Preview

Australian Society of Exploration Geophysicists

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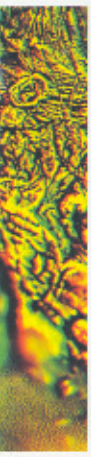

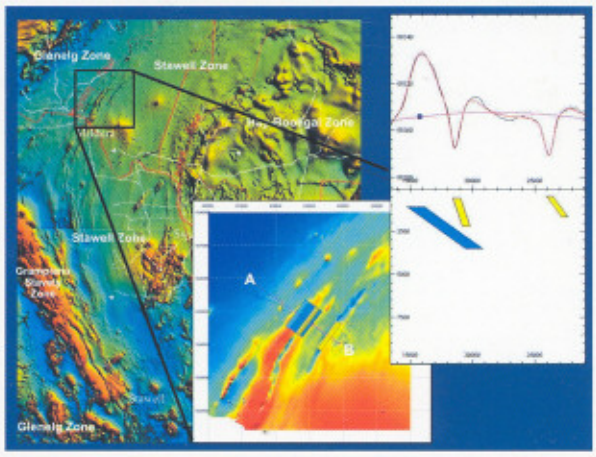

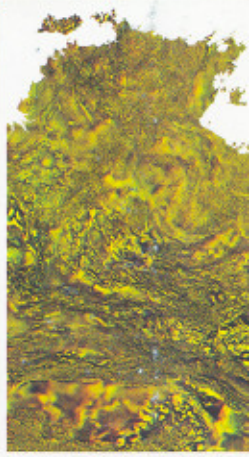

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Stern Report makes global impact

Economists to the fore

A few years ago politicians, economists and even scientists were arguing about whether global warming was a myth or a reality. How times have changed!

Today, main stream economists and most governments throughout the world recognise that global warming is happening. There is also considerable agreement that it is time to act now to limit the social and economic damage caused by humans adding billions of tonnes of CO2 to the atmosphere every year.

As Kofi Anna stated in his recent speech to the UN Climate Change Conference in Nairobi:

A few diehard sceptics continue to deny "global warming" is taking place and try to sow doubt. They should be seen for what they are: ***out of step, out of arguments and out of time****. In fact, the scientific consensus is becoming not only more complete, but also more alarming. Many scientists long known for their caution are now saying that global warming trends are perilously close to a point of no return.*

David Denham

One of the most significant impacts in this debate was the release in November this year of the ***Stern Review: The Economics of Climate Change***. This is a 580 page well reasoned, comprehensive report that cannot be swept under the carpet.

Politicians like Al Gore and scientists like Tim Flannery can easily be attacked by sceptics as being fringe dwellers. However, when the former chief economist of the World Bank, Sir Nicholas Stern of the United Kingdom, called climate change the greatest and widest-ranging market failure ever seen. Everyone has to take notice. He warned that climate change could shrink the global economy by 20 per cent, and cause economic and social disruption on a par with the two World Wars and the Great Depression.

To tackle this issue Stern called for:

- **Very strong reductions in carbon emissions** to reduce the risk of climate change.
- **Urgent action** as stocks of greenhouse gases are rapidly approaching dangerous levels and it will take time to develop technologies that deliver zero emissions at low cost.
- **Long term goals for stabilising greenhouse gases.**
- **Action to mitigate, innovate and** adapt to climate change.
- **Countries to agree on a broad set of mutual responsibilities** to contribute to reduce the risks of climate change.

- **International cooperation to include:**
  - **Emissions trading** – including cooperation to create carbon prices and markets
  - **Technology co-operation to develop low-carbon technologies**
  - **Action to reduce de-forestation around the world** (this contributes more to emissions than the transport sector).
  - **Help poor countries** adapt to the worst impacts of climate change.

In terms of implementing these actions the recent UN conference in Nairobi was not very successful. The greatest greenhouse gas generator, the US, with Australia following in its wake, still appears unwilling to cut greenhouse gas emissions. Not good.

Is the Sky Falling?

Mike Dogget from Queens University delivered a luncheon address at the SEG's New Orleans meeting in October this year that obtained considerable press coverage.

He discussed the problem of the ***Dwindling supply of talent*** in the Mineral Industry, with a focus on the North America.

He argued that the current mineral commodities boom has resulted in a tight supply of skilled workers, ranging from university educated geologists, geophysicists, engineers through to tradespeople and miners. Although there have been several boom and bust cycles in the past, the present boom is taking place within a workforce dominated by soon-to-be-retired employees. Hence the question: Is the sky about to fall in? Are we about to run out of skilled workers?

So what's different between there and here in Australia? Nothing it seems.

In North America, as in Australia, geoscience programs in tertiary institutions are generally small in comparison to other science disciplines and hence pressure is created from university administrations to maintain minimum enrolment levels. This has resulted in the closure of many geoscience programs, which have been forced to diversify away from core courses towards environmental, atmospheric and oceanographic curricula.

So we are left with very few students who have the skills needed in exploration industry.

So what's to be done? What does the nexus cohort want from a job?

Doggett quoted from Duxbury, 2004

They want fun, challenging, interesting, and exciting work with flexibility and balance. Money ranks seventh to tenth on their list. In fact, they will take a job with learning and development opportunities that pays less. Employees in this group do not want a boss: rather they want a coach, a mentor, someone who listens to their concerns.

They also do not want to be sacked at the next resources boom downturn.

So a major responsibility rests with the resource companies themselves. As Bill Gates put it:

You guys have it all wrong. In today's market I can buy any kind of technology, I can buy any kind of processing, any kind of equipment. In today's market, those things simply level the playing field. In today's market, the only thing that gives you your competitive advantage is the hearts and souls of your people, because that's the asset that can't be copied.

In other words: value your people! Food for thought.

ARC research grants cut for 2007

In this issue of Preview we comment on the new ARC grants awarded for 2007 and beyond. It is of concern that the Commonwealth funding dropped from $370 million in 2005 to $365 million in 2006. Furthermore the success rate has fallen from 24.5% to 20.4%. The net outcome from this is that because only 49 applications were deemed ineligible, there were 3,137 potentially solid, viable research proposals without any funding. Not a very satisfactory situation.

Seasons Greetings

This is the last issue of Preview for 2006, and I would like to take this opportunity to thank our contributors, readers, advertisers, sponsors and publisher for their support during the year.

I hope you all have a relaxing Christmas, and that the New Year brings prosperity and exciting challenges for us all.

Don't forget to enjoy the ***ASEG wines*** over Christmas and to register early for the ***Exploration and Beyond*** Convention in Perth in November 2007.

David Denham

SEG Annual Meeting

In early October, I was fortunate to be able to attend the SEG Annual Meeting in New Orleans on behalf of the ASEG. The meeting was a great success, with over 7000 delegates. In addition to the technical program, I was able to attend the Honours and Awards ceremony and the presidential address by outgoing president Terry Young. Koya Suto and I also attended the presidential reception for incoming president Leon Thomsen, whose term commenced at the end of the conference. ASEG and SEG also held a meeting of executives of both societies, attended on ASEG's behalf by Howard Golden, Kevin Dodds, Koya Suto and I (see Conference Section in this issue). The main topic of discussion was increased cooperation between SEG and ASEG.

Publications

ASEG's publications have been a major focus of the Federal Executive over the last few months. We have recently called for tenders for a 'one stop shop' for print and online publication of Exploration Geophysics and Preview, as well as provision of an online submission and review facility (or 'author gateway'). Tenderers are also required to actively seek accreditation of Exploration Geophysics by Thompson ISI, with the objective of obtaining accreditation within two years and achieving a journal Impact Factor greater than 1. This accreditation is extremely important to authors from universities and research organisations such as CSIRO. I am sure all members look forward to digital publication of Exploration Geophysics early in 2007. If all goes to plan, the complete back catalogue of Exploration Geophysics will be available online by the middle of the year.

A number of people from the Federal Executive and Secretariat have been involved in developing the tender documents, but I would like to particularly thank the chairman of the publications committee, Phil Schmidt, NSW Branch Acting President Glenn Wilson, whose enthusiasm has kept the ball rolling over the last couple of months, and our editors Lindsay Thomas and David Denham for their contributions.

Position vacant on Federal Executive – Technical Committee Chairman

The current chairman of the technical committee, John Hughes, has indicated that he would like to stand down from the position after several years' service. I would like to thank John for his very dedicated efforts as Chairman. The main responsibility of the Technical Committee is to provide local organisation for the SEG Distinguished Instructor Short Course (DISC), as well as ASEG technical presentations and continuing education courses. Anyone interested in taking over from John should contact me or their local Federal Executive representative.

James Reid

Conference News

ASEG recently supported the 8th International Symposium of the Japanese Society of Exploration Geophysicists (SEGJ), held in Osaka in late November. ASEG was represented by Derecke Palmer of the University of New South Wales, who was invited to give a presentation on refraction seismology at a special tutorial lecture session for young Southeast Asian Geophysicists. A report on the symposium will appear in a future edition of Preview.

I am pleased to announce that the ASEG will sponsor the upcoming International Conference on Airborne Electromagnetics, to be held in Finland in 2008. The last such conference was held by ASEG in Sydney in 1998. Details of the conference will be available shortly at http://geo.tkk.fi/AEM2008/.

James Reid

Business Insurance – what do I need?

With the current level of activity in the resources sector there is an increasing call for consultants to undertake work which was historically carried out by employees. One of the key considerations in setting up a business to provide consulting services is what insurance do I need to purchase.

ASEG has arranged through ACI Broking a facility for ASEG members to purchase professional indemnity insurance at preferential rates. Further details can be obtained by clicking on the following link: http://www.acibroking.com.au/quote/?dcid=12; or contacting ACI Broking Services to discuss your specific requirements either at info@acibroking.com.au or by phoning Neil Watson on 08 9427 0856

Business insurances can be divided into three categories:

- The "must have" policies
- The "recommended" policies; and
- The "nice to have" policies

"Must have" policies

When starting a consulting business ACI recommend that you consider the following as essential insurance requirements:

- **Public Liability**
  A public liability policy will protect you for amounts which you become legally liable to pay for personal injury to third parties or damage to third party property.
- **Professional Indemnity**
  Professional Indemnity insurance is designed to indemnify you for civil liability arising out of any claim for, breach of professional duty in the conduct of the business, or any act, error or omission.
- **Workers Compensation**
  Depending upon the state in which your business is based, you may be required to arrange a workers compensation policy.

"Recommended" policies

In addition to the "must have" policies there are a number of other policies which ACI recommends that you consider (depending upon your individual circumstances). These policies are:

- **Office/Business Package**
  A typical policy will include the following covers:
  Property, Business Interruption, Money, Glass, Liability, Employee Dishonesty, Machinery, Computer and Electronic Equipment, General Property and Taxation Investigations
- **Directors and Officers Liability**
  Private companies and their directors continue to face greater corporate governance and increasing regulatory surveillance of the management of their business activities.
  These policies provide protection not only for the assets of the individual directors and officers but cover is also extended to the company for defined exposures.
- **Corporate Travel**
  If in the course of your business you are likely to travel more than 100 km from your office on more than one or two ocassions you should consider taking out a Corporate Travel policy.
- **Life Insurance**
  Term Life Cover
  Total and Permanent Disability Cover
  Trauma Cover

"Nice to have" policies

While these are shown as "nice to have" in reality they may be a necessary part of your operations and should be considered in light of where and how you conduct your business.

- **Expatriate Health**
  If you work overseas for more than 6 months at any one time it is likely that a Corporate Travel policy will not provide cover for you.
- **Income Protection**
  Depending upon your status with regard to Workers Compensation insurance you should also consider appropriate income protection insurance.

ASEG well represented in New Orleans

The Society of Exploration Geophysicists showed their faith in the emergence of the hurricane-ravaged city of New Orleans Louisiana by staging the SEG International Exhibition and Seventy-sixth Annual Meeting at the New Orleans Convention Centre. Over 7,200 delegates attended to find the city centre mostly rebuilt and vibrant, although the residential neighbourhoods in the low-lying delta remain virtual ghost towns. Nevertheless, the mood at the meeting was upbeat, reflecting the booming resources industry worldwide.

The ASEG was represented at the SEG Council meeting by two voting members, Howard Golden and Kevin Dodds. James Reid and Koya Suto attended as observers. Much of the discussion at the meeting was centred on how efforts can increase to encourage Associate (non-voting) members to upgrade, if qualified, to Active (voting) membership. ASEG was also active in three meetings of the SEG Global Affairs Committee. At the Pacific/Asia regional meeting Chaired by Kevin Dodds, Koya Suto gave a brief overview of ASEG and promoted the 2007 Perth Conference. The SEG is actively planing to set up several Regional Offices throughout the world to better serve a membership that is now well over half from outside North America. Perth is high on the list of candidate cities, with other cities in the Region such as Delhi and Beijing possible office venues. A decision is expected in time to get SEG representatives on the ground by year's end.

Fig 1. Attendees after a special meeting between SEG and ASEG, held on Wednesday 4 October 2006 during the New Orleans SEG Convention.
From left to right we have Pamela Terechova, SEG liaison officer to the SEG Global Affairs Committee, Dave Pitcher, SEG Global Affairs Chairman (newly elected), Kevin Dodds, SEG Global Affairs Committee Asia/Pacific Representative, former ASEG President, Koya Suto, SEG Global Affairs Committee Australian Representative, ASEG International Affairs Chairman, Howard Golden, former ASEG President, ASEG Federal Executive, James Reid, ASEG President, Terry Young, SEG President (at the time of photo; he finished his term next day) Leon Thomsen, SEG President Elect (at the time of photo; he started his President term next day), Mary Fleming, SEG Executive Director and Peter Pangman, SEG's Director of Geophysics.

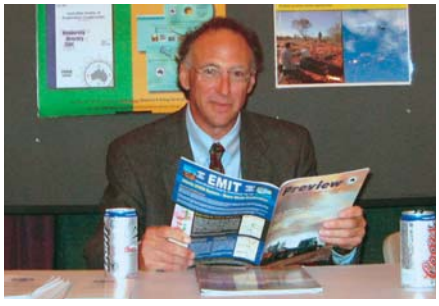

Fig. 2. Howard Golden catching up on his Preview with the help of a Coors.

Fig. 3. Koya Suto and James Reid with the President of the SEG Leon Thomsen and his wife Pat.

Figs 4 - 6 New Orleans in October 2006 – still experiencing the effects of hurricane Katrina.

Fig. 7. New Orleans, back to normal.

ASEG was also represented by a booth that displayed ASEG information, copies of Preview, and membership application forms. Senior ASEG officers met with their counterparts in SEG to discuss continued cooperation on such matters as journal publications, DISC speakers, Distinguished Lecturers, and addressing common issues such as the dearth of geophysics graduates. A sincere invitation was extended to SEG members to the upcoming ASEG Conference scheduled for next November in Perth.

Howard Golden

19th International Geophysical Conference and Exhibition, 18-22 November, 2007

The 2007 Conference in Perth joins the ASEG with PESA and is to be held for the first time at Perth's new Conference and Exhibition Centre in the city's central business district. The conference is being held during the 50th Anniversary of the International Geophysical Year, and as a result we are hoping to attract many more international speakers and delegates than normal. SEG and EAGE are associated with the conference as are the other local geophysical societies.

Advertising for the conference started at the last conference hand-over ceremony in Melbourne, with the showing of our conference movie-clip and the distribution of welcoming flyers. The song in the video was actually written for the International Geophysical Year by Donald Fagin, so is most appropriate as the conference tune. Arrangements have been made to show the clip and distribute flyers at the SEGJ in Kyoto (November) and EAGE Dubai conference (December).

To date we have already had an enthusiastic uptake of available exhibition booths. We have put a call out for Platinum sponsorship and our expectation is that the conference should be well supported by industry. The call for technical papers will be made in February, 2007.

We are expecting to run three streams during most of the conference. The conference will take the form of a Conference Ice Breaker on Sunday night, technical sessions (and the Exhibition) on Monday, Tuesday, Wednesday, and finishing with the usual ASEG/PESA Golf Day on Thursday. Workshops and field trips will occur before and after the conference, details of which are yet to be resolved. A feature of the Tuesday will be an extra stream which will be operated by the Formation Evaluation Society of WA (FESWA), as well as the conference dinner that evening.

Co-Chaired by Brian Evans and Howard Golden, an impressive organising committee has been formed to cover the three areas of greatest geophysical interest: the oil & gas, minerals, and groundwater/environmental sectors. The Conference Organising Committee includes the following:

- Technical Papers: Andre Gerhardt (Oil & Gas), Kim Frankcombe (Minerals) and Greg Street (Groundwater/Environmental).
- Editor: Norm Uren
- Treasurer: Bill Peters
- Sponsorship/Exhibition: Brett Johnson, Megan Evans, Laurence Hansen, Mike McLerie and professional conference organizers Promaco. A subcommittee assists with the fine details, and includes Carina Simmat and Craig Annison.
- Workshops/Field Trips: Steve Pickering.
- PESA Representative: Cecilia D'Ercole

We look forward to seeing you at the conference, to continue the technology and networking development of **exploration & beyond**. See you there.

Brian Evans and Howard Golden, Co-Chairs ASEG 2007 Conference and Exhibition.

Recollections of Melbourne 2006

My name is Lachlan Brown, I am an honours student at the University of Tasmania, and my project involves a geophysical investigation of a tailings dam. I was one of the lucky recipients of the ASEG student scholarship to the 2006 Australian Earth Science Convention.

My attendance at this meeting was a rewarding and valuable experience. The most impressive aspect of the conference was the diversity of content covered. It was an event that brought people from industry and research backgrounds together in an environment that knowledge was shared freely. This gave me the opportunity to see what was happening around Australia in this time of rising metal prices. I was particularly interested in the lectures relating to new geophysical techniques, it is apparent that technological advancements will continue to shape how geophysical instruments are utilized. The program was well organized with presentations kept to time constraints which allowed insightful and relevant aspects of each talk to be shared without extreme detail. The conference dinner at the Crown Casino was exceptional and provided an ideal opportunity to meet people from various backgrounds and experiences.

I would like to thank the ASEG for the scholarship which enabled me to attend the conference and I am looking forward to the next one.

Calendar of Events 2007/2008

2007

25–30 March
3rd New Caledonia Nickel Conference
Le Meridien Noumea
http://www.informa.com.au/ni07
Including a review the global nickel industry and its markets

1–5 April
20th Environmental and Engineering Geophysical Society, Annual Meeting (SAGEEP 2007)
Marriott City Center, Denver, Colorado
Website: http://www.eegs.org/sageep/index.html
Email: john_nicholl@urscorp.com

15–18 April
2007 APPEA Conference & Exhibition
Adelaide Convention Centre, South Australia
Website: http://www.appea.com.au/Events/AppeaEvents.asp#2007
Contact: Julie Hood at jhood@appea.com.au.

