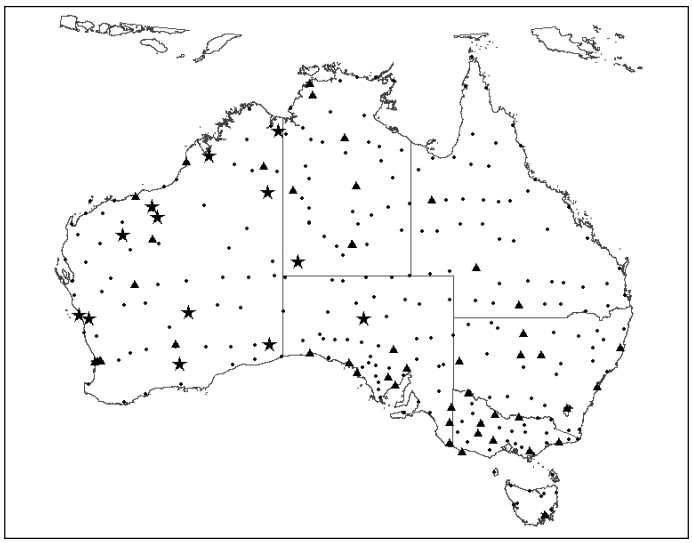


Fig. 1. Locations of Australian Fundamental Gravity Base Station (dots) showing absolute gravity stations occupied during 2003 and 2004 (triangles) and those occupied during 2005 (stars).

Fig. 2. The A10 portable absolute gravimeter set up at a Fundamental Gravity Base Station. The yellow device is the sensor and the trolley behind houses batteries, electronics, and computer interface for the instrument. It also serves to transport the complete system when it is not set up in a vehicle. The vertical gravity gradient is being measured alongside the A10 using a LaCoste & Romberg gravimeter.

- Tidal loading deformation on the Earth's crust. This phenomenon has 2 components. The first is the varying force of attraction on the earth by the orbiting sun and moon. The second is the variation in loading on the earth's crust from the changing ocean mass due to ocean tides.

These absolute gravity measurements collocated with other space geodetic measurement systems enable correlation of the gravity determined vertical movement with that determined by the space measurement techniques. The gravity determined movement is independent to the space measurement results and provides a means for checking and improving the spatial reference frame.

The Australian Precision Absolute Gravity Network will also contribute to the current Geoscience Australia analysis of the Australian Fundamental Gravity Network datum.

While in Canberra the FG5 absolute gravimeter will be deployed for a four day calibration measurement of the GWR superconducting gravimeter installed at Mount Stromlo. The superconducting gravimeter is owned by the National Astronomical Observatory of Japan and operated for them by the Australian National University's Research School of Earth Sciences.

Geoff Luton
Email: geoff.luton@ga.gov.au

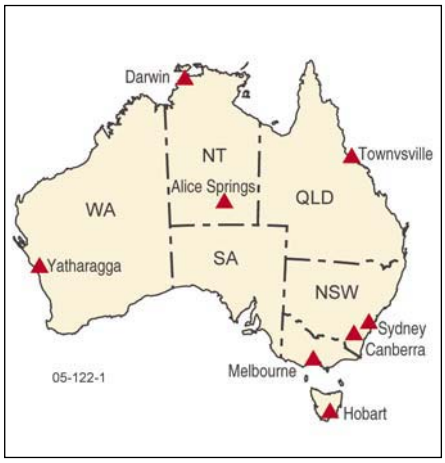


Fig. 3. Location of sites to be observed during the 2005 absolute gravity survey.

Fig. 4. FG5 gravimeter setup in shed at Dampier WA during June 2003 FG5 absolute gravity survey. John Peacock from Fugro Ground Geophysics is on the left. He assisted Kip Buxton from Micro-g Solutions on the right, during June 2003 FG5 absolute gravity survey.

Western Australian Geological Survey and Geoscience Australia

Time table for release of South Yilgarn data announced

GSWA and Geoscience Australia (GA) have announced the schedule for the release of airborne geophysical data from the South Yilgarn region of Western Australia (refer to associated figure and table for survey locations and specifications).

