Preview

Australian Society of Exploration Geophysicists

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Surface waves and engineering geophysics

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Australian bathymetry and topography

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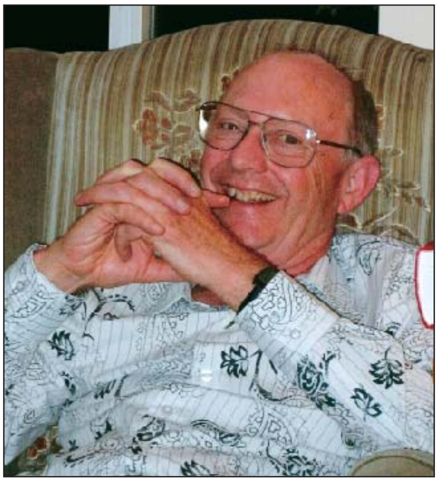

David Denham

Eristicus was not able to write the Canberra Observed column for this Preview, so I picked out three issues that crossed my desk this month. These relate to research infrastructure in Australia, the Productivity Commission tackling the value of research and innovation, and communication and censorship in science. I hope you find these topics to be of interest.

Earth Sciences do well in infrastructure research road map

Structure and evolution of the Australian continent has been identified as a priority area to access the $541 million committed in the 2004-2005 Budget for investing in research infrastructure to 2010/11.

As part of the *Backing Australia's Ability: Building Our Future through Science and Innovation* package, the Government identified the need to bring more strategic direction to Australia's investment in research infrastructure. In the 2004-05 Budget, it announced the National Collaborative Research Infrastructure Strategy (NCRIS) to provide greater focus and coordination to develop and maintain these facilities.

In October 2004, Brendan Nelson, the then Minister for Education, Science and Training, appointed an Advisory Committee, chaired by Rory Hume, to advise on how NCRIS should be implemented. The Advisory Committee submitted its recommendations to the Minister in July 2005 following a public call for submissions and extensive consultations with stakeholders and the Minister accepted the recommendations as the basis for the implementation of NCRIS. Then on 28 February 2006 Julie Bishop the current Minister for Education, Science and Training, announced details of the Roadmap which will outline priority areas of the Australian Government's major research infrastructure investment over the next five years.

The nine selected areas so far are:

1. ***Evolving biomolecular platforms and informatics;***
2. ***Integrated biological systems;***
3. ***Characterisation;***
4. ***Fabrication;***
5. ***Biotechnology products;***
6. ***Networked biosecurity framework;***
7. ***Optical and radio astronomy;***
8. ***Integrated marine observing system; and***
9. ***Structure and evolution of the Australian continent.***

Two other areas were identified where further development work needed to be done on current capabilities before proceeding to full implementation proposals. These are:

- *Population health and clinical data linkage; and*
- *Terrestrial ecosystem research network.*

Anyway, the next step will be to develop and consider proposals for access to NCRIS funds, and that is where the really hard work will start.

The Roadmap and complete list of priority areas for investment are available through the NCRIS website: http://www.dest.gov.au/sectors/research_sector/policies_issues_reviews/key_issues/ncris/

Productivity Commission to review public support for science and innovation

Meanwhile, the Productivity Commission is to undertake a research study into the economic, social and environmental returns on public support for science and innovation in Australia.

According to the media statement released by Ministers Costello and Bishop, "science and innovation is a Government priority and makes a significant contribution to productivity, growth and Australia's recent and ongoing economic and social prosperity".

"The study will provide a rigorous evaluation of science and innovation support in Australia and would complement ongoing and planned reviews of the Backing Australia Ability programmes".

The Commission's study will consider all key elements of the innovation system, including research and development, and especially:

- The economic impact of public support for science and innovation, including impacts on Australia's recent productivity performance;
- Impediments to the effective functioning of Australia's innovation system; and
- The broader social and environmental impacts.

The Commission has been asked to report within 12 months.

Further information on the study is available from the Commission's website: http://www.pc.gov.au/study/science/index.html. The media release by Ministers Bishop and Costello can be accessed at: http://www.treasurer.gov.au/tsr/content/pressreleases/2006/010.asp.

It could be a very interesting report.

Freedom of speech for scientists?

Climate Change (or Global Warming) has recently become a very political issue in both Australia and in the US. Here there have been accusations in the media about CSIRO scientists being gagged and censored. Likewise, in the US, the New York Times and the Washington Post recently published articles concerning NASA's treatment of James Hansen, Director of the Goddard Institute for Space Studies.

In the US, the House Science Committee Chairman Sherwood Boehlert (R-NY) responded promptly on the issue by sending Michael Griffin, Administrator of NASA a very clear letter (see http://www.house.gov/science/press/109/109-184.htm), which I have reproduced in full below:

Dear Dr. Griffin:

I am writing in response to several recent news articles indicating that officials at NASA may be trying to "silence" Dr. James Hansen, the director of the Goddard Institute for Space Studies.

It ought to go without saying that government scientists must be free to describe their scientific conclusions and the implications of those conclusions to their fellow scientists, policymakers and the general public. Any effort to censor federal scientists biases public discussions of scientific issues, increases distrust of the government and makes it difficult for the government to attract the best scientists. And when it comes to an issue like climate change, a subject of ongoing public debate with immense ramifications, the government ought to be bending over backward to make sure that its scientists are able to discuss their work and what it means.

Good science cannot long persist in an atmosphere of intimidation. Political figures ought to be reviewing their public statements to make sure they are consistent with the best available science; scientists should not be reviewing their statements to make sure they are consistent with the current political orthodoxy.

NASA is clearly doing something wrong, given the sense of intimidation felt by Dr. Hansen and others who work with him. Even if this sense is a result of a misinterpretation of NASA policies – and more seems to be at play here – the problem still must be corrected. I will be following this matter closely to ensure that the right staff and policies are in place at NASA to encourage open discussion of critical scientific issues. I assume you share that goal.

Our staff is already setting up meetings to pursue this issue, and I appreciate NASA's responsiveness to our inquiries thus far. I would ask that you swiftly provide to the Committee, in writing, a clear statement of NASA's policies governing the activities of its scientists.

NASA is one of the nation's leading scientific institutions. I look forward to working with you to keep it that way, and to ensure that the entire nation gets the full benefit of NASA science.

Sincerely,
Sherwood Boehlert
Chairman

What a great letter and what a breath of fresh air! It seems that even on the Republican side of politics in the US there is a clear understanding of the importance of unfettered communication on science issues.

If 'CSIRO' replaced 'NASA' in the above text, would Julie Bishop replace Sherwood Boehlert as signatory? It would be good if this happened but it is most unlikely.

David Denham

Terry Crabb

This is my farewell President's Piece as a new President will be elected at the AGM commencing at 17:30 on Tuesday April 11 at Chifley on the Terrace, St Georges Terrace, Perth.

On behalf of all ASEG members, I thank the Federal Executive for their honourable efforts in managing and supporting your Society. I have enjoyed the extraordinary support of

- Jenny Bauer, First Vice President, kept the Executive updated on Conference issues;

- Howard Golden, Past President, in addition to providing moral support and continuity in decision making, has been most active in promoting and supporting the Indigenous Summer School, and has also been involved in the constitutional change process;

- James Reid, President Elect, has been the ASEG's representative on the AGC;

- Phil Schmidt, recently appointed Publication Chair, has been managing the development of our website via The Research Institute, our newly appointed website developer;

- Koya Suto, Membership Chair, has done another superb job of managing membership matters as well as instigating and continued support of the Joint Publication of *Exploration Geophysics* with SEGJ and KSEG;

- Lisa Vella, Secretary, has done a great job given the time she has spent outside the country in her new position with Teck Cominco; and

- John Watt, Treasurer, who presided over the difficult task of amalgamating State ASEG Accounts, and managed to cope with the increased load of tracking funds and expenditures.

Our prestigious publications, the flagships of our Society reflect proudly on our Editors and their support teams and authors. The *Exploration Geophysics* Editor, Lindsay Thomas, the *Preview* Editor, David Denham, the Associate Editors and contributors tireless efforts in getting publications out to our members in a timely manner has been much appreciated by all. With Exploration Geophysics now back on schedule, ISI listing should follow shortly.

I mentioned in the last issue of *Preview* that the 34th International Geological Congress will be held in Brisbane in 2012. This event, **AUSTRALIA 2012 – Unearthing our Past and Future** is being suggested as a target date for the implementation of the consolidation of the Geoscientist representative organisations into a single body.

Within the different Federal Executives over the past few years there has been discussion of the merit of amalgamation of the different Geoscience Societies.

Many ASEG members are also members of the SEG, EAEG, PESA, GSA, AusIMM, AIG, AAPG or SEG, and as a consequence have a plethora of meetings, conferences, seminars and events to attend, many of which often conflict.

Our membership demographic shows a rapidly ageing society, with the lengthy commodity slump and renowned cyclic nature of the industry, not helping to provide a supply of younger geoscientists to reverse this trend.

Our numbers are not increasing, and, apart from the decrease in graduate numbers, perhaps this is due to the fact that the option of joining a number of smaller specific societies rather than one larger, more encompassing society is not attractive to the more multi-functional/ talented graduates being produced by today's Educational system.

If you are interested in discussing this matter, and how such a consolidation may be implemented, it is intended to be a topic at the Council Meeting at the AESC on Sunday July 02, where other Geoscience Societies will be invited to attend. I hope to see you there.

I wish the incoming Federal Executive every success in providing more of what you as members of the ASEG wish your Society to provide – I wonder if an amalgamated Geoscience Society is what you want?

CALENDAR OF EVENTS

2006

19-21 April
AAS Elizabeth and Frederick White Conference
Theme: Mastering the data explosion in the Earth and Environmental sciences
Venue: Shine Dome of the Australian Academy of Science, Canberra
Website: http://rses.anu.edu.au/cadi/Whiteconference

1-7 May
Australian Institute of Geoscientists 25th Anniversary Conference
Theme: Outcrop to orebody - applied geoscience in exploration and mining. Presentations will integrate modern theory, practice and procedure in the exploration and mining industry.
Website: http//:www.aig.asn.au/aig25.htm

3-5 May
7th International Gold Symposium
National Museum, Lima, Peru
Website: www.snmpe.org.pe

7-10 May
2006 APPEA Conference
Venue: Gold Coast Convention & Exhibition Centre, Qld
Website: http://www.appea.com.au/conference/CallforPapers2006.pdf

Lisa Vella

Come to the Council Meeting

What a year 2006 is shaping up to be! First there was the excitement and the danger of the Torino Winter Olympics. This was closely followed by the drama – packed lead up to the commencement of the Melbourne Commonwealth Games. And as I type this, with the telecast of Day 1 of the Commonwealth Games on TV in the background, and I suddenly hear that Australia has won a gold medal in the cycling, I know there are going to be many more wonderful moments (and trials and tribulations) to come in the next few weeks. But, I digress. When the Commonwealth Games have finished and the glorious wins start to fade in our mind, what do we have to look forward to? Why, the Australian Earth Sciences Convention (AESC), of course! And one of the highlights of the AESC is the ASEG Council Meeting! Don't laugh! Alright, you can laugh a little…but, let's get serious here for a moment…

The Council Meeting is arguably the ASEG's most important business meeting in our calendar. It is an opportunity for all members to participate in our future program.

It will be held from 2-5 pm on the Sunday 2 July before the conference ice breaker drinks. All members are invited and encouraged to attend.

Representatives from other geoscientific societies are also often invited. The Council Meeting is an opportunity for office bearers to present to members information on the current status of the society and plans for the years ahead. For example, in the previous Council Meeting, at the 2004 conference, brief presentations were given on society finances, membership, conferences, the Research Foundation, the constitution and publications, to name a few. Each state branch also presented an update of their activities. In addition, several other topics were discussed among the attendees, as a very important aim of the Council Meeting is also to solicit ideas and feedback from society members.

At the coming ASEG Council Meeting, aside from the abovementioned presentations, there will likely be discussion on topics such as formalized relationships between the ASEG and other geoscientific organisations, improvements to the website, digital publications, amendments to the constitution, and more. If there is a subject, or issue you wish to bring to the attention of ASEG office bearers, the Council Meeting is an opportune time to do this. I strongly encourage members to attend and take an active interest in what is going on behind the scenes in your society. So put into your diary now: 2 pm, Sunday, July 2nd, 2006, in Melbourne.

Looking forward to seeing you at the AESC!

Lisa Vella
ASEG Secretary

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

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

10-11 July
Australia's Uranium: World Leadership in Exploration, Resources, Mining, Processing and Regulation
Venue: Adelaide, South Australia
Organiser: AusIMM
Contact: Donna Edwards
Email: dedwards@ausimm.com.au or
Website: http://www.ausimm.com/uranium/

24-27 July
AGU Western Pacific Geophysics Meeting
Sponsored by the AGU, 10 Chinese societies and many others

Venue: Beijing, China
Website: http://www.agu.org/meetings/wp06/

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

5-8 November
2006 AAPG International Conference and Exhibition
Theme: Reunite Gondwana – realise the potential
Host: PESA
Venue: Perth Conference and Exhibition Centre
Contact: www.aapg.org/perth/

16-28 November
8th International Symposium on Imaging and Interpretation
Sponsored by SEGJ
Co-sponsored by ASEG, KSEG, SEG, EAGE and EEGS
Venue: Kyoto University, Kyoto, Japan
Abstract deadline: 12 May 2006
Website: http://www.segj.org/is8/
Email: segj8th@segj.org

2007

23-28 September 2007
SEG International Exposition & 77th Annual Meeting
Venue: San Antonio, Texas, U.S.
Contact: http://seg.org/meetings/calendar

18-22 November 2007
ASEG's 19th International Conference and Exhibition
Perth, WA
Contact: Brian Evans
Email: brian.evans@geophy.curtin.edu.au


Howard Golden


Roger Henderson

Indigenous Engineering Summer School – 2006

by Howard Golden
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John Peacock and Jenny Powell demonstrate GPR technology to the Indigenous students on the grounds of the University of NSW.


Howard Golden explores the secrets of gravity measurements with the IAESS class of 2006.


An enthusiastic group of potential Indigenous geophysicists receive an explanation of magnetic methods from Roger Henderson

The Indigenous Australian Engineering Summer School (IAESS) was established 8 years ago by Engineering Aid. This is a non-profit organisation designed to attract Indigenous students with an aptitude in maths, science and technology to consider engineering as a career, increase engineering awareness within the Indigenous community and the importance of engineers within their direct communities and the world at large. The Summer School is organised by the UNSW Faculty of Engineering, Nura Gili Indigenous Programs at UNSW, and Engineering Aid.

Beginning in 2004, ASEG joined the IAESS to provide input for a Geophysics module in an effort to attract highly numerate Indigenous students to study geophysics in university. To that end, volunteers from ASEG spend time each January with about 20 Aboriginal and Torres Strait Islander students, male and female, entering Years 11 and 12.

In 2006 the five day session attracted 20 students, giving them a taste of engineering and geophysics as a university course and career. Applicants are selected for IAESS on the basis of their interest in useful engineering subjects (mathematics and science) and personal initiative and outlook.

The geophysics component this year was held on 20 January. The students were presented with a demonstration of geophysical equipment and procedures by volunteers Howard Golden of Gravitec Instruments, Jennie Powell of Curtin University, John Peacock of Fugro, Mads Toft of Alpha GeoInstruments and consultant Roger Henderson.

After a five minute talk from Howard, the students were formed into groups that rotated between hands-on use of a gravity meter, magnetometer, spectrometer, susceptibility and conductivity meters and two types of ground probing radar. Unfortunately, the originally planned concept of inspiring the students by having a fully equipped helicopter land on the lawn this year was overruled by the regulators.

Following the activities, Howard and Jennie were fortunate enough to attend the graduation dinner along with the students and dignitaries including Bob Hawke, the IAESS Patron. They also joined the students and Governor-General Michael Jefferies at Admiralty House the following morning for tea and award giving.

Even though the geophysics session was at the end of a packed week for the students, they were responsive, interested and asked pertinent questions, including how much geophysicists are paid! Thanks to the current boom the answers were all positive. All involved were pleased with the session and now 20 more indigenous high school students going on to university have been exposed to the wonders of geophysics.

Next year, there are plans to include the shallow seismic technique and have the students conduct a mini survey and interpret the results.

John Peacock and Jenny Powell demonstrate GPR technology to the Indigenous students on the grounds of the University of NSW.

Howard Golden explores the secrets of gravity measurements with the IAESS class of 2006.

An enthusiastic group of potential Indigenous geophysicists receive an explanation of magnetic methods from Roger Henderson.

A group of Aboriginal scholars are fascinated by Mads Toft's elucidation of the finer points of high resolution ground penetrating radar.

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Australian Society of Exploration Geophysicists — Honours and Awards

ASEG members are invited to submit nominations for the next round of ASEG Honours and Awards. Nominations that are judged to be appropriate and are then subsequently selected will be presented at the 18th ASEG conference, in Melbourne, July 2-6, 2006. Details of the available awards follow.

1. ASEG Gold Medal

For exceptional and highly significant distinguished contributions to the science and practice of geophysics by a member, resulting in wide recognition within the geoscientific community. The nominee must be a member of the ASEG.

2. Honorary Membership

For distinguished contributions by a member to the profession of exploration geophysics and to the ASEG over many years. Requires at least 20 years as a member of the ASEG, except where the nominee is a recipient of the ASEG Gold medal.

3. Grahame Sands Award

For innovation in applied geophysics through a significant practical development of benefit to Australian exploration geophysics in the field of instrumentation, data acquisition, interpretation or theory. The nominee does not need to be a member of the ASEG.

4. Lindsay Ingall Memorial Award

For the promotion of geophysics to the wider community. This award is intended for an Australian resident or former resident for the promotion of geophysics, (including but not necessarily limited to applications, technologies or education), within the non-geophysical community, including geologists, geochemists, engineers, managers, politicians, the media or the general public. The nominee does not need to be a geophysicist or a member of the ASEG.

5. ASEG Service Medal

For outstanding and distinguished service by a member in making major contributions to the shaping and the sustaining of the Society and the conduct of its affairs over many years. The nominee will have been a member of the ASEG for a significant and sustained period of time and will have at some stage been one of the following:

- Federal President, Treasurer or Secretary,
- State President, Conference Chairman or Standing Committee Chairman
- Editor of *Exploration Geophysics* or *Preview*

6. ASEG Service Certificates

For distinguished service by a member to the ASEG, through involvement in and contribution to State Branch committees, Federal Committees, Publications, and Conferences.

Nomination Procedure

For the first four award categories any member of the Society may nominate applicants. These nominations are to be supported by a seconder, and in the case of the Lindsay Ingall Memorial Award by at least four geoscientists who are members of an Australian geoscience body (eg GSA, AusIMM, AIG, IAH, ASEG or similar). Nominations for the ASEG Service Medal and the ASEG Service Certificates are to be proposed by the State and Federal Executives.

All aspects of the criteria should be addressed, and a nomination must be specific to a particular award. To gain some idea of the standard of nomination expected, nominees are advised to read past citations for awards published in Preview.

Nominations including digital copies of all relevant supporting documentation are to be sent electronically to:

Chairman, ASEG Honours and
Awards Committee
Email: bill@sgc.com.au
Tel: 08 9316 2814 Fax: 08 9316 1624

Applications will close on May 2nd 2006

AUSTRALIAN CIVIL HONOUR AWARDS

Distinguished ASEG members may also be nominated for one of the following Australian Civil Honour Awards

- Companion in the Order of Australia (AC)
- Officer in the Order of Australia (AO)
- Member in the Order of Australia (AM)
- Medal of the Order of Australia (OAM)

Such nominations should be made directly using the following website:

http://www.itsanhonour.gov.au/about/medal_descriptions/order_of_australia.html

Jim Peacock Chief Scientist

Dr Jim Peacock

The Minister for Education, Science and Training, the Hon Julie Bishop MP, announced the appointment of Dr Jim Peacock as Australia's new Chief Scientist on 28 February 2006.

Jim Peacock is currently, President of the Australian Academy of Science, and is a Research Fellow of CSIRO Plant Industry in Canberra (where he was Chief of Division from 1978 -2003). His laboratory is recognised internationally in the field of plant molecular biology and its applications in agriculture.

He was made a Companion of the Order of Australia, Australia's highest honour, for his contribution to the nation. Dr Peacock is a Fellow of The Royal Society of London, the Australian Academy of Technological Sciences and Engineering, a Foreign Associate of the US National Academy of Sciences and a Foreign Fellow of the Indian National Science Academy. In 2000 he was a co-recipient of the Inaugural Prime Minister's Science Prize. He is also a Member of the Prime Minister's Science, Engineering and Innovation Council.

Dr Peacock is prominent in the interfacing of plant science with modern agribusiness. He drives innovative communication efforts to extend research results and educate key decision-makers and the general public as to the outcomes and value of modern science. He has brought the excitement of biological research to a broad cross-section of the community and to a large population of Australian school students.

The ASEG wishes him well in his new role.

Chief Scientist still part-time

It is unfortunate that it took the Government so long to appoint a replacement for Robin Batterham (the previous Chief Scientist), who announced that he would resign as long ago as 16 May 2005.

It is also disappointing that the position is still only a part-time appointment.

With science and technology becoming central to a wide range of government activities, it appears very strange that only a part-time appointment was made. It is difficult to see why we don't have a full-time Chief Scientist as recommended by a Senate Committee in 2004.

