

PREVIEW

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS



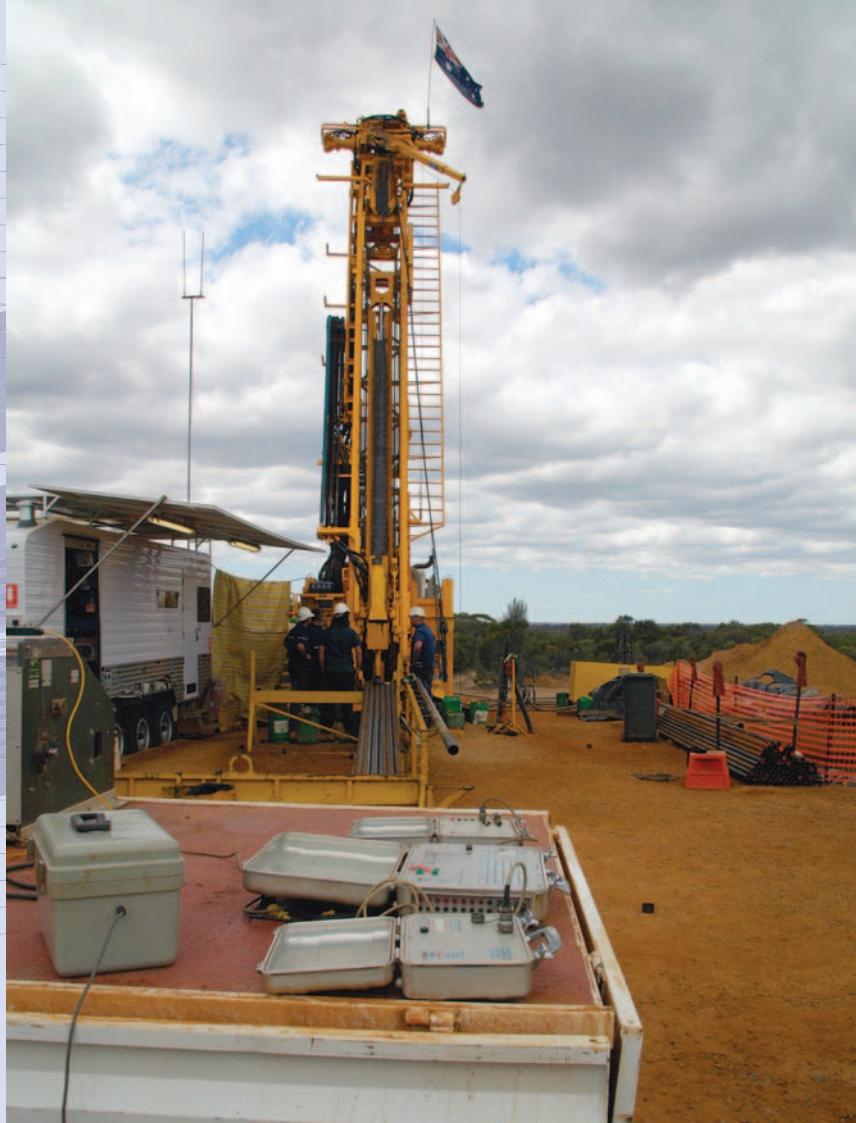
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- Update on ASEG Publications
- Report from the SEGJ
- Business investment in R&D
- New offshore exploration permits

FEATURES

- Archaeological geophysics at Flinders University
- ARC results for 2010





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FRONT COVER



World's first purpose built marine EM vessels, the Boa Galatea and Boa Thalassa (see article on p.27). Photo courtesy of EMGS and Fugro Electro Magnetic Pty Ltd.

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Ann-Marie Anderson-Mayes

I read with much interest the Editorial in the latest edition of *PESA News: Resources* (issue no. 102). Adrian Williams was bemoaning the fact that the 'oil and gas industry has allowed the sensationalist' reporting of PPTEP Australasia's *West Atlas* oil leak to go unchallenged. As I read his piece, I had the feeling that the more things change, the more they stay the same.

In the 1980s, my father worked for WMC on the feasibility project to develop the processing plant at the Roxby Downs copper, uranium, gold, and silver mine. As a high school student in Adelaide at the time, I learnt pretty quickly not to say too much about where my father worked. 'Roxby Downs' was a dirty word. Most people were just told that my Dad worked 'up north'. Media stories broke periodically that blew facts out of all proportion. I remember one occasion when a water leak occurred during transportation of a container of uranium-copper ore. Of course, it would have been better all round if the container had not had the leak. But the scientific fact was that the radioactivity level of the leaked water was no higher than the average granite outcrop which appears all over Australia. It was certainly not the radioactive 'disaster' that hit the newspapers.

The West Atlas accident is on a much larger scale than the minor incidents that made such an impression on me during

my youth. However, in a digital age where there is such a large amount of information readily available, it seems inexcusable that a more balanced view of all aspects of the West Atlas leak are not reported in the general media.

But I wonder if this is entirely fair? The problem in this highly complex, knowledge rich, but time poor world of ours is that it can be difficult to get this sort of reporting right. I wonder how many reporters, let alone the average men and women on the street, know enough about petroleum to know that the dispersal characteristics of the Exxon Valdez heavy oil slick in a partially frozen waterway are totally different to those of the gas and condensate leaking from West Atlas into an open, tropical marine environment? If they are a generalist reporter for a typical media outlet, there is a pretty good chance that they have had little or no scientific training beyond high school level. Furthermore, the air time or newspaper space given over to the reporting is limited, and thus a reporter will naturally stick to the story that she (or her editor) thinks will have the greatest impact.

The scientist in me agrees completely with Adrian Williams. I too become utterly frustrated when general media reporting lacks scientific accuracy and I wish more scientists would make their voices heard in the media.

However, then I put on my Editor's hat and I suddenly find myself empathising with those general media reporters. Every two months, I make decisions about what to include in an issue of *Preview* magazine. I try to find out from colleagues what they want to read about; I keep a watch on mining, petroleum, exploration, education and research news; I have a network of regular contributors and associate editors; and I occasionally get unsolicited submissions (and I love these!). But

ultimately, what appears in *Preview* comes through a filter with two parts – material that has traditionally been published in *Preview* and material that I find interesting and decide to publish on the basis that I hope at least some of you will find it interesting too.

If I am not aware and *not made aware* of a new development in our industry then I can't publish an article about it. In this respect, I am no different to the reporter who doesn't know that there is a significant difference between the Exxon Valdez oil spill and the West Atlas condensate leak, and furthermore *he doesn't know that he should be looking at this difference*. Thus, it is incumbent upon us all to be good, proactive science communicators in the interests of improving general reporting of scientific issues in the media. Similarly, it is critical for ASEG members to inform me about new and interesting developments in their field of expertise so that *Preview* content can be as current and relevant as possible.

This issue's feature article was generated as a result of the archaeology articles published in the August issue (*Preview* 141). Ian Moffat has put together a very interesting piece outlining the geophysics and archaeology program at Flinders University. Unlike the earlier pieces, this article reports the Australian geophysics and archaeology story. David Denham has provided us with a comprehensive report on the latest round of ARC grants. The book review looks at the 2nd edition of *Groundwater in Geologic Processes*. And there is plenty of ASEG, industry and conference news.

As this is the last issue of *Preview* for 2009, I would like to thank our contributors, readers, advertisers, sponsors and publisher. May you all have a happy and relaxing festive season, and a successful 2010.

Maintaining our individuality while seeking strength in teamwork – III

In the last two issues of *Preview* I have talked about the synergies we are developing in working with sister professional societies in Australia. In this issue it is time to think beyond our shores and talk about collaboration on the international stage.

Relationship with sister societies – SEG

I attended the SEG Annual Meeting in October, and supported by Dennis Cooke and Natasha Hendrick spent an hour in discussion with Steve Hill (SEG President) and Mary Fleming (Executive Director). We discussed three areas of mutual interest:

- *SEG Distinguished and Honorary Lecturer program.* Thanks to the efforts of our Vice President Koya Suto we have three visiting speakers lined up to visit Australia over the next year, and two further ones under discussion. The SEG pays the travel and accommodation for these programs, with local branches picking up venue and advertising costs. It is a significant benefit to professional education for our members that we can be part of these programs.
- *Publication.* The ASEG has reached agreement with two of our local distinguished members Dave Isles and Leigh Rankin to publish their forthcoming book *Aeromagnetic Interpretation – A Practical Manual*. The SEG is supportive of this project

and subject to details to be provided will jointly market the book with the ASEG via its own bookshop and world-wide network. This is an exciting development which will give an Australian initiative in geophysics education a global reach.

- *A possible office base in Perth.* The SEG has an ongoing interest in adding offices outside north America (it has recently opened offices in Beijing and Rio de Janeiro). If we invite them to do the same in Perth, we may build a synergy in shared facilities. Should we? There is no proposal as yet from either side, but we are open to considering the benefits.

Relationship with sister societies – SEGJ and KSEG

Over the last five years we have enjoyed an excellent collaboration with the SEG of Japan and the Korean SEG in publishing a joint issue of *Exploration Geophysics* each year. We recently posed the question as to whether this should be expanded to make *Exploration Geophysics* an international journal jointly published by the three societies ASEG, SEGJ and KSEG.

There are substantial advantages to our sister societies in having an English-language journal for their members, and likewise there are advantages to our members in having an expanded journal with a greater international reach and impact factor – issues of importance

in the academic world for rating the research output of our graduate students and academically inclined constituents. We held informal meetings with SEGJ and KSEG representatives in Japan in September, and at the SEG in October, and believe a formula for shared cost and responsibility is feasible. A firm proposal to ASEG branches and members should be available for discussion by the end of this year.

I had the pleasure of visiting State branches in ACT and Queensland during the past two months. I hope to have opportunity to visit the SA and WA Branches early next year before my Presidential role reduces to that of the proverbial pumpkin. I take this opportunity to wish all members of the ASEG warmest best wishes for the Christmas season, with success and new opportunities in the New Year.



Michael Asten
President
michael.asten@sci.monash.edu.au

Changes to ERA Journal Rankings in Progress

The submission by the Australian Geoscience Council to Minister Kim Carr regarding the Australian Research Council grading of academic publications (see *Preview* issue 142 (October), p. 11) appears to have produced a positive result. In October the AGC was invited by the ARC to provide a panel of experts to grade all geosciences journals, and AGC Chairman Michael Leggo is currently coordinating input from five geoscientists nominated by AGC member societies. ASEG President Michael Asten is one of the panel. The use of a panel including both industry and academic sources is expected to result in a more balanced grading of journals whereby authors publishing in top applied geosciences journals (e.g. *Geophysics*, and *Economic Geology*, *AAPG Bulletin*, *Hydrology Journal*) may get similar recognition to authors publishing in the purer science journals.

ASEG's 2010 Annual General Meeting

This is advanced notice that the 2010 Annual General Meeting of the Australian Society of Exploration Geophysicists will take place at 5:30 pm on Tuesday, 13 April 2010, at the Citywest Function Centre, 45 Plaistowe Mews, West Perth.

At this meeting we will elect members to fill the following positions: President, President-Elect, Secretary and Treasurer.

We will also be proposing changes to the Constitution and will transact any other

business which may be properly brought before the meeting.

So put this date in your diary, and if you will be in Perth on that day, be there to make a difference.

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Australian Capital Territory

On 12 August, the ACT Branch heard a fascinating presentation by Ian Moffat (Flinders Uni and ANU) on the challenges of doing archaeogeophysics in Australia (see the feature article on p. 29 of this issue). Ian and his team certainly face large challenges (e.g. small and subtle anomalies) in comparison to the television-friendly results produced by the BBC's *Time Team*. Despite the challenges, Ian demonstrated the potential for using geophysics to identify rock shelters, alleged locations of frontier conflict and human burial sites.

On 13 October, President Michael Asten visited Canberra and shared his thoughts on the current status of the ASEG and his visions for the future. This was a great opportunity for members to hear first hand from the president – we commend the initiative to send the federal president to visit branches and hope that this will continue in the future. Michael followed his ASEG perspective with a technical talk on an EM induction system that his team has developed for detection of unexploded ordinance. The results suggest that the system has a high chance of success, but it seems the US government remained true to their own and haven't continued funding for a promising system with a clear societal benefit.

A joint Christmas Barbeque with the local branches of the GSA and AusIMM on 8 December (from 5 pm at Geoscience Australia) will probably mark the end of activities for 2009. We thank all our speakers for 2009 and also the SEG, together with ASEG FedEx, for sending this year's Distinguished and South Pacific Honorary lecturers to Canberra. We look forward to another full and enlightening year in 2010.

Ron Hackney

New South Wales

In September, the 2009 NSW branch dinner was held in a Chinese restaurant in Chinatown. Matters of great geophysical importance (and other less critical subjects) were discussed over a few bottles of white and red. A good time was had by all.

In October, Dave Robson from the Geological Survey of NSW spoke on the reprocessing of the Broken Hill radiometric data and its impact for geological mapping in the area, as well as touching on new geophysical programmes

that the department will be undertaking in 2010. Many technical questions were asked during and following Dave's presentation.

In November, we held our student evening where two Honours students presented the results of their research. Elyse Schinella, from Macquarie University, spoke about convergence within the Wedges region of Europa and Grace Shephard, from Sydney University, spoke about the contribution of mantle convection to shifting South American coastlines during the Cainozoic.

Do not forget the ASEG-PESA conference in 2010 in Sydney, 22–26 August.

An invitation to attend NSW Branch meetings is extended to interstate and international visitors who happen to be in town at that time. 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.

Mark Lackie

Queensland

The Queensland Branch assembled on 24 September for a double dose of coal related geophysics. Xun Luo of CSIRO described the results of an Australian Coal Association Research Program study entitled 'Roof Condition Monitoring Ahead of a Longwall'. This was followed by Koya Suto of Terra Australis with 'Application of the Multi-Channel Analysis of Surface Waves (MASW) Seismic Method for Shallow Open Cut Coal Exploration'. Thanks to both speakers for giving us an insight into these unusual applications of geophysics.

On 9 November we heard from Dr Yoonho Song of the Korean Institute of Geoscience and Mineral Resources on 'Magnetotellurics for mine exploration and deep geological survey – results from Queensland and Victoria'. Dr Song was in Brisbane for the Australian Geothermal Energy Conference and we thank him for making time in his schedule to make this presentation.

With the end of year fast approaching I'd like, on behalf of the Queensland branch committee, to wish all ASEG members and their families a merry and safe festive season.

Wayne Mogg

South Australia

The South Australian Branch of the ASEG has had two recent events. The first was a technical meeting at the end of September when Geoff Lowe, Exploration Manager of Rex Minerals, presented 'The Hillside Cu-Au Project, Yorke Peninsula, SA'. A large mixed crowd including some shareholders turned out for a very interesting overview of the recent geophysical activities over Rex acreage on the Yorke Peninsula.

The Annual Melbourne Cup Luncheon was again a success, thanks largely to Neil Gibbins of Beach Petroleum for his MC and auctioneering skills and Jenni Clifford of Santos for organising the event. Beach Petroleum as ever was the very generous exclusive sponsor, both financially and with help on the day.

