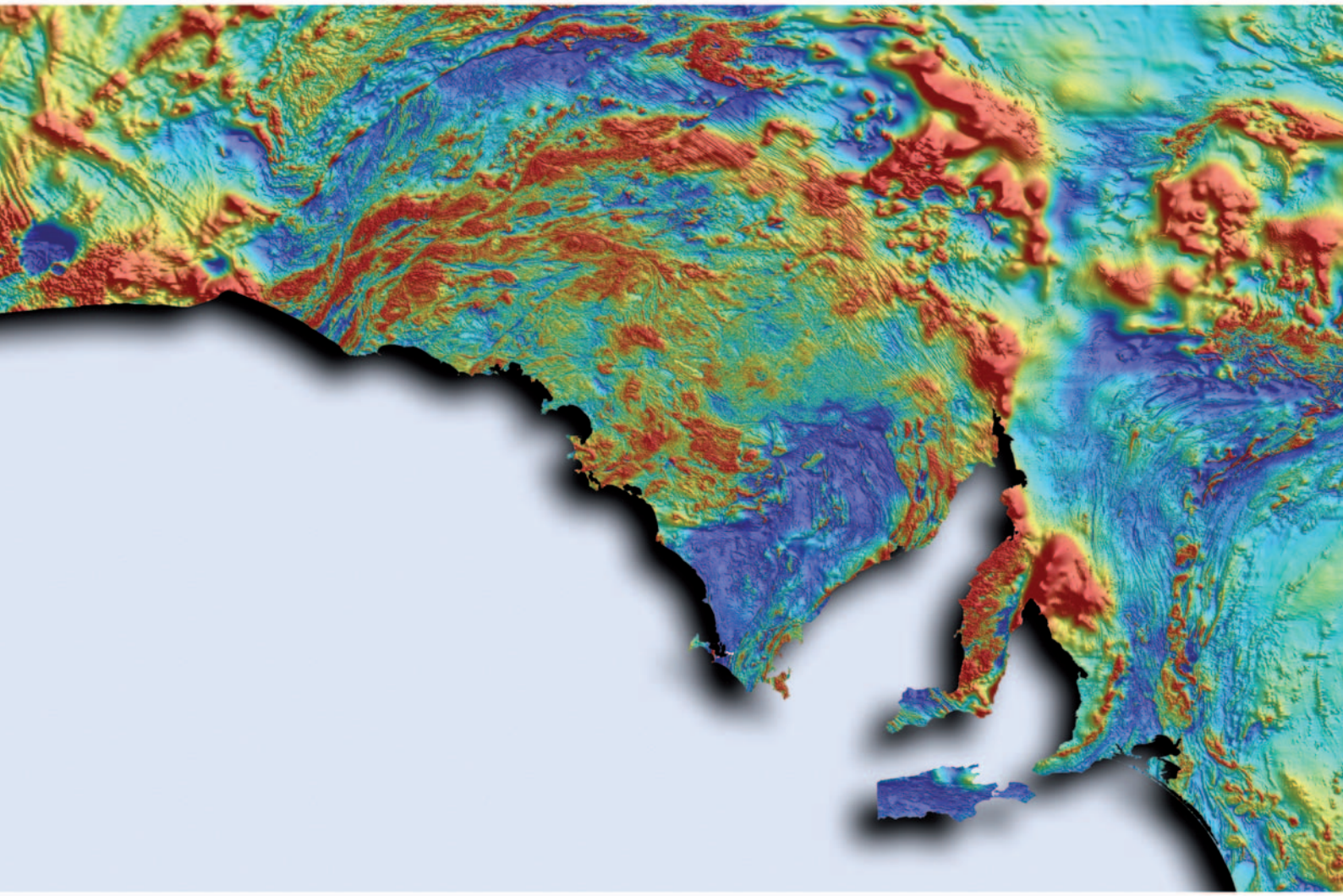
APRIL 2014 • ISSUE 169
ABN 71 000 876 040 ISSN 1443-2471

PREVIEW

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS



NEWS AND COMMENTARY

EARLY CAREER GEOSCIENTISTS

exploration *in the* house 2014

DAY 1: EXPLORATION IN THE HOUSE

TUESDAY 20 MAY 2014
PARLIAMENT HOUSE THEATRETTE
MACQUARIE STREET, SYDNEY

TALKS BY THE GEOLOGICAL SURVEY OF NEW SOUTH WALES, NSW TRADE & INVESTMENT:

1:00 PM Welcome by Brad Mullard, Executive Director, Mineral Resources
Opening by the Hon. Anthony Roberts MP, Minister for Resources and Energy

1:15 PM Overview and strategic directions of the Geological Survey of NSW — *John Greenfield*

1:30 PM Developments in mineral system studies at the Geological Survey of NSW — *Peter Downes*

1:45 PM Layers upon layers of data: towards a seamless database for NSW — *Glen Phillips*

2:00 PM An overview of 3D geological modelling in NSW: progress and objectives of statewide coverage — *Jamie Robinson*

2:15 PM Afternoon tea

3:00 PM Regional mapping overview: completed and new projects — *Phil Gilmore*

3:15 PM Failed granites spread far and wide: implications from high precision dating in the New England Orogen — *Phil Blevin*

3:30 PM Hylogger™ results of the Nymagee Mineral Systems Project — *Meagan Clissold*

3:45 PM Southern Thomson Orogen Project: collaboration along the Qld–NSW border — *Rosemary Hegarty*

4:00 PM Geoscience Information: discovering our data — *Trisha Moriarty*

4:20 PM Poster viewing and light refreshments

6:45 PM Meal at Thai on 1
NSW Leagues Club, 165 Phillip St, Sydney

NSW MINING

NSW MINERALS COUNCIL EXPLORATION FORUM 2014

DAY 2: *BEYOND THE ROCKS* EXPLORATION FORUM – COMPLIANCE, COMMUNITY AND ENVIRONMENT

WEDNESDAY 21 MAY 2014
LEVEL 47, MLC CENTRE, MARTIN PLACE, SYDNEY

9:00 AM Welcome by Lucy McClean, NSW Minerals Council
Opening by Stephen Galilee, CEO

9:20 AM Rebuilding the economy: role of the resources and energy sector — *Kylie Hargreaves, Deputy Director General Resources & Energy, NSW Trade & Investment*

9:50 AM Common Ground: a new approach to providing information services to the community — *Guy Fleming, Geological Survey of NSW*

10:20 AM How Mineral Resources Branch is working for you — *William Hughes, Director Minerals Operations, and Steve Barry, A/Director Environmental Sustainability Unit, NSW Trade & Investment*

11:00 AM Morning tea

11:30 AM Keynote speaker — *Jock Laurie, NSW Land and Water Commissioner, NSW Trade & Investment*

12:15 PM Changing the narrative with stakeholders before things get ugly! — *John Dengate, Director, Twyfords*

1:00 PM Best practice consultation with Aboriginal communities — *Clare McHugh, Director Policy and Research, NSW Aboriginal Land Council*

1:30 PM Lunch

2:30 PM The Hera Project: getting a mine started in NSW and what comes next — *Rimas Kairaitis, Managing Director, YTC Resources*

3:00 PM The Cowal Gold Mine: achieving broad community support in a difficult environment — *Shane Goodwin, Community Relations Manager, Cowal Gold Mine*

3:30 PM Bias: impacts on our decision making — *Simon Corcoran, Partner, A Human Agency*

4:00 PM Afternoon tea

Note: times subject to change.

These events will give an insight into the latest geological information and new and emerging regulatory compliance, environment and community issues in New South Wales.

REGISTER TODAY

SECURE YOUR SPOT BY 12 MAY

Contact us for registration details, or scan here...

Lynn Fletcher:
geosurvey.events@trade.nsw.gov.au | +61 2 4931 6714

NSW GOVERNMENT Trade & Investment Resources & Energy

new frontiers new south wales

Geological Survey of New South Wales

PREVIEW

ADVERTISERS INDEX

2014 ASEG CORPORATE MEMBERS

CORPORATE PLUS MEMBERS

BHP Billiton Limited
Elliott Geophysics International Pty Ltd
Outer-Rim Exploration Services Pty Ltd
Vale Exploration Pty Ltd
Velseis Pty Ltd

CORPORATE MEMBERS

Aeroquest Airborne
Alpha Geoscience Pty Ltd
Archimedes Financial Planning
Beach Energy Limited
CGGVeritas Services (Australia) Pty Ltd
Chevron Australia Pty Ltd
Eni Australia Limited
Fugro Airborne Surveys Pty Ltd
Geokinetics (Australasia) Pty Ltd
Geopublishing Ltd
Geoscience Australia
Geosensor Pty Ltd
Geosoft Australia Pty Ltd
Geotech Ltd
Gold and Copper Resources
Instrumentation GDD Inc.
Newmont Australia Pty Limited
Origin Energy Resources Ltd
Papuan Oil Search Limited
Petrosys Pty Ltd
PGS Australia Pty Ltd
Quantec Geoscience Pty Ltd
Rio Tinto Exploration Pty Ltd
Santos Limited
SGI Search Group Inc.
Seismic Asia Pacific Pty Ltd
Southern Geoscience Consultants Pty Ltd
Terrex Seismic
Thomson Aviation Pty Ltd
WesternGeco
Woodside Energy Ltd
Zonge Engineering

FRONT COVER

A Total Magnetic Intensity (TMI) image of South Australia (see *Web Waves* article, p. 29; images courtesy of South Australian Resources Information Geoserver (SARIG), Resources and Energy Group, DMITRE)

Preview is available online at
www.publish.csiro.au/journals/pv
ISSN: 1443-2471 eISSN: 1836-084X

P

CONTENTS

Editor
John A. Theodoridis
Email: previeweditor@aseg.org.au

Associate Editors
Book Reviews: Ron Hackney
Email: ron.hackney@ga.gov.au

Canberra Observed: David Denham
Email: denham@webone.com.au

Data Trends: Guy Holmes
Email: guy.holmes@spectrumdata.com.au

Minerals and Environment: –
Email: –

Seismic Window: Michael Micenko
Email: micenko@bigpond.com

ASEG Head Office & Secretariat
Ron Adams
Centre for Association Management
Tel: (08) 9427 0838
Email: secretary@aseg.org.au
Website: http://www.aseg.org.au

Publisher
CSIRO PUBLISHING

Production Editor
Helen Pavlatos
Tel: (03) 9662 7613
Email: helen.pavlatos@csiro.au

Advertising
Doug Walters
Tel: (03) 9662 7606
Email: doug.walters@csiro.au

John A. Theodoridis

By the time this issue of *Preview* reaches you, the ASEG Annual General Meeting (AGM), to be held in Canberra on 10 April 2014, shall be recent history. Our Outgoing President, Koya Suto, is set to step down and be replaced by President Elect, Greg Street. On commencing his presidency in April 2013, Koya Suto wasted no time implementing his clear vision for the ASEG. A vision that both acknowledged and employed all available resources. His pragmatic approach ensured an effective application of his passion and ability, whilst showing infinite respect to all. Moreover, he demonstrated a style of leadership that is one of example – not mere spectatorship. The rapid replies to my diurnal and nocturnal e-correspondence, for me, exemplifies Koya's diligence and tireless efforts. Notably, as a good facilitator, he fostered growth and acceptance through encouragement, rather than blatant criticism. In this sense, Koya built and maintained 'internal bridges', treating each of his colleagues as valued members of the 'ASEG Team', true to his mission statement.

An important development within the ASEG is the establishment by the Federal Executive of Specialist Groups (p. 9), the existence of which is permitted by the adoption of a new By Law (p. 10). Crucially, the Federal Secretary, Barry Drummond, reminds us that the '[ASEG] Constitution allows for members to comment on and disallow By Laws', hence its publication. In brief, Specialist Groups are an extension of the Branch model of the ASEG, providing an extra dimension incorporating workshops, conference sessions, newsletters and publications, each with its own executives, budget and programme of activities. It is an exciting initiative, more so because expressions of interest are now open, with additional opportunity to be actively involved in setting up a group.

A special thank-you is extended to Kelly Keates, Managing Director at Zonge Engineering & Research Organisation (Australia) Pty Ltd; Larry Hughes, Senior Geophysicist at EnSafe; and others, for assisting in the procurement of permission to re-republish the Memorial to Kenneth L. Zonge (1936–2013), originally published in the March issue of *The Leading Edge*.

As part of the ASEG Continuing Education programme, members are reminded of the up-coming SEG DISC with Shawn Maxwell: 'Microseismic imaging of hydraulic fracturing: improved engineering of unconventional shale reservoirs', to be held in Perth (28 April), Melbourne (30 April) and Adelaide (5 May). Tour information including, abstract, instructor biography, course objectives and booking information, can be obtained via the SEG directly (www.seg.org/disc), or by contacting your local ASEG State Branch.

In closing, I give recognition to Ristch Camille's article entitled 'Constrained magnetic modelling of the Hawsons Iron Deposit, western New South Wales', for being the inaugural piece of *Preview's* new section, 'Early Career Geoscientists'.

Student membership now free

On 27 March 2014, a motion passed in the Federal Executive Committee meeting to waive the student membership fee. Effective immediately, all student members are no longer required to pay an annual subscription, currently $44 including GST. Those student members who already paid the 2014 subscription will receive a refund in the near future.

Accordingly, the Student Sponsor Programme, in which corporate sponsors subsidise the student membership fee, shall now cease. The ASEG thanks the sponsors, Origin Energy, Rio Tinto and Coffey Geoscience, for their past sponsorship.

Call for Associate Editors: *Preview* magazine

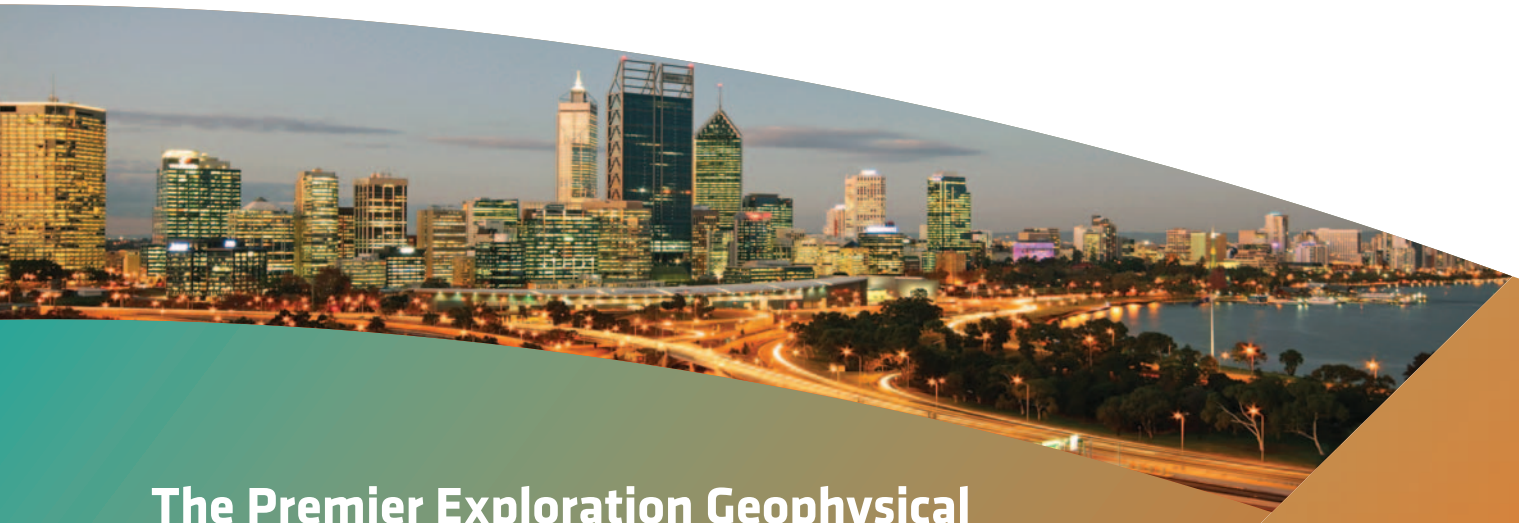
Expressions of interest are sought from ASEG members to fill multiple positions as Associate Editor for the following columns: Industry News; Canberra Observed and Minerals and Environment. Successful applicants shall be required to independently source material and submit quality articles to be overseen by the Editor, whilst adhering to stringent publication schedules for the bi-monthly publication.

Interested persons are encouraged to contact the Editor of *Preview,* Dr John Theodoridis, by email: previeweditor@aseg.org.au.

ASEG-PESA 2015

Geophysics and **Geology** together for **Discovery**

24th International Geophysical Conference and Exhibition
15 – 18 February 2015 Perth, Western Australia



The Premier Exploration Geophysical Conference in the Southern Hemisphere

You are invited to attend the 24th International Geophysical Conference and Exhibition in Perth, Western Australia, to be held from 15 to 18 February 2015. The event will be jointly hosted by the Australian Society of Exploration Geophysicists and the Petroleum Exploration Society of Australia.

The theme for the conference is "Geophysics and Geology together for Discovery", invoking the fundamental tenets behind our shared efforts to discover and develop the natural resources needed for future generations. We are promoting a programme with a strong focus on case histories, best practice, and the new methods and technologies that underpin the exploration effort. We will celebrate the diversity and commonalities between minerals, petroleum, geothermal, geotechnical, and environmental geophysics.

