

A Successful 22nd ASEG Conference and Exhibition in Brisbane

The 22nd ASEG Conference was one of the largest ASEG conferences, and certainly the largest Brisbane ASEG conference, with nearly 1000 delegates representing over 45 countries from around the globe. The conference provided excellent networking opportunities for all attendees from Australia and overseas.

The conference theme was 'Unearthing New Layers'. It covered a broad range of topics on seismic, borehole logging, gravity, electrical, electromagnetic, and magnetic methods and their applications in exploration for oil and gas, unconventional gases, minerals, and geothermal resources, as well as in geotechnical, environmental and engineering problems. The conference featured:

- 89 exhibitors;
- 9 workshops, which attracted a total of 342 attendees;
- 5 parallel technical sessions with a total of 50 sessions;
- 21 keynote presentations (12 petroleum and 9 non-petroleum); and
- 138 contributed oral presentations consisting of 60 petroleum related papers and 78 non-petroleum papers, and 59 poster presentations.

Every presentation was of the highest quality and of great interest to the audience. This conference was able to provide a true world-class forum where delegates heard about the latest technical advances and research achievements in all areas of applied geophysics. It was truly a pleasure to be part of such an energetic exchange of ideas.

Many people worked diligently behind the scenes to make the conference so successful. In particular, thanks go to the eight scientific committee members who helped compile such a fantastic technical program; the 58 paper reviewers who were responsible for the conference's high calibre presentations, as well as the 50 session chairpersons who were integral to the smooth and timely running of the individual conference sessions. We all congratulate and thank you for your contributions towards such a successful ASEG event.

Special thanks go to all the staff from Arinex, our conference management team, and particularly to Erin Simmons,

for doing all the work behind the scenes, communicating with our paper reviewers, chair persons, conference attendees and presentation authors. Without their help, we would not have been able to deliver such a high quality conference.

Conference Awards

As the final highlight of the conference, we presented several awards giving formal recognition to the distinguished contributions from both technical presenters and exhibitors. The following list summarises these awards.

Laric Hawkins Award

This award is presented to the contributor or contributors for the most innovative use of a geophysical technique from a paper presented at the ASEG Conference.

David Pratt, Keith Blair McKenzie and Anthony S. White - *The remote determination of magnetic remanence*

Best Paper – Petroleum

Jeffrey Shragge and David Lumley - *Elliptical dip moveout (EMO) for 3D seismic imaging in the presence of azimuthal anisotropy*

Best Paper – Minerals

Stephen J. Fraser, Glenn A. Wilson, Leif H. Cox, Martin Cuma, Michael S. Zhdanov and Marc A. Vallée - *Self-organizing maps for pseudo-lithological classification of 3D airborne electromagnetic, gravity gradiometry and magnetic inversions*

Best Paper – Coal

Kate E. Godber, James Reid and Guy LeBlanc Smith - *Application of Airborne EM to Bowen Basin Coal Projects*

Best Paper – Environment/Engineering

Niels B. Christensen and James E. Reid - *Assessing the presence of hard rock along a gas pipeline alignment with airborne EM*

Best Paper – Student

Students are the future of geophysics. 72 students attended this conference and 28 students gave talks. To encourage the involvement of the new generation of geophysicists at conferences, we also

provided this best paper award for a student.

Wendy Young and David Lumley - *Feasibility of time-lapse gravity monitoring of producing gas fields in the Northern Carnarvon Basin, Australia.*

Best Poster

Hashim Almalki, Mohanad Alata and Tariq Alkhalifah - *Laboratory coupling test for optimum land streamer design over sand dunes surface*

Best Single Booth Exhibitor

GPX Surveys

Best Mid-Size Booth Exhibitor

Ikon Science

Best Large Booth Exhibitor

CGGVeritas

Thank you for everyone's outstanding contributions and we look forward to seeing you and your great work at future ASEG events.

Binzhong Zhou



David Pratt – Laric Hawkins Award



Jeffrey Shragge – Best Paper Petroleum



Kate Godber – Best Paper Coal



Stephen Fraser – Best Paper Minerals



Wendy Young – Best Student Paper



Katherine McKenna, GPX Surveys – Best Single Booth Exhibitor



Ikon Science – Best Mid-Size Booth Exhibitor



CGGVeritas – Best Large Booth Exhibitor



A very happy (and relieved!) 22nd ASEG Conference Organising Committee at the end of the conference: (L to R) Andrea Rutley (co-chair), Cameron Hamilton, John Donohue, Henk van Paridon, Koya Suto, Sylvia Michael, Ron Palmer, Noll Moriarty, Binzhong Zhou, Wayne Mogg (co-chair). (Absent – Margarita Pavlova).

34th International Geological Congress (IGC)



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As at 13 March 2012, the Scientific Program Committee of the IGC had received **5050 abstracts** for papers to be presented at the IGC in August. These have been received from **4117 individuals** as some authors have submitted multiple abstracts. The real test comes in April because these authors must be paid up as delegates in order to be placed in the technical program. While some authors will drop out, the high number of submitting authors is positive. Several last minute abstract submissions include case history papers given at the February ASEG Conference in Brisbane, these being presentations that have particularly strong messages for our geological colleagues about the beneficial use of geophysics.

A notable highlight of the abstracts is the high level of talks submitted in the themes that are of direct relevance to industry. The distribution of the countries of origin of submitting authors is also interesting:

- highest – Australia at 936, with China second highest at 864;
- between 150 to 300 authors – USA, Brazil, Russia, Japan;
- 60–120 authors – India, Canada, UK, Italy, Germany, South Korea, NZ, France, Iran;
- 1–50 authors – a very long list of countries from Azerbaijan to Zambia.

Sponsorship continues to come in, making a current total of \$766,500, which does not include the targeted AusAID support for the Geohost program. Bookings for the GeoExpo have been particularly strong.

A highlight of the IGC will be the release of comprehensive new information and maps from a decade of geological and geophysical surveys conducted over

Central and Eastern Asia (for more information, see *Preview Issue 156*, February 2012, p. 14).

Industry-relevant IGC themes

Theme 6. Energy in a Carbon-Constrained World

Coordinators: Peter COOK (pjcook@co2crc.com.au) and David LUMLEY

Global demand for energy continues to grow strongly but at the same time pressure mounts to reduce greenhouse gas emissions to mitigate the impacts of rapid climate change. Symposia will explore issues and options for future energy use including: the future of fossil fuels; carbon capture and storage; geothermal energy including exploration and resource characterisation; renewable energy resources; nuclear energy – including uranium and thorium resources and demand, and nuclear waste disposal.

Theme 7. Mineral Resources and Mining

Coordinators: Graham CARR (graham.carr@csiro.au) and Dale SIMS

This theme will include a global perspective on mineral resources; leading edge technologies for increased automation and decreased wastes and mine-site pollution; high technology commodities for the future; industrial minerals; advances in in-mine geophysics; resource definition, modelling, estimation and reporting; resource development techniques and issues over a range of commodity types; specialist sessions on industry issues and case studies for uranium, iron ore, diamonds, nickel, base metals, sampling and geometallurgy; future sources of industrial and construction materials.

Theme 8. Mineral Exploration Geoscience

Coordinators: Cam MCCUAIG (campbell.mccuaig@uwa.edu.au) and David GILES

This theme will address the science of mineral exploration against the backdrop of increasing global demand for mineral resources. Indicative Symposia topics include: mineralising systems; the science of exploration targeting; exploration geophysics; advances in geochemical exploration; 3D geology and geophysics in targeting; deep exploration and

discovery; quantifying and managing uncertainty and risk in exploration, and declining exploration success rates; major discovery case histories; exploration trends and emerging mineral districts.

Theme 9. Mineral Deposits and Ore Forming Processes

Coordinators: Ross LARGE (ross.large@utas.edu.au) and Cornel DE RONDE

Understanding the controls on the distribution and formation of ore deposits is critical to future discovery of new ore deposits. Symposia will include: major mineral provinces of the world; mineral alteration halos; tectonics and ores in magmatic arcs; magmatic sulfides; basin-hosted ores; dating of ore deposits; geometallurgy; iron oxide copper gold (IOCG) – the unhappy family; volcanic-hosted metal sulphide (VHMS) deposits; sediment-hosted base metal and gold deposits; structure and gold; and submarine mineralisation.

Theme 11. Petroleum Systems and Exploration

Coordinators: Marita BRADSHAW (marita.bradshaw@ga.gov.au), Chris URUSKI and Sylvia ANJOS

Global demand for petroleum continues to grow, driving the search for resources to new frontiers as well as the need to extract petroleum as efficiently as possible from existing basins. Indicative topics include petroleum geoscience – advances in seismic applications, petroleum geochemistry, other geophysical techniques, and applications of palaeontology; frontier petroleum basins – extending exploration in time and drilling depths; southern hemisphere petroleum prospectivity; enhanced oil recovery – horizontal drilling, reservoir fracturing, chemical methods, water/CO₂ injection and re-injection; petrophysics – pressure, permeability and rock property predictions; advances in petroleum exploration – new ideas on prospectivity, basin modelling, source rock models, reservoir modelling; putting the geo into geophysics – use of potential fields in interpreting economic basement, structure and reservoir presence/quality, seismic sequence analysis, facies mapping and depositional environments.