21–25 May
American Geophysical Union Joint Assembly
Acapulco, Mexico
Website: http://www.agu.org/meetings/ja07/

2007

11–14 June
69th EAGE Conference & Exhibition incorporating SPE Europec 2007
Venue: ExCel London, UK
Website: http://www.eage.org/events/

15–18 August
2007 APPEA Conference & Exhibition
Adelaide Convention Centre, South Australia
Contact: Julie Hood, T 07 3802 2208 / jhood@appea.com.au www.appea.com.au/2007conference <file:///\\www.appea.com.au\2007conference>=20

9–12 September
5th Decennial International Conference on Mineral Exploration (Exploration 07)
Theme: Exploration in the new millennium. Exploration 07 will review the current state of the art in geophysics, geochemistry, remote sensing, data processing and integration.
Venue: Toronto, Canada
Website: www.exploration07.com

2007

23–28 September
SEG International Exposition & 77th Annual Meeting
Venue: San Antonio, Texas, U.S.
Contact: http://seg.org/meetings/calendar

18–22 November
ASEG's 19th International Conference and Exhibition
Perth, WA
Contacts: Brian Evans
Email: brian.evans@geophy.curtin.edu.au
http://www.promaco.com.au/2007/aseg
promaco@promaco.com.au

2008

6–9 April
2008 APPEA Conference & Exhibition
Perth Convention & Exhibition Centre
Contact: Julie Hood, T 07 3802 2208 / jhood@appea.com.au=20

20–25 July
Australian Earth Science Convention 2008
Held in conjunction with the Australian Institute of Geoscientists + GSA
Venue: Perth WA

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Email: julianna.toms@geophy.curtin.edu.au

New Members

The ASEG welcomes the following new members to the Society. Their membership was approved at the Federal Executive meetings held on 27 September and 25 October 2006.

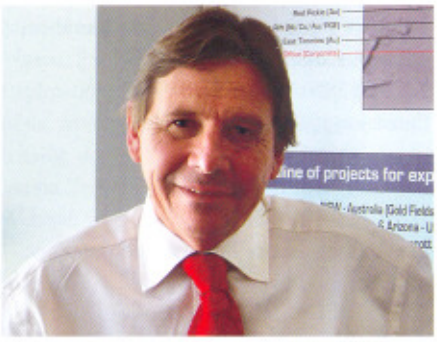
Name	Organisation	State
David Barrett	Finder Exploration Pty Ltd	Jamaica
Simon John Blake	Geoforce Pty Ltd	WA
Mohammad Lotfolah Hamedani	University of Adelaide	SA
Cameron Blair Jones	Finder Exploration Pty Ltd	WA
Odo Arne Larsen		WA
William Robert Lodwick	Fletchwick International Pty Ltd	Vic
Stephen Lynch		NSW

Name	Organisation	State
Grant Andrew Macpherson	Mosaic Oil	NSW
Gregory John Maude	Gem Geophysical Surveys	WA
Keith Blair McKenzie	Encom Technology Pty Ltd	NSW
Michael McLerie	Chevron Australia	WA
Sandra Ann Menpes	Wakelin Associates	Vic
Stephen Petrie	PIRSA Minerals	SA
Ockert Terblanche	Anglo American Exploration	Africa

Nick Archibald elected to FTSE

ASEG congratulates Nick Archibald on his election on 11 November as Fellow of The Australian Academy of Technological Sciences and Engineering (ATSE). Nick has been a member of the ASEG for several years and is CEO of Geoinformatics Exploration Inc and Director, Fractal Technologies Pty Ltd. He received his Fellowship for "his achievements as a geoscientist and entrepreneur, building several businesses with global reach and multinational partners."

As CEO of Fractal Graphics/Geoinformatics Exploration's, Nick has devoted considerable time to developing strategic collaborations with CSIRO's Division of Exploration, Mining and Mathematical Information Sciences. These collaborations have led to exiting new applications, such as potential field interpretation by FracWormer, and the



Nick Archibald

development of haptic workbench applications (FracBench) - now in the process of being commercialised.

This work has enabled Fractal Graphics/ Geoinformatics Exploration to participate in two highly successful cooperative research centres: the Australian Geodynamics CRC and the Advanced Computational Systems CRC. The company is participating in two new CRC applications: Predictive Mineral Discovery and Medical Engineering.

Nick remains, actively involved in the core business of Geoinformatics Exploration Ltd - namely conducting geoscience investigations using three dimensional computer visualisation, analysis and modelling.

Two other well known geoscientists were also elected as Fellows to the ATSE.

Bruce Hobbs, the former Chief Scientist in Western Australia – for his contribution in building the Australian mining industry's world-leading research capability and

Agu Kantsler, Director, Exploration and New Ventures, Woodside Energy Ltd – for his application of sophisticated exploration technology which has generated major hydrocarbon discoveries offshore in WA and Mauritania.

Congratulations to all three.

Western Australia — by Megan Evans

2006 has been a very busy year, check out our highlights:

8th February: Technical evening: Adam O'Neill (Seismic landstreamers and rapid Vs imaging) and Leif Larsen (Q - Our new revolutionary seismic system)

12th April: Technical evening: SEG distinguished lecturer Panos Kelamis - Land multiple elimination with emphasis on wave equation based techniques.

12th May: Workshop: Controlled Source Electromagnetics, Presenters: Niels Christensen, Ben Clennell, Kevin Dodds, Brett Harris and Andrew Lockwood. Go to the WA website to order your DVD copy of the workshop.

30th June: SEG DISC: Kurt Marfurt - Seismic attribute mapping of structure and stratigraphy.

21st July: Social Event: Xmas in July and wine tasting: check out our photos on the website.

27th September: Workshop: Advances in environmental geosciences: Presenters: Colin Pain, John Clarke, Kirsty Beckett, Greg Street, Brett Harris, Simon Abbott, Gabriella Pracillo, and Tristan Campbell.

11th & 18th October: Student Evenings: Honours students presented their research.

27th October: Social Event: PESA-ASEG Annual Golf Classic.

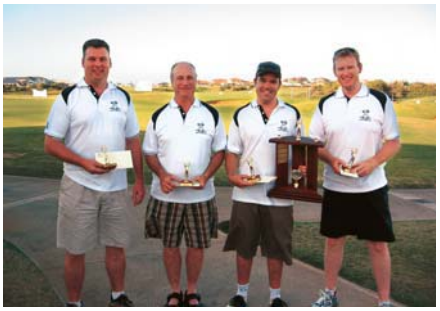
5th December: AGM/Social Event

Based on the success of these events we've already planned our calendar for 2007. Everyone please put these dates in your diaries:

14th February: Technical Evening

14th March: Social/Networking Event

16th April: SEG DISC: Biondo Biondi – Concepts and Applications in 3D Seismic Imaging.



The winners of the PESA-ASEG golf day. The team name was ENI Australia Igneous Noramus. The team members were Sean Breadsell, Brad Brown, Aaron Bond and Shane McGilligan.

Santa and party goers at the Christmas in July event.

9th May: Workshop:

13th June: Technical Evening

14th July: ASEG WA Gala Ball

8th August: Workshop

12th September: Technical meeting

10th October: Student Night

22nd November: Annual ASEG-PESA Golf Classic

12th December: AGM/Social/Networking Event

The WA Branch wishes to thank all persons involved in making 2006 such a successful year. We especially extend our gratitude to the many technical speakers and chair persons who volunteered their time and expertise at the workshops and technical evenings. Please feel free to contact a committee member if you wish to present at any of next years technical evenings or workshops.

Merry Xmas everyone!!!

South Australia — by Selina Donnelley

On September 14th, the SA Branch held the annual industry night. This year we decided to have a specific focus, and concentrated on the current hot industry, Geothermal Energy. We heard an introduction/overview from Tony Hill (PIRSA), then heard 4 interesting & engaging presentations from Peter Reid (Petratherm), Chris Giles (Havilah/ Geothermal Resources), Chris Mathews (Torrens Energy) and Terry Teoh (Pacific Hydro). The evening was a great success and was well received by the members who attended.

In October we were lucky enough to have a Schlumberger sponsored lunch at the Sebel Playford Hotel featuring Professor John Kaldi. John Kaldi is the Professor (Chair) Geosequestration at the University of Adelaide and Program Manager, CRC for Greenhouse Gas Technologies. John's presentation was entitled "Geosequestration of CO2: Using Proven Petroleum Industry Technologies to Reduce Greenhouse Gas Emissions to the Atmosphere". John gave an excellent talk covering many issues related to both emissions and sequestration of CO2. Many case & pilot studies from around Australia and the world were given to demonstrate the potentials for sequestration. Members enjoyed a particularly good lunch during John's talk and I suspect Schulmberger will be keen to sponsor another meeting next year!

On October 28th we joined with PESA in raising money for the Royal Flying Doctors association by holding a quiz night. The night was very well attended (almost 300 people) and hosted by Xavier Minniecon who managed to keep everyone entertained through the evening. It was a fun night and it was great to see so many geophysicists and families keen to raise money for such an important organisation.

November in Adelaide marks the annual Melbourne Cup Luncheon sponsored by Beach Petroleum. This year we decided to go for a more upmarket venue – the Adelaide Town Hall. We had equal numbers of members and non-members, which is great to see, and once the rules of the Calcutta

lunch were explained in detail, buying of tickets and then bidding for horses got along in earnest. Lunch was an excellent 3 course meal which was enjoyed by all. While there was not a lot of geophysical talk during the lunch, it was good to get out and socialise within the geophysical community.

We thank our sponsors for technical meetings in 2006: PIRSA, BHP, Santos, Cooper Energy, Australian School of Petroleum, Minotaur Resources, Petrosys, Zonge Engineering, Beach Petroleum, & Stuart Petroleum. We appreciated the continued support of the South Australian Meetings.

We welcome new members and interested persons to come along to our technical meetings, usually held on a Thursday night at the Historian Hotel at 5:30pm. Please contact Selina Donnelley (selina.donnelley@santos.com) for details.

New South Wales — by Glenn Wilson

The October meeting was arranged as the NSW students' night where the results of five Honours theses were presented; namely by Andrew Bray (*Geological and geophysical logging with a guided electromagnetic wave*), Glyn Jones (*Terrace structures in borehole radar data*), Scott Keenan (*3D rock mass modelling by geophysical methods*) and James Moran (*Igneous Intrusions in the Dendrobium Area, Southern Coalfield*) from The University of Sydney, and James Shadlow (*High resolution refraction statics computations in a hard rock environment*) from The University of New South Wales. The Branch rewarded each of the students with a $100 book voucher. The evening was generously sponsored by Coffey Geotechnics and their support is gratefully acknowledged.

In November, Julian Vrbancich of the Defence Science and Technology Organisation delivered a well received address on the state of the art AEM for bathymetry, using an example from Sydney Harbour. DSTO have been experimenting with AEM for predicting water depths where traditional LIDAR methods are unreliable. Julian covered advances in signal calibration, altimetry and motion tracking of the bird, as well as the inversion of AEM system parameters in addition to the layered earth model.

As this is the final Branch News for 2006, the NSW Committee would like to thank all presenters and members for their attendance at meetings throughout the year. The first Branch meeting in 2007 will be on Wednesday 21 February from 5:30 pm at The Rugby Club in the Sydney CBD, and include the Annual General Meeting and election of office bearers for 2007.

Christmas spirit on the web

After spending my entire life in a Canadian winter wonderland during the Christmas holidays, it is difficult to associate forty degree days with Santa Claus and warm eggnog. But in honour of the festive season, I thought it would be appropriate to explore what the internet has to offer in relation to maintaining our Christmas spirit.

NORAD Tracks Santa (www.noradsanta.org)

Since the tradition began in 1955, NORAD (North American Aerospace Defense Command) has kept track of Santa Claus' movements during the all-important night of Christmas Eve. By tracking the heat emanating from Rudolf's nose, NORAD has been able to maintain a vigilant record of exactly where in the world Santa is located using their missile satellite defense system. Since 1997, this program has expanded to the web. In 2005, the website received a billion hits with over 500 volunteers taking calls from 181 countries requesting the precise location of the man in the red suit. The website activates on November 17th and is well maintained with fantastic graphics and a child-friendly interface. It is a guaranteed method of increasing the excitement we all feel over the holidays.

NASA Tracks Santa (http://liftoff.msfc.nasa.gov/home/seasonal/SantaTrack.html)

NASA is also highly effective in monitoring the airspace activity on the 24th of December. The seasonably activated site follows Santa via a tracking monitor that is installed on his sleigh and is tied to NASA's North Pole Christmas Report System (NPCRS). NASA

engineers promise to run their surveillance via the Marshall Space Flight Center to the best of their capabilities to avoid website crashes. To keep up with the jolly old elf you will need a JAVA enabled browser to keep watch during this all important eve via the interactive map.

North Pole (http://www.northpole.com/)

This child-friendly site allows the user to enter the world which promotes the 'magic of Christmas' in Santa's Secret Village. The site offers many free activities such as stories, karaoke carols, recipes, games, puzzles and much more. Parents can create personalized Christmas stories which can make the children's experience more special. *Northpole.com* is a commercial banner-free, child-safe website designed to provide a family-oriented Christmas site for children and families to share together. The graphics are dynamic and the links are easy to follow.

Australian Christmas Carols (http://users.tpg.com.au/sharenet/c/drove.html)

Because of the unique weather situation Australia enjoys during this festive time of the year, it was necessary to 'modify' certain Christmas classics to enable kids Down Under a chance to better relate to what Christmas means to them. The *Christmas In Australia* website is a basic page with links to such classics as:

- Let us Barbeque
- The Three Drovers
- Aussie Jingle Bells
- Six White Boomers
- Bonzer Aussie Christmas
- Deck the sheds with bits of wattle
- Aussie 12 Days of Christmas
- The Traditional 12 days of Christmas

This site also includes other Australian traditions such as 'how to build an Australian snowman'. The topics are endearing, and although the page's graphics are extremely basic they are very effective.

Australia Post (http://www.auspost.com.au/EDP/0,1398,CH3484%257EMO19,00.html)

Australia Post receives over 100,000 letters addressed to Santa every year. This institution works in conjunction with Santa's elves to ensure children who write to Santa receive a reply. This website offers contact details for mailing your letters, special Santa mail letterhead which can be downloaded with Adobe Acrobat and a fun game for the kids titled 'Santa's day at the Beach'.

Emailing Santa (http://www.emailsanta.com/)

Though I am certain that Santa Claus would still prefer a traditional letter posted to him, the age of the internet has made it possible for kids to email Santa to explain their exemplary behaviour during the year. Most of these websites state that it is preferable that parents supervise the activity and many have posted certifications from children agencies stating they have been approved as a child-safe site. *Emailsanta.com* is a bit of quick fun for kids as they can pick their background, add a personal comment and simply fill in the necessary fields on the page. Once they have 'sent' their email to Santa, an automatic reply is generated including the information the user provided in the fields to personalize the reply.

I hope you enjoyed this bit of Christmas fun and the rest of 2006. Happy Holidays!

Uranium the flavour of the month in Canberra

Two key reports on Uranium were released recently.

Uranium Industry Framework Steering Group

On 15 November the report of the **Uranium Industry Framework Steering Group** chaired by John White of Global Renewables was released by Industry and Resources Minister Ian Macfarlane.

There were 17 other members on the committee representing industry, governments and lobby groups.

The Group's Vision was: ***A sustainable, safe, secure, socially and environmentally responsible uranium industry, making a growing contribution to Australia and the world's energy supply well into the 21st century and assisting in reduced global greenhouse gas emissions.***

So global warming and energy supplies were the two key issues.

The report recommends a two-year action plan for government and industry to remove impediments to the growth of Australia's uranium industry. The driver for the group was the rising demand for uranium as more countries making more use of nuclear power. With the spot price for uranium almost tripling over the last three years, the plan was to investigate what could be done to create valuable export opportunities.

As the Minister said "While Australia holds around 40 percent of the world's low cost uranium resources, we account for only 23 percent of the world's uranium production." So there should be plenty of scope to increase exports.

The Group report includes a total of 20 recommendations addressing the key themes of stewardship, competitiveness (including skills and transport), regulation, Indigenous engagement and land access, and communication.

Some of these recommendations include establishing a national uranium stewardship platform, initiating reforms to remove transport constraints in Australia and internationally, harmonising environmental and other regulatory arrangements, boosting the returns to Indigenous communities from uranium mining and, providing better public information on the uranium industry.

The full report can be accessed at: http://www.industry.gov.au/assets/documents/itrinternet/Uranium-I-F20061110152858.pdf

Uranium Mining, Processing and Nuclear Energy - opportunities

Then on 21 November the eagerly awaited draft report of the taskforce set up by the Prime Minister in June 2006 to examine **Uranium Mining, Processing and Nuclear Energy -opportunities for Australia** was released.

The taskforce was headed by Ziggy Switkowski, the former chief executive officer of Telstra, with support from: George Dracoulis Head of the Department of Nuclear Physics at the ANU; Warwick McKibbin Professor of Economics at the ANU, and a member of the Board of the Reserve Bank of Australia; Arthur Johnston who has been responsible for the supervision, on behalf of the Commonwealth Government, of the environmental regulatory regime for uranium mining in the Northern Territory; Martin Thomas, Chairman of Dulhunty Power Limited and Peter Johnston, Head of Physics at the School of Applied Sciences, RMIT.

The whole-of-government Secretariat to support the work of the Taskforce was headed by John Ryan. a Deputy Secretary from the Department of Industry, Tourism and Resources.

The task force estimated that Australia's demand for electricity will more than double before 2050. Over this period, more than two-thirds of existing electricity generation will need to be substantially upgraded or replaced and new capacity added. This additional capacity will need to be near-zero greenhouse gas emitting technology if Australia is just to keep greenhouse gas emissions at today's levels while maintaining good economic growth.

So that is the problem, and the solution through nuclear power is not easy.

The report concludes that "nuclear power would be between 20 and 50 per cent more costly to produce than coal or gas-fired power. With both nuclear power, and renewable energy sources, only becoming competitive in Australia in a system where the costs of greenhouse gas emissions are explicitly recognised." In other words with carbon taxes.

Private investment in the first-built nuclear reactors may require some form of government support or directive. The earliest that nuclear electricity could be delivered to the grid would be 10 years, with 15 years more probable. At the outset, the establishment of a single national regulator supported by an organisation with skilled staff is required

In one scenario, deployment of nuclear power starting in 2020 could see 25 reactors producing over a third of the nation's electricity by 2050. This is a position already surpassed by France, South Korea, Sweden, Belgium, Bulgaria and Hungary, among others.

Since the Chernobyl accident in 1986, the nuclear industry has developed new reactor designs which are safer, more efficient and produce lower volumes of radioactive waste, so the technical problems have been reduced.

However, the government is in a difficult position, it will not want to dump the coal industry and at present the thought of a carbon tax is an anathema.

There are also questions on where the nuclear power stations will be built, and with such a huge lead time we will need other options in the next 20 years to make a difference to our emission levels. There will also be a huge skills shortage in Australia if we are to build and commission nuclear power stations from scratch.

The draft report is well written and contains a huge amount of relevant information for anyone with an interest in the nuclear power industry. It can be accessed from:

http://www.dpmc.gov.au/umpner/reports.cfm

Government investment on R & D in 2004/05 drops by 4.3%

Research and Experimental Development expenditure in Australia by government and non-profit organizations in 2004/05 was $2,551 million, according to a report published by the Australian Bureau of Statistics in October 2006. (ABS 8109.0, 2004-05). This represented an increase of 2.8% in current price terms over 2002–03, but a decrease of 4.3% when adjusted for inflation.