Call for Abstract Titles opens March 1

From 1 March 2014 authors will be able to express interest in submitting an abstract and also submit their proposed abstract title/s via the conference website. This initial interest secures a non-binding position for an extended abstract and allows the committee to begin planning the technical programme.

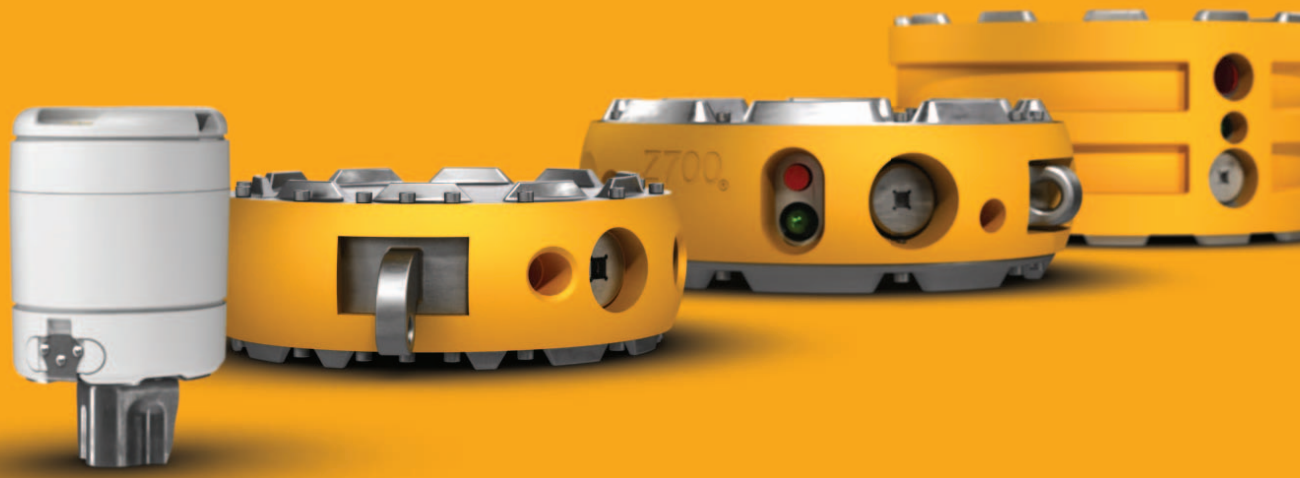
The call for extended abstracts will open on 1 June 2014 and close on 31 August 2014. The conference programme committee encourages you to plan your submission now.

www.conference.aseg.org.au

Sponsorship and Exhibition details from the Conference Secretariat, ASEG-PESA2015@eecw.com.au

**ON ANY STRETCH OF LAND,
IN SHALLOW WATER OR DEEP,
CAPTURE THE SEISMIC YOU NEED
WITH LESS TROUBLE.**

A LOT LESS TROUBLE.



Dealing with piles of cable hinders any seismic acquisition, land or marine. That's why our true cable-free ZNodal® systems pay huge dividends in any environment.

Our lightweight, compact ZLand® system, now with the ability to add external sensors or available in a cable-free 3C version, lets crews work faster and much more safely, anywhere on earth.

Our ZMarine system, also completely self-contained, deploys easily and safely, even in congested areas, to water depths of 3000m, which makes it ideal for 4D reservoir monitoring.

fairfieldnodal

SYSTEMS ACQUISITION LICENSING PROCESSING IMAGING

Bridge over troubled water

This is my last President's piece.

When I started my presidency in April last year, I thought the year 2013–14 will be an easy year for an ASEG president. My predecessors worked hard and many projects were started with most of them well in order. Our journal *Exploration Geophysics* had passed the first year as a joint publication with SEGJ and KSEG, and with an improving impact factor rating. The publication of *Geological Interpretation of Aeromagnetic Data* (Isles and Rankin, 2013) was almost ready to hit the market. The new website had been launched in August 2012 and its development was in its final stage. Preparation for the 23rd Conference in Melbourne was well advanced. The first OzSTEP courses were ready to go ahead. All of these had gone through several years of preparation, negotiation and planning. They were all going well.

In the middle of the year, we noticed a link between the website and the membership database failed to function properly. Then it became apparent the mailing of our publications did not proceed as each member requested. These needed to be fixed between the secretariat, the web service provider and the publisher, with a superhuman effort of committee chairs coordinating it all, finding and implementing a stable solution. This caused the delay in the membership renewal this year. By the time this issue of *Preview* reaches your desk, the problems will have been solved, restoring online access to profiles and publications for our members. The meeting notices will be posted on the web page as well as sent as e-mail alert by each branch.

These troubles led to a change of secretariat. We terminated the secretariat contract with Centre of Association Management (CASM) in Perth at the end of February after 11 years of service. I hope this ensures an improvement of membership service, particularly related to application of computers. The new secretariat has been selected through a tendering process, which took over 10 weeks. The selection subcommittee members worked during the summer holiday period. The new secretariat is The Association Specialists (TAS; see this issue for introductory article).

Computer technology should make our life easy. This statement, however, needs a qualifier: 'when it is used sensibly'.

How often do you spend time at the checkout of a supermarket because the scanner does not find the barcode; the price does not come up for the barcode; the operator cannot reverse a wrong entry; or, to wait for the supervisor? Geophysical data processing, analysis, interpretation and presentation benefit from this enormously. How often do we see a map by computer gridding that does not make plausible geological sense? We do need some sense to interpret and 'read' the data.

During my studentship in Japan, my professor told us a story of his time: when returning from a field trip to transcribe data from the field notes to data sheets, the first thing to do is to select good data records to analyse first. The subsequent calculations being the hard work: mostly with pen and paper; slide rule and sometimes an abacus. A noisy mechanical calculator with a handle, called an adding machine, proved the best tool available. We found an electronic calculator in the common room for researchers and postgraduate students to share. The size of that machine had been comparable to a small microwave oven and awfully heavy. In fact it sat on a custom-made trolley.

As data processing is such an onerous task, and time is limited, they could only process some of the data acquired. The data they decided to analyse, of course, should be meaningful. They, therefore, needed good insight into the data even before starting processing.

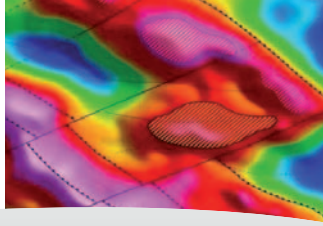
We live in a different world. Data flow and work flow are streamlined. An enormous amount of data is fed to computers for number crunching every day using latest software through the advanced data transmission technology. A new idea can be tested on a desktop PC, and is implemented into production mode quickly. Yet, geophysical interpreters are needed to monitor what the computer throws at them in terms of geological reality. Perhaps, geological reality is sometimes vague and accidental to be logically modelled. Even with the techniques to allow uncertainty and ambiguity such as fuzzy logic and stochastic modelling, a program to model the entire geological history of even one oil field or mineral region is still a dream. This is still a domain of the human brain: combination of learning, training and imagination. The computer technology made the manual and routine work a lot easier. But learned geophysicists are still needed to bridge the data and reality.

In the first *President's Piece*, I introduced myself as a 'bridge' between disciplines in geophysics, between ASEG and associated societies in other countries, and between industry and academia. Now I look back to my predecessors from 1970 to 2012 and look forward to my successor in 2014, and I recognise I am a bridge to connect the past and future of the ASEG. Crossing a bridge, the scenery may change, but we are still on the same earth where geophysicists stand upon. I wish all the best to my successors.

Koya Suto
Outgoing ASEG President

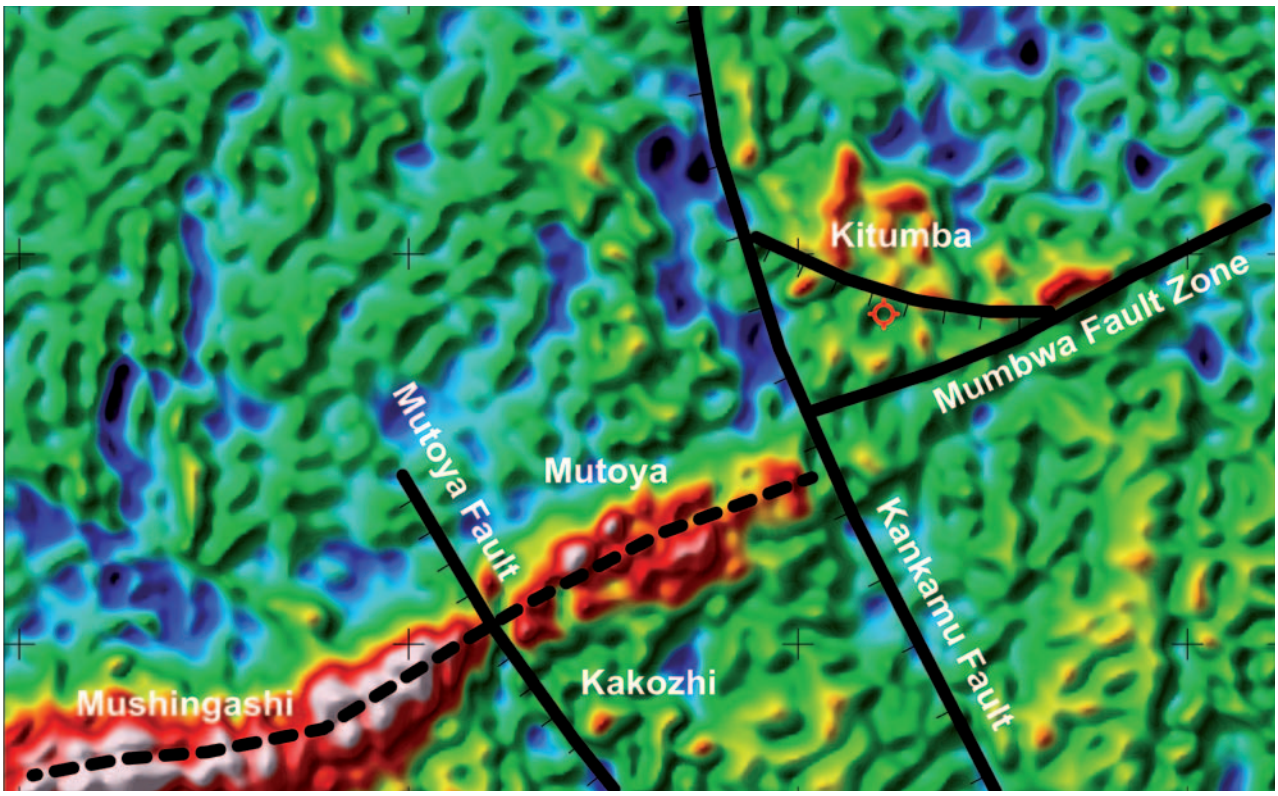
Koya charting across a bridge: Bath, England.



FALCON

World-beating Airborne Gravity Gradiometry closes in on 1 eötvös



Gdd FALCON image showing structures controlling IOCG mineralisation. Image courtesy of Blackthorn Resources.

FALCON® is the only purpose-built Airborne Gravity Gradiometer (AGG) and thus has the lowest noise, highest sensitivity and best spacial resolution available. This combined with complimentary geophysical data, renowned project management, safety & quality practices and sector-leading interpretation ensures fast, effective and non-invasive solutions founded on CGG's experience gained in providing in excess of 2 million AGG survey kilometres.

cgg.com/airborne

CGG
Passion for Geoscience

ASEG Federal Executive 2013–14

President, International Affairs Committee – Chair: Koya Suto
Tel: (07) 3876 3848
Email: president@aseg.org.au

President Elect: Greg Street
Tel: (08) 9388 2839
Email: presidentelect@aseg.org.au

Vice President, Publications Committee – Chair: Phil Schmidt
Tel: 0410 456 495
Email: publications@aseg.org.au

Vice President, Education Committee – Chair: Mark Tingay
Tel: (08) 8303 3080
Email: education@aseg.org.au

Past President: Kim Frankcombe
Tel: (08) 6201 7719
Email: pastpresident@aseg.org.au

Secretary: Barry Drummond
Tel: (02) 6254 7680
Email: fedsec@aseg.org.au

Treasurer: Reece Foster
(Finance Committee – Chair)
Tel: (08) 9378 8000
Email: treasurer@aseg.org.au

Committee Members

State Branch Representative: Philip Heath
Tel: (08) 8463 3087
Email: Branchrep@aseg.org.au

Web Committee – Webmaster: Carina Kemp
Tel: 0412 514 075
Email: webmaster@aseg.org.au

Membership Committee – Chair: Katherine McKenna
Tel: (08) 9477 5111
Email: membership@aseg.org.au

Continuing Education: Wendy Watkins
Tel: (02) 9921 2010
Email: continuingeducation@aseg.org.au

Specialist and Working Groups: Tania Dhu
Tel: 0422 091 025
Email: Tania.Dhu@nt.gov.au

Chair people for Standing Committees (not on FedEx)

Research Foundation – Chair: Philip Harman
Tel: (03) 9909 7655
Email: research-foundation@aseg.org.au

Research Foundation – Donations: Peter Priest
Email: priest@senet.com.au

ASEG History Committee – Chair: Roger Henderson
Tel: 0408 284 580
Email: History@aseg.org.au

Conference Advisory Committee – Chair: Michael Hatch
Tel: 0417 306 382
Email: CAC@aseg.org.au

Honours and Awards Committee – Chair: Andrew Mutton
Tel: (07) 3278 5733
Email: Awards@aseg.org.au

Technical Standards Committee – Chair: David Robson
Tel: (02) 4931 6717
Email: technical-standards@aseg.org.au

ASEG BRANCHES

Australian Capital Territory

President: Marina Costelloe
Tel: (02) 6249 9347
Email: actpresident@aseg.org.au

Secretary: Millie Crowe
Tel: (02) 6249 9846
Email: actsecretary@aseg.org.au

New South Wales

President: Mark Lackie
Tel: (02) 9850 8377
Email: nswpresident@aseg.org.au

Secretary: Sherwyn Lye
Tel: (02) 8907 7900
Email: nswsecretary@aseg.org.au

Queensland

President: Fiona Duncan
Tel: (07) 3024 7502
Email: qldpresident@aseg.org.au

Secretary: Megan Nightingale
Tel: (07) 3839 3490
Email: qldsecretary@aseg.org.au

South Australia & Northern Territory

President: Erin Shirley
Tel: (08) 8338 2833
Email: Sa-ntpresident@aseg.org.au

Secretary: Joshua Sage
Tel: 0438 705 941
Email: Sa-ntsecretary@aseg.org.au

NT Representative: Tania Dhu
Tel: (08) 8999 5214
Email: Nt-rep@aseg.org.au

Tasmania

President: Mark Duffett
Tel: (03) 6165 4720
Email: taspresident@aseg.org.au

Victoria

President: Asbjorn Norlund Christensen
Tel: (03) 9885 1378
Email: vicpresident@aseg.org.au

Secretary: –
Tel: –
Email: vicsecretary@aseg.org.au

Western Australia

President: Anne Tomlinson
Tel: 0400 183 679
Email: wapresident@aseg.org.au

Secretary: –
Tel: –
Email: wasecretary@aseg.org.au

The ASEG Secretariat

Centre for Association Management (CASM)
36 Brisbane Street, Perth, WA 6000
Tel: Ron Adams (08) 9427 0800
Fax: (08) 9427 0801
Email: aseg@casm.com.au

New members

The ASEG extends a warm welcome to the nine new individual members approved by the Federal Executive on 27 February 2014 (see table).

Name	Organisation	Country	Membership grade
James Ross Austin	CSIRO	Australia	Active
Nicholas Badillovich	–	Australia	Student
Mitchell John Clement	–	Australia	Student
Marcel Bernard Croon	–	Australia	Active
Madeleine Louise Hearnden	–	Australia	Student
Martinez Monoz	–	Australia	Associate
Ken Tokeshi	UWS	Australia	Active
Benjamin Ross Witten	–	Australia	Student
Benjamin John Wruck	Santos	Australia	Associate

ASEG's new secretariat: The Association Specialists

The Federal Executive of the Australian Society of Exploration Geophysicists (ASEG) is pleased to announce that The Association Specialists (TAS) has been appointed as the new secretariat contractor for the ASEG as of Thursday 20 February 2014.

The Association Specialists is one of the most experienced and technologically advanced Association Management Companies (AMC) and Professional Conference Organisers (PCO) in Australia. TAS has existing relationships with over 30 Australian and New Zealand based professional bodies, trade associations, government departments, societies and not-for-profit agencies providing solutions for secretariat, event management and financial services.

The Association Specialists has collaborated with ASEG on a number of prior occasions under its previous brand, Conference Action. TAS was responsible for the successful delivery of at least three ASEG-PESA Conferences and Exhibitions, most recently in Sydney in 2004 and 2010.

The Association Specialists brings to the Society a number of benefits:

- Access to specialised skills: financial, managerial, marketing and sales, customer service, secretarial, IT support and meetings management.
- Improved efficiencies through economies of scale and extensive investments in technology, communication systems, methodologies, people and security.
- Knowledgeable, tertiary trained, full-time staff providing a complete set of secretariat and management skills.
- Access to a network of proven and trusted specialist suppliers.
- Shared knowledge and trends developed across similar organisations under TAS's care.