Theme 12. Unconventional Hydrocarbons – Emerging Fuels

Coordinators: James UNDERSCHULTZ (james.underschultz@anlecrd.com.au) and Ingo PECHER

Unconventional hydrocarbons, notably shale gas and coal seam gas, have become a vital component of the North American domestic gas supply and are touted to have high potential to be the same in Europe, China, India and southeast Asia. In Australia, coal seam gas production is on the verge of a step change in production to supply a new LNG export industry. However, unconventional gas development has not been without its critics and environmental concerns. What are the lessons learned in North America and how can these be applied elsewhere? Technological advancement in oil sands and enhanced oil recovery has made these resources competitive even at low oil prices. CO₂ enhanced recovery has the potential to add value not only in increased production but also as carbon storage in an emerging global carbon market. Symposia will focus on the unconventional hydrocarbons and their emergence as important future sources of energy including: transport fuels; coal seam gas, resources and extraction and water production and management; shale

gas and tight gas resources and potential; and gas hydrates, the ultimate unconventional hydrocarbon.

Theme 28. Groundwater/Hydrogeology

Coordinators: Ken LAWRIE (ken.lawrie@ga.gov.au) and Chris DAUGHNEY

The past decade has seen an increased demand for hydrogeological predictions to sustain growth, promote wealth and protect landscape, infrastructure and biodiversity assets. Improved understanding of hydrogeological systems underpins the development of more effective groundwater models and management strategies and actions. Indicative topics covered in this theme include: climate-change impacts on groundwater; surface-groundwater interaction; managed aquifer recharge; groundwater modelling and parameterisation; delineation and management of groundwater resources; aquifer and aquitard mapping and characterisation; recharge and discharge mapping; groundwater and mining; coastal groundwater; groundwater-dependent ecosystems; risks to groundwater quality including salinity; hydrogeochemistry including water-rock interactions; and socio-economic and

legal aspects of groundwater management.

Theme 31. Engineering Geology and Geomechanics

Coordinators: Mark EGGERS (mark.eggers@psmconsult.com.au) and Francisco DE JORGE

The interface between geology and engineering is critical to our rapidly expanding urban space and increasing demand for the Earth's resources. Indicative Symposia in this theme include: geoenvironmental challenges for our ever-growing cities; geoscience inputs to major infrastructure developments, including underground construction and corridor studies; increasing use of engineering geology concepts in the optimisation of open pit and underground mine design; key roles of geoenvironmental in mitigating climate change; improving the development of geological models for engineering projects; and advances in geomechanics.

The IGC Organising Committee looks forward to the support of the societies in encouraging attendance at the IGC, especially by younger geoscientists.

Mike Smith, Chairman AGC

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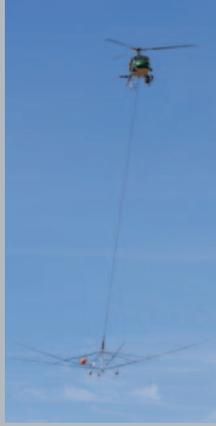


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ASEG 2013 conference in Melbourne

The preparations for the ASEG 2013 conference in Melbourne are now underway! The ASEG Victoria Branch has formed the ASEG 2013 Conference Organising Committee (COC), and most sub-committee chairman roles have now been filled. We still have many positions vacant in the sub-committees, so if you are interested, then contact any of the chairpersons listed below.

The ASEG 2013 COC is:

- COC Joint Chairman (Petroleum) – Jarrod Dunne
jarrod.dunne@meoaustralia.com.au
- COC Joint Chairman (Minerals) – Asbjörn Norlund Christensen
asbjorn_n_christensen@yahoo.com
- Exhibitor Sub-Committee Chairman – Richard MacRae
richard.macrae@mmg.com

- Technical Papers Sub-Committee Chairman – Mark Dransfield
mdransfield@fugroairborne.com.au
- Sponsorship Sub-Committee Chairman – *Vacant*
- Publicity Sub-Committee Chairwoman – Suzanne Haydon
suzanne.haydon@dpi.vic.gov.au
- Finance Sub-Committee Chairman – Theo Aravanis
theo.aravanis@riotinto.com
- Workshop Sub-Committee Chairman – Bob Smith
greengeo@bigpond.net.au
- Social Event and Activities Sub-Committee Chairman – John Theodoridis
jthe1402@bigpond.net.au
- Student Coordinator Sub-Committee Chairman – James Macnae
james.macnae@rmit.edu.au

- Conference CD Sub-Committee Chairman – Michael Asten
michaelasten@flagstaff-geoconsultants.com.au

The theme for the ASEG 2013 conference in Melbourne is **'The Eureka Moment'** – capturing the ASEG's quest for discovery, insight and learning, but also with a sub-contextual nod to the golden riches of Victoria's past.

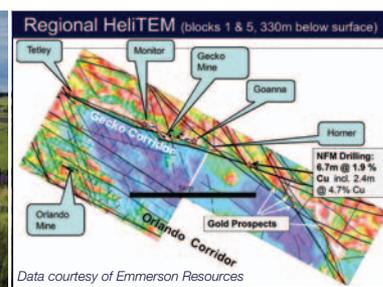
We are currently focusing on securing a fantastic Melbourne venue for the ASEG 2013 conference, so watch this space for further announcements. See you all in Melbourne in 2013!

Asbjörn Norlund Christensen

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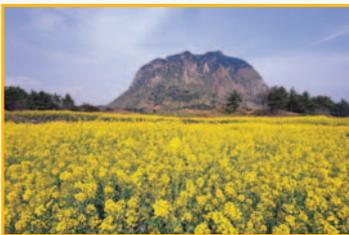
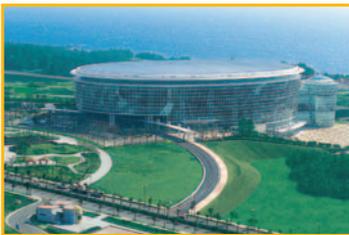
KSEG

KSEG International Symposium on “Geophysics for Discovery and Exploration”

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September 19 - 21, 2012

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Dear Colleagues;

We are very pleased to announce that the Korean Society of Earth and Exploration Geophysicists (KSEG) is organizing an “International Symposium on Geophysics for Discovery and Exploration” to be held at the International Convention Center (ICC) of Jeju Island, Korea on September 19 - 21, 2012.

Through sponsorship of this International Symposium, the KSEG intends to foster international collaborations in pure and applied geophysics between our members and our colleagues in other geophysical societies around the world.

For additional details and a preliminary program of the symposium, please visit our website: <http://2012symp.seg.or.kr/>.

Abstract submission: April 1 through June 30, 2012.

On-line registration deadline: August 15 (Wednesday), 2012.

The correspondent author should pre-register before July 31 (Tuesday), 2012.

We are looking forward to your participation.

Convener:

Dr. Mutaek Lim

Vice President of Korean Society of Earth and Exploration Geophysicists

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Mineral exploration powers ahead in 2011; petroleum holds steady

2011 a record year for minerals

The global financial crisis is now almost a distant memory as far as resource exploration is concerned. Figures released by the Australian Bureau of Statistics in March 2012 show that the trend estimate for total mineral exploration expenditure in Australia rose by 2.9% to a record \$944.7 million; this is 35.4% higher than the December quarter for 2010 (see Figure 1).

Although the rate of increase is declining the current level of investment is impressive and more than twice that of

the 1997 peak, even when adjustments have been made for CPI changes. The two largest states – Western Australia and Queensland still dominate the exploration scene. WA accounted for 52% of the investment in the December quarter and Queensland accounted for 25%. This leaves just 23% for all the other states and territories.

One major change in exploration strategy during the last few years has been the ratio of greenfield to brownfield exploration investment. This number is a good indicator of the state of mineral exploration.

Throughout 2008 the focus was on exploring for new deposits, but this has now changed significantly. In the December 2011 quarter, the focus was on existing deposits and more than twice as many dollars were spent in the vicinity of existing mines as were invested in greenfield areas. In other words the current strategy has a greater emphasis on expanding the resource base from existing deposits rather than going out and looking for something new in an unexplored area. Figure 2 shows how this emphasis has changed in the last five years.