Table 1 shows the trends over the last 8 years (this survey is only undertaken every second year). The level of spending has declined slightly over the period in terms of dollars invested in real terms. Notice that the trend for the States/Territories is very similar to that for the Commonwealth. However, the number of people involved has dropped significantly from 19,190 in 1996-97 to 16,989 in 2004-05.

		1996-97	1998-99	2000-01	2002-03	2004-05
Expenditure on R&D - current prices						
Commonwealth	$M	1 266.6	1 179.4	1 404.8	1 531.3	1 573.4
State/territory	$M	797.7	863.6	951.0	950.9	977.3
Total	$M	2 064.3	2 043.1	2 355.8	2 482.2	2 550.7
Expenditure on R&D –adjusted for inflation						
Commonwealth	$M	1 599.4	1 378.9	1 592.9	1 644.7	1 573.4
State/territory	$M	1 008.4	1 015.4	1 081.6	1 021.9	977.3
Total	$M	2 607.6	2 393.9	2 674.3	2 666.5	2 550.7
Human resources devoted to R&D						
Commonwealth	PYE[1]	10 377	9 353	9 565	10 185	9 335
State/territory	PYE	8 813	9 069	8 587	8 357	7 654
Total	**PYE**	**19 190**	**18 422**	**18 152**	**18 542**	**16 989**

Table 1. R&D investment by the Commonwealth and States and Territories

	2000-01	2001-02	2002-03	2003-04	2004-05
	%	%	%	%	%
Iceland	0.70	0.61	0.76	0.73	na
France	0.37	0.36	0.37	0.36	0.36
Korea	0.32	0.32	0.34	0.33	0.34
United States of America	0.28	0.31	0.32	0.33	0.33
Germany	0.33	0.34	0.34	0.34	0.33
Finland	0.36	0.35	0.36	0.34	0.33
New Zealand	na	0.37	na	0.33	na
Japan	0.30	0.29	0.30	0.29	0.30
Australia	0.34	na	0.32	na	0.29
Czech Republic	0.31	0.29	0.28	0.29	0.27
Hungary	0.21	0.24	0.33	0.30	0.26
Netherlands	0.23	0.25	0.24	0.25	0.26
Norway	na	0.23	0.26	0.26	0.25
Poland	0.21	0.20	0.26	0.23	0.23
Canada	0.22	0.22	0.22	0.20	0.21
United Kingdom	0.23	0.18	0.17	0.18	na
Total OECD[2]	**0.26**	**0.27**	**0.27**	**0.28**	**0.28**

Table 2. Investment by governments in R & D for selected OECD countries; the % numbers are Government/GDP ratios

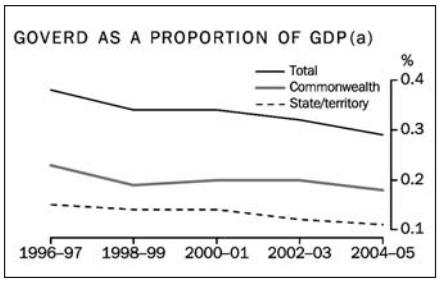


Fig. 1. Government R & D as a percentage of GDP. Note the steady decline since 1996.

Perhaps the most significant parameter is the percentage of GDP spent in the period. Figure 1 shows how this has declined during the period.

Comparing the Australian numbers with those from the OECD is instructive. Although Australia is still above the OECD average of 0.28% we have dropped from 4th ranked in the table (table 2) for 2000/02 to ninth in 2005/05. Fortunately the drop in government spending has been more than made up by the increase in industrial R & D which increased from 0.72% of GDP to 0.95% GDP during the same period (see Preview 124 October 2006).

There is still a lot of work to do.

Broadband uptake in Australia nearly doubles in one year

Broadband up is arguably one of the most significant parameters when assessing a country's intellectual resources.

The OECD recently released its survey of broadband uptake through to June 2006. These show that:

- Northern European countries have continued their advance with high broadband penetration rates. In June 2006, six countries (**Denmark, the Netherlands, Iceland, Korea, Switzerland and Finland**) led the OECD in broadband penetration, each with at least 25 subscribers per 100 inhabitants.

[1] People years

[2] This table only shows the top part of the original table. The average is taken from the complete OECD table.

- **Denmark** now leads the OECD with a broadband penetration rate of 29.3 subscribers per 100 inhabitants.
- The **strongest per-capita subscriber growth** comes from Denmark, Australia, Norway, the Netherlands, Finland, Luxembourg, Sweden and the United Kingdom. Each country added more than 6 subscribers per 100 inhabitants during the past year.
- The **United States** has the **largest total number of broadband subscribers** in the OECD at 57 million. US broadband subscribers now represent 36% of all broadband connections in the OECD, up from 31% in December 2005.
- **Canada continues to lead the G7** group of industrialized countries in broadband penetration.

The Australian increase is very good, as is shown in the table below. The numbers went up from 7.7 to 13.8 per hundred in one year. It is also interesting to note that in most countries the uptake appears to level out at about 25%.

	2001	2002	2003	2004	2005
Iceland	3.7	8.4	14.3	18.2	26.7
Korea	17.2	21.8	24.2	24.8	25.4
Netherlands	3.8	7.0	11.8	19.0	25.3
Denmark	4.4	8.2	13.0	19.0	25.0
Switzerland	2.0	5.6	10.1	17.5	23.1
Finland	1.3	5.5	9.5	14.9	22.5
Norway	1.9	4.2	8.0	14.8	21.9
Canada	8.9	12.1	15.1	17.6	21.0
Sweden	5.4	8.1	10.7	14.5	20.3
Belgium	4.4	8.7	11.7	15.5	18.3

	2001	2002	2003	2004	2005
Japan	2.2	6.1	10.7	15.0	17.6
United States	4.5	6.9	9.7	12.9	16.8
United Kingdom	0.6	2.3	5.4	10.5	15.9
France	1.0	2.8	5.9	10.5	15.2
Luxembourg	0.3	1.5	3.5	9.8	14.9
Austria	3.6	5.6	7.6	10.1	14.1
Australia	0.9	1.8	3.5	7.7	13.8
Germany	2.3	4.1	5.6	8.4	13.0
OECD	**2.9**	**4.9**	**7.3**	**10.2**	**13.6**
EU15	**1.6**	**3.4**	**5.9**	**9.7**	**14.2**

Table 3. Broadband subscribers per 100 inhabitants, 2001-2005

$365M for new ARC research projects – a $5M reduction over 2005 commitment

In October, Julie Bishop, the Minister for Education, Science and Training announced the outcomes of the Australian Research Council's National Competitive Grants Program for 2007. A total of than $365 million has been provided over the next five years to support 1,154 new research projects.

While the overall funding for ARC in 2007 will be a record $576 million, the funding for new grants has dropped. In 2005 $370 million was awarded to support 1214 projects, so the amount of new money has been significantly reduced in real terms.

In response to the announcement, Professor Kurt Lambeck, the President of the Australian Academy of Science, expressed:

"Grave concern for the future health and competitiveness of the nation's scientific research in the wake of the announcement of the latest Australian Research Council Discovery Project grants."

He pointed out that:
"Despite the fact that an overwhelming number were deemed suitable, only 20 per cent of the 4,033 applications eligible for the $365 million in grants on offer have been approved.

Only 49 applications were deemed ineligible, leaving 3,137 potentially solid, viable research proposals out in the cold."

The bulk of the money ($275 million) was allocated to 822 Discovery Projects, followed by $59 million for Linkage projects.

Discovery Grants harder to win

Discovery Projects aim to

- support excellent fundamental research by individuals and teams;
- enhance the scale and focus of research in the National Research Priorities;
- assist researchers to undertake their research in conditions most conducive to achieving best results;
- expand Australia's knowledge base and research capability;
- foster the international competitiveness of Australian research; and
- encourage research training in high-quality research environments.

	2004	2005	2006	2007
Applications received	3,260	3,441	3,766	4,047
Withdrawn	20	27	24	14
Applications funded	875	1,055	917	822
Average total grant size	$271,939	$282,030	$298,350	$334,267
Success Rate (%)	27.0	30.9	24.5	20.4
Requested funds over project life for approved proposals	$1160.6	$443.7	$496.1	$502.1
Total funding approved (million)	$238.0	$295.5	$273.6	$274.8
Average first year funding	$84,060	$94,340	$103,768	$105,019

Table 1. Discovery Project funding, 2004 through 2006

National Research Priority Area	Proposals received	Approved Proposals	Success rate (%)	Funds over project life for approved proposals ($M)
None selected	590	116	19.7	35.6
An Environmentally Sustainable Australia	624	130	20.8	42.8
Promoting and Maintaining Good Health	786	153	19.5	45.6
Frontier Technologies for Building and Transforming Australian Industries	1462	299	20.5	115.0
Safeguarding Australia	571	124	21.7	35.8
Total proposals	4033	822	20.4	274.8
Total priority proposals	3443	706	20.5	239.2
% within priority areas	85.4	85.9		87.1

Table 2. Numbers of proposals and success rates for Discovery Projects by National Research Priority

Table 1 summarises the funds provided for Discovery Projects in the last four years. Notice how the success rate has steadily declined.

National Research Priorities

The Australian Government has identified four National Research Priorities and, within these, 21 national research priority goals.

Within this round, 3,443 of the 4,033 *Discovery Projects* proposals considered were identified by their proponents as addressing a National Research Priority. This represents 85.4% of proposals considered. Of those 3,443 proposals, 706 (20.5%) were approved for funding, representing 85.9% of the total 822 proposals approved for funding.

The overall commitment for proposals addressing National Research Priorities is $239,200,892 (87.1% of the total funding).

The greatest amount of funding ($115,026,887) is for projects in the area of Frontier Technologies for Building and Transforming Australian Industries.

Notice how the success rate for the Priority Area projects (20.5%) is very similar to the project applications submitted in the Non-Priority areas (19.7%). Makes one wonder why we have priority areas for Discovery Grants.

Outcomes by Institution: – Sydney and ANU top the list

Seven tertiary institutions received funding of more than $10 million. These are all members of the Group of Eight Universities. The list is similar to the 2005 awards with Sydney University and The Australian National University topping the list. Queensland and the New South Wales Universities were the biggest movers in the success table; Queensland advanced from 5th to 3rd and NSW dropped from 3rd to 5th. As for last year the University of Adelaide was the only Go8 Member not to make the $10 million level (see Table 3).

In terms of spending power, the real funding has effectively been reduced as universities grapple with inflation, rising wages and other increased costs. Not a very encouraging picture. In this issue of Preview we are listing the geoscience related Discovery Grants. In February we will examine the ***Linkage*** and other awards.

Institution	Proposals considered	Proposals approved	Success rate (%)	Funding over life of project ($M)	2005 comparison ($)
Total	4,033	822	20.4	274.8	273.6
The University of Sydney	382	97	25.4	40.5	40.4
The Australian National University	312	100	32.1	35.1	36.2
The University of Queensland	320	91	28.4	35.0	26.1
The University of Melbourne	440	92	20.9	28.6	25.3
The University of New South Wales	363	79	21.8	24.4	26.3
Monash University	312	52	16.7	17.6	20.9
The University of Western Australia	153	37	24.2	13.2	14.1
The University of Adelaide	163	31	19	9.6	9.8

Table 3. Numbers of proposals and success rates for Discovery Projects for funding commencing in 2007, by Administering Institution:

Geoscience-related Discovery Grants

The successful geoscience related projects are listed below. Out of the 822 Discovery Grants awarded only 46 were grouped under the Earth Science heading and only four listed under the 'Geophysics' Sub-heading. Climate change is all the vogue and a large number of grants were awarded on this topic.

Sea-level change in the Australasian region during the past 6000 years: understanding the past to predict the future.

Researchers: K Lambeck, CD Woodroffe, J Zhao, SG Smithers, D Fabel and J Stone

Funding: **2007**: $128,000
2008: $137,000
2009: $96,000

Administering Institution:
The Australian National University

Project Summary: Interactions of climate, ice, oceans, and solid earth result in complex variations sea level in time and space. This proposal develops a predictive understanding of this change through an interdisciplinary integration of geophysical theory and geological observations. Focus is on the Australian area and on the present interglacial but the outcomes will be placed in a global frame. Outcomes will include estimates of rates and amplitudes of sea-level change, of changes in ice volume and of land movements from isostatic and tectonic causes. It also provides the framework necessary for separating natural change from anthropogenic change during the recent past and for predicting future regional and global sea-level change on a century time scale.

The bipolarity of Late Palaeozoic marine faunal distributions: origin, processes and implications for modern global marine biogeography

Researchers: GR Shi, AS Biakov, S Shen, J Tazawa, CM Henderson and K Ueno

Funding: **2007**: $60,000
2008: $60,000
2009: $50,000

Administering Institution:
Deakin University

Numerical modelling of deformation partitioning and its role in metamorphism, tectonism and mineralization

Researchers: TH Bell and BE Hobbs

Funding: **2007**: $68,000
2008: $73,000
2009: $38,000

Administering Institution:
James Cook University

Project Summary: Targeting blind mineralization is the biggest problem facing the Australian mining industry. The modelling developed in this project will integrate deformation, fluid and chemical processes and provide a means for understanding the deformation partitioning that localizes epigenetic ore regionally as well as along portions of large-scale structures. Applying this to known ore deposits may delineate adjacent plus regionally distributed zones where the deformation event responsible for mineralization is locally present at sufficient intensity to form ore. This would allow targeted deep drilling in ground with no ore close to the surface saving millions in drilling costs and dramatically increasing the financial viability of this industry.

Numerical modelling of coupled deformation, fluid flow and heat flow in modern and ancient rifts

Researchers: NH Oliver, BE Hobbs, SF Simmons, RH Sibson; T Baker and J Rowland

Funding: **2007**: $100,000
2008: $90,000
2009: $90,000

Administering Institution:
James Cook University

Project Summary: Computer modelling of geological processes is increasingly important to mineral and hydrocarbon exploration, to hazard prediction (e.g. earthquakes) and to plate tectonics. Because it is difficult to understand geological processes from ancient rocks, we will use new computer models to study fluid circulation in an active volcanic fault zone in New Zealand, where many of the parameters obscured in ancient rocks can be measured directly. We will determine processes of fluid migration that contributed to the formation of mineral deposits in ancient rocks, such as those mined in eastern Australia for gold. The project also has implications for discovery and development of energy resources including fossil fuels and geothermal waters.

Earth's Internal System: deep processes and crustal consequences

Researchers: SY O'Reilly, WL Griffin, NJ Pearson, O Alard, K Regenauer-Lieb, S Grand, S Chung, J Cottin, R Herrington, M Scambelluri, E Rampone, T Stachel and X Xu

Funding:	**2007:**	$230,000
	2008:	$230,000
	2009:	$230,000

Administering Institution:
Macquarie University

Project Summary: Outcomes will include significant new information about the structure and formation of the Earth's crust and the underlying mantle. An improved framework for interpreting the architecture of Australia and other continents will be directly relevant to exploration for world-class economic deposits, the Earth resources on which society depends. Innovations in geochemical technology and in the integration of information from geochemistry, geophysics and geodynamics will maintain our high international profile in research relevant to National Priority 1.6 (Developing Deep Earth Resources). The project and its interaction with the minerals industry will provide advanced postgraduate training in a field critical to Australia's future.

Mantle melting dynamics and the influence of recycled components

Researcher: SP Turner

Funding	**2007**:	$90,000
	2008:	$90,000
	2009:	$95,000

Administering Institution:
Macquarie University

Project Summary: This proposal is directly concerned with the continuing aim of building a sustainable Australia through knowledge of deep earth resources. The more we know about the processes of melting and melt and fluid migration the better we will be able to inform models for resource exploration and volcanic hazard mitigation. Uranium series isotopes are relevant to the very recent history of the planet (< 350 000 years) - time scales which are often overlooked.

Application to mantle melting as described in this proposal may also have direct application to gold exploration in the Manus Basin and elsewhere. It is to these techniques we must look if we are to understand the immediate past as a clue to the immediate future of our planet.

Exposure dating with manganese-53, neon-21 and beryllium-10: a new toolkit for studying long-term landscape evolution

Researchers: LK Fifield, JM Chappell and M Honda

Funding:	**2007**:	$130,000
	2008:	$125,000
	2009:	$123,000

Administering Institution:
The Australian National University

Project Summary: Australia today is the driest inhabited continent but this was not always the case. Tens of millions of years ago the climate of Australia was considerably wetter. Then, several million years ago, aridity in Australia developed producing most of the desert features of the red Centre that we see today. The age of our deserts and other arid features are not, however, well known. This project will determine the age of desertification in Australia, thereby enhancing our understanding of such processes and the response of our landscape to changing climate.

Experimental and natural constraints on trace element and volatile recycling in subduction zones

Researcher: J Hermann

Funding:	**2007**:	$100,000
	2008:	$100,000
	2009:	$100,000

Administering Institution:
The Australian National University

Project Summary: The results of this project will provide important constraints on the differentiation of Earth, which ultimately leads to the concentration of elements suitable for mining. Trace element and volatile recycling in subduction zones is an integral part of the research theme 'Journey to the centre of the Earth' which has been identified as a key project (4.4) in the national strategic plan for geosciences. CO2 recycling in subduction zones is crucial for our understanding of the long-term greenhouse gas variations on Earth. The ANU is one of the world-leading research institutions in experimental petrology and geochemistry, and the outcomes of this project will ensure that Australia remains at the forefront in these disciplines.

Solidification, channel formation and thermal erosion in lava flows

Researchers: RC Kerr and KV Cashman

Funding:	**2007**:	$56,000
	2008:	$56,000
	2009:	$45,000

Administering Institution:
The Australian National University

Project Summary: This project will elucidate the complex dynamics that control the cooling rates and advance rates of lava flows. It will result in improved hazard assessments for volcanic areas around the world affected by the advance of lava flows, including many Pacific islands and most countries around the Pacific Rim. The project will also provide a quantitative understanding of thermal erosion in lava channels, which will help explain the formation and location of major ore deposits of nickel, copper and platinum in Western Australia and elsewhere around the world.

Magmatic processes, volatiles and ore formation

Researchers: J Mavrogenes, RJ Arculus and JE Mungall

Funding: **2007**: $50,000
2008: $50,000
2009: $40,000

Administering Institution:
The Australian National University

Project Summary: A major current source of Australia's export wealth derives from mining of gold and copper ores. Many of our largest ore deposits, such as those at Mt Isa and Broken Hill, formed in paleo- environments equivalent to the active submarine volcanic arcs which we are proposing to study. Modern systems yield the vital clues to explore intelligently for fossil equivalents. We propose a two-pronged approach in world-renowned analytical and experimental laboratories to understand active processes that will guide experimental simulations under controlled conditions. Results are critical for national economic advantage and the maintenance of Australian Earth science in the forefront of global research effort.

An experimental exploration of silicate melt thermodynamics

Researcher: HS O'Neill

Funding: **2007**: $43,000
2008: $43,000
2009: $36,000

Administering Institution:
The Australian National University

Project Summary: The chemical properties of magmas are the key to understanding igneous activity in the Earth, and hence the tectonic significance of magmatism, and the mineral resources resulting from past magmatism. The chemistry of magmas is also a determining factor in assessing the hazards associated with volcanic eruptions, including natural inputs into the atmosphere against which anthropogenic inputs causing climate change must be assessed. This research program will measure experimentally the way different magma compositions affect the solubilites of important volatile and trace-element components in magmas, providing the much-needed fundamental data to model magmatic activity.