The Annual Wine Offer has had a very good uptake, and wines should be at collection points in major cities by the time you read this. The next meeting will likely be the AGM, in mid-February. As usual, all positions on the committee are open, and I would urge any members willing to be on the local committee to nominate for 2010.

The SA Branch holds technical meetings monthly, usually on a Thursday night at the Historian Hotel, from 5:30 pm. New members and interested persons are always welcome. Please contact Luke Gardiner (luke.gardiner@beachpetroleum.com.au) for further details.

Luke Gardiner

Victoria

More than 20 Victorian ASEG branch members met on 5 October at the Kelvin Club for the presentation '3D Modelling and Model Management at GeoScience Victoria' by Dr Tim Rawling from Geoscience Victoria, Department of Primary Industries (GV-DPI). Tim gave an initial overview of GV-DPI's approach to regional 3D modelling, and presented a recently completed depth-to-basement map of the Murray Basin as derived from magnetic modelling and existing well information. Tim also provided a fascinating insight into his past work in 'Augmented Reality' – in which information in real time is superimposed on real world imagery (akin to the cyborg vision system in the *Terminator* movie and television series). Thanks to Tim for a very informative and entertaining presentation and thanks to

all the branch members for coming out in force.

On 25 November at the Kelvin Club, the ASEG Victorian Branch will be hosting the Annual Student Night, giving local graduating geophysics students the opportunity to present their research in a professional forum. We look forward to supporting the graduating geophysicists about to join our ranks.

Asbjorn Christensen

Western Australia

The WA student evening was held on 4 November. There was a very good turnout to hear from six Honours students completing their studies at Curtin

University. The presentations were as follows:

- Faisal Khalid Alfuaid – Vertical seismic profiling for recovery of nearwell hydrostratigraphy, Perth Basin, Western Australia.
- Mohammed Abdulaziz Almaghlouth – Velocity independent migration in curvelet domain.
- Faisal Abdulkader Alonaizi – Numerical testing of virtual source method.
- Adam Gangemi – Implications of azimuthal anisotropy for the Barrow Sub Basin, North West Shelf of Australia.
- David Linton Stannard – Geophysical delineation of iron sand deposits on the west coast of the North Island, New Zealand.

- Ismail Yavuz – Estimation of shear wave anisotropy from VSP data: CO2CRC Otway project case study.

The presentation skills of the students were uniformly excellent and the projects reported a nice mix of fieldwork and numerical modelling. We wish these students and their colleagues well for their future careers in geophysics.

By the time you read this, the WA branch will have had their annual Christmas function on 11 December. We would like to take this opportunity to wish everyone a very merry Christmas and a Happy New Year.

Reece Foster

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New members

The ASEG welcomes 22 members to the Society (see table). Their membership was approved at the Federal Executive meetings held in September and November 2009.

We would also like to welcome a new corporate member to the ASEG.

Alpha Geoscience Pty Ltd was accepted as a new corporate member as of November 2009. Alpha Geoscience was established in 1997 and is led by Timothy Pippett. Four additional geophysicists as well as technical and support staff complete the team.

Their survey capabilities include high sensitivity magnetics, time or frequency domain electro-magnetics, resistivity mapping, ground penetrating radar and seismic techniques. These services combined with the digital processing of the data to produce colour images of the site and the interpretation of the data gives high-resolution detail of the sub surface on the site. This data can be imported into Geographical Information Systems for future reference and auditable documentation.

For environmental targets, Alpha Geoscience has experience in mapping buried structures, site assessments, and detection of chemical pollutants. It has also combined with BACTEC South East Asia to assist in the location of buried ordnance or unexploded ordnance. For the

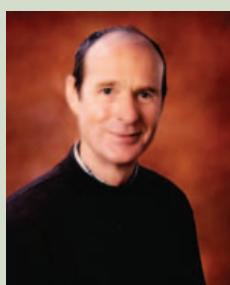
| Name | Affiliation | State/Country | Membership Category |
|-----------------------------|----------------------|---------------|---------------------|
| Majed Ahmed Almaki | Curtin University | WA | Student |
| Nicole Bergersen | Acoustic Imagina PL | NSW | Active |
| Marissa Betts | Macquarie University | NSW | Student |
| Tad Choi | Woodside Energy | WA | Associate |
| Guillermo Chutrau | Chevron | WA | Active |
| Liam Clarke | Curtin University | WA | Student |
| Ed Cunion | | USA | Active |
| Hamish Donovan | Macquarie University | NSW | Student |
| Katherine Louise Farrow | Macquarie University | NSW | Student |
| Aidan Fitzallen | Coffey | NSW | Associate |
| Peter Griffiths | Woodside Energy Ltd | WA | Active |
| Thomas Harris | Macquarie University | NSW | Student |
| Troy Hewitt | Macquarie University | NSW | Student |
| Kjell Larsen | Aker Geo | WA | Active |
| Joanna Jane Linck (Ponting) | Curtin University | WA | Student |
| Max Rohrman | Woodside Energy Ltd | WA | Active |
| Shannon Rutty | Chevron | WA | Associate |
| Kieran Ryan | Santos Ltd | SA | Associate |
| Matthew Strika | Woodside Energy | WA | Associate |
| Ruan Swanepael | Curtin University | WA | Student |
| Geraint Peter Thomas | Woodside Energy Ltd | WA | Active |
| Anand Tripathi | PGS | WA | Active |

engineering sector, it has a wide range of experience in civil engineering, mine engineering, and construction.

Alpha Geoscience also offers a broad range of geophysical instruments for both sale and rental.

Contact details are:
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John Watt retires from GSWA



Well known ASEG member, John Watt, is retiring from the Geological Survey of WA (GSWA) on Friday 20 November 2009. John was ASEG Treasurer from 2003 to 2007, and prior

to that Treasurer for the WA Branch for several years. He was awarded the ASEG Service Certificate 'for distinguished service by a member to the ASEG, through involvement in and contributions to State Branch committees, Federal Committees, Publications, and Conferences' in 2006.

John joined the GSWA in 1970 after a short spell with GSI (Geophysical Service Incorporated) as a junior observer. John started at GSWA as a Geophysical Technician running refraction seismic surveys for water, road and rail cuts, and almost all of the WA dam sites.

He also looked after the department's well logging operations and developed standards for water well logging in WA. During the last 12 years or so, as a geophysical associate, John has been managing the state airborne geophysical data repository.

After retiring, John plans to do some contract work doing geophysical data processing. He and his wife will also be pursuing their business in health maintenance from home. After almost 40 years with GSWA, we wish John all success in his retirement.

ASEG's publications – 2009 update

In *Preview* 132 and 133 I reported on some of the actions **CSIRO PUBLISHING** had taken to raise the online profile of *Preview* and *Exploration Geophysics*. Time then for an update and a focus on usage.

From the website we measure download data, the number of times a PDF or HTML version of an *Exploration Geophysics* paper or *Preview* issue is opened. Both ASEG publications are being more widely used.

Preview is regularly receiving 2500 views per month. *Preview* is freely available online and appears online about three weeks in advance of the print version. The jump in online readership from September 2008 is interesting and we seem for the moment to have reached a new and higher 'steady state' readership, to the benefit of ASEG profile and for advertisers.

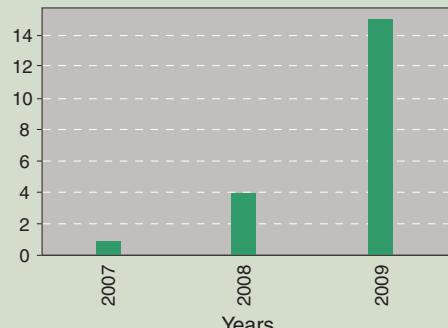
Something exciting is happening with *Exploration Geophysics*. Historically we'd enjoy about 1000 papers, new and

archival, being read each month, with spikes as the larger ASEG/SEGJ/KSEG combined issue appeared. Towards the end of 2008 the long project of full indexing in SEG's Digital Content Index (DCI) was completed, and usage tripled overnight. In August 2009 we completed a second refinement to the indexing, to allow direct connection to the individual papers, with a consequent upward trend in usage.

In the next months we'll also complete work on indexing all of the online *ASEG Extended Abstracts*, and we're starting the same with *Preview*.

A consequence of being found is being read and cited. *Exploration Geophysics* has been accepted for indexation by ISI Web of Knowledge and next year will receive an official Impact Factor. In the meantime the number of citations acquired is increasing at a great pace.

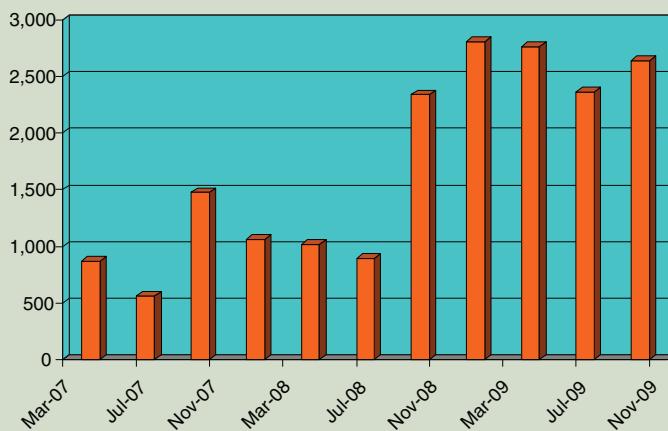
In turn, the consequences of being found, read, and cited are institutions wish to



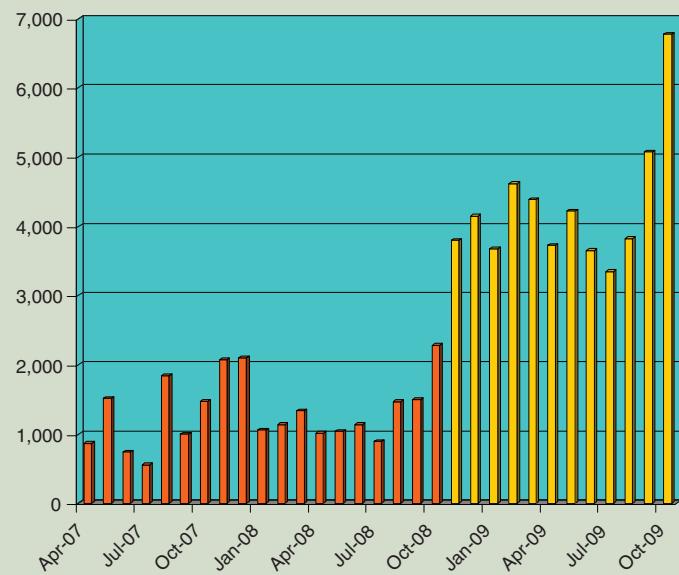
Annual citations attributed to *Exploration Geophysics* (to 1 Nov 09).

subscribe to ASEG publications. The number of institutional subscribers that chose an online-only subscription jumped 63% on the 2008 subscriber numbers. We're hard at work on institutional libraries world wide to gain still greater interest in 2010.

Richard Hecker
CSIRO PUBLISHING
richard.hecker@csiro.au



Downloads of *Preview* by month.



Downloads of *Exploration Geophysics* by month. The yellow data marks when DCI indexation was complete.



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ASEG members play key roles in the 9th SEGJ Symposium in Japan

First class symposium

Increased cooperation between geophysicists from Japan (SEGJ), Korea (KSEG), Vietnam (VAG), China (SPG), the USA (EEGS) and Australia (ASEG) was in evidence at Sapporo in Japan, during the 9th SEGJ Symposium. The well organised meeting with the theme *Imaging and Interpretation – Science and Technology for Sustainable Development* coincided with Sustainability Week at Hokkaido University and was attended by 188 delegates from 23 countries.

The only major problem was that most of the Chinese delegates could not get visas in time due to the long string of public holidays in Japan (Autumnal Equinox and Respect-for-the-Aged Days, when the embassies are not open) and China where the 60th anniversary of the revolution was celebrated – too many public holidays!?

The fifteen themes covered at the symposium covered a wide range of issues:

1. Sensors and acquisition technologies
2. Seismic/geodetic imaging technologies
3. DC/EM imaging technologies
4. GPR imaging technologies
5. Data processing/signal processing
6. Laboratory/scaled geophysics
7. Marine technologies
8. Airborne studies
9. Geophysical observations in time lapse problems
10. Reservoir characterisation
11. Energy and resource explorations
12. Shallow/near-surface applications
13. Environmental and engineering applications

14. Geological disposal and storage applications
15. Disaster mitigation applications

In total there were 60 oral presentations, three plenary lectures open to the public, 58 poster displays and one SEG Distinguished Lecture.

Six ASEG members attended the meeting and each made major contributions to the symposium as outlined below.

- Asbjorn Christensen gave presentations at a pre-conference workshop and also at the main symposium, as well as setting up a booth for Intrepid Geophysics.
- Borys Data was responsible for the booth for Hampson Russell Software.
- Koya Suto was a member of the organising committee, gave a presentation at the main symposium and also led the discussion at the inter-society meeting to discuss the future of the journal *Exploration Geophysics*.
- Jim Cull was a co-convenor of the ‘DC/EM imaging technologies’ theme, represented ASEG at the conference banquet and also made a presentation at the main symposium.
- Brian Evans gave a keynote address at the ‘Reservoir characterisation’ session and enlivened the meeting by asking searching questions wherever he went.
- David Denham delivered a key note address at the opening plenary session, which was open to the public. The title of the address was *The Future of People on Planet Earth: Challenges for Geophysicists*. He was also a co-convenor of the ‘Energy and resource explorations’ theme.

The full program together with abstracts is now available at: <http://www.segj.org/is/9th/>.

Proposed expansion of *Exploration Geophysics*

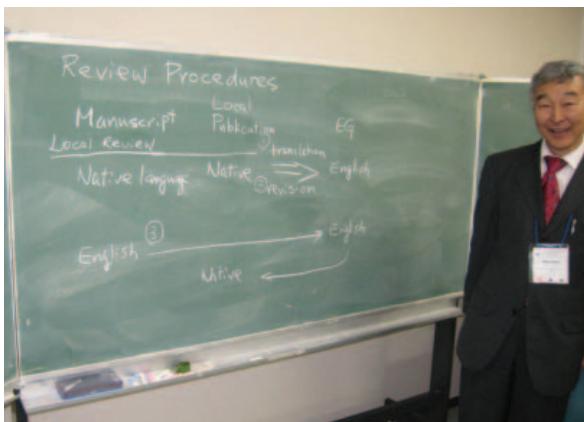
During the symposium, a meeting between ASEG, SEGJ and KSEG was held to look at options to increase cooperation between the three societies by enlarging the scope of *Exploration Geophysics* and making the journal a fully integrated publication with papers from each of the three societies. It was agreed that we will work towards the enlarged journal with a start target of 2011. Detailed discussions will be held in the next few months in an effort to make this happen.

Toru Mogi, the Chairman of the Organising Committee, and his team are to be congratulated on running an excellent symposium.

David Denham



Jim Cull thanks the SEGJ for hosting a very successful symposium at the official banquet.



Koya Suto shows members of the ASEG, KSEG and SEGJ his plans for an enlarged and integrated Exploration Geophysics.