TAS is confident in its ability to bring to ASEG the highest level of skill and experience available, to carry out the day to day functions of the Society allowing the Federal Executive to focus on strategy and delivery of value to the membership base. Below are the TAS team members who will be working closely with the ASEG Federal Council and performing the day-to-day administration of the Society:

TAS team members

Francis Child
Managing Director

Francis Child was born and educated in the United Kingdom where he obtained a BSc in Economics with Statistics at the University of Bristol. He qualified as a member of The Institute of Chartered Accountants in England and Wales in 1981. Since leaving the accounting profession Francis gained extensive experience in both the entertainment and events based industry sectors. After working with Chrysalis Records and EMI Records in the UK for 8 years, Francis moved to Australia in 1992, where for 8 years he worked for AIC Worldwide, one of the leading global conference and exhibition organisers. Francis acquired The Association Specialists (then known as Conference Action) in July 2000 introducing a strong culture of integrity and transparency to the business.

Doug Wiles
Team Manager – Association Management

Doug graduated from Macquarie University with a Bachelor of Social Science majoring in Social Policy and Politics. Through his experience volunteering overseas and experience with TAS over the past 4 years, Doug has gained a working knowledge of associations and not-for-profit organisations. He is passionate about aiding his clients in the pursuit of their strategic goals and as a team manager drives the same level of excellence, enthusiasm and commitment from his staff.

Ben Williams
Client Services Manager

Ben has always been interested in hospitality and tourism because of the variety of work environments. This interest took him to Southern Cross University where he obtained a Bachelor of Business majoring in hotel management. Ben started his career with Business Events Sydney (BESydney) as a work experience student in 2005. Over the course of his career with BESydney he was promoted three times, holding the position of National Business Development Manager before joining The Association Specialists team in 2013. Ben brings a wealth of knowledge from his experience in the NFP and business event sectors assisting a highly varied portfolio of clients in his Client Services Manager role.

Ben Williams, as ASEG's Client Services Manager will be the first point of call for all enquiries. He can be reached on the contact details below.

Mail:
Australian Society of Exploration Geophysicists
c/- The Association Specialists
PO Box 576
Crows Nest, NSW 1585, Australia
Tel: +61 2 9431 8622
Fax: +61 2 9431 8677
Email: secretary@aseg.org.au

ASEG to establish Specialist Groups

The Federal Executive of the ASEG has cleared the way for the society to establish Specialist Groups through the adoption of a By Law that sets out how Specialist groups can be established and operated.

Specialist Groups provide a way for members who have a particular geophysical interest to network with other members with the same interest. But they are more than a networking opportunity. They will conduct regular scientific workshops, plan and hold sessions at future conferences, produce newsletters, report regularly to the society membership at large through articles in *Preview*, and encourage the publication of papers from their workshops in *Exploration Geophysics*. They will be a catalyst for advancing the breadth and depth of the science researched and applied by their members.

Specialist groups will therefore provide another dimension to how the society is organised. To date, the society's structure has been built around Branches – that is, the structure is very much geographically based. Specialist Groups are based around the work that members do. The society's members can therefore now be associated with a branch and also join one or more Specialist Groups.

However, whereas members (in Australia) automatically become associated with a Branch when they join the society, and move Branches when they move to another state or territory, membership of a Specialist Group is voluntary, and would have to be applied for to the relevant Specialist Group.

Specialist Groups will be part of the formal structure of the society. Each Specialist Group would have an Executive (at least a Chair, Secretary and Treasurer) and its own budget and programme of activities. Each is expected through time to become self-funding, either through sponsorship or through a nominal annual fee for its members. The Chairs of Specialist Groups will automatically become members of the ASEG Council, which is the peak advisory body to the Federal Executive.

The By Law that establishes Specialist Groups requires that Specialist Groups have at least 10 founding members – this is a nominal number chosen to ensure at least a small critical mass of members to get the Specialist Groups off to a start.

Anyone interested in setting up a Specialist group in any aspect of geophysics should contact Tania Dhu (Tania.Dhu@nt.gov.au) who is the Federal Executive member who will provide coordination between Specialist Groups and the Federal Executive.

Specialist Groups have been foreshadowed in the society's Constitution for some time but to date none have been set up. The society's Constitution does not provide details of how they should be managed, or any expectations of what they would or should do for their members. The new By Law does so. Because the Constitution allows for Members to comment on and change or disallow By Laws, the By Law that establishes Specialist Groups is published in this edition of Preview. Anyone wishing to comment on the By Law should contact the Society's Secretary, Barry Drummond (Fedsec@aseg.org.au).

By Laws
Australian Society of Exploration Geophysicists

ABN 71 000 876 040

Contents

Definitions

ASEG: The Australian Society of Exploration Geophysics, "the Society".

Council: A meeting of the Federal and State Executives of the ASEG, usually held every 18 months at ASEG conferences.

Federal Executive: The paramount management body of the Society comprised of 12 ASEG members, four of whom are elected into the positions President, President Elect, Secretary and Treasurer and are Directors of the Society.

Financial member: Any ASEG Active, Associate, Corporate, Corporate Plus, Retired, Honorary, or Student member whose names are from time to time contained within the official list of members and who have paid their membership fees for the current year.

State Executive: The President, Treasurer and Secretary of each state or territory branch of the Society.

By Laws

A By Law to establish, manage, and terminate Specialist Groups

This By Law is established under the terms and conditions of Clause 12 [Specialist Groups] and Clause 15 [By Laws] of the Constitution of the Australian Society of Exploration Geophysicists.

1. FORMING SPECIALIST GROUPS:

i. Specialist Groups may be formed following a request to the Federal Executive by at least ten (10) financial members of the society.

ii. The Federal Executive may also choose to establish a Specialist Group and will approach suitable members of the Society and ask them to form the Specialist Group.

iii. Each Specialist group must develop and keep current a charter stating its purpose and use the charter when promoting its activities to members of the Society.

2. EXECUTIVES OF SPECIALIST GROUPS:

i. Each Specialist Group will have a Chairperson appointed under the terms of Clause 12 of the Constitution.

ii. Each Specialist Group will appoint a Secretary and Treasurer who together with the Chairperson will constitute the Executive of the Specialist Group.

iii. The Executive of each Specialist Group will be responsible for the operation of the Specialist Group subject to the terms of this By Law and the Constitution of the ASEG.

iv. The Executive of a Specialist Group may co-opt as many additional members to the Executive as it deems necessary for the successful operation of the Specialist Group.

v. The Chairperson of a Specialist Group or his or her nominee may attend meetings of the Council of the Society.

3. JOINING A SPECIALIST GROUP:

i. Financial members of the Society may apply to the Executives of the Specialist Groups to join the Specialist Groups.

4. FINANCIAL MANAGEMENT:

i. Treasurers of Specialist Groups will develop and maintain budgets for the Specialist Groups that are operated through the central virtual account system of the Society.

ii. The general principle will be that Specialist Groups will become financially self sustaining.

iii. However, if the Federal Executive observes that a Specialist Group is accumulating funds to a level beyond its immediate or longer term needs and cannot demonstrate to the satisfaction of the Federal Executive that it has plans to spend the money for the benefit if its members, the Federal Executive may at its discretion redistribute any excess funds for the benefit of all members of the Society.

iv. The Executives of a Specialist Group may at their discretion impose an annual fee for membership of the Specialist Group to support the day to day operation of the Specialist Group but
   a) the general principle should be that this fee be kept sufficiently low that it is not a barrier to membership of the Specialist Group, and
   b) the annual fee should not be used to cross subsidise activities such as workshops and conference sessions which cannot be attended by all members of the Specialist Group.

v. Notwithstanding the principles outlined in the paragraph (ii) of this Clause 4, the Federal Executive may at its discretion provide seed funding for the establishment of a Specialist Group.

5. ACTIVITIES OF SPECIALIST GROUPS:

i. Specialist Groups may conduct any activities that benefit their members that are consistent with the Objects of the Society.

ii. They might include but not be limited to:
   a) Holding regular meetings and workshops
      • These meetings and workshops should be open to other members of the Society.
      • They should also be open to geophysicists who are not members of the Society.
      • The principles for charging fees for meetings and conferences and for acknowledging the Society that have been established by the Federal Executive will apply.
   b) Issuing newsletters to inform members of the Specialist Groups of their activities.
   c) Organising sessions at ASEG Conferences and Exhibitions.

d) Cooperating with the Society's Sister Societies where relevant.
e) As a general principle arranging at least one article for Preview each year; Specialist Groups which hold workshops and conferences should offer their papers for publication in Exploration Geophysics.

6. REPORTING:

i. Specialist Groups will report annually to the Society and at other times as requested by the Federal Executive [Clause 12.2 of the Constitution].
ii. Federal Executive will nominate one of its members to act as a point of contact between Specialist Groups and Federal Executive.
iii. Specialist Groups will report to ASEG Council when it meets.

7. TERMINATION:

i. Federal Executive may terminate a Specialist Group if in the opinion of a majority of the Federal Executive the Specialist Group has become inactive or ineffectual.
ii. In making a decision whether a Specialist Group has become inactive or ineffectual, Federal Executive will take account of:
a) Whether the Specialist Group is conducting business consistent with its charter;
b) Whether the Specialist Group is conducting the kinds of activities set out in Clause 5, or other relevant activities, that in the opinion of the Federal Executive would be of benefit to the members of the Specialist Group;
c) Whether the Specialist Group remains financially viable; and
d) Whether the Specialist Group is communicating its activities effectively with the members of the Specialist Group, the Federal Executive and other members of the Society;
iii. If a Specialist Group is terminated its financial assets will revert to the central accounts of the Society, and any material assets will be distributed to ASEG members, branches, other Specialist Groups or otherwise disposed of by the Federal Executive as it deems appropriate.

8. HISTORY:

i. This By Law was adopted by the Federal Executive of the Society on 30 January 2014.
ii. Subsequent revisions of this By Law will be noted here.

Disclaimer

By Laws are established under the terms and conditions of Clause 15 [By Laws] of the Constitution of the Australian Society of Exploration Geophysicists.

An appreciation of Kenneth L. Zonge (1936–2013)

Kenneth Zonge.

Several decades ago, if you arrived early enough at Zonge Engineering's Tucson office, you might have noticed an unassuming man with a well-worn broom, diligently sweeping the porch of whatever debris the warm desert winds had deposited the previous evening. You would have received a smile and a chipper welcome, and if this was your first visit, an enthusiastic escort into the building. Passing a poster of misspelled delivery labels (Zeonge, Zonke, Ponge, Donge, etc.), he would usher you into an open-architecture expanse, its soaring truss ceiling anchored by a maze of cluttered cubicles. Emanating from these, you could hear a muffled cacophony of keyboards rattling out reports, the shuffling of geophysical sections, the slurping of fatally strong coffee, a field crew chief fuming about someone taking his truck keys, a woman excitedly shouting in Mandarin into a phone, a man with a Santa beard wielding a soldering iron, and a cluster of geo nerds locked in a fierce debate about the terminal velocity of a grape thrown from the Empire State Building. Who could possibly preside over such an eclectic mélange of "Zongies"? Looking into the eyes of your tour guide and groundskeeper, you had your answer. He was, in fact, Dr. Kenneth L. Zonge, an industry icon in leading-edge electrical geophysics and president of the company.

Ken Zonge grew up in Pennsylvania and Ohio. Joining the Army at 18, he was stationed as an electronics technician in Alaska, a wondrous place that drew him back after his military service to employment in fishing and trapping. It was on the banks of the Kenai River that he met Kim, soon to be his bride. Three children followed — Gene, Tammy, and Lynn. Ken obtained a B.S. from the University of Alaska (1962), followed by an M.S. from the University of Arizona (1965), both in electrical engineering. The family then returned to Alaska, where Ken took up residence as associate professor at the University of Alaska in Fairbanks, focusing on lightning research and developing portable self-potential instrumentation.

The next move was back to the University of Arizona, where Ken began a Ph.D. program in geophysics under John Sumner, one of the pioneers of the induced polarization (IP) method developed in the 1950s by Newmont Mining and MIT. Unlike DC resistivity, which generally is not diagnostic in distinguishing mineralization from lithology, IP exploits ion-mobility effects arising from mineralization and alteration. Because IP effects were known to vary spectrally and thus depend on the timing of the measurement, Ken became interested in developing a broadband IP method that would more fully characterize mineral responses and perhaps distinguish them from noneconomic sources of polarization (e.g., clays or barren pyrite). Drawing on his electrical engineering background, he dubbed it complex resistivity (CR).

Although time-domain IP methodology was widely utilized in that period, Ken embraced the promise of frequency domain for broadband IP in what he correctly envisioned as an emerging new generation of digital instrumentation, soon to revolutionize data acquisition through bandpass filtering, in situ FFT analysis, stacking, etc. His early tests utilized off-the-shelf minicomputers and auxiliary gear piled on the tailgate of his iconic Chevrolet Suburban, affectionately known as the Red Baron. One early indication of the digital age of electrical geophysics came in his whimsically entitled seminar, "Backpacking a Box Full of Bits into the Bush."

Box of bits in hand, Ken attracted a crew of bright field assistants, including Claude Wiatrowski, Jeff Wynn, Bob Staley, Gary Young, Emmett Van Reed, Carlos Aiken, Dave Rabb, and Bobby Jack, as well as several strategic supporters in industry, particularly Frank Fritz. Their initial field tests for several mining companies (notably AMAX Inc.) showed indications that CR was indeed capable of mineral discrimination. In 1972, Ken loaded several eager assistants into the Red Baron and drove to Anaheim to present their results at the SEG conference. Packed four to a room and subsisting on cheap hamburgers, they did not seem ready for prime time, but Ken's SEG talk was revolutionary — so much so that the question period brought strong, intensely personal opposition from several icons of analog time domain, who doubted the results.

Unexpectedly, a week later, Ken received a letter from the same critics, offering to buy out his fledgling operation. For a second, he thought about it. Here he was, working out of his bedroom with little but mounting debts to show for it all. That dire predicament had been underscored when, as Ken was repairing some broken equipment, Kim marched in and announced: "I have a name for this company of yours: Zonge Engineering and Research Organization, which spells out as ZERO — which is exactly what we have in the bank account right now!" The name stuck, but fear did not. His response to the critics: File their letter in the trash can, and file a patent on CR (U. S. 3967190).

One problem remained in interpreting CR data. For large arrays, and especially at the low resistivities and higher frequency range characteristic of many mining surveys, the mineral signatures were overwhelmed by electromagnetic coupling between the array wires. At the time, coupling was typically addressed by comparing field data to reference curves, but CR required an automated, inverse solution. As he was completing his Ph.D., Ken had met another graduate student, Jeff Wynn, who was looking for a dissertation topic. Teaming intellect and practicality, they came up with an algorithm to first remove the calculated electromagnetic coupling response of a homogeneous earth, then iteratively remove the responses of as few layers as possible to achieve a minimal-coupling result. The dominant coupling response on the Argand diagrams was effectively eliminated, leaving well-behaved CR residuals. Another round of papers published in Geophysics and at conferences unleashed yet another wave of criticism, which was soon followed by the sincerest flattery of

imitation. But word was out. Zonge Engineering, now relocated from the Zonge bedroom to a former bicycle shop, was fielding crews for an increasing number of mining clients.

CR's FFT approach placed unprecedented demands on waveform stability, transmitter-receiver synchronization, and signal processing. At first, these were handled in a central recording truck with rack-mounted, AC-powered equipment. But greater logistical flexibility was needed for remote areas and for other electrical techniques. One of Ken's greatest contributions was development of a multichannel, backpackportable, computer-based receiver, the GDP-12, as well as a stable, high-powered transmitter. For field Zongies with the lungs and legs for it, the most inaccessible mining areas became fair game with the new gear. Equipment sales to international industry clients, even competitors, became a critical part of ZERO's services.

The GDP-12 opened up new geophysical vistas as a multipurpose system. In the late 1970s, Ken developed controlled-source audiofrequency magnetotellurics (CSAMT) as a practical exploration tool, and other techniques, including MT and TEM, were added. New applications were developed, often self-funded (confirming the "Research" part of the company name). One of the most significant was mapping CR effects of geochemical alteration overlying petroleum deposits, which occupied a good part of that research effort into the 1980s. Geotechnical and environmental work joined the mix of energy exploration in the following decade.

In the mid-1980s, a depression in mineral and petroleum prices nearly closed the company's doors. Zonge Engineering entered into Chapter 11 bankruptcy, laid off the staff, and awaited seizure by the bank. But Ken's indomitable spirit and support from his loyal employees pulled out a miracle. The company returned as a dominant force in electrical geophysics, added new staff, and expanded its offices in Australia and Chile. The Australian enterprise provided an especially fruitful collaboration between Australian and American geophysical talents and opened up a geologically demanding proving ground for Zonge equipment. New endeavors followed: a fast turnoff TEM system for UXO and expanded capabilities for the GDP-based equipment line.

In 2007, Ken turned 71 and moved toward retirement, selling the Australian and Chilean subsidiaries and transferring the USA company to employee ownership under a new name, Zonge International. To mark his many notable accomplishments at this transition and to honor him personally, a special two-day seminar on IP and CR was organized at the 2007 SEG Annual Meeting. To our great loss, Ken Zonge passed away 21 November 2013. His family legacy includes his wife of 54 years, Kim; children Gene (electrical engineer), Tammy (fiscal operations manager), and Lynn (fluvial geomorphologist); and three grandchildren.