1. 'Individual block' packages consist of:
   - *New regional dataset:* Point-located magnetic, gamma-ray and elevation located data collected at a flying height of 60 m along lines spaced 400 m apart in surveys flown for GSWA and GA between September 2004 and April 2005. (Magnetic data sampling: 0.1 seconds, ~ 7 m; radiometric data sampling: 1.0 s, ~ 70 m; GPS navigation and flight path recovery information sampling: 1.0 s ~70 m).
   - *Existing company datasets*: Point-located magnetic, gamma-ray and, where available, elevation located data from pre-existing private company surveys, the rights to which have been acquired by GSWA and/or GA.
   - *Grided data*: Merged grids (80 m cell size) of data from the new survey flying and the pre-existing private company surveys.

9 May 2005	Block A: Boorabbin – Lake Johnston
	Block B: Kellerberrin – Southern Cross – Hyden
30 Jun 2005	Block C: Newdegate – Bremer Bay – Ravensthorpe Block
30 Sep 2005	Block D: West Kalgoorlie
30 Sep 2005	Block E: Nyabing

2. 'Integrated dataset' for Blocks A, B and C, consisting of:
   - Company data levelled with the 2004-05 government survey data to create a combined dataset giving a continuous coverage over all three blocks.

Geological Survey of Queensland and Geoscience Australia

Maryborough - Gympie Airborne Magnetic and Radiometric Survey

The Geological Survey of Queensland is conducting an extensive airborne magnetic and radiometric survey in the Maryborough region of Queensland.

UTS Geophysics has been engaged to acquire 51,000 line-km of magnetic and radiometric data over an area of approximately 18,600 square km in the Maryborough-Gympie region.

The new data will be acquired on east-west lines spaced 400 m apart with a ground clearance of 80 m above ground level. Geoscience Australia will be managing the flying program, which commenced in May 2005.

Data from the survey are expected to be released in October 2005.

For further details, contact David Searle by telephone on 07 3362 9357 or by Email at david.searle@nrm.qld.gov.au or Murray Richardson by telephone on 02 6249 9229 or by e-mail at murray.richardson@ga.gov.au.