Three stalwarts at the ASEG booth (Brian Evans, David Denham and Koya Suto).



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are in our hands

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Conference & Exhibition

22-26 August 2010, Sydney Australia



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ANNOUNCEMENT

AIRBORNE GRAVITY 2010 WORKSHOP

Sydney, Australia

Sunday 22nd August 2010

In conjunction with the 21st International Geophysical Conference & Exhibition to be held 22-26 August 2010 in Sydney, a one day Airborne Gravity Workshop is now being organised for Sunday August 22. The objective of this workshop is to review advances in airborne gravity since the Airborne Gravity Workshop 2004, also held in Sydney.

The Airborne Gravity Workshop 2010 will follow four themes:

- Current operating airborne gravity and gravity gradiometry systems
- Developing airborne gravity and gravity gradiometry systems
- Advances in processing and interpretation software
- Review of complementary technologies

This workshop is being planned by Bob Smith - Greenfields Geophysics, David Robson - Geological Survey of New South Wales, Richard Lane – Geoscience Australia and Mark Dransfield – Fugro Airborne Surveys.

For further information please contact either:

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Richard Lane +61 2 6249 9264, richard.lane@ga.gov.au

Mark Dransfield +61 8 9273 6400, mdransfield@fugroairborne.com.au

David Robson
Workshop Chair
21st International Geophysical Conference & Exhibition Committee
ASEG / PESA Conference

Geo-Computing 2010: 'uses and abuses'

From 29 September to 1 October 2009, the Australian Institute of Geoscientists (AIG) is hosting a technical conference focused on computer applications in geosciences. Geo-Computing 2010 is designed to provide all geoscientists with up-to-date information on computer uses and abuses within the industry. The conference themes are:

- Computer applications in target generation, exploration and mining

- Intelligent use of multidisciplinary data sets in GIS compilations
- 3D modelling in geophysics and its integration with geological models
- Database protocols, data migration, functionality and data sources
- Future developments and directions of hardware and software
- Statutory reporting and compliance requirements.

The Call for Papers has now been circulated. Abstracts in English and

containing no more than 300 words need to be submitted to Ross Logan (conference@rglogan.com) by 26 March 2010.

ASEG member, Nick Sheard, is helping to organise the geophysics related theme. If you would like more information on this aspect of the conference, Nick can be contacted at nick.sheard@capex.net.au.

Professional education lectures coming to Australia, supported by the SEG and ASEG

The following three lecturers will be visiting Australia next year as part of the SEG's Professional Development program. The ASEG supports these programmes by paying venue and advertising costs.

Geophysics Under Stress: Geomechanical Applications of Seismic and Borehole Acoustic Waves

*Distinguished Lecturer Short Course (DISC)
Colin Sayers, Schlumberger, Houston*

The course will run in August 2010 in Sydney (associated with the ASEG Conference) and Adelaide.

Robust Workflows for Seismic Reservoir Characterization

*SEG Spring Distinguished Lecturer
Patrick Connolly, BP Corporation, London*

Lecture tour scheduled for first half of 2010. Seven locations requested in Australia.

Electrical Properties of Sedimentary Rocks From DC to Dielectric Frequencies

*SEG Regional Honorary Lecturer
Ben Clennell, CSIRO – Wealth from Oceans Flagship*

Lecture tour scheduled for first half of 2010. Seven locations requested in Australia.

Geophysical Services

- > Geophysical consulting
- > Survey design
- > Data acquisition
- > Data processing
- > Forward and inversion modelling
- > Geotechnical staff hire
- > Field Services
- > Equipment sales, rental and repairs

Applications

- > Minerals Exploration
- > Structural delineation
- > Groundwater evaluation including salinity mapping
- > Geotechnical investigation
- > Environmental studies

Survey Methods

- > IP / resistivity including 3D, dipole-dipole, pole-dipole and other techniques in either time or frequency domains
- > Surface EM including moving and fixed geometries
- > High resolution surface EM (NanoTEM)
- > Controlled and Natural Source Magneto-Telluric techniques (CSAMT, AMT, MT)
- > Down hole techniques including EM, IP / resistivity and MMR
- > Ground Penetrating Radar (GPR)

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\$394M for new ARC research projects – \$31M more than 2008 allocations

The Minister for Innovation, Industry, Science and Research, Senator Kim Carr, on 26 October 2009, announced total funding of over \$394 million for 1145 new research projects to be funded through the Australian Research Council's National Competitive Grants Program (NCGP). This is an increase of \$31 million or 8.5% over last year's funding.

All these projects are funded through the Council's *Discovery Indigenous*

Researchers Development, Discovery Projects and Linkage Projects schemes (see <http://www.arc.gov.au/applicants/fundingoutcomes.htm>).

Of the three schemes, the Discovery Projects captured the bulk of the money with \$325.6 million committed to 925 projects; followed by \$66.8 million for 201 Linkage Projects and \$1.8 million for nine Discovery Indigenous Researchers Development, Discovery Projects.

Discovery Projects still hard to get – but easier than 2008

Discovery Projects aim to:

- support excellent fundamental research by individuals and teams;
- enhance the scale and focus of research in the National Research Priorities;
- expand Australia's knowledge base and research capability;
- encourage research and research training in high-quality research environments;
- enhance international collaboration in research; and
- foster the international competitiveness of Australian research.

They are the main vehicles for funding basic research in tertiary institutions.

Table 1 summarises the funds provided since 2005 for Discovery Projects. There are several worrying trends. The first is that in real terms (CPI adjusted) the total funding provided for Discovery Projects has declined by 15% since 2005. The second is that the success rate of 20.4% remains very low and the third is that the number of Discovery grants awarded is much lower than it was in 2004/2005.

Table 1. Discovery Project funding 2005–2010*

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| Applications received | 3441 | 3766 | 4047 | 4121 | 4164 | 4085 |
| Withdrawn | 28 | 24 | 14 | 9 | 12 | 17 |
| Applications funded | 1053 | 917 | 822 | 878 | 845 | 925 |
| Success rate (%) | 30.9 | 24.5 | 20.4 | 21.4 | 20.4 | 22.7 |
| Average total grant size | \$282 030 | \$298 350 | \$334 267 | \$342 593 | \$341 344 | \$351 973 |
| Total funds requested (million) | \$443.7 | \$496.1 | \$502.1 | \$532.0 | \$2106.3 | \$2097.8 |
| Total funds approved (million) | \$295.5 | \$273.6 | \$274.8 | \$300.8 | \$288.4 | \$325.6 |
| Average first year funding | \$94 340 | \$103 768 | \$105 019 | \$106 469 | \$116 055 | \$109 179 |

*None of the dollar numbers have been adjusted for inflation

Table 2. Top Ten Universities for Discovery Projects starting in 2010

| Administering Organisation | Proposals considered | Proposals approved | Success rate (%) | Funding over project life (approved proposals) | 2009 comparison |
|-------------------------------------|----------------------|--------------------|------------------|--|----------------------|
| The University of Melbourne | 349 | 103 | 29.5 | \$38 821 177 | \$37 471 712 |
| The University of Sydney | 383 | 102 | 26.6 | \$38 164 052 | \$45 847 060 |
| The University of Queensland | 344 | 91 | 26.5 | \$36 685 217 | \$35 780 231 |
| The University of New South Wales | 381 | 94 | 24.7 | \$36 381 799 | \$27 310 860 |
| The Australian National University | 339 | 92 | 27.1 | \$35 697 944 | \$32 017 007 |
| Monash University | 338 | 94 | 27.8 | \$29 015 749 | \$20 123 948 |
| The University of Western Australia | 151 | 41 | 27.2 | \$16 144 610 | \$11 771 610 |
| The University of Adelaide | 162 | 30 | 18.5 | \$10 587 493 | \$7 630 943 |
| University of Wollongong | 117 | 26 | 22.2 | \$9 456 182 | \$8 649 575 |
| Macquarie University | 153 | 34 | 22.2 | \$9 177 180 | \$6 807 035 |
| Totals | 4068 | 925 | 22.7 | \$325 575 289 | \$288 435 583 |

The average project duration has increased from 3.18 years for 2006 to 3.3 years for 2010; average first year funding has decreased from \$116 055 for 2009 to \$109 179 for 2010; the number of proposals fell from 4164 for 2009 to 4085 for 2010; and the success rates were 22.7% up from 20.4% for 2009 (but lower than 24.5% for 2006 and 30.9% for 2005). There was a big increase in the number of projects funded – up from 845 in 2009 to 925 for 2010 but still well short of the record 1053 for 2005.

Forty-eight tertiary institutions applied for grants but only 33 received funding. Eight universities received funding of more than \$10 million for Discovery Projects starting in 2010, compared to seven for projects starting in 2009.

The top ten universities are shown in Table 2, together with last year's results. The same universities occupy the top ten places in the league table but the order has changed a little. For example, Melbourne retakes the number one spot, ahead of Sydney, and the ANU has been overtaken by NSW. In fact ANU was third in 2008 and has now slipped to

Table 3. Numbers of proposals and success rates for Discovery Projects by National Research Priority

| National Research Priority Area | Proposals considered | Proposals approved | Success rate (%) | Indicative funds over project life |
|---|----------------------|--------------------|------------------|------------------------------------|
| None selected | 378 | 91 | 24.1 | \$25149313 |
| An Environmentally Sustainable Australia | 712 | 159 | 22.3 | \$57712364 |
| Promoting and Maintaining Good Health | 752 | 173 | 23 | \$57151078 |
| Frontier Technologies for Building and Transforming Australian Industries | 1628 | 363 | 22.3 | \$142206702 |
| Safeguarding Australia | 598 | 139 | 23.2 | \$43355832 |
| Total proposals | 4068 | 925 | 22.7 | \$325575289 |
| Total priority proposals | 3690 | 834 | 22.6 | \$300425976 |
| % within priority areas | 90.7 | 90.2 | | 92.3 |

Table 4. Numbers of proposals and success rates for Linkage Projects Round 1 by discipline panel for 2010

| Panel* | Proposals considered | Proposals approved | Success rate (%) | Requested funds over project life | Approved funds over project life |
|--------------|----------------------|--------------------|------------------|-----------------------------------|----------------------------------|
| BSB | 85 | 37 | 43.5 | \$42209729 | \$18561793 |
| EE | 100 | 55 | 55.0 | \$42221107 | \$12192807 |
| HCA | 32 | 18 | 56.3 | \$11985968 | \$4233951 |
| MIC | 45 | 24 | 53.3 | \$18161993 | \$9177983 |
| PCG | 39 | 16 | 41.0 | \$14150304 | \$4455562 |
| SBE | 140 | 68 | 48.6 | \$50086557 | \$18205795 |
| Total | 441 | 218 | 49.4 | \$178815658 | \$66827891 |

*BSB = Biological Sciences and Biotechnology; EE = Engineering and Environmental Sciences; HCA = Humanities and Creative Arts; MIC = Mathematics, Information and Communication Sciences; PCG = Physics, Chemistry and Geoscience; SBE = Social, Behavioural and Economic Sciences

Table 5. Top Ten list of proposals, success rates, and partner organisation contributions for Linkage Projects Round 1 2010

| Administering Organisation | Proposals considered | Proposals approved | Success rate (%) | ARC funding over project life | Partner contributions (cash & in-kind) |
|-------------------------------------|----------------------|--------------------|------------------|-------------------------------|--|
| The University of New South Wales | 51 | 28 | 54.9 | \$11363300 | \$19220240 |
| The University of Melbourne | 46 | 25 | 54.3 | \$6976733 | \$12013378 |
| The University of Queensland | 40 | 19 | 47.5 | \$6787093 | \$14952963 |
| The University of Sydney | 28 | 15 | 53.6 | \$4931676 | \$8833893 |
| Monash University | 23 | 17 | 73.9 | \$4884284 | \$8094164 |
| The Australian National University | 18 | 10 | 55.6 | \$3900349 | \$10166291 |
| The University of Western Australia | 18 | 8 | 44.4 | \$3369007 | \$6626183 |
| Deakin University | 17 | 10 | 58.8 | \$2513212 | \$3964376 |
| University of South Australia | 21 | 7 | 33.3 | \$2084978 | \$2576792 |
| The University of Adelaide | 21 | 8 | 38.1 | \$2018757 | \$4289718 |
| Totals | 470 | 211 | 44.9 | \$66827891 | \$121330707 |

fifth. However, the top four all received grants totalling more than \$35 million so the top five have consolidated their positions. As expected the Group of Eight universities occupy the top positions in the table with Adelaide hanging on to eighth place.

National research priorities

Of the 4068 Discovery Projects proposals considered in this round, 3690 (90.7%) were identified by the applicants as addressing a National Research Priority. Of those 3690 proposals, 834 (22.6%) are approved for funding, representing 90.2% of the total 925 proposals approved for funding. However, the success rate of non-priority projects (24.1%) is much higher than for the priority project proposals (22.6%). So why bother with National Research Priorities?

The overall commitment for approved proposals addressing National Research Priorities is \$300425976 (92.3% of the total indicative funding). The greatest amount of indicative funding (\$142206702) is for projects in the area of Frontier Technologies for Building and Transforming Australian Industries (Table 3).

Linkage Grants still deliver better success rates

The Linkage Projects scheme funds collaborative projects between university researchers and Partner Organisations. These projects encourage and develop long-term strategic research alliances between higher education organisations and other organisations, including within industry, in order to apply advanced knowledge to problems and/or to provide opportunities to obtain national economic, social or cultural benefits.

Of the 441 Linkage Projects proposals considered, 218 were approved for funding and represent an ARC commitment of \$66.8 million over the life of these projects. This is less than the \$71.7 million committed in 2008. The total partner contributions in cash and kind amount to approximately \$121 million, so Linkage Projects should be very effective as far as taxpayer investment is concerned. Table 4 summarises the results; the success rate of 44.9% is approximately twice the success rate for Discovery Projects – so these are the ones to go for!

Project size

The average first year funding allocation for approved Round One 2010 Linkage Projects is \$104 265 which represents 71.6% of the average first year request. The average first year funding allocation has increased from \$96 131 in Round One 2007 to \$104 265 in Round One 2010. Thirty-five tertiary institutions applied for grants and all but two received funding. The Top Ten Universities are shown in Table 5. For these grants the Group of Eight universities fill the first seven places with The University of New South Wales at the top of the list. The University of Adelaide just scrapes into the top ten.

Earth science-related Discovery Projects

The exploration-related Earth Science Discovery Projects are listed below. Out of the 925 projects approved only 17 could be considered as relating to resource exploration. These are listed below.

Congratulations to ASEG members Boris Gurevich who obtained ARC funding as team leader for the project *Seismic attenuation and dispersion in reservoir rocks: broad-band experiments versus theoretical modelling* and Graham Heinson who was successful with his project *Three-dimensional magnetotelluric and controlled-source electromagnetic modelling and inversion in isotropic and anisotropic media with Gaussian Quadrature Grids*.

Mapping Fluid Flow in the Earth's Crust: a Li and B micro-isotopic and thermodynamic study of serpentinisation

Researchers: KA Evans and BR Frost.

Funding: 2010, \$65 000; 2011, \$60 000; 2012, \$30 000.

Administering organisation: Curtin University of Technology.