The increase in mineral expenditure over the last few years has been spread across a whole range of commodities. Iron ore is

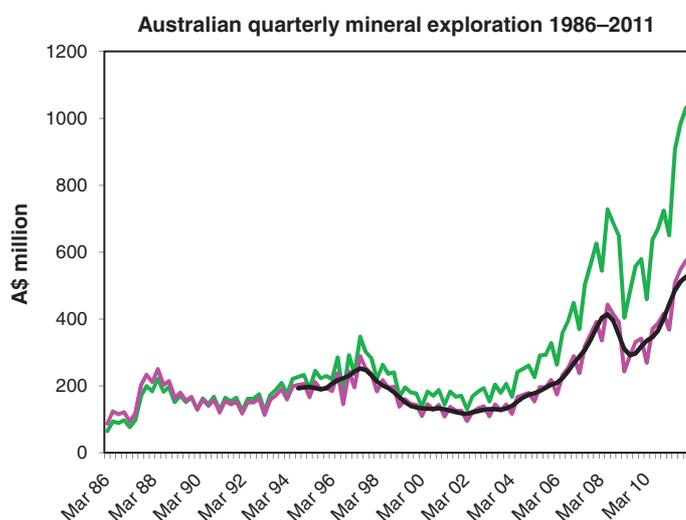


Fig. 1. Quarterly 'actual' mineral exploration expenditure from March 1986 through December 2011 (from ABS data). The green curve represents actual dollars spent, the purple curve shows the CPI adjusted numbers to 1998/99 levels and the black line is the trend line (ABS data). Notice that the effects of the GFC have been overcome completely.

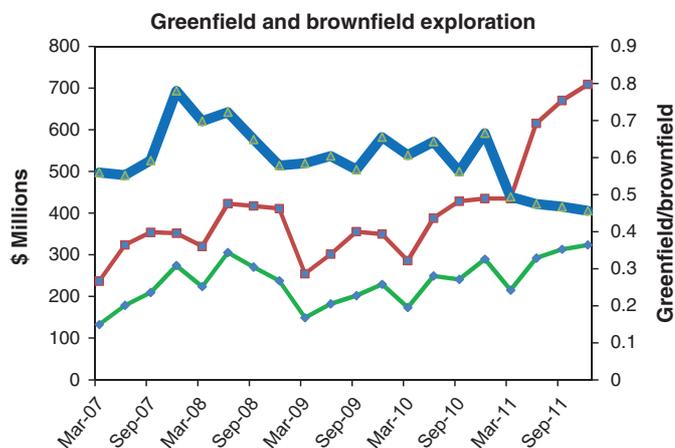


Fig. 2. Change in emphasis in greenfield (new deposits – green curve) and brownfield (existing deposits – brown curve) exploration (left axis). Notice the large change in the greenfield/brownfield parameter (blue curve) from the end of 2007 (right axis).

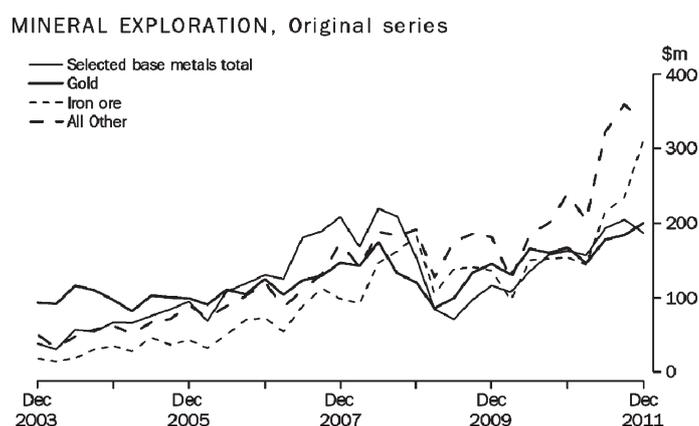


Fig. 3. Trends in exploration expenditure for selected commodities (from the Australian Bureau of Statistics Report 8412.0, December Quarter 2011).

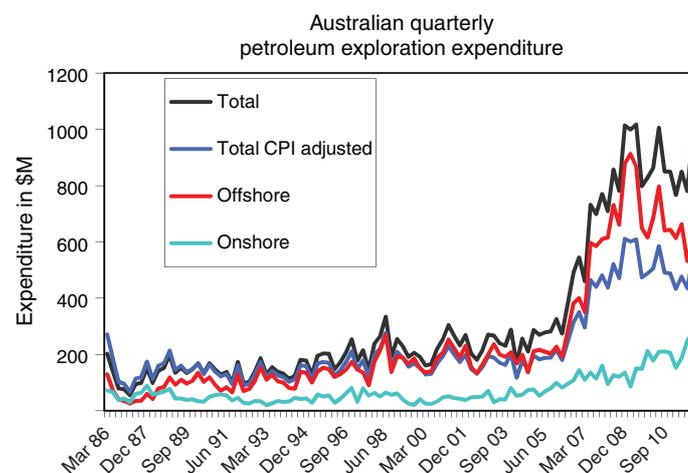


Fig. 4. Quarterly petroleum expenditure from March 1986 through December 2011. The individual offshore and onshore numbers are actual numbers spent at the time, not CPI adjusted. The black line shows the contemporary dollars spent and the blue curve shows the CPI adjusted number to 1989/90 dollars for the total expenditure.

at the top of the heap with \$312 million in the December quarter (see Figure 3). It was followed by \$218 million for coal, with gold in third place at \$200 million.

Petroleum exploration stays steady

Petroleum exploration expenditure rose by \$117 million from the previous quarter to \$897 million. However, because of the scatter in the data set (see Figure 4), the total expenditure has remained approximately constant at approximately \$900 million a quarter for the past three years.

Western Australia was the dominant state. It attracted a substantial 68% of the total Australian expenditure for the December quarter. One interesting trend is the gradual increase in onshore exploration expenditure. As shown in Figure 4 it has been gradually climbing since 2003.

In summary, a very healthy situation for both the mineral and the petroleum resource sectors.

David Denham



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Exploration Environmental Engineering

CSIRO Earth Science and Resource Engineering Magnetism and Gravity Team

Clive Foss^{1,3} and Phil Schmidt^{1,2*}

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*Phil Schmidt is now at MagneticEarth (see Business Directory in this issue).

CSIRO Earth Science and Resource Engineering (CESRE) has a research team in North Ryde, NSW focussed on magnetic and gravity methods, and one in Perth, WA focussed on electromagnetic (EM) capabilities. The Magnetism and Gravity Team consists of Phil Schmidt and Clive Foss, together with three post docs – James Austin, Majid Beiki and Dean Hillan – and also has input from Dave Clark, Peter Warren and Xiaolin Luo. This article reports on current research in the CESRE Magnetism and Gravity Team. A future article will profile the research being undertaken by the CESRE EM team.

CSIRO recognised the need to invest in and strengthen its geophysics capability and decided that a major focus should be on improved interpretation of magnetic, gravity and EM data. Magnetic field data form the most complete and detailed geophysical coverage across Australia. They are also the most widely used geophysical data for greenfields mineral exploration, location and design of mineral exploration drill holes, and geological mapping, and importantly are available for free download from Geoscience Australia's GADDS facility. The value of these data can be enhanced considerably by upgrading our ability to recover geological information from it.

We have concentrated on several research topics, including:

- improved interpretation of remanent magnetisation;
- better treatment of self-demagnetisation results;
- recognition of the geophysical signature of mineral systems; and
- new automated interpretation of source depth.

The Magnetism and Gravity Team wants to ensure the reliability and wide application of its research through extensive cooperation with external groups. The team has ties with Geoscience Australia on multiple

research projects, with several of the state and territory geological surveys, with Sydney and Macquarie Universities, and with Intrepid Geophysics and Tensor Research. Another major focus of the group, funded through CSIRO's involvement in the Deep Exploration Technologies Cooperative Research Centre (the DET CRC), is down-hole magnetic tensor gradiometry being developed in close collaboration with CSIRO Materials Science and Engineering (CMSE) at Lindfield.

Brief information on the Magnetism and Gravity Team's research projects is given below – further details are available on the Team's website at www.magresearch.org. As the research projects progress, the results, publications and any software developed will be posted on this site.

Palaeomagnetic and rock magnetic studies

CSIRO has for many years run a palaeomagnetic and rock magnetic laboratory in North Ryde which both undertakes research projects and provides a sample measurement service to industry. The laboratory shares facilities with Macquarie University, and is linked in a LIEF (Linkage Infrastructure, Equipment and Facilities) grant with

ANU. Direct measurement of magnetisation and magnetic properties of rock samples is essential to understand the connection of magnetisation to the mineralogy, petrology and geological history of the rock.

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Down-hole magnetic tensor gradiometry

For deep magnetic targets, aeromagnetic and ground magnetic data represent distal samples of the magnetic field. A borehole provides access for measurements much closer to the source. To compensate for the limited spatial distribution of down-hole measurements we have chosen to measure the gradient tensor, which has superior targeting capabilities. This work, undertaken as part of the DET CRC, includes both instrument manufacture and development of interpretation software. The instrument is in large part based on previous CSIRO airborne SQUID magnetic tensor gradiometry research and development, but the current project uses AMR (anisotropic magnetoresistive) sensors.