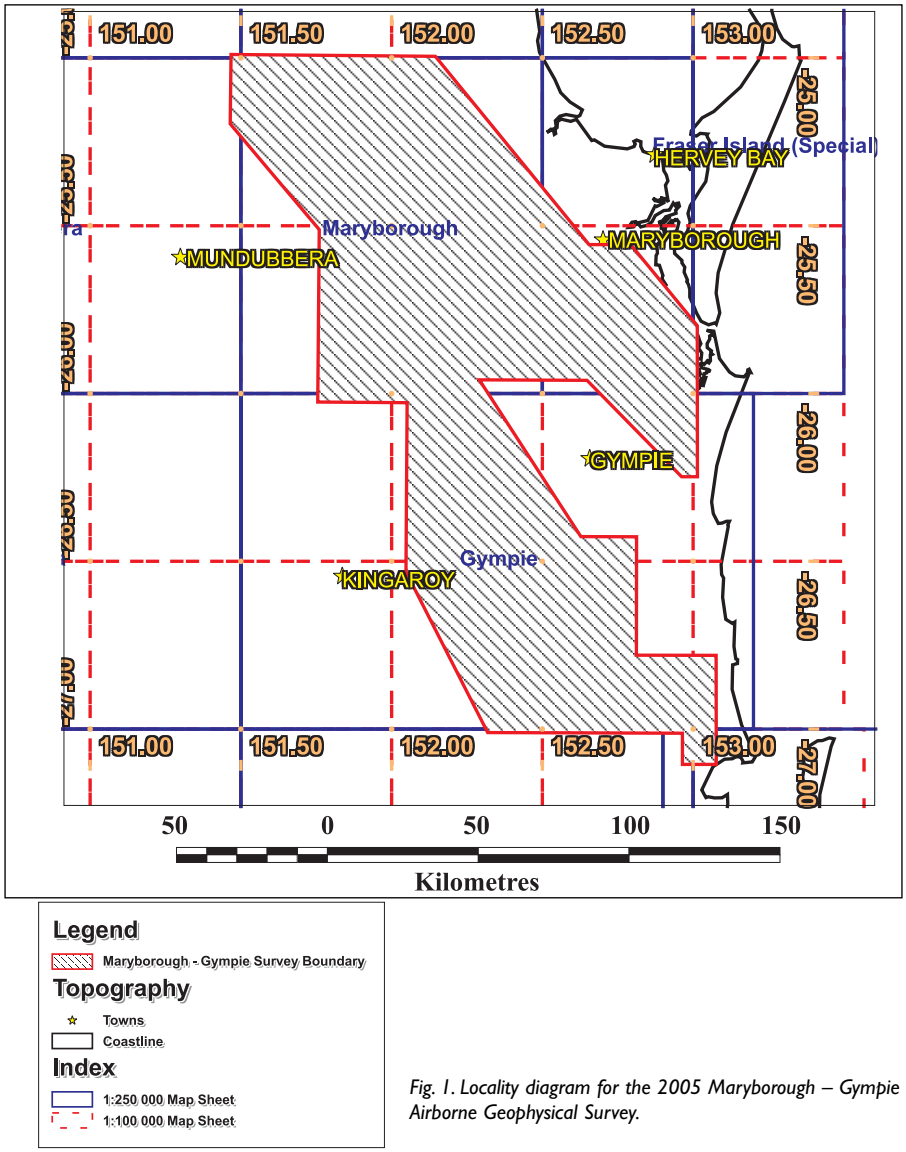


Fig. 1. Locality diagram for the 2005 Maryborough – Gympie Airborne Geophysical Survey.

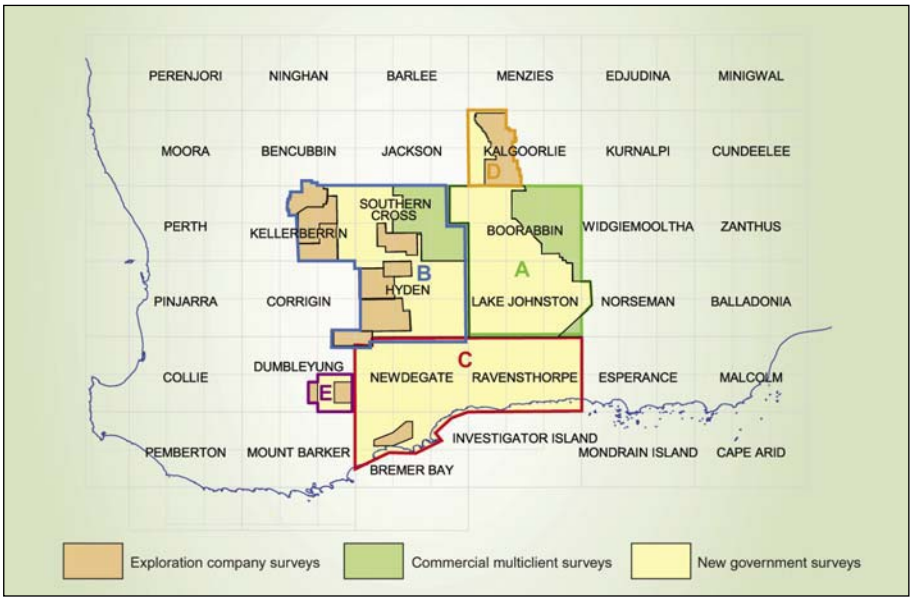
- Magnetic and radiometric grids (80 m cell size) made from the combined dataset.
- Total Magnetic Intensity and Ternary Radiometric Images (ecw formats) and maps (Adobe pdf files) of individual 1:250,000 sheet areas (whole sheets only) and entire area.

Anticipated Release date: 30 September 2005

These digital data (point located and grided) along with GA's entire geophysical database will be accessible for free download using the Geophysical Archive Data Delivery System (GADDS) available at www.geoscience.gov.au/gadds. CD- or DVD-ROMs of these data will also be available at a cost of A$99 (incl. GST; postage and packaging extra) from:

The Sales Centre, Geoscience Australia
Email: sales@ga.gov.au

For further details, contact David Howard by telephone on 08 9222 3331 or by email at david.howard@doir.wa.gov.au.



Location diagram for the South Yilgarn data sets.

SpectrumData to preserve WA government's petroleum archive

SpectrumData were awarded, in May 2005, a two year contract by the Western Australian Government to restore and migrate its vast archive of legacy seismic and petroleum data.

The project will be carried out on behalf of The WA Department of Industry and Resources. It will involve the remastering and migration of approximately 80,000 legacy tapes to high density 3590 media technology.