Project summary: Interaction of fluids with magnesium-rich rocks creates new minerals and, on a global scale, affects the physical and chemical evolution of the Earth. On a more local scale, such fluid–rock interactions can lock up carbon dioxide via the formation of carbonate minerals. However, the extent to which such reactions may self-propagate is unclear. A primary benefit of this study will be new constraints on

the viability of magnesium-rich rocks in geosequestration applications. Additional benefits will be provided by the development of advanced new analytical methodologies, and an increased level of understanding of the way that fluid flow can modify nickel sulphide ore bodies.

The enigmatic link between crustal growth and supercontinent formation

Researchers: WJ Collins, MP Hand and KC Condie.

Funding: 2010, \$80 000; 2011, \$80 000; 2012, \$80 000.

Administering organisation: James Cook University.

Project summary: This project links with major energy and resource initiatives from the Australian Government. It will provide detailed geological information that will help constrain our understanding of the deep structure of the Earth in northern and central Australia. This knowledge will assist in mineral and energy resource exploration of these highly prospective regions. The information will also link with other ARC-funded geological studies, to help understand how a large, but enigmatic, part of the Australian continental grew rapidly, almost 2 billion years ago.

Tracking mass transport during metamorphism using in situ micro-analysis of minerals

Researchers: C Spandler, NH Oliver and AI Kemp.

Funding: 2010, \$120 000; 2011, \$120 000; 2012, \$120 000.

Administering organisation: James Cook University.

Project summary: The continental masses we inhabit developed in response to the colossal forces of plate tectonics. Through compression and heating, rocks of the crust can experience fluid loss or melting. Movement of these fluids or magmas can, among other things, impact on the heat budget of Earth, the carbon and water cycles and the formation of ores in the crust. This project will utilize state-of-the-art scientific instruments and methods to greatly improve our understanding of these issues, which, in turn, will enhance our knowledge of how the Earth's crust develops. Research training and development will be provided through two PhD projects supported through this project.

The Initiation and 3D Evolution of Instabilities in the Deep Continental Lithosphere

Researchers: LN Moresi, TA Stern, CM Cooper and S Zlotnik.

Funding: 2010, \$140 000; 2011, \$120 000; 2012, \$110 000.

Administering organisation: Monash University.

Project summary: This project is part of a new international initiative in the Geodynamics of the Australian Plate bringing together studies of the active tectonics of the boundary regions of our plate and the ancient analogues of these processes which are locked into the stable interior of the Australian continent. The proposed research is a good fit to the Identification and Extraction of Deep Earth Resources priority goal. Detachment of the lithosphere is associated with fertile mantle being emplaced at shallow depth below the crust; an important precursory event for mineralization. The project builds upon AuScope (NCRIS 5.13) to create infrastructure for a new, smart resource exploration and extraction industry based on modelling and simulation.

Platinum deposit genesis: A new way of thinking

Researchers: AG Tomkins, J Mavrogenes and S Barnes.

Funding: 2010, \$75 000; 2011, \$65 000.

Administering organisation: Monash University.

Project summary: Platinum is becoming increasingly crucial to the high technology sector, and is used particularly in catalytic converters and fuel cells, which serve to minimise or eliminate car exhaust pollution. Greatly expanded resources of this precious metal are needed to help society's transition to a low carbon dioxide (CO_2) lifestyle. This project will combine high temperature-pressure experiments with geological field research to greatly improve our understanding of how platinum ore deposits form and thus where to find them. The outcomes of this project will change mineral exploration strategies in Australia and around the world, and facilitate our progression to a cleaner, greener future.

Dynamic permeability and the evolution of fluid pathways in fracture-controlled hydrothermal systems

Researchers: SF Cox, JL Urai and GM Dipple.

Funding: 2010, \$95 000; 2011, \$110 000; 2012, \$95 000.

Administering organisation: The Australian National University.

Project summary: This project will advance knowledge of how fracture-controlled fluid flow at depth in the Earth influences the strength and mechanical behaviour of the crust, earthquake processes and the formation of hydrothermal ore systems. Fundamental new knowledge of the dynamic variations in fluid transport properties and flow distribution in deep fracture networks also will have application for understanding hydrocarbon migration in fractured reservoirs, controls on seal integrity in geosequestration projects, and for geothermal energy production from hot, fractured rock. The project will develop international collaboration and train young scientists in applying multidisciplinary approaches to exploring fluid systems in the Earth's crust.

Experimental studies on hydrothermal reaction processes at the molecular level: the role of mineral replacement reactions in ore formation

Researchers: A Pring and J Brugger.

Funding: 2010, \$160 000; 2011, \$160 000; 2012, \$140 000; 2013, \$130 000.

Administering organisation: The University of Adelaide.

Project summary: Most of the World's supply of metals such as copper (Cu), gold (Au), molybdenum (Mo), lead (Pb), zinc (Zn) or uranium (U) comes from hydrothermal ore deposits. The metals were deposited deep below the Earth's surface when hot fluids, carrying minute quantities of the metals, reacted with suitable rocks to form ore minerals. By understanding molecular-level reaction mechanisms at high pressure and temperature, we can predict the nature of the ore minerals formed for a given set of physical and chemical conditions. This multidisciplinary research project is devoted to understanding these chemical and physical processes and how this knowledge can be applied to improve mineral exploration, mining and ore processing.

The dynamic evolution of sheared continental margins

Researchers: AJ Gleadow, BP Kohn, JM Fletcher, TM Harrison and PW Reiners.

Funding: 2010, \$100 000; 2011, \$100 000; 2012, \$110 000.

Administering organisation: The University of Melbourne.

Project summary: This project will contribute to the fundamental science of understanding plate tectonic processes, and also have important practical implications for the oil and gas resources that are developed and hosted in continental margin settings. The study is therefore relevant to the National Research Priority goal of 'Developing Deep Earth Resources'. The project will also enhance our national scientific standing by addressing important scientific questions of global significance, and by establishing strong international collaborations with prominent researchers outside Australia. In addition, the work will help sustain a world-leading research capability and provide a training ground for a new generation of younger scientists in Australia.

The dynamic strength of continents and how they break apart

Researchers: K Regenauer-Lieb, RF Weinberg, G Rosenbaum and G Manatschal.

Funding: 2010, \$100 000; 2011, \$100 000; 2012, \$100 000.

Administering organisation: The University of Western Australia.

Project summary: Sedimentary basins formed as a result of continental extension are the source of many oil and gas and geothermal resources. The geometries of the deepest part of these basins and their temporal and thermal evolution, are essential for basin prospectivity, but can seldom be investigated directly. This Australia-based project is expected to overhaul how we understand continental deformation, which is a crucial, but relatively vaguely understood, component of plate tectonics. By modelling continental extension, the project will improve our understanding of basin development, deep geometry and heat distribution, providing the basis for new applied and specific research projects directed at enhancing energy resource exploration.

Kimberlites and flood basalts: linking primary melts with mantle and crustal sources

Researcher: V Kamenetsky.

Funding: 2010, \$35 000; 2011, \$35 000; 2012, \$35 000.

Administering organisation: University of Tasmania

Project summary: Intimate relationships between kimberlites and diamonds, and between flood basalts and sulphide mineralisation make the study of deep mantle-derived magmas important to the scientific and exploration communities. The proposed research therefore represents a logical scientific step forward and is hence timely and important in this internationally competitive field, and serve as a training base for young researchers keen to learn the techniques and methodologies involved. The possible outcomes of the project are of wide interest to geoscientists, and may benefit the Australian economy in that they help to predict whether the continental magmas and respective rocks have formed in parts of deep mantle with mineralisation potential.

Seismic attenuation and dispersion in reservoir rocks: broad-band experiments versus theoretical modelling

Researchers: B Gurevich, M Lebedev, DN Dewhurst and TM Mueller.

Funding: 2010, \$105 000; 2011, \$105 000; 2012, \$85 000.

Administering organisation: Curtin University of Technology.

Project summary: We propose to develop theoretical models of seismic attenuation and dispersion in hydrocarbon reservoirs, and a new method for experimental testing of these models. These models will provide new information to substantially improve characterisation of hydrocarbon reservoirs from geophysical data. The results will help optimise exploration and improve oil and gas recovery through development of new technologies for quantitative reservoir characterisation in Australian basins. This research will enhance Australian competitiveness in basic and applied geophysical research, and will benefit the Australian geophysical industry as a provider of advanced geophysical technologies for oil exploration and production.

Mineral physics of the Earth's core

Researcher: L Dubrovinsky.

Funding: 2010, \$200 000; 2011, \$180 000; 2012, \$185 000; 2013, \$160 000; 2014, \$100 000.

Administering organisation: Macquarie University.

Project summary: Most information on the nature of Earth's core properties has come from teleseismic studies, which detect weak earthquake-wave signals that have traversed the Earth's deepest interior. These studies have revealed several unusual and enigmatic phenomena in the core, but interpretation of these observations must rely on mineral-physics data on the materials of the core (e.g. iron-based alloys). This project will create a unique world-class ultra-high pressure laboratory to obtain such data. By defining the composition and mineralogy of Earth's core, it will place Australia in the forefront of this exciting research field, and will also represent a major national resource for the study of novel materials at extreme conditions.

Three-dimensional magnetotelluric and controlled-source electromagnetic modelling and inversion in isotropic and anisotropic media with Gaussian Quadrature Grids

Researcher: GS Heinson.

Funding: 2010, \$112 000; 2011, \$115 000; 2012, \$115 000.

Administering organisation: The University of Adelaide.

Project summary: Electromagnetic methods are widely used by geophysicists in many applications, including mineral, petroleum and geothermal exploration, environmental and groundwater characterisation, and in imaging of Earth and other planets. Large data-sets are routinely collected, but to interpret these carefully we need efficient computer modelling tools that incorporate the complexity of the subsurface. We will develop a new computer algorithm that uses an innovative approach to model the Earth in three dimensions. Computer codes will be available through the national AuScope infrastructure facilities, so that researchers will have free access to algorithms, largely for the first time, to better interpret their data.

Molecular fossils, the evolution of Earth's early oceans and the origin of the oldest oil

Researchers: JJ Brocks and NJ Butterfield.

Funding: 2010, \$165 000; 2011, \$150 000; 2012, \$155 000; 2013, \$110 000; 2014, \$75 000.

Administering organisation: The Australian National University.

Project summary: Australia retains undiscovered oil reserves. We believe that a change in primitive marine life forms may have fundamentally changed the chemistry of the Earth's oceans and is responsible for the world's oldest oil reserves. While these reserves have been found, and successfully commercialised, overseas, similar reservoirs in Australia remain elusive. The project will develop and apply technologies based on hydrocarbon biomarkers to help determine the oil-producing rock types of Precambrian sedimentary rocks. This allows us to estimate the oil's age and predict where petroleum reservoirs may be hidden. PhD students involved in the project will gain valuable knowledge about the link between changes in ecology and the carbon cycle.

Biogeochemical drivers of uranium isotope fractionation in regolith and groundwater

Researchers: D McPhail, Norman, SA Wakelin, Stirling and TK Kyser.

Funding: 2010, \$140 000; 2011, \$120 000; 2012, \$120 000.

Administering organisation: The Australian National University.

Project summary: Water and soil resources are critical to Australia's present and future health and wealth. This project provides necessary data to increase our understanding groundwater recharge, flow and quality, weathering rates and uranium behaviour in soil and water. It will help delineate the impacts of agricultural activities and climate change. It may also trigger the development of new mineral exploration strategies for uranium and other commodities.

The high temperature geochemistry of the precious metals

Researchers: HS O'Neill and IH Campbell.

Funding: 2010, \$100 000; 2011, \$90 000; 2012, \$100 000.

Administering organisation: The Australian National University.

Project summary: Many commercially valuable elements including platinum and gold are extracted from magmas into sulphide melts under some conditions whose nature is poorly understood. The proposed research will make the first reliable measurements of the factors controlling the ability of sulphide melts to extract a range of sulphur-loving elements from magmas. The results will not only aid the search for new deposits of precious metals, but will provide fundamental knowledge for use in such diverse disciplines as extractive metallurgy and planetary geochemistry.

The geomicrobiology and (bio) geochemistry of platinum, palladium and rhodium

Researchers: F Reith, A Ball, SA Wakelin, J Fein and G Southam.

Funding: 2010, \$170 000; 2011, \$170 000; 2012, \$160 000; 2013, \$70 000; 2014, \$70 000.

Administering organisation: The Flinders University of South Australia.

Project summary: Few economic (Platinum) Pt, (Palladium) Pd or (Rhodium) Rh deposits are known in Australia despite an abundance of potential host rock. By improving onshore exploration techniques this project will ensure the supply of these strategic metals to the Australian economy. By integrating geochemical, molecular microbial and microanalyses (e.g., synchrotron) techniques this project will also: (i) enhance Australia's status in the breakthrough science of Geomicrobiology; (ii) secure a leading role for Australian science in the assessment of anthropogenic Pt, Pd and Rh pollution; (iii) access expertise developed overseas by fostering international collaborations; and (iv) explore the transformational capabilities of microbiota for ore-processing of and nano-particle production.

Earth Science-related Linkage Projects

The exploration-related Earth Science Linkage Projects are listed below. Out of

the 211 projects approved only six were placed under the Earth Science heading and of these only one had strong links to exploration. This is listed below.

Tectonic evolution and lode gold mineralisation in the Southern Cross district, Yilgarn Craton (Western Australia): a study of the meso- to Neoarchaean missing link

Researchers: ME Barley, TC McCuaig, K Gessner, JM Miller, E Tohver, MP Doublier, SS Romano, S Wyche and N Thebaud.

Administering organisation: The University of Western Australia.

Partner organisation: Geological Survey of Western Australia.

Funding: 2010, \$70 000; 2011, \$90 000.

Project summary: In the December quarter 2008, Gold export earnings increased by 2% to \$3.9 billion. Over the past 20 years and despite an increase in exploration expenditure to around \$50 million per year, the discovery rates have been declining. Although the easy

targets have been found, there remains considerable potential for future major discoveries. This project addresses the pressing need for new data and improved exploration techniques to enable industry to target new discoveries. As the Southern Cross district is located in remote communities such discoveries also have major benefits for regional Australia.