The government's response to this recommendation was quite trite. It simply said:

The Government determines whether the appointment of the Chief Scientist should be full-time or part-time in the light of the requirements of the position at the time of the appointment and the best arrangements for the appointee at the time.

Hardly a compelling argument for such an important position!

New Members

The ASEG welcomes the following new members to the Society. Their membership was approved at the Federal Executive meetings on 25 January and 22 February 2006.

Name	Organisation	State
Gregory John Armstrong	Consultant	WA
Alex Hugh Guy Browne	CGG Australia Pty Ltd	WA
Mark Browne	Stuart Petroleum	SA
Kristofer Davis	Colorado School of Mines	USA
Thomas Godfrey Evans	Spectrum Geo-Consulting	SA
Karen Gilgallon	Southern Geoscience Consultants	WA
Christopher Bernard Harrison	Curtin University	WA
Bruce Phillip Harvey	Fugro Airborne Surveys Pty Ltd	WA
Philip John Heath	Uni of Adelaide	SA
Matthew Alan Hope	Fugro Airborne Surveys Pty Ltd	WA
James Jensen	Fugro Ground Geophysics Pty Ltd	WA
Mason Kass	Colorado School of Mines	USA
Anthony John Kielniacz	Xstrata Copper Exploration	Qld
Terence James McConnell	Fugro Airborne Surveys Pty Ltd	WA
Neil Stewart Millar	Origin Energy	Qld
Thangapandian Muthupandian	Independence Group NL	WA
Richard Newport	Richard Newport & Associates	NSW
Craig Raynes	Indigeo Consultants	India
Indrajit Roy	Geoscience Australia	ACT
James Marsden Shadlow	Univ NSW	NSW
Phillip Skladzien	Geoscience Victoria	Vic
Andrew Hamilton Tucker		SA
Benjamin Wielstra	Newexco Services	WA
Christopher John Wiles	Newmont Mining Corporation	WA
David Wynn	Contractor	USA

David Giles now Director of Centre for Mineral Exploration Under Cover

Prof. David Giles has been appointed the inaugural State of South Australia Chair of Mineral Exploration and is Director of the newly established Centre for Mineral Exploration Under Cover (CMXUC) at the University of Adelaide.

David comes to the University of Adelaide from Monash University where he completed his PhD in 2000 under the supervision of Gordon Lister.

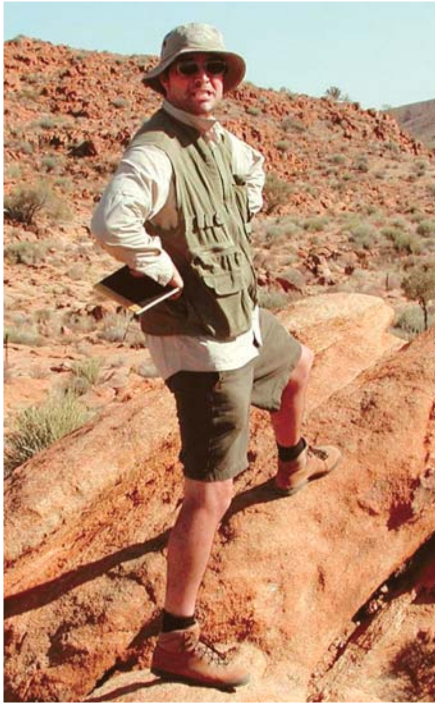
In the early to mid-90s David worked in gold exploration for Acacia Resources (née Billiton) and Great Central Mines. Since 2000 he has worked on a number of collaborative research projects with exploration companies, principally BHP Billiton. The underlying theme of this work is that mineral systems can be (indeed must be) understood within the context of the tectonic environment in which they formed.

The Centre for Mineral Exploration Under Cover is an initiative of the Department of Primary Industry and Resources South Australia (PIRSA) and the University of Adelaide. The aim is to establish a world leading research centre, explicitly addressing the challenge of mineral exploration beneath and within cover rocks, which conceal much of the metallogenically endowed basement of Australia.

The CMXUC will build upon existing research strengths at the University of Adelaide and PIRSA, including regolith and landscape evolution, tectonics and metallogeny, and exploration geophysics. Key to the success of the Centre will be building effective, long-standing relationships with the exploration and mining industry and aligning our research aims with those of explorers. A major theme of CMXUC research will be managing risk and building exploration confidence – from identifying prospective greenfield terranes to refining targets in near mine exploration.

This is an exciting time for mineral exploration in Australia and particularly in South Australia. We have been buoyed by recent successes both within the cover (Eucla Basin mineral sands) and beneath it (Carrapateena, Prominent Hill). Our challenge is to maintain this level of excitement and help create a research environment that will facilitate continuing exploration success.

ASEG wishes David and the CMXUC well, and hopes that they will contribute to many more discoveries in South Australia and beyond.



David Giles

Australian Capital Territory — by Adrian Hitchman

The 2006 AGM for the ACT Branch took place on 21 February. Reports delivered at the meeting by the President and Secretary were a reminder of the active year enjoyed by the Branch in 2005. The Committee for 2006 was elected at the meeting; it is:

President:	Adrian Hitchman
Vice President:	Alice Murray
Secretary:	Matthew Purss
Treasurer:	Hugh Tassell
Committee:	Grant Butler
	Leonie Jones
	Andrew Lewis
	Nick Rawlinson
	David Robinson

A vote of thanks for outgoing President, Jacques Sayers, Treasurer, Mario Bacchin, and committee member Brian Minty for their service in 2005 was passed unanimously. Members also expressed their gratitude to those who continue to serve on the committee and welcomed those who have joined it for 2006. Their contributions to supporting branch activities in the coming year will be invaluable.

Jacques Sayers (CO2CRC, Geoscience Australia) gave an interesting presentation on *Carbon dioxide storage somewhere in Queensland* immediately following the AGM. Jacques has contributed a geophysical perspective to CO_2 sequestration investigations at Geoscience Australia with the CO2CRC and will pursue further research on the topic as part of a PhD at the University of Adelaide during the coming years. We are grateful for his informative and topical talk and wish him well in his studies.

This year promises to be another active year for the ACT Branch with a number of technical presentations already arranged. A complete program of presentations will soon be formulated.

New members and visitors who may wish to participate in branch activities are always welcome. Please contact Matthew Purss (02-6249 9383, matthew.purss@ga.gov.au) or Adrian Hitchman (02-6249 9800, adrian.hitchman@ga.gov.au) with enquiries.

New South Wales — by Glenn Wilson

The NSW Branch held the first meeting of the year and it's AGM in February. After years of service, both Michael Moore and Naomi Osman retired from their respective offices of President and Secretary. Carina Simmat was elected as President *in absentia* and Glenn Wilson was elected as Secretary. Roger Henderson continues as Treasurer and Peter Gidley as Webmaster. The 2005 President's and Treasurer's Reports are available from the Branch website. Mike Smith gave an impromptu overview of Australian Geoscience Council activities, including planning for the International Geological Congress to be held in Brisbane in 2012. Roger Henderson provided a report on the ASEG's contributions to the Indigenous Australian Engineering Summer School held at the University of New South Wales in January 2006.

In March, the Branch snared the travelling Tim Munday of CSIRO Exploration and Mining from Perth who presented a recent history (and frank account) of the lessons learnt, mistakes made and future directions in the application of airborne electromagnetics to natural resource management applications in the Murray Basin. Topical presentations for forthcoming branch meetings include exploration geophysics for coal, noise reduction in radiometric data and joint geophysical inversion. A Branch dinner is planned for July in the weeks following the Australian Earth Science Convention.

An invitation to attend (and present at) NSW Branch meetings is extended to interstate and international visitors with Sydney *en passant* itineraries. Meetings are held on the third Wednesday of each month from 5:30 pm at The Rugby Club in the Sydney CBD. Meeting notices, addresses and relevant contact details can be found at the NSW Branch website.

South Australia — by Selina Donnelley

The South Australian Branch held their AGM on the 15th of February. A new committee was voted in, with Selina Donnelley re-elected as President, David Cockshell re-elected as Treasurer, and Matt Densley elected as Secretary. A large crowd of members and students were entertained by an excellent presentation by the new Professor for Exploration Under Cover, at the University of Adelaide, David Giles. David presented a talk entitled *Where to for Geophysics? A geologist's perspective on the future of geophysics in exploration.* David presented examples of geophysics and geology combining very effectively in the minerals exploration industry, and how geophysical modelling can be greatly improved with geological knowledge and constraints.

We again thank our sponsors for technical meetings in 2005: PIRSA, Schlumberger, Santos, Cooper Energy, Australian School of Petroleum, Minotaur Resources, Petrosys, Zonge Engineering, Beach Petroleum, Stuart Petroleum and PGS Reservoir. We hope to include this generous group again in 2006 as sponsors for the SA Branch.

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

ASEG Research Foundation

Project Results

The ASEG Research Foundation has been supporting students in all facets of Applied Geophysics at the BSc (Honours), MSc and PhD (or equivalent) levels for 15 years. In this issue of *Preview* we provide summaries of two research projects undertaken at The University of Adelaide.

ASEG Research Foundation Project RF03P02

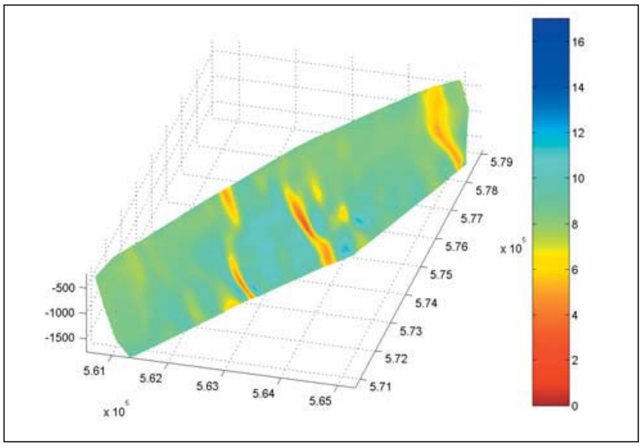
Stress Modelling for Hydrocarbon Exploration and Development

Student:
Emma Nelson
PhD Student 2003-2006 at the Australian School of Petroleum, University of Adelaide
Supervisors:
Richard Hillis and Scott Mildren
Funding: *$24050*

Project Summary

Accurate knowledge of the present-day stress tensor is critical to the efficient development of petroleum provinces, mineral resources and underground excavations. The present-day stress tensor has applications to petroleum and geothermal well design including the assessment of wellbore stability and the design of fracture stimulation and waterflooding programs. In most studies the present-day stress tensor is determined at a sedimentary basin or hydrocarbon field scale. However, it is well known that different lithological units behave differently with applied tectonic stress load depending on their individual mechanical properties. It has also been observed that the orientation and magnitude of the present-day stress may be perturbed around large geological structures such as faults, and that injection and/or depletion of porous rock may also lead to changes in local present-day stress magnitudes.

In this study, knowledge and understanding of the distribution of present-day stress at a field and reservoir scale has been applied to reservoir development issues in the Champion Southeast Field (Brunei), the Gippsland Basin (offshore Victoria) and the Cooper Basin (onshore South Australia). The Champion Southeast and Gippsland Basin present-day stress studies utilised finite element methods to model stress distribution and partitioning between different lithologies at a field and near-wellbore scale. A dense data-set of mini-frac pressure decline curves and image logs were used to (analytically) model stress variation in individual lithological units to help optimise hydraulic fracture stimulation operations in the Cooper Basin. The distribution of present-day stress has also been considered at a regional scale across Southeast Australia (the Otway and Gippsland Basins). Summaries of the four case studies undertaken from March 2003 to January 2006 are presented below.



Case Study I. Reactivation risk during re-pressurisation on fault 13/10 assuming P_p = 6.5MPa/km (looking Northeast). The fault is coloured by the increase in pore pressure gradient (MPa/km) required to reactivate the fault. Blue corresponds to low risk, while red indicates high risk. Although fault 13/10 is predominantly green, the minimum (highest risk) pore pressure increase is greater (less risk) than that required to cause faulting of the intact rock.

Case Study I: Champion Southeast Field, Brunei (2003)

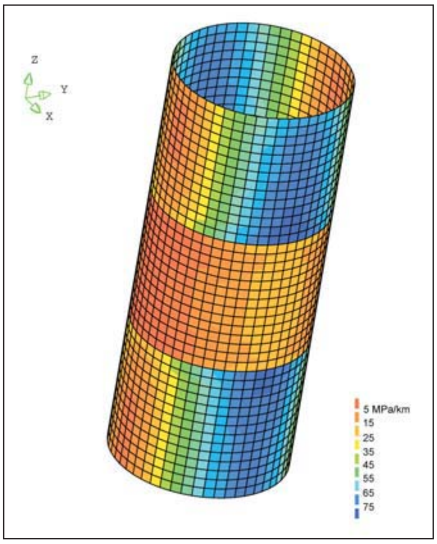
Linear elastic finite element modelling of present-day stress was undertaken in the Champion Southeast field using the DIANA finite element code. Modelling was undertaken to help assess the possibility that faults might reactivate due to perturbations in the present-day stress field caused by contrasts in fault/reservoir-rock properties and high levels of differential depletion. In general, the combined effects of across-fault differential depletion and contrasting material properties act to reduce the risk of fault reactivation. The exception to this occurs where the fault is particularly soft (Young's modulus of the fault rock is half that of the reservoir-rock), and there is significant depletion (4 and 6 MPa/km in the footwall with respect to a hydrostatic hanging wall). In these cases the orientation of S_{Hmax} and S_{hmin} rotate by 90 (or swap around). Rotation of the minimum horizontal stress to fault-normal results in the block-bounding faults becoming suitably oriented for reactivation. The large Young's modulus contrast assumed for the soft fault case means the maximum depletion value may be conservative. A paper entitled: *The reservoir stress path and it's implications for water-flooding, Champion Southeast Field Brunei*, was submitted to the ARMA Alaska Rocks Conference (2005) for review in November 2004 and was accepted for publication in 2005.

Case Study II: Borehole deformation in the West Tuna area, Gippsland Basin (2003-2004)

The present-day stress tensor was determined from petroleum data as a first step in examining stress distribution within the West Tuna area (Gippsland Basin). Analysis of wireline log data, rock strength tests, image logs and pressure data revealed that the present-day stress in the Gippsland Basin is high (border of strike-slip and reverse faulting). A paper derived from this work entitled: *Present-day stresses of the West Tuna area, Gippsland Basin*, was submitted to the Australian Journal of Earth Sciences in August 2004 and was accepted for publication in December 2004.

Two types of drilling-induced tensile fractures were observed in the West Tuna image logs during the present-day stress study. These were transverse DITFs, which are oriented horizontally across the (vertical) wellbore, and axial DITFs which are oriented parallel to the wellbore axis. Transverse DITFs have not previously been identified in the literature to date and are very useful in constraining the magnitude of the minimum and maximum horizontal stresses. A paper entitled: *Transverse drilling-induced tensile fractures in the West Tuna area, Gippsland Basin, Australia:*

implications for the present-day stress regime, was submitted to the International Journal of Rock Mechanics and Mining Sciences in May 2004. The paper was accepted for publication in December 2004. Analysis of image logs from the Gippsland Basin also indicated that wellbore failure (borehole breakout) only occurred in cemented sandstone units. This observation was considered unusual as wellbore failure is normally expected in the weaker lithological units. Finite element methods were utilised to investigate the far-field and near-wellbore stress distribution in modelled horizontal, interbedded sands and shales. Preliminary modelling indicates that very high stress concentrations can occur at the wellbore wall in basins where sandstones are harder than shales and high horizontal present-day stresses are present. These high stress concentrations at the wellbore wall can result in high levels of borehole breakout and wellbore instability. A paper entitled: *Stress partitioning and wellbore failure in the West Tuna area, Gippsland Basin*, was submitted to Exploration Geophysics in January 2006 and is under review.

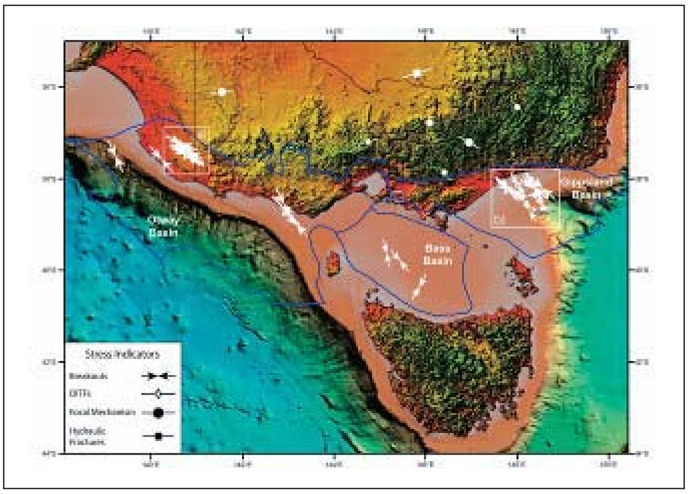


Case Study II. 3D finite element model of interbedded sandstone and shales. The 'sandstone' layers (red) were assigned an elastic moduli of 40 GPa and a Poisson's ratio of 0.25. The shale layer (orange) was assigned an elastic moduli of 0.86 GPa and a Poisson's ratio of 0.3. The model shows the circumferential stress at the wellbore wall derived for the 'sand' and 'shale'.

The image log data also revealed significant fracturing in the sandstone units of the deep intra-Latrobe and Golden Beach Subgroups. Four fracture sets (one electrically resistive and three electrically conductive) were interpreted in the West Tuna area. Fracture susceptibility analysis (analysis of the orientation of natural fractures with respect to the present-day stress field) of the interpreted fractures suggests that the electrically conductive fractures are optimally oriented to be hydraulically conductive with the present-day stress field. However, fracture density is low in the West Tuna area and it is unlikely that the fractures contribute significantly to reservoir permeability. The fractures are located in cemented sandstones with low matrix permeability they may be important to reservoir connectivity in the area. This work (titled: *The present-day stress field of the West Tuna area, Gippsland Basin: implications for wellbore stability and natural fracture-enhanced permeability*) was presented at the 2004 ASEG-Sydney conference and won the Best Petroleum Presentation Award.

Case Study III: Southeast Australian Stress Field

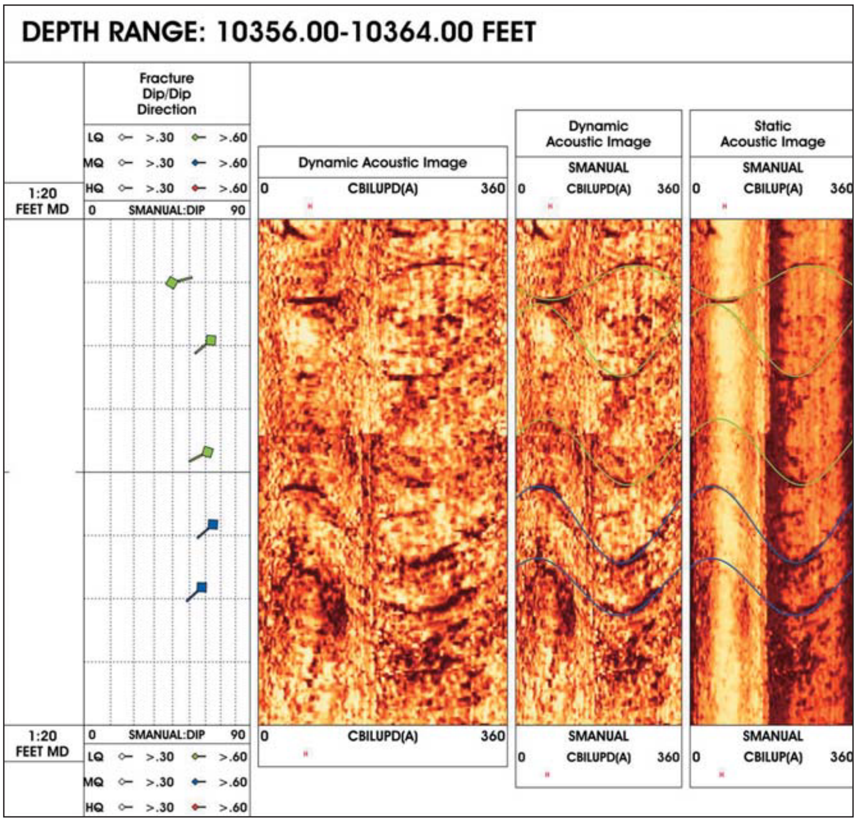
The study on borehole deformation in the West Tuna area of the Gippsland Basin (outlined above) revealed that horizontal present-day stresses in the Gippsland Basin are much higher than are observed in other Southeast Australian basins. Further work comparing the Gippsland stress tensor to the South Australian (SA) and Victorian (Vic) Otway stress tensors has shown that the maximum horizontal stress rotates from ~ 125 N in the SA Otway to 136 N in the Vic Otway to ~ 139 N in the Gippsland Basin. The minimum horizontal stress magnitude increases from 16.4 MPa/km in the SA Otway to 18.5 MPa/km in the Vic Otway and 19.5 MPa/km in the Gippsland Basin. Both the orientation and magnitudes of the present-day stress tensor, derived using petroleum well data, are consistent with present-day stress data derived from earthquake focal mechanism solutions. It is believed that the range in present-day stress magnitude and orientation from East to West across southeast Australia is primarily controlled by proximity to the (oblique compressional) plate boundary at New Zealand. A paper entitled: *Present-day stress in southeast Australia*, has been submitted and accepted for publication in the APPEA journal and will be presented at the APPEA conference at the Gold Coast in May 2006.