Due to the age of many of the data sets, it is expected that a significant proportion of the tapes will be suffering from damage or deterioration. SpectrumData plans to employ specialist data recovery techniques, and along with their wealth of experience in data recovery and data migration are confident they will achieve a better than 98% recovery rate.

During 2004, SpectrumData was awarded a 3 year multimillion dollar contract with the federal Government Department Geoscience Australia to provide similar data migration services. This contract was the largest of its kind ever awarded in Australia. SpectrumData also provide ongoing seismic data management services for several other State Governments, including the NSW Department of Primary Industries and the Victorian Department Natural Resources and Energy.

In addition, over the past quarter, Spectrum Data has successfully established long term contracts for the provision of seismic transcription, duplication, media conversion, recovery and archiving services with Woodside, Chevron Texaco, TGS-NOPEC Pty. Ltd., and Apache Energy.

It is expected that the old WA data sets will soon become available to potential explorers and encourage further petroleum exploration in that state.

New Acreage for Petroleum Exploration*

Twenty nine new offshore petroleum exploration areas were released at the annual APPEA conference in Perth on the 11th April 2005. These areas are off the Northern Territory, Western Australia, Ashmore and Cartier Islands and South Australia coastlines. The thirteen different regions (see Figure 1) include:

- Large frontier blocks in the Outer Exmouth Plateau, Bremer Sub-basin and the Otway Basin,
- Moderate to smaller blocks in the mist of large gas accumulations in the Northern Browse Basin and the Carnarvon Basin,
- Moderate sized blocks under various water depths, in the immature to sub-mature basins of the Northern Exmouth Plateau, the Barcoo Sub-basin, the Southern Exmouth Sub-basin and the Vlaming Basin and,
- Shallow water blocks over the Darwin Shelf and Londonderry High and Otway Basin.

The 2005 release includes five Designated Frontier Areas which are subject to the 150% frontier tax concession incentive announced in last year's budget.

The latest release of 29 areas adds to the 161 exploration permits already granted by the Australian Government. "Under these permits, petroleum exploration work worth more than $3.4 billion has been committed to," according to Ian Macfarlane the Minister for Industry, Tourism and Resources.

Bids for 15 of the 29 new areas will close on the 20th October 2005 and the remainder on the 20th of April 2006. All bids will be assessed under the work program bidding system and any subsequent exploration permits will be awarded for an initial term of six years.

Details of all the release areas including closing dates for bids can be found by requesting the release package at petroleum.exploration@industry.gov.au or at the Departmental website: www.industry.gov.au/petexp. More information can also be obtained from Geoscience Australia www.ga.gov.au

The Bremer Sub-basin is the first release resulting from the May 2003 budget decision to support Geoscience Australia's petroleum program with an additional $25 million over 4 years for seismic remastering and new data acquisition – in the quest for a new oil province.

* Information in this article provided by Geoscience Australia and the Department of Industry, Tourism and Resources.