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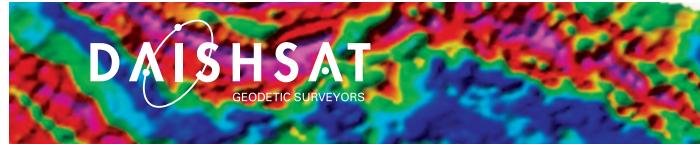
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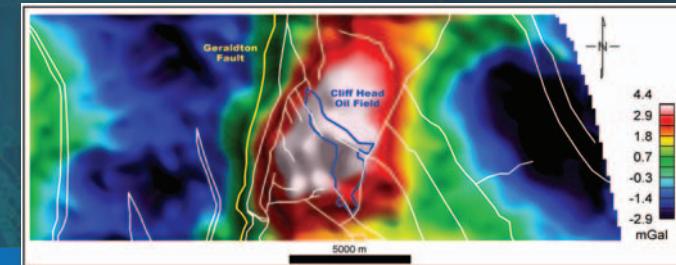
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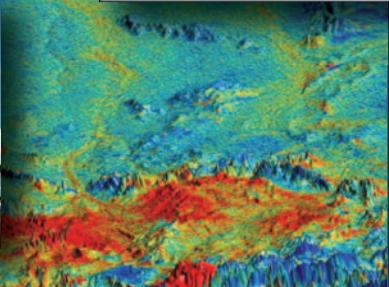
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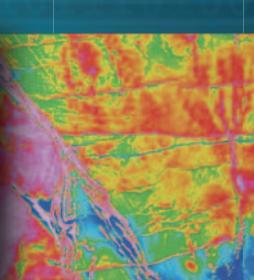
MAGNETICS & RADIOMETRICS

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- Magnetic Gradiometry
- Multiclient Datasales



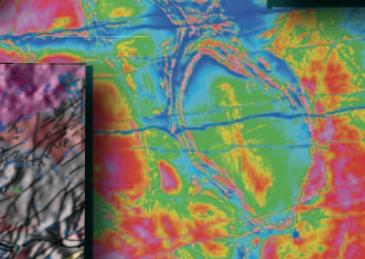
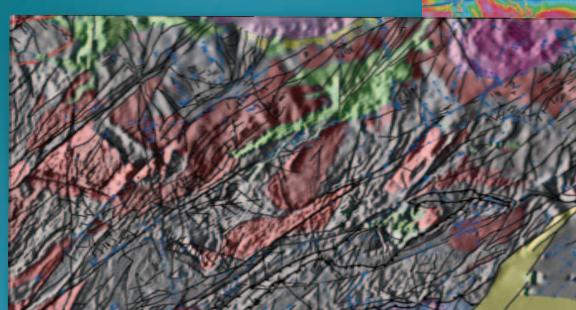
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Update on Geophysical Survey Progress from the Geological Surveys of Queensland, Western Australia, Northern Territory, New South Wales and Geoscience Australia (information current at 9 November 2009)

Tables 1–3 show the continuing acquisition by the States, the Northern Territory and Geoscience Australia of new gravity, airborne magnetic and radiometrics, and airborne EM over the Australian continent. All surveys are being managed by Geoscience Australia.

There are two new surveys listed in this issue. The Southeast Lachlan airborne magnetic and radiometric survey (Figure 1) will cover an area of approximately 17 200 km² with E–W flight lines at a spacing of either 250 m in NSW or 500 m in the ACT.

The Southern Cross gravity survey (Figure 2) will cover an area of approximately 41 250 km² with 7000 stations on a regular 2.5 km grid.

Table 1. Airborne magnetic and radiometric surveys

| Survey Name | Client | Project Management | Contractor | Start Flying | Line (Km) | Spacing AGL Dir | Area (km ²) | End Flying | Final Data to GA | Locality Diagram (Preview) | GADDS release |
|---|--------|--------------------|------------------|-----------------|-----------|---|-------------------------|------------------------------------|------------------|----------------------------|---------------|
| Cape York | GSQ | GA | GPX | 23 Apr 09 | 239 180 | 400 m, 60 m E–W | 59 480 | 100% complete @ 12 Oct 09 | TBA | 139 – Apr 09 p. 21 | TBA |
| Seemore (Eucla 1) | GSWA | GA | Thomson Aviation | 6 June 09 | 88 300 | 200 m, 50 m E–W | 15 810 | 100% complete @ 6 Sep 09 | 8 Oct 09 | 141 – Aug 09 p. 19 | 22 Oct 09 |
| Cornish – Helena (East Canning 2) | GSA | GA | Thomson Aviation | 6 June 09 | 121 100 | 400 m, 60 m N–S | 43 270 | 100% complete @ 25 Oct 09 | TBA | 141 – Aug 09 p. 19 | TBA |
| Yampi – Derby (North Canning 2) | GSA | GA | GPX | 30 June 09 | 66 700 | 400 m, 60 m N–S | 23 720 | 100% complete @ 3 Sep 09 | 22 Oct 09 | 141 – Aug 09 p. 19 | 5 Nov 09 |
| Crossland – Noonkanbah (East Canning 1) | GSA | GA | GPX | 10 Aug 09 | 116 700 | 400 m, 60 m N–S | 41 720 | 80% complete @ 8 Nov 09 | TBA | 141 – Aug 09 p. 19 | TBA |
| Central Canning | GSA | GA | Fugro | 10 June 09 | 91 700 | 800 m, 60 m N–S | 64 900 | 100% complete @ 18 Aug 09 | TBA | 141 – Aug 09 p. 19 | TBA |
| Naretha (Eucla Basin 3) | GSA | GA | Fugro | 11 June 09 | 123 100 | 200 m, 50 m E–W | 22 090 | 100% complete @ 4 Nov 09 | TBA | 141 – Aug 09 p. 19 | TBA |
| Broome (North Canning 1) | GSA | GA | UTS | 14 July 09 | 76 000 | 400 m, 60 m N–S | 26 370 | 100% complete @ 19 Sep 09 | TBA | 141 – Aug 09 p. 19 | TBA |
| Mt Anderson – McLarty Hills (North Canning 3) | GSA | GA | UTS | 3 July 09 | 98 200 | 400 m, 60 m N–S | 34 860 | 100% complete @ 29 Sep 09 | TBA | 141 – Aug 09 p. 19 | TBA |
| Eucla Coast (Eucla Basin 6) | GSA | GA | UTS | 24 September 09 | 121 645 | 200 m (onshore); 400 m (offshore); 50 m N–S | 27 400 | 42% complete @ 8 Nov 09 | TBA | 141 – Aug 09 p. 19 | TBA |
| Southeast Lachlan | GSNSW | GA | TBA | Summer 09/10 | 73 600 | 250 m (NSW); 500 m (ACT) E–W | 17 200 | Quotation request closed 26 Nov 09 | TBA | This issue | TBA |

TBA: to be advised

Table 2. Airborne electromagnetic surveys

| Survey Name | Client | Project Management | Contractor | Start Flying | Line (Km) | Spacing AGL Dir | Area (km ²) | End Flying | Final Data to GA | Locality Diagram (Preview) | GADDS release |
|---|---------------|--------------------|------------------|---|-----------|--|-------------------------|--|--|----------------------------|---|
| Paterson South (Western Areas Infill) TEMPEST AEM | Western Areas | GA | Fugro | 8 Sep 07 (for the entire Paterson AEM survey) | 861 | 286, 333 & 400 m; Southwest–Northeast; 120 m agl | 294.3 | 100% complete @ 14 Sep 08 (for the entire Paterson AEM survey) | Jan 09 (for the entire Paterson AEM survey) | 130 – Oct 07 p. 30 | Data released via free download on the GA website and on DVD on 11 August 2009. All requests to the GA Sales Centre |
| Pine Creek (Kombolgie) | GA | GA | Geotech Airborne | 21 Aug 08 | 9350 | 1666 & 5000 m for GA; 200–1000 m company infill; E–W flight lines; flying height 30 m | 30 710 | 100% complete @ 16 Oct 08 | At the time of writing corrected data were expected mid November | 133 – Apr 08 p. 21 | At the time of writing the release of data was expected mid December |
| Pine Creek (Woolner & Rum Jungle) | GA | GA | Fugro | 11 Oct 08 | 20825 | 1666 & 5000 m for GA; 200–1000 m company infill; E–W flight lines; Flying height 120 m | 44 689 | 100% complete @ 23 May 09 | Data acquisition resumed 15 April for completion by June 09 | 133 – Apr 08 p. 21 | Data for Pine Creek (Rum Jungle) released via free-download via the GA website and on DVD at the end of September 2009. All requests to the GA Sales Centre |

Table 3. Gravity surveys

| Survey Name | Client | Project Management | Contractor | Start Survey | No. stations | Station Spacing (km) | Area (km ²) | End Survey | Final Data to GA | Locality Diagram (Preview) | GADDS release |
|----------------------|--------|--------------------|------------|--------------------------|--|----------------------|-------------------------|---------------------------|------------------|----------------------------|---------------|
| Cape York | GSQ | GA | Daishsat | 12 May 09 | 10 315 | 4 km regular | 171 900 | 100% complete @ 16 Sep 09 | TBA | 139 – Apr 09 p. 21 | TBA |
| Barkly | NTGS | GA | Atlas | 4 June 09 | 7268 in Area A & a possible 3875 in Area B | 4 km regular | 178 230 | 100% complete @ 28 Sep 09 | TBA | 140 – Jun 09 p. 17 | TBA |
| South Yilgarn Margin | GSWA | GA | Fugro | 24 July 09 | 6500 | 2.5 km regular | 39 240 | 100% complete @ 22 Oct 09 | TBA | 140 – Jun 09 p. 17 | TBA |
| Southern Cross | GSWA | GA | Atlas | No later than 1 Feb 2010 | 7000 | 2.5 km regular | 41 250 | TBA | TBA | This issue | TBA |

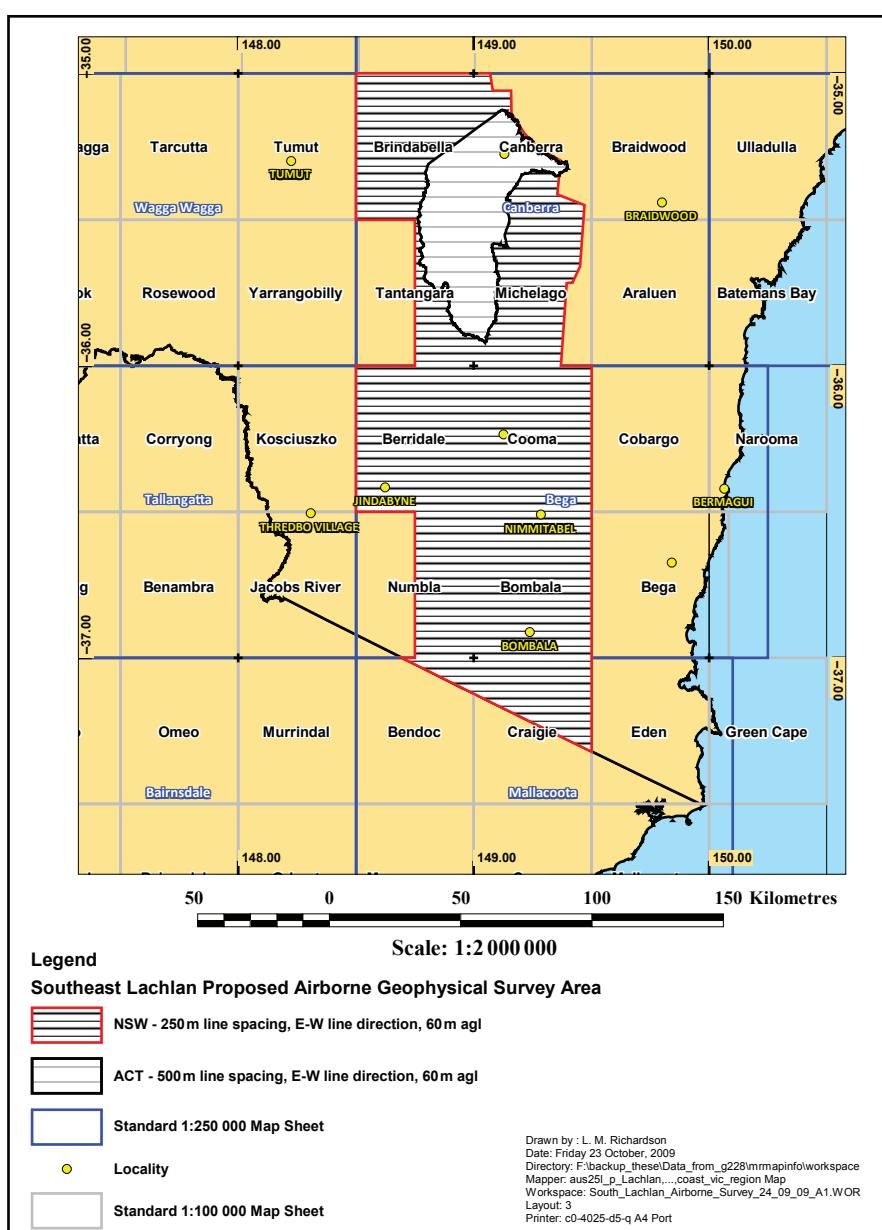


Fig. 1. Location diagram for the Southeast Lachlan airborne magnetic and radiometric survey.

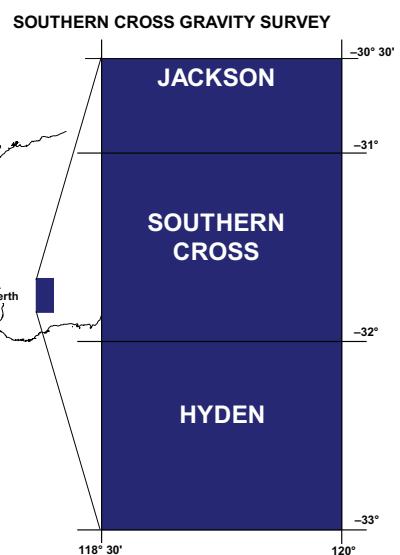


Fig. 2. Location diagram for the Southern Cross gravity survey.

Geophysical investigations of the domain boundary between Broken Hill and Olary, South Australia

A new geophysical interpretation of the Mingary 1 : 100 000 map sheet in the Broken Hill domain was prepared for release at the Broken Hill Exploration Initiative 2009 conference. This study was undertaken with the aim of better understanding the location and extent of the boundary between the mineralised Broken Hill domain and the Olary domain.

New magnetics and gravity grids were created for the region, along with value-added products such as an auto-gain controlled TMI and gradient strings (worms). A data package containing these new datasets will be released in the near future through PIRSA's Customer Service Centre or our online SARIG application.