Relationship between subduction zone geometry, trench kinematics and great subduction earthquakes

Researcher: WP Schellart

Funding: **2007**: $179,893
2008: $139,893
2009: $124,893
2010: $114,893
2011: $114,893

Administering Institution:
The Australian National University

Project Summary: The devastating Boxing Day 2004 earthquake near Sumatra and the four other largest earthquakes in recorded history all occurred along subduction zones. This research will compare the geodynamic setting of these subduction zones with those surrounding the Australian continent and assess whether the Australian subduction zones are capable of producing great earthquakes and tsunamis that might pose a risk for the east and northwest coast of Australia. Also, Eastern Australia is a composite of fossil arcs rich in ore deposits and the Tasman Sea region is composed of basins that host hydrocarbons, all of which formed by subduction processes. The proposed research will thus improve the basis for mineral and hydrocarbon exploration.

Old brains, new data - early evolution of structural complexity in the vertebrate head

Researchers: GC Young, JA Long and M Zhu

Funding: **2007**: $175,000
2008: $180,000
2009: $173,000

Administering Institution:
The Australian National University

Project Summary: Of the all the complex structures biology has provided, the evolution of the vertebrate brain and its sensory organs is perhaps the most enigmatic. The fossil record occasionally provides a chance to trace this evolution, but only with the use of novel X-ray scanning techniques can these secrets be detailed in three dimensions. Exploiting the exceptional fossil record from Australia and China, this team will for the first time collect a vast comparative data base which will yield clues on the early evolution of the ear, eye and brain.

Minerals replacement reactions: understanding mineral formation under hydrothermal conditions

Researchers: J Brugger, A Pring and A Putnis

Funding: **2007**: $130,000
2008: $90,000
2009: $85,000

Administering Institution:
The University of Adelaide

Project Summary: Many geological processes involve the transformation of one mineral into another. By understanding molecular-level reaction mechanisms, we can predict how fast reactions progress, and what the final product will look like. This project focuses on a reaction mechanism called 'coupled dissolution-reprecipitation', in which the parent mineral is dissolved into a thin layer of fluid at the reaction front, and the daughter mineral subsequently precipitates. This concept will be applied to sulfide minerals for the first time. The results have many applications for the Australian mining industry, in particular in improving the efficiency of the processing of Ni- and Au-ores.

Modern-style subduction reflected in the 2.0 billion year old East African eclogites

Researchers: AS Collins, MP Hand, A Mruma, KM Barovich and GS Heinson

Funding: **2007**: $50,000
2008: $45,000
2009: $30,000

Administering Institution:
The University of Adelaide

Project Summary: Plate tectonics is the crustal expression of the dynamic Earth, and has been so for the past 2 billion years (Ga). As the link between the deep Earth, the hydrosphere and the atmosphere, plate tectonics is fundamental to life on Earth: it is what stands us apart from our planetary neighbours. Yet, plate tectonics

may not have existed in the same form for the first half of the planet's life. This project will 1) increase our understanding of the Earth at the dawn of plate tectonics and foster community knowledge of the evolving Earth; 2) address the fundamental nature of the Earth at the time of much Australian ore formation, thus assisting in deep Earth resource exploration.

The initiation of Early Palaeozoic subduction in Eastern Australia and North America: causes and effects

Researchers: JD Foden, BF Schaefer, PG Betts, MA Elburg, GA Jenner and CR Kincaid

Funding:	**2007**:	$70,000
	2008:	$60,000
	2009:	$50,000

Administering Institution:
The University of Adelaide

Project Summary: Identified thirty or more years ago subduction is the return of cold, dense, oceanic lithosphere to the mantle and is one of the key dynamic elements of the plate tectonic paradigm. It is this process that is responsible for the 'Pacific Ring of Fire'. It is the root cause of many key geological processes and is a primary control of some of the Earth's largest-scale physiographic features, including deep-sea trenches and mountain ranges. Using the important record of Cambrian in eastern Australia and in the comparable Canadian Atlantic margin, we will look at the causes and impact of the earliest stages of subduction as it first developed in the western Pacific and pre-cursor Atlantic 500 million years ago.

Microscale evolution of deformed rocks and glaciers

Researchers: CJ Wilson, JC Burg, PD Bons, MW Jessell and K Stuewe

Funding:	**2007**:	$105,000
	2008:	$105,000
	2009:	$105,000

Administering Institution:
The University of Melbourne

Project Summary: Scientific outcomes from this research have significant implications for predictions on material properties and are applicable to rock behaviour in mineralised systems, a focus of Australia's minerals industry, and the development of new materials for the Australian manufacturing industries. It will help maintain Australia's excellent international research reputation in the fields of microstructural geology and glaciology.

Wave-by-wave bed-level changes at the beachface of gravel and sand beaches

Researchers: IL Turner, G Masselink and PE Russell

Funding:	**2007**:	$104,000
	2008:	$103,000
	2009:	$97,000

Administering Institution:
The University of New South Wales

Project Summary: Australia's coastline is one of this country's greatest natural, cultural and economic resources. Recent experiences internationally have shown that in a changing climate, coastal erosion is a real and growing threat to the present-day sustainability of our coasts. Innovative instrumentation developed by our team now enables fundamental erosion and accretion processes to be quantified for the first time. Working within the framework of two collaborative, fully-integrated, international research programs commencing in 2007 and 2008, this study will place Australia at the forefront of break-through coastal research, leading to rapid advances in the scientific, engineering and operational understanding and modelling of coastal change.

Computationally modelling a volcano: flow and stability

Researchers: HB Muhlhaus, AJ Hale, RS Sparks, OE Melnik and G Wadge

Funding:	**2007**:	$100,030
	2008:	$85,030
	2009:	$95,030

Administering Institution:
The University of Queensland

Project Summary: Mainland Australia is fortunate not to suffer directly from active volcanism. However, this does not mean volcanoes are of little importance. The products of ancient eruptions can define the wealth of a nation. But they are also highly destructive and there are currently 30 active volcanoes capable of generating a tsunami that could affect Australia. Understanding the physical processes using computational models is essential to save lives and help us benefit from their products. This is a relatively new research field and owing to the resources in Australia, our research team has the potential to be at the forefront. There is also the capability to build and impressive research team within the University of Queensland.

Links between modern and fossil microbes and the evolution of life in Earth's extreme early environments

Researcher: CP Marshall

Funding:	**2007**:	$143,673
	2008:	$148,573
	2009:	$156,053
	2010:	$147,263
	2011 :	$146,808

Administering Institution:
The University of Sydney

Project Summary: The quest to understand early and modern life in extreme environments tackles some of the most profound questions of humankind. The novel application of spectroscopic techniques to investigate modern and fossil microbes presents an unprecedented opportunity to establish the link between primitive living and fossil organisms, thus enriching our understanding of the early evolution of life and its interactions with Earth's early environments. The project links fundamental processes that shaped the Earth and thus fits into the National Research Priority 1: An Environmentally Sustainable Australia.

Reconstruction of marine ecosystems following the greatest mass extinction during the Phanerozoic history of Earth life: lessons for the present

Researchers: ZQ Chen, RJ Twitchett, J Tong and S Xie

Funding:	**2007**:	$136,614
	2008:	$128,614
	2009:	$104,614
	2010:	$96,614
	2011:	$96,614

Administering Institution:
The University of Western Australia

Project Summary: Frequent defaunation events strongly threaten sustainable development of marine resources and human environments especially in countries that are surrounded by oceans such as Australia. By analysing recovery mechanisms of marine ecosystems following the Permian-Triassic mass extinction, the greatest crisis of Earth life, we will develop predictive tools for analysing restoration of modern marine defaunated ecosystems. Understanding biotic extinction and recovery is crucial to understanding the evolution of the Earth's biosphere. This study increases Australia's research profile on this global issue. The target strata are quality oil source rocks in Perth Basin, and thus this project is beneficial to the Australian petroleum industry.

Neoproterozoic global geodynamic and climatic events: were they linked?

Researchers: Z Li, D Evans, E Hegner, P Hoffman, G Jiangand X Li

Funding:	**2007**:	$150,000
	2008:	$60,000
	2009:	$20,000

Administering Institution:
The University of Western Australia

Project Summary: This project will study a unique cluster of global geodynamic and climatic events 850-700 million years ago that will help us to understand the interactions between the Earth's deep mantle, its crust, and its atmospheric climate. Academic values aside, the work will bring direct benefit to the Australian industry. Knowledge on the distribution of the Neoproterozoic plume events will provide new exploration targets for Ni-Cu-PGE and V-Ti deposits. Better constrained palaeogeography will help to locate mineral-rich crustal provinces that were once connected. Understanding climatic consequences of global geodynamic events will help to better understand and respond to climate changes.

Landscape evolution and palaeoclimates in Indonesia: environmental, faunal and archaeological implications

Researcher: KE Westaway

Funding:	**2007**:	$102,030
	2008:	$102,030
	2009:	$102,030

Administering Institution:
University of Wollongong

Project Summary: The influence of environmental and climatic changes on faunal (including human) populations is a pressing issue for Australian communities in environmentally sensitive areas. This project will address this issue by documenting how certain flora and fauna in Indonesia, our nearest northern neighbour, responded to environmental challenges. Revealing when humans first dispersed through the region and how they adapted to changing environmental conditions will also contribute to our understanding of the cultural heritage of Australia's indigenous settlers. This project will build on established collaborations with Indonesian researchers and pioneer new dating methodologies to further enhance Australia's place at the forefront of geochronology.

Seismic response of partially saturated petroleum reservoir zones: towards quantitative recovery monitoring

Researchers: B Gurevich, AV Dyskin, TM Mueller and L Paterson

Funding:	**2007**:	$90,000
	2008:	$70,000
	2009:	$60,000

Administering Institution:
Curtin University of Technology

Project Summary: In most Australian reservoirs less than 50% of the original oil in place is recovered. A major factor that contributes to low recovery rates is bypassed oil/gas. Even a small, 1% improvement in recovery is of substantial economic significance. The proposed project aims to develop quantitative models for reservoir monitoring of zones with bypassed hydrocarbons using time-lapse (4D) seismic measurements, and thus to improve the hydrocarbon recovery factors. Developing these models will be a cutting edge research achievement, which will make a significant contribution to the knowledge base of the discipline and advance the international reputation of Australian science.

From crust to core: probing the heterogeneity of the Earth with seismic arrays

Researchers: BL Kennett and N Rawlinson

Funding:	**2007**:	$80,000
	2008:	$91,000
	2009:	$80,000

Administering Institution:
The Australian National University

Project Summary: Seismic array deployments will be used for a variety of studies including tomographic mapping of upper mantle structure, coda analysis for crustal properties and delineation of deeper Earth structure. The high resolution information on crustal and upper mantle structure will provide important detail on the building blocks of the Australian plate at depth. This class of information helps to refine our understanding of the way that the Australian continent has been assembled with regard to the interaction of the crust and mantle and the emplacement of mineral resources.

Numerical simulation of seismic waves in the regional and global earth with 3D Gaussian quadrature grids

Researcher: SA Greenhalgh

Funding:	**2007**:	$105,000
	2008:	$105,000
	2009:	$115,000

Administering Institution:
The University of Adelaide

Project Summary: The ability to realistically model the propagation of seismic waves through the global 3D earth, taking account of all internal and surface complexity, is extremely important for predicting the response to earthquakes and imaging the interior structure. This will lead to fundamental new knowledge on Earth constitution and heterogeneity, and will have spin-off benefits in others areas such as exploring for oil and minerals, and better understanding of seismic hazard. The numerical modelling and seismic data analysis will be done on a supercomputer, thus providing important training for research students.

To be continued in the February 2007 Preview.

Magnetic stereograms[1]

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Introduction

With all the ambiguities of magnetic structure interpretation, sometimes one yearns for a more tangible grip on the data. Nowadays we have what amounts to a sea of magnetic data over the area of interest, so surely there must be a way of visualising the depth clues it contains? Wouldn't it be good to be able to get a feel for the data, some way of inputting the information through our senses so that our skilled minds can fit our concepts against it? Fortunately, there is a way, using the shift due to the reduction-to-pole (RTP) transform in a standard stereogram. This is demonstrated with the Northern Territory as an example.

Magnetic inclination gives rise to parallax

The field induced in a small buried ferrimagnetic body adds most strongly to the inducing field at a point d*tan(i) further north along the surface, where d is the depth and i is the magnetic inclination. To the south of that point, closer to the body, the magnitude of the vector sum of the two fields, or TMI, falls off rather more sharply than it does on the other side of the maximum. The net effect is that the TMI anomaly is shifted further northward in its longer wavelengths than the shorter.

RTP applies a reverse parallax

The RTP transform reverses the shifts, and tightens the shape of the anomaly, moving it back above its source. In general, an RTP transform alters the phases of the wavelengths of each anomaly in a TMI grid, shifting the longer wavelengths further than the shorter. As a deeper anomaly lacks the shorter wavelengths, the anomaly itself is shifted further than a shallower one.

Stereo vision infers depth from parallax

A standard stereogram consists of a pair of images printed in red and green for viewing through spectacles with red (left) and green lenses. The two images are projected from slightly different angles, each of which is filtered out by the lens of the other colour, so that only the green image reaches the right eye and only the red image reaches the left. As the images are taken from two different angles, deeper objects have a greater shift than shallower objects. The process of visual perception interprets this shift as depth.

Realisation requires preconception

There is more to the process. Facts being supplied to the sensual perception system make up a very small subset of the facts that constitute the body being observed. Nevertheless the preconception of what one is looking at allows the viewer to infer the rest of those facts from the subset. When the evidence is ambiguous, we stare at the scene for a while, sorting through the possibilities in our mind and eventually settle on one. At that point the object seems to grow in our mind's eye, the realisation giving rise to the familiar declaration, "Aha, I can see it now". Preconceptions are an essential part of visualisation in the same way that models are essential to interpretation.

Both of these processes can be applied to visualising structures in the magnetic field. The RTP shifts of a body quite adequately represent the shifts due to its depth. Figure 1 is a standard stereogram, with TMI imaged in green and RTP imaged in red. Red-green glasses allow one to see these images, each to an eye. The sense of colour is replaced by the sensation of a monochrome stereo pair. Our perception system tries fitting a series of possible structures against the evidence coming in, settles on one and the structure then materialises before one's eyes.

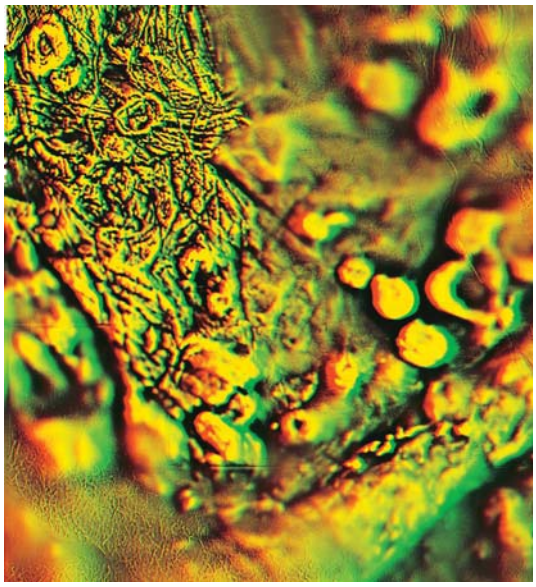

Fig. 1. Granites in the Amadeus Basin basement, southern NT. The area is approximately 200 km across, and the image is rotated, so that north is on the right. A dozen circular granites step down from the surface to several kilometres depth. The fine details are in the regolith, perhaps 100 m deep. The sediments between have negligible susceptibility and consequently appear transparent. With red-green glasses, the regolith details are seen to float high above the basement.

[1] *This contribution is based on Roger's presentation at the AESC 2006 meeting in Melbourne, which shared the Western Geco best Paper Award with Mike Roach's talk published in the October edition of Preview.*

Creation of the stereogram in this manner assumes that the user is willing to rotate the image from its conventional orientation so that north is on the right. This is because the magnetic vector inclines to the north whereas our eyes are arranged left and right. The advantages of a conventional orientation, with north at top, may be achieved by reproducing the shifts of the TMI in an east-west direction.

Using RTP to create east-west parallax

Remanence issues aside, the RTP image is more "real" than the TMI image it was derived from, in the sense that the anomaly in the RTP is tighter and located above its source. By setting the declination to 090° a further shift, east–west, is obtained by running the reduction-to-pole transform again. Although the resulting shifts are artificial, they are exactly equivalent to the shifts of the original TMI they are designed to correct. By pairing the real RTP image with the twice transformed image, objects again appear shifted in proportion to their depth. Accordingly, a valid conventionally oriented stereogram can be obtained for routine use. See Figure 2.

A vertical derivative transform does not change the phases of the component wavelengths, so the arguments apply equally to the vertical derivative images of the TMI and the RTP. Since VD images are easier to stretch, all images here are of the vertical derivative.

Regolith can be seen separate from basement

The impression of depth is most pronounced in sedimentary basins, where shallow features in the regolith seem to float kilometres above the magnetic basement, with the intervening non-magnetic sediments being transparent (see Figures 1 and 2).

Depth of large bodies can be distinguished

Anomalies of large geological bodies can be assembled as algebraic sums of the anomalies of small dipole bodies. To a certain extent, shorter wavelengths of the component dipole anomalies cancel out, weakening the clues to shallowness. Remarkably, our perception finds sufficient depth clues in the surviving wavelengths. The granites in Figures 1 and 2 are quite large, yet we are able to pick out their increasing depths as they step down.

Use of stereogram to test hypotheses

Deep crustal structures also emerge. In Figure 3, some fine detail is seen on a central object. When seen in a single RTP image, the detail appears to associate with the object as of a cylinder rising to the surface. As such it is a candidate source for the Kalkarindji flood basalts. When viewed in the stereogram through red-green glasses the detail is seen to be in the near surface whereas the object is wholly at depth. The stereogram allows one to conclude that the deep object does not reach the surface. The source remains unknown.

Need for state-wide RTP stitches

With one's attention is on the scale of basins hundreds of kilometres in extent, one soon needs to explore beyond the boundaries of the survey used to collect that area of data. However, the changing magnetic inclination stops the taking of an RTP transform across a larger north–south extent. As the RTP is based on the Fourier transform, it must be performed across the whole area of the dataset with a single setting of the magnetic inclination parameter. Although workers such as Duncan Cowan and Des Fitzgerald (pers. comms.) have produced filters with varying magnetic inclination, conventional RTP transforms can

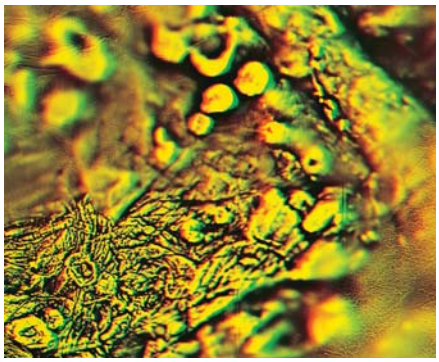

Fig. 2. Granites in the Amadeus Basin basement, upright image. The area is the same as in Figure 1; however this time north is at top. The green image is now the true RTP, and the red image is a false east–west RTP transform with shifts equivalent to those in the original TMI. Structures can be seen in depth without having to rotate the image.