Case Study III. Orientation of the maximum horizontal stress in southeast Australia as determined from image log and 4-arm dipmeter data. The maximum horizontal stress orientations from A-C quality focal mechanisms from the Australian Stress Map are also shown.

Case Study IV: Mechanical Stratigraphy of the Cooper Basin

Fracture stimulation treatments of tight formations in the Cooper Basin can be associated with hydraulic fracture complexity that results in abnormally high treating pressures, low proppant placement and poor economic success. Detailed analysis of minifrac data, rock strength data (from core) and wellbore failure on image logs was undertaken to help understand the interplay between rock strength, present-day stress and rock fabric during fracture stimulation operations in the Cooper Basin. Pre-completion (image log and rock testing data) and post completion data (hydraulic fracturing pressure decline plots) were reviewed in 13 treatment zones from the Cooper Basin, seven of which had rock strength, image log and stimulation data over a single reservoir. From this analysis, a distinct relationship between rock properties (shear and tensile rock strength), geological weaknesses (natural fractures and other fabrics) and fracture stimulation complexity (net pressure, near wellbore pressure loss and pressure dependent leak-off) was observed. The analysis suggests that high present-day stress (S_{hmin} 18.1 MPa/km) and a large contrast in tensile strength between intact rock



Case Study IV. Dynamic and static representations of an acoustic image log from the Cooper Basin. The track to the far left shows 'tadpoles' representing the natural fracture orientations. The image log may be thought of as an 'unwrapped' image of the wellbore wall hence natural fractures plot as sinusoids.

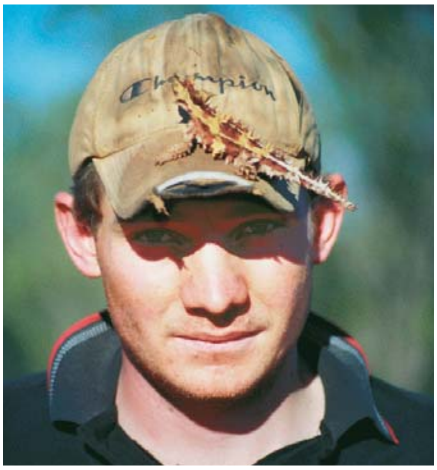
(T >7 MPa) and pre-existing weaknesses in the reservoir (T ~ 0) promotes the propagation of fracturing fluid along multiple fracture pathways during fracture stimulation treatments in the Cooper Basin. Two papers: *Using Geological information to optimise stimulation practices in the Cooper Basin, Australia'* and *The relationship between closure pressures identified from fluid injections and the minimum principal stress in strong rocks*, were submitted to '*Petroleum Geoscience*' and '*The International Journal of Rock Mechanics and Mining Science*' respectively in January 2006 and are presently under review.

Acknowledgements

I would like to thank my supervisors, Richard Hillis and Scott Mildren for their encouragement and guidance during these studies, Santos (Simon Chipperfield, Jim McGowen, John Gilbert, Dave Warner, Eric Dunlop and Thomas Flottmann) and Brunei Shell (Andreas Briner and Dan Van Nispen) for providing data and technical advice and the ASEG Research Foundation for providing financial support.

ASEG Research Foundation Project RF04P02:

Magnetotellurics for terrestrial petroleum exploration: a case study from the Officer Basin



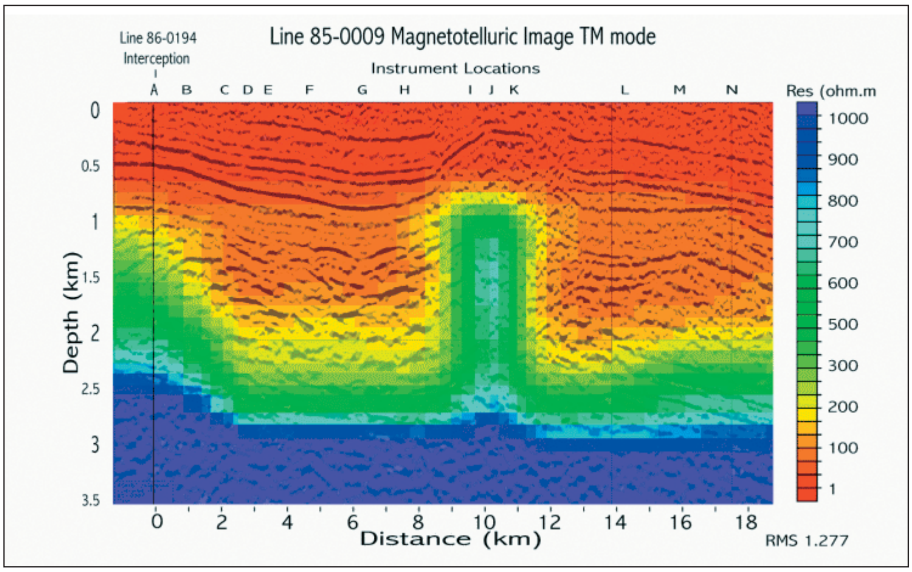


Fig. 1. Results of smooth 2D inversion of the TM mode MT responses from 14 sites in the bandwidth 1-1000 s. The starting model was constrained from the seismic data (also shown in the Figure), and then inverted for 100 iterations. The electrically resistive salt region (beneath stations IJK) is coincident with the seismic structures.

Student:
Clarke Petrick
Honours Student 2004 at School of Earth and Environmental Sciences
University of Adelaide
Supervisors:
Graham Heinson (University of Adelaide) and Peter Boult (PIRSA, Petroleum Group)
Funding: *$2704*

Project Summary

The Officer Basin is Australia's largest intra-cratonic sedimentary basin. It contains a number of salt diapiric structures that have been partially defined from two-dimensional seismic transects. The ASEG Research Foundation supported a pilot study using magnetotellurics (MT) and gravity data to assess the potential of these methods to delineate salt diapiric structures. The study aimed to develop an economical and low impact technique for greenfields exploration of basins for which hydrocarbon resources may be structurally controlled by salt tectonics. Twenty-six MT sites with a site spacing of less than 1 km were deployed across two orthogonal seismic transects, one that crosses a known salt structure and the other with no salt. The depth of top-salt was 700 m with a width 2.5 km, and appears to be quite disseminated resulting in low acoustic impedance contrasts.

Both sets of MT data were inverted for two-dimensional resistivity structure to a depth of 10 km and evaluated against the seismically imaged basin model (Figure 1). We found that the salt diapiric structure is only marginally defined by the MT and gravity data, but with more sites and better quality data the resolution will undoubtedly improve. The salt structure was imaged in the same location as the seismic anomaly, and appears as a slightly more resistive body (>500 Ω.m) compared to the porous sedimentary host (~1-200 Ω.m). The resistivity model imaged depth of dipping basement (> 1000 Ω.m), and we show a consistency with the gravity data. We conclude that in areas of salt structure poorly imaged by seismic methods, MT may be a significant new exploration tool to delineate potential targets.

More ARC geoscience awards

In the February Preview we listed the successful Linkage Grants that were awarded to geoscience-related projects. In this issue we list the geoscience-related Discovery grants and also a couple of Linkage Grants that were not listed earlier. Where the projects are directly related to geophysics or resource exploration the Project Summary is given. For all others we have listed only the project title.

Geoscience-related Discovery Grants

Tectonic links between the Musgrave Province and the North Australian Craton: correlations, event chronology, and tectonothermal regimes
Researcher: DE Kelsey
Funding:
2006: $90,000 2007: $65,000
2008: $70,000 2009: $70,000
Administering Institution:
The University of Adelaide

Project Summary: Developing effective mineral exploration strategies relies on data-rich tectonic models that seek to explain the full history of a terrane. In the Australian context the tectonic evolution of the Musgrave Province is a key focus of the minerals industry due to its widely recognised potential for base-metal mineralisation. This project will develop tectonic models that encompass the evolution of the Musgrave Province and the adjacent North Australia Craton. The outcomes of the project will reduce risk to mineral explorers and make an important contribution to the broader question Australia's Proterozoic evolution.

Crustal stress field of SE Asia
Researchers: MR Tingay, R Hall; CK Morley and D Coblentz
Funding:
2006: $65,000 2007: $65,000
2008: $65,000 2009: $55,755
Administering Institution:
The University of Adelaide

Project Summary: The key project benefit is to advance our fundamental understanding of tectonic processes such as sedimentary basin development and continental collision. It has major implications for natural hazard assessment and resources exploration in SE Asia, consistent with Australia's participation in the APEC Energy Working Group. The project has major ancillary benefits. It will strengthen international links between Australia, SE Asia, the UK, USA and Germany. It will provide high-quality research and training experience for the APD and PhD student involved, whom will spend time with research groups and oil companies in Australia, UK, USA and SE Asia. Finally, the project will increase the institutional capacity for contract research in SE Asia.

The Indian Ocean Dipole, Australasian drought, and the great-earthquake cycle: long-term perspectives for improved prediction
Researchers: MK Gagan; WS Hantoro; DH Natawidjaja; JM Lough; G Meyers; Z Liu; K Sieh
Funding:
2006: 260,000 2007: $190,000
2008: $180,000 2009: $183,000
2010: $203,000
Administering Institution:
The Australian National University

Project Summary: The protracted drought across Australia and Boxing Day 2004 earthquake in Sumatra defied prediction, and are causing incalculable environmental, economic, and social harm Knowledge of past climate extremes will enhance our ability to predict climate change, and alleviate adverse affects for Australasian nations who miss-out in the future redistribution of life-giving moisture. Insights into the great-earthquake cycle will help fulfil Australia's responsibility to predict tsunamis, for the benefit of nations fringing Australasian seismotectonic zones. Development of improved techniques in palaeoclimatology, palaeoclimate modelling, and palaeoseismology will provide new collaborations and opportunities for research, training, and education.

Monsoon extremes, environmental shifts, and catastrophic volcanic eruptions: quantifying impacts on the early human history of southern Australasia
Researchers: MK Gagan; J Zhao; RN Drysdale; WS Hantoro; GA Schmidt
Funding:
2006: $245,000 2007: $100,000
2008: $100,000
Administering Institution:
The Australian National University

Microanalysis of human fossils: new insights into age, diet and migration
Researchers: R Grun; MJ Spriggs; IS Williams
Funding:
2006: $105,000 2007: $90,000
2008: $90,000
Administering Institution:
The Australian National University

The role of Halide Melts in Platinum-Group Element mobility
Researcher: JJ Hanley
Funding:
2006: $83,090 2007: $81,340
2008: $81,340
Administering Institution:
The Australian National University

Exploring the Hadean Earth
Researchers: TM Harrison; J Blichert-Toft; G Turner; B Bourdon; SJ Mojzsis
Funding:
2006: $120,000 2007: $80,000
2008: $80,000
Administering Institution:
The Australian National University

Sources and processes in the early solar system – an isotopic study
Researchers: TR Ireland; Y Amelin; EK Zinner
Funding:
2006: $90,000 2007: $70,000
2008: $70,000
Administering Institution:
The Australian National University

Seismic constraints on the assembly of cratons
Researcher: BL Kennett
Funding:
2006: $200,000 2007: $120,000
2008: $120,000 2009: $95,000
Administering Institution:
The Australian National University

Project Summary: Improved definition of the 3D seismological structure and nature of the major lithospheric blocks in Australia and their assembly to form the present-day continent will be sought from seismological data. The inclusion of information on the depth extent and character of the lithosphere will improve geological understanding of the evolution of the continent, with relevance to the interaction of the crust and mantle and the placement of mineral resources.

Understanding the deep mantle: experimental petrology at very high pressures
Researchers: HS O'Neill; B Wood; T Irifune
Funding:
2006: $190,000 2007: $145,000
2008: $145,000
Administering Institution:
The Australian National University

Project Summary: The great processes that shape the Earth at its surface, including plate tectonics and continental drift, can only be understood by appreciating how the interior of the Earth works. However, studying the deep Earth is difficult because of the enormous pressures and temperatures involved. This research proposes to simulate conditions in the Earth's lower mantle (that is, below 670 km in depth) by making use of an Australian invented diamond-based ceramic, to double the pressure at which experiments can be performed. The information gained from this fundamental research will help predict how giant ore bodies form. The development of the high-pressure apparatus will also aid material scientists in their quest for novel materials.

Precise location of earthquakes: combining arrival times with Coda Wave Interferometry
Researchers: M Sambridge; RK Snieder
Funding:
2006: $113,000 2007: $112,000
2008: $112,000
Administering Institution:
The Australian National University

Project Summary: The location of earthquakes is important for improving our knowledge of the contemporary plate tectonic regime, mapping of active crustal faults and quantifying risk posed to population centres and infrastructure. Precise relative location of micro-earthquakes also has important industrial applications, including mapping the extent of underground geothermal reservoirs, and in exploration for ore producing hydrothermal systems. This project will advance the field of earthquake location by introducing new techniques that will increase the amount of seismic information that can be used for both research and national monitoring purposes.

Ellipsoidal physical geodesy - improved global and local gravity field modelling
Researchers: WE Featherstone; SJ Claessens
Funding:
2006: $150,000 2007: $150,000
2008: $150,000 2009: $150,000
2010: $150,000
Administering Institution:
Curtin University of Technology

Project Summary: Improved techniques for gravity field modelling, using the ellipsoidal approach proposed in this research, will increase the accuracy of the Australian geoid model. A more accurate model of the geoid will bring great cost-benefits mainly to the Australian surveying, mapping and exploration community. For example, height determination from GPS [Global Positioning System] or similar satellite-based measurements is only possible with the aid of an accurate geoid model. This will allow the use GPS to its full capacity and save valuable time and money (by as much as a factor of 10).

Mineral reaction, deformation, and accessory phases in migmatites: what controls monazite behaviour during high-grade metamorphism?
Researchers: IC Fitzsimons; SL Harley
Funding:
2006: $75,000 2007: $65,000
2008: $70,000
Administering Institution:
Curtin University of Technology

New molecular and isotopic biomarker approaches to establishing source, palaeoclimate, facies and thermal history of sedimentary organic matter
Researchers: K Grice; PF Greenwood; RE Summons; PD Franzmann
Funding:
2006: $134,000 2007: $100,000
2008: $100,000
Administering Institution:
Curtin University of Technology

Project Summary: The ability to identify crude oil sources is a key issue in petroleum exploration, especially in Australia where vast gas deposits occur but very limited reserves of liquid hydrocarbons have been discovered. Discoveries of new petroleum reservoirs/ provinces will benefit all Australians. Technological developments made will be extended to other Australian basins leading to more effective petroleum and mineral exploration strategies. The project described will also help our understanding of climate variability of past episodes and help predict what might happen in the future. The PhD scholars will foster high-calibre postgraduate research students suitable for employment in research or in industry.

The effects of Crystal-Plastic Deformation on Zircon geochemical systems
Researchers: SM Reddy; PD Kinny; SA Wilde; PV Crowhurst; JK Lee
Funding:
2006: $115,000 2007: $114,000
2008: $92,000
Administering Institution:
Curtin University of Technology

Spreading ridge sedimentation processes: a novel approach using Macquarie Island as a natural laboratory
Researchers: NR Daczko; JA Dickinson
Funding:
2006: $60,000 2007: $70,000
2008: $65,000
Administering Institution:
Macquarie University

Project Summary: This research will examine the south eastern tectonic plate boundary of Australia, providing analogues for seafloor spreading related crustal processes that relate to present plate boundaries and ancient examples now joined to the Australian continent. The scientific innovation represented by this project will help Australian scientists to better understand an important part of the plate tectonic cycle. This project will be of direct relevance to the Australian minerals exploration industry and will provide better constraints on rift-related metallogenesis

Stable water isotopic simulation and analysis to improve Earth System models and deliver better predictions of Australian water resource vulnerability
Researcher: A Henderson-Sellers
Funding:
2006: $210,000 2007: $165,000
2008: $170,000 2009: $180,000
2010: $180,000
Administering Institution:
Macquarie University

Thallium isotopes: a novel geochemical tracer to map recycling in Earth's mantle
Researcher: SG Nielsen
Funding:
2006: $105,000 2007: $80,000
2008: $85,000
Administering Institution:
Macquarie University

A revolution in Earth history: life and environment in the Neoarchaean (2.5-2.8 Ga)
Researchers: MR Walter; AH Knoll
Funding:
2006: $50,000 2007: $45,000
2008: $40,000
Administering Institution:
Macquarie University

The behaviour of geochemical tracers during differentiation of the Earth
Researchers: B Wood; D Rubie; SP Kelley; R Hervig
Funding:
2006: $150,000 2007: $100,000
2008: $100,000
Administering Institution:
Macquarie University

Reconstructing the morphotectonic evolution of rifted continental margins from low-temperature thermochronology
Researchers: AJ Gleadow; BP Kohn; RW Brown; JM Fletcher; F Chemale Jr.
Funding:
2006: $110,000 2007: $103,000
2008: $90,000
Administering Institution:
The University of Melbourne

Project Summary: Knowledge of how continental rifting occurs will improve our ability to predict the locations of important oil and gas resources on the margins of Australia and elsewhere, which is directly relevant to the National Research Priority goal of Developing Deep Earth Resources. The project will enhance our national scientific standing by developing and maintaining key expertise and facilities that can sustain a world-leading research capability in Australia. The project will also forge strong international links with researchers outside Australia, build our research profile in an area of significant worldwide scientific interest at the present time, and provide a training ground for a new generation of younger scientists in Australia.

Geodynamic evolution of the Banda Arc
Researcher: G Rosenbaum
Funding:
2006: $75,000 2007: $75,000
2008: $75,000
Administering Institution:
The University of Melbourne

Project Summary: The project will contribute to a better understanding of plate tectonic processes and will provide insights into the dynamics of the Indo-Australian plate. This information is fundamentally important for estimating seismic hazards and the potential for generating large magnitude earthquakes in Australia. Outcomes of this project will facilitate to unravel analogue tectonic systems that were active during the geological evolution of Australia (e.g. the Lachlan fold belt in eastern Australia), thus providing a new insight into the Australian environment. The project will also elucidate the nature of tectonic processes that are known to generate major ore deposits and is therefore likely to have important economic implications.

Of caves, bones, and climate change: new insights from old speleothems
Researchers: JD Woodhead; PW Williams; F McDermott
Funding:
2006: $80,000 2007: $80,000
2008: $80,000
Administering Institution:
The University of Melbourne

The eruption, emplacement and characteristics of extremely large volume pyroclastic flow deposits (ignimbrites)
Researchers: RA Cas; KV Cashman; S de Silva; G Giordano; O Roche; JG Viramonte
Funding:
2006: $132,000 2007: $110,000
2008: $110,000 2009: $60,000
Administering Institution:
Monash University

Plate kinematics to plate dynamics: understanding plate boundary processes at the global scale
Researchers: LN Moresi; HB Muhlhaus
Funding:
2006: $150,000 2007: $150,000
2008: $150,000
Administering Institution:
Monash University

Project Summary: This proposal aims to create geodynamic models which can be used a basis for a new, smart resource exploration and extraction industry which uses simulation to help characterize regions where traditional geophysical imaging alone is not able to penetrate. It provides essential scientific underpinnings for The Australian Computational Earth System Simulator Major National Research Facility (ACcESS).

Planetary pulsations: exploring links between superplumes, supercontinents, and superchrons with 3D spherical mantle convection models
Researchers: DR Stegman; TH Torsvik; MA Richards
Funding:
2006: $125,000 2007: $90,000
2008: $90,000
Administering Institution:
Monash University

Project Summary: This project advances the tools and knowledge base regarding historic motions of tectonic plates (including the Australian continent). This furthers understanding of the current and past state of stress in the Earth's surface, ultimately improving ways of characterizing earthquake hazard and mineral exploration. This project also benefits researchers interpreting the climate record as two processes which affected the ancient climate are investigated: major outbursts of greenhouse gases during periods of major volcanism and the reorientation of the planet with respect to its spin axis. The results are obtained with these computer simulations highlight Australia's emerging strength in supercomputing on the international scene.