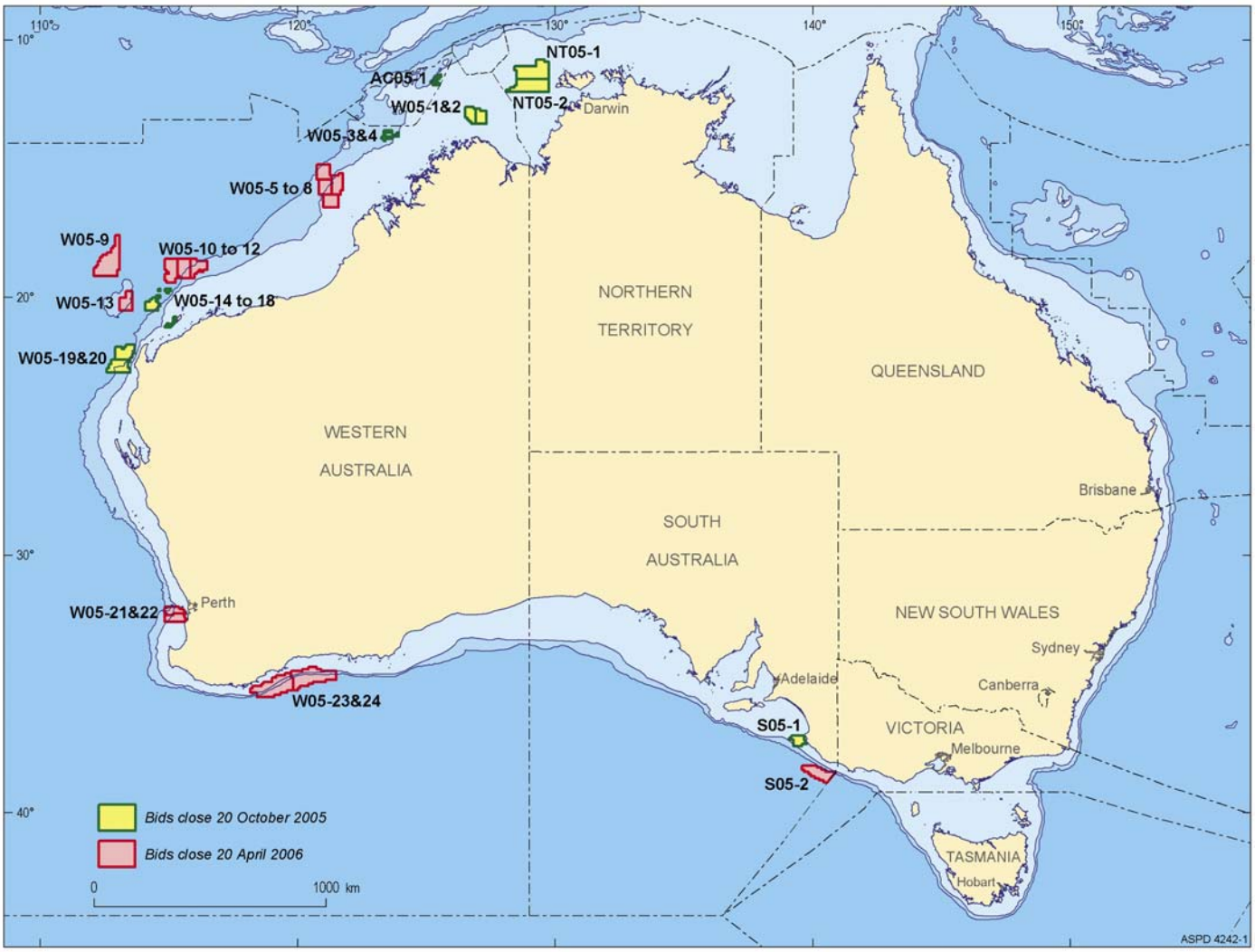


Fig. 1. Locations of new areas released for offshore petroleum exploration

The new 2D seismic was acquired and processed, under commercial contract, in November 2003, using the Veritas vessel the Pacific Sword. The data were released at the cost of transfer ($220 including GST), 5 months later at the 2005 Acreage Release at the Perth APPEA meeting in April. This is indeed a first showing Geoscience Australia's commitment to making pre-competitive data and information available to stimulate exploration interest in the SW basins.

Hot rocks the target in new geothermal exploration

Four companies have recently increased their exploration effort for hot rocks in South Australia.

Green Rock Energy Limited has now acquired (11 May 2005) the geothermal energy licences over a 2,700 km^2 area surrounding the Olympic Dam mine in South Australia.

The deal involved Green Rock (formerly Mokuti Mining) acquiring both Green Rock Energy Pty Ltd and Perilya Geothermal Energy Pty Ltd, which jointly owned the geothermal energy licences. This acquisition also includes a new 498 km^2 licence that has been granted since shareholders approved the acquisitions in March 2005.

The plan is to test drill the immediate vicinity to the Olympic Dam mine where information from drill holes and underground data indicate that the rocks are anomalously hot at depth.

"When this data is coupled with seismic lines shot over the licences, we are able to map a substantial body of granitic rock that is interpreted to relate to the heat anomaly", said Green Rock managing director, Adrian Larking.

Mr Larking said the next step was to drill a number of cored holes in the licences down to 2 km in depth. Based on existing information, Green Rock expects the first geothermal energy well to be drilled in 2006 to about 5 km in depth.