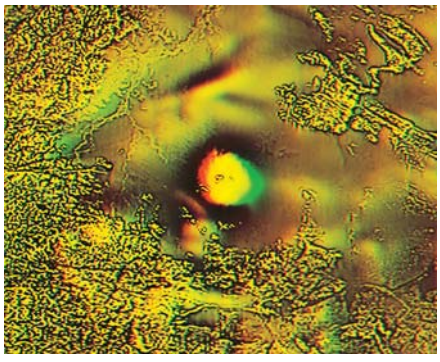

Fig. 3. Deep magnetic feature in Neoproterozoic sediments, Waterloo, NW NT. The shallow, finely textured material is the Kalkarindji flood basalt, which is only a few hundred metres deep. Little is known about the deep object, although it is apparently very large and magnetically distinct from the surrounding Neoproterozoic sediments. Area is 100 km across.

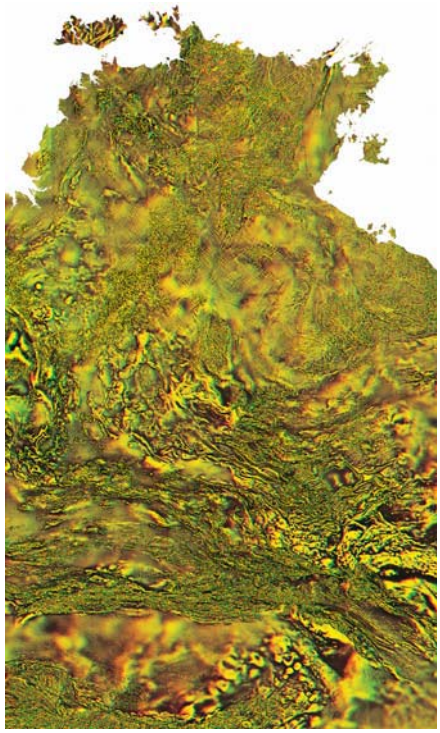

Fig. 4. Magnetic depths image of the Northern Territory. On this scale, magnetic depths are too fine to be resolved. On the NTGS' Image Web Server, one can zoom in to more localised areas to see the 3-D effect. On a web mapping system using the WMS protocol, subsets of this image may be superimposed with vector data such as roads etc from other specialist websites.

only be performed accurately over areas up to a hundred or so kilometres north–south.

Intrepid to the rescue

A couple of years ago, Intrepid software implemented an automatic calculation of the magnetic inclination, the last step required for making a state-wide RTP grid. By cutting the vertical derivative of the TMI grid of the Northern Territory into tiles, then taking local RTP transforms and stitching them back together, an RTP VD grid of the NT has been obtained. The RTP VD grid has been used in order for Figures.

Latitude dependence

Magnetic inclination varies with latitude, so the peak shift d*tan(i) also varies with latitude. When using a large area of TMI against its real RTP image in a stereogram, one has to take into account any different shift of the TMI at different magnetic latitudes. In the case of the Northern Territory, Darwin in the north has twice as much shift as at the Territory's southern border. Melbourne has half that shift again. Consequently, as one's attention moves across such a scale, it is necessary to be aware of the changing vertical exaggeration.

Controlling the vertical exaggeration

An advantage of using the east–west transform pair is that the vertical exaggeration is preset and constant across the full extent of the stitch. In that form, interpreters can work undistracted by the peculiarities of the magnetic field vector. Accordingly, the upright stereogram for viewing across the Internet, is provided on the NTGS' Image Web Server (http://apps.minerals.nt.gov.au/IWS), labelled simply "Magnetic depths".

Obtaining red-green spectacles

The red-green glasses necessary for viewing the stereogram may be ordered via the Internet using the keyword "anaglyph" and no doubt from all scientific suppliers as well. Some are currently available from geoscience.info@nt.gov.au.

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Geophysical interpretation of the Murray Basin Region, southwestern NSW[1]

Abstract

Interpretation of recently acquired airborne magnetic and radiometric data and regional gravity data was carried out to investigate basement geology in a region covered by a substantial thickness of Mesozoic and Cainozoic sedimentary units. Broad scale interpretation was intended to correlate geophysical signatures across the border from Victoria.

The new airborne data combined with the regional gravity delineate major structural zones and boundaries within New South Wales, defining major faults, buried granite bodies and sedimentary troughs and basins. The magnetic and gravity data suggest that the gold-rich Stawell structural zone defined in Victoria continues unobstructed into New South Wales.

Location

The Murray Basin covers parts of New South Wales, Victoria and South Australia. The location of the New South Wales portion is shown on Figure 1.

Airborne Geophysical Surveys

Between 2003 and 2005, the NSW Department of Primary Industries carried out three large airborne geophysical surveys (magnetic, radiometric and digital terrain) in southwestern NSW (outlined in red in Figure 2.).

The first of these, over the Murray-Riverina (1) extended from the Victorian border to the north as far as the town of Mossgiel. This survey comprised 160,000 line-km of data and was the largest single airborne survey block acquired in NSW.

The second and third surveys were acquired in 2005 over the Southern Darling Basin (2), north of the Murray-Riverina survey, and over the Murray Basin (3) to the west, bordering Victoria and South Australia.

Tectonic Interpretation

The new surveys cover large areas of southwestern NSW. Interpretation of the geophysical data extends the major structural zones in Victoria through into NSW, including the Glenelg Zone, the Stawell Zone, the Bendigo Zone and the Tabberabbera Zone (Figure 3.).

The high resolution of the new data permits the interpretation to focus on narrow lineaments and faults in specific areas of interest in addition to allowing interpretation of the broader tectonic structure.

The Stawell Zone hosts the rich Stawell gold deposits and the Bendigo Zone hosts the world class orogenic gold deposits of Bendigo, Ballarat, Castlemaine, among others. To the year 2000, the Stawell Zone produced more than 167 tonnes of gold. Over 1870 tonnes of gold has been recovered from the Bendigo Zone (VandenBerg *et al.*, 2000).

Continuation of these two major tectonic zones well into NSW, albeit under cover, enhances the potential for the discovery of significant gold deposits under Murray Basin sedimentary units.

Stawell-style gold targets in NSW – remanence dominated magnetic anomalies

Fig. 1. Location of the study area is defined by the orange line. The coloured area within the orange boundary is a composite TMI image derived from three airborne magnetic surveys carried out by the NSW Department of Primary Industries between 2003 and 2005 – see Figure 2.

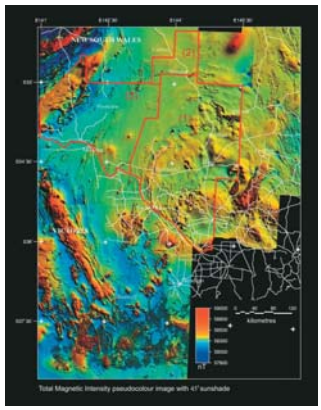

Fig. 2. Outline of airborne geophysical surveys over Total Magnetic Intensity image with 45 degree sun angle.

[1] *This contribution is based on Michael Hallett's poster, presented at the AESC 2006 Conference held in Melbourne, which was awarded the Best Poster Presentation Award at that meeting.*

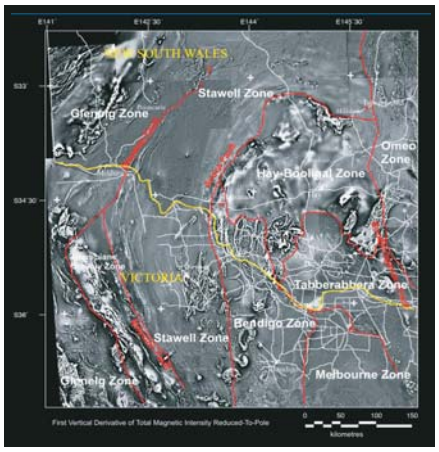

Fig. 3. Interpreted tectonics zones over an image of the First Vertical Derivative of Total Magnetic Intensity, reduced to the pole.

Strong linear magnetic anomalies with parallel negative and positive lobes are visible east of the Moyston Fault, northeast of Mildura (see inset, Figure 4.). These anomalies lie along strike of the Stawell deposits within the Stawell Zone and show similar character to magnetic anomalies in western Victoria, at the Kewell prospect northwest of Stawell, which hosts gold mineralisation.

Recent work by Musgrave *et al*. (in press) in the area of the Kewell Dome, documents aeromagnetic anomalies with intense positive and negative lobes. Magnetic modelling to adequately fit these anomalies requires that remanence dominates magnetisation. Musgrave *et al*. directly relate the negative lobes of the anomalies with high fluid flow areas on the flanks of the basalts at the location of gold mineralisation.

Modelling of the linear magnetic features northeast of Mildura (Figure 4.) also requires dominant remanence to account for the negative anomalies. These may also reflect pyrrhotite bearing units potentially hosting gold mineralisation.

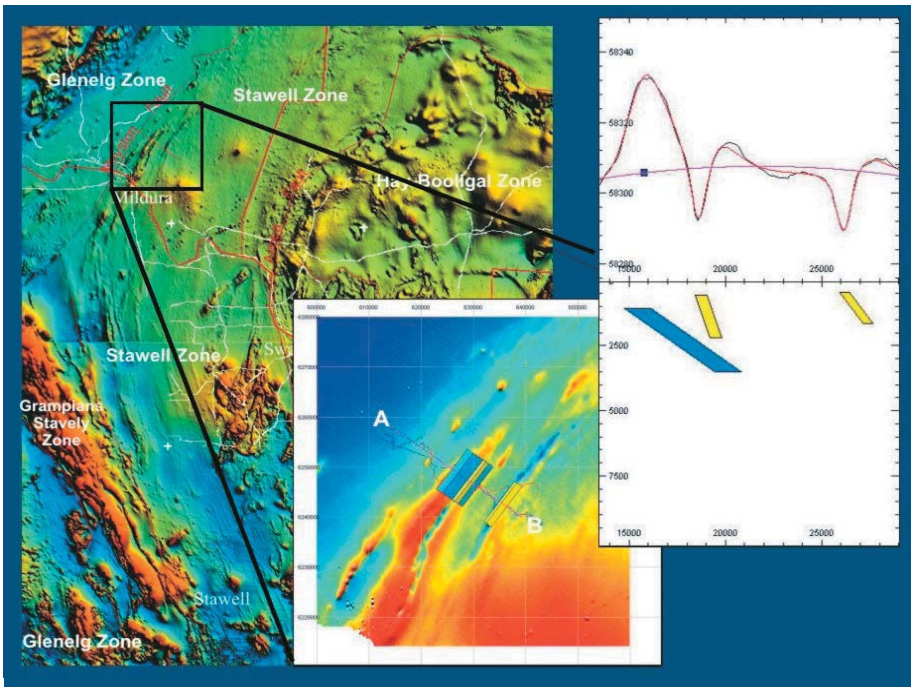

Fig. 4. TMI image of the region with an inset of remanence dominated magnetic lineaments and an inset of a simplified magnetic model.

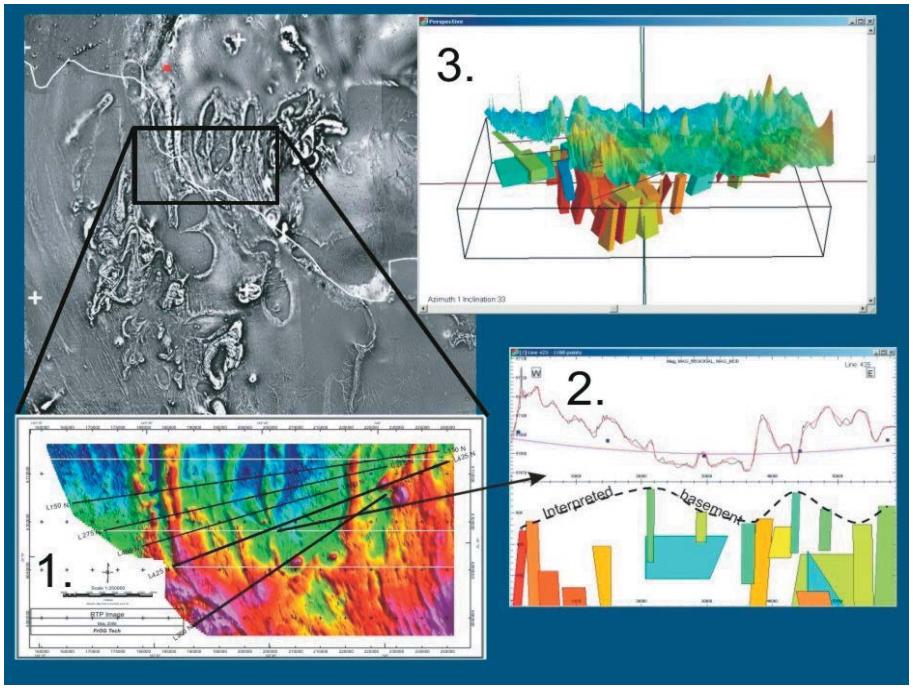

Fig. 5. Composite image of depth to basement study. The area is outlined on an image of the 1VD of TMI. Inset 1 shows the locations of some of the profiles modelled over the TMI of the study area. Inset 2 shows 2D magnetic modelling/inversion results of the line identified by arrow. Inset 3 shows a 3D representation of all the modelled bodies under a colour image of TMI.

Bendigo Zone Depth to Basement study

A section of the Bendigo Zone that extends into NSW shows a fabric in the magnetic data which is interpreted to be buried, steeply dipping metamorphosed turbidites (Figure 5).

2D magnetic modelling was carried out to estimate the depths of burial of these units. Drillhole data in the region are sparse and previous estimates suggested depths of cover of ~500 m. On Figure 5, the red dot north of the black inset outline box indicates Balranald DDH1 which intersected steeply dipping Ordovician/Silurian units at 322 m depth. Further southeast, the lithological fabric is more evident, so the bedrock is possibly shallower.

Magnetic modelling and inversion concurred with our interpretation of steeply dipping tabular bodies of long strike length. Depths ranged from 100 m to 700 m below ground

Continued on page 29

Richard Partner
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Fugro Airborne Surveys
Email: RPartner@fugroairborne.com

GeoRanger Aeromagnetic UAV – from development to commercial survey

The use of Unmanned Aerial Vehicles (UAVs) for geophysical exploration offers a number of advantages over conventional manned systems.

UAVs remove aircraft crew from potential risk when operating in hazardous environments such as offshore or at extremely low altitudes. Several UAVs may be operated simultaneously by a single crew providing for efficient survey economics, which are further improved if aircraft endurance exceeds 10 hours. UAV autonomous autopilot systems are capable of tracking planned flightpath with greater precision than manned aircraft giving better data imaging quality.

Recognizing these advantages, Fugro Airborne Surveys initiated a development program in 2003 that resulted in the GeoRanger aeromagnetic UAV. Early days of the program were spent researching UAV manufacturers for a suitable business partner with the expertise and capability of producing a vehicle and associated ground systems appropriate for aeromagnetics. In 2004 a partnership was established with *The Insitu Group*, pioneer developer of long range miniature robotic aircraft based in Bingen, Washington on the Columbia River an hour east of Portland, Oregon. Fugro's geophysical data acquisition experts and Insitu's aircraft specialists joined in a team that developed a UAV with a high resolution cesium vapour magnetometer, fluxgate magnetometer and data acquisition payload.

The innovative GeoRanger weighing in at 18 kg with a 3 metre wingspan is capable of fully autonomous 3D (drape) flight and has an endurance of over 15 hours cruising at 100 kilometres per hour (see Figures 1 and 2). Using patent-pending, small-footprint launch and

Fig. 1. GeoRanger departing on a 12 hour survey mission 70 km offshore over the Gulf of St Lawrence north of Gaspe, Quebec.

Fig. 2. GeoRanger in full flight.

Figs. 3 and 4. GeoRanger small footprint ground systems can be set up inside an acre or on the deck of a marine vessel (control unit on left and retrieval system on right).

recovery systems, GeoRanger can be operated from unimproved sites in close proximity to survey areas, or from the deck of a marine vessel. The UAV is capable of autonomous return-to-base in the event of in-flight difficulties or communications problems. A continuous telemetry stream of geophysical data and aircraft performance parameters is received at the Ground Control Station over medium range VHF, or long range Iridium data connections. An optional radar altimeter is available which is fully integrated with the payload data acquisition system. Several vehicles may be operated from a single GCS by a crew of 3 to 4 operators.

Extensive aerodynamic design and testing was put into GeoRanger early in 2004 to allow maximal separation between the magnetometer sensor and aircraft electrical or propulsion systems. Flight trials began at Insitu's test site in the restricted airspace of MOA Boardman Oregon during the summer of 2004 with initial testing aimed at reducing aircraft induced magnetic noise to attain a Figure Of Merit comparable to conventional manned survey aircraft (Figure 5). In addition to signal processing design in the Fugro PASDAS data acquisition system, work during this phase included rewiring of aircraft servo controls as well as modifications to avionics and engine components. By late summer several repeatable FOMs in the order of 1.5 nT were flown and a test survey was planned at a typical mineral exploration altitude of 100 m AGL. Approximately 720 line-km were flown in two flights demonstrating line tracking capabilities and reliability of magnetic recording.

After several months of cold-weather testing performed at Fugro's Winchester test site near Ottawa, Ontario Canada in early 2005, a series of small mineral survey grids were flown in northern Quebec to directly compare

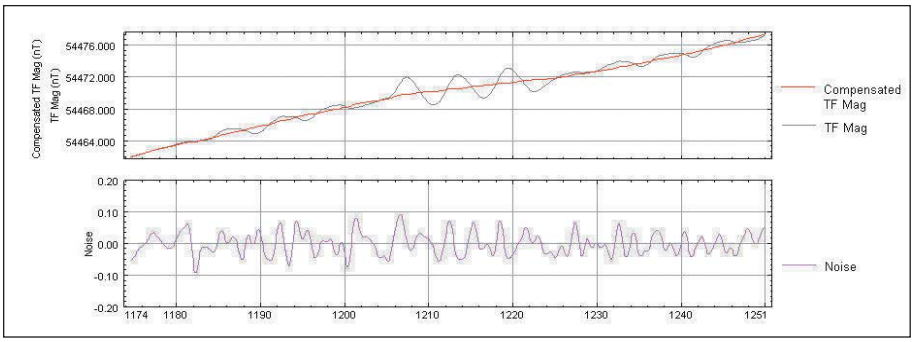

Fig. 5. GeoRanger 1.32 nT Figure Of Merit flown at MOA Boardman Oregon in August 2004.