Functional complexity of modern marine stromatolites
Researchers: BP Burns; MR Walter
Funding:
2006: $130,000 2007: $103,000
2008: $103,000 2009: $103,000
2010: $103,000
Administering Institution:
The University of New South Wales

Australia's mammalian carnivore diversity in space and time
Researcher: SW Wroe
Funding:
2006: $200,000 2007: $150,000
2008: $150,000 2009: $125,000
2010: $125,000
Administering Institution:
The University of New South Wales

TERRESIM: A simulation system for understanding and managing the interactions between runoff, vegetation, soils and climate in a changing environment
Researchers: GR Willgoose; PJ Binning; ST Lancaster; MJ Kirkby; PM Bishop
Funding:
2006: $250,000 2007: $200,000
2008: $200,000 2009: $200,000
2010: $170,000
Administering Institution:
The University of Newcastle

Out of Africa and into Australia: robust chronologies for turning points in modern human evolution and dispersal
Researchers: RG Roberts; R Grun; Z Jacobs; GA Duller
Funding:
2006: $86,000 2007: $30,000
2008: $60,000 2009: $70,000
2010: $70,000
Administering Institution:
University of Wollongong

Extinction and survival: biotic responses to environmental change in Late Devonian oceans during a greenhouse-icehouse transition
Researchers: KJ McNamara; AD George; ZQ Chen; R Feist
Funding:
2006: $90,000 2007: $80,000
2008: $65,000
Administering Institution:
Museum of Western Australia

Developing biogeographic know-how: improving species divergence and dispersal estimations to examine geological and climatic evolutionary drivers
Researchers: AJ Lowe; M Rossetto; DM Crayn; MS Pole; D Lambert; PM Hollingsworth
Funding:
2006: $115,000 2007: $87,000
2008: $80,000
Administering Institution:
The University of Queensland

Supercomputer simulation and risk evaluation of tsunami generation induced by earthquakes
Researchers: PR Mora; H Xing
Funding:
2006: $95,000 2007: $90,000
2008: $90,000
Administering Institution:
The University of Queensland

Project Summary: New hotspot forecasts show that great earthquakes are likely to occur during the next decade in the Western Pacific north of New Zealand which potentially poses a tsunami risk to Australia. The project will enable this risk to be reliably assessed thereby providing the information needed to properly manage this risk thus addressing the national research priority: Safeguarding Australia. Building on extensive geo-data and Australia's forefront position in solid earth simulation via investment in the ACcESS Major National Research Facility, the project provides an opportunity for Australia to play a key role in constructing next generation real-time tsunami warning systems.

Weathering on Mars and Australian analogues: developing suitable chronological tools and theoretical approaches
Researchers: PM Vasconcelos; K Farley
Funding:
2006: $70,000 2007: $60,000
2008: $50,000
Administering Institution:
The University of Queensland

Trace element geochemistry of microbialites: towards an independent record of biogenicity, microbial communities, and seawater chemistry
Researchers: GE Webb; R Bolhar; M Preda; K Grey
Funding:
2006: $70,000 2007: $55,000
2008: $32,000
Administering Institution:
Queensland University of Technology

Schwertmannite in acid sulphate soil landscapes: iron cycling induced acidification
Researchers: RT Bush; LA Sullivan
Funding:
2006: $70,000 2007: $70,000
2008: $70,000 2009: $70,000
2010: $70,000
Administering Institution:
Southern Cross University

Project Summary: Acid sulphate soils impact over 24 million ha of land throughout the world, 4 million ha of valuable coastal land in Australia alone. Their oxidation and acidification are the cause of catastrophic declines in water quality, aquatic habitat, agricultural productivity and urban infrastructure. The practical benefits of this project arise from an improved understanding of the processes controlling acidification and water quality in these areas. Intellectual benefits include the development and application of novel geochemical concepts involving iron minerals relevant to acidity impacted coastal rivers, wetlands and estuaries; this project will enhance Australia's capacity for sustainable environmental management.

Active ice-shelf rift systems on the Amery Ice Shelf, East Antarctica
Researcher: R Coleman
Funding:
2006: $110,000 2007: $90,000
2008: $90,000
Administering Institution:
University of Tasmania

Marine geological investigation of the Naturaliste Plateau and Diamantina Zone – the tectono-magmatic development of a non-volcanic passive margin
Researcher: AJ Crawford
Funding: 2006: $70,000 2007: $40,000
Administering Institution:
University of Tasmania

Project Summary: Australia's continental margins impact enormously on our major industries including tourism, hydrocarbon production and fisheries, and are particularly significant with respect to biodiversity and hazard planning (both long and short term), yet knowledge of the seafloor of our margins is desperately poor. To contribute to alleviating this problem, we will use the R/V Southern Surveyor research vessel to produce swath mapping imagery and dredge samples from the seafloor of a geologically fascinating part of the southern section of the Western Australian margin dominated by the Naturaliste Plateau and Diamantina Zone.

Application of field penetrometer data to offshore geotechnical design in deep water
Researcher: MF Randolph
Funding:
2006: $180,000 2007: $160,000
2008: $180,000 2009: $120,000
2010: $100,000
Administering Institution:
The University of Western Australia

Project Summary: Offshore oil and gas extraction is a $17 billion/year industry and a major component of GDP, but facing increasing challenges in Australia as exploration extends into water depths exceeding 1 km. In order to develop safe and economic facilities in these environments, solutions to significant technical challenges are required, ranging from new technology to assess the strength of seabed soils, to formulating response models for oil and gas pipelines and shallow foundations or anchoring systems. This project contributes to future exploitation of offshore hydrocarbon reserves while minimising impact on the marine environment; it brings direct benefits to our economy and helps maintain our world leadership in offshore geotechnical research.

Palaeoclimatic and environmental significance of major Late Quaternary drainage contributions and disruptions in the Lake Eyre Basin
Researchers: GC Nanson; BG Jones
Funding:
2006: $110,000 2007: $80,000
2008: $80,000
Administering Institution:
University of Wollongong

Additional Linkage Grants

A high-throughput stable isotope ratio mass spectrometer for water resource management and climate change studies
Researchers: RN Drysdale; ID Goodwin; SW Franks; JD Woodhead; J Zhao
Funding:
2006: $100,000
Partner Organisations:
The University of Newcastle[1],
The University of Melbourne,
The University of Queensland

A state-of-the-art trace element and speciation analysis facility for the Earth, Environmental and Chemical Sciences
Researchers: BF Schaefer; RJ Morrison; SD Kolev; MR Grace; G Mark; I Cartwright; IS Buick; ID McKelvie; AL Chaffee; R Beckett; AI Mechler
Funding:
2006: $250,000
Partner Organisations:
Monash University;
The University of Melbourne

Project Summary: Outcomes of the research utilising the proposed facility will feed directly into monitoring the health of the nation's water systems (both ground and surface waters) and constraining processes responsible for the mobility and subsequent accumulation of toxic metals and metallic species in the environment. Pure research into trace element partitioning in geological materials will inform crust formation and mineral deposit models and aid in exploration of world-class ore bodies and the associated economic benefits of this activity. Applications in nanotechnology include laser cleaning and predictive laser ablation characterisation of potential application in manufacturing technology.

[1] Administering organization in bold

Neumayer: pioneer exploration geophysicist (Part I)

"…all my instruments are constructed on new principles, and the performances which have been accomplished during the last five years on the European Continent with such instruments have shown that there exists a relation between the productiveness of a tract of land and the values of the magnetic constants.

Further there exists a relation between the same quantities and some geological formations, for instance the Coal-beds as I have shown in the Palatine.

These facts are true beyond doubt; the old countries have given us the opportunity of making such observations let the new ones reap the advantage.

By a Magnetic Map of a country we can draw a conclusion as to its probable value for agricultural and mining purposes.

It is more than probable that there exists a relation of terrestrial Magnetism and the great tracts of auriferous land in Australia, and such a map would enable us to point out new spots of the above mentioned interest without making trials on an expensive scale."

When Georg Neumayer penned the above prophetic words, on 15th June 1857[1], he was only 31 years of age, so it is not surprising with such insight he was to go on to hold a significant place in the history of a number of sciences. In applied geophysics his wonderfully simple and innovative 1861 calculations of the magnetic properties, dimensions, orientation and weight of the buried Cranbourne meteorite by just the use of a silk thread and suspended needle [*Preview 111* August 2004] was an example of his talents. He was also to put in the hard slog by personally acquiring, over a number of years, routine field measurements over large distances and over much of Victoria. He is considered Australia's first exploration geophysicist.

Neumayer and his mentors

Georg Balthasar von Neumayer (Fig 1), ennobled later in life, was born on the 21st June 1826 in Kirchheimbolanden, Pfalz (Bavarian Palatinate) and the Australian Dictionary of Biography describes him as a "scientist, magnetician, hydrographer, oceanographer and meteorologist" and he was all of those; "educator and administrator" and possibly "politician" I suggest should also be added to the list.

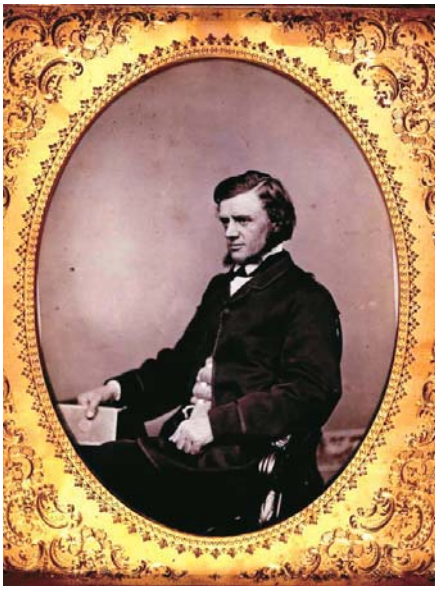


Fig. 1. "Professor Neumayer", 1864; photographer Frederick Frith. Courtesy La Trobe Picture Collection, State Library of Victoria (H3850).

He attended the elite Gymnasium and Lyceum in Speyer from 1842 to 1845 under Professor Friedrich Schwerd[2] before studying at the Polytechnic and then the Engineering Schools in Munich. He graduated in 1849 and in that same year was appointed as an assistant at the Bogenhausen Observatory run by the Scottish-German astronomer, geophysicist and instrument maker Johann von Lamont (the very gifted Lamont in the mid-1830s had input into the design and construction of Gauss and Weber's first magnetometer and he had recently published a textbook on his studies of the earth's magnetic field[3]). Neumayer, in addition to his observatory duties, was a witness to and possibly helped Lamont collate his regional magnetic survey data of Bavaria and other parts of Europe (Figure 2).

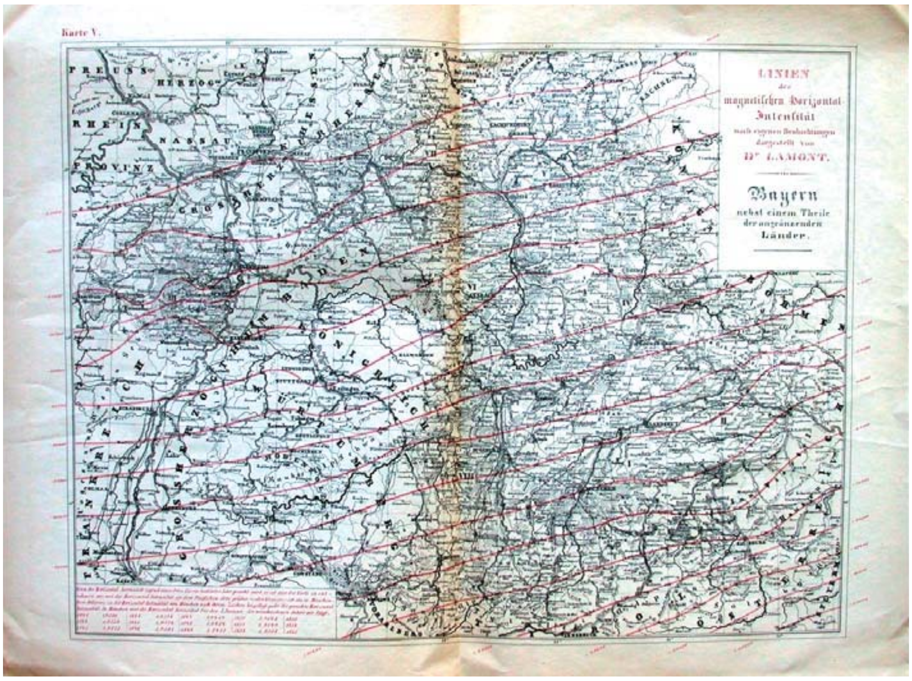


Fig. 2. Johann Lamont's 1854 horizontal magnetic intensity map of Bavaria from his "Magnetische Karten von Deutschland und Bayern". Contour interval not known, but the trends are consistent with current observations in Contour interval in % differences (+0.0100 = +1%) from Lamont's Munich origin, which had a mean value of 1.9508 cgs units in 1852. Courtesy CIW/DTM-GL Library, Washington DC.

1 Extracted from Neumayer's submission to W.C.Haines, Chief Secretary, Colony of Victoria for direct assistance for a magnetic and navigational observatory in Melbourne. PRO Vic, VPRS 1189, Box 744, B57/4287.

2 Friedrich Magnus Schwerd 1792-1871, science educator, astronomer, physicist and mathematician.

3 Lamont, Johann von Handbuch des erdmagnetismus (1849)

4 Home, R.W. and Hans-Jochen Kretzer The Flagstaff Observatory, Melbourne: New Documents relating to its Foundation Historical Records of Australian Science, Vol.8 No.4, June 1991 pp213-243.

The science historians R.W.Home and H-J. Kretzer[4] say at this time Neumayer was "simultaneously" an assistant to the professor of physics Karl Joseph Reindl at the Munich University. Neumayer however resigned these positions to pursue a career on the open seas, with his first trip being to Brazil. On his return in 1851, he was to study (and reside with) Christian Carl Rümker at the School of Navigation in Hamburg and there obtained his merchantman Mate's Certificate. Rümker had an important Australian connection, but that is another story[5].

The gold rush

In 1852 Neumayer arrived in Sydney, as a crewmember on the sailing ship "Rieherstieg", and after a couple of coastal trading trips to Queensland and South Australia was paid off at his request and travelled onto the Victorian goldfields. He was to spend a year on the diggings; and at Kangaroo Flat, near Bendigo he was to intriguingly establish a night school for fellow Germans teaching nautical astronomy, observation methods and map compilation. He was also to travel to the Mallee and along the Murray during this time.

On the 27th January 1854 he departed Melbourne for Europe having been hired as a helmsman on the great clipper ship "Sovereign of the Seas". He mentioned in a later essay that he had much time to study during this voyage[6]; it took eighty days to reach London.

Neumayer's return to Germany

Neumayer's interest in science certainly hadn't waned during his travels, in fact the opposite was the case, for on his return to Germany (1855-56) he acquired magnetic data on field surveys in Bavaria, Schleswig-Holstein and some detail work near Hamburg. Interestingly Neumayer recorded that he stored his original field notes in soldered tin cans for protection, he revisited these many years later. With the backing of Rümker, Lamont and Justus von Liebig, and tacit support from the esteemed Alexander von Humboldt and others, he obtained funds from King Maximilian II of Bavaria to purchase instruments for the establishment of a magnetic and nautical observatory in Melbourne. He also travelled to England to meet (and obtain introductions) from a number of British scientists and bureaucrats including Sir Edward Sabine and Michael Faraday.

Back to Melbourne

Travelling as a crewman on the clipper "La Rochelle" (owned by one of his sponsors, Hamburg shipping magnates G.C. Godeffroy and Son) he both planned and assisted with the navigation via the great circle route to Melbourne, travelling as far south as the then tentatively located Heard Island. He arrived in Melbourne in late January 1857 with most of his equipment (an extensive list), including Lamont designed and built observatory magnetometers, Gay Lussac barometers, declinometers, inclinometers, etc.etc; some Lamont field instruments were to arrive later:

"The magnetic part of the Observatory will, in its working, furnish the facts on which to base a magnetic survey of the colony, which will be carried out with the staff and the instruments of the Observatory, a large addition to which is expected early, namely, those used by Professor Lamont in making the magnetic survey of Spain." [7]

Neumayer immediately commenced local magnetic and meteorological observations.

In June 1857 he firmly proposed to the Governor a site in the Melbourne Botanic Gardens for his observatory, a site that was to be rejected; permission was granted, however, to establish an observatory at his second choice site, Flagstaff Hill, on the condition he also acquired meteorological data there.

Neumayer was not particularly happy with this arrangement, nor was he happy with the geological environment of Flagstaff Hill. He was at this time also receiving no financial assistance at all from the Colonial government, although he had support from the local German community, who had successfully run a campaign and raised £500 within days. The Melbourne newspapers gave him a good run and were to do so for his entire stay in Victoria.

Flagstaff Hill and Mr Wills

In May 1858 Neumayer commenced nautical instrument calibrations, magnetic measurements and meteorological observations at the Flagstaff Hill Observatory, he was to hire a number of assistants during his stay[8]. On the 14th and 15th September 1858 Neumayer made a set of magnetic observations at seven places, all within 300 feet of his observatory pillars, to determine the local interference and Neumayer was not impressed with the gradients he discovered, however he was able to determine mean values for all magnetic components.

In 1859 Neumayer received his long hoped for government grant, along with official notification that he had been appointed the director of the colony's meteorological stations (which upset a few people – apparently). He was also looking for some professional help and he selected William John Wills to be his assistant to relieve him of much of his observatory and field commitments. Despite Wills having a strong surveying and mathematical background, Neumayer needed to vigorously defend his decision to appoint him.

Flagstaff Hill problems

In May and June 1860, Neumayer and the astronomer/geodesist Robert L.J. Ellery made some detailed geological studies and magnetometer measurements at various sites in the new Melbourne suburbs to determine a more suitable observatory location, their results (Figure 3) found that Neumayer's original proposed site near Government House and the Botanic Gardens was the most suitable.

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5 Christian Carl Ludwig Rümker 1788-1862, astronomer and observer at the Parramatta Observatory in the 1820s, under Sir Thomas Brisbane (pendulum and magnetic measurements were also made).

6 An essay by Neumayer on his time in Victoria 1852-54 was published in German, in seven parts in the Sydney bi-weekly Die Brücke Vol.1, Nos 34 to 40, 13th October to 24th November, 1934.

7 Neumayer, Professor George Description and System of Working of the Flagstaff Observatory, Trans. Phil. Inst. Vic. Art.XI, Vol III 1858 pp94-103.

8 Neumayer in his reports noted the following paid observers 1857-64, Jacob Bauer (political refugee, an interesting character – later to travel on an expedition to Adelaide River, sadly drowning there), J.W.Osborne, who was later replaced by William Wills, Charles E. Pickering, Charles Mörlin, B. Löwy and casuals E.J. Welch and John O. Rose. They deserve more than to be just footnotes to history.

By 1862 the Flagstaff Hill Observatory had, magnetically, become contaminated by nearby constructions (a number of tin sheds and a sawmill) and this was exacerbated when regular blasting started on the adjacent King Street cutting – the magnets were, at times, set into continual motion and the observation pillars were to become permanently damaged. It was the death knell for the observatory. Ellery's Williamstown astronomical and geodetic observatory was also under pressure from nearby construction.

The new Melbourne observatory

After two years of solid lobbying and negotiation, permission was finally given to build a new observatory in the Botanic Gardens (Figure 4) with the proviso that it did not in any way interfere with the Government House environment. Instruments were progressively transferred from both Flagstaff Hill and Williamstown as new rooms were completed.

The first magnetic measurements made at the new observatory were in September of 1862, overlapping by two months those made at the old observatory. Let no one forget that observations and measurements were laboriously observed hourly (without failure) by Neumayer and his assistants from the 1st May 1858 to the 28th February 1863.

The Argus newspaper on the 13th January 1863 included the following description of the new and unfinished magnetic observatory site:

"The two isolated rooms which the pedestrian passing through the Domain cannot fail to notice, the one to the left and the other to the right of the main buildings, are those in which the magnetical observations are conducted. Both of them are wooden buildings, lined with copper and copper-fastened; iron, for obvious reasons having been carefully eschewed. The horary-house, as the one is termed, is of circular shape, is sixteen feet in diameter, and is partly below the surface and partly embedded in a bank of earth. Here sets of instruments are employed to test and ascertain the relative value of the magnetic properties of the earth, which are constantly and continuously changing; while in the second, or absolute room which is similar in construction to the first, the value of these properties is absolutely determined…"

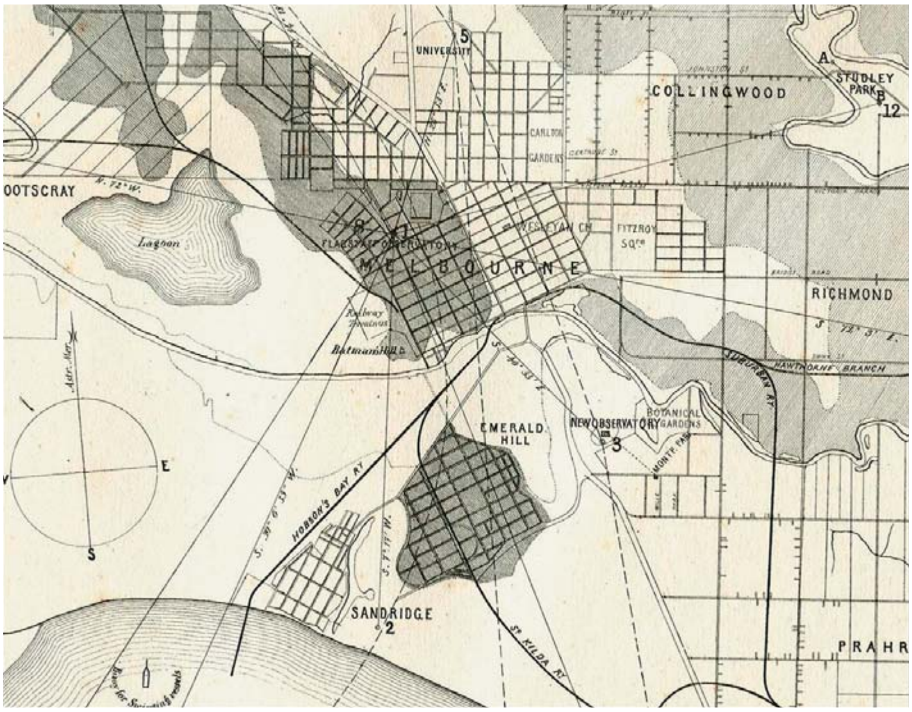

Fig. 3. Detail from Neumayer's geological and observatory plan of Melbourne. Dark shading "older Volcanic", light shading "upper Volcanics". Note observatory sites, outlying observation points, his telegraph line to Montpellier Parade and offshore buoy for ship compass swings. From "Results of the Magnetic Survey of the Colony of Victoria Executed during the years 1858-1864" published in Mannheim Germany 1869. Author's copy.