The Olympic Dam mine is potentially a local market for electricity generated from Green Rock's geothermal project. Another potential

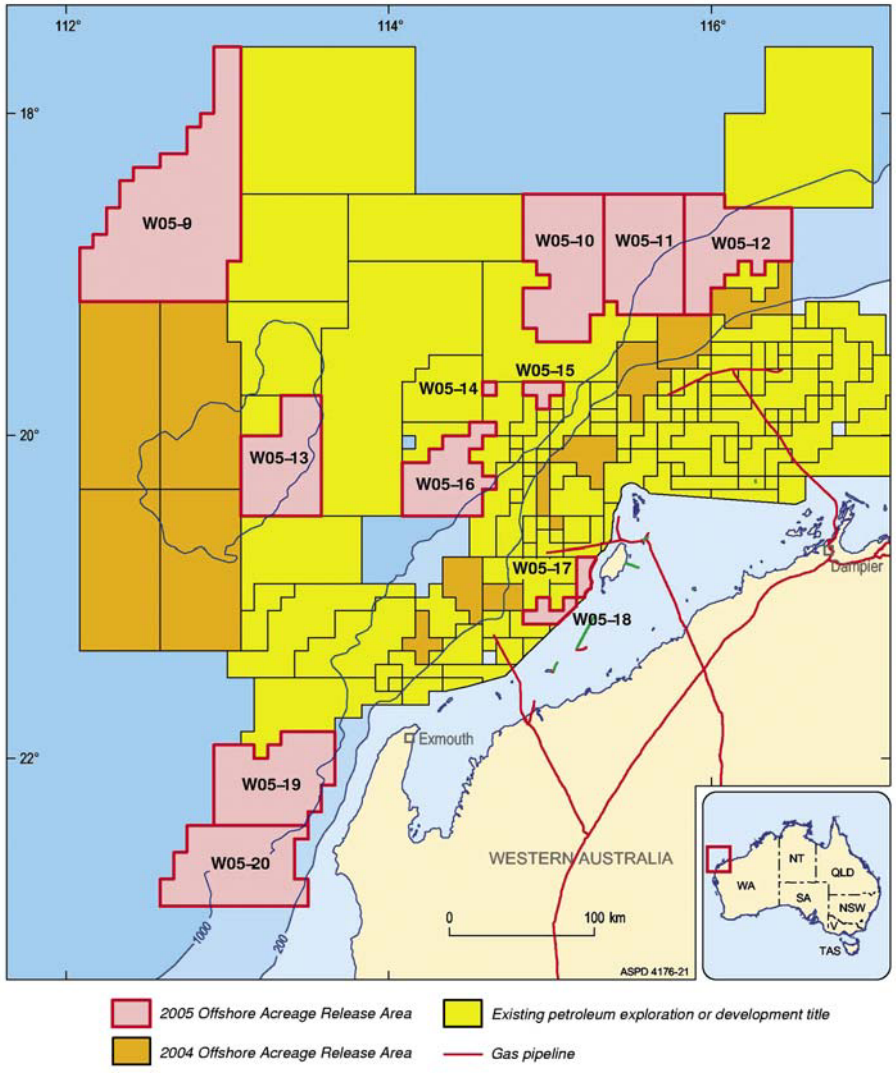


Fig. 2. Lease map showing areas currently held and available for bidding during 2005 in an area off the west coast of WA.