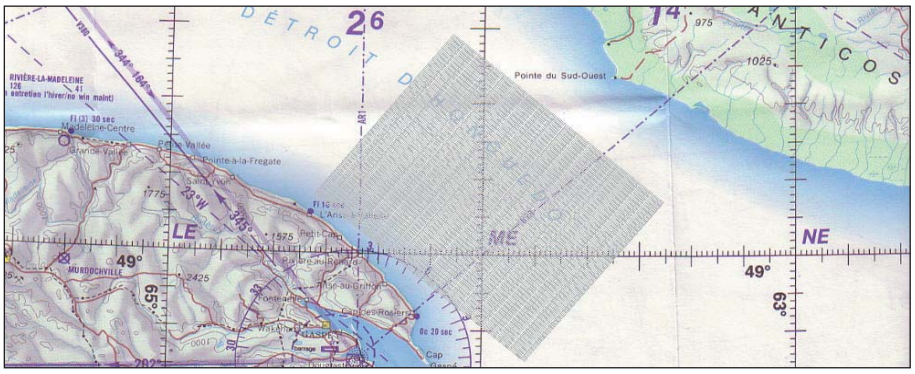

Fig. 6. GeoRanger nonexclusive commercial survey over the Gulf of St Lawrence between the Gaspé Peninsula and Anticosti Island, Quebec, Canada. The survey was flown using VHF telemetry at ranges up to 75 km.

GeoRanger data with previously acquired data flown by Fugro Cessna C404 C-FYAU. Results were excellent which prompted planning of a 13,000 line-km nonexclusive commercial survey over the Gulf of St Lawrence near Gaspé Quebec Canada.

The survey, located between 5 and 70 km offshore, was flown at 120 m altitude with 300x1000 m line spacing by two GeoRanger UAVs during autumn 2005. The acquired data, which has subsequently been sold, is comparable with manned survey aircraft.

GeoRanger development in 2006 was focused around expanding capabilities to operate multiple aircraft from a single GCS, cold-weather operations and long range satcom telemetry. The system is currently deployed on land-based survey work in Australia which will be followed by a maritime program the South Pacific early in 2007.

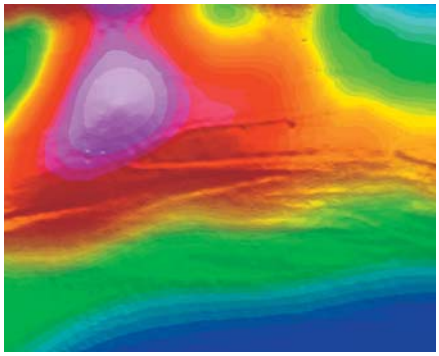

Fig. 7. Total Field Magnetics acquired by GeoRanger over the Gulf of St Lawrence. Line spacing 300 x 900 m, altitude 120 m.

Continued from page 27

surface, indicating some bedrock significantly shallower than previously thought. The line depicted in Figure 5 shows one of fourteen lines modelled in this study.

Acknowledgements

Bob Musgrave for his contribution to this study in identifying the Stawell style magnetic anomalies in NSW and modelling a profile across them.

Zhiqun Zhi of FrogTECH for creating the numerous magnetic models in the Bendigo Zone study.

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Geological Surveys of Queensland, Western Australia, Northern Territory, Tasmania and Geoscience Australia

Update on Geophysical Survey Progress (information current at 15 November 2006)

Table 1. Airborne Magnetic and Radiometric Surveys

Survey Name	Client	Project Management	Contractor	Start Flying	Line km	Spacing AGL Dir	Area (km2)	End Flying	Final Data to GA	Locality Diagram (Preview)	GADDS release
Bowen – Surat North	GSQ	GA	UTS	25 Jan 06	169,800	400 m 80 m E/W	53,800	1 Aug 06	4 Sep 06	118 – Oct 05 p41	17 Oct 06
Ashburton (3)	GSWA	GA	UTS	4 Aug 06	105,840	400 m 60 m N/S	34,920	50% complete @ 12 Nov	TBA	121 – Apr 06 p35	TBA
Southern Officer Basin (2)	GSWA	GA	GPX	15 Aug 06	105,200	400 m 60 m N/S	37,330	51% complete @ 3 Nov	TBA	121 – Apr 06 p35	TBA
Musgrave (1)	GSWA	GA	Fugro	15 Jun 06	83,950	400 m 60 m E/W;N/S	27,920	10 Oct 06	TBA	121 – Apr 06 p35	TBA
Isa South – West	GSQ	GA	Fugro	3 Apr 06	140,000	400 m 80 m E/W	50,100	2 Aug 06	TBA	118 – Oct 05 p41	TBA
Isa South – East	GSQ	GA	Fugro	8 Aug 06	101,200	400 m 80 m E/W	35,800	98% complete @ 12 Nov	TBA	118 – Oct 05 p41	TBA
Tiwi Islands	NTGS	GA	Fugro	2 Oct 06	29,300	400 m 80 m N/S	10,200	96% complete @ 12 Nov	TBA	123 – Aug 06 p39	TBA
North – East Tas	MRT	GA	GPX	TBA	52,000	200 m 90 m E/W	8,600	TBA	TBA	123 – Aug 06 p39	TBA
Flinders Island	MRT	GA	UTS	Dec 06	17,900	200 m 90 m E/W	2,900	TBA	TBA	123 – Aug 06 p39	TBA
East Isa North	GSQ	GA	UTS	31 Jan 07	113,000	400 m 80 m E/W	39,940	TBA	TBA	This issue	TBA
East Isa South	GSQ	GA	Fugro	31 Jan 07	145,900	400 m 80 m E/W	51,560	TBA	TBA	This issue	TBA
AWAGS2	GA	GA	UTS	Jan 07	145,350	75km 80 m N/S	7,659,861	TBA	TBA	124 – Oct 06 p15	TBA

TBA:To be advised

Table 2. Gravity Surveys

Survey Name	Client	Project Management	Contractor	Start Survey	No. of stations	Station Spacing (km)	Area (km2)	End Survey	Final Data to GA	Locality Diagram (Preview)	GADDS release
Isa Area B	GSQ	GA	Fugro	4 Jul 06	9,898	2 and 4 regular	78,000	10 Oct 06	TBA	118 – Oct 05 p41	TBA
Webb (4)	GSWA	GA	Daishsat	14 Aug 06	4,100	2.5 regular	24,800	13 Sep 06	4 Oct 06	123 – Aug 06 p38	Dec 06

Table 2. Gravity Surveys cont'd											
Isa Area C	GSQ	GA	Fugro	19 Oct 06	9,236	2 and 4 regular	68,500	31% complete @ 12 Nov	TBA	124 – Oct 06 p29	TBA
Murchison (5)	GSWA	GA	Fugro	Feb 07	3,600	2.5 regular	24,800	TBA	TBA	123 – Aug 06 p39	TBA
Isa Area D	GSQ	GA	TBA	Quotes close 22 Nov 06	4,903	4 regular	75,460	TBA	TBA	TBA	TBA
Isa Area E	GSQ	GA	TBA	Quotes close 22 Nov 06	6,233	4 regular	97,420	TBA	TBA	TBA	TBA

TBA: To be advised

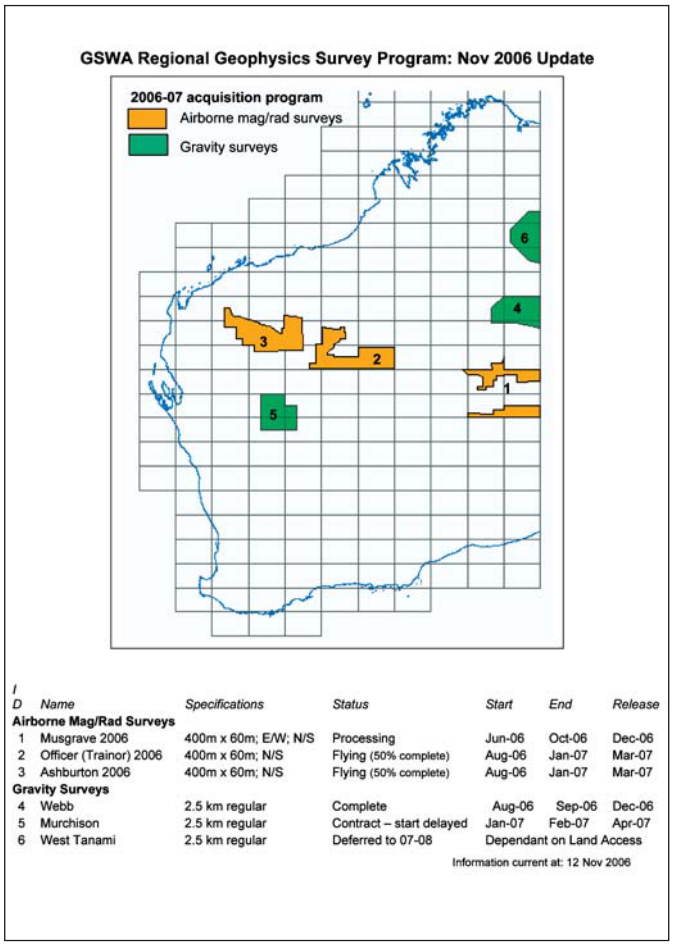


Fig. 1. Location of geophysical surveys in WA.

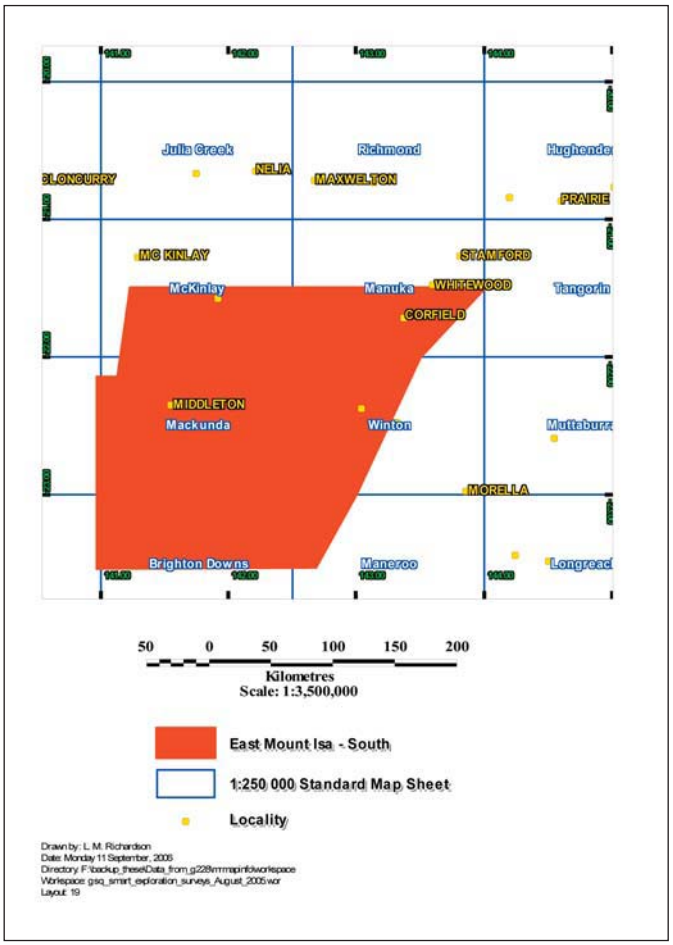


Fig. 2. Location of East Mount Isa South airborne geophysical survey - see Table 1.

In addition to the surveys in Table 2 the West Tanami gravity survey ((6) in Figure 1) in WA has been delayed, pending a land access agreement.

Preliminary data releases are made periodically on the GSWA website (www.doir.wa.gov.au/GSWA). Final data releases are available by download from the GA Data Delivery System at www.ga.gov.au/gadds.

Release of final datasets from the Musgrave (extension) airborne survey and the Webb Gravity survey should occur in December 2006.

Subscribe to the GSWA newsletter (subscription link located on the News and Events page of the GSWA website) to keep informed of preliminary and final data release dates.

Figure 1 shows the locations of the six WA magnetic and gravity surveys as per the numbers in column 1 in Tables 1 and 2 on the previous page.

Information provided by Murray Richardson and David Howard.

Murray's email address is: murray.richardson@ga.gov.au

Seismic Reflection Surveys

Since the last update, the Commonwealth Government has announced its Offshore and Onshore Energy Security Initiative and has provided funds to Geoscience Australia to allow it to pioneer innovative and integrated

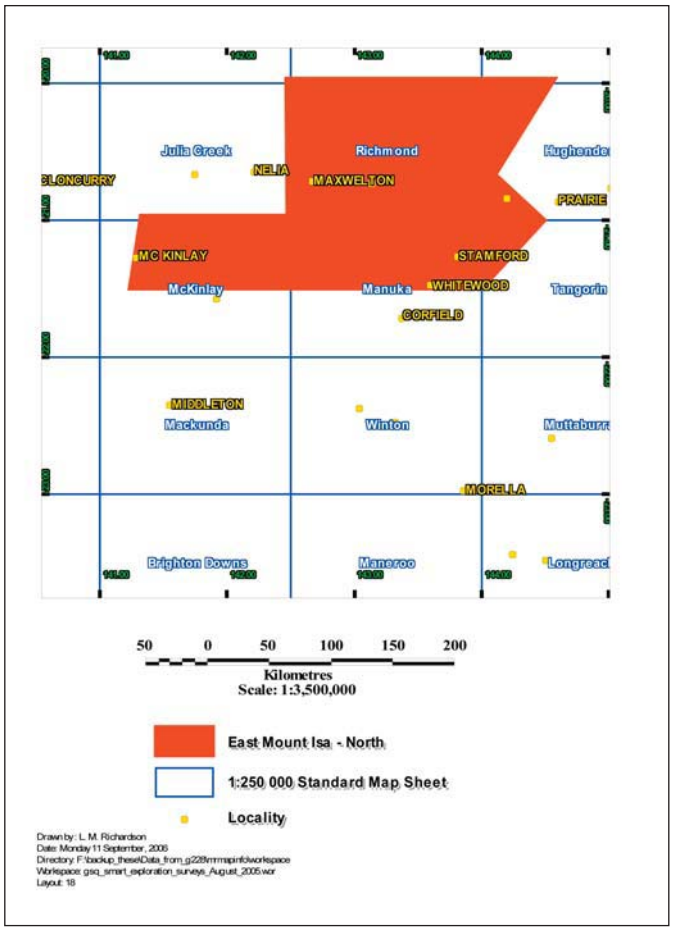
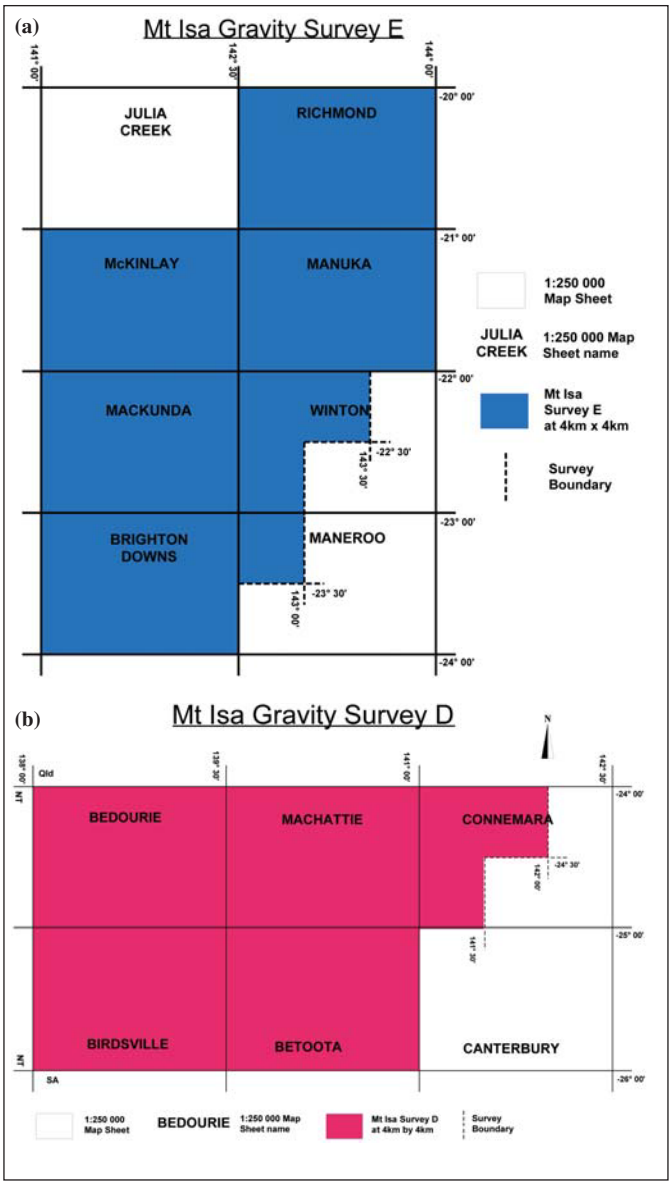


Fig. 3. Location of East Mount Isa North airborne geophysical survey - see Table 1.



Figs. 4a & 4b. Location of the two Mount Isa gravity surveys listed in Table 2.

geoscientific research to better understand the geological potential of onshore Australia for energy commodities. The research will apply the latest developments in geophysical imaging and mapping technologies, including seismic, airborne electromagnetics and radiometrics. These will assist in defining the potential for new mineral energy sources and also highlight the potential for geothermal energy from high heat producing terrains under blankets of sedimentary cover. The seismic data will also assist in identifying potential opportunities for exploration of onshore petroleum.

Currently Geoscience Australia Seismic Staff are scoping an Isa-Georgetown-Charters Towers deep seismic reflection survey and integrated add-on geophysical surveys. This survey will be funded, in part, through the Onshore Energy Security Initiative and in part by an initiative of the Geological Survey of Queensland. Industry has already expressed interest in collaborating in the project.

At the time of writing, the ANSIR seismic crew are half way through the 2006 Mt Isa Seismic Transect Project. The project has grown and will acquire ~ 800 km of seismic reflection data. It is still a race to see how many kilometres can be acquired before the rains come, and hopefully they will come, but just after we finish. If the rains come before completion we will stand down and return as early as we can next year. The Mt Isa project involves the Geological Survey of Queensland - Queensland Department of Natural Resources and Mines, Geoscience Australia, Zinifex Limited, *pmd**CRC and ANSIR. The objectives of the project involve improving the understanding of crustal architecture which will assist in the discovery of further mineral resources.

Seismic data from the 2005 high-resolution seismic traverse collected north of Broken Hill were included with reprocessed 1996-1997 regional Broken Hill seismic reflection data to produce a transect that crosses the Broken Hill region. These results were presented at the September BHEI symposium that was held in Broken Hill.