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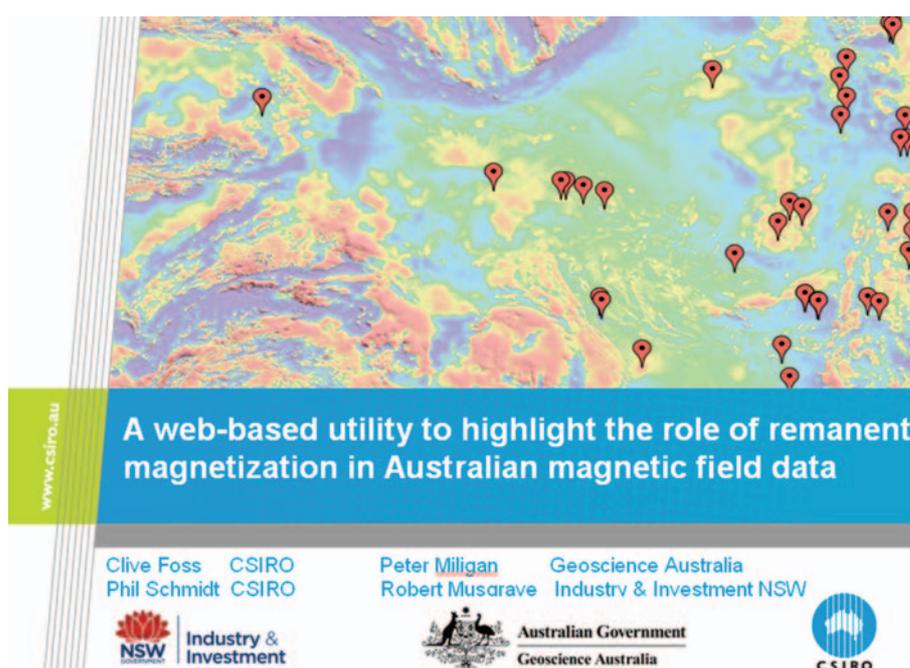


Fig. 1. Talk given at the 2012 ASEG conference on the remanent anomaly database.

Remanent anomalies database

Knowledge about the distribution of magnetisation across Australia is available from direct measurement in palaeomagnetic and rock magnetic studies, and also from various magnetisation direction analyses and inversions of magnetic field data. At present these results are not readily available in any one location. The Remanent Anomalies Database is a collaborative project between CSIRO, Geoscience Australia, and various state and territory geological surveys, to collect this information and make it available via a web delivery service through the AuScope web portal. When geoscientists start work in a new area, they will be able to utilise this facility to determine what remanence magnetisations have been previously recognised in the area, and thus recognise the characteristic expression of that remanence in the magnetic field data. Figure 1 is the title slide from a talk on the database given at the 2012 ASEG Conference in Brisbane, which can be downloaded from www.anomalydatabase.magresearch.org.

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Recovery of magnetisation direction from magnetic field data

To support remanent magnetisation studies and help build the remanent magnetic anomalies database we are undertaking research into many means of

recovering magnetisation direction from magnetic field data. The objective of this study is to produce a suite of software tools that can be applied in magnetic field interpretation. These tools range from rapid automatic scanning of magnetic field grids to provide a first-pass detection and analysis of remanent magnetisation, through to intensive study of an anomaly to define the best-estimated location, geometry and magnetisation parameters of the source body. Considerable progress has already been made in tensor-based magnetic moment analysis, and in a wide range of automated methods to scan various magnetisation directions (or perform down-hill searches through magnetisation direction space) to select optimum magnetisation direction estimates as defined by various chosen statistics defined from reduction to pole (RTP) and reduction to equator (RTE) transforms using trial magnetisation directions.

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Self-demagnetisation studies

There is an increasing interest in strongly magnetised ore bodies, in particular magnetite deposits, for which standard forward modelling codes provide an inaccurate representation of the source body through failure to account for the substantial internal secondary fields (self-demagnetisation). Exact analytic solutions for self-demagnetisation only exist for ellipsoidal sources, and beyond using this geometric approximation for a geological source body, existing commercial software packages invoke

simple approximation methods that break down at susceptibilities far less than 1 SI. We have developed a much improved forward modelling code for self-demagnetisation effects, and have wrapped this in a Monte-Carlo inversion process. Ongoing research aims to link this voxel-based forward modelling of self-demagnetisation to more powerful, better guided inversion processes. Figure 2 shows the first vertical derivative of total magnetic intensity over the Hawsons Deposit south of Broken Hill being developed by Carpentaria Exploration (www.carpentariaex.com.au) where we are ground-truthing the software.

Contact: dean.hillan@csiro.au

Geophysical signatures of iron-oxide copper-gold (IOGC) and other selected Australian mineral deposits

The search for new mineral deposits beneath cover benefits considerably from understanding the geophysical signatures of those deposits already found, as well as learning from misinterpretation of what proved to be un-mineralised drill targets. IOGCs are a particularly rich and popular exploration target, but they have very variable, and in some cases enigmatic geophysical signatures. We are attempting to better understand the geophysical signatures of these bodies by measurement and collation of physical property information, forward modelling of synthetic source models, development of structural models, and understanding the processes that link mineralisation to physical property. Of particular importance is incorporation in these studies of remanent magnetisation, which has rarely been considered before, but which in some cases has a profound influence on the magnetic field signature of the mineralised system.

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Inversion of magnetic and gravity field data

Our research at CESRE Magnetics and Gravity team is focussed on:

- developing new inversion methods and optimisation tools for inversion of magnetic and gravity field data;
- joint inversion of magnetic and gravity gradient tensor components for a better interpretation of short wavelength

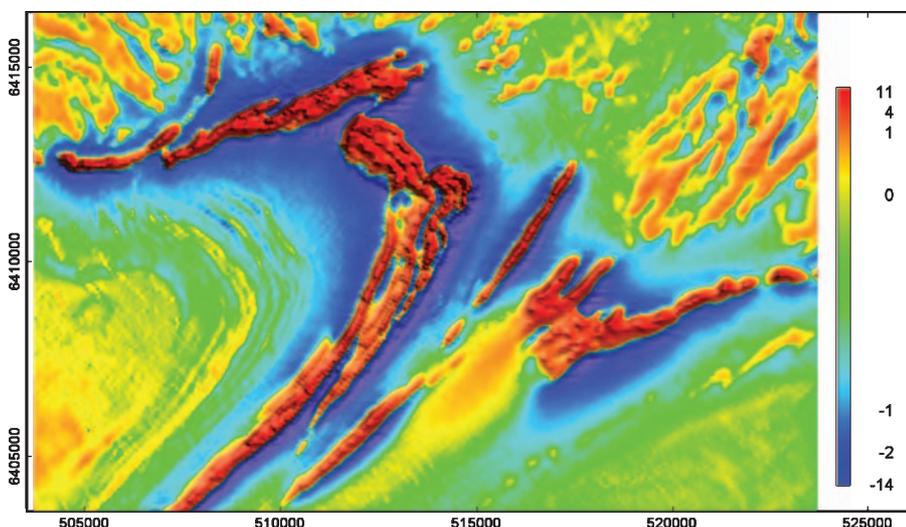


Fig. 2. First vertical derivative of total magnetic intensity over Carpentaria Exploration's Hawsons Deposit south of Broken Hill.

- anomalies using regularised focusing inversion method;
- joint inversion or parallel inversion of magnetic gradient tensor and electromagnetic data for mineral exploration.

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Quantification of uncertainty in potential field inversion

Inversion of potential field data is inherently non-unique – therefore it is not possible to assign true confidence limits to the results. This reduces the value of those results in, for instance, quantitative risk analysis of decisions such as whether or not to drill a selected target. In lieu of full confidence estimates we are undertaking a statistical study of the justified complexity of a model. Results obtained to date relate to the required complexity in cross-sectional shape for a 2D model to explain a gravity or magnetic profile. Studies to extend this analysis to joint inversion (gravity field and gravity gradient, magnetic field and magnetic gradient, or gravity and magnetic) are near complete, and we are now extending this analysis to the complexity of 3D sources.

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Automated magnetic depth to source mapping

One of the most common quantitative objectives of magnetic field interpretation in Australian mineral exploration projects is the mapping of depth to source (most commonly the mapping of crystalline basement beneath cover). We are investigating a novel, semi-automated multi-stage process of magnetic source depth estimation. This research is being performed in collaboration with Simon Williams of Sydney University, and provisional arrangements have been made with Geoscience Australia to utilise this research in development of a new national depth of cover investigation as recommended in ‘Searching the deep Earth: the future of Australian resource discovery and utilisation’ proceedings published by the Australian Academy of Science: <http://www.science.org.au/events/thinktank/thinktank2010/documents/thinktankproceedings.pdf>. Figure 3 illustrates the close relationships between the magnetic field and geology in one of our test areas in the Northern Territory.

