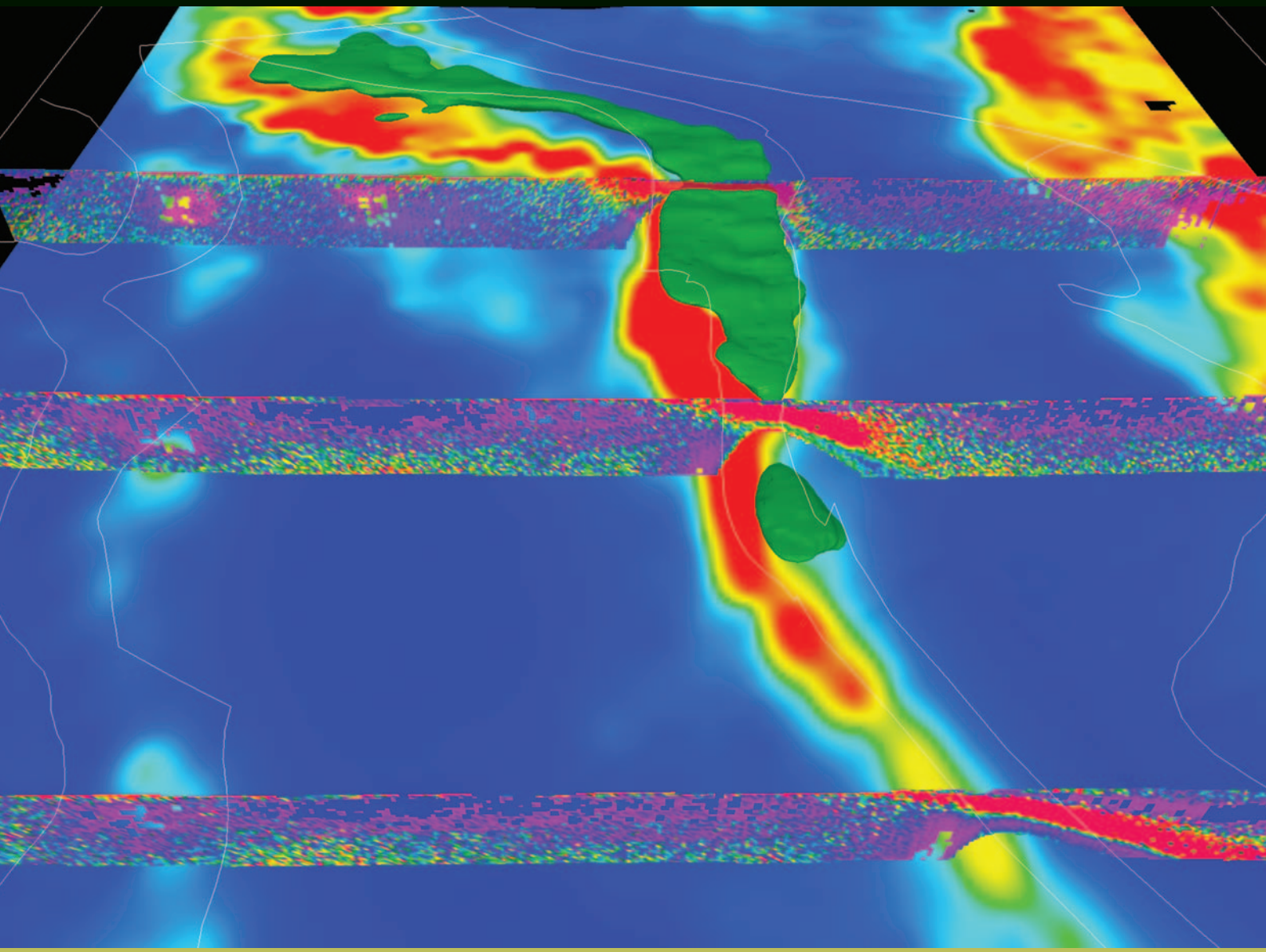
AUGUST 2012 • ISSUE 159
ABN 71 000 876 040 ISSN 1443-2471

PREVIEW

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS



NEWS AND COMMENTARY

23rd IGC: ASEG-PESA 2013 update
AAS UNCOVER: ASEG response
AGC: Dr Neil Williams reports

FEATURE ARTICLES

Adelaide gamma-ray model logging pits
3DEMI: capabilities and outcomes

Downhole EM, MMR and IP Surveys

Surface EM and MMR Surveys

Surface IP Surveys including 3D

Geophysical Consulting

Instrument Repair

VORTEX GEOPHYSICS

www.vortexgeophysics.com.au

4/133 Kelvin Rd, Maddington, Western Australia 6109
PO Box 3215, Lesmurdie, Western Australia 6076