Fig. 4. Stereo image c1870-74 "Old Melbourne Observatory Melbourne taken from Government House Tower", note the two magnetic houses at either end of the main building. American & Australasian Photographic Company, Holtermann Collection. Courtesy the Mitchell Library, State Library of New South Wales (PXA 4999).

Underground pendulum measurements

On the 31st August 1863 Neumayer read a short paper to the Royal Society of Victoria on his observations using his newly received pendulum, a German built instrument to which a micrometer with an accuracy of "0.0007 of an inch" was added, this being built in Melbourne to Neumayer's own design. Neumayer designed and built a number of pieces of equipment at this time.[9]

Neumayer's pendulum was set up in the basement cellar of his residence in Montpellier Parade and wired with a "telegraphic needle" to the standard clock at the observatory, some 500 metres away[10]. This was an impressive setup with Neumayer opening his basement observatory to inspection to both the public and his peers in the Royal Society of Victoria.

Neumayer, Joseph Kay, the VEE and Melbourne society

Neumayer spent much of his time within the social circles of Melbourne – whether it be in science, the arts or politics he was very well connected and respected, although it is known from his writing, and by other commentators, that he and his German compatriots were never completely accepted. The former magnetic observer from the Rossbank Observatory (Hobart) and then Secretary to the Victorian Executive Council, Captain Joseph Henry Kay FRS never visited the observatory, despite a number of personal invitations by Neumayer – but I guess Kay had an excuse after a tortuous 13 years of continuous observing (1840-53), he had probably seen enough!

Neumayer also had to front some pretty bitter and petty professional jealousies early in his stay. Home and Kretzer go into some detail in their writings on the attempted back stabbings. Neumayer was also to have a central role in the establishment of the Burke and Wills Victorian Exploring Expedition (VEE). It appears he was a good public speaker and lecturer; he spoke publicly in English and German on various subjects including navigation, Arctic and Antarctic exploration, meteors, etc. He also was to write verse[11].

Neumayer's extensive field trips, his journal of these trips and his companion's artworks have left Victoria, and Australia in general, with a rich historical record of colonial life in the early 1860s.

(to be continued)

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9 The Argus, July 20th 1863, an extensive article on Neumayer's pendulum.

10 Neumayer.G. Description of a Pendulum Apparatus for Determining the Length of a Seconds Pendulum in Melbourne Trans. Roy.Soc.Vic. Vol.VI 1861-64 Art.XXIV pp 91-92.

11 Struve, Walter Nineteenth Century German Melbourne on Display: Musings of a Curator Plenty Valley Papers Vol.3, Baron von Mueller's German Melbourne, 1999 pp105-135.

Rapid S-wave velocity imaging with seismic landstreamers and surface wave inversion

By Adam O'Neill*, Jamhir Safani, Toshifumi Matsuoka and Kazuya Shiraishi

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Abstract

Layered S-wave velocity imaging with surface wave inversion is becoming routine for shallow engineering site evaluation. Little dependence on good coupling allows landstreamers to be employed, with production of over up to a few hundred shots per day on any surface (e.g. natural soil, asphalt road).

Profiling 2D/3D structure using 1D inversion at high shot density produces accurate subsurface images, proven with numerical simulations. However, 'pushing' a spread over the termination of a soft-layer pinchout can lead to overestimation of its lateral extent by up to 20% of the spread length. Shallow V_S models have the potential to be used for weathering static corrections of S-wave or converted wave reflection surveys.

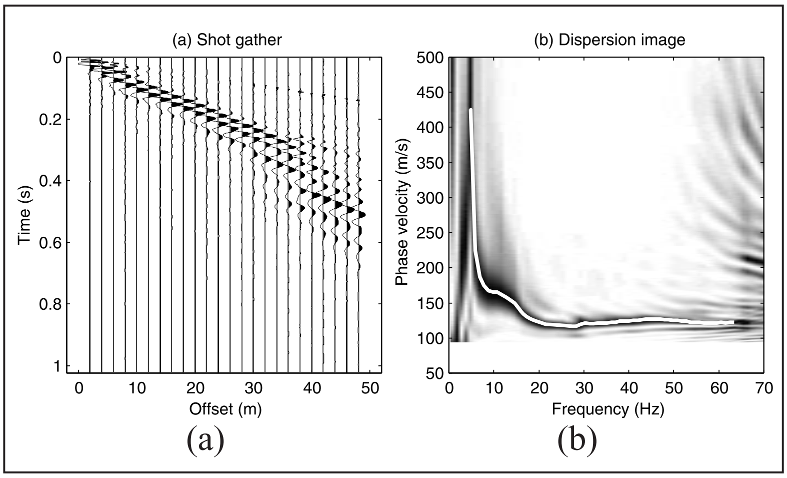

Fig. 1. (a) Acquisition of surface wave ('ground-roll') data by off-end shot, and (b) processing (by plane-wave transform) to a dispersion image.

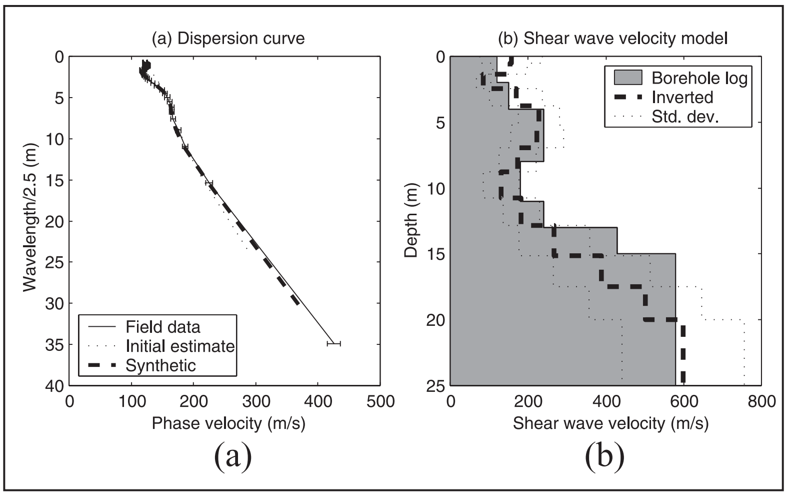

Fig. 2. (a) Inversion of the observed dispersion curve (by iterative optimisation), and (b) S-wave velocity model at the final iteration (with nearby downhole V_S log for comparison).

Introduction

Surface wave methods utilise the 'ground-roll' to image the S-wave velocity structure of the subsurface. It is now a routine tool used for engineering site evaluation, either 'blind' or to support and/or interpolate between boreholes. The depth penetration of surface waves is proportional to their wavelength, thus, in a layered system, propagation velocities of short wavelengths represent the shallow zone, and vice versa. By measuring phase velocities over a broad frequency range, a dispersion curve is compiled, and inverted using well-proven theoretical forward models.

As surface waves respond continuously with depth, stiffness reversals can be imaged, which is the primary advantage over body-wave seismic methods. The strong signal-to-noise ratio also means they can be employed in noisy areas and/or where receiver coupling is poor, and highly suited for landstreamer acquisition. However, model resolution decreases with depth, and imaging is restricted to 1D.

With active source methods (e.g. impact or explosive), the frequencies involved are about 5-100 Hz and with a linear spread, maximum resolvable wavelengths (and thus depth penetration) are in the order of half the array length. For example, with a 48 channel array at 1 m spacing and a hammer source, models are reliable to about 20-25 m depth. Passive source methods employ natural (e.g. microtremors) and/or cultural (e.g. traffic) vibrations to sub-Hz resolution, and, with array apertures in the tens of metres, depths over 100 m can be routinely attained.

The standard active-source surface wave workflow involves four stages:

(1) Acquisition of (usually off-end) shot gathers (Figure 1a);

(2) Processing by plane-wave transform to extract the surface wave dispersion, by picking the ridge of the (usually f-k or tau-p) lobe maxima (Figure 1b);

(3) Inversion of the dispersion curve, either fundamental, multiple or 'effective' modes (Figure 2a), and;

(4) Appraise the image into a geological framework (Figure 2b).

In this case, a stiffer gravelly layer exists at about 5-10 m depth, within a mostly clay overburden, with consolidated sediments at depth. Note in Figure 2a, the dispersion is

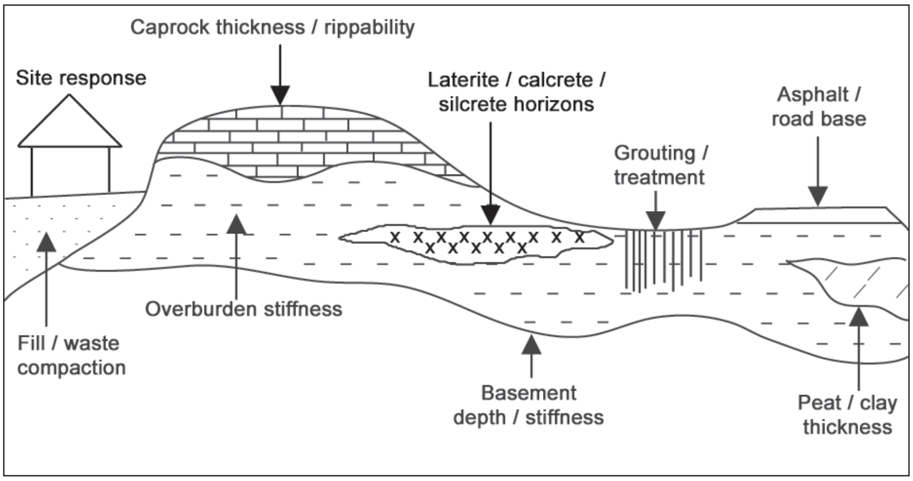

Fig. 3. Typical engineering scenarios where surface waves can be applied for VS imaging, invariably where dominant higher modes are observed.

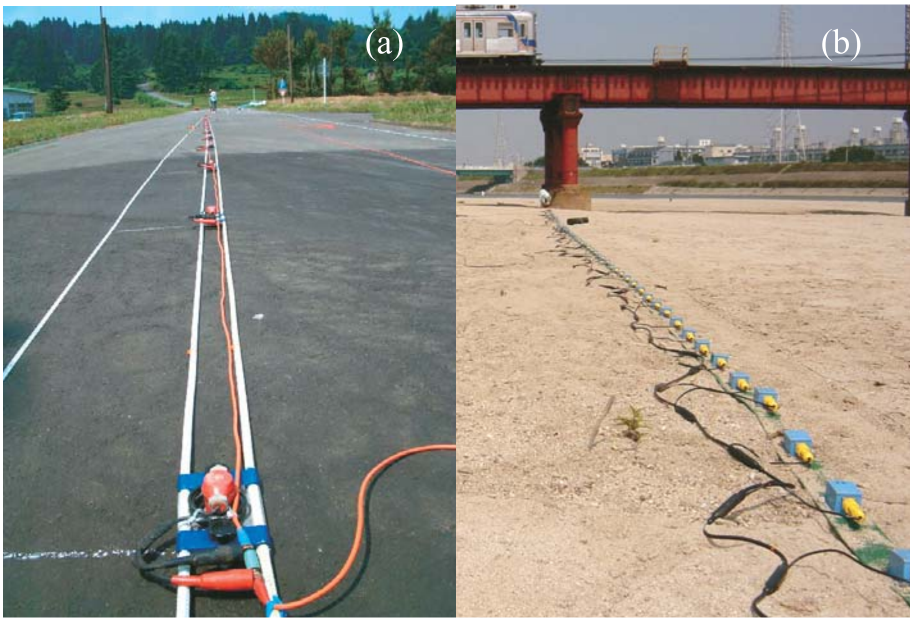

Fig. 4. (a) 24-channel landstreamer on asphalt, with standard 4.5 Hz vertical component geophones, and (b) 96-channel landstreamer on sand, with custom made transverse component geophones.

transformed to wavelength (phase velocity divided by frequency), scaled by a factor of 2.5 to approximate depth.

The conventional 'modal' dispersion inversion procedure was improved by O'Neill *et al.* (2003) by employing full-wavefield P-SV modelling. This method more realistically simulates the field test, by including all surface and body wavefields, spreading wavefronts and source-receiver effects. In addition, it does not require identification of the propagating modes, by inverting the 'effective' dispersion, which comprises a mix of the fundamental and dominant higher modes, which is commonly observed at field sites where abrupt stiffness reversals and contrasts exist (Figure 3).

Landstreamer overview

A commercial, 24-channel landstreamer is shown in Figure 4a, being used at 2 m geophone spacing on asphalt road. It comprises cast aluminium baseplates with flat undersides, bracketed onto parallel ropes, and any spacing arrangement is achievable. The geophones are standard vertical component 4.5 Hz, fastened by a nut in a recess on the baseplate underside. Even at 2 m geophone spacing, a 24-channel (46 m) spread can be easily pulled by one person through soft sand. A 96-channel custom-built model with transverse component transducers at 0.5 m spacing is shown in use on a sandy site in Figure 4b. For surface waves, and body waves especially, at least 5 stacks are desirable at each shotpoint. A three person crew (shooter, observer and puller/driver) can comfortably record 200 shotpoints per day, and upwards of 1 shotpoint per minute at peak production.

Landstreamers have been employed for some time for reflected and refracted wavefield imaging, but only recently for surface wave profiling. O'Neill *et al.* (2006) showed data comparisons with conventional planted geophones, and effects of employing 1D inversion at high shot density to image abrupt 2D structure, supported with numerical simulations, and those results are summarised here.

Comparison to planted geophones

Field shot gathers and dispersion images comparing coincident landstreamer and planted geophone data are shown in Figure 5, and the picked dispersion curves and surface wave spectral power are shown in Figure 6. The dispersion is identical, although above 80 Hz a higher mode becomes dominant in the planted geophone data. The spectral power of the landstreamer signal is as good as or better than the planted geophones over the measured bandwidth. When inverted, these data provide identical models.

The early time data with a 64 ms AGC applied is shown in Figure 7. The refracted arrivals are possibly not as easily picked at far offsets in the 4.5 Hz landstreamer data. Moreover, the landstreamer appears more susceptible to air wave corruption and noise before the first arrivals. The surface wave data are thus a more robust wavefield for shallow imaging with landstreamers.

Field example - mud volcano

A profile over a 'mud volcano' in the mountains of Niigata, Japan, was surveyed with surface seismic. Here, overpressured muds and gas emanate from formations at depth, which can be a shallow engineering hazard, especially for offshore foundations.

The 24-channel landstreamer shown in Figure 4a was used, with a 2 m geophone spacing and 10 m near offset. As surface wave phase velocity represents the average structure below the recording array, model positions are arbitrarily considered at the spread centre. A shot interval of 2 m, ensured much overlap and redundancy.

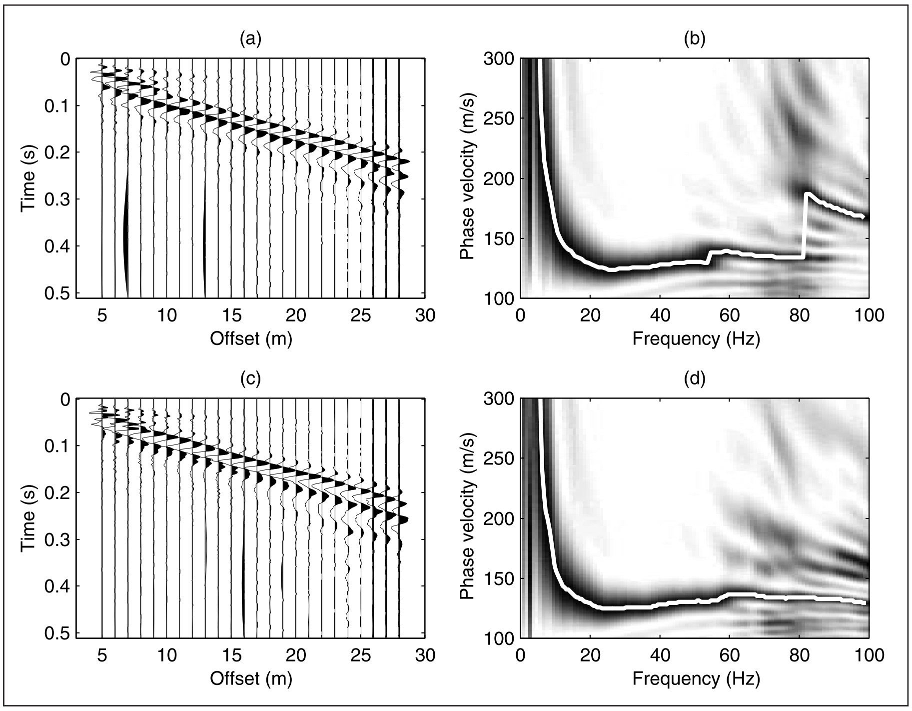

Fig. 5. Shot gathers and dispersion images comparing (a) and (b) 28 Hz planted geophones, and (c) and (d) 4.5 Hz landstreamer geophones.

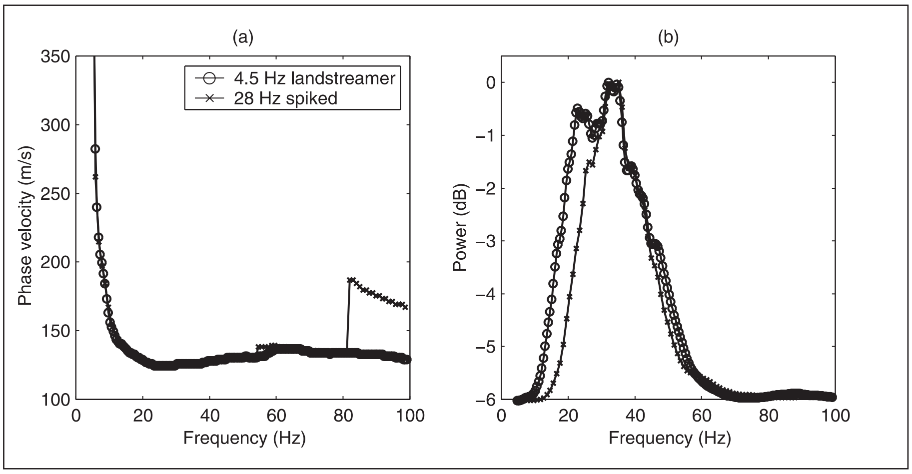

Fig. 6. (a) Dispersion curves, and (b) spectral power comparing 28 Hz planted and 4.5 Hz landstreamer geophones.

The source was a wooden mallet with 5 stacks, 'pushing' from behind the spread.

The dispersion was measured from the trace normalized shot gathers, with a 220 m/s top mute (to exclude early time and air wave noise). No CMP gathering or dispersion stacking was performed. All dispersion curves were inverted using the full-wavefield method of O'Neill *et al*. (2003), employing frequencies from 4.5 Hz to 50 Hz. Each 1D profile is parameterised into 24 layers, starting at 0.5 m thickness and increasing to 2.5 m thickness, with a half-space at 20 m depth. An example dispersion image and inverted profile at midpoint position 48 m are shown in Figure 8. There are many higher modes present, both at high frequency (due to the stiff asphalt surface) and possibly low frequency (with leaky mode contributions), but the full-wavefield inversion automatically accounts for these.

The complete inverted S-wave velocity profile is shown in Figure 9, along with an earlier resistivity image along a parallel line. There are several coincident features:

(i) The low velocity zones (V_S = 50-100 m/s) between positions 10-20 m and 40-60 m correlate with very low resistivity (1-2 Ωm) at depth, and are possibly the main conduits for mud venting;

(ii) The stiff zone (V_S = 200-300 m/s) at depth starting around positions 80-90 m correlates with a homogenous higher(er) resistivity (2 Ωm on average), as well as borehole logs which reached weathered basement at this end of the area; and

(iii) The thin, low velocity layer (V_S = 50-100 m/s) at 1-5 m depth from positions 0 m to 80 m correlates with a similar surficial anomalous zone, but of higher resistivity (5-15 Ωm), which may indicate more gas rich muds, or, more sandy lithology.

In spite of the recording spread being 46 m long, the surface wave inversion has imaged well the lateral variation of S-wavevelocity (stiffness) associated with the surficial mud volcano vents. Nevertheless, the effects of rollalong 1D surface wave inversion over abrupt 2D features are still not properly known, thus this result is used as a basis for some numerical simulations.

Synthetic simulations

Soft layer pinchout

A full-wavefield, P-SV elastic, 2D Finite-Difference (2DFD) numerical simulation (Nagai *et al.*, 2005) was used to test the surface wave profiling ability over a shallow pinchout, such as the soft layer termination at about position 80 m in Figure 9. The change to low velocity layer (LVL) profile employed for 1D tests in O'Neill *et al.* (2003) was used, where the LVL terminates abruptly as shown in Figure 10.

The same acquisition geometry and processing as used at the field site were simulated, and the imaging results with the dispersion curves at each spread midpoint are shown in Figure 11a. A 50 m section of the mud volcano field data in the vicinity of the shallow LVL pinchout is shown in Figure 11b for comparison.