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Investigation of multi-scale edge mapping (‘worming’)

CSIRO was at the forefront of developing multi-scale edge detection analysis (‘worming’), which combines wavelet analysis, edge detection and upward continuation in an attempt to resolve a gravity or magnetic grid into responses attributed to a series of physical property contrast interfaces at different depths. We have created an improved implementation of the original code and are currently testing this in an investigation, in conjunction with the NSW Geological Survey, of part of the Lachlan Fold Belt. At the same time we are mapping capabilities and limitations of the method using both synthetic forward computed grids derived from detailed 3D models, and data grids from selected test areas.

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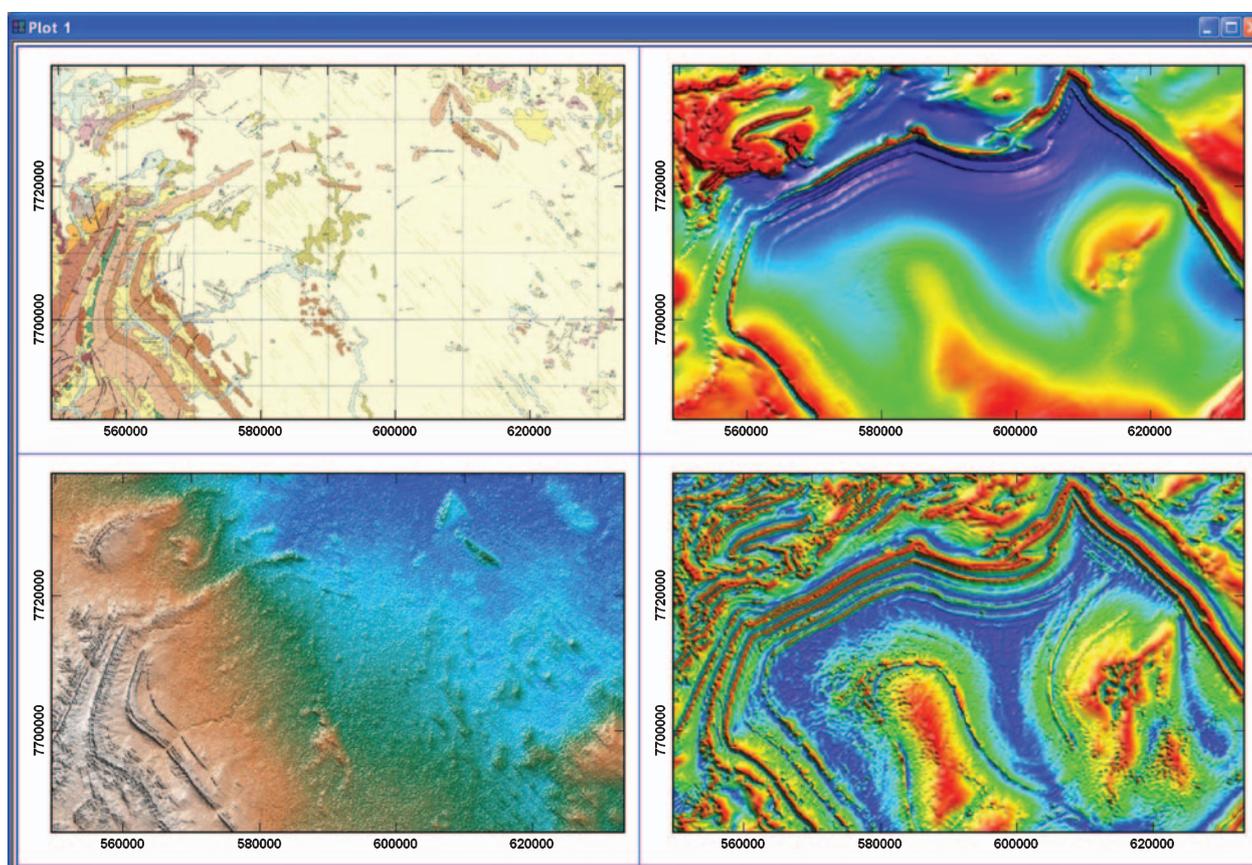


Fig. 3. Relationships between geology and the magnetic field in the Frew River area of the Northern Territory, one of the test areas for testing new magnetic source depth estimation techniques.

TESEP update – a continuing success story and now an award-winning program

The following TESEP update mainly comprises material summarised from a review published in the PESA News Resources, No. 115 Dec 2011/Jan 2012.

How it all started

The Teacher Earth Science Education Programme (TESEP) began as an idea in 2007, and developed with the help of seed funding from the Petroleum Exploration Society of Australia (PESA) and under the guidance of ExxonMobil geologist, Jill Stevens. By 2008 the idea had blossomed into a major educational initiative, with the aim of raising the capacity of middle school (Years 7–10) teachers to teach the Earth Science components of the curriculum through the development and delivery of teacher orientated professional development workshops.

When TESEP was first proposed in 2007, Earth Science WA (ESWA) was already underway and running classroom Earth Science workshops for primary and secondary students and teachers. These workshops informed and enabled teachers and resulted in increased Earth and Environmental Science student numbers. As the ESWA program runs only in WA there was a need for teacher education in the other states, and it was with this need in mind that TESEP was created, albeit using a different model to ESWA.

By 2008, TESEP had gathered a team of teacher-educators, surveyed teachers to identify high priority workshop needs, commenced workshop development and by mid-2008 was in a position to deliver the first of eight workshops in the 'Challenging Earth' series. TESEP had also assembled an advisory board comprising key personnel from all sectors of the Earth Science community, and had attracted several industry, university and

government partners to assist with funding and logistics (including the ASEG and AIG). The final key to the initial success of the program was the inclusion of the Australian Science Teachers Association (ASTA), to provide administrative and financial management of TESEP, and to provide the quality endorsement and accreditation that teachers look for when choosing professional development workshops.

Since 2008, TESEP has developed eight workshops on earth science topics, and has also had input into the development of the new Australian Curriculum for Science. TESEP is now considered a key stakeholder in discussions about Earth Science education in Australia. TESEP has also delivered over 77 workshops to more than 945 teachers in 23 locations across all states and territories other than Western Australia. Teachers report very high levels of satisfaction with the entire workshop delivery program, and it is estimated that each satisfied teacher shares their learning, the support materials and the enthusiasm for teaching the subject, with at least 2 or 3 other teachers.

TESEP's success recognised

In recognition of her outstanding efforts in initiating, nurturing and promoting TESEP, Jill Stevens, the founder and chairperson of TESEP, has been awarded the prestigious American Association of Petroleum Geologists (AAPG) Harrison Schmitt Award, further adding to the recognition she received for TESEP with the PESA Meritorious Service Award in 2008. The AAPG citation states it is in recognition of outstanding accomplishment in Teacher Education outreach work.

Following her nomination for the award, Jill advised AAPG that the founding

members of the TESEP team were a talented, dedicated group of educators/geologists, who had developed and presented the material at face-to-face workshops and were collectively the reason for the success of the workshop series. In response to Jill's representations, the AAPG awards committee have re-conferred the award to 'Jill Stevens and TESEP'.

The Harrison Schmitt Award will be presented to Jill at the AAPG Awards Ceremony during the AAPG Conference in Los Angeles in April this year.



Teachers in action with TESEP Executive Officer, Greg McNamara (image courtesy of TESEP).

The program continues

In 2012 TESEP continues to progress, delivering workshops across many more locations, developing the ASTA online webinar portal, and compiling additional case study examples and new classroom support materials. The continuing success of TESEP is, however, dependent on the financial and logistical support of its partner organisations. To find out more about TESEP and how to be a partner visit: www.tesep.org.au.

Mike Smith

1st Australian Geoscience Teaching Workshop

The teaching of geosciences in Australian universities has recently been facing a number of challenges, particularly associated with a rapid increase in undergraduate student numbers. With some university classes doubling in size over the past few years, teaching practices have been required to quickly adapt, and new approaches are being adopted to improve student learning in both the classroom and the field. These changes in teaching methods and practices are vital for maintaining and improving graduate standards, despite increasing student to staff ratios.

In late January 2012, 40 geoscience lecturers from across Australia gathered in Adelaide for the inaugural **Australian Geoscience Teaching Workshop**. This workshop was the first time that Australian geoscience academics had come together for the sole purpose of discussing new teaching approaches, techniques and strategies. This workshop also represented the first event run by the newly formed Australian Geoscience Learning and Teaching Network, which involves partnerships between geoscience departments in 12 universities, spread

across seven states and territories, to work together and improve geoscience teaching.