Ken did not seek industry accolades, but they sought him: best presentation award, 1975 SEG Annual Meeting; 1995 SEG Enterprise Award; 2002 American Mining Hall of Fame Medal of Merit; 2002 SAGEEP meeting general chairman; 2005–2006 Small Business Administration's Award for Excellence; 2011 EEGS/SEG-NSG Frank Frischknecht Leadership Award; and more than 50 publications and numerous presentations.

It would be impressive enough if these accomplishments were the sole substance of Ken Zonge's credentials, but that is hardly the case. They are matched by his legacy as a compassionate mentor and friend. Just by following him around for a day, you might learn more about applied science than in graduate school (some of us thought of him as "Zonge U"). He extended his mentorship to countless summer field-camp students at the University of Arizona by supplying equipment, field personnel, and free pizza. He also established the Zonge Scholarship under the SEG Foundation for graduate students for research and development in electrical methods and instrumentation and a similar fund at the University of Alaska, Fairbanks.

Ken displayed an understated compassion that seemed boundless — whether it was a teetotaler Ken cheering a discouraged employee with the gift of a first-growth Bordeaux (who can argue with the Rothschilds?) or a cash-strapped Ken floating an informal loan to an employee who found herself with more month than money or a time-crunched Ken arranging tickets home for a bereaved international intern — his hand was an extension of his heart. The accountant always winced whenever Ken would conclude a phone call and walk her way with a concerned look on his face … might as well pull out the checkbook.

These characteristics point to perhaps Ken's quintessential quality. Most would agree that his strong suit was not business management, but he had leadership qualities no M.B.A. program could imbue. He had the ability to *inspire*, to make you better than you thought you could be individually, and to make a group far better than the sum of its members. If he pulled 60 kg of electrical cables in the Arizona heat without complaint, you did too. If he squatted over a receiver to monitor data somewhere deep in the Outback, you did too — no standing around idly swatting flies. When he took a critical second look at data or a pet theory, you learned the

Kenneth Zonge works with colleagues as part of a field-training exercise.

value of healthy skepticism. And watching him treat a competitor with civility, you learned a valued lesson in humanity.

These traits rubbed off. During the company's financial crisis in the mid-1980s, a visibly pained Ken was forced to lay off the entire staff. The next Monday morning, a handful of employees turned into the gravel parking lot and went in to work as usual. Perplexed, Ken explained that he couldn't pay them. Their reply was yes, fine, but we need to get these reports out, and maybe we could talk about details like money another time. The reports went out, the pay didn't materialize for a long while, but the company recovered and eventually thrived. This outcome was the direct result of Ken's inspiring leadership. It was a privilege to work for him.

To have written this tribute in the past tense is somewhat misleading, for Ken still teaches us in the present tense. We think of his guiding example often as most of us hit the home stretch of our professional careers. Take risks and innovate. Work hard. Inspire others to be their best. Befriend those needing help. Be a mentor. Be humble in the face of both praise and criticism. Take our science and our professional responsibilities seriously. But never, ever take yourself so seriously that you think you're above getting out there to sweep off the front porch.

Larry Hughes[1]*, Lynn Zonge, Emmett Van Reed, Norman Carlson, Chet Lide, Scott Urquhart, Jeff Wynn, Gary N. Young and Jerry Roth*
[1]*lhughes@ensafe.com*

SEG Kenneth L. Zonge Scholarship
Further details: foundation@seg.org

This article is reproduced from *The Leading Edge* (TLE), by kind permission from the Society of Exploration Geophysicists (SEG):

Hughes, L., Zonge, L., Van Reed, E., Carlson, N., Lide, C., Urquhart, S., Wynn, J., Young, G., and Roth, J. (2014). 'Memorials — An appreciation of Kenneth. L. Zonge (1936–2013).' The Leading Edge, 33 (03), 354–356, doi: 10.1190/tle33030354.1

Passing of Kim Zonge
It is with the deepest respect, that we express our condolences for the passing of Ken's wife, Kim Zonge, on 11 April 2014 at 9:15 am, at age 73 years. She is to be remembered as the rock of the family.

Australian Capital Territory

The branch AGM was held on 6 March 2014. Prior to the AGM, eight members visited the Joint Australian Tsunami Warning Centre (JATWC) located and operated by Geoscience Australia. Tour guide, Hugh Glanville, showed us the systems and procedures that detect verify and warn the Australian (and international) community of potential tsunami impacts on Australia's coastline and external territories. The centre was established following the Boxing Day Tsunami in 2004. The principle objective of the JATWC is to provide emergency managers with as much warning as possible of a potential impact on Australia's coastline from tsunamis that are generated from earthquakes occurring on plate boundaries in the Indian, Pacific and Southern Oceans. 'Fortuitously' several small earthquakes occurred during the visit so we could see the process unfold. The centre provides 24 hour a day, seven days a week tsunami monitoring and analysis capability.

After a very busy year professionally and personally Carina Kemp stood down from her role as ACT branch President. Tim Jones who has started a PhD in 2013 at ANU (the topic is around reconciling the geophysical and geochemical mantles), stood down from his role as Branch Treasurer after 2 years. Millie Crowe continues in her role as Branch Secretary. At the AGM Marina Costelloe was elected as Branch President and Ross Costelloe was elected as Branch Treasurer. The 2014 committee members are Carina Kemp, Tim Jones, Bill Jones, Ron Hackney, Ray Tracey, Eva Papp and Ned Stolz. We would like to acknowledge the work the committee has done in the past 12 months and thank them for their continued support in 2014.

To celebrate the past years successes and the future year's opportunities, members of the ASEG joined with new and old committee members at Gryphons in Griffith for a relaxing and enjoyable social event.

We will be hosting the 2014 Pacific South Honorary Lecturer Sandeep Chandola at GA on 17 March at 4 pm. Sandeep will be presenting his talk Marine Seismic Acquisition: 'Expanding the possibilities! Light refreshments will be available after his talk'.

Planning is underway for the FEDEX AGM being held in Canberra on Thursday, 10 April. The ACT branch is looking forward to showing members of the FEDEX why Canberra is Australia's most liveable city.

Marina Costelloe and Millie Crowe
ACT Branch President & Secretary

New South Wales

In February, we held our AGM and the usual suspects (myself, Sherwyn Lye and Roger Henderson) were elected to the roles of President, Secretary and Treasurer.

Following the AGM, Brian Spies, gave a talk on the science and politics of climate change. Brian's talk attempted to unravel the science from the politics, and discussed the importance of, and barriers to, achieving an international agreement on reducing emissions. The talk also included updates of the latest scientific observations and climate trends . Data from old and new climate change reports was presented and much discussion ensued after the 'official' talk had finished.

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
NSW Branch President

Victoria

On Wednesday 12 February members of the ASEG Victorian branch enjoyed the joint ASEG-PESA-SPE Summer Social Function at the Boatbuilder's Yard in Melbourne's South Wharf.

On Friday 14 March we will have hosted SEG 2014 Pacific South Honorary Lecturer Sandeep K. Chandoola from Petronas who will present Marine Seismic Acquisition: 'Expanding the Possibilities!'. This will have been a noon-time lunch meeting at the Victoria Hotel.

On Wednesday 16 April we are looking forward to Richard Schodde from MinEx Consulting presenting 'The Rise and Rise of Geophysics: an Overview of Minerals Exploration Trends over the Past Century'. This will be an evening meeting at the Kelvin Club starting at 6pm (drinks and nibbles) for a 6:30 pm technical presentation. The annual AGM of the ASEG Victorian Branch will precede the technical talk. Due to relocation John Theodoridis is stepping down from his role as Secretary, and Theo Aravanis will shortly take up other ASEG responsibilities. Hence both the State Secretary and State Treasurer positions are up for nominations. Please forward your nominations to vicpresident@aseg.org.au.

On 30 April we will host the one-day SEG Distinguished Instructor Short Course (DISC): 'Microseismic Imaging of Hydraulic Fracturing: Improved Engineering of Unconventional Shale Reservoirs', by Shawn Maxwell of Schlumberger. For registration and payment for this course, please use the dedicated web site: http://www.seg.org/education/lectures-courses/disc/2014/maxwell-schedule.

We look forward to seeing many ASEG Victoria Branch members at the meetings in the coming months.

Asbjørn Nørlund Christensen
VIC Branch President

ASEG News

ASEG national calendar: technical meetings, courses and events

Date	Event	Presenter	Sponsor	Time	Venue
2014					
16 Apr	'The rise and rise of geophysics: an overview of minerals exploration trends over the past century'	Richard Schodde from MinEx Consulting		1800–2000	Kelvin Club, Melbourne
14 May	TBC			1730–1900	City West, West Perth
11 Jun	Albany-Fraser MT and seismic surveys	Catherine Spaggiari, GSWA, Perth		1730–1900	City West, West Perth
9 Jul	Frequency-domain full waveform inversion: applications to marine and land seismic experiment	Rie Kamei, UWA, Perth		1730–1900	City West, West Perth
13 Aug	Humanitarian geophysics	Jeff Shragge, UWA, Perth		1730–1900	City West, West Perth
10 Sep	New logging and sensing technologies for mineral exploration	Brett Harris, Curtin University, Perth		1730–1900	City West, West Perth
8 Oct	TBC			1730–1900	City West, West Perth
13 Nov	Honours and Masters Students Research Presentations	Various		1730–1930	City West, West Perth
10 Dec	AGM and Christmas Party			1730–2030	TBC
2014 SEG Pacific South Honorary Lecturer: 'Marine Seismic Acquisition: Expanding the possibilities!' Presented by Sandeep K. Chandola, PETRONAS, Carigali, Kuala Lumpur, Malaysia. *(http://www.seg.org/education/lectures-courses/honorary-lecturers/2014)*					
Date	**State branch**	**–**	**–**	**Time**	**Venue**
14 Apr	Hobart, TAS			TBA	TBA
2014 SEG Distinguished Instructor Short Course (DISC): 'Microsiemic imaging of hydraulic fracturing: improved engineering of unconverntional shale reservoirs' Presented by Shawn Maxwell, Schlumberger. *(http://www.seg.org/education/lectures-courses/disc/2014/maxwell-schedule)*					
Date	**State Branch**	**–**	**–**	**Time**	**Venue**
28 Apr	Perth, WA			0900–1700	Technology Park Function Centre
30 Apr	Melbourne, VIC			0900–1700	The Victoria Hotel
5 May	Adelaide, SA			0830–1630	Hotel Richmond
EAGE Distinguished Lecturer Programme (DLP): 1 hour Webinar Q&A on 16 July 2014 at 1300 EST 'Controlled source EM and magnetotelluric data for sub basalt imaging' Presented by G. M. Hoversten. *(http://lg.eage.org)*					
2014 SEG/AAPG Distinguished Lecturer: '3D seismic image processing for interpretation of faults and horizons' Presented by David Hale, Colorado School of Mines, Golden Colorado, USA Supported by CGG and Paradigm. *(http://www.seg.org/dl)*					
Date[TBC]	**State branch**	**–**	**–**	**Time**	**Venue**
4 Aug	Brisbane, QLD			TBA	TBA
5 Aug	Canberra, ACT			TBA	TBA
7 Aug	Melbourne, VIC			TBA	TBA
8 Aug	Hobart, TAS			TBA	TBA
11 Aug	Adelaide, SA			TBA	TBA
12 Aug	Perth, WA			TBA	TBA

TBA, to be advised; TBC, to be confirmed (please contact your state branch secretary for more information).

National science agencies feel force of government cuts

The effects of annual efficiency dividends of 2.25% across all government departments from July 2014 (introduced by the former government), and the drive by the current government to have a smaller public service, is now hitting the main national science agencies.

A service-wide cut is the lazy way to reduce the size of the public sector. There is no need for a process to assess the priorities of government programmes or to identify national goals – it's just cuts all round. Not a good way to govern a mature developed country, but very easy to implement. I would have thought that as Australia grows and society becomes more reliant on science and technology skills we should be increasing our investments into organisations like Geoscience Australia and CSIRO, but this seems not to be. Both organisations are really suffering. Even the Australian Bureau of Statistics, which provides invaluable data for socioeconomic planning, is feeling pain from budget cuts.

$40 million cut from Geoscience Australia's budget

According to a report in the *Sydney Morning Herald* on 21 February 2014, GA's annual budget of $180 million will be cut to $140 million. As a result, there will be significant job losses. According to CEO Chris Pigram, $6 million of the cuts will come from the efficiency dividend and remainder from income previously derived from other government agencies, such as Defence and Environment and who are also battling with the efficiency dividend.

Assuming that approximately half of the $40 million would be made up of staff reductions; it follows that 50–100 staff may have to be shed from the ~740 currently employed.

These cuts are likely to have a major impact on Australia's national capability and capacity to develop and manage our mineral, petroleum, ground water and other earth based-resources. It is also likely they will affect the hazard management programs of floods, landslides, earthquakes and tsunamis.

Australia relies heavily on the wealth of our resource industries to maintain our prosperity. This prosperity will require a pool of highly skilled geoscientists, which we hope will be trained in Australia. The loss of jobs at Geoscience Australia will do little to encourage young scientists to take up geoscience as a career. And it is difficult to see how it will do anything to increase our national prosperity.

CSIRO to lose up to 600 jobs

In November 2013 Assistant Treasurer Arthur Sinodinos indicated that the job cuts in CSIRO would be between 500 and 600. More recently, CSIRO Staff Association Secretary Sam Popovski said (in February 2014) that the number employed in CSIRO had fallen from 6477 in June last year to 6143 as at the end of January 2014. That's bad news for science. Perhaps more importantly, those affected will be the younger part time contract workers, who may find it very difficult to find other jobs in other science related areas.

Australian Bureau of Statistics faces $50 million funding cut

The Australian Bureau of Statistics (ABS) has to tackle a $50 million funding cut that could lead to 70–100 redundancies (*Sydney Morning Herald*, 5 March 2014). The ABS employs approximately 3300 workers. According to the *Sydney Morning Herald* report the acting chief statistician Jonathan Palmer said 'We are going into next financial year with an increased efficiency dividend, so we need to find about $50 million over the next three years.'

How these cuts will affect the delivery of ABS statistics has not yet been decided, but compared with other OECD countries our coverage is not that good. For example the UK and the US produce CPI data monthly, while the ABS only manages quarterly data releases. I would have thought that good data would have been vital for governments to make good decisions, and that ABS resources should be increased – but then there must be others who disagree with this argument.

David Denham
denham1@iinet.net.au

News

Update on the Geophysical Survey Progress from the Geological Surveys of Western Australia, South Australia, Northern Territory, Queensland and WA Department of Water (information current at 7 March 2014)

Tables 1–3 show the continuing acquisition of the airborne magnetic, radiometric, gravity and AEM data of the Australian continent respectively. All surveys are being managed by Geoscience Australia (GA). Further information on these surveys is available from Murray Richardson at GA via email at Murray.Richardson@ga.gov.au or telephone on (02) 6249 9229.

Table 1. Airborne magnetic and radiometric surveys

Survey name	Client	Contractor	Start flying	Line (km)	Spacing AGL Dir	Area (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Browse Basin	GA	Thomson Aviation	21 Aug 13	189 361	800 m 80 m ASL N–S	123 187	100% complete @ 7 Nov 13	29 Jan 14	Issue 164 (Jun 13) p. 19	Final data released via GADDS on 5 Mar 14
Menzies North	GSWA	GPX Surveys	7 Aug 13	93 386	100 m 50 m E–W	8200	100% complete @ 26 Nov 13	29 Jan 14	Issue 165 (Aug 13) p. 11	Final data released via GADDS on 20 Feb 14
Kalgoorlie East and Kurnalpi North	GSWA	Thomson Aviation	5 Aug 13	122 000	100 m 50 m E–W	Kalgoorlie: 11 000; Kurnalpi N: 11 000	92.1% complete @ 2 Mar 14	TBA	Issue 165 (Aug 13) p. 11	TBA
Widgiemooltha North	GSWA	UTS Geophysics	25 Jul 13	92 000	100 m 50 m E–W	8200	100% complete @ 27 Jan 14	TBA	Issue 165 (Aug 13) p. 11	TBA
Menzies South	GSWA	GPX Surveys	28 Nov 13	92 000	100 m 50 m E–W	8200	82.8% complete @ 2 Mar 14	TBA	Issue 165 (Aug 13) p. 11	TBA
Kurnalpi South	GSWA	UTS Geophysics	28 Jan 14	92 000	100 m 50 m E–W	8200	20.8% complete @ 2 Mar 14	TBA	Issue 165 (Aug 13) p. 11	TBA
Coompana	GSSA	TBA	TBA	TBA	Survey design is underway	The proposed survey may cover all or part of Noorina, Wyola, Cook, Coompana, Nullarbor, Ooldea, Maurice, Wells and Birksgate standard 1:250 000 standard Map Sheets				

ASL, above sea level; TBA, to be advised.