Several coincident features are immediately evident:

(i) At either end of the synthetic profile, over relatively laterally homogenous ground, the measured dispersion (and inverted images) is more or less contiguous, even at midpoints where the spread is obviously overlapping some lateral geological variation.

(ii) In the vicinity of the pinchout, the measured dispersion shows anomalous features, within a range of up to 20% of the recording spread length. This is most likely due to surface wavefield scattering effects.

(iii) The lateral extent of the pinchout in the numerical data appears to be overestimated by about 10% of the spread length. In the field data image, although no borehole data are available, the soft layer shows a similar extension beyond the zone of 'normal' LVL dispersion character (i.e. into midpoints where wavefield scattering exists).

The individual synthetic data inversion result at the midpoint over the pinchout is shown in Figure 12. The dispersion pattern, especially in the 10-50 Hz band, shows large discontinuities due to wavefield scattering. Nevertheless, the estimated model agrees quite well with the true 1D profile below the midpoint.

Hard layer with sinkhole

A model was created which simulated to represent a sinkhole in a shallow calcarenite layer, shown in Figure 13. This is an engineering hazard both onshore and offshore. A hard layer was added at depth to show the static shifts in a reflected wavefield from this horizon, due to the near-surface stiffness variations. Rollalong 96-channel shot gathers were simulated using 1 m for all of geophone spacing, near-offset and shot interval. The S-wavevelocity image from the full-wavefield surface wave inversion is shown in Figure 14. The stiff layer and the 50 m wide soft-zone are imaged very well. Note the asymmetry (due to the shot 'pushing' from the left, and the non-detection of the basement layer (beyond the half-spread length depth penetration).

The same model was used to simulate the P-wave reflection image from the basement layer, using a finite-difference exploding-reflector calculation, shown in Figure 15. This horizon shows a clear static shift due to the low-velocity 'pull-down' in the vicinity of the sinkhole, plus PP and PS diffractions from the stiff layer terminations. To correct for this static shift, the model of Figure 14 was used to calculate the weathering delay time in the uppermost 10 m. With a Poisson's ratio assumption of 0.4 (same as used in the inversion), the average P-wave velocity was used to shift up the event, shown as the wiggles in Figure 15. The reflection horizon now appears flat, with slight residual

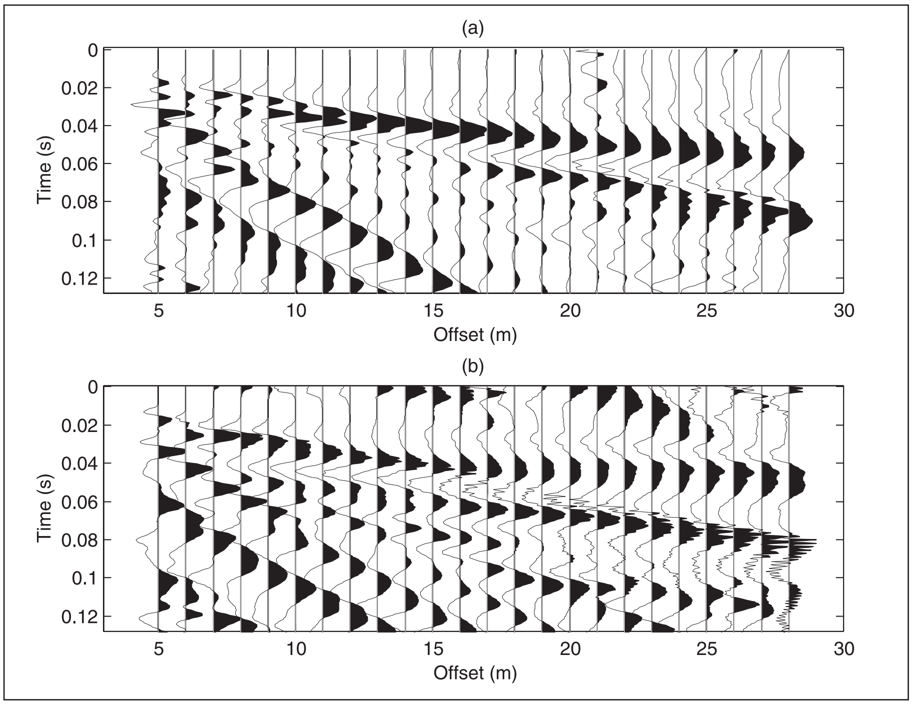

Fig. 7. Early time data with 64 ms AGC applied for (a) 28 Hz planted, and (b) 4.5 Hz landstreamer geophones.

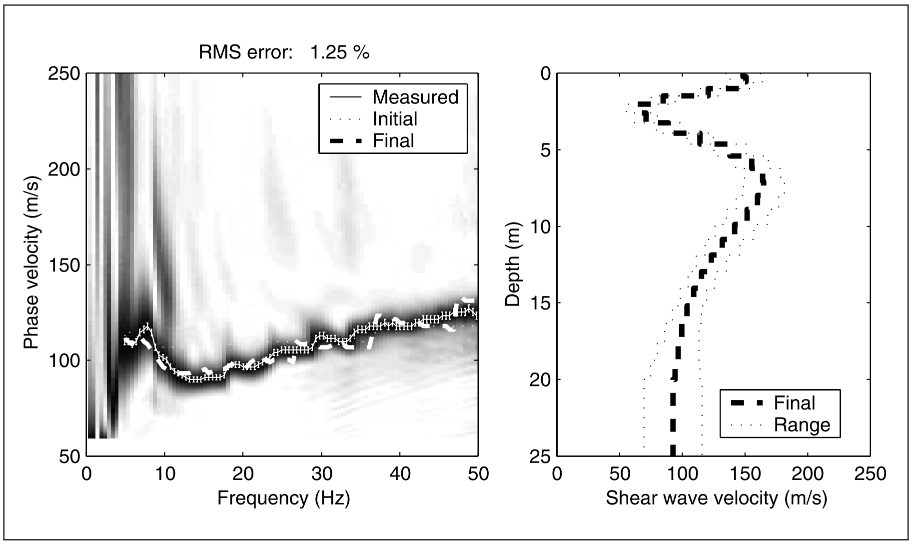

Fig. 8. Inversion results of the mud volcano field data at midpoint position 48 m.

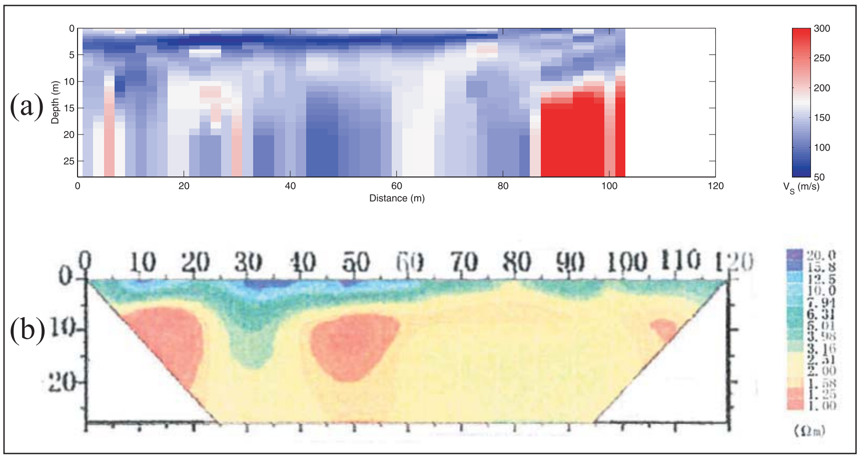

Fig. 9. (a) Surface wave inversion image, and (b) earlier resistivity section along the mud volcano line.

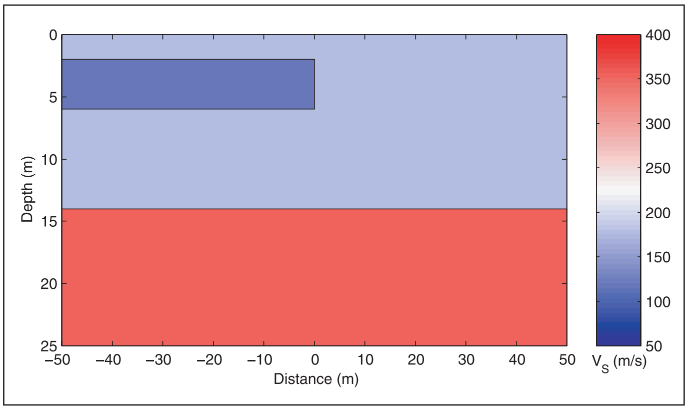

Fig. 10. Pinchout model used for 2DFD tests.

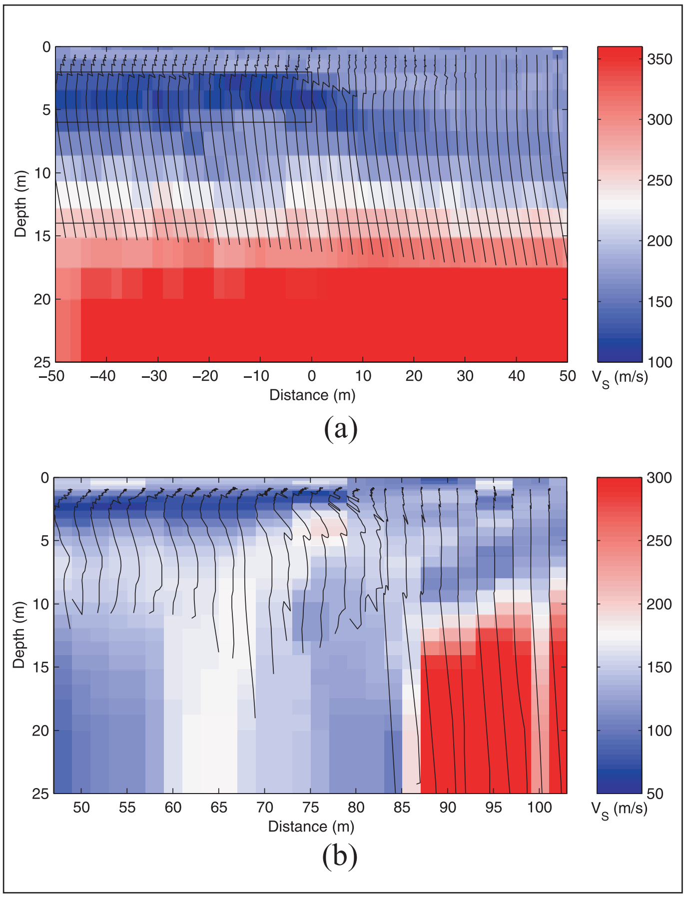

Fig. 11. S-wave velocity imaging results using rollalong 1D full-wavefield inversion: (a) 2DFD numerical data, and (b) Mud-volcano field data, both acquired with shot 'pushing' from the left.

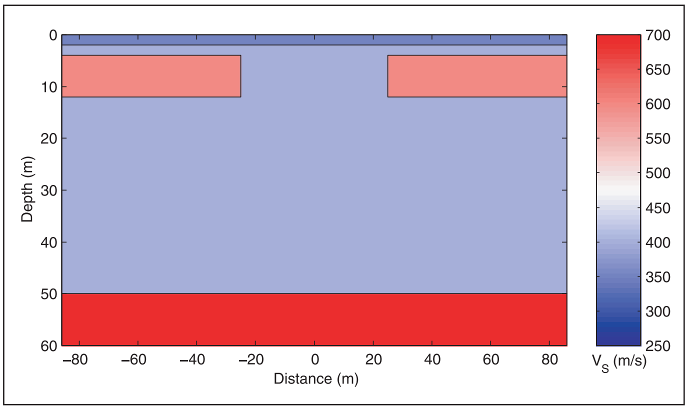

Fig. 13. S-wave velocity model of a shallow stiff layer with soft, 50 m wide 'sinkhole' and deeper basement horizon.

statics due to errors and asymmetry of the surface wave inversion. The S-wave static would be more accurate as it does not rely on the V_p/V_S ratio assumption.

Conclusions

Seismic landstreamers comprising lightweight baseplates with flat undersides provide robust and rapid surface wave data acquisition. At 5 stacks, from 200 (off road) to 400 (on road) shotpoints up to 200 shotpoints can be acquired per day on cleared terrain, more on sealed roads can be acquired per day. Dispersion compares almost identically to conventional planted geophones, and dependence on geophone frequency and coupling is negligible.

'Pseudo' 2D profiling using 1D inversion at high shot density produces accurate subsurface S-wave velocity images, shown in both field and numerical data. Even long spreads (96 channels at 1 m) show little lateral smearing. The lateral extent of a shallow low velocity layer (LVL), which pinches out abruptly appears to be overestimated by about 10%-20% of the recording spread length, at least when the shot is 'pushing' from the LVL side. If data from only one shot direction is available, there is asymmetry due to wavefield scattering, and plotting the 1D model position closer to the shot (than the 'normal' spread midpoint location) may be more suitable.

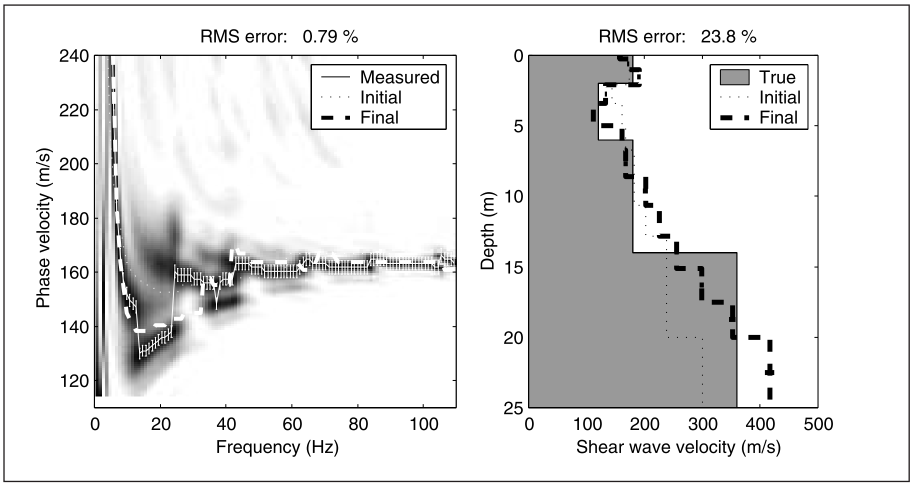

Fig. 12. Inversion results of the 2DFD synthetic data at the midpoint over the pinchout (position 0 m).

One potential application of shallow V_S imaging with surface waves is for static corrections of shear- and converted-wave reflection data. Both on-land ('ground-roll') and marine seafloor ('mud-waves') data could be inverted using exactly the same procedures as in engineering site surveys.

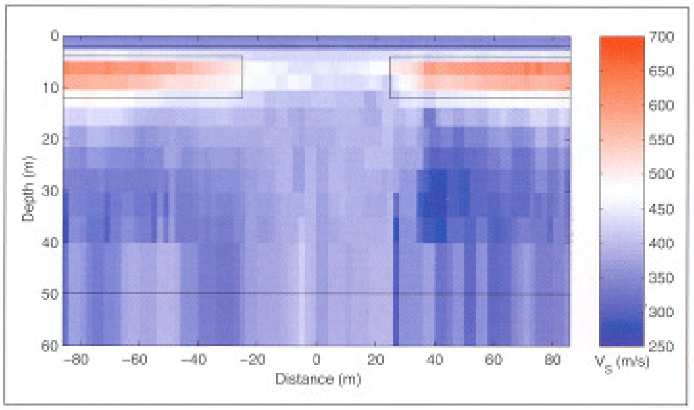

Fig. 14. Surface wave inversion image of the synthetic 2DFD rollalong data simulated at the surface with 2 m shot spacing.

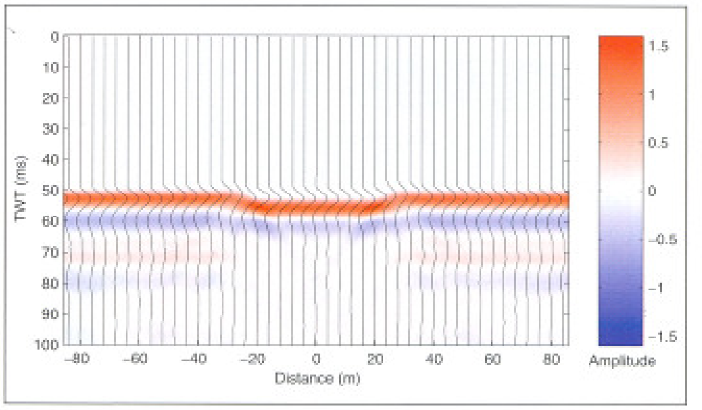

Fig. 15. Zero-offset synthetic P-wave reflection section of the basement horizon, calculated by the 2DFD exploding reflector method at 1 m receiver spacing. Overlying wiggle traces are P-wave static corrected using the surface wave inversion model (trace decimated to 4 m for clarity).

Acknowledgements

Staff and students of Kyoto University Engineering Geology and Exploration Geophysics labs are thanked for much assistance during my 2-year tenure, funded with a post-doctoral fellowship from the Japan Society for the Promotion of Science (JSPS).

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The New Australian Bathymetry and Topography Grid

Data sources

In 2005, Geoscience Australia (GA) and the National Oceans Office completed a joint project to produce a consistent, high-quality 9 arc second (0.0025° or ~250 m at the equator) bathymetric grid of the Australian region (Figures 1 and 2). The grid covers ~41 million sq km of the Australian marine jurisdiction between 92° E – 172° E and 8° S – 60° S. Its dimensions are 32003 x 20803 cells with a file size of ~1.3 Gb, and the grid synthesises ~1.7 billion data values stored in GA's databases. This article discusses the data content and processes that went into making the grid, and some of the issues about which users of the grid need to be aware.

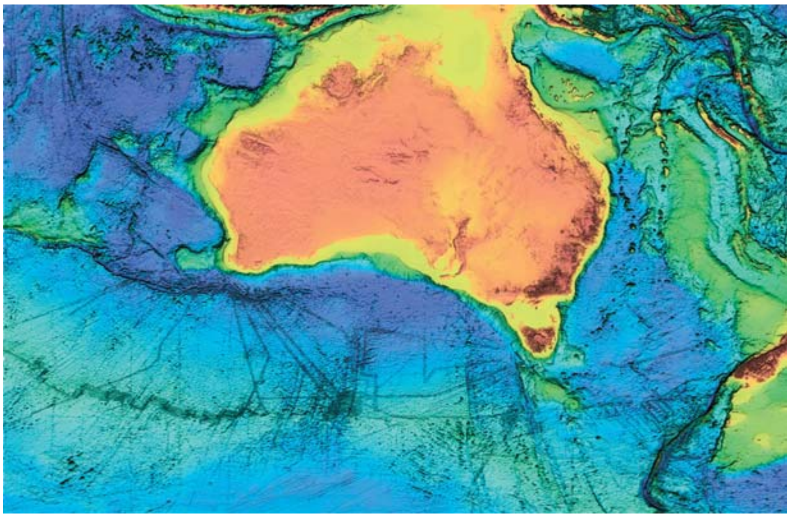

Fig. 1. Final image of Australian region with 9 arc second (~250 m at the equator) grid size.

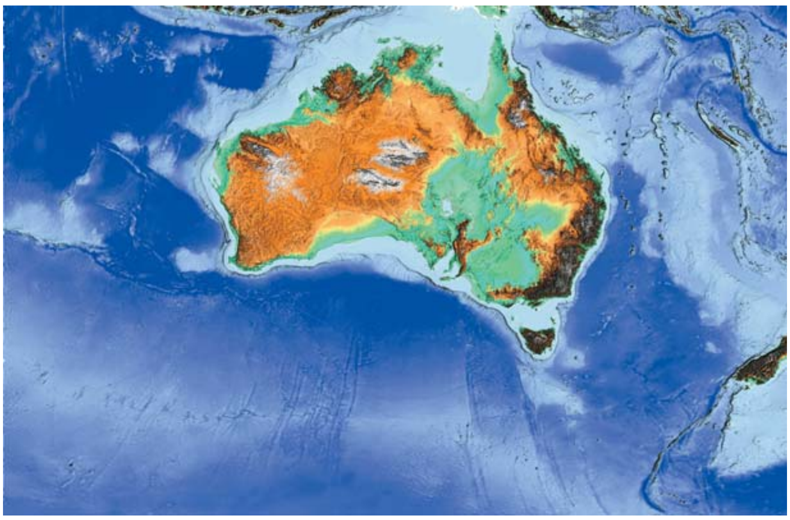

Fig. 2. Same as Fig. 1 but with different colour shading.

Geoscience Australia has been collecting bathymetry data routinely from seismic and sampling surveys around the Australian margin since 1963. More recently, GA has taken on the role of national bathymetry custodian for all holdings within the Australian Marine Jurisdiction. These data consist of ship-track bathymetry, swath bathymetry, digitised soundings from hydrographic charts and laser airborne depth sounder (LADS) data from over 1400 surveys. The data were acquired by GA as well as by other scientific institutions, oil exploration companies and academic organisations. In addition, some data have been sourced from the National Geophysical Data Centre (USA) to which various institutions have contributed.

This diversity of data sources using a variety of systems with differing data densities and levels of accuracy makes grid building a non-trivial task. The user needs to be aware of these issues and to interpret features in the grid in a considered manner. For example, for ship-track data, the typical point spacing along track is 25-200 m, and the two-dimensional spacing of points covered by swath surveys is of similar order. However, the coverage of surveys is widely variable. Ship-tracks may be many tens of kilometres apart, whereas for swath bathymetry surveys, the coverage is of high density along the swath but possibly of limited areal extent.