The workshop was conducted over two days and included 26 presentations, split into seven sessions, as well as dedicated time for open discussion on key teaching issues. A diverse range of topics were covered, including the development of field work and geophysical skills, methods for improving 3D visualisation, smoothing the transition from school to university, online teaching, and assessment practices. Furthermore, the workshop also extensively discussed major strategic aspects, such as improvements in teaching facilities and the development of nation-wide learning and teaching academic standards in the earth sciences. Particular highlights from the workshop included:

- Marion Anderson's presentations on Monash's urban field work exercises, which involves analysis of modern 'trace fossils' in concrete;
- Michael Roach's use of cameras attached to remote controlled helicopters to build three dimensional photogrammetric models for outcrops on University of Tasmania fieldtrips; and,

- Ian Clarke (University of South Australia) laying the foundations for identifying fundamental 'threshold concepts' in earth science education.

Overall, the participants of the workshop unanimously agreed that the workshop had been extremely beneficial in learning and sharing of teaching experiences and approaches, and there are plans for a second workshop to take place in 2013. The workshop has also led to the formation of ongoing working parties on core issues, such as improving first year teaching and the development of national teaching standards in earth sciences. The proceedings of the workshop have been published as volume 100 of the Geological Society of Australia Abstracts series.

The workshop could not have taken place without the generous sponsorship and support of the Geological Society of Australia, Australian Society of Exploration Geophysicists, the Minerals Tertiary Education Council, the Australian Institute of Mining and Metallurgy and the Australian Geoscience Information Association.

Mark Tingay



The workshop included presentations on new laboratory facilities in several institutions that are being used to revolutionise hands-on teaching. This included a tour of the new teaching spaces in the Mawson Laboratory, University of Adelaide.



Several attendees stayed on for the weekend after the workshop and took part in a field trip to the Hallett Cove Conservation Park south of Adelaide. Hallett Cove is famous for its excellent exposures of pre-Cambrian sequences folded during the Delamerian Orogeny and glaciated during the Permian.

Update on Geophysical Survey Progress from the Geological Surveys of Queensland, Western Australia and New South Wales (information current at 16 March 2012)

Tables 1 and 2 show the continuing acquisition by the States, the Northern Territory and Geoscience Australia of new gravity, airborne magnetic and radiometric data over the Australian continent. All surveys are being managed by Geoscience Australia.

There is one new airborne magnetic and radiometric survey in this issue. Figure 1

shows the survey boundary for the Thomson North survey in Queensland. This survey adds to the previously reported surveys – Thomson East and Thomson West. Thomson North will cover an area of 21 900 km² with 400 m E–W lines collecting a total of 7543 line km.

Poor weather conditions and standing water on the survey blocks have delayed

both the Thomson and Galilee surveys in central and south-west Queensland. No flying was possible in the Thomson survey area from 21 January to 12 March. Similarly the Galilee survey has been on hold since 25 February. As a consequence of the poor weather the release date for the data has been pushed back and is now expected in July, weather permitting.

Table 1. Airborne magnetic and radiometric surveys

| Survey name | Client | Contractor | Start flying | Line (km) | Spacing AGL Dir | Area (km ²) | End flying | Final data to GA | Locality diagram (Preview) | GADDS release |
|---|--------|------------|--------------|-----------|---|-------------------------|-----------------------------|------------------|----------------------------|---|
| South Officer 1 (Jubilee) | GSWA | Thomson | 1 Jun 10 | 180 000 | 200 m 50 m N–S | 32 380 | 100% complete @ 22 Jun 11 | TBA | 148 – Oct 10 p23 | QA/QC of final data in progress |
| South Officer 2 (Waigen – Mason) | GSWA | Thomson | 28 Jun 10 | 113 000 | 400 m 60 m N–S | 39 890 | 100% complete @ 5 Jan 11 | TBA | 148 – Oct 10 p24 | QA/QC of final data in progress |
| Grafton – Tenterfield | GSNSW | GPX | 16 Jun 11 | 100 000 | 250 m 60 m E–W | 23 000 | 100% complete @ 6 Nov 11 | TBA | 151 – Apr 11 p16 | QA/QC of final data in progress |
| West Kimberley | GSWA | Aeroquest | 29 Jun 11 | 134 000 | 800 m 60 m N–S Charnley: 200 m 50 m N–S | 42 000 | 100.0% complete @ 11 Dec 11 | TBA | 150 – Feb 11 p20 | TBA |
| Perth Basin North (Perth Basin 1) | GSWA | Fugro | 11 Jun 11 | 96 000 | 400 m 60 m E–W | 30 000 | 100% complete @ 18 Dec 11 | TBA | 150 – Feb 11 p20 | QA/QC of raw data in progress |
| Perth Basin South (Perth Basin 2) | GSWA | Fugro | 22 Mar 11 | 88 000 | 400 m 60 m E–W | 27 500 | 99% complete @ 23 Dec 11 | TBA | 150 – Feb 11 p20 | TBA |
| Murgoo (Murchison 1) | GSWA | Thomson | 28 Feb 11 | 128 000 | 200 m 50 m E–W | 21 250 | 100% complete @ 16 Nov 11 | TBA | 150 – Feb 11 p20 | TBA |
| Perenjori (Murchison 2) | GSWA | GPX | 21 Oct 11 | 120 000 | 200 m 50 m E–W | 20 000 | 100% complete @ 12 Jan 12 | TBA | 150 – Feb 11 p21 | TBA |
| South Pilbara | GSWA | GPX | TBA | 136 000 | 400 m 60 m N–S | 42 500 | TBA | TBA | 150 – Feb 11 p21 | Start planned for April 2012 |
| Carnarvon Basin North (Carnarvon Basin 1) | GSWA | GPX | 24 Jul 11 | 104 000 | 400 m 60 m E–W | 32 500 | 100% complete @ 20 Oct 11 | TBA | 150 – Feb 11 p21 | Data released via GADDS on 16 February 2012 |
| Carnarvon Basin South (Carnarvon Basin 2) | GSWA | GPX | TBA | 128 000 | 400 m 60 m E–W | 40 000 | TBA | TBA | 150 – Feb 11 p21 | Commenced 21 March 2012 |
| Moora (South West 1) | GSWA | Aeroquest | 13 Jun 11 | 128 000 | 200 m 50 m E–W | 21 250 | 84.2% complete @ 11 Dec 11 | TBA | 150 – Feb 11 p22 | QA/QC of final data in progress |

Table 1. *Continued*

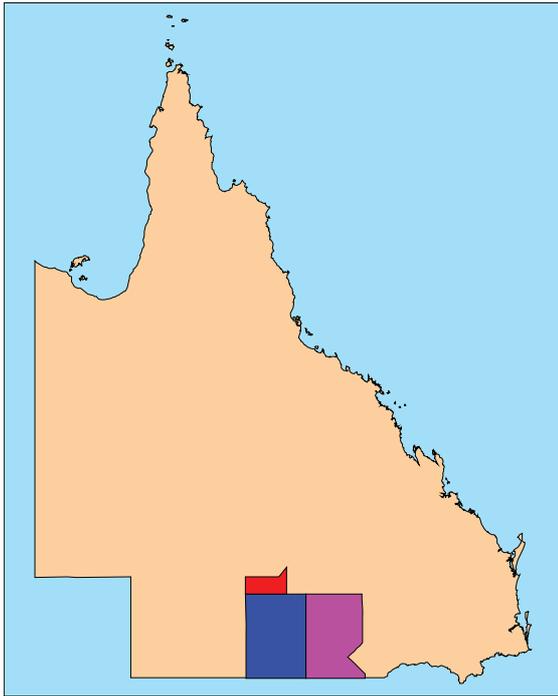
| Survey name | Client | Contractor | Start flying | Line (km) | Spacing AGL Dir | Area (km ²) | End flying | Final data to GA | Locality diagram (Preview) | GADDS release |
|--------------------------------------|--------|------------|--------------|-----------|-----------------------------|-------------------------|----------------------------|------------------|----------------------------|------------------------------------|
| Corrigin (South West 2) | GSWA | GPX | 12 Jan 12 | 120 000 | 200 m 50 m E-W | 20 000 | 90.6% complete @ 11 Mar 12 | TBA | 150 – Feb 11 p22 | TBA |
| Cape Leeuwin – Collie (South West 3) | GSWA | Fugro | 25 Mar 11 | 105 000 | 200/400 m 50/60 m E-W | 25 000 | 100% complete @ 23 Dec 11 | TBA | 150 – Feb 11 p22 | TBA |
| Mt Barker (South West 4) | GSWA | GPX | 24 Apr 11 | 120 000 | 200 m 50 m N-S | 20 000 | 22.2% complete @ 11 Mar 12 | TBA | 150 – Feb 11 p22 | Survey resumed 11 February 2012 |
| Galilee | GSQ | Aeroquest | 11 Aug 11 | 125 959 | 400 m 80 m E-W | 44 530 | 50.7% complete @ 11 Dec 11 | TBA | 151 – Apr 11 p15 | Survey suspended due to rain |
| Thomson West | GSQ | Thomson | 14 May 11 | 146 000 | 400 m 80 m E-W | 52 170 | 75.3% complete @ 1 Dec 11 | TBA | 151 – Apr 11 p15 | Survey suspended due to rain |
| Thomson East | GSQ | Thomson | 14 May 11 | 131 100 | 400 m 80 m E-W | 46 730 | 75.3% complete @ 1 Dec 11 | TBA | 151 – Apr 11 p16 | Survey suspended due to rain |
| Thomson Extension | GSQ | Aeroquest | 22 June 11 | 47 777 | 400 m 80 m E-W | 16 400 | 100% complete @ 10 Aug 11 | TBA | 151 – Apr 11 p16 | QA/QC of final data in progress |
| Thomson North | GSQ | Thomson | 11 Mar 12 | 21 900 | 400 m 80 m E-W | 7 543 | TBA | TBA | This issue | Survey crew mobilised 9 March 2012 |

TBA, to be advised.