The ANSIR high frequency minivib is currently in the field undertaking a series of collaborative projects with Curtin University. It has recently completed work at Argyle, WA with Curtin and Rio Tinto where the project looked at the structure of a Southern Devonian Basin near the Argyle Diamond Pipe. In November the minivib will be undertaking profiling work at Leinster Nickel Operations (BHPB) with Curtin University. It will also be undertaking some experimental surveys in conjunction

Continued on page 33

Capel and Faust Basins Seismic Survey 2006

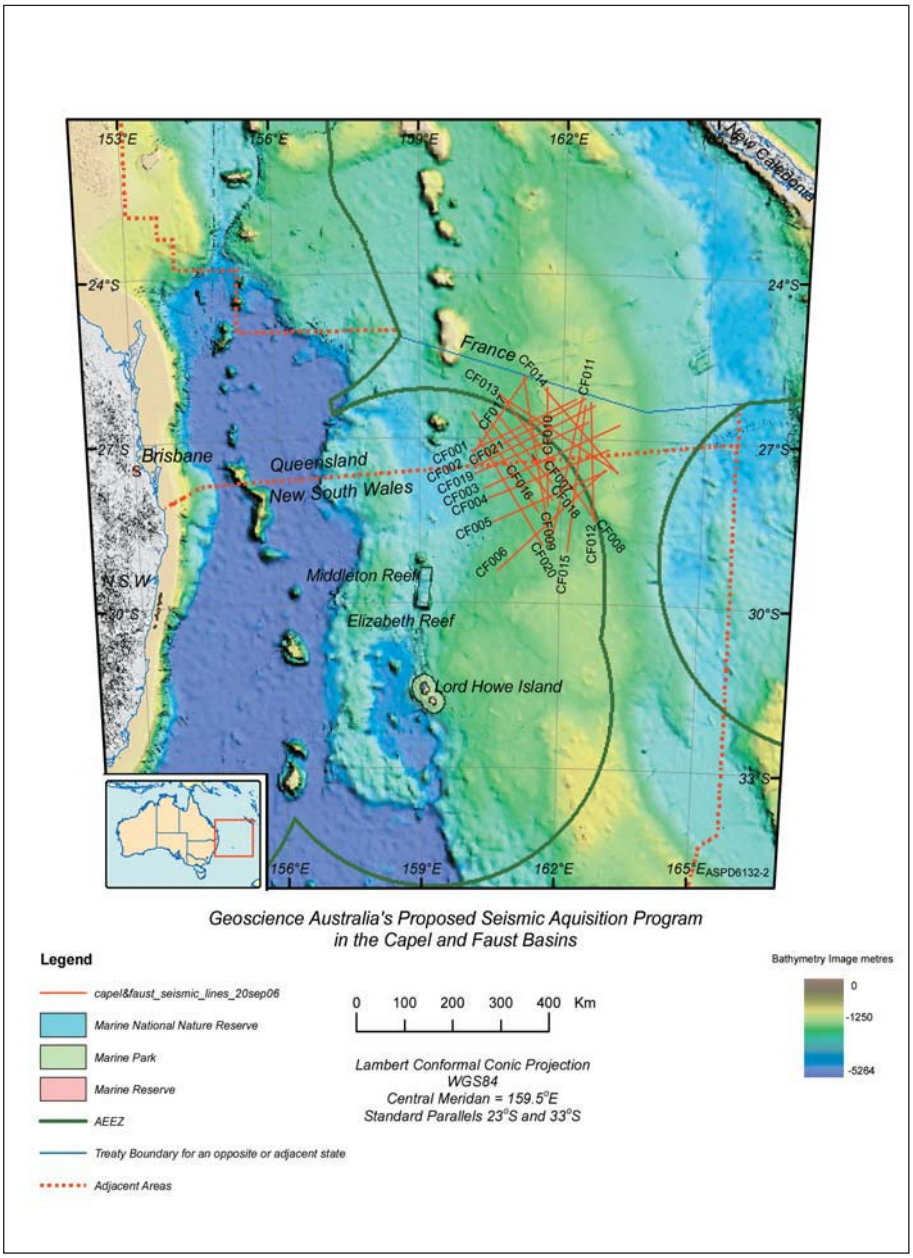
The 2006-07 Budget for Geoscience Australia includes $10 million for the acquisition of new seismic information and remastering of existing digital seismic data. This represents the final stage of data collection under the 2003-2007 New Oil initiative funding, and will provide pre-competitive data in support of acreage release. The Capel and Faust Basins, two remote offshore frontier basins 800 km due east of Brisbane, are the target areas for the new program. These areas were identified, in consultation with the petroleum industry, as basins with hydrocarbon potential.

The contract will be for the collection of approximately 4000 km of 2D seismic data over approximately 35-45 days in the period November to December 2006. The vessel will use an 8 km solid seismic streamer and collect seismic reflection data penetrating down to 12 s (twt). The shot point interval will be 37.5 m with 12.5 m group intervals. The resultant data will be a 106 fold CMP stack.

The purpose of the survey is to acquire high-quality, industry-standard 2D seismic reflection data as well as seismic refraction (sonobuoy) data to better understand basin architecture and assess the petroleum potential of the region. Ship-track gravity and magnetic data will be collected concurrently.

Existing seismic lines in the region show the presence of a number of graben and half-graben structures containing up to 5+ km of sediments of probable Cretaceous and Cenozoic age. The proposed survey straddles the main depocentres of the Capel and Faust Basins, as currently understood from existing sparse seismic coverage and satellite gravity data. The data to be acquired will tie into existing Geoscience Australia seismic lines, as well as to Deep Sea Drilling Program borehole 208 in the north of the study area. Ultimately the data will be used to promote the petroleum potential of the region. All data acquired on the survey will be available to explorers through Geoscience Australia's Data Repository at the cost of transfer. The figure below shows the location of the survey lines.

Information provided by Robin O'LearyEmail: robin.oleary@ga.gov.au



Continued from page 32

with Newmont Mining and Curtin University mapping local Archaean stratigraphy and structure that hosts nickel sulphide deposits in the Wiluna Greenstone Belt

In December and January the minivib will undertake some groundwater surveys in the Perth Basin with the Western Australia Water Board and Curtin University.

For further info please contact Bruce Goleby +61 2 6249 9404 or bruce.goleby@ga.gov.au

 by Doug Morrison sth.lands@optusnet.com.au

NEUMAYER: pioneer exploration geophysicist (Part V – final)

Neumayer returns home

After returning to Germany in late 1864 Neumayer certainly didn't slow down, for in addition to the preparation of his Victorian results for publication, he spent much of his time lecturing on subjects varying from the studies of meteorite paths to the need for polar exploration. He was also involved in politics by promoting that the Palatinate (Pfalz) should join the German Empire. He was not to lose interest in down-under however, for in 1868 he proposed an expedition to central Australia – sadly a plan that was never to materialise.

He becomes a science administrator

Neumayer advocated long and hard for both the establishment of a German national geophysical institute and the need for government supported polar scientific expeditions (particularly Antarctica) and when he was appointed the first hydrographer of the German Admiralty in 1871, and later (1875) as the founding director of the "Deutsche Seewarte" he was in a unique position to both promote and direct such programs. The "Seewarte" was the all-encompassing scientific, hydrographic, oceanographic, meteorological, navigational and educational department within the German bureaucracy and the directorship was an esteemed position. Neumayer was to remain the director until his retirement in 1903.

After instigating a number of scientific expeditions, including the significant "Gazelle Expedition" of 1874-76, he was in 1879 appointed chairman of the International Polar Commission. This commission planned the 1882-83 International Polar Year (the precursor to the much later IGYs) when fourteen international polar and near-polar experimental stations were established. In 1895 he was to direct the German Commission for South Polar Exploration, an involvement which culminated in the construction of the research ship *Gauss* and the establishment of the German Antarctic Expedition of 1901-03 led by Erich von Drygalski.

Neumayer was to introduce both telegraphic meteorological reporting and daily weather map production throughout middle Europe.

Publications, recognition and credits

A number of books, educational texts, atlases and scientific papers were produced in Neumayer's name (as director of the Seewarte); some he wrote, some he edited and some he approved. I particularly like the quality of the "Atlas des Erdmagnetismus" published in 1891 for which he wrote the extensive text. This atlas included a very fine set of global and polar magnetic maps based on those separately published in the fourth edition of Berghaus's Physical Atlas (see Figure 1).

Neumayer was to receive many awards and presentations during his lifetime (over 150 reported) including honorary membership to a number of associations. He was accepted as a foreign member of the Royal Society of London and in 1900 was ennobled by his homeland.

Neumayer, in his old age, was never to lose his scientific interest or involvement and was to personally instruct a number of polar explorers, including Helmer Hannsen and Roald Amundsen, on the use of their various scientific instruments. He taught them how to set-up and make various geophysical observations.

Better late than never

In 1905, some fifty years late, the results of Neumayer's 1855-56 magnetometer survey of parts of Bavaria (Rhein-Pfalz) were published! Neumayer was at that time 79 years of age. The results were published as a report for the Natural Sciences Society of Rheinpfalz[1].

There were a few reasons to publish this report after 50 years, not least was the fact the observations were, even in 1905 quite

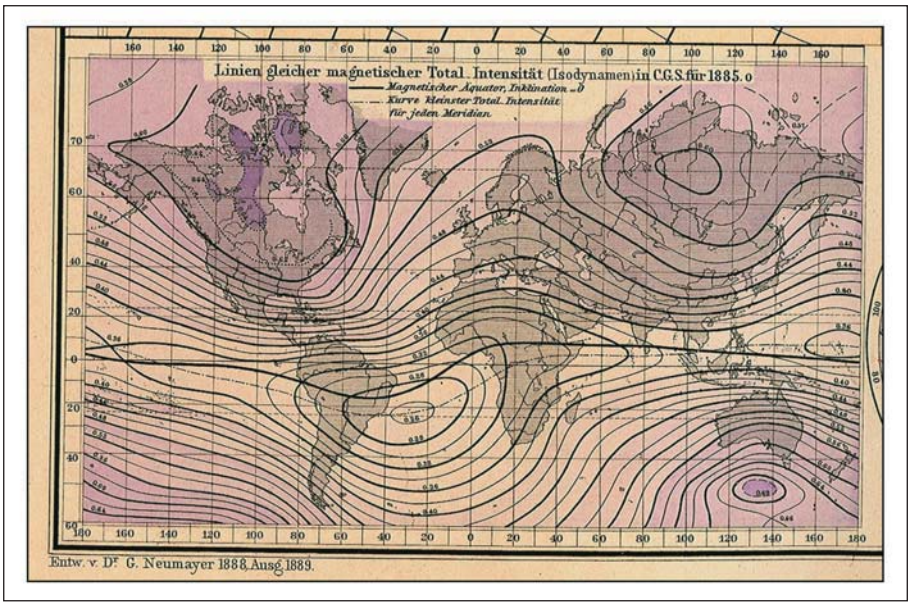


Fig. 1. Total magnetic intensity map of the world for the 1885 epoch. Extracted from the "Atlas des Erdmagnetismus" published in 1891 with twenty pages of text by Neumayer and 16 coloured maps (on four large folded plates). The maps had been updated from "Berghaus' Physikalischer Atlas, Abteilung IV". D. Morrison's copy.

[1] Neumayer, Dr. G. von. "Eine erdmagnetische Vermessung der bayerischen Rheinpfalz 1855/56", Mitteilungen der POLLICHIA eines naturwissenschaftlichen Vereins der Rheinpfalz. No.21. LXII. Jahrgang 1905. Bad Dürkheim 1905.

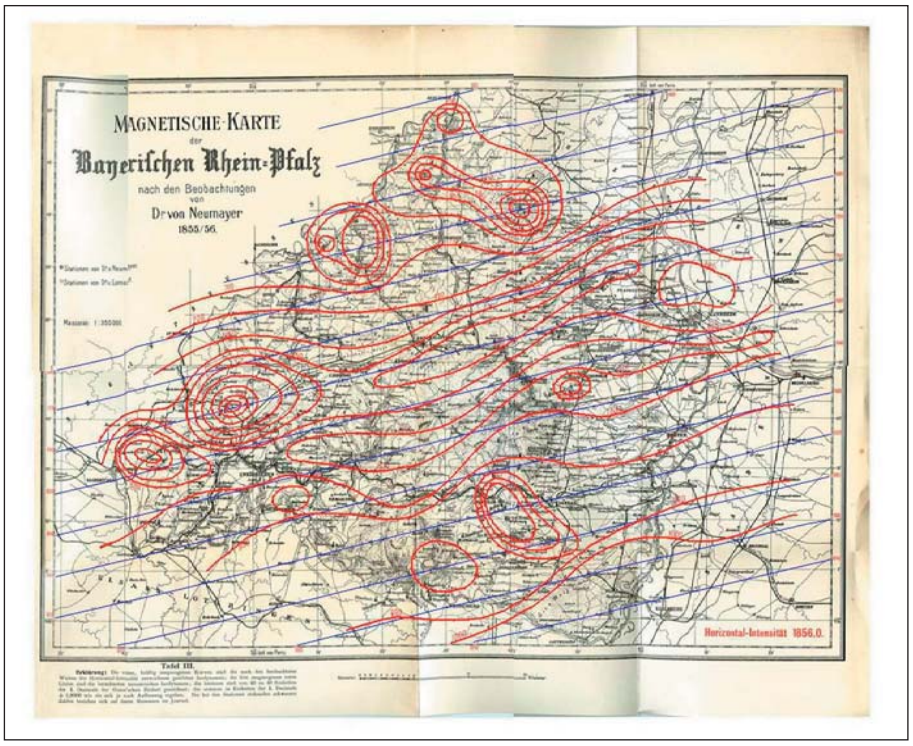


Fig. 2. Neumayer's horizontal magnetic intensity map of his 1855-56 survey of Bavaria-Pfalz published in 1905. This map also includes some earlier observations made or collated by Johann Lamont. Contours have been heavied here for reproduction. Detailed study by the author has revealed that the contours on this map are, disappointingly, a misleading and poor representation of Neumayer's and Lamont's data. A base level of 1.8000 cgs units was used with an inconsistent contour interval. D. Morrison's copy.

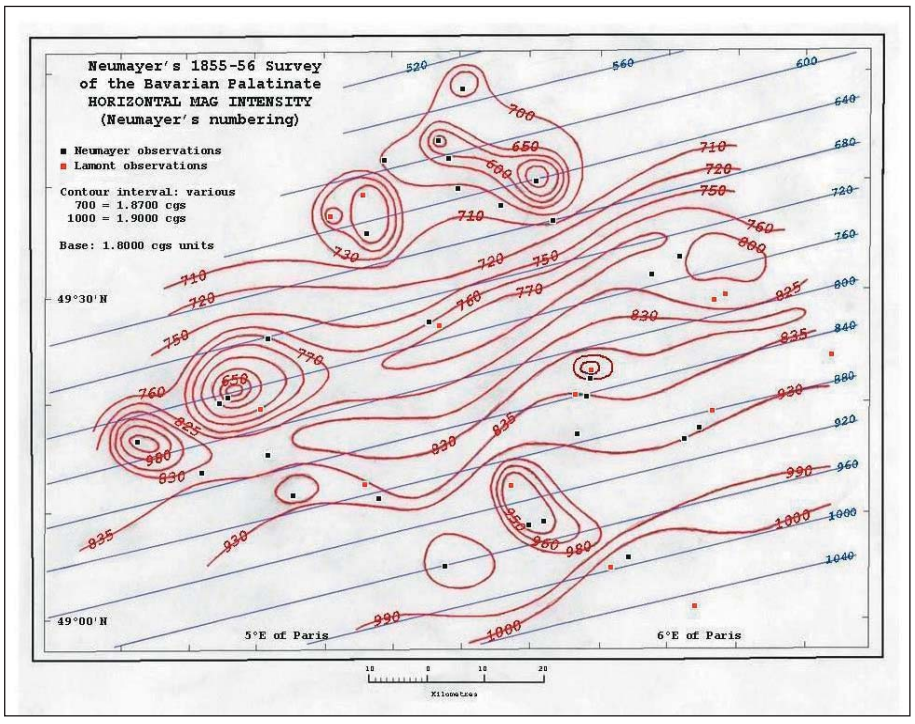


Fig. 3. A reproduction of Neumayer's contours as shown in Fig.2 indicating station locations. The contouring in the centre of the map and the lack of contours south of contour "835" has distorted the true picture. Blue lines indicate the then known theoretical regional gradient.

historic. Neumayer had soldered his data in a tin capsule in 1856, travelling with him to and from Australia, and it was not until many years later that the capsule was opened. Neumayer wrote that he never had time to write-up these original results. ASEG member Peter Wolfgram feels Neumayer was both respecting a debt to his "friend and teacher" Johann Lamont to publish and, as an old man, was tidying up his life's work – this is how it appears to us nowadays.

By 1905 the connection between geology and terrestrial magnetism was an active field of research and as Neumayer had made some basic geological/geophysical conclusions in his original 1856 writings, they were of considerable local interest, although Neumayer modestly questioned the worth of his old work. He wrote the foreword to the 1905 publication, with his actual survey measurements, station locations and field descriptions being published and supplemented by later work by other persons. The report does indicate that before his travel to Australia, Neumayer was very interested in the geological influence on his observations and that is historically significant. He was also to specifically describe two Victorian examples in his 1905 writings, that of the Cranbourne meteorites (1861) and the Mount Useful greenstones (1863)[2]. He mentioned (a number of times) the magnetic influences in the vicinity of coal-beds within his Pfalz survey, even discussing individual anomalies, although he did resist interpreting them.

Maybe not better late

Neumayer's published geophysical maps of Pfalz, the picturesque region bounded by the Rhine in the east and Luxemburg and France in the west, included one of horizontal magnetic intensity, reproduced here (see Figure 2). It is not explained in the 1905 report when this map was actually drawn and whether or not it was based on later knowledge of the regional geology, however it was produced much later than 1856. Despite the confusion on the map timing, the map itself is disappointing as it

[2] The Mount Useful observations made on the 20th December 1863 have not been mentioned previously in this series, they were never included in Neumayer's Victorian survey because of their incompatibility to the regional map – he observed the horizontal intensity at 2.7610 cgs/5.9881 British Units and when this is compared to the average regional field, the anomaly, in our modern terminology, would peak in the vicinity of 3800 nT and the declination measured at 23° 26.54' W was extremely disturbed compared to the regional average of just over 9°E! Neumayer's original station description concluded that *the Volcanic rocks on the summit of the mount make the magnetic observations valueless*, strangely he made no comment of any of this in his narrative – he was however in raptures of the view from the summit.

Fig. 4. A surviving Reisetheodolit. Lamont manufactured forty five of these instruments. Image courtesy of Professor Heinrich Soffel, University of Munich.

shows a somewhat poor contour portrayal of Neumayer's observed (and by all appearances legitimate) survey data. The presentation shows an elongated east-west oriented anomaly that is not supported by Neumayer's observation points and the contour intervals, as drawn, are quite misleading (see Figure 3). Recompiling this data using only Neumayer's (and Lamont's) original observations would eliminate the east-west trends completely! This begs the question whether the map was in someway biased by information not measured during the survey – there were no real rules when this map was drawn so to produce a picture that was both representative of known geology as well as the observed horizontal magnetic intensity may have been a compromise and justified in Neumayer's mind. I am not quite sure how to react to this as a lasting memory to Neumayer's work – a little disappointing.

In conclusion

In this series I have been primarily concentrating on Neumayer's Victorian travels, particularly his descriptions during his regional magnetic survey; all of which was only one component of a very full life in science – I do not do him justice. In the latter half of the 19th century, Neumayer was a significant and possibly the dominant figure in European meteorology, oceanography and polar science.