Table 2. Gravity surveys

Survey name	Client	Contractor	Start survey	No. of stations	Station spacing (km)	Area (km²)	End survey	Final data to GA	Locality diagram (*Preview*)	GADDS release
North Perth – Gingin Brook	WA Dept of Water	Atlas Geophysics	9 Apr 13	1230	1.5 km regular grid	3900	100% complete @ 7 Jun 13	29 Jul 13	Issue 163 (Apr 13) p. 17	Final data released via GADDS on 20 Feb 14
Goldfields, WA	GSWA	Atlas Geophysics	8 Nov 13	8100	2.5 km regular grid	51 140	100% complete @ 13 Dec 13	20 Jan 14	Issue 166 (Oct 13) p. 34	Final data released via GADDS on 20 Feb 14
WA Reconnaissance Gravity Surveys Stage 3	GSWA	TBA	TBA	Approx. 53 900 in total across 7 proposed surveys	2.5 km regular grid and 2 km road traverses	TBA	TBA	The Quotation Request opened on 28 Jan 14 and closed on 27 Feb 14	The proposed surveys are located in: 1. Ngururrpa Region, 1 survey: Stansmore and surrounds 2. NE Yilgarn, 4 surveys: Herbert-Robert, Throssel, Sir Samuel and Wiluna-Nabberu 3. SW Yilgarn, 2 surveys: Perth and Albany	
West Amadeus	NTGS	TBA	TBA	TBA	4 km regular with areas to be defined for 2 km infill	45 050	The proposed survey may cover all or part of Mount Rennie, Bloods Range, Petermann Ranges, Ayers Rock, Lake Amadeus and Mount Liebig standard 1:250 000 standard Map Sheets			

TBA, to be advised.

Table 3. AEM surveys

Survey name	Client	Project management	Contractor	Start flying	Line (km)	Spacing AGL Dir	Area (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Swan/Scott Coastal Plain and Albany/ Esperance	WA Dept of Water	GA	CGG Aviation (Australia)	25 Mar 13	8607	300/600 m	TBA	100% complete @ 15 May 13	Final data to GA 20 Jan 14	Issue 163 (Apr 13) p. 17	TBA
Capricorn Orogen	GSWA	GA	CGG Aviation (Australia)	19 Oct 13	29697	5 km N–S	146300	100% complete @ 9 Jan 14	24 Feb 14	Issue 166 (Oct 13) p. 34	TBA
Southern Thomson Orogen	GA/ GSNSW/ GSQ	GA	TBA	At the time of updating this table the survey was expected to commence in mid-late March	4198 (3327 in survey and 871 in traverses)	5 km E–W	16270	TBA	TBA	Issue 168 (Feb 14) p. 24	TBA

TBA, to be advised.

New airborne magnetic data covering the Browse Basin

Ron Hackney and Marina Costelloe

Geoscience Australia

In late 2013, Geoscience Australia acquired airborne magnetic data over a large part of the Browse Basin (Figure 1). The Browse Basin is a northeast-trending Palæozoic to Cænozoic depocentre located offshore in the Timor Sea region of Australia's North West Shelf. The basin contains a Palæozoic, Mesozoic and Cænozoic sedimentary succession in excess of 15 000 m thick (Struckmeyer et al, 1998). The main structural elements of the basin include the Barcoo and Caswell sub-basins and the Leveque and Yampi shelves (Figure 1), which lie in water depths of up to 2000 m. The Caswell Sub-basin hosts several large gas fields planned for Liquefied Natural Gas (LNG) and condensate development. The outboard and frontier parts of the basin include the Scott Plateau and Seringapatam Sub-basin in water depths of up to 5000 m.

Government-funded pre-competitive regional-scale airborne magnetic data have an important role in understanding energy and mineral systems. The data help to reduce exploration risk and provide a framework for detailed studies that seek to identify energy and mineral resources. In recognising the benefits of airborne magnetic data to regional basin studies, Geoscience Australia contracted Thomson Aviation to acquire the new data over the Browse Basin. From late August to early November 2013, two aircraft acquired approximately 190 000 line km of data along north–south traverses spaced 800 m apart, east–west tie lines spaced 4000 m apart, all at a nominal flying height of 80 m above sea level. These data were made available for download from the Geophysical Archive Data Delivery System (GADDS; www.geoscience.gov.au) on 5 March 2014.

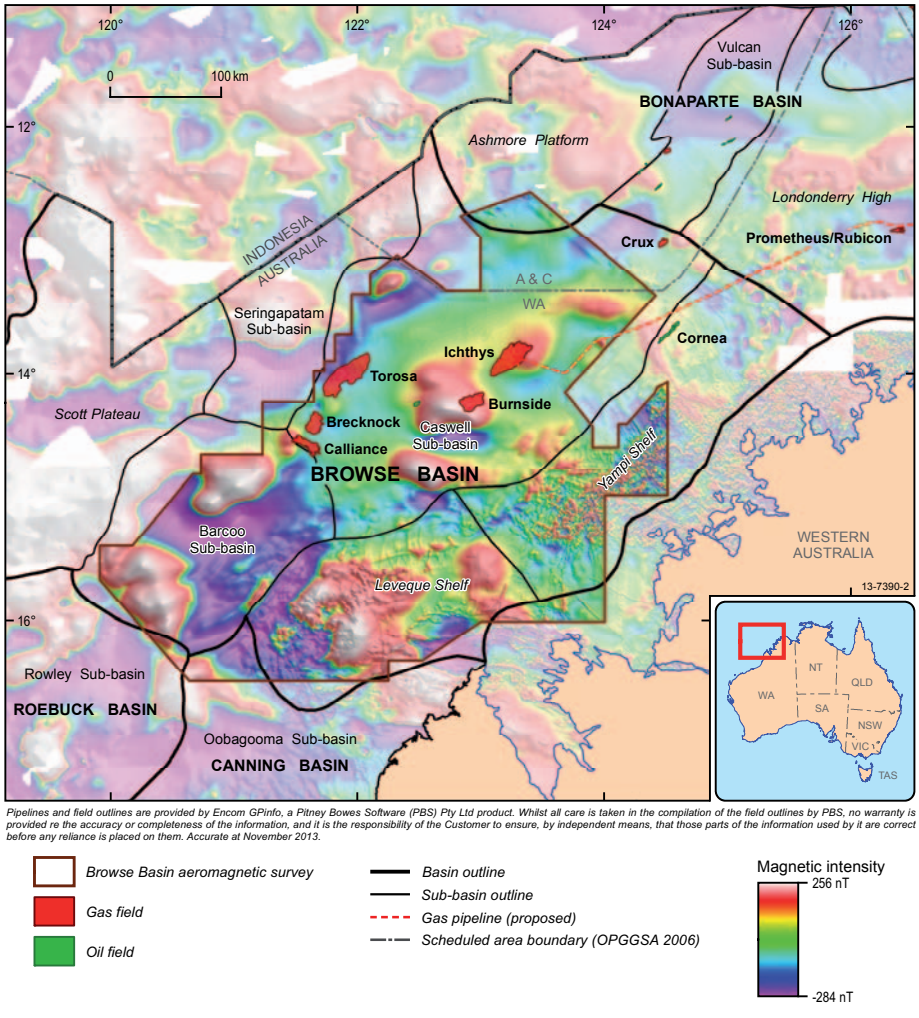


Fig. 1. *Map of the Browse Basin showing the new aeromagnetic data after a preliminary merge with existing airborne and marine magnetic data. The main structural elements and gas fields of the basin are also shown. Key: A&C denotes Territory of Ashmore and Cartier Islands.*

The Browse Basin airborne magnetic survey was conducted as part of the National CO_2 Infrastructure Plan (NCIP; www.ga.gov.au), which aims to acquire, interpret and integrate new and existing pre-competitive data to assess the suitability of various basins for the geological storage of CO_2. Geoscience Australia's current focus on the Browse Basin as a potential area for CO_2 storage is the precursor to more regional studies of the North West Shelf that aim to identify, characterise and map structural events and variations in structural architecture, as well as to regionally examine the role of structural inheritance and controls on the distribution of volcanics. This mapping will aid the interpretation of the structural fabric of the basin and the nature of its basement. The new airborne magnetic data will be a key component of this mapping as the data will facilitate the mapping of strongly-magnetised volcanic rocks and basin structure.

Better knowledge of the distribution of volcanic rocks is a key part of assessing the suitability of any given reservoir for storing CO_2 or holding hydrocarbons. If a reservoir is adjacent to or contains volcanic rocks, the reservoir's storage capacity could be reduced by mineral precipitation within pore space. This precipitation arises from the chemical reactions driven by the heating and fluid flow induced at the time the hot volcanic rocks were emplaced.

Structures mapped from the new airborne magnetic data can also be used to assist in assessing the integrity of the geological seal above reservoirs deemed suitable for CO_2 storage or that have the potential to store hydrocarbons. When faults cut through a geological seal above a potential reservoir, the seal can be breached and, depending on the permeability of the fault, CO_2 or hydrocarbons in the underlying reservoir may migrate into overlying rock formations.

The new magnetic data will ultimately be merged with existing data to produce updated national magnetic anomaly maps that will help future resource exploration.

For further information on the new Browse Basin airborne magnetic data, contact Ron Hackney (ron.hackney@ga.gov.au) or email GADDS (gadds@ga.gov.au).

Reference

Struckmeyer, H. I. M., Blevin, J. E., Sayers, J., Totterdell, J. M., Baxter, K., and Cathro, D. L. 1998. Structural evolution of the Browse Basin, North West Shelf: New concepts from deep-seismic data. In: Purcell, P.G. and Purcell, R.R. (Editors), The Sedimentary Basins of Western Australia 2: Proceedings of the Petroleum Exploration Society of Australia Symposium, Perth, 1998, 345–367.

News from the surveys: SA
The 2013 Woomera Prohibited Area gravity survey

The northern Gawler Craton, South Australia, hosts the world class Olympic Dam Cu-Au-U deposit, as well as mines such as Prominent Hill (Cu-Au), Challenger (Au), Cairn Hill (Fe-Cu-Au) and Peculiar Knob (Fe; Figure 1). The highly prospective region of the Gawler Craton that hosts these deposits is also the location of a Department of Defense military testing range, the Woomera Prohibited Area (WPA).

In order to assist mineral exploration in the WPA a major regional gravity survey was recently undertaken by the Geological Survey of South Australia and Geoscience Australia. This region had previously been surveyed by only regional 7 by 7 km spaced points acquired in the 1970s and was consequently lacking in detail; the type of detail that is vital for area selection within this region of the Gawler Craton that is largely covered by Phanærozoic sediment.

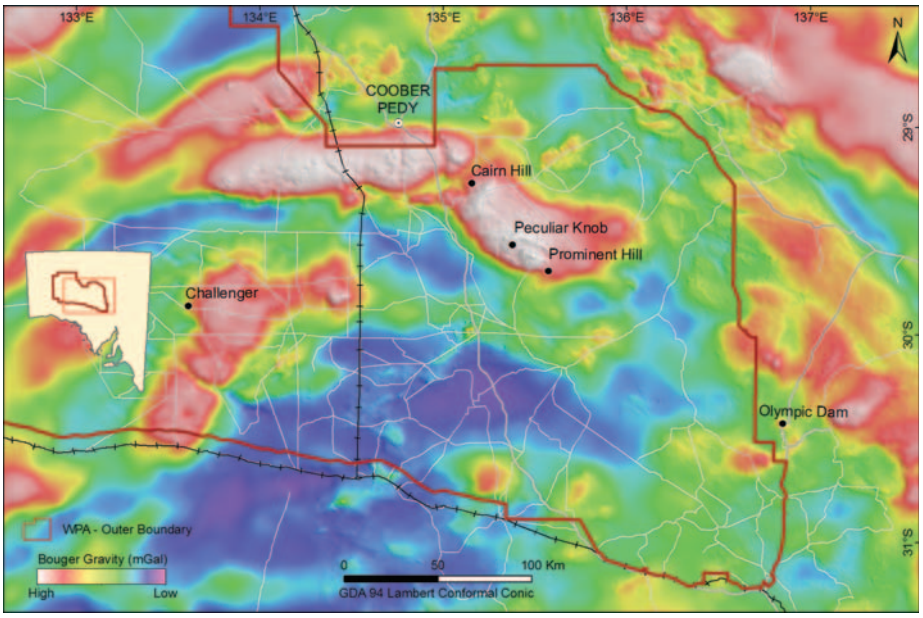


Fig. 1. *The regional gravity in the WPA area prior to the 2013 survey is shown here.*

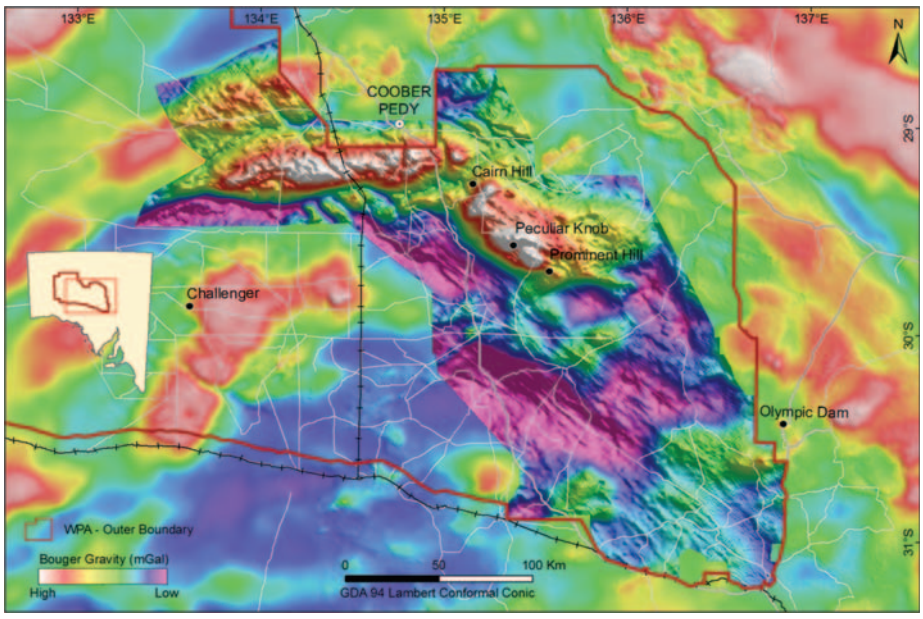


Fig. 2. *The new survey has provided valuable insight into the geology of the region.*

Between 2 May and 18 September 2013, DaishSat Geodetic Surveyors undertook a major gravity survey covering a large portion of the WPA (Figure 2). The survey included 34,541 new gravity stations: 33,132 stations at a regular spacing of 1 km by 1 km resolution, and 1409 stations at a spacing of 2 km by 2 km resolution within the continual use zone of the WPA.

The shape of the survey was chosen to cover the northwestern Olympic Domain (Figure 3). The survey also covers adjacent domains that are considered prospective for IOCG deposits (the Coober Pedy Ridge, the Mt Woods Domain and parts of the Christie and Nawa Domains).

Gaps were left in the survey area to tie in pre-existing gravity surveys that had the same (or better) resolution. Some points were offset by 500 m to allow improved resolution of the gravitational response of the region.

Data from the survey has been combined with pre-existing gravity surveys to produce a single grid of the area. This grid exhibits many new features, as well as highlighting known features at a higher resolution.

The Coober Pedy Ridge is the major gravity high south of Coober Pedy in the central north of the survey area. Much of the structure and faults seen here were not visible prior to this survey. A major NW-SE fault appears to cross-cut through the middle of the Coober Pedy Ridge and into the Nawa Domain to the NW. Further short wavelength features can be seen in the Mt Woods domain, the high gravity region hosting Cairn Hill, Peculiar Knob and Prominent Hill.

South of the Coober Pedy Ridge and Mt Woods Domain is the Christie Domain. The Christie Domain exhibits a broad low-magnitude gravitational response in the survey area, and the new data shows a prominent boundary between the areas. This apparent boundary is likely to be the Karari shear zone which separates the Christie Domain and Nawa Domain to the west.

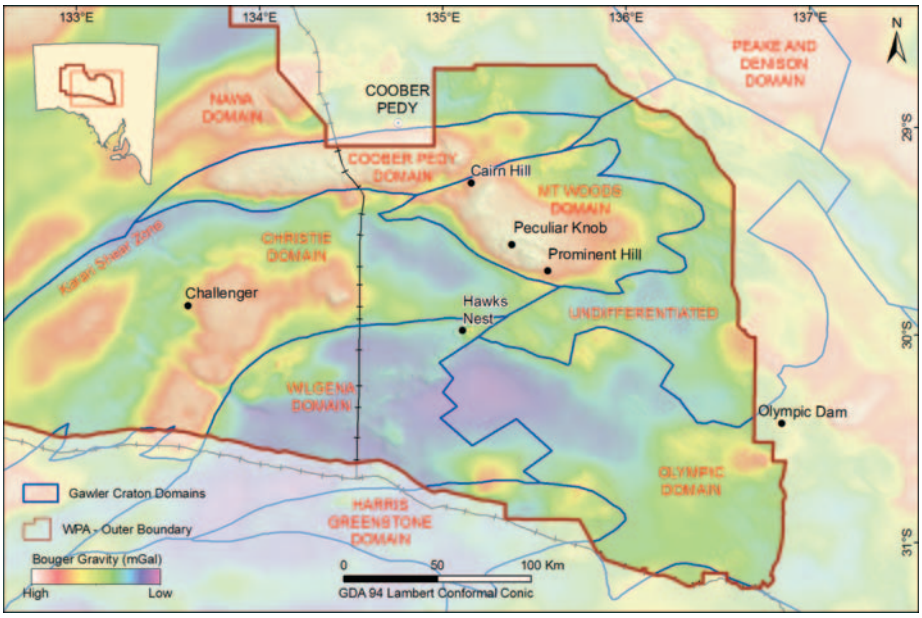


Fig. 3. *For reference, this image shows the domains of the Gawler Craton in the WPA.*

There are subtle gravity highs in the vicinity of the Hawks Nest Fe deposit (Figure 3). These highs are probably partly because the basement is shallower in these regions. This new data gives improved resolution of the structure of that basement. These features are really well expressed in the new gravity data and are regions of some IOCG potential.