Phone: (08) 9291 7733 Fax: (08) 9459 3953
Email: sales@vortexgeophysics.com.au

PREVIEW

ADVERTISERS INDEX

Aerosystems	3
Alpha Geoscience	29, 30
Archimedes Financial Planning	30
ASEG	11, 13, 19
Baigent Geosciences Pty Ltd	30
Borehole Wireline	30
Daishsat	3
EMIT	OBC
Elliott Geophysics International Pty Ltd	30
Fairfield Nodal	8
Flagstaff GeoConsultants	30
Fugro Airborne Surveys	5
Fugro Ground Geophysics	16
Fugro Instruments	10
GBG Australia	30
GEM Advanced Magnetometers	4
GEM Geophysics	2
Geophysical Software Solutions Pty Ltd	30
Geosensor	30
GPX Surveys	23
Groundwater Imaging	30
MagneticEarth	31
Minty Geophysics	31
Mira Geoscience	31
Monex GeoScope Pty Ltd	12
Outer-Rim Exploration Services Pty Ltd	31
OYO Geospace	IBC
Systems Exploration (NSW) Pty Ltd	31
TechnoImaging	18
Tensor Research	31
Thomson Aviation	7
Vortex Geophysics	IFC
Zonge	14
ZZ Resistivity Imaging Pty Ltd	31

2012 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
Geoscience Australia
Geosensor Pty Ltd
Geosoft Australia Pty Ltd
Geotech Ltd
Haines Surveys Pty Ltd
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

3D mapping of graphite-rich phyllite (see article beginning p. 24) (image courtesy of Chris Wijns, 3DEM presentation).

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

P

CONTENTS

Editor's Desk 2

ASEG News

President's Piece 4
Executive Brief 6
People 7
Branch News 9

News

Conferences and Events 11
Research 12
Geophysics in the Surveys 15
General Announcements 17

Feature Papers

Adelaide model logging pits 20
3D EM inversion: capabilities and outcomes 24

Data Trends 28
Business Directory 30
Calendar of Events 32

Editor
John A. Theodoridis
Tel: (03) 9897 3825
Email: jthe1402@bigpond.net.au

Associate Editors
Book Reviews: Mike Middleton
Email: mike.middleton@dmp.wa.gov.au

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

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

Minerals and Environment: Greg Street
Email: gstreet@intergeo.com.au

Petroleum: Mick Micenko
Email: micenko@bigpond.com

Web Waves: Andrew Long
Email: andrew.long@pgs.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
helen.pavlatos@csiro.au

Advertising
Wendy Wild
Tel: (03) 9662 7606
Email: wendy.wild@csiro.au

Vision statement

John A. Theodoridis

Many years ago, when I had been possessed by an antisocial fetish for clocks and watches, as many a schoolboy did no doubt, I read a rather profound statement on the art of watchmaking: a good watchmaker merely contributes to design; the complicated mechanism itself develops over time through innumerable incremental refinements – in effect, evolution not revolution! It is this same philosophy that shall guide me in my new role as Editor and in so doing give recognition to the achievements of my predecessors: Ann-Marie Anderson-Mayes and David Denham (although, I dare say my shirt isn't as flamboyant as David's!). For those who have been dutiful enough to retain their early copies of *Preview*, I encourage you to flip through these early editions to come to appreciate how careful refinement has brought *Preview* to its current form. But, in my first contribution I would like to reintroduce our 'Letters to the Editor' section, and I invite all our readers to view *Preview* as a virtual tea-room within which you can discuss at leisure matters of relevant interest. But children, play nicely and no squabbling over the legitimacy of climate science, as it runs against the grain of the ASEG's respective impartiality.

In earlier issues there has been a great deal of discussion on the state of science in education – canvassing aspects such as depth, authenticity and pedagogy. Need I say that many of our readers have expressed concern that science in general, never mind geophysics, is not properly dignified within our current education system. But I can ensure my troubled readers that your concerns and protestations aren't entirely in vain. A few years ago I tried my hand at teaching and came face-to-face with a system in a state of flux – one such progression: inquiry-based learning displacing traditional 'chalk-n-talk' pedagogy. Now, what one needs to fully appreciate is that the low take-up of new strategies such as these has little to do with a non-progressive teaching mass, but more to do with limited funding and ever-increasing class sizes resulting in many teachers being chronically time and resource poor. It seemed to me that teachers by virtue of circumstance are compelled to teach from the book and by the book – making for dry and dull lessons. Straying beyond the safe confines of a textbook is a risky and time-consuming endeavour (job security inclusive) – although stimulating and highly rewarding for the student. Therein lays the great dilemma of science education! One of the most illuminating and uplifting of all experiences during my brief time in teaching occurred when a teacher who helped coordinate change at his school said that to do so is risky, but we did so in response to a call from students (paraphrasing their declaration): we want an education that is global in context and outlook, but relevant locally – his students wanted an education that is both authentic and relevant.

Some issues ago, my predecessor Ann-Marie Anderson-Mayes (see *Preview*, Issue 152, p. 25) voiced her astonishment that few teachers, if any at all, are members of professional societies representing their respective field of expertise. This is no slight against teachers, but a point of concern that many in technical areas are missing out on vital support networks and resources. She went on to encourage teachers to join these societies and become acquainted with the abundance of quality online journals – *Preview* included. So it is here I come full circle. My second little contribution shall be to foster the educational role of *Preview* in a twofold manner: I shall endeavour to extend the research section to include regular submissions by our graduate and postgraduate students, and reinforce our partnership with TESEP to build a reliable resource kit for secondary and primary schoolteachers. However, all this is to be achieved authentically through embedding these articles within a resource that serves the geophysical community entire.