Magnetotelluric surveys collected in 2002 and 2007 by Adelaide University Honours students were also examined. A significant change in the resistivity within the magnetotelluric model (Figure 3) coincides with magnetic gradient string data (Figure 4). This correlation has led to a proposed change in the location of the current Broken Hill–Olary domain boundary to the north to align with the

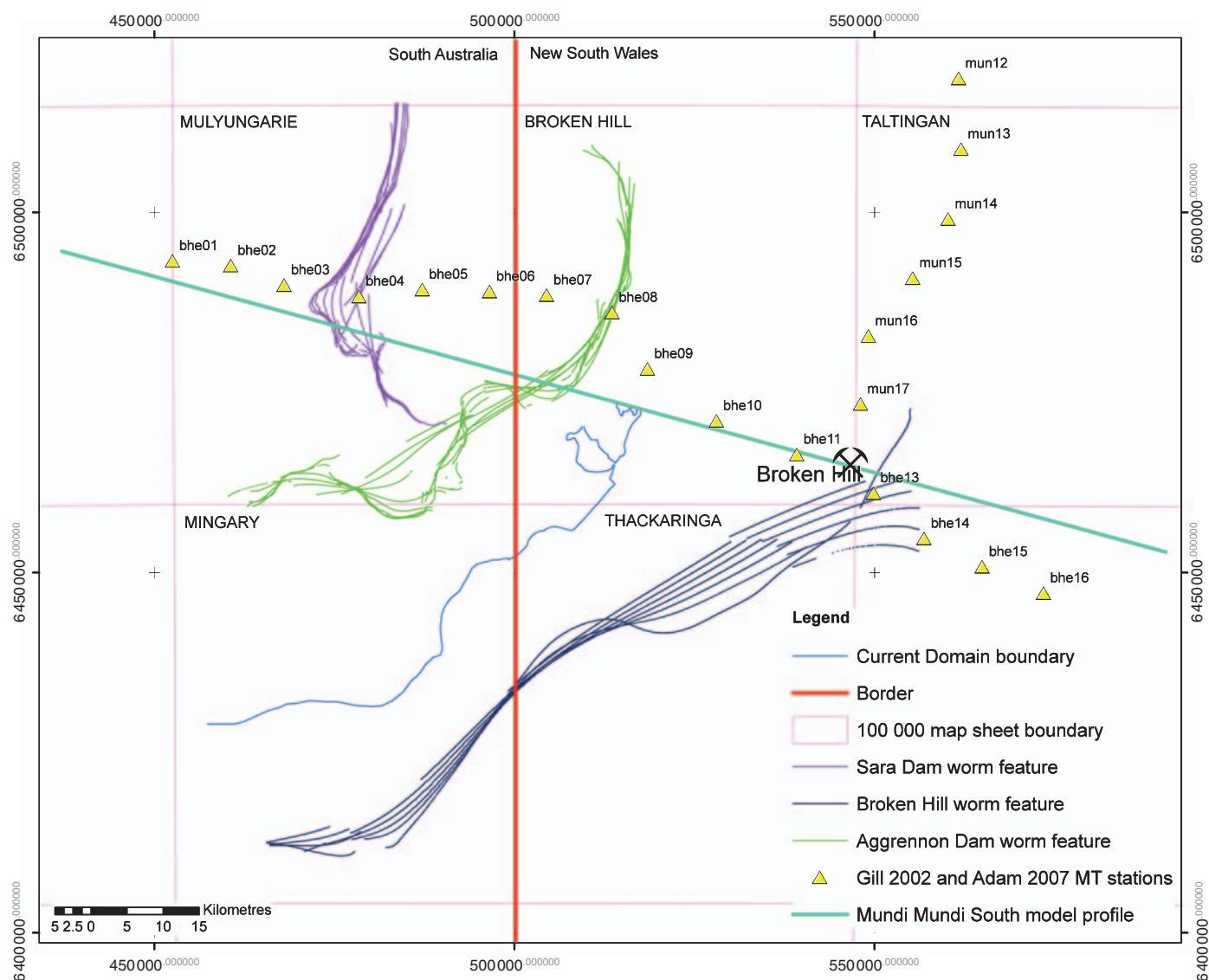


Fig. 3. Map of magnetic worm features and location of magnetotelluric surveys.

Aggrennon Dam feature. Further work is planned to confirm this hypothesis.

Further geophysical interpretation packages are planned for the Tallaringa region in the far west of the Gawler Craton and other regions of interest around South Australia.

For more information please contact Stephen Petrie (stephen.petrie@sa.gov.au).

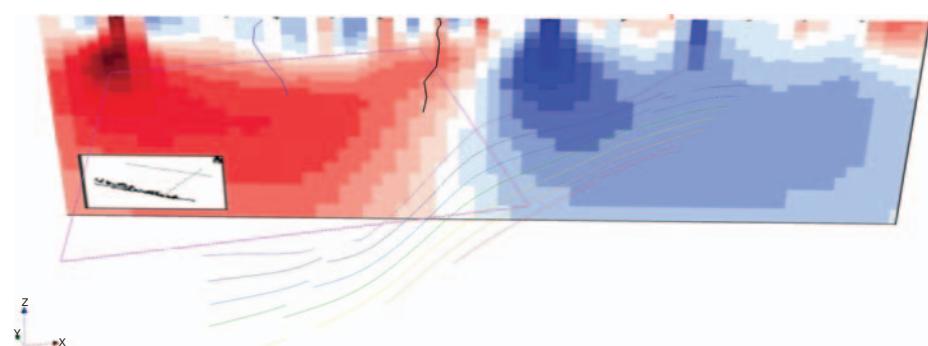


Fig. 4. Mundi Mundi South MT profile (Source: Adam, H., 2007, A magnetotelluric survey of the Broken Hill and Olary domains: Honours Report, University of Adelaide), with worm features marked. The pink rectangle is the Mingary 1:100 000 map sheet boundary.

Yanzhou set to takeover Felix Resources

Yanzhou Coal Mining's shareholders have approved the Chinese miner's plan to take over Australian coal miner Felix Resources. Yanzhou announced that it agreed to buy Felix for \$3.54 billion, in what would be the biggest Chinese takeover of an Australian company so far. This price is close to the current market value of about \$3.42 billion but

considerably lower than the \$4.5 billion value that it had in May 2008.

Australia's Assistant Treasurer, Nick Sherry, has announced the approval of Yanzhou's application to acquire Felix, subject to it complying with legally enforceable conditions, a week ago. The conditions apply to all of its operations,

including the Austar mine near Newcastle in New South Wales that Yanzhou already owns.

The majority of both Yanzhou and Felix shareholders must approve the proposal for the transaction to proceed. It looks like Yanzhou is getting value for money by this acquisition.

Business investment in R&D highest ever

Business spending on research and experimental development (BERD) in Australia increased for the eighth year in a row in 2007–08, to a total of \$14.4 billion, according to figures released by the Australian Bureau of Statistics on 25 September 2009.

BERD increased by 15% in current price terms and 9% in CPI adjusted terms from 2006–07. Business human resources devoted to R&D in 2007–08 totalled 49 114 person years of effort, an increase of 6% from 2006–07 and 31% over 2003–04.

In 2007–08, the largest contributors to BERD were manufacturing (\$4305 million or 30%), mining (\$3283 million or 23%) and professional, scientific and technical services (\$2230 million or 16%). Of all industries, mining and manufacturing reported the largest absolute growth from 2006–07, increasing their expenditure on R&D by \$510 million (18%) and \$469 million (12%) respectively. Other industries to record large increases included financial and insurance services (up \$313 million or

28%) and professional, scientific and technical services (up \$233 million or 12%). The mining category includes petroleum. Notice in Figure 1 how the mining R&D effort has increased dramatically by a factor of seven in this century.

Total business expenditure on R&D as a proportion of GDP increased from 1.20 to 1.27%. Australia is still fourteenth in the ladder and below the OECD average of 1.59% (see Figure 1 and Table 1). However, we have overtaken Canada and the UK in the last few years and if the strong upward trend continues we are bound to increase our ranking.

New South Wales and Victoria continued to record the highest levels of BERD in 2007–08, at \$4371 million (30%) and \$3949 million (28%) respectively. Western Australia reported the largest absolute growth in BERD (up \$532 million) from 2006–07, followed by Victoria (up \$521 million) and New South Wales (up \$361 million).

Further information is in *Research and Experimental Development, Businesses, Australia, 2007–08* (cat. no. 8104.0), published by the Australian Bureau of Statistics.

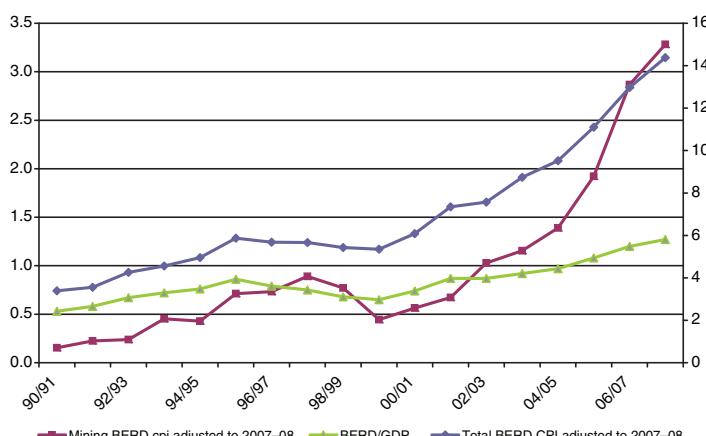


Fig. 1. Right hand axis shows total business R&D expenditure in Australia (BERD) in \$billion (blue curve). Left hand axis shows BERD/GDP in % (green curve) and mining (including petroleum) BERD in \$billion. All \$ are normalised to 2007–08 values.

Table 1. BERD/GDP for OECD countries

| Country | 2000–01 | 2001–02 | 2002–03 | 2003–04 | 2004–05 | 2005–06 | 2006–07 | 2007–08 |
|-------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Japan | 2.12 | 2.30 | 2.36 | 2.40 | 2.38 | 2.54 | 2.63 | 2.68 |
| Sweden | na | 3.28 | na | 2.86 | 2.66 | 2.62 | 2.79 | 2.66 |
| Korea | 1.96 | 1.97 | 1.90 | 2.00 | 2.18 | 2.29 | 2.49 | 2.65 |
| Finland | 2.41 | 2.35 | 2.34 | 2.42 | 2.42 | 2.47 | 2.46 | 2.51 |
| USA | 2.04 | 2.00 | 1.86 | 1.84 | 1.79 | 1.83 | 1.89 | 1.93 |
| Austria | na | na | 1.42 | na | 1.53 | 1.70 | 1.73 | 1.81 |
| Germany | 1.75 | 1.72 | 1.72 | 1.76 | 1.74 | 1.72 | 1.77 | 1.79 |
| Denmark | na | 1.64 | 1.73 | 1.78 | 1.70 | 1.67 | 1.66 | 1.66 |
| Iceland | 1.55 | 1.75 | 1.71 | 1.46 | na | 1.45 | 1.59 | 1.50 |
| Luxembourg | na | na | na | 1.48 | 1.46 | 1.34 | 1.43 | 1.36 |
| France | 1.41 | 1.39 | 1.41 | 1.36 | 1.36 | 1.30 | 1.32 | 1.31 |
| Belgium | 1.48 | 1.51 | 1.37 | 1.31 | 1.29 | 1.25 | 1.30 | 1.30 |
| Australia | 0.74 | 0.84 | 0.89 | 0.92 | 0.97 | 1.08 | 1.20 | 1.27 |
| UK | 1.21 | 1.24 | 1.25 | 1.11 | 1.09 | 1.06 | 1.08 | 1.15 |
| Canada | 1.21 | 1.29 | 1.17 | 1.16 | 1.18 | 1.15 | 1.11 | 1.05 |
| Netherlands | 1.10 | 1.05 | 0.98 | 1.01 | 1.03 | 1.01 | 1.02 | 1.03 |
| Czech Republic | 0.78 | 0.72 | 0.73 | 0.76 | 0.79 | 0.91 | 1.03 | 0.98 |
| Ireland | 0.82 | 0.77 | 0.76 | 0.79 | 0.81 | 0.82 | 0.88 | 0.88 |
| Norway | na | 0.95 | 0.95 | 0.98 | 0.87 | 0.82 | 0.82 | 0.88 |
| Spain | 0.50 | 0.50 | 0.56 | 0.57 | 0.58 | 0.60 | 0.67 | 0.71 |
| Italy | 0.53 | 0.53 | 0.54 | 0.52 | 0.52 | 0.55 | 0.55 | 0.55 |
| New Zealand | na | 0.42 | na | 0.49 | na | 0.48 | na | 0.51 |
| Total OECD | 1.55 | 1.57 | 1.52 | 1.51 | 1.48 | 1.51 | 1.56 | 1.59 |

na, not available.

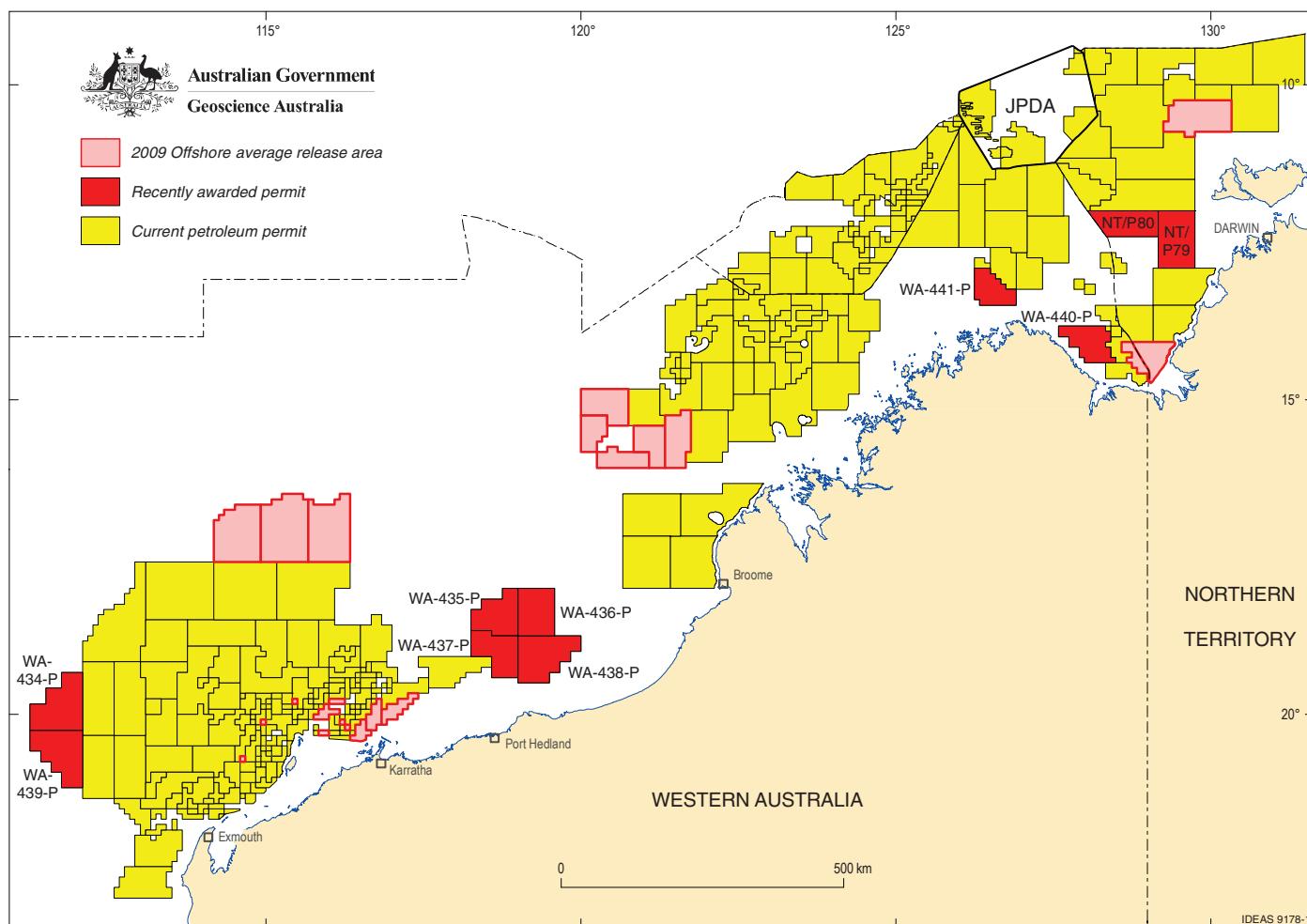


Fig. 2. Map showing petroleum permits off the NW coast of Australia. Current permits are shown in yellow; recently awarded permits are in red; and the 2009 offshore acreage release area is shown in pink.