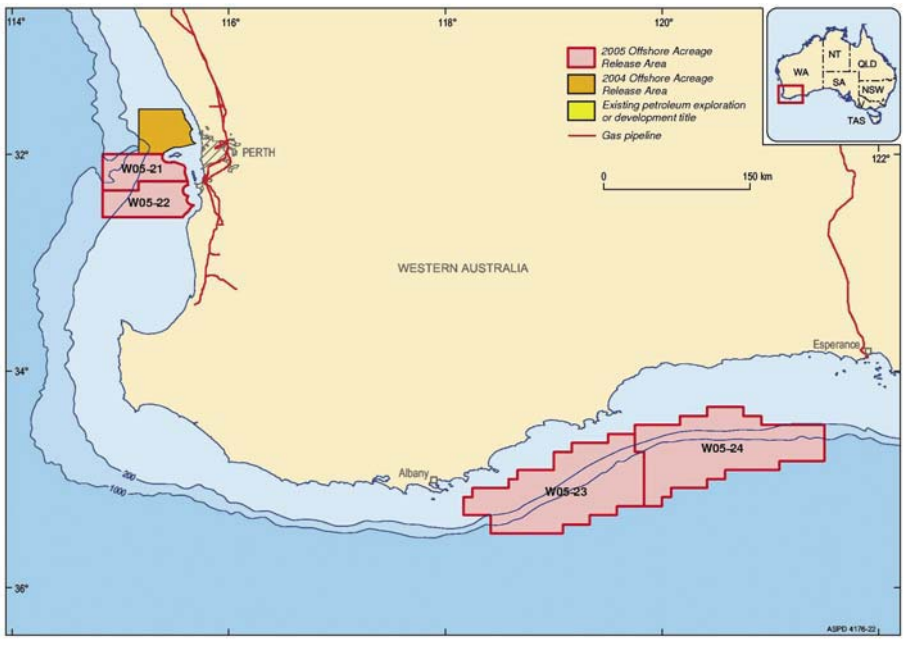


Fig. 3. Details of the frontier areas available for bidding during 2005 in Bremer and Perth Basins in offshore WA.

market is the eastern states power grid. A major 275 kV electricity transmission line connecting Olympic Dam to the grid passes directly through the licences.

Meanwhile, **Geodynamics** has announced that it had completed a placement of 3.2 million shares, at $1.55 per share, in an effort to raise $5 million.

The funds raised from this placement will be used to prepare for the start of Stage Two of the Cooper Basin geothermal project.

Since Geodynamics became a publicly listed company some two and a half years ago, it has made excellent progress in its quest to unleash the economic potential, of extracting heat from a known geothermal resource in the Cooper Basin for the generation of zero emission, base load electricity (see Preview February 2005).

The third major hot rocks explorer in the news is ***Havilah Resources NL***, which is adding geothermal energy projects to its minerals exploration push.

It has made an application for three hot rock blocks, contiguous to its existing geothermal exploration licence in South Australia's Lake Frome area.

"On this basis, we are planning to proceed with a geothermal exploration program over the next 12 months, leading to drilling," Havilah Chairman, Dr Bob Johnson, said.

"We now hold a substantial ground position south of Lake Frome over an area of buried granite that we believe has potential for the discovery of geothermal energy," Dr Johnson said.

"Based on published geophysical data and the known geological setting, two key ingredients for a "hot rock" geothermal energy source appear to be present in our acreage, a large granite body with elevated levels of radioactive elements, a true "hot" granite, and suitable depths of burial beneath an insulating blanket of sedimentary rocks.

"The granite concerned is a large, composite body, phases of which are abnormally radiogenic and host to numerous historic uranium occurrences in the Olary Ranges. This granite is interpreted to extend northwards from the outcropping areas for at least 70 km in the subsurface.

Dr Johnson said it was proposed to explore the GELs in a special purpose vehicle so as not to detract from Havilah's encouraging copper-gold exploration programs.

Preliminary work would involve gravity surveying to build a better picture of the basement geology, with the objective of determining the best geothermal target zones. This would be followed by deep drilling in order to obtain reliable heat flow measurements, which are sparse in this area.

The fourth company in the hot rock news is **Petratherm** which has just received a $140,000 South Australian Government "Plan For Accelerating Exploration" (PACE) grant to support the drilling of its geothermal evaluation well at Callabonna.

Petratherm has said that drilling of the Callabonna target will begin in June. The well, to be called Yerila-1, is named after the granite of the same name which outcrops just 40 km southwest of the drilling site and is one of the highest heat producing granites known.

Yerila-1, to be drilled to approximately 1 km depth, will pass through the artesian aquifer modelled at 620 m, and then penetrate into the interpreted Cooper Basin equivalent strata below. Data collected from the well will enable Petratherm to calculate inherent stress characteristics and a temperature gradient profile, as part of the hot rock evaluation process.

BHP Billiton finally consumes WMC

On Friday 3 June BHP Billiton announced it had acquired 76.25 percent of WMC, following its $9.2 billion takeover bid. By Monday 6 June, it appointed BHP Billiton Executive Director Mike Salamon as WMC Chairman following the retirement of Tommie Bergman. As well as Mr Bergman, six other WMC directors, including CEO Andrew Michelmore, have retired from the WMC Board and been replaced by three new directors, nominated by majority shareholder BHP Billiton.

These actions mark the end of WMC resources, which was formed by W S Robinson in 1933 to explore for and develop gold mines in Western Australia. It has had a proud history of research and innovation. As early as 1934 it undertook an aerial survey of the Eastern Goldfields in WA and engaged a group of Harvard geologists to examine several prospects. It made its first profit, of $26,490 in 1937.