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

A smorgasbord of conferences

I'd like to start my piece in this edition of *Preview* by thanking those people that took the time to respond to my last President's piece, on asking how you read your journals. From this feedback it is clear that we have good support for moving towards a digital-only option for journals when we send out the subscription notices in December.

Talking of subscriptions, each year the secretariat spends 6 months chasing up late payers, most of whom do eventually renew their subscription. The reasons for late payment vary, but a common refrain is that the person concerned has moved and their contact details have not been updated. We are working to make this process a little easier within the new website. However, given that the renewal process each year chews up a considerable amount of the secretariat's time, I would welcome any suggestions you may have that could increase the number of people paying their subs at the first call. No need to send a new cattle prod – I just need more batteries! I personally think we are being way too soft in allowing membership rights to continue beyond the renewal date. Maybe a sudden decrease in the amount of ASEG-related mail in people's mailboxes would trigger a reaction – hopefully not one of relief!

Carina tells me that the new website is ready for testing and will hopefully go live sometime in the 5 week gap between me writing this and it landing on your desks. I look forward to crossing 'fix the website' off the Fed-Ex job list after Phil Harman put it there over 2 years ago during his term as President! There should also be a welcome drop in the email traffic to the ASEG Complaints Department (i.e., me).

Many of you will be aware of the UNCOVER initiative coming out of the Australian Academy of Science. Some of you might have also attended the associated information sessions. Although the goals of the project are worthy, they are currently not much more than motherhood statements. As an industry outsider at their information sessions, it was hard to not get the impression that it was all about a bunch of academics fighting over a funding trough. On behalf of our members, the Fed-Ex, guided by Barry, have responded to the call for input and that response is published in this edition of *Preview* for your benefit. I understand that the UNCOVER working group are now fine tuning their proposal and that there will be a revised proposal distributed. We will keep you posted on its progress.

Conference devotees have a smorgasbord of choice laid out for them over the next few months. For those who like things induced, the 21st EM Induction Workshop will have just happened. Then, in early August, again possibly before you receive this, the 34th International Geological Congress (IGC) will be (or will have been) held. These two events represent opposite ends of the spectrum in terms of size, diversity of topics and numbers of papers, but both

have a lot to offer. The ASEG is supporting the EM Induction Workshop in Darwin through sponsorship of student travel, and in concert with Australia's other earth science organisations is financially supporting the IGC in Brisbane, through the Australian Geoscience Council (AGC). We also have a number of volunteers, led by Mike Smith and David Denham, on organising committees and the various subcommittees required to stage this huge event. I hope that both these were great successes and that the delegates walked away with a fire in their belly for more geophysics.

In September the Korean SEG are holding their first International Conference on the resort island of Jeju off the south coast of Korea – the ASEG is supporting this conference through our volunteers. Koya Suto is on their International Advisory Board and I am on their technical papers committee. Although smaller and shorter than one of our conferences, this conference offers a different perspective from what we usually see and the Island venue looks great! See http://2012symp.seg.or.kr/ for more information.

The second half of next year will also be busy with our own conference on in Melbourne (see notice in this edition), WABS in Perth, SAGA followed by AEM 2013 in South Africa and the first in what is planned to be a series of Pan-Pacific, Near Surface conferences. I'll have more to say about the Eureka Moment in Melbourne in future editions as the committee works to bring it to us.

The Near Surface Conferences are being organised jointly by the SEG, KSEG, SEGJ, CGS and the ASEG. The first Conference will be hosted by the CGS in China, followed 2 years later by the SEG in Hawaii. ASEG will be supporting the conference through our volunteers as well as sharing in the risk and reward on the financial side. Koya Suto is on the organising committee and Binzhong Zhou has volunteered to help with the technical programme committee. As this conference is likely to draw smaller delegate numbers than our traditional conferences, we can consider non-traditional venues when it comes our turn to host the event – possibly in 2017. For those states and territories that miss out on hosting ASEG conferences, this could prove advantageous and engaged either individually or jointly. Although 2017 seems a lifetime away, organisations will have to start in late 2015, so have a think about it at state level and make a case if you are interested.

We are always on the lookout for volunteers to assist with these sister-society conferences. So if it is something you have an interest in, and are willing to help, get in touch with either Koya Suto or me.

Until next edition, happy hunting!

Kim Frankcombe
kfrankcombe@iinet.net.au

ASEG Federal Executive 2012–13

President, Conferences & Technical Standards:
Kim Frankcombe
Tel: (08) 6201 7719
Email: kfrankcombe@iinet.net.au

President Elect & Research Foundation:
Koya Suto
Tel: (07) 3876 3848
Email: koyasuto@gmail.com

Vice President Education: Mark Tingay