Table 2. Summary of exploration programs for the recently awarded offshore exploration permits

| Permit area, No. of bids | Operating companies | Exploration programs |
|---|--|---|
| Carnarvon Basin off Western Australia, WA-434-P (released as W08-21) Three bids Frontier Area | Woodside Energy Ltd | 1505 km of 2D seismic reprocessing, 2610 km ² of new 3D seismic surveying and four exploration wells to an estimated value of \$121.52 million. The secondary work program consists of geotechnical studies and one exploration well to an estimated value of \$24.0 million. |
| Roebuck Basin off Western Australia, WA-435-P (released as W08-11) Two bids | Carnarvon Petroleum Ltd | 2500 km of 2D seismic reprocessing and geotechnical studies to an estimated value of \$0.50 million. The secondary work program consists of 400 km ² of new 3D seismic surveying, one exploration well and geotechnical studies to an estimated value of \$48.25 million. |
| Roebuck Basin off Western Australia, WA-436-P (released as W08-12) One bid | Finder Exploration Pty Ltd | 4550 km ² of new aeromagnetic surveying, 500 km of 2D seismic reprocessing and geotechnical studies to an estimated value of \$0.47 million. The secondary work program consists of 250 km of new 2D seismic surveying, geotechnical studies and one exploration well to an estimated value of \$6.60 million. |
| Roebuck Basin off Western Australia, WA-437-P (released as W08-14) Two bids | Finder Exploration Pty Ltd | 2350 km ² of new aeromagnetic surveying, 500 km of 2D seismic reprocessing and geotechnical studies to an estimated value of \$0.42 million. The secondary work program consists of 250 km of new 2D seismic surveying, geotechnical studies and one exploration well to an estimated value of \$6.60 million. |
| Roebuck Basin off Western Australia, WA-438-P (released as W08-15) One bid Frontier Area | Finder Exploration Pty Ltd | 6050 km ² of new Aeromagnetic surveying, 500 km of 2D seismic reprocessing and geotechnical studies to an estimated value of \$0.55 million. The secondary work program consists of 250 km of new 2D seismic surveying, geotechnical studies and one exploration well to an estimated value of \$6.60 million. |
| Carnarvon Basin off Western Australia, WA-439-P (released as W08-22) Three bids Frontier Area | Chevron Australia Pty Ltd and Shell Development (Australia) Pty Ltd | 501 km ² of new 3D seismic surveying, geotechnical studies and one exploration well to an estimated value of \$25.25 million. The secondary work program consists of geotechnical studies and 500 km of new 2D seismic surveying to an estimated value of \$1.15 million. |
| Bonaparte Basin off Western Australia, WA-440-P (released as W08-6) Two bids | Goldsborough Energy Pty Ltd | 450 km of new 2D seismic surveying to an estimated value of \$1.55 million. The secondary work program consists of geotechnical studies and one exploration well to an estimated value of \$15.6 million. |
| Bonaparte Basin off Western Australia, WA-441-P (released as W08-4) One bid Frontier Area | Goldsborough Energy Pty Ltd | 550 km of new 2D seismic surveying to an estimated value of \$1.55 million. The secondary work program consists of geotechnical studies and one exploration well to an estimated value of \$15.6 million. |
| Bonaparte Basin off Northern Territory, NTP/79 (released as NT08-2) One bid | Finder Exploration Pty Ltd | 400 km of new 2D seismic surveying and geotechnical studies to an estimated value of \$0.83 million. The secondary program consists of one exploration well and geotechnical studies to an estimated value of \$6.30 million. |
| Bonaparte Basin off Northern Territory NTP/80 (released as NT08-1) One bid | Murphy Australia Oil Pty Ltd and Diamond Resources Australia Pty Ltd | 3000 km of 2D seismic reprocessing, 750 km of new 2D seismic surveying and geotechnical studies to an estimated value of \$5.70 million. The secondary program consists of 500 km ² of new 3D seismic surveying, geotechnical studies and one exploration well to an estimated value of \$48.70 million. |

Award of 10 new offshore exploration permits

Ten new offshore petroleum exploration permits in the ocean off Western Australia (eight permits) and the Northern Territory (two permits) have been granted (see Figure 2). The exploration permits are awarded under a work program bidding system for an initial term of 6 years, with a maximum of two renewals each of 5 years. Under this system, applicants are required to nominate a guaranteed minimum 'dry hole' exploration program for each of the 3 years of the permit term and a secondary program

for the remaining 3 years. Alterations to the secondary work program can be negotiated provided these changes are made before the commencement of the second 3 year period.

The total work program commitments for the awarded permits are valued at A\$158 million over the next 3 years with a further \$179 million committed to secondary work programs. The largest investment will be made by Woodside Energy Ltd. It plans to spend a minimum

of \$121.5 million in a 'Frontier Area' in the offshore Carnarvon Basin in Western Australia.

These new permits result from the second round of the 2008 Acreage Release that closed on 9 April 2009. All offshore exploration permits are jointly administered by the Australian Government and the respective State and Northern Territory Governments. Table 2 provides details of the work being proposed.

26 areas now open for bidding

There are currently 26 offshore areas open for bidding; eight of these are being re-released from the second round of the 2008 releases (seven in offshore Western Australia and one in offshore Northern Territory). The other 18, plus two special areas, are from the first round of the 2009

releases. These releases include 14 from WA, two from the NT, three from Victoria, and one from South Australia. The WA and NT areas are shown on Figure 2.

It must be of concern that no bids were received for eight of the 2008 areas open for auction. Perhaps with the gradual rise of the oil price to US\$80 per barrel there

will eventually be renewed interest in these areas.

Further information on these areas and application requirements can be found by visiting this website: <http://www.ret.gov.au/petexp> or by requesting a free CD-ROM by email: petroleum.exploration@ret.gov.au

Exploration budgets decline 40% in 2009

The 20th edition of Corporate Exploration Strategies produced by Metals Economics Group (MEG) was published in October 2009. The study indicates that 2009 exploration budgets will reach roughly US\$8.4 billion for expenditures related to precious and base metals, diamonds, uranium, and some industrial minerals.

After six consecutive years of increase, 2009 represents about a 40% decline from the 2008 exploration budget total

of US\$14 billion. This result is in line with the effects of the global recession that began one year ago. The decrease in exploration budget allocations is evident in all commodities, at all stages, and in all regions.

Junior mining companies are accounting for the largest share of the overall decline, although most intermediate and major players have also made significant cuts to their 2009 exploration plans.

Despite the juniors' contribution to the overall decline, the attrition rate within the junior ranks never reached the significant level predicted by some analysts earlier in the year.

Estimates in MEG's study are based on information collected from more than 2800 mining and exploration companies worldwide, of which almost 2000 had exploration budgets in 2009.

Petratherm and Geodynamics share in \$235 million from the REDP

The Minister for Resources and Energy, Martin Ferguson, awarded \$235 million to four commercial-scale renewable energy projects from the Renewable Energy Demonstration Program (REDP) on 9 November 2009. According to the Minister, this funding – combined with money from successful applicants – will deliver approximately \$810 million in renewable energy investment in Australia. It will deliver almost 80 MW of new renewable generation from wave technology, geothermal sources, and an integrated mini-grid project involving wind, solar, biodiesel and storage technologies.

The four successful companies and a summary of their projects are listed below:

MNGI Pty Ltd – \$62.762 million

The 30 MW Paralana Geothermal Energy Project is an engineered geothermal system project, based on Petratherm's 'Heat Exchanger Within Insulator' model. The Paralana project is located adjacent to the Beverley uranium mine. Demonstration of the Paralana

project will provide a sound foundation upon which to underpin the large-scale development and deployment of geothermal energy in Australia.

Geodynamics Ltd – \$90.000 million

The Geodynamics Cooper Basin 25 MW Geothermal Demonstration Project will demonstrate the potential for hot-rock geothermal energy to be a major generator of zero-emission, base-load power. The project will be the world's first multi-well hot fractured rock power project. It will be located in the north east corner of South Australia in the Cooper Basin, between Moomba and Innamincka, where Geodynamics has assessed its resource as holding geothermal energy sufficient to support several thousand megawatts of electricity generating capacity.

Victorian Wave Partners Pty Ltd – \$66.465 million

Ocean Power Technologies (Australasia) and its partner Leighton Contractors will construct the first commercial

scale ocean energy project in Australia. The 19 MW Victorian Wave Power Demonstration Project involves the staged construction and demonstration of wave power generation using Ocean Power Technologies PowerBuoy technology off Portland, Victoria.

The Hydro-Electric Corporation (Hydro Tasmania) – \$15.280 million

The King Island Renewable Energy Integration Project will demonstrate the potential for enabling technologies to help integrate renewable technologies into established electricity networks and mini-grid systems in remote areas. The King Island project is to integrate wind, solar and storage with a biodiesel generator to provide base-load and peak power for the King Island mini grid system, which currently uses diesel generators for its primary energy supply. The integration of these energy sources will require the provision of innovative control mechanisms for load and frequency control.

It's good to see that we are getting closer to a full-scale geothermal power project.

Fugro and EMGS establish Perth office to facilitate Co-operation Agreement

An office of Fugro Electro Magnetic Pty Ltd has been established in Perth, Western Australia to facilitate a Global Co-operation Agreement between Fugro N.V. (Fugro) and Electromagnetic Geoservices ASA (EMGS), the market leader in marine electromagnetic (EM) imaging.

Under the terms of the agreement, Fugro will gain access to EMGS's marine EM methods for hydrocarbon exploration and production for conventional oil and gas exploration and production in water depths greater than 50m. EMGS will gain access to Fugro's worldwide marketing network and marine operating expertise. Fugro and EMGS will also continue to work independently in other areas of specialisation for marine EM outside of the cooperation agreement.

The agreement will enable cooperation for survey planning, data acquisition, survey operation and processing, sale and marketing of Marine EM data. It will also facilitate the integration between EM data and other geophysical data,

including seismic data and other non-seismic data such as magnetics and gravity.

The new office in Perth will service to clients throughout the Asia-Pacific Region, and includes technical and operational experts from EMGS. Personnel in the Perth hub will liaise closely with existing Fugro companies in Perth such as Fugro Geoteam, Fugro Multi Client Services, Fugro Seismic Imaging, Fugro-Jason and Fugro Surveys, as well as the existing EMGS office in Kuala Lumpur. The EMGS office in KL will continue to take the lead for any projects in Malaysia, and selected existing clients.

Helen Anderson has been appointed as Manager of the Perth Hub. Helen was previously Interpretation Manager for Fugro Airborne Surveys. Carl Hedvall has been appointed as Business Development Manager for the Perth Hub. Carl's previous position was as Business Development Manager for Fugro-Jason.

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Archaeological geophysics at Flinders University

Ian Moffat^{1,2,4} and Lynley A. Wallis³

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Ian Moffat and Lynley Wallis attempt to repair a differential GPS antenna, Woolgar River Open Site, Northwest Queensland. (Image: Rob Koch.)

Introduction

Internationally, in recent decades the potential of geophysical techniques to contribute to archaeological investigations has been recognised, and these methods have become commonplace, especially in the United Kingdom and in North America. English Heritage (2008) estimates that nearly 25% of planning applications with a heritage component in the United Kingdom in 2006 included geophysics as an investigation technique. Accompanying this change, the recognition of ‘geofizz’ techniques by the general public has increased markedly, driven principally by the popularity of television programs such as *Time Team*. Reflecting this popularity, research in this discipline is vibrant, as showcased by journals such as *Archaeological Prospection* and specialist training is now provided by several universities through dedicated postgraduate degrees.

In contrast, archaeological geophysics has remained a small discipline in Australia, with limited utilisation of these techniques in academic, government and consulting archaeology. Over the last few years, however, interest in this area has expanded considerably, driven by recognition that geophysical techniques provide a non-invasive, rapid and culturally appropriate method of assisting in archaeological investigations. This change has been accompanied by a renewed interest in research in this area (i.e. Fanning *et al.*, 2005; McKinnon *et al.*, 2007; Stanger and Roe, 2007; Moffat and Raupp, 2008; Moffat *et al.*, 2008; Wallis *et al.*, 2008, 2009; Brooks *et al.*, 2009; David *et al.*, 2009; Gibbs and Gojak, 2009), following a long hiatus since the pioneering work of Stanley (Connah *et al.*, 1976; Stanley and Green, 1976; Stanley, 1983) on the application of these techniques to Australian conditions.

Despite this, the provision of formal training in archaeological geophysics in order to nurture a new generation of skilled graduates has been noticeably lacking. Recognising this deficiency, the Department of Archaeology at Flinders University has established a programme in this area which aims to undertake innovative, industry-relevant research and teaching in this discipline, and complement archaeological research projects in the department. Initially developing out of informal collaborations between consulting company Ecophyte Technologies and the Department, the archaeological geophysics program has grown considerably to now be an integral, vibrant component of the teaching and research program. In this article we profile some of the recent research and teaching activities of the Department of Archaeology relating to archaeological geophysics.

Academic teaching

Teaching geophysical techniques to students whose background is humanities, arts or social sciences (as opposed to ‘hard science’ areas) requires an approach that makes the subject accessible, engaging and demonstrably practical, without compromising the quality and rigor of the content. With this in mind, archaeology students are first exposed in small measures to geophysical techniques throughout their undergraduate degree in field-based subjects such as ARCH1003 Field Archaeology, ARCH2201 Archaeological Field Methods, ARCH3303 Historical Archaeology Field School, ARCH3306 Indigenous Archaeology Field School and ARCH3304 Maritime Archaeology Field School. This usually involves geophysicist Ian Moffat participating in the topics as a member of the general teaching staff, providing practical instruction on the field use of geophysical equipment. This approach somewhat demystifies geophysics and, having lost their fear of the unknown, students inevitably seek to develop a broader understanding of how such techniques might usefully be applied in archaeological contexts. This desire is then sated with the opportunity to enrol in an intensive field topic of two weeks duration, entitled ‘ARCH8307 Introductory Archaeological Geophysics’ offered annually within the Graduate Programs in Archaeology, Cultural Heritage Management and Maritime Archaeology. In this topic students are introduced to geophysical techniques through a combination of lectures and practical sessions (see Figures 1 and 2) where they collect data using a ground penetrating radar, an electromagnetic induction device and a magnetometer from an historic cemetery and then process and interpret it to locate possible unmarked graves. A strong emphasis is placed on the practical applications of archaeological geophysics and ‘hands-on’ instruction in field settings, rather than concentrating on the physics behind the techniques or resorting to ‘show and tell’ methods of teaching. The aim is always to foster a ‘deep approach’ to learning, whereby students are encouraged to understand and apply knowledge (Gibbs, 1992; Gordon and Debus, 2002; Warburton, 2003). This subject is the only one of its kind in Australia and is particularly tailored to providing students without a geophysics background with a basic understanding of which techniques may prove useful for archaeological projects.