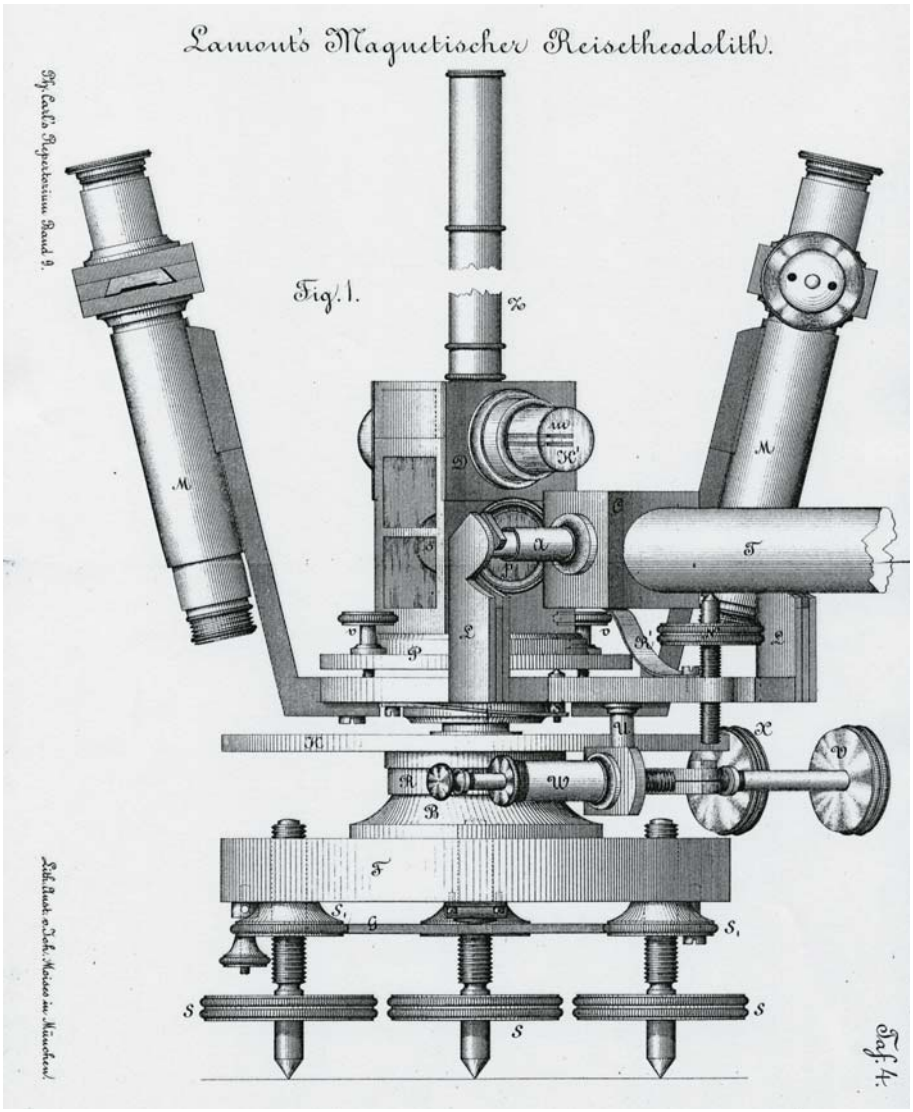


Fig. 5. Lamont's combined declination, inclination and horizontal intensity "Reisetheodolit". Neumayer measured all of his Victorian field measurements using a similar instrument. Image courtesy of Professor Heinrich Soffel, University of Munich.

Reportedly much of the Neumayer's "Seewarte" records and archives were destroyed in the intense firestorms that followed the allied World War II bombings of Hamburg, although some memorabilia has survived including items at the Pfalzmuseum für Naturkunde, Bad Dürkheim. This modest but important collection includes the presentation photographic portrait album of Melbourne residents who had attended Neumayer's 1864 farewell dinner – a significant colonial record.

Before Neumayer left Victoria he made a number of donations including books to the Melbourne Public Library and original oceanographic and navigational material to the Melbourne Chamber of Commerce – much of which has survived – with the books now residing in the State Library of Victoria and the historic oceanographic data at the Victorian State Archives. He also left some of his surveying and astronomical gear at the Melbourne Observatory. I have not been able to locate whether any of the geophysical instruments that returned with Neumayer to Europe have survived, although I suspect some probably have.

A number of photographs are known of Neumayer in his later life, being identified in various group photographs including those from the first polar conferences.

Herr Doktor von Neumayer (as he would have been respectfully addressed in later life) never married and he died on the 24th May 1909, aged 82 years 11 months, at Neustadt an

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Practical Magnetotellurics

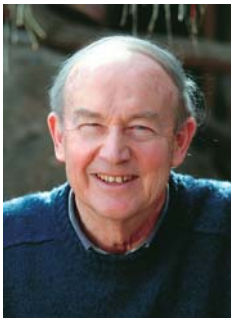
by Fiona Simpson and Karsten Bahr

Cambridge University Press, February 2005
270 pages

A$140 Hardback[1]

ISBN 0-521-81727-7

Reviewed by:



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This book is friendly, just what is needed to welcome newcomers to magnetotellurics, and start them off in the right direction. Having done that, the book will then accompany them for quite a long way. In its pleasant manner it gets to the heart of the subject, and to many of the more advanced points.

Much of Australia is ideal for MT, being flat and remote. The flatness makes for easier observation (such as the laying out of cables), and the remoteness makes for quiet low-noise electromagnetic conditions. The saltiness of the surface layer in many places however can cause distortions which are hard to handle.

In this review, written especially for Australian audiences, it is of interest to note that Simpson and Bahr, in collaboration, have extensive Australian experience, having held field programs here in recent years. Their purpose has been to exploit the expected high resistivity of the Australian Proterozoic crust to see through it into the mantle, and to test there for anisotropic electrical properties, reflecting tectonic history. The cover figure of the book shows Australian results.

At the start of the book, a sensible list of symbols used and their units follows a welcoming Preface. Especially in electricity and magnetism it is essential to keep units correct, and the widespread adoption of SI has been of great benefit. The reader still needs to take care however with what may be the practical units of geophysics. For example whereas in the symbols skin depth is listed as km, a later equation for its calculation will result in a quantity in metres.

Chapter 1 describes the basic natural physical phenomena being exploited in MT studies, and immediately goes to the geological significance of Earth electrical conductivity values. In fact of the two possibilities, conductivity and (its reciprocal) resistivity, the authors more often use resistivity. In some diagrams, an axis for the other could be included as well, to advantage. The historical perspective concluding Chapter 1 is particularly good value, given the direct lineage of MT back to a scientific giant like Gauss.

Chapter 2 is a very efficient production of the theoretical results upon which modern MT practice is based. At the start a list of assumptions of the MT method are stated. With these accepted, critical situations are dealt with in more detail, such as induction as a diffusion phenomenon and its frequency dependence; the case of horizontal layering; and the particular case of two-dimensional structure. Induction arrows (many Australian readers will know them as Parkinson arrows) are introduced in a discussion of transfer functions, and the MT impedance tensor is also introduced. In many respects, the extent to which the elements of this chapter are grasped will ultimately govern the success of many MT field projects.

While the reader is digesting the important information in Chapter 2, Chapter 3 moves to planning a field campaign. Here the approach is that of a field manual, with proven techniques described. It explains what the newcomer needs to know straight away. It is now relatively easy to make MT measurements (the signals are there naturally all the time) and the best way to get started in the subject may well be to get started on some measurements. This chapter tells you how.

No sooner has one gone to the field and set some MT gear going, than one will have data, and be waiting with excitement to see what is there. Initially the actual forms of the time series recorded will be of great interest, and perhaps this fascination will never be lost.

An appeal of geophysics is to see basic physics happening on a grand scale, in this case electromagnetic induction taking place “in real time”.

While you watch, the magnetic field changes, and corresponding voltages are induced at the surface of Earth. However very soon the large number of data recorded have to be reduced to fewer (and more easily managed) transfer functions. Transformation to the frequency domain arises, and complex quantities. In Chapter 4 the book provides a clear path to follow.

Then, with values for magnetotelluric impedance tensors in hand, interpretation starts in Chapter 5 with the matter of determining basically how complicated the inversion of the data will need to be. Rotation of axes may arise here too. A major advance occurred in MT with the recognition that much of the strongest distortion of observed data occurs locally (some boulder in the ground near where one of the electrodes has been buried, perhaps) and that such distortions can be removed reasonably easily. The procedure may be viewed as MT tensor decomposition, and often a 2D situation is then left, greatly aiding subsequent modelling and inversion of the data. The discussion in the book on this point is realistic, and the policy is advised of facing up to data more complicated than galvanically scattered 2D, if that is what you clearly have.

Chapter 6 on numerical forward modelling is brief, and demonstrates how MT is dependent on the ability of

[1] *Copies can be ordered directly from Cambridge University Press: Tel (03) 9676 9955 or from www.cambridge.edu.aus*

computers to handle differential equations applied simultaneously to a mesh of points dividing up a block model. For anyone, especially the newcomer, some forward modelling will be very instructive, and help them to understand their data much better. Ultimately they may use an inversion scheme which will be more automated and they will not have so much the feel of their data. Forward modelling will have prepared them well.

Chapter 7 is on Inversion of MT data, and we have now travelled a long way from when instruments were first installed in the field. The most important points of basic inversion science are addressed, so that much of this chapter forms a good introduction to inversion in geophysics generally. The closing sections of this chapter coach the reader in inversion techniques, and pass on the benefits of a lot of experience.

The procedure has now been followed to the point of having models of Earth electrical conductivity, and in Chapter 8 the book goes into its final stage, of returning to the geological significance of the results. There is further discussion on rock electrical conductivity, at a more advanced level than earlier. The discussion covers the crustal conductivities familiar in the exploration geophysics world, and also includes the conductivities of the lower crust and upper mantle as, most importantly, these are within reach of the lower frequencies and strong natural source fields exploited by MT. Dependence on temperature is fundamental, and attention is also given to the strong anisotropy often observed in field data. Resistor networks are introduced as models of rock resistivity.

Chapter 9 brings in a wider look, first of the relation of MT with seismic results. Various applications to geodynamics are then addressed, and lead naturally to seafloor MT and the probing of ocean plates, rises and trenches. Mentioning the ocean introduces motional induction due to the movement of seawater in Earth's steady magnetic field. The phenomenon, which occurs with tides, currents and waves, is demonstrated with tidal observations. The chapter concludes with attention to industrial and environmental applications.

Chapter 10 continues to look widely, revisiting various things possible with magnetometer measurements only, whether in arrays or as gradiometers. It is pleasing, at the end, to return to where some of the subject started, and a resolution of the journey. Active induction techniques are mentioned where they overlap with MT and may be used in a complementary manner, such as to determine the surface resistivity. Such surface values may be used to reset MT data which have been left floating after distortion removal.

The book concludes with succinct and valuable appendices on the mathematical tools needed, and a glossary of terms occurring frequently in MT discussion. The glossary is a summary of the subject in itself, and suggests all sorts of pithy examination questions for a lecture course on MT. The

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der Weinstrasse. He is rightly remembered with a number of memorials, a prestigious scientific medal awarded in his name, a German high school, and many placenames including a homestead, valley[3] and parish in Queensland, a New Guinea river, a group of New Guinea islands, a mountain in Greenland, a number of significant Antarctic features, the current German Antarctic base and a crater on the moon.

Acknowledgements

I must thank the Directors of the State Library of Victoria, the State Library of New South Wales, the National Library of Australia and the National Gallery of Australia for their kind permissions to reproduce some unique and historic images for this series and I particularly wish to thank the following for their continued interest and input – Shaun Hardy of the CIW/DTM-Geophysical Laboratory Library, Washington DC; Walter Struve of the State Library of Victoria; Hobartian and ASEG member Bob Richardson; ASEG member Peter Wolfgram for his helpful responses to my detailed questions on Neumayer's German language writings (particularly the 1856 Pfalz survey); and our editor David Denham who volunteered and obtained permissions for some essential images.

Postscript – Lamont's *Reisetheodolit* :

In June 2006, Heinrich Soffel, Emeritus Professor of geophysics, University of Munich, published an article in EOS, the newsletter of the American Geophysical Union commemorating the 200th anniversary of the birth of Georg Neumayer's mentor, Johann Lamont[4] and in July co-authored with Reinhold Häfner a substantial book on the life work of Lamont[5]. These writings confirm that Lamont performed regional magnetic surveys of France, Spain and Portugal in 1856-57 using a magnetically clean instrument of his design and construction, his "Reisetheodolit" (Figures 4 and 5).

It is significant that Neumayer wrote that the start of his Victorian fieldwork was delayed as his magnetometer was being used by Lamont in Spain and Professor Soffel's stories confirm this was the case. Eugene von Guérard sketched Neumayer observing with this particular instrument at Benalla in 1862 (see *Preview 123, page 18*). Neumayer had two of these Lamont magnetometers in Victoria and it was the backup instrument which was used briefly on the Burke and Wills expedition. It is possible the instruments have survived.

[3] Neumayer Valley, in the gulf country of Queensland was named on the 15th February 1862 by William Landsborough on his expedition in search of Burke and Wills.

[4] Soffel, H., "Johann von Lamont: A Pioneer in Geomagnetism", EOS, Vol.87, Number 25, p.247, 20 June 2006.

[5] Häfner, Reinhold and Heinrich Soffel, "Johann von Lamont, 1805-1879, Leben und Werk", Astronomical and Geophysical Observatory, University of Munich, July 2006.

Continued from page 38

list of references covers the topic well, and there is a good index.

Were space unrestricted, what would I add to the subject matter above? Further to the important caution about care in the calibration of instruments, I would add that it is easy to give recorded electric fields the wrong sign, due to making a mistake in the convention for a positive electric field. Electric fields are often squared in MT, and wrong signs may be lost sight of. However their effects may become evident elsewhere, such as in phase values in the wrong quadrant.

Regarding phase values, I would mention that there is a consequence for the signs of phases when making the choice of exp (+iωt) or exp(-iωt) in the Fourier transform process (on this point one of equations A5.6 has a negative sign missing). Also (a personal favourite) I would draw Mohr circles to illustrate dimensionality and distortion of the MT tensor. Such diagrams can be helpful in understanding what is going on.

The authors have produced a valuable book which I expect will be used widely. I am not aware of any other book like this dealing with magnetotellurics. For a variety of reasons magnetotellurics has in recent years reached a stage of maturity. Newcomers can proceed down a beaten path in the comfort of applying a developed technique, rather that having the feeling, as was the (albeit exciting) case just a generation or so ago, that they were in frontier research from the first observation. That is not to say that their particular geological situation and MT data will not provide frontier research, and its excitement, soon enough!

It is entirely appropriate that the book should come from the University of Gottingen, Germany, which has a great tradition in geomagnetism, dating back to Gauss.

Also, Australian readers will enjoy joining the authors and others around the world for whom it is a pleasure to imagine, as examples of diffusion, roast beef being cooked in an oven, while red wine is brought up from a cellar.

The book is well produced by CUP, with hard cover. Each chapter starts with a summary. Every group making MT observations should have a copy (perhaps several).

The Microtremor Survey Method

by Hiroshi Okada translated by Koya Suto

Geophysical Monograph Series (Number 12)

Series Editor: David V. Freedman

Volume Editor: Michael W. Asten

Publisher Society of Exploration Geophysicists[1]

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RRP: USD29.00 (SEG Member: USD19.00 - Student: USD15.20) + P&H 2004

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"The Microtremor Survey Method" (MSM) is a translation of Hiroshi Okada's Japanese text that shares the same title. It is translated into English by two of our own ASEG members, Koya Suto as translator and Michael Asten as editor, and is published by the Society of Exploration Geophysicists as Number 12 of the Geophysical Monograph Series. It covers the basics of microtremor surveying and how properties of the Earth's subsurface can be modeled from microtremor recordings.

Microtremors refer to the ubiquitous natural low amplitude vibrations that are recorded at the Earth's surface. Typically, the amplitude is too small for direct human observation. Sources of microtremors are diverse and include anything that creates a disturbance on the Earth's surface such as ocean waves or traffic. Chapter 1 describes the microtremor survey as a "natural field method" and compares it other geophysical applications that exploit natural signals such as the gravity, magnetic, magnetotelluric and self-potential (SP) techniques. Strictly speaking many microtremor sources are urban in origin and not completely natural. However since the microtremor observer has no control over the source the MSM is considered a natural field method.

Chapter 2 describes the "fundamental properties of microtremors". It includes a discussion of power spectra, and temporal and spatial variations of microtremors. Temporal changes relate to variation in source and are most striking in urban areas where one can observe diurnal changes in human activity. Spatial variations can be linked to changes in atmospheric pressure and Earth structure. Okada demonstrates that for frequencies less than 1 Hz spatial variation in microtremors are most sensitive to geological structure.

The "principle of the microtremor survey method" is discussed in chapter 3. The chapter describes how microtremors are dominated by surface waves and in particular how the dispersion of surface waves can be used to estimate isotropic homogenous velocity layers. Central to the MSM is the identification of surface waves. Okada describes two approaches for detecting surface waves; the frequency-wavenumber (f-k) method and the spatial autocorrelation (SPAC) method.

Chapter 4 discusses "estimating phase velocity and subsurface structure". It describes how an inversion can be used to model subsurface structure from phase velocity when two basic assumptions are considered: (1) the phase velocity observed from microtremors represents that of fundamental mode Rayleigh waves, and (2) the structure under the array is layered. This chapter also presents an extension of the SPAC method known as the extended spatial autocorrelation (ESPAC) method. Unlike SPAC which requires stations on a circle to record simultaneously, ESPAC can use multiple station arrays in equilateral triangles with different recording times.

"Data acquisition and analysis methods" is the subject of chapter 5. Station and orientation requirements are presented for the f-k, SPAC and ESPAC methods. Each technique has advantages and disadvantages. For example, ESPAC is demonstrated to require fewer stations and be superior at lower frequencies then f-k. However, unlike the f-k method it can not be used to detect the direction of the source wave or higher modes.

Chapter 6 covers three case studies. The first is for the Tokachi Plain, Hokkaido. The f-k method is used and the resulting layered velocity model compared to a density model from gravitational measurements and two reflection seismic surveys. Okada demonstrates that the f-k method identifies many of the reflectors that are shown in the seismic survey; although it does miss some due its dependence on wavelength. However, the f-k method is identifies some reflectors that are seen on P-wave sonic logs but are not present in the seismic sections. In case 2 the SPAC technique is used to model phase velocities and the results compared to logging and refraction surveys. It is demonstrated that a 4-point equilateral array with radius 3 m is sufficient to estimate structure to a depth of 50 m. In the last of the case studies the SPAC technique is applied to the Osaka and Hyogo region to model layered velocity structure. This region is of particular engineering interest due to observed high correlation between damage from the 17 January 1995 Kobe earthquake and local geological structure. Okada demonstrates that subsurface structure determined from the SPAC technique compares favorable with the work of others.

In the final chapter Okada offers closing remarks on the MSM and in particular identifies the potential for its expansion in the future. I recommend "The Microtremor Survey Method" to anyone who is interested in unraveling the information contained in microtremors. Usefulness of the technique is demonstrated for urban earthquake engineering applications; however it also has potential in oil and gas prospecting.

[1] *Copies can be ordered from the SEG web page (http://www.seg.org/)*