Consequently the grid needs to be interpreted in conjunction with the data distribution information in order to properly assess whether certain features are genuine sea-floor features or artefacts of the data content and method of production. The user needs to be aware that the 2005 grid depicts the sea floor topography at the maximum 9″ resolution only where direct bathymetric observations are sufficiently dense (e.g. where swath bathymetry data or digitised hyrographic chart data exist). In areas where only track-line data exist, the grid resolution is high along-line but away from the lines, in areas where no sounding data are available, the grid is interpolated from nearby soundings or from indirectly observed satellite gravity derived bathymetry. The latter can only support a resolution of 2 arc minutes (2 nautical miles {nm} or ~3.7 km), and has the characteristic 'orange peel' noise (Smith and Sandwell, 1997).

The grid processing system was designed to routinely create grids with a range of specifications and data content, and with minimal manual intervention. The aim was to ensure the grid properly represents the input values resident in the source databases, and to allow the grid to be reproduced as required, such as after the addition of new survey data or re-levelling of old data. The influx of

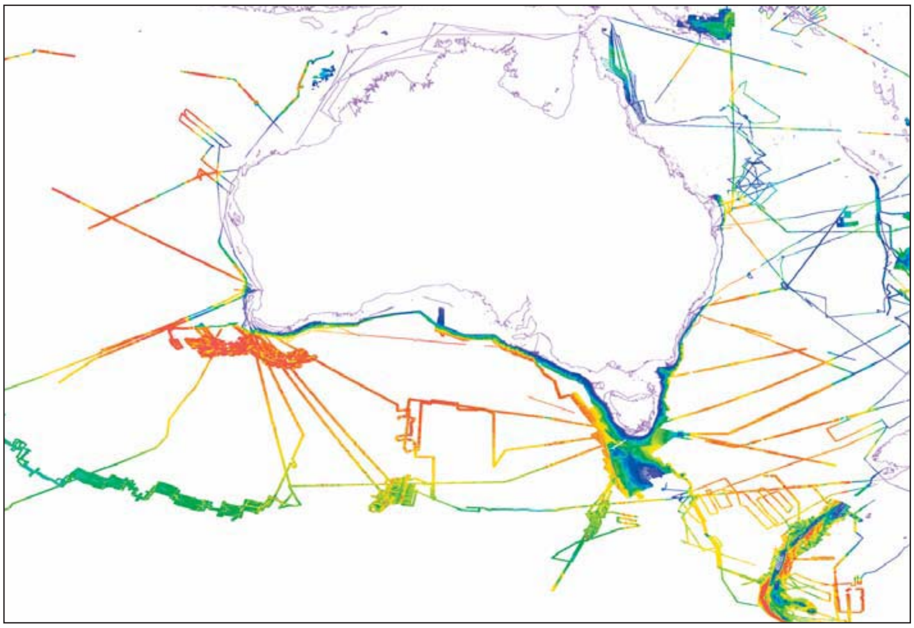

Fig. 3. Map showing the ship track data used in the compilation.

a large amount of new swath data is creating new challenges in terms of data management and storage.

In order to build the grid, data were exported from GA databases and centralised into a set of Intrepid[1] databases containing ~1.7 billion points, comprising the largest number of points ever used to make a bathymetry grid within GA (the superseded grid of 2001 synthesised a mere 200 million points). Intrepid, a versatile geophysical data processing tool produced by Intrepid Geophysics, was suited to this task because its gridding component was able to handle the data volume and variability, and allowed fine control over input parameters.

The following lists some of the categories of data loaded into the Intrepid™ databases and from which the grid was computed.

1. Ship-track database

This included surveys from Geoscience Australia, from Australian and foreign institutions, surveys from the National Geophysical Data Centre (NGDC) in the USA, and oil exploration surveys obtained under the Petroleum Submerged Lands Act. Bathymetry data from 650 of these surveys were used in the grid (Figure 3). These data were levelled to reduce misties at intersections.

2. Multi-beam swath bathymetry

GA holds data from multi-beam swath surveys acquired by government organisations (including GA), academic and foreign institutions. The 106 swath surveys used for the 2005 grid comprised a very important component of the bathymetry holdings because of the very high resolution coverage, good speed of sound control, and modern navigation systems employed (see Figure 4).

3. Digital bathymetry from NATMAP 1:250,000 series and AHS fairsheets

The Australia Hydrographic Service provided 1049 charts as scanned images for the shelf in selected regions. These 'fairsheets' displayed hand-written spot depths for surveys completed over various periods of time. The fairsheets were digitised selectively, digitising lines to a minimum spacing of 2 nm (~3.7 km). Some charts in areas of high interest were digitised in their entirety.

4. Laser airborne depth sounder (LADS)

The Australian Hydrographic Service has been operating its LADS systems since 1993. The system uses red and green laser light emitted from a stabilised platform inside a fixed wing aircraft. The light pulses reflected from the sea surface (red) and sea floor (green) are separately detected, and the time difference between the sea surface and sea floor returns allows calculation of the water depth. Data are typically acquired at a rate of 900 soundings in a 240 m wide by 5 m long swath per second. The system works best in clean water at an average depth of ~30 m.

5. Satellite measurements

In deep-water areas, where there are no water depth soundings, the 2 arc minute bathymetry predicted from satellite altimetry (Smith and Sandwell, 1997) was used to infill the grid to provide regional continuity to the grid.

Processing

The process used to derive the grid began with the collection, processing and preparation of data from various database systems, before being imported into Intrepid databases. Within this system two grids were created: a high resolution (9″ cell, level 1) and a low resolution (108″ cell, level 2) grid.

The level 1 grid was based only on the high resolution swath data and digitised charts, uncontaminated by trackline artefacts, and was tightly clipped to minimise extrapolation. Consequently the level 1 grid represents the only areas where the 9″ resolution of the grid is supported by the underlying data. The level 2 grid was created using all datasets, including the high-resolution datasets used for the level 1 grid, as well as being constrained by zero depth at the coastline to facilitate later merging of inland topography.

To ensure adequate (over-night) turn-around the level 1 process was broken down into 16 sub-grids or tiles and segmented across eight high-performance PCs linked via a Condor[2] distributed system.

The level 1 & 2 grids were then feather merged, with precedence given to the level 1 grid.

Finally, obvious spurious grid cell values were identified and deleted, and then the holes created by this process were smoothly interpolated across or filled with satellite predicted values.

GA's 9″ digital inland topography model was written onto the final bathymetry grid produced by the above process. Further work will be undertaken to ensure the best possible match

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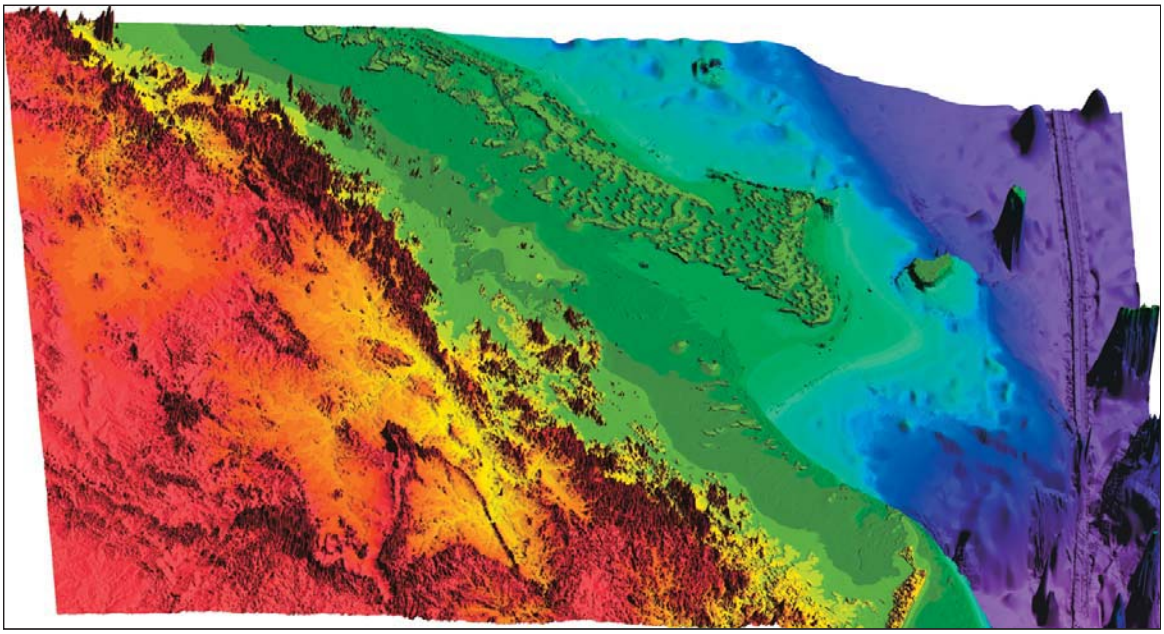
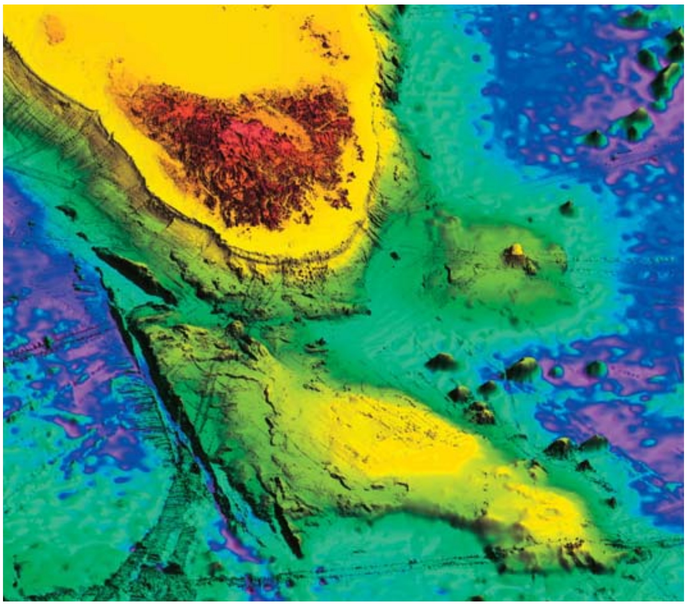
1 Intrepid is a trademark of Intrepid Geophysics Intrepid Geophysics website is: http://www.intrepid-geophysics.com/

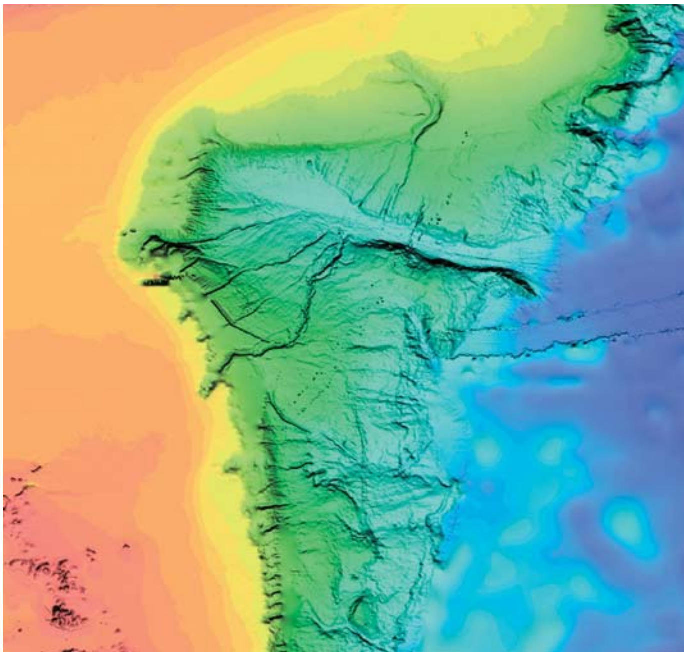
2 Condor was developed at the University of Wisconsin-Madison http://www.cs.wisc.edu/condor/



3D bathymetry image of Reefs of Queensland.



3D bathymetry image of Tasmania.



3D bathymetry image of the bass canyon.

between those two datasets, which are partly constrained by the generally poor coverage of soundings in the near shore areas.

The combined 9″ bathymetry and topography grid (Bathymetry and Topography Grid 2005) was then written to several formats as used by common GIS, imaging and modelling applications: ERmapper, BIL, ESRI grid and ASCII. These formats are for all levels of users and are included in the product, available from the Geoscience Australia Sales Centre (sales@ga.gov.au) at the cost of transfer. There is a more comprehensive report available detailing the processes used to develop the grid. A movie derived from the grid, simulating a flight over the Australian continent with surrounding water removed, is also available as a DVD from the Geoscience Australia Sales Centre.

These products will be revised with the inclusion of more datasets and improved processes, and it is expected that updates will become available every 1-2 years.

Reference and further information

Smith, W. H. F., and Sandwell, D. T., 1997, Global seafloor topography from satellite altimetry and ship depth soundings: Science, 277, 195-196. http://topex.ucsd.edu/marine_topo/mar_topo.html.

See the following website for more details of the system and the processing: https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=63539

For more information about the product phone Mark Webster on +61 2 6249 9599 (Email: mark.webster@ga.gov.au)

To order copies of the grid on DVD or movie on DVD phone Freecall 1800 800 173 (in Australia) or +61 2 6249 9966 (Email: sales@ga.gov.au).

Update on Geophysical Survey Progress: Geological Surveys of Queensland, Western Australia and Geoscience Australia

Paterson Province WA – Airborne Magnetic and Radiometric Surveys

This survey is being flown for the Geological Survey of WA (GSWA) with project management by Geoscience Australia. UTS Geophysics commenced data acquisition on the Paterson Central and Paterson South-East surveys on 24 June 2005. Approximately 123,000 line-km of magnetic and radiometric data will be acquired over an area of approximately 42,000 square kilometres. At the end of December UTS Geophysics had completed 49% of this survey. Flying is expected to re-commence in April 2005 at the completion of the Gascoyne magnetic and radiometric survey. See *Preview 115* (April 2005 – Page 33) for a locality diagram of this survey.

Gascoyne WA – Airborne Magnetic and Radiometric Survey

This survey is being flown for the Geological Survey of WA (GSWA) with project management by Geoscience Australia. UTS Geophysics commenced data acquisition on the survey on 6 October 2005. Approximately 105,000 line-km of magnetic and radiometric data will be acquired over an area of approximately 43,000 square kilometres. At the end of February UTS had completed 71% of this survey. See *Preview 117* (August 2005 – Page 34, Figure 4) for a locality diagram of this survey.

Bowen – Surat North Airborne Magnetic and Radiometric Surveys

This survey is being flown for the Geological Survey of Queensland with project management by Geoscience Australia. UTS Geophysics undertook the survey on the 25th January, and commenced data acquisition on 27th January 2006. Approximately 154,000 line-km of magnetic and radiometric data will be acquired over an area of approximately 53,800 square kilometres. At the end of February UTS had completed 19% of this survey. See *Preview 118* (October 2005 – Page 41) for a locality diagram of this survey.

Bowen – Surat South Airborne Magnetic and Radiometric Surveys

This survey is being flown for the Geological Survey of Queensland with project management by Geoscience Australia. Fugro undertook the survey on 26th January, and commenced data acquisition on 28th January 2006. Approximately 170,000 line-km of magnetic and radiometric data will be acquired over an area of approximately 60,550 square kilometres. At the end of February UTS had completed 52% of this survey. See *Preview 118* (October 2005 – Page 41) for a locality diagram of this survey.

Isa West Airborne Magnetic and Radiometric Surveys

This survey is being flown for the Geological Survey of Queensland with project management by Geoscience Australia. Fugro commenced data acquisition on the survey on 4 February 2006. Approximately 63,533 line-km of magnetic and radiometric data will be acquired over an area of approximately 22,030 square kilometres. At the end of February UTS had completed 48% of this survey. See *Preview 118* (October 2005 – Page 41) for a locality diagram of this survey.

Bowen – Surat Gravity Survey

This survey is being carried out for the Geological Survey of Queensland with project management by Geoscience Australia. Daishsat commenced data acquisition on 17 November 2005. Approximately 5,263 new gravity stations will be acquired over an area of approximately 85,000 square kilometres. At the end of December 2005 Daishsat had completed 68% of this survey. Data acquisition has recommenced and is expected to be completed in early April.

See *Preview 118* (October 2005 – Page 41) for a locality diagram of this survey.

Tasmanian geophysical data now available from GADDS (Geophysical Archive Data Delivery System)

Airborne geophysical datasets acquired by the Tasmanian State Government are now available for free download from GADDS (see Figure 1).

The main features of GADDS are:

1. Data are requested using a standard web-browser.
2. Only the data required by the client are delivered to the client.
3. Data formats (ASCII columns or Intrepid Database) can be selected, as well as the required datum and projection.
4. Both vector (line and point) and raster (grid) datasets are delivered to the user.

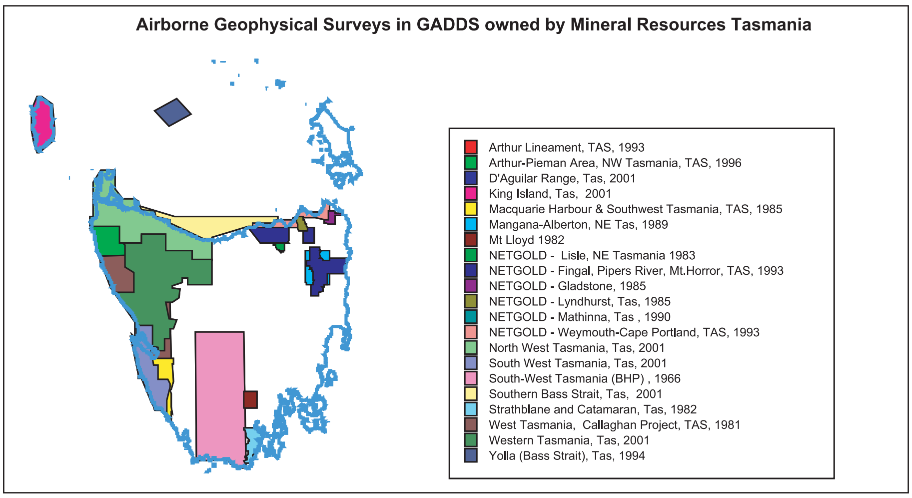


Fig. 1. Tasmanian surveys available from GADDS (see www.ga.gov.au/gadds for more information.)

New Geophysical Surveys

Western Australia

Tenders have been called for the acquisition of magnetic and radiometric data in three regions of Western Australia (see Figure 2):

34,920 km^2 in the Ashburton region;

37,330 km^2 in the Southern Officer Basin region;

27,920 km^2 in the Musgrave region.

When completed, the projects will acquire a total of more than 284 000 line km of magnetic and radiometric data, which will be released in the public domain.

In the Ashburton and Officer Basin surveys the new data will be acquired on north-south flight lines spaced 400 metres apart with a ground clearance of 60 metres.

In the Musgrave region two separate survey areas will be flown.

In the Musgrave North area, north–south flight lines spaced 400 metres apart, with a ground clearance of 60 metres, will cover an area of approximately 16,220 km^2;

In the Musgrave South area, east–west flight lines spaced 400 metres apart, with a ground clearance of 60 metres, will cover an area of approximately 11,700 km^2.

Geoscience Australia will be managing the flying program in all three regions of Western Australia.

For further details, contact
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Email at david.howard@doir.wa.gov.au
or
Murray Richardson on 02 6249 9229 or
Email at murray.richardson@ga.gov.au.

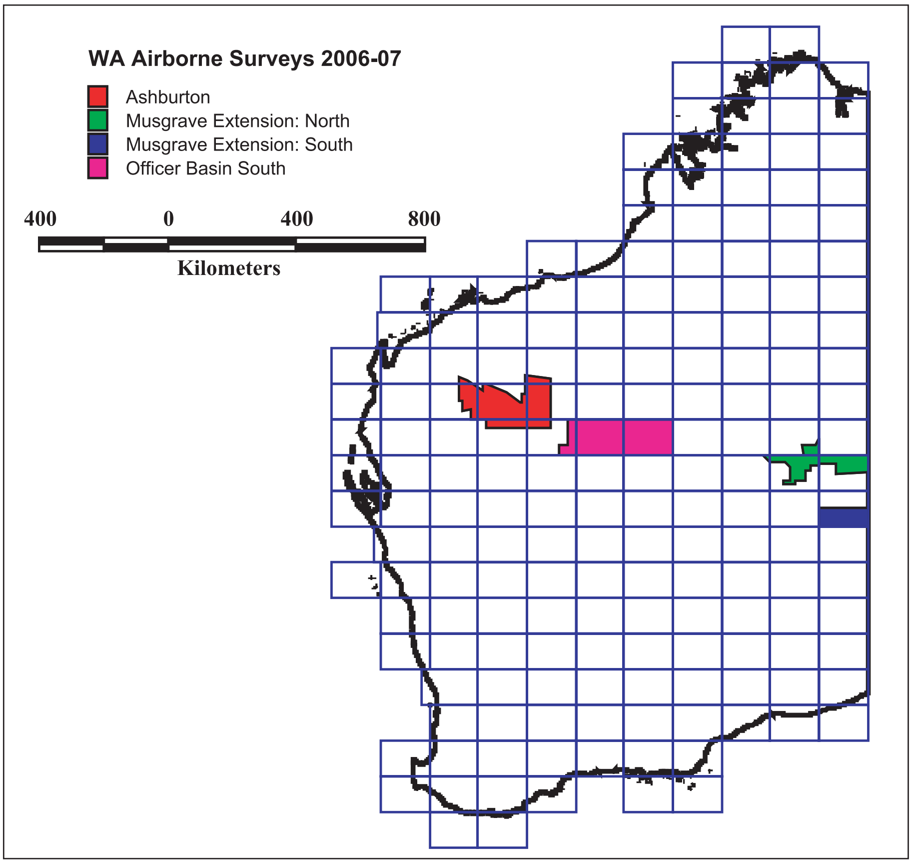

Fig. 2. Areas where tenders have been called for the acquisition of airborne data in WA.