The new data also shows up significant new zones in a similar structural position to the south of the eastern end of the Coober Pedy Ridge. These regions might be good places to consider the intersection of NE trending shear zones in this region with potential Hiltaba Suite or Gawler Range Volcanics magmatic rocks.

Noticeable also are the dykes of the Gairdner dolerites. These are the linear features striking NW-SE. These features are also prominent in the magnetics in the area and some have been dated to 827 Ma.

The data can be downloaded through SARIG (sarig.pir.sa.gov.au).

Philip Heath[1]*, Tim Keeping, Gary Reed, Laz Katona*

[1]*Philip.Heath@sa.gov.au*

Geological Survey of South Australia
Resources and Energy Group
Department for Manufacturing, Innovation, Trade, Resources and Energy (DMITRE)

Constrained magnetic modelling of the Hawsons Iron Deposit, western New South Wales

Ristch (Rusty) Camille

ASEG Research Foundation Project RF12M04. Honours student, Ristch (Rusty) Camille. Supervisor, Dr Mark Lackie, Macquarie University. Industry contact, John Donohue, Carpentaria Exploration Limited.

Project summary

Hawsons Iron Deposit is a folded, bedded Neoproterozoic iron formation, situated approximately 60 km south-west of Broken Hill, New South Wales. The magnetite rich prospect overlies rocks of the folded, bedded Neoproterozoic iron formation of the Nackara Arc in the Adelaidean Fold Belt. The Hawsons Iron Deposit is separated into three domains: Core, Fold and South Limb.

The project investigated the size of the resource of magnetite at the Hawsons Iron Deposit by interpreting newly acquired ground magnetic data and petrophysical measurements in conjunction with existing magnetic susceptibility and drillhole data. This was achieved by developing 2.5D and 3D magnetic models using various geophysical software packages and comparing them to the Davis Tube Recovered (DTR) models developed by Carpentaria Exploration Limited.

The magnetic signature of a rock is dependent on the concentration, orientation and specific type of magnetic mineral present within the rock or unit. Magnetite is the most naturally magnetic occurring rock that exhibits permanent magnetism, which is characteristically ferromagnetic. Magnetic data suggests that there is limited structural disturbance within the Hawsons magnetite rich deposit (Figure 1). The prospect is dominated by a large intense magnetic anomaly of up to ~7000 nT.

Samples from sixteen drillholes were selected over various locations of the Hawsons Iron Deposit and drilled and cored for petrophysical analyses. Petrophysical measurements were applied as constraints for magnetic modelling. Newly acquired bulk *k* magnetic susceptibilities obtained from the petrophysical analyses and magnetic susceptibilities measured with a hand held meter were used to constrain 2.5D and 3D models. Forward models and sensitivity analysis was undertaken to determine the depth to the basement and the thickness of the cover sequence; the vertical extent of the deposit; and the effect of self-demagnetisation. All magnetic bodies are subjected to a degree of self-demagnetisation, this becoming significant when greater than 10% of the body is magnetite (k > 0.1SI). In the Hawsons Iron Project, many samples have a magnetic susceptibility greater than 0.1 SI.

The software packages ModelVision and UBC Mag3D were used for modelling

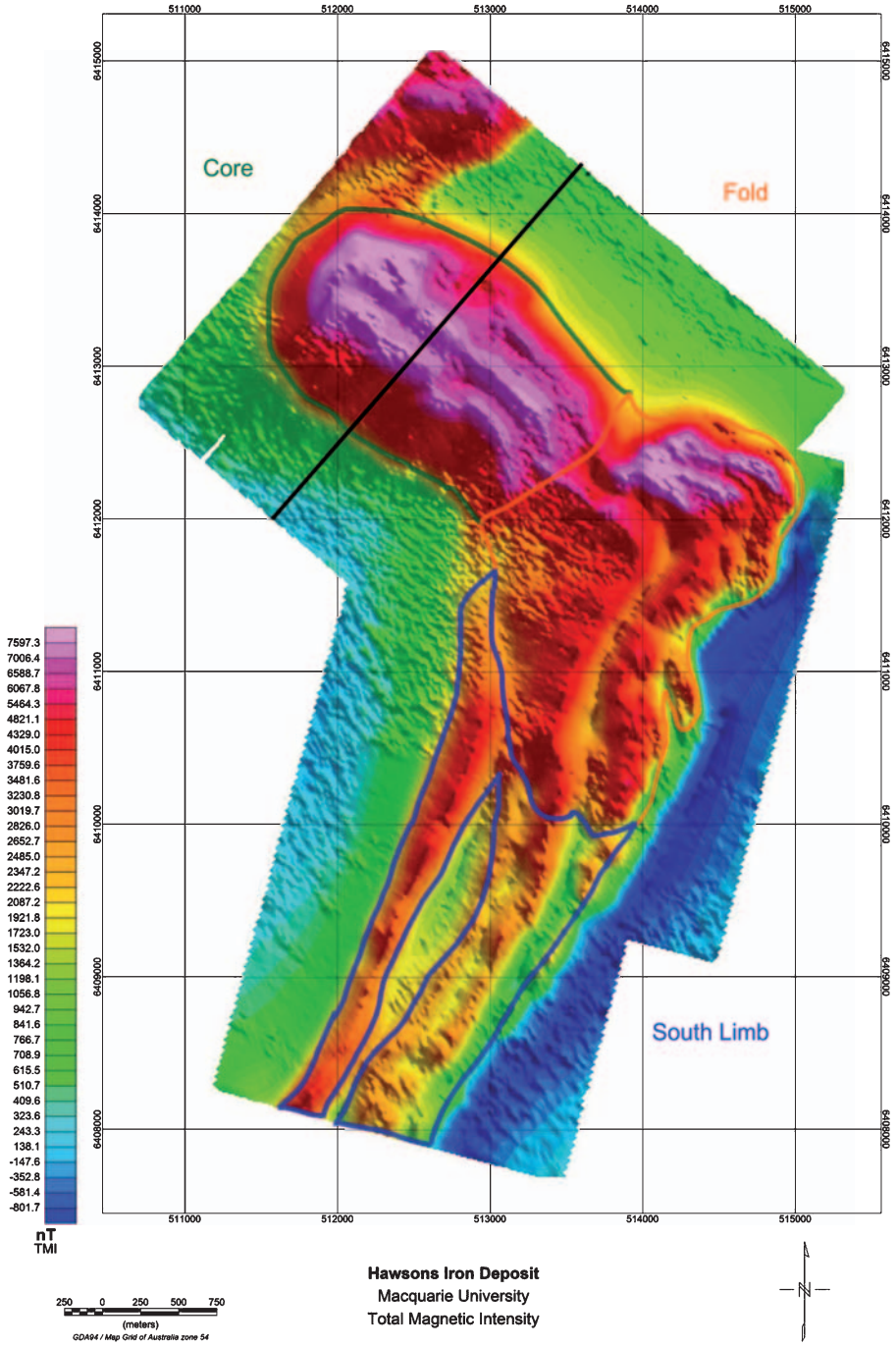


Fig. 1. *Total Magnetic Intensity (TMI) map of the ground magnetic data of the Hawsons Iron Deposit. Black line is Line 27 (Figure 2).*

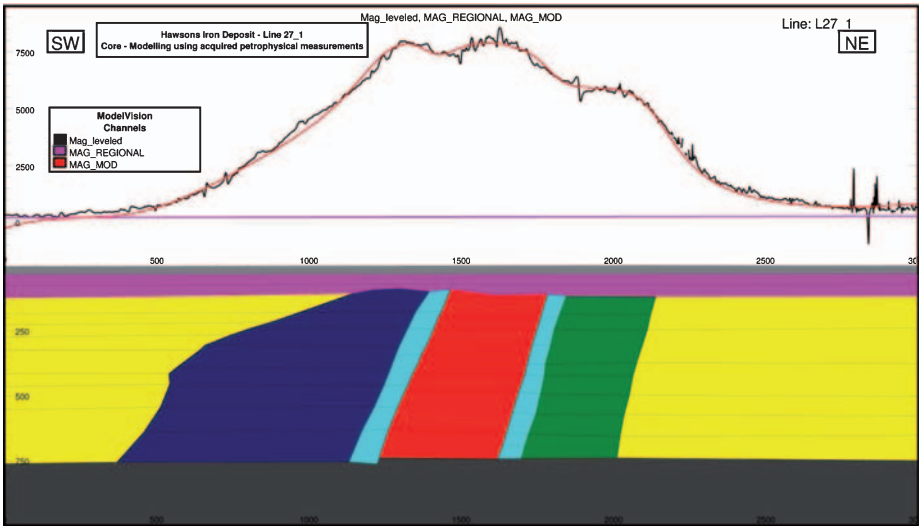


Fig. 2. *Forward modelled cross section along the Core of the Hawsons Iron Deposit. Cover sequence (0.0005–0.02 SI). Non deposit rocks (yellow) (0.05–0.1 SI). Deposit (blue, red, green) (0.1–1.2 SI).*

the Hawsons Iron Deposit (Figure 2). Modelling high resolution ground magnetic data shows that the polygons representing the magnetite-rich limbs in the Core and Fold are dipping to the southwest and striking at a northwest-southeast direction, consistent with drilling data. The study suggests that it is possible to predict the resource of magnetite at Hawsons Iron Deposit provided that geological and geophysical constraints are available to assist with the forward modelling of the deposit. Geological, geophysical and petrophysical constraints were used to delineate and map the thickness of the cover sequence and base of the magnetite deposit. Based on the results of the sensitivity analysis of the base of the mineralisation, the magnetite deposit could be modelled with a cover sequence ranging from 30 to 110 m thick, and with the magnetite mineralisation being 700 m to 1100 m in extent.

When self-demagnetisation was considered in ModelVision, the resultant models indicate that the magnetite mineralisation may have greater depth extent and still be consistent with the data. However, this is only indicative as more robust analyses of the effect of self-demagnetisation using numerical models would need to be done and this was beyond the scope of this Honours Project.

The three-dimensional inversion models of the Hawsons Iron Deposit share some resemblance to the DTR resource model. Based on the results of the 3D magnetic model, the depth extent of the magnetite mineralisation lies between 200–800 m. However, the inversions produced were different to the forward models. At the Core, the deposit has a strike direction towards the northwest, however, the dip of the magnetite body was difficult to define, when 3D inversion alone was used.

The 2.5D and 3D models produced using ModelVision and UBC CODE were used to develop a representation of the geological and magnetic response of the Hawsons Iron Deposit. However, the models produced were inconsistent with Carpentaria's DTR Model. The modelled magnetite deposit from the 2.5D and 3D models had a large depth range, based on the sensitivity analysis of the models, indicating that the extent of mineralisation was not well defined. Therefore, further geological and geophysical constraints are required to comprehensively model the geological structure and basement of the Hawsons Iron Deposit.

Project outcomes

The main outcomes of the studies were:

1. It is possible to model the Hawsons Iron Deposit using data obtained from hand held magnetic susceptibility meters and bulk *k* magnetic susceptibilities obtained from laboratory measurements. However, sensitivity analysis shows that the extent of magnetite mineralisation is not well defined and that the more data from drill core that is incorporated in the modelling, the better the model.
2. Modelling applying various constraints and parameters to delineate and map the thickness of the cover sequence as well as the base of the magnetite deposit is possible.

So what happened?

Guy Holmes
Guy.Holmes@spectrumdata.com.au

In February 2013, my usual article was published in *Preview*'s 'Data Trends' section. It was another average attempt at humour, but with a serious edge that clearly got everyone thinking about data management and its dimly lit future. After publishing my article, Twitter went into overdrive with some of my statements being tweeted and then re-tweeted in some case as many as two times each. It was nice to see that people were listening and actually interested in what I had to say.

In that February 2013 'New Year's Resolution' style piece, I made three bold and undeniably tweet-able predictions. When some of the worlds most followed Twitterers like Katy Perry and Oprah started to 'follow' me, I was pretty sure that I was on to something and when Bieber stopped following me, I was absolutely positive I was…. So how did I go in predicting the future?

Firstly, there was no apocalypse, the world did not end, there was no alien invasion and I truly regret taking that 'selfie' with the tin foil hat that was published in February's issue. As for my other bold, but damning predictions:

Prediction #1: *Data management will remain the source of blame as well as the trusted custodians of the corporation's data.*

Result: *I was 100% correct.*

No revolution has come about and data management teams continue to struggle to get attention, budget or in fact any credit of any kind. Although I was clearly correct in this prediction, I was certainly not happy to be correct. Data management teams deserve better treatment, better tool sets, and better budgets. Being in the data management area myself, I had no choice but to predict this and then dance in the delight of being right. After all, it is not often that a data management technician can be correct and also take the credit for it. Oh – this industry is so ironic.

Prediction #2: *The data management team will continue to be the source of blame rather than the source of information it is intended to be.*

Result: *I was 100% correct. In fact, 3 weeks after publishing this article I was blamed for being the source of this very prediction.*

The typical trend of only being noticed when something goes wrong or something cannot be found has continued. When data management does it right, there is no special treatment or recognition, just a theme of 'well, that is their core function'. When we get it wrong, we get slapped on the back of the head with a nice 'don't do it again' comment tossed in. What people should be doing is tossing in money and training, not slaps to the cranium. And if I had to predict the likelihood of that getting budget and training in 2014, I think I would be 100% correct on that prediction as well.

Prediction #3*: Data management professionals in the resource sector will continue to ignore the 'Big Data' issues facing every other industry in the world and will fail to look at the solutions that are being created to deal with them.*

Result*: I was incorrect.*

Over the last 12 months I have read several articles by leading experts talking about 'Big Data' and how the tools used in major corporates are forging their way into the resource sector. It is very exciting to see and I believe it will change what data management looks like in the not so distant future. 'Big Data' tools, and the thinking behind them, will put the colour in the black and white TV of data management. It will make it more interesting to watch and people will see more detail than ever before from within a massive matrix of data. I am actually happy that I was wrong on this prediction.

So after reviewing 2013, this is actually the time when I should probably make predictions for 2014. I think I will pass on that. I am going to focus on doing rather than talking and singlehandedly make a difference through the power of positive thought, sheer undeniable skill and the extensive use of social media. Besides, it is quite exhausting always being right.

An in-depth look at AVO and fluid prediction

Michael Micenko
micenko@bigpond.com

Some years ago I worked in an area that was successfully explored using Amplitude Versus Offset (AVO) and seismic amplitude because the rock physics was just right for useful fluid prediction. But amplitude and AVO are fickle. Their successful utilisation requires an in-depth knowledge of the reservoir and overburden rocks or, as most of us have found, dry holes will be drilled. Here is an example.

Recently another amplitude based prospect was drilled adjacent to a producing field in the same area. Here's a sketch (Figure 1) – I have included sketches rather than real data to avoid confidentiality issues. Both the prospect and field are about the same depth below sea level with similar amplitudes. So the prospect should be a certain oil discovery – right? Well actually no. The two are quite different because the seismic velocities and densities are related to depth below sea floor, not the sea surface. And the water depth varies so that the prospect has 3–400 m more overburden. This is enough to affect the prediction if the depth difference is not taken into account. Again another sketch of the prediction (Figure 2). Based on this analysis the prospect falls into the hydrocarbon zone. But the prediction ellipses are based on data from the shallower producing field and have not been corrected for the difference in overburden thickness.