Table 2. Gravity surveys

| Survey name | Client | Contractor | Start survey | No. of stations | Station spacing (km) | Area (km ²) | End survey | Final data to GA | Locality diagram (Preview) | GADDS release |
|--------------------------|--------|------------------|--------------|-----------------|---|-------------------------|---------------------------|------------------|----------------------------|--|
| Peak Hill – Collier | GSWA | Daishsat | 29 Jul 11 | 9100 | 2.5 km regular | 56 140 | 100% complete @ 30 Nov 11 | January 2012 | 153 – Aug 11 p18 | Data released via GADDS 22 February 2012 |
| Kimberley Road Traverses | GSWA | Daishsat | 8 Aug 11 | 7560 | 400 m station spacing along 2700 km of gazetted roads | N/A | 100% complete @ 26 Sep 11 | January 2012 | 153 – Aug 11 p20 | Data released via GADDS 22 February 2012 |
| Eucla Basin SW | GSWA | Atlas Geophysics | 19 Jan 12 | 3798 | 2.5 km regular | 23 030 | 100% complete @ 9 Feb 12 | TBA | 154 – Oct 11 p23 | TBA |
| Eucla Central | GSWA | Atlas Geophysics | 28 Nov 11 | 5704 | 2.5 km regular | 36 100 | 100% complete @ 18 Jan 12 | TBA | 154 – Oct 11 p23 | TBA |
| Eucla Basin East | GSWA | Atlas Geophysics | 31 Oct 11 | 5201 | 2.5 km regular | 31 340 | 100% complete @ 27 Nov 11 | TBA | 154 – Oct 11 p23 | TBA |

TBA, to be advised.



Client: Geological Survey of Queensland
Funding: Greenfields 2020 Exploration Initiative
Project Management: Geoscience Australia
Survey Area: Thomson North (Red)

Current Surveys:
Thomson West (Blue); Thomson East (Purple)

Projection: Geodetic
Datum: GDA94

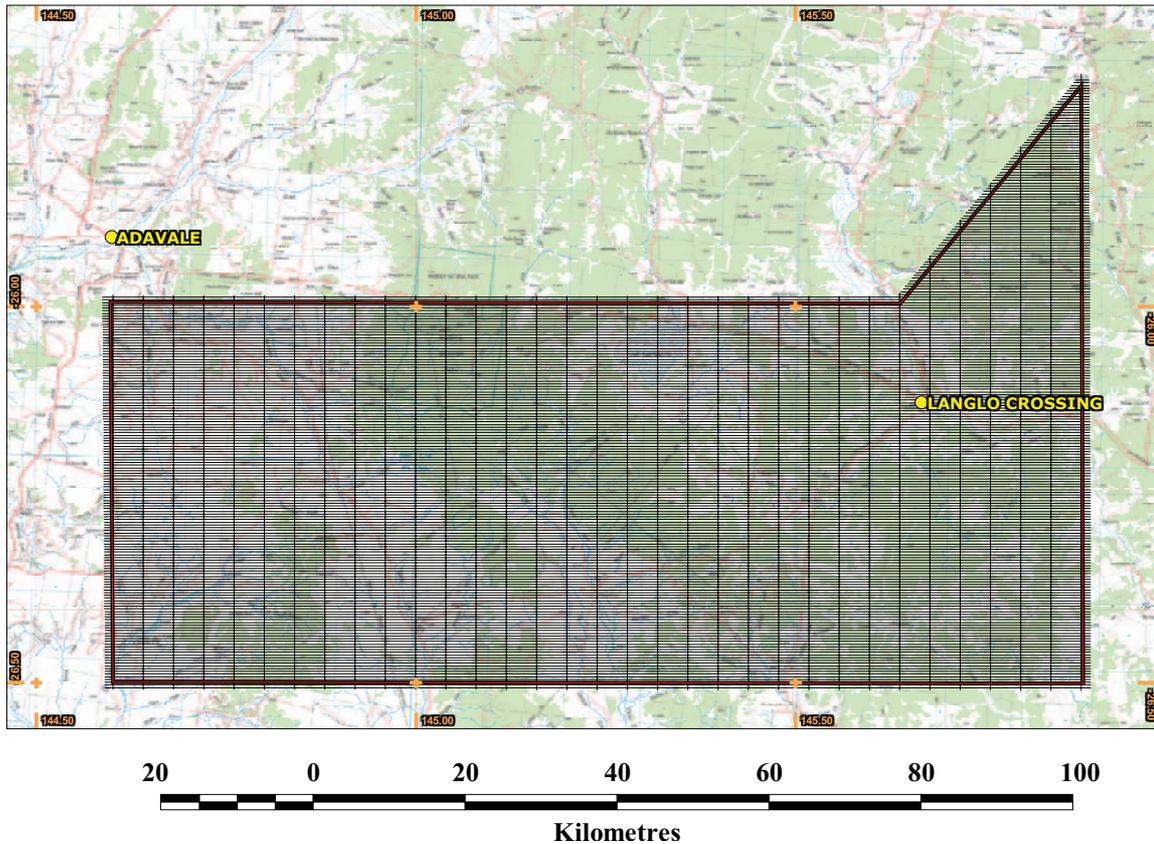
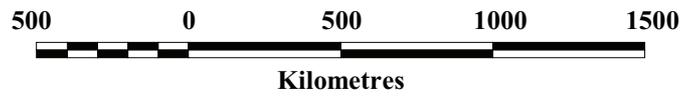


Fig. 1. Locality diagram for the Thomson North airborne magnetic and radiometric survey.

New SARIG layer

Introduction

Department of Manufacturing Innovation Trade Resources and Energy (DMITRE) (formerly PIRSA) has recently developed a new layer in the SARIG 2020 Geoserver to view and download processed SEG-Y open file seismic data. This layer is called '2D lines with SEG-Y data' and is located under 'Seismic Lines' in the main Map Layer list (see Figure 1). This exciting development enables web viewing of processed seismic data not previously possible. Downloading the SEG-Y data will allow users to further manipulate the seismic data to suit individual requirements.

The SARIG Geoserver provides a wealth of geophysical, geological and ancillary information relating to South Australia to facilitate exploration.

Once the bastion of the 'oil patch', processed seismic data is now available for easy use without the need for sophisticated hardware platforms, software requirements or prior extensive

knowledge and experience of the seismic recording technique.

Since 1975, there have been over 350 2D seismic surveys recorded in SA, producing more than 110000 km of line profile data over the main onshore sedimentary basins. While much of this activity has been concentrated on the deeper parts of the basins, a percentage has encroached into areas now deemed to be prospective for other commodities and targets such as uranium, coal seam methane, base metals and geothermal energy.

Most surveys have been recorded under the 'Petroleum Acts' of the day. Under the regulations relating to these Acts, 'basic data' is made open file (public) two years after the recording of the survey. Key data sets that are covered by this requirement include line location, processed data and various operational reports.

DMITRE has collated and databased all available open file SEG-Y data and standardised the format of file

presentation to assist the user. Items such as samples per trace, sample interval, line names, shot-point and CDP numbers, rectangular coordinates and time of first sample have all been entered into standard byte locations to assist with workstation applications. All coordinates are in a GDA94 format.

2D SEG-Y data availability

To date, data sets have been consolidated, edited and uploaded for the following provinces: Officer, Pedirka, Eromanga, Cooper (in part), Arckaringa, Arrowie, Otway and Murray Basin areas. It is anticipated that data for the Stansbury, Gawler Craton and Cooper Basin areas will be finalised by mid-2012.