Queensland

Tenders have been called for the acquisition of gravity data in the Mount Isa Area:

A nominal 9898 new gravity stations over an area of approximately 78,000 km^2 in the Mount Isa region of western Queensland. The survey covers the Lawn Hill, Donors Hill, Camooweal, Dobbyn and Mount Isa (western half) standard 1:250 000 Map Sheet areas. The survey is proposed to start in July 2006.

Planning is also underway for the next airborne geophysical survey projects of the Queensland government's Smart Exploration Initiative.

Tenders have been called for the acquisition of magnetic and radiometric data in the southern Mount Isa region of western Queensland:

86,000 km^2 over the Mt Whelan, Bedourie, Birdsville, Machattie, Betoota, Connemara and Brighton Downs standard 1:250 000 Map Sheet areas;

When completed, the Southern Mount Isa airborne magnetic and radiometric survey project will acquire a total of more than 241,000 line kilometres of magnetic and radiometric data, which will be made available in the public domain.

The new data will be acquired on east-west flight lines spaced 400 metres apart with a ground clearance of 80 metres above ground level.

Geoscience Australia will be managing the flying program.

See *Preview 118* (October 2005 – Page 41) for a locality diagram of the Queensland surveys.

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Seismic Reflection Surveys

Planning for the 2006 Central Victorian Seismic Transect is progressing. This transect is now ~400 km in length, through the injection of additional funding from Geoscience Australia. Other parties include GeoScience Victoria, pmd*CRC, Leviathan Resources, GoldFields, Ballarat Goldfields and ANSIR. ANSIR, the Australian National Facility for Earth Sounding will be acquiring the seismic data. The survey is currently planned to start in May this year. This transect begins north of Stawell and runs eastwards, going northeast of Bendigo and on into the Melbourne Trough. The survey will provide valuable information on the nature of the crust in the Stawell, Bendigo and Melbourne structural zones and a better understanding of the relationship of gold mineralisation to structure in this part of the Lachlan Fold Belt.

Locations of traverses for the 2006 Mt Isa Seismic Transect Project have now been finalised following considerable input from the Queensland State Government, local exploration companies and Geoscience Australia. The project partners currently include the Geological Survey of Queensland - Queensland Department of Natural Resources and Mines, Geoscience Australia and ANSIR, with the local mining industry being encouraged to get involved. The project currently includes approximately 500 km of deep seismic reflection profiling, which is aimed to improve the understanding of crustal architecture, fluid flow and regional scale mineral systems, which will assist in the discovery of further mineral resources.

Work is now progressing on processing and interpretation of wide-angle seismic data collected as part of the 2005 Tanami Seismic Collaborative Research Project. This additional data set will provide valuable constraints on upper crustal seismic velocities within the Tanami Region. Final results from the reflection seismic work will be collectively presented at a Seismic Workshop in June 2006 in Alice Springs.

Fig. 1. ANSIR MiniVib (IVI T15000, 6,000 lb configured in P-wave configuration) and recording system operating during the BHP Billiton Illawarra Coal project near Appin, NSW.

ANSIR in conjunction with staff from Curtin University, completed a baseline seismic traverse for the CO2CRC Otway Basin Pilot Program (see *Preview 120*, February 2006, p 17), using its MiniVib as the energy source. This survey was aimed at establishing time-depth relationship for improved depth conversion of existing 3D seismic data to assist in monitoring changes in a depleted gas reservoir after the injection of CO_2. ANSIR also provided its MiniVib to a BHP Billiton Illawarra Coal project (see Figure 3). Results are now being investigated regarding their benefits to coal exploration and mine seam delineation.

ANSIR, in conjunction with Curtin University, is preparing to undertake a seismic survey around the Beverly Uranium mine. The mine operators now see seismic as their principal exploration tool to help define the geometry of the deposit.

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$413 million boost to offshore exploration in WA

The award of eight new offshore petroleum exploration permits in Western Australia, announced on 24 February 2006 by Ian Macfarlane, the Australian Minister for Resources, will see additional $413 million invested in offshore petroleum exploration over the next six years. The eight new areas have been allocated as follows:

•One in the Browse Basin, a proven major hydrocarbon province, to Shell Development (Australia);

•Five in the Carnarvon Basin to Woodside Energy, Total E&P Australia and Japan Australia LNG; Chevron Australia, Shell Development (Australia) and Mobil Australia; and Holloman Corporation, some in deep water, close to giant gas discoveries, others in shallow water, close to production infrastructure; and

•Two in the Bonaparte Basin, adjacent to significant hydrocarbon discoveries, to Goldsborough Energy Pty Ltd, which plans some 3D seismic work.

Figures 1-4 show the locations of these areas.

The new permits were allocated as part of the government's ongoing program of releasing offshore acreage for petroleum exploration. This program provides a steady supply of new offshore exploration areas for bidding and is supported by funding for pre-competitive petroleum geoscience work by Geoscience Australia.

The largest investment will be by Shell, which plans to spend $159 million in the Browse Basin, analyzing seismic information and drilling 12 wells.

Under the work-program bidding system for the award of exploration permits in Australia's offshore areas, applicants are required to nominate a guaranteed minimum 'dry hole' exploration program for each of the first three years of the permit term and a secondary program for the remaining three years. Each component of the program must be completed in the designated year or earlier. Permits are granted for an initial term of six years.

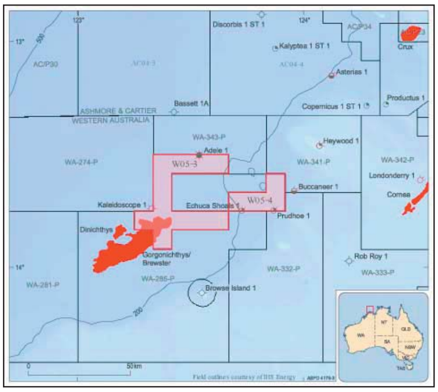

Fig. 1. Location of permit WA-371-P (W05-3) in the Browse Basin, showing bathymetry, gas fields (in red) and well sites.

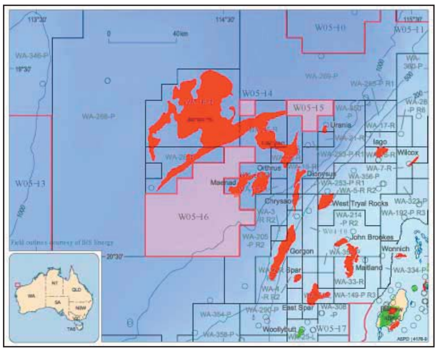

Fig. 2. Location of permits WA-369-P (W05-14), WA-370-P (W05-15) and WA-374-P (W05-16) in the Central Exmouth Plateau of the Carnarvon Basin, showing bathymetry, gas fields (red), oil fields (green) and well sites.

There was strong bidding interest in the Browse Basin near major gas discoveries and encouraging investor interest in other areas offered.

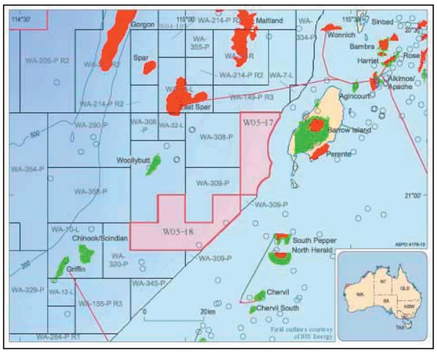

Fig. 3. Location of permit WA-372-P (W05-17) in the Barrow Sub-basin of the Carnarvon Basin,

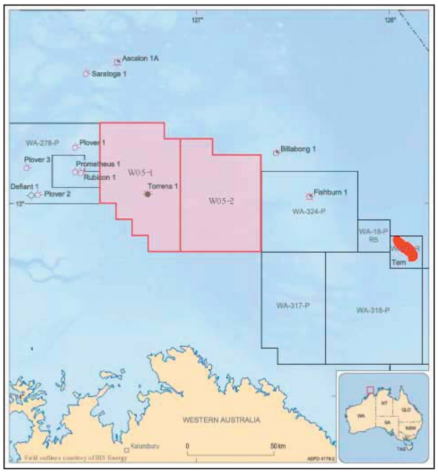

Fig. 4. Permit WA-376-P (released as W05-1) in the Bonaparte Basin, WA-375-P (released as W05-2) showing bathymetry, gas fields (red), and well sites.

The table below summarises the results of the bids and the exploration programs being proposed.

Continued on page 38

Permit Area Number of Bids	Operating Companies	Exploration Program
Browse Basin Permit WA-371-P (released as W05-3), Eight bids	Shell Development (Australia) Pty Ltd.	Primary work program of studies, seismic data reprocessing and 12 exploration wells with an estimated cost of $148 million. Secondary work program of studies and one exploration well, at an estimated cost of $11 million.
Carnarvon Basin, Central Exmouth Plateau Permit WA-369-P (released as W05-14) Two bids	Woodside Energy Ltd, Total E&P Australia and Japan Australia LNG (MIMI) Pty Ltd.	Primary work program of studies, an electromagnetic survey and the purchase of 3D seismic data, at an estimated cost of $2.6 million. Secondary work program of studies, seismic data reprocessing and one exploration well, at an estimated cost of $16.3 million.
Carnarvon Basin, Central Exmouth Plateau Permit WA-370-P (released as W05-15) Two bids	Woodside Energy Ltd, Total E&P Australia and Japan Australia LNG (MIMI) Pty Ltd.	Primary work program of studies, 324 km^2 of 3D seismic surveying and 3 exploration wells, at an estimated cost of $46.6 million. Secondary work program of studies, seismic data reprocessing and one exploration well, at an estimated cost of $16.3 million

T.W. Edgeworth David: A Life

by David Branagan
National Library of Australia, 2005
$39.95 (648 pp.)
ISBN 0 642 10791.2

Reviewed Ted Lilley

While pondering the present task of reviewing Branagan's life of Edgeworth David, who lived 100 years ago in Sydney, I was given a copy of Pumfrey's life of the geomagnetician Gilbert, who lived more than 400 years ago in Elizabethan England. Addressing the Gilbert biography, which is a book on an historical figure well beyond living memory, helped me see, in Branagan's book also, its measure as a history of science. For in addition to being the definitive history and personal narrative of a founding giant of Australian geology, the Edgeworth David book is a history of science, and science achieved in Australia.

Mackay, David and Mawson at the South Magnetic Pole, 16 January 1909.

For while Edgeworth David is central to the book now under review, it is also the wider setting, meticulously researched and described with great clarity by Branagan, which comes through with powerful impact. We thus have an account of early geological education in Australia; the concept of mapping the Australian continent as a single unit; Australian universities at a critical growth phase; the first stirrings of evidence for continental drift; and first hand participation in heroic and successful Antarctic expeditions. These are all set against Australia a century ago, together with a substantial participation in the trenches in France during the First World War, as a benchmark of time. There is also material on the continent-wide organisation of science in Australia, in a forerunner of the present Australian Academy of Science. With this goes easy seamless movement from pure to applied science, still important in a country owing its prosperity to the export of mineral resources.

Continued from page 37

Permit Area Number of Bids	Operating Companies	Exploration Program
Carnarvon Basin, Central Exmouth Plateau Permit WA-374-P (released as W05-16) Six bids	Chevron Australia Pty Ltd, Shell Development (Australia) Pty Ltd and Mobil Australia Resources Company Pty Ltd.	Primary work program of studies, 1800 km2 of 3D seismic, 2350 km of 2D seismic surveying and two wells, at an estimated cost of $54.78 million. Secondary work program of studies and 3D seismic data reprocessing, at an estimated cost of $0.3 million.
Carnarvon Basin, Barrow Sub-basin Permit WA-372-P (released as W05-17) Two bids	Holloman Corporation	Primary work program of seismic data purchase, 58 km2 of 3D seismic surveying and 2 wells, with an estimated cost of $21.2 million. Secondary work program of studies and two exploration wells, at an estimated cost of $20.2 million.
Carnarvon Basin, Barrow Sub-basin Permit WA-373-P (released as W05-18) Two bids	Holloman Corporation	Primary work program of seismic data purchase, 58 km2 of 3D seismic surveying and 2 wells with an estimated cost of $21.2 million. Secondary work program of studies and two exploration wells, at an estimated cost of $20.2 million.
Bonaparte Basin Permit WA-376-P (released as W05-1) One bid	Goldsborough Energy Pty Ltd	Primary work program of studies and 800 km2 of 2D seismic surveying with an estimated cost of $1.75 million. Secondary work program of studies and one exploration well, at an estimated cost of $15.6 million.
Bonaparte Basin, Permit WA-375-P (released as W05-2) One bid	Goldsborough Energy Pty Ltd	Primary work program of studies and 800 km2 of 2D seismic surveying with an estimated cost of $1.75 million. Secondary work program of studies and one exploration well, at an estimated cost of $15.6 million.

For those not familiar with the petroleum exploration industry, Holloman Corporation, which will explore in the Barrow Sub-basin, is a Texas-based employee-owned, company that provides engineering and construction services for the oil and gas industry, public and private water and wastewater infrastructure, and sports facilities. So this exploration venture is a little outside its core business.

Goldsborough Energy Pty Ltd is a bit of a mystery, I could find nothing about it on the internet, but I am told it is a small unlisted Australian company based in Melbourne in the Geoffrey Albers stable.

For Edgeworth David was an active leader in all these things; remarkable now, and extraordinary then, given the different logistics, communication and transport of his times. Also, 100 years ago, geophysics is encouraged by Edgeworth David, in its pioneering days of classical magnetics, gravity and seismology.

In this review I use the abbreviation ED. The "Edgeworth" was a given name, and came from his mother's family. Branagan presents a remarkable time-line. Part 1 of the book goes from the birth of ED in Wales in 1858, the oldest child in the family of an Anglican minister, and includes education at Oxford. It describes the move of ED to Australia in 1882 to accept the appointment of Assistant Geological Surveyor of New South Wales, leading to many years in the field, for example in the Hunter Valley.

Part 2 starts with the appointment of ED to the University of Sydney in 1891, to a chair in geology newly described as Professor of Geology and Physical Geography. Here his wide and creative contributions developed on many fronts, for example a drilling expedition in 1897 to the coral atoll Funafuti in the Ellice Islands, to test Darwin's theory of atoll formation.

Part 3 covers the period 1907-1914 and is devoted to "Antarctic business", especially ED's participation in Shackleton's "Nimrod" expedition of 1907-1909. At the end of their first summer in Antarctica ED led the first ascent of Mt Erebus, and then after wintering over, a four-month expedition to the South Magnetic (Dip) Pole in 1908-1909. This successful expedition, with companions Douglas Mawson and Alistair Forbes Mackay, demonstrated impressive competence in polar travelling under the notorious hardships and dangers of such conditions. The adventures captured the imagination of the public, contributing to ED's subsequent great popularity.

Part 4 is then devoted to the important scientific milestone of the meeting in Australia in 1914 of the British Association for the Advancement of Science. Noteworthy at that meeting was ED's diversion into anthropology, regarding an Aboriginal skeletal remnant found in Queensland, the "Talgai skull".

Part 5 changes to the wasteland scenes of trench warfare in the First World War. In Australia, ED played a major part in the formation of the Australian Tunnelling Corps. Then, in the army on the Western Front in France (and some 57 years of age), he applied his geological skills to problems of groundwater and tunnelling.

Part 6, entitled "Seeing, Reading and writing Geology", covers the post-war period 1919-1928. ED is back at the University of Sydney until his retirement in 1924, and strongly engaged in science. He is knighted and, in particular, returns to mount a campaign on his long-planned "Geology of the Commonwealth of Australia". His experience and leadership is in demand from many quarters, not least in the formation of the Australian National Research Council, a national body intended to represent Australian science internationally, and forerunner of the present Australian Academy of Science.

Part 7 deals with some special and significant geological interests pursued by ED in the latter stages of his career, notably landscape development, oil occurrence, and the new ideas of continental drift. ED was an enthusiastic supporter of Wegener's ideas, and found an ally in the South African geologist, Alexander du Toit.

Part 8 covers his work 1924-1934 on the book and map of the Geology of the Commonwealth of Australia, and his search for Precambrian fossils. He started writing the book, and preparing its adjunct, the map of Australian geology, in 1922. The map was printed in 1931, with accompanying valuable printed notes, but ED did not live to see the book completed. It was finally finished in 1950, by W.R. Browne. In this part also, there is an account of ED's contribution to the establishment in Australia of the Imperial Geophysical Experimental Survey, the report of which resulted in the book "Principles of Geophysical Prospecting" by A.B. Broughton Edge and T.H. Laby (Cambridge University Press, 1931).

Part 9 covers ED's last years, 1930-1934. ED is continuing to struggle to complete his book, but is weakening physically. His death occurred in 1934. He was given a state funeral and thousands of people attended, according ED a remarkable tribute.

Throughout the book a recurring theme is ED leading and inspiring students, whether on excursions to the cliffs of the ocean coast of Sydney, or to the glacial lakes of Mt Kosciuszko. And while ED fades from living memory, a host of students whom he inspired, such as Browne, L.A. Cotton, Mawson, H.G. Raggatt, T.G. Taylor, L.K. Ward and W.G. Woolnough, have passed the legacy on. Present ASEG members are likely to be able to trace links down to their own geological and geophysical traditions.

The private correspondence of ED has been an important and major source of material for this biography (indeed a lot of his scientific papers were lost). There is a great deal of significant correspondence with his professional friends and colleagues, such as Mawson. The members of this group influenced each others' lives in most pivotal ways. The personal letters also allow a full account of his family life, from meeting his wife Cara on the voyage out to Australia, to their series of homes in Sydney, and to the upbringing of their children. Such material helps complete a rounded and balanced picture of the man, and offers insights into his thoughts and attitudes.

It is hard in a brief review to do justice to a book which contains so much, but the term "renaissance man" rings true. With his classical education and upbringing, ED is a renaissance geologist in the early days of palaeontology, geodynamics and sedimentology. Practising geophysicists, though, concerned with the tasks of the moment, will find satisfaction from the perspective of their science offered by this book. It records major foundations, upon which so much of the present Australian edifice is built. If it had not actually happened, what novelist would ever so strain the credulity of his readers by fitting so much into a life? It is, perhaps, truth exceeding fiction. The book reads like an adventure story from the heroic age of exploration. One might add that in Earth Sciences the age of exploration continues to the present day.

The book is published by the National Library, which supported the author by the award of a Harold White Fellowship during the book's production. It is very good value for its price, being a robustly produced paperback. I was fortunate to attend the book launching at the University of Sydney on 21 October 2005, and subsequently caught an evening bus to Canberra. With this book to read, the journey has never passed so quickly.

Aims and Scope

Preview is published by the Australian Society of *Exploration Geophysicists*. It contains news of topical advances in geophysical techniques, news and comments on the exploration industry, easy-to-read reviews and case histories of interest to our members, opinions of members, book reviews, and matters of general interest.

Contents

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References

References should follow the author (date) system as used by the SEG (see their website for full details). When reference is made in the text to a work by three or more authors, the first name followed by *et al*. should be used on all occasions. References should be listed in alphabetical order at the end of the paper in the standard form:

Blackburn, G. J., 1981, Seismic static corrections in irregular or steeply dipping water-bottom environments: *Expl. Geophys.*, **12**, 93–100.

Abbreviations and units

SI units are preferred. Statistics and measurements should always be given in figures e.g. 10 mm, except where the number begins a sentence. When the number does not refer to a unit of measurement, it is spelt out, except where the number is greater than nine. Confusing mathematical notation, and particularly subscripts and superscripts, should be avoided; negative exponents or the use of a solidus (i.e. a sloping line separating bracketed numerator and denominator) are acceptable as long as they are used consistently. The words 'Figure' and 'Table' should be capitalised (first letter) and spelt in full, when referred to in the text.

Deadlines

Preview is published bi-monthly, February, April, June, August, October and December. The deadline for submission of all material to the Editor is the 15th of the month prior to the issue date. Therefore the deadline for the **June 2006 issue is 15 May 2006.**

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Advertising copy deadline is the 22nd of the month prior to issue date. Therefore the advertising copy deadline for the **June 2006 issue will be 22 May 2006**. A summary of the forthcoming deadlines is shown below:

Preview Issue	Text & articles	Advertisements
122 Jun 2006	**15 May 2006**	**22 May 2006**
123 July 2006 (AESC Conference Handbook)		
124 Aug 2006	15 Jul 2006	22 Jul 2006
125 Oct 2006	15 Sep 2006	22 Sep 2006
126 Dec 2006	15 Nov 2006	22 Nov 2006