A review of velocity – depth trends in the area (Figure 3) shows the shale trend has velocity increasing with depth below sea floor more than the sand trend. So as the overburden thickness increases the acoustic impedance contrast increases and hence seismic amplitude will increase. The effect of this is that a deeper

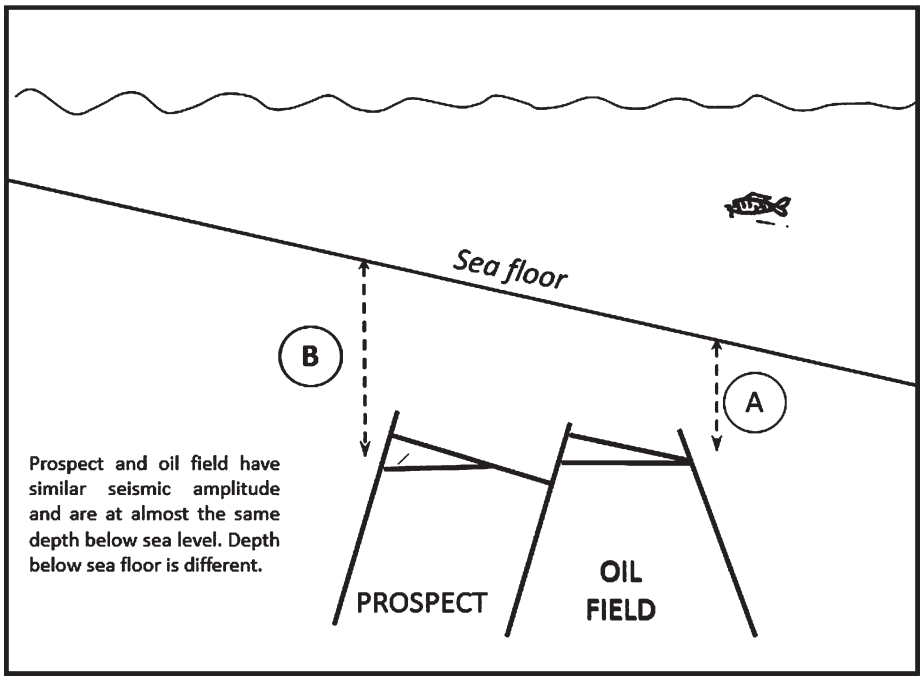


Fig. 1. *Sketch of prospect located adjacent to a producing oil field. The prospect and oil field are at a similar depth below sea level and have similar seismic amplitude. However, the oil field is 3–400 m shallower (A) below the sea floor compared with the prospect (B).*

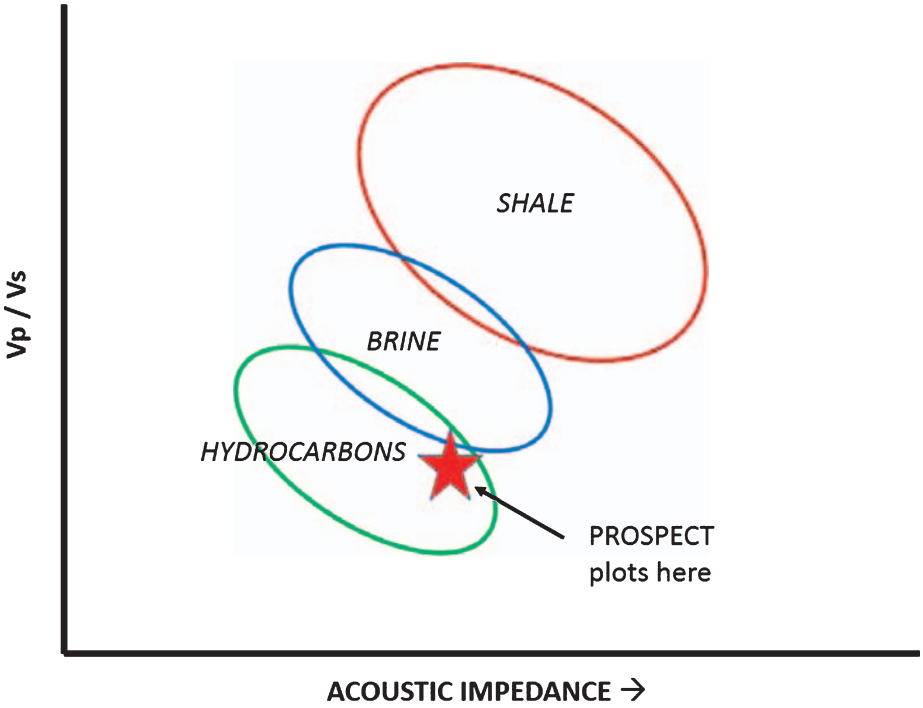


Fig. 2. *Cross plot of Acoustic impedance vs Pressure-wave/ Shear-wave velocity (Vp/Vs) ratio based on data from the producing field. The brine and hydrocarbon ellipses have a small overlap, but fluid type should be predictable in most cases. The prospect plots in the hydrocarbon ellipse, close to the brine ellipse.*

brine sand will have the same seismic amplitude as the shallower oil filled sand in the producing field. With this information, the prediction is that a well on the prospect will most likely be a dry hole (Figure 4).

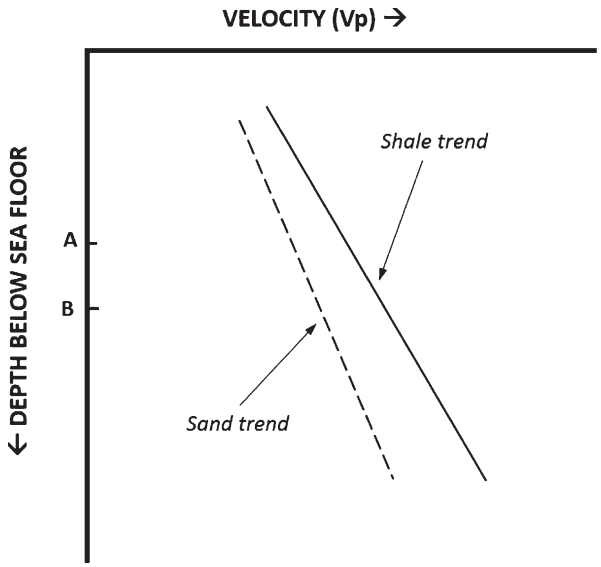


Fig. 3. *Plot of seismic velocity (Vp) versus depth below sea floor. The sand and shale trends are different and diverge with depth. The velocity difference (and hence impedance contrast) is greater than depth A at depth B. A brine filled sand at depth B will have a brighter amplitude than one at depth A.*

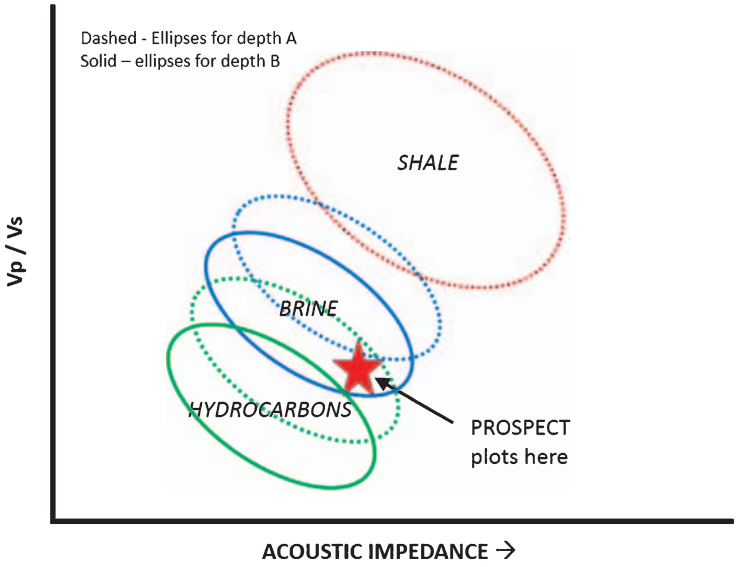


Fig. 4. *Taking the depth–velocity trend into account results in a new set of ellipses for depth B (solid). Using this corrected plot the prospect now falls into the brine ellipse and a dry hole would be predicted.*

The well was drilled and indeed was dry.

Sometimes as explorers we can be a bit too optimistic and forget to trust the science.

Optimism

In the case above the well proposal had comments such as:

- 'The seismic amplitude is similar but dimmer compared to nearby wells. This dim response is interpreted to be either thinner sands or brine filled sands.'
- 'The prospect plots at the upper oil – brine window and will contain either heavy oil or brine.'
- '…relies on a high AI shale overburden' (present in only 1 of 5 offset wells) '…and is unlikely to be hydrocarbon'.

Yet with all these comments the prospect risk was increased by almost half from a marginal value to a more attractive one. This increase was based on the 'positive' seismic amplitude response.

Downloading geophysics from SARIG

Philip Heath
philip.heath@sa.gov.au

SARIG 2020 (South Australian Resources Information Geoserver) is an award winning online map application proving state-wide information for the mineral, petroleum and geothermal exploration industry. Users are able to search, view and download information free of cost from over 400 map layers. This includes a variety of geophysical data.

The website was developed by the Government of South Australia, operated by DMITRE (Department for Manufacturing, Innovation, Trade, Resources and Energy), and can be found online at sarig.dmitre.sa.gov.au. The internet providers that support SARIG with the best performance are Google Chrome, Firefox and Safari, Internet Explorer Versions 8+ does support SARIG. The SARIG application requires no plug-ins.

The geophysicists at the GSSA (Geological Survey of South Australia) are the custodian of geophysical data, and the Energy Resources Division are custodians of the Seismic data available on SARIG.

The SARIG Help website (www.minerals.dmitre.sa.gov.au/sarighelp) provides step-by-step instructions.

The application opens a default basic map of South Australia, displaying a main menu and available mapping tools.

It is currently possible to view and download gravity, magnetic, radiometric, magnetotelluric, seismic, airborne electromagnetic, and petrophysical data. There is no charge for viewing or downloading data. Viewing data is a simple case of finding the appropriate layer in the Map Layers window and switching it on (see Figure 1).

The Geophysical Data drop-down option in the Map Layers will show the boundaries of individual surveys (and in the case of surveys that are individual lines, these will be shown as individual lines). The Geophysical State Images drop-down option contains statewide imagery or magnetics, radiometrics and gravity. Seismic lines can be found under the Seismic Lines drop-down option. Once a layer is switched on, hovering your mouse above a shape on the screen will allow a window to pop up with some basic attributes regarding the shape, point or line you're examining (see Figure 2).

Many of the layers in the Map Layers list can easily be downloaded. Simply

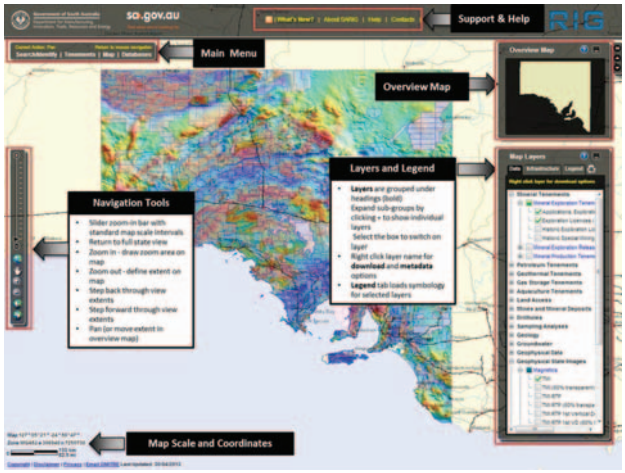


Fig. 1. *The SARIG window shows a map of South Australia, along with a series of layers that can be switched on and off.*

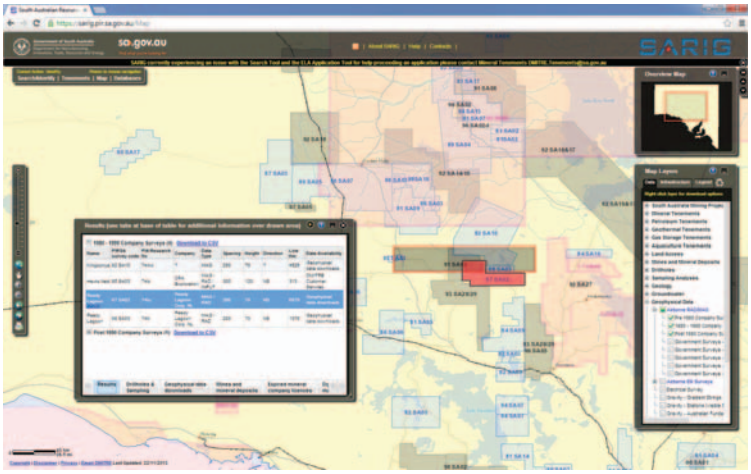


Fig. 3. *Using the Identify tool to draw a box around an area of interest allows the user to view information regarding those surveys in that area.*

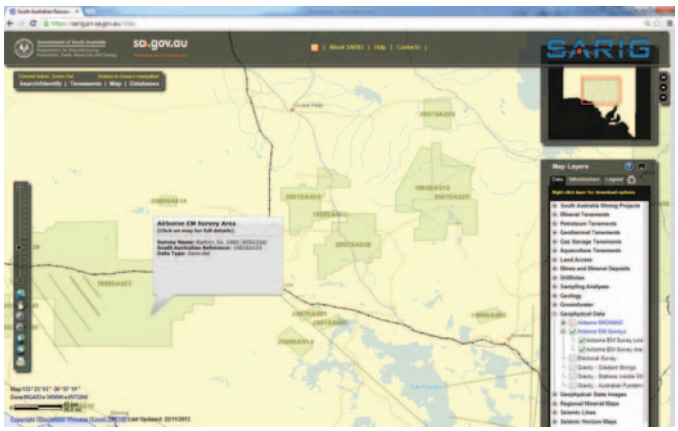


Fig. 2. *Switching on a layer and hovering your mouse above a feature allows a pop-up window to give the user some basic survey information.*

Fig. 4. *The Geophysical Data Downloads tab allows the user to specify geophysical data they'd like to search for in a specified search area.*

right click on the layer name and select download. By downloading state geophysical imagery in this way the user has the choice to download imagery of the entire state as an ER Mapper grid or a geo-referenced '.tiff' image.

Potential field data

To download portions of the state images, or individual surveys, the user should use the Identify tool located in the Main Menu (shift-i, or use the first tool on the top left-hand-side of the screen), then draw a box covering part of the survey that interests you (see Figure 3).

A window will appear containing information regarding the survey, including the line spacing and flight height. Most surveys will have a survey code, a string of text in the form yyyySAxxx, where yyyy is the year of the survey, SA signifies the state, and xxx is simply a number to differentiate the survey from other surveys undertaken that year. Some older surveys may still be in the form yySAxx, however the surveys match, e.g., 1988SA001 is the same as 88SA01.

At the base of this window are a series of tabs. The third tab from the left is labelled Geophysical Data Downloads. Clicking on this tab opens a search tool (Jetstream software from Intrepid Geophysics) where the user can select specifically what geophysical data to download in the current Search Extent. The Search Extent is defined by the red box drawn with the Identify tool, alternatively the user can type coordinates in manually (see Figure 4).

The user needs to select a Theme (Gravity, Magnetics, Radiometric or AEM), a Format (ASCII or Grid), A Projection (Geodetic, MGA52, MGA53, MGA54) and Datum (GDA94 or AGD66). Clicking of the Perform Search button will open a new tab or window (depending on your browser) containing a list of all surveys in your search area, not just from the layers selected in the Map Layers area (see Figure 5).

(As an aside: ASCII data has been prepared on a survey-by-survey basis. Raw contractor data is imported into Intrepid, Quality Controlled, and when downloaded it is supplied as ASEG-GDF2 compliant ASCII data. All Grid data is being clipped from pre-prepared state images. GSSA geophysicists recognise that different surveys are best gridded at different resolutions, and are preparing individual grids for download too. These individual grids should be available for download in May 2014.)

Each survey listed includes an indication of survey size, the date of the survey, and the option to look at a thumbnail of the survey. By expanding the + symbol next to the survey code the user can select individual fields to download. By default all fields are downloaded.

To download a dataset, simply select the Download data tick box, enter your email address and click on Download results. The Intrepid software will clip the survey to the user's search area and place it in a zip file, and send an email to the given email address with a link to the zip file. The process usually takes only a few seconds, and will rarely take more than a few minutes. (Large datasets will take longer to prepare, and heavy traffic on the website may slow the process down.)

As well as the survey data, zip files will include survey metadata, and where available, the contractor's report for the survey.

Seismic data

SARIG contains over 17700 seismic lines, over 8000 with processed SEG-Y data. Information regarding these lines can be viewed by first switching on the layer (2D lines with SEG-Y data) under the Map Layers and hovering the mouse above individual seismic lines. A pop-up window will appear with some basic information regarding the survey and line in question.

Using the Identify tool, the user can select a line, or lines, and draw a box around it, or them (see Figure 6). The results window that appears will contain metadata for the line, and an option to either view the line as a jpeg image or download the SEG-Y file (see Figure 7). The image is representative only as the data has been adjusted to always fit an A4 page.

More information on available seismic data can be found in MESA journal 62 (September 2011) pages 21 to 24.

The original Shotpoint data is available on request, however, as these datasets are large we ask the users to contact customer services (details at end of article) in the first instance.