Using the layer

Using the identify tool from the Search/Identify menu, draw a box area to select the line(s) of interest in the map area. A Results window for the selected lines will appear with three hyperlinked fields

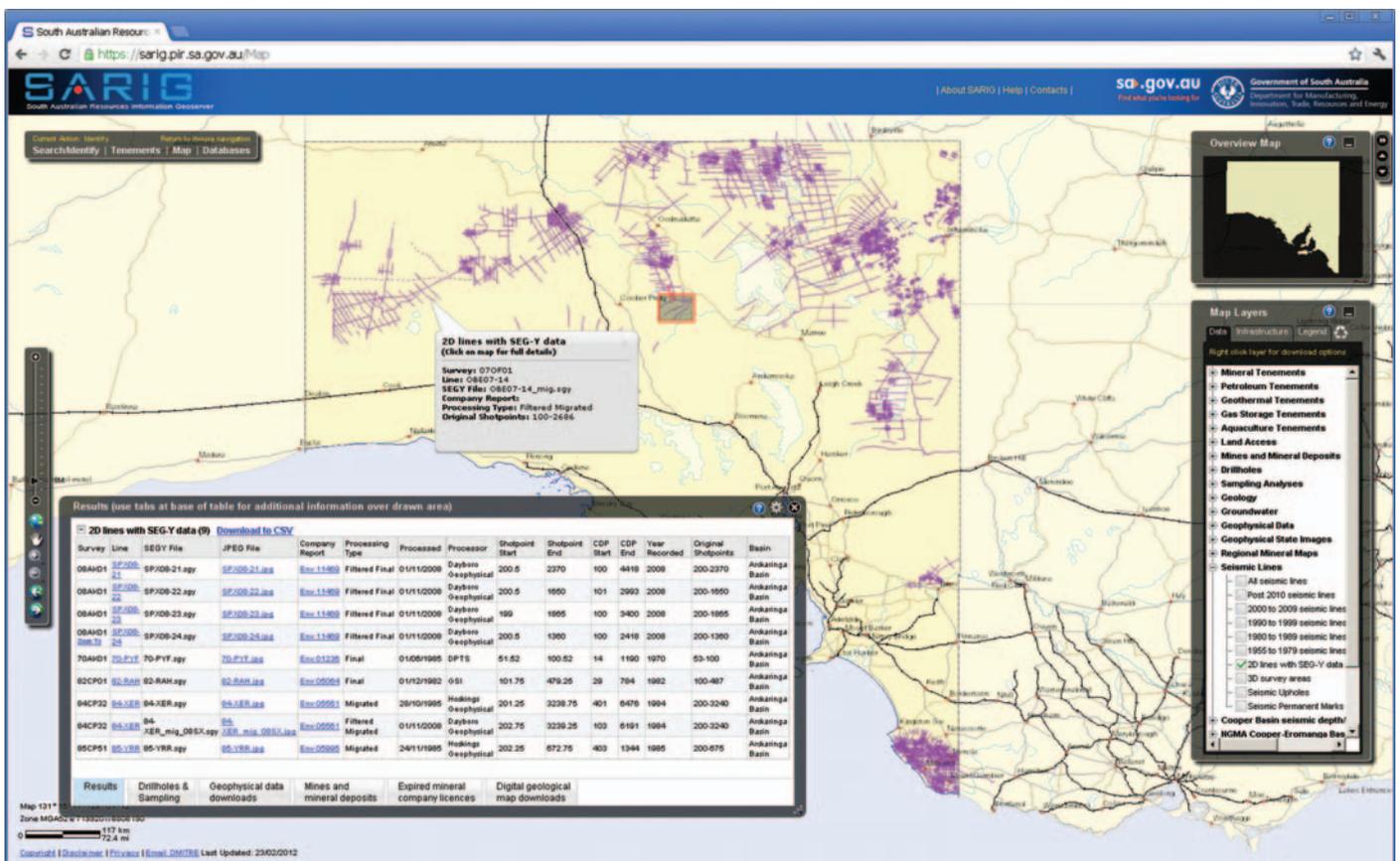


Fig. 1. SARIG screen showing results from a selected subset (red box) of 2D lines with SEG-Y data (shown in purple).

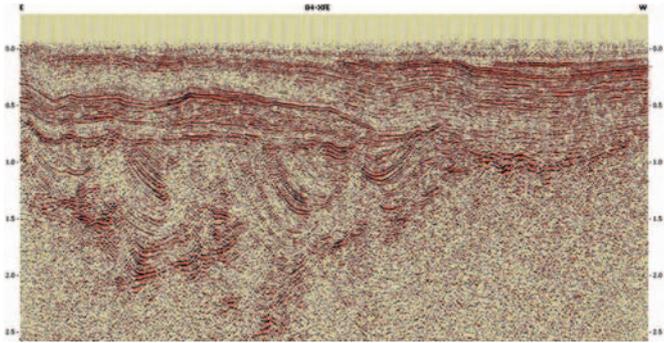


Fig. 2. Example JPEG image of line 84-XFE, Arckaringa Basin.

shown as blue underlined text (see Figure 1). DMITRE suggests using these in the following sequence to view and download the SEG-Y data:

- 1) **JPEG file:** this provides a quick preview option of an A4 JPG image of the seismic data without having to download the larger seismic dataset. Note: the image is representative only as the data has been adjusted to always fit an A4 page (see Figure 2).
- 2) **Line:** this option returns a list and file size of SEG-Y datasets for the selected line plus some other key

- attribute data. Note: there may be more than one version for some lines. A SEG-Y viewer is required to view the downloaded SEG-Y data file and SARIG provides links to two suggested free viewers (see Figure 3).
- 3) **Company report:** returns a list and direct links to all downloadable open file reports for this line and related seismic survey in PDF format.

DMITRE can also provide more comprehensive province-based SEG-Y datasets. For more information on data availability and pricing, visit: http://www.pir.sa.gov.au/petroleum/access_to_data/seismic_data/seismic_workstation_datasets

Peter Hough

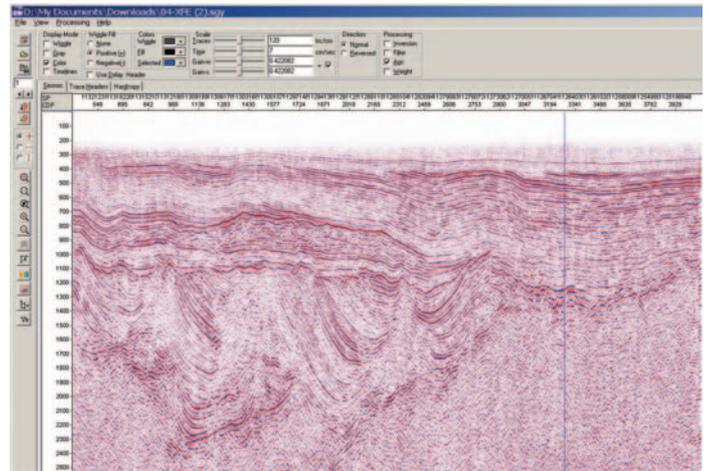


Fig. 3. Example SEG-Y image of line 84-XFE, Arckaringa Basin.

The CarbonNet Project Airborne Gravity survey – Victoria

Sander Geophysics Ltd has completed an airborne gravity survey on behalf of the Victorian Department of Primary Industries (DPI). The survey was completed as part of The CarbonNet Project, which is investigating the potential for carbon capture and storage in the region. The 10523 line km survey was flown in November and December 2011 over the near shore Gippsland Basin between Lakes Entrance and Woodside in Victoria (Figure 1). Acquisition lines approximately 140 km long were flown NE–SW at 1 km spacing with infill at the coastline to 500 m spacing, tie lines were flown NW–SE at 10 km spacing. Survey outcomes will be published on DPI’s website: <http://new.dpi.vic.gov.au/ccs>.

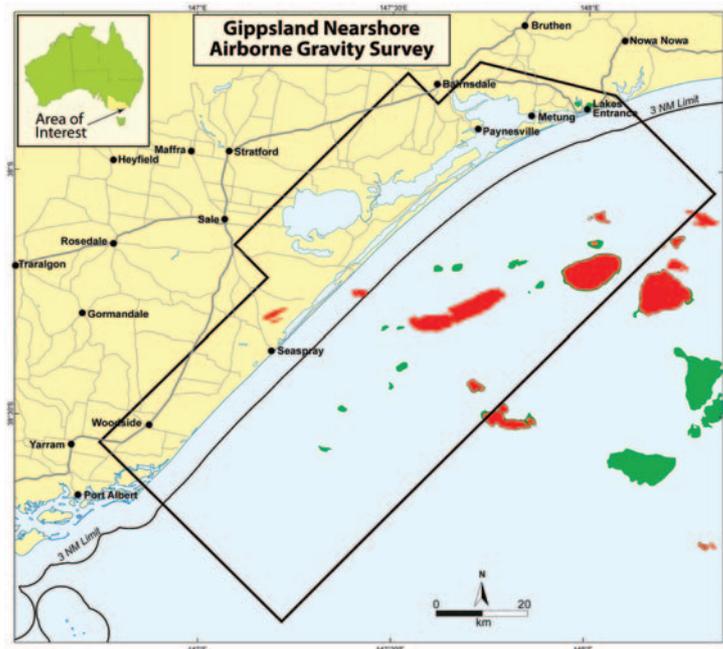


Fig. 1. Location diagram showing survey boundary of the Gippsland Nearshore Airborne Gravity Survey. (NB: The red and green areas are existing oil and gas fields.)