This subject is also available as a two-week duration short course on a fee-paying basis to non-Flinders students on an



Fig. 1. Introductory Archaeological Geophysics students collect data at the Meadows' Wesleyan Cemetery in October 2009. (Image: Louise Holt.)



Fig. 3. Graduate student Hayley Heffernan prepares to collect magnetometer data under the supervision of Ian Moffat. (Image: Lynley Wallis.)



Fig. 2. Introductory Archaeological Geophysics students are instructed in the operation of a ground penetrating radar on the Flinders campus in December 2008. (Image: Lynley Wallis.)



Fig. 4. Undergraduate student Mathew Ebbs collects magnetometer data at the Pioneer Park Cemetery, Adelaide. (Image: Alice Beale.)

annual basis. It routinely attracts a range of participants from engineering and heritage consulting firms, geophysics and heritage government agencies, Indigenous organisations and students from other institutions. Most participants come from archaeology and heritage management backgrounds, although a small number with geophysics backgrounds have also completed the course in order to develop their archaeological knowledge.

Short courses and workshops in archaeological geophysics

Beyond instruction in archaeological geophysics in formal university level topics, we also offer a range of course and workshop options for students and external participants alike; these offerings change each year depending on availability of staff.

In July 2009 Associate Professor Larry Conyers from the Department of Anthropology, University of Denver presented a three day short course specialising in ground penetrating radar. Associate Professor Conyers is recognised as one of the

premier practitioners in archaeological geophysics, and is the author of the well-known text book *Ground Penetrating Radar for Archaeology* (Conyers, 2004). The first day of the course was spent in the classroom, where participants were introduced to some of the theoretical principals underpinning geophysics. This included a potted history of the development of GPR technique in archaeology, drawing heavily on Larry's own pioneering research in Central America. The emphasis was on illustrating theory using actual case studies to ensure the science does not overwhelm the beginner. Day two comprised a field survey of an historic cemetery, with Larry offering his extensive experience on survey considerations, site gridding and data collection methods. Under guidance, participants were required to collect data from the site to be used for the following day of the workshop. On day three participants went into the computer laboratory to process their data; with no prior experience, by the end of the day participants were able to grid data and produce interpretable maps of simple data.

In December 2009 as a precursor to the Australian Archaeological Association Annual Conference to be held at Flinders University, Ian will offer a professional development workshop aimed at graduate students and professionals in archaeology who wish to develop an understanding of archaeological geophysics, particularly as it might be employed in a consulting environment. The course is designed to provide participants with a considered awareness of the opportunities and limitations of geophysical methods, thereby facilitating a better result when applied in consulting and research projects.

Of course, these training programs are not designed to – nor claim to – produce students capable of undertaking commercial archaeological geophysics survey unaided after just a day – or ten – of instruction. Instead, we aim to produce students who are sophisticated and informed consumers of contract geophysical information. The courses are designed to whet people's appetite and arm them an awareness of how and where to seek more information if archaeological geophysics is an area in which they want to expand their knowledge and training. Should students wish to develop their skills further in this area, they are encouraged to participate in the numerous geophysical research projects (see below) undertaken every year within the department, to seek industry placements with the numerous departmental geophysical industry partners, or undertake a research study on a suitable topic.

Research

As is true with any discipline, research should inform, and be an integral part of any teaching program (Hattie and Marsh, 1996; Deem and Lucas, 2006). Current research in archaeological geophysics at Flinders University focuses on two principal foci: an examination of the potential contribution of magnetic techniques to Indigenous archaeology in Australia, and the development of a robust methodology for the location of burials (both historic and Indigenous) using geophysical techniques.

Magnetic techniques have significant potential to make a contribution to understanding Australian Indigenous archaeological sites. Human occupation, particularly involving fire, can enhance the magnetism of archaeological sites and can be detected using magnetometry and magnetic susceptibility techniques (Marmet *et al.*, 1999; Linford and Canti, 2001). While this phenomenon is well understood experimentally, research at Flinders is focused on locating features of interest in a field setting where logistical and financial considerations may be the principal constraining factors as to whether a technique can realistically be deployed rather than it being theoretically possible. A particular focus of this research has been on locating heat retainer hearths, which despite being ubiquitous in the Australia archaeological record and easily datable using radiocarbon and luminescence techniques, have not been the focus of significant research attention. They are typically only located after they have eroded from sub-surface contexts, at which time their integrity and dating potential is often much reduced; thus the ability to locate these features before erosion occurs would have substantial management and research implications. Ongoing research shows that a combination of geophysical techniques and high quality spatial information can provide insights into the location of these features (Figure 3). Additional research has identified

the potential of a similar approach to locate burials when funerary practices involving burning occurred, as well as to provide information about the intensity occupation in rock shelter sites.

Methods including ground penetrating radar, electromagnetic induction, magnetometry and direct current resistivity have been applied to locating human burials. Most recently, the Historic Graves Project has been systematically surveying cemeteries around Australia containing unmarked burials in a variety of soil types. Cemeteries that have been included in this project to date include Albany Memorial Cemetery (WA), Encounter Bay Cemetery (SA), Meadows' Wesleyan Cemetery (SA), Selheim Cemetery (Qld) and Pioneer Park Cemetery (SA) (Figure 4). This project aims to develop a robust methodology for locating burials in all sites, taking into account the specific site conditions. The results have been encouraging and suggest that geophysics has an important potential contribution to make to understanding and managing similar sites throughout Australia.

Graduate student research

Several Masters of Archaeology students are undertaking their thesis research on topics in archaeological geophysics. Jennifer 'Texas' Milani is investigating the possibilities of magnetic susceptibility mapping to image rock art covered by silica or carbonate skins in collaboration with Dr Maxime Aubert from the ANU. Matt Harder is integrating multi-technique geophysical data with archaeological data and high resolution aerial photograph using GIS from the Woolgar River Open Site 1 (a large Indigenous camping ground comprising thousands of stone artefacts and heat retainer hearths) in northwest Queensland. Archaeology Honours student Ben Keys has recently submitted his thesis entitled 'Engrained in the Past: Using Geoarchaeology to Understand Site Formation Processes at the Gledswood Shelter I Site, Northwest Queensland' in which magnetic susceptibility techniques were used to assist in understanding the anthropogenic contribution to the sedimentation history of this site.

Industry partners

The archaeological geophysics program at Flinders has been generously supported by several industry partners, who have provided equipment and expertise to support the teaching and research programs. These include TAFESA, Ecophyte Technologies, Alpha Geoscience, Ultimate Positioning and GPRtech. The benefits for these industry partners are various and include the opportunity to 'keep their hand in' with teaching and research, to promote their own skills and expertise to participants who are, or will be in the future, in a position to engage geophysical consultants on heritage related projects, and to network with students who may seek employment with them in the future.

Research funding

Research in archaeological geophysics at Flinders University has been generously supported by the Australian Institute of Aboriginal and Torres Strait Islander Studies, the Australian Geographic Society, the Sir Mark Mitchell Foundation and the Faculty of EHLT Flinders Research Grant scheme.

Future directions

Ian Moffat is co-chairing a session entitled ‘Seeing Beneath the Soil: The Possibilities of Archaeological Geophysics in Australia’ with Kelsey Lowe from Coastal Environments Inc. within the Australian Archaeology Conference to be held at Flinders University from 11 to 14 December 2009. As mentioned above, a one day introductory archaeological geophysics professional development workshop will also be offered on 10 December 2009.

Conclusion

Archaeological geophysics has become a vibrant part of the teaching and research programs within the Department of Archaeology at Flinders University. If you are interested in obtaining more information about archaeological geophysics or the department in general please refer to the website <http://www.flinders.edu.au/ehlt/archaeology/> or contact the authors directly.

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Author profiles

Ian Moffat is a PhD candidate at the Research School of Earth Sciences at the Australian National University and a Research Fellow with the Department of Archaeology at Flinders University. Until October 2009 Dr Lynley Wallis was a Senior Lecturer with the Department of Archaeology at Flinders University; she has recently taken up a Senior Research Fellow position within the Aboriginal Environments Research Centre at the University of Queensland. Ian and Lynley have collaborated extensively on using geophysical techniques to help understand the Australian Indigenous archaeological record.

Groundwater in Geologic Processes, 2nd edition

by Steve Ingebritsen, Ward Sanford and Chris Neuzil

Publisher: Cambridge University Press, 2006, 536 pp.

RRP: \$130.00, ISBN 978-0-521-60321-8 (paperback)

Many of us may consider that the study of groundwater is for the hydrogeologist who is in search of potable water for drinking purposes. To a certain extent this is true, but the science goes much further and this text provides an excellent description of the importance of ground fluid movement.

The first four chapters provide the theory of groundwater movement. Initially I thought I would give this a miss and go straight to the practical aspects. But then I was caught; there was so much I did not know, or had forgotten, which was of real interest. These chapters include Darcy's Law and then proceed to explain hydromechanical coupling, solute transport and heat transport. The text may be heavy in the mathematics but it is still very readable and instructive. (Do you know what a 'dimensionless number' is? – fascinating.)

The process of fluid movement in major geological structures is explained. These

include large sedimentary basins, volcanic terranes and major fault structures such as the San Andreas Fault Zone.

This is followed by a discussion of the role fluid movement plays in the establishment of mineral concentrations, or, as we call them, ore bodies. This includes the lead/zinc Mississippi Valley deposits, other sedimentary deposits and, of particular relevance today, uranium deposits. To understand the processes and the geological environment required for the establishment of these mineral deposits goes a long way to determining where we should be looking for them.

This is not restricted to just minerals but continues into the environment of hydrocarbons where aspects of thermal maturation, migration and entrapment within a fluid flow and thermal regime are all explained in detail.

Crustal heat flow and geothermal resources, which are very relevant today, are fully explained. The authors continue to examine other aspects of fluid movement effecting metamorphism and subsea hydrogeology; this latter topic is also of growing importance in the developing trends of mineral exploration.

One of the criticisms of the first edition was that the examples were all from the

USA. This second edition includes a few examples from elsewhere. However, most of us are familiar with world-wide geology and are aware of the geological details of the case histories described.

I thoroughly recommend this text to all those involved in earth sciences and particularly those whose work includes mineral exploration, geothermal evaluation or a general understanding of fluid movement within the Earth's subsurface.

Copies can be obtained from Cambridge University Press, Private Bag 31, Port Melbourne, Victoria 3207.



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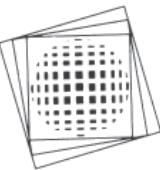
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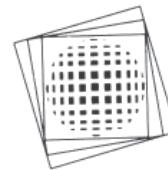
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| March | | 2010 | |
| 7–10 Mar | GEO 2010: 9th Middle East Geoscience Conference and Exhibition http://www.eage.org | Manama | Bahrain |
| 24–26 Mar | Australasian Oil & Gas Exhibition and Conference http://www.aogexpo.com.au | Perth | Australia |
| 25 Mar | Geophysics and Geohazards: Defining Subsea Engineering Risk (associated with AOG Expo above) | Perth | Australia |
| April | | 2010 | |
| 5–8 Apr | EAGE: Saint Petersburg 2010 http://www.eage.org | St Petersburg | Russia |
| 11–15 Apr | SAGEEP 2010 http://www.eegs.org | Keystone | Colorado |
| May | | 2010 | |
| 2–7 May | European Geosciences Union (EGU) General Assembly 2010 http://meetings.copernicus.org/egu2010 | Vienna | Austria |
| 17–19 May | Developments in Land Seismic Acquisition for Exploration (EAGE North African Workshop 2010) http://www.eage.org | Tripoli | Libya |
| 24–27 May | Oceans '10 IEEE Sydney Conference and Exhibition http://www.oceans10ieeesydney.org | Sydney | Australia |
| June | | 2010 | |
| 14–17 Jun | Barcelona 2010: 72nd EAGE Conference and Exhibition incorporating SPE EUROPEC 2010 http://www.eage.org | Barcelona | Spain |
| 14–17 Jun | ICEEG 2010 – 4th International Conference on Environmental and Engineering Geophysics http://www.iceeg.cn | Chengdu | China |
| 22–25 Jun | 2010 Western Pacific Geophysics Meeting http://www.agu.org/meetings/wp10 | Taipei | Taiwan |
| August | | 2010 | |
| 8–13 Aug | 2010 Meeting of the Americas http://www.agu.org/meetings | Iguassu Falls | Brazil |
| 22–26 Aug | ASEG – PESA: 21st Conference and Exhibition http://www.aseg.org.au/Events/Conference | Sydney | Australia |
| 29 Aug–4 Sep | Seismix 2010 – 14th International Symposium on Deep Seismic Profiling of the Continents and their Margins http://www.earthscrust.org/earthscrust/seismix2010.htm | Cairns | Australia |
| September | | 2010 | |
| 5–10 Sep | 11th IAEG Congress http://www.iaeg2010.com | Auckland | New Zealand |
| 6–8 Sep | Near Surface 2010: 16th European Meeting of Environmental and Engineering Geophysics http://www.eage.org | Zurich | Switzerland |
| 29 Sep–1 Oct | Geo-Computing 2010: 'Uses and Abuses' http://www.aig.org.au/events | Brisbane | Australia |
| October | | 2010 | |
| 17–22 Oct | SEG International Exposition and 80th Annual Meeting http://www.seg.org | Denver | USA |

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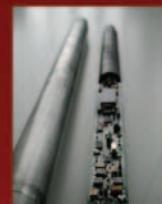
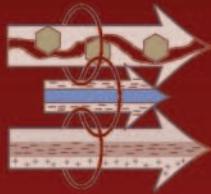
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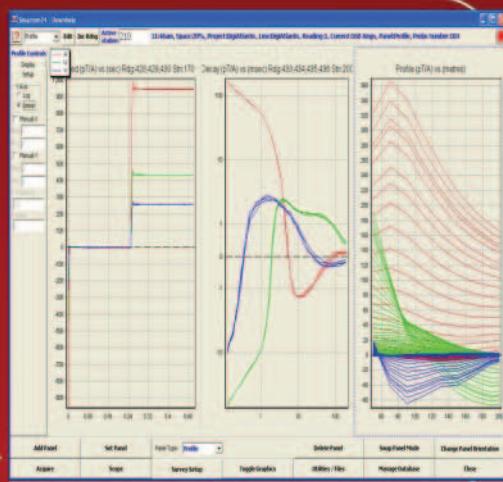
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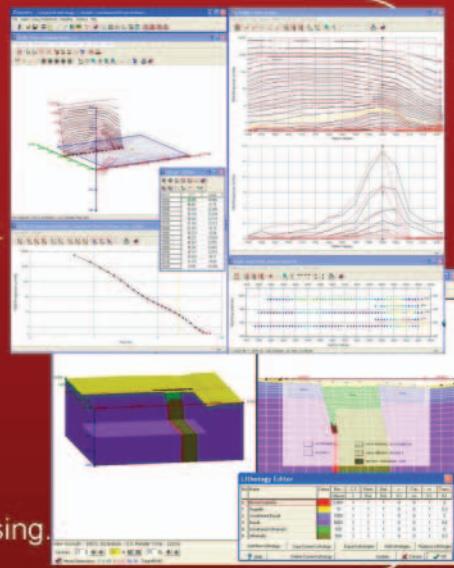


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