Petrophysics

Petrophysical data (specific gravity and magnetic susceptibility; see Figure 8) are available in many drill-holes, and as the GSSA geophysicists populate their petrophysical database the data becomes available online. Drill-holes with petrophysical data can be viewed by the Petrophysical drill hole map layer. Using this layer and the Identify tool the user can access the map layer attribute information which provides a drill-hole

Fig. 5. *The list of surveys in the search area is not dependant on which layers are currently switched on in the map screen: all surveys are listed fitting the search extent and criteria.*

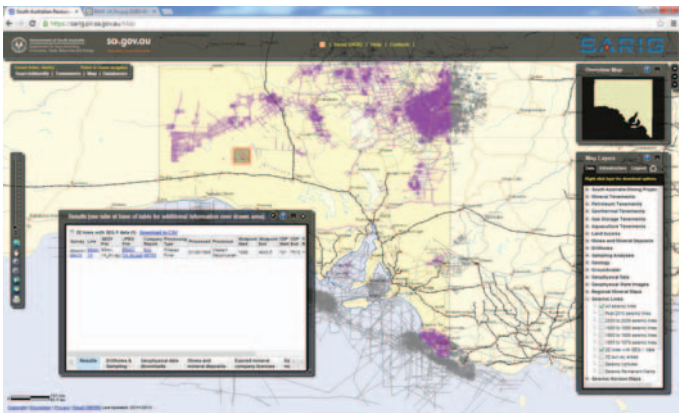


Fig. 6. *The position of seismic lines are viewable in SARIG and survey information is viewable using the Identify tool.*

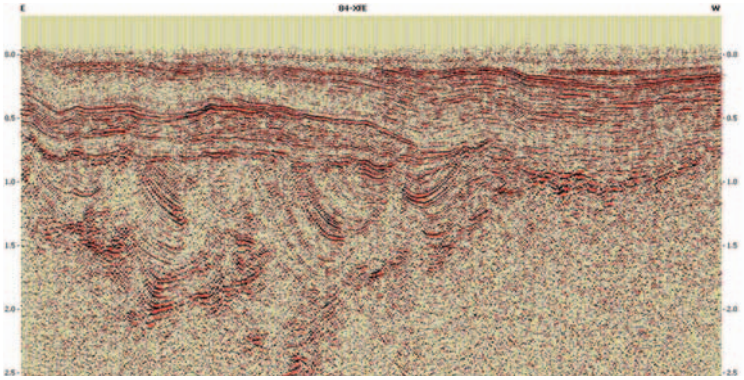


Fig. 7. *Jpeg images – like this one from the Arckaringa Basin – are quickly accessible for over 8000 seismic lines in South Australia.*

Fig. 9. *Petrophysical information includes Specific Gravity and Magnetic Susceptibility data.*

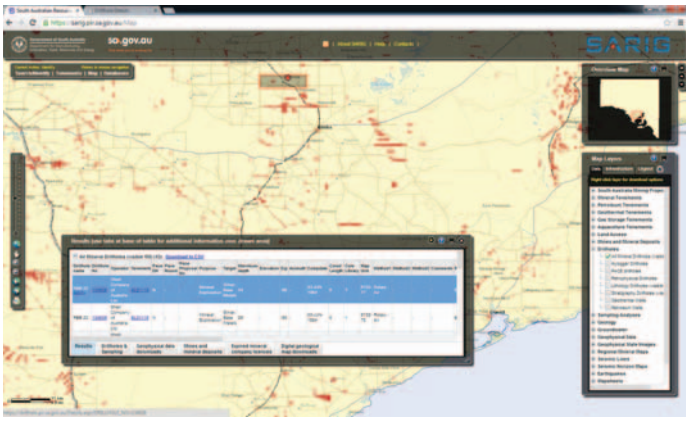


Fig. 8. *Using the Identify tool over drill-holes will allow the user to view drill-hole information.*

Fig. 10. *Magnetotelluric data is searchable and '.edi' files are downloadable through SARIG.*

hyperlink (see Figure 9). By clicking on this link the user is taken to a new window that contains a series of tabs – one of which is labelled Petrophysics. If this tab is greyed out it means that no data is yet available for this hole, but may be forthcoming in the future.

Where petrophysical data is available the user should expand the + symbol to view the data. Data can be copied directly from the screen, or there is a print details option at the bottom of the screen.

Magnetotellurics

The magnetotelluric (MT) spatial data layer is listed under Map Layers, Geophysical Data, and Electrical Survey. Each point shown on the map is an MT station. Raw MT data is large and isn't downloadable through SARIG. As with seismic data please contact customer services (details at end of article) if you need to acquire this data.

However, SARIG does allow you to download processed '.edi' files and survey specifications using the Identify tool and following the hyperlinks in the results window (see Figure 10).

Other data

A wealth of geophysical information is available on SARIG, including earthquake information, Australian Fundamental Gravity Network (AFGN) sites, seismic horizon maps and potential field gradient strings. Other geophysical data such as ground magnetics and down-hole electromagnetic (DHEM) data have not yet been incorporated into the SARIG spatial layers, but are usually attached to open file reports (envelopes) that are searchable using the Publications and Reports option under the Databases tab.

An exhaustive list of all geophysics available on SARIG is too extensive to include here, so we invite the user to explore SARIG at their leisure, or perhaps attend a free training session at the DMITRE offices. If you experience any technical difficulties using SARIG, or if you're interested in attending a SARIG training course, please contact DMITRE customer services (resources.customerservices@sa.gov.au).

Geological Interpretation of Aeromagnetic Data

by David J. Isles and Leigh R. Rankin
Publisher: CSIRO Publishing, Collingwood, Vic., 2013 (on behalf of the ASEG)
ISBN: 9780643098091 (CD-ROM)

The e-book available in PDF format on CD-Rom, *Geological Interpretations of Aeromagnetic Data*, integrates aeromagnetic survey data, geological data, geological interpretations, valuable career history lessons learnt, combined with Isles and Rankin's engaging and practical writing style to create a volume every geoscientist should have on their top shelf. Yes, every geoscientist. The point is made, with examples, of how aeromagnetic data is a valuable exploration tool when used with a good understanding of geology and a multidisciplinary approach to interpretation is undertaken.

> *The cornerstone of this book is a set of worked examples of 'real-life' aeromagnetic interpretations compiled by the authors for their established short course workshop.* – Isles and Rankin (2003).

Preface, Acknowledgement and Chapter 1 Introduction

An informative Preface explains why this book is for you, and it is for every student of the geosciences and every professional who will work with someone new to aeromagnetic data. The Acknowledgements page is an authentic appreciation recognising the collaboration, depth of knowledge, skill and exploration history that is contained within the book. Chapter 1, the Introduction, outlines the necessity of bridging the gap between geophysical data and geophysicists with geological data and geologists, or rather the bringing together of expertise to formulate evidence-based geoscientific results.

Chapter 2 Basic physics

Definitions of the Earth's magnetic field, magnetic susceptibility, magnetic induction and the Curie point are succinctly given in Chapter 2 in a no-fuss, no scary mathematical formulas way. Concepts including IGRF, dipoles and magnetic field asymmetries, depth effects, depth estimation, dip and plunge effects, anomaly superposition, resolution, sensor–source distance ambiguity are fully described, with references and clear figures utilising a recurring model.

Real-world context is illustrated within the following example:

> *The model, a rectangular prism 800 m long ('strike length'), 200 m wide and 500 m in vertical extent, magnetic susceptibility of 0.03 SI (roughly 1% 'magnetite').* – Isles and Rankin (2003).

Care is taken to educate the reader using examples more probably found as well as explaining limitations to the techniques discussed.

Chapter 3 Magnetisation of rocks

Chapter 3 describes induced magnetisation and magnetic susceptibility; distribution of magnetic minerals; the less common and more complex forms of magnetisation and; measuring magnetisation in outcrop or drill core. Geological processes that influence the magnetic signature of the rock including bulk rock geochemistry; iron-bearing mineralisation and the different types of magnetisation, as well as the geological processes that influence magnetic minerals (e.g. sedimentation, primary fractionation, metamorphism, metasomatic alteration, deformation and weathering), are explained geochemically. Again, detailed explanations are followed up with informative figures of aeromagnetic data overlain with surface geology.

Chapter 4 Structural analysis from aeromagnetic data

Chapter 4 examines into the types of magnetic signatures and structural 'patterns' that are encountered during an analysis of aeromagnetic data at all scales. The nature of geological contacts, deformational structures, faults, shears and fold morphology are discussed with a plethora of solid illustrations. A step-wise interpretation and iteration approach is promoted where a logical sequence of interpretations are utilised to move from objective observation to more evidence-based interpretation.

Chapter 5 Data acquisition and processing

Chapter 5 considers all of the important details for planning, acquisition and processing of aeromagnetic surveys, and provides valuable guides to conduct a safe and effective campaign. Chapter 5 details: survey planning – survey shapes, sizes, line orientations, spacing, flying height and safety; data acquisition; routine processing; numerical transformations and filters as well as data products and their use. The chapter is a thorough synopsis educating the reader about

> *… the critical parameters that determine the interpretability of a dataset - line spacing and flying height and, to a lesser degree, line orientation and survey outline shape.* – Isles and Rankin (2003).

Chapter 6 Observation methodology

Chapter 6 covers the methodology message very clearly.

> *Careful, considered and comprehensive observations, duly recorded, are the essence of high-quality interpretation. Be familiar with the regional and local geology. Record geological features that have magnetic expressions, not their magnetic responses. Use other datasets to help understand the geology as reflected by the magnetic data, and to assist with your observations on the aeromagnetic imagery. Be objective. Expect your observations to challenge and extend existing geological knowledge.* – Isles and Rankin (2003).

Chapter 7 Integration methodology

Chapter 7 provides a user-friendly methodology to incorporate and integrate surface geological mapping and aeromagnetic survey data with other relevant data including: radiometric, gravity, seismic, electromagnetic and satellite–airborne 'reflectance' data. Each method is briefly described and includes capabilities and limitations. Guidelines

are provided on how to start a solid geology map.

Chapter 8 Quantitative techniques and their role in interpretation

Chapter 8 defines and provides examples of: forward modelling and inversion for simple and complex systems; depth determinations and worming. The point is made that when the best available geological, geophysical and petrophysical knowledge is used, quantitative techniques add substantial value to interpretation. Accompanying figures for Chapter 8 highlight various quantitative methods and their outputs.

Chapter 9 Interpretation strategies

Chapter nine reinforces the importance of the regional geological setting and moves towards targeting and field-testing initial interpretations. Apparent conflicts between aeromagnetic data and outcropping geology are discussed so apparent conflicts can be resolved. The importance and practicalities of recording, presenting, documenting, capturing GIS layers and the eventual final presentation are discussed.

Chapters 10–13 Case studies

Chapter 10, 'Aeromagnetic data in sedimentary basins', emphasises the range of geological information that modern, high-resolution aeromagnetic data can add to sedimentary basin studies. Specific examples include: Cliff Head offshore Western Australia, exploring for oil; and, the Galmoy lead-zinc district in Ireland, mapping shallow carbonates. Chapter 11, 'Menzies-Comet Vale-Goongarrie case study- Achaean granite-greenstone terrain', details a real-life aeromagnetic interpretation for gold and nickel. Thirteen new targets are identified through the worked example. Chapter 12, 'Pine Creek–Golden Dyke case study – folded sedimentary sequence with mineralised granites', shows how integrating various datasets identifies 11 new target areas and exposes new faults, folds and alteration zones. Chapter 13, 'Amadeus Basin case study – Palaeozoic sedimentary basin with complex thrust margin', is an excellent case study where the sedimentary basin has magnetic sources of various ages, geological affinities and depths, poor outcrop and limited ancillary data. This example highlights the cost-effectiveness of high resolution aeromagnetic surveys.

> *The book has evolved from a short course created to address the demand from exploration geologists who, faced with an explosion of high-resolution aeromagnetic data in the Australian gold and base-metal provinces in the early 1990s, recognised the need to take ownership of the interpretation function on their project areas.*
> – Isles and Rankin (2003).

Pricing and purchasing

ASEG: Please visit the ASEG website to download an Order Form (www.aseg.org.au/aseg-books).

SEG: Please visit the SEG website (www.seg.org/resources/publications/books; Catalog #159A).

Reviewed by Marina Costelloe
actsecretary@aseg.org.au

April			**2014**
21–24	CPS/SEG 2014 Conference: Advancing Geophysical Innovation http://member.seg.org/Default.aspx?TabId=319	Beijing	China
May			**2014**
28–30	130th SEGJ Conference http://www.segj.org	Tokyo	Japan
June			**2014**
16–19	76th EAGE Conference and Exhibition incorporating SPE EUROPEC 2014 http://www.eage.org	Amsterdam	The Netherlands
20–23	6th International Conference on Environmental and Engineering Geophysics (ICEEG2014) http://tdem.org/iceeg2014/	Xi'an	China
18-22	GeoBaikal 2014 Exploration and Field Development in East Siberia http://www.eage.org	Irkutsk	Russia
September			**2014**
15–17	EAGE Near Surface Geoscience 2014 20th European Meeting of Environmental and Engineering Geophysics of the Near Surface Geoscience Division of the EAGE http://www.eage.org	Athens	Greece
28 Sep–2 Oct	2014 Canadian Geotechnical Conference *Conference website pending. Please email cgs@cgs.ca for additional information or visit the CGS website (www.cgs.ca).*	Regina	Canada (Saskatchewan)
October			**2014**
26–31	SEG International Exhibition and 84th Annual Meeting http://www.seg.org	Denver, CO	USA
27–29	KazGeo 2014 : From Challenges to Opportunities http://www.eage.org	Almaty	Kazakhstan
December			**2014**
10–12	The 8th International Petroleum Technology Conference (IPTC) http://www.iptcnet.org	Doha	Qatar
January			**2015**
11–14	3rd South Asian Geosciences Conference and Exhibition http://geo-india.com/	New Delhi	India
February			**2015**
15–18	ASEG-PESA 2015: Geophysics and Geology together for Discover 24th International Geophysical Conference and Exhibition http://www.conference.aseg.org.au/	Perth	Australia
June			**2015**
1–4	77th EAGE Conference and Exhibition 2015 http://eage.org	Madrid	Spain
October			**2015**
18–23	SEG International Exhibition and 85th Annual Meeting http://www.seg.org	New Orleans, LA	USA
December			**2015**
7–9	The 9th International Petroleum Technology Conference (IPTC) http://www.iptcnet.org	Doha	Qatar
October			**2016**
16–21	SEG International Exhibition and 86th Annual Meeting http://www.seg.org	Dallas, TX	USA

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

Advertising and editorial content in *Preview* does not necessarily represent the views of the ASEG or publisher unless expressly stated. No responsibility is accepted for the accuracy of any of the opinions or information or claims contained in *Preview* and readers should rely on their own enquiries in making decisions affecting their own interests. Material published in *Preview* becomes the copyright of the ASEG.

Permission to reproduce text, photos and artwork must be obtained from the ASEG through the Editor. We reserve the right to edit all submissions. Reprints will not be provided, but authors can obtain, on request, a digital file of their article. Single copies of *Preview* can be purchased from the Publisher.

All editorial contributions should be submitted to the Editor by email at jthe1402@bigpond.net.au. For style considerations, please refer to the For Authors section of the *Preview* website at: www.publish.csiro.au/journals/pv.

Preview is published bi-monthly in February, April, June, August, October and December. The deadline for submission of material to the Editor is usually before the 15th of the month prior to the issue date. The deadline for the June 2014 issue is 8 May 2014. For the advertising copy deadline please contact Doug Walters on (03) 9662 7606 or doug.walters@csiro.au.

GRAVITY

DAISHSAT is the leading provider of GPS positioned gravity surveys in Australia with the latest acquisition equipment and most experienced staff, resulting in the highest quality data for our clients. Contact David Daish for your next gravity survey.

- Ground and helicopter borne gravity surveys
- Precision GPS surveying
- Image processing
- Terrain corrections
- Operating Australia wide with support bases in Western and South Australia
- Specially developed vehicles for safe efficient cross country surveying

T: 08 8531 0349 F: 08 8531 0684
E: info@daishsat.com
www.daishsat.com

DAISHSAT
GEODETIC SURVEYORS

World first piston engine helicopter stinger installation for low cost, high quality airborne radiometric and magnetic data collection

Helicopter
- 30% the cost of existing helicopter platforms
- Close transect spacing
- Safe operations in rugged terrain
- Accurate terrain draping
- Remote site operations

Fixed wing
- High efficiency large area coverage
- Remote airstrip operations

Contact us for your next airborne survey
T 08 8532 5973 F 08 8531 0684
E info@aerosystems.com.au
www.aerosystems.com.au

AEROSYSTEMS

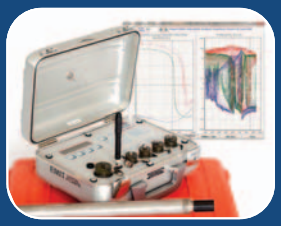
AEROSYSTEMS

Is it down there?

Find out.

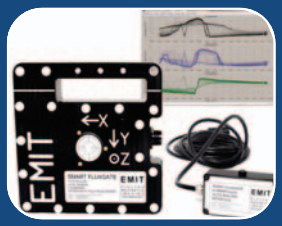
SMARTem24

16 channel, 24-bit electrical geophysics receiver system with GPS sync, time series recording and powerful signal processing



DigiAtlantis

Three-component digital borehole fluxgate magnetometer system for EM & MMR with simultaneous acquisition of all components

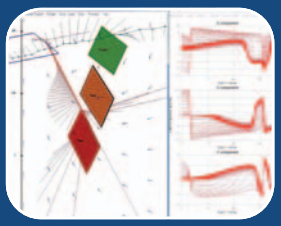


SMART Fluxgate

Rugged, low noise, calibrated, three-component fluxgate magnetometer with recording of Earth's magnetic field, digital tilt measurement and auto-nulling

SMARTx4

Intelligent and safe 3.6 kW transmitter for EM surveys, clean 40A square wave output, inbuilt GPS sync, current waveform recording, powered from any generator



Maxwell

Industry standard software for QC, processing, display, forward modelling and inversion of airborne, ground and borehole TEM & FEM data

EMIT
www.electromag.com.au

ELECTRO MAGNETIC IMAGING TECHNOLOGY

6 / 9 The Avenue
Midland WA
AUSTRALIA 6056
✆+61 8 9250 8100
info@electromag.com.au

Advanced electrical geophysics instrumentation and software