However, perhaps its greatest success was the discovery of copper at Olympic Dam in 1975, as a result of a very deep drilling program and some inspiring geophysical analyses of where to look for attractive targets.

In December 2002 WMC was split up into WMC Resources and Alumina, and it did not take long before the takeover maneuverings started.

Incoming Chairman Mike Salamon said that BHP Billiton would continue to pursue complete ownership of WMC with its $7.85 cash per share offer which has been extended to 17 June.

How the takeover will affect WMC's exploration program is not yet clear, but judging by press reports, as few as 1 in 15 of the white collar workers will be retained.

In way, a very sad day for a great Australian icon, but part of a relentless trend over the last few years, to consolidate the number of players in the global resource sector.

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Dominion expects doubled resources at Challenger

Dominion Mining Limited says it expects to more than double its current indicated and inferred resource at the Challenger gold project to between 800,000 and one million ounces of gold.

Addressing the "2005 South Australian Resources & Energy Investment Conference" in Adelaide, Dominion Managing Director, Peter Alexander, said the target was part of a very clear strategy to increase mineable reserves at the mine – on South Australia's Gawler Craton.

He expects to produce 50,000 ounces of gold from Challenger for the full 2004-2005 year; following a production of 12,244 ounces for the first quarter of 2005 at a cash cost of A$398/oz, and more recently, the production rate has lifted to around 75,000 ounces per annum. This would be equivalent to 2.3 t of gold or about 3.5% of Australia's annual gold production

This rate coincides with the start in March this year of underground mining at Challenger, following completion of open pit operations.

The indicated and inferred resources at Challenger stand currently at 390,000 ounces but they want to develop this envelope to a more satisfactory longer-term outlook of an indicated and inferred resource of between 800,000 and one million ounces.

"Challenger will always be a small to medium size gold mine but our extension and infill drilling continues to generate high grades" said Mr Alexander.

Review by David Robinson

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Evolution and Dynamics of the Australian Plate

Edited by R. R. Hillis and R. D. Müller

Joint Publication of the Geological Society of Australia (Special Publication 22) and the Geological Society of America (Special Paper 372)

Copies can be purchased from the GSA website bookstore at http://www.gsa.org.au/

Price including Postage:
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A$100 for non-members within Australia
A$100 for members outside Australia;
A$120 for non-members outside Australia

"Evolution and Dynamics of the Australian Plate" is a collection of papers representing the state of science regarding the dynamics and evolution of Australia and its surrounding region. It was originally inspired by a session at the 15th Australian Geological Convention in Sydney 2000, from which 12 of the 27 papers are reproduced. This volume is a truly multi-disciplinary effort with contributions from a range of earth science disciplines. The latest geophysical, geological and geochemical data are used with new interpretative techniques and numerical modeling to demonstrate the state of the art in our understanding of the Australian Plate and highlight what we are yet to understand.

The editors begin the volume with a well constructed introduction that is enjoyable to read in its own right. It summarises the contents and sets the scene for the papers to come. This is followed by two manuscripts on the seismic structure of the lithosphere from tomography. Stress and strain is discussed in 6 papers, including research in GPS measurements of strain, stress field modelling, the Australian stress map, stress tensor inversions of Australian earthquakes and neotectonics in Southeastern Australia. Papers on crustal thickness, potential fields and the Carpentaria Anomaly follow. There are two papers discussing heat flow in the Australian continent, a manuscript on the structure of the lithosphere and a paper on plume related volcanism in Eastern Australia. These are followed by two manuscripts on the tectonic evolution of offshore basins, focusing on the North West Shelf, the Great Australian Bight and the Petrel Sub-basin, and two papers on the collisional processes of the Northern Margin. The following paper describes a collection of web-based datasets conveniently delivered by the Web Map Server Protocol. The volume concludes with six papers discussing the evolution of areas beyond Australia but within the Australian Plate.

"Evolution and Dynamics of the Australian Plate" is best suited to researchers and postgraduate students, however advanced undergraduate students may also find something of interest amongst the quality papers.

The volume also offers something to professionals in the petroleum or minerals sector who wish to stay abreast of current theories. Corporate sponsorship from Santos and Woodside ensure a high quality, yet economical publication with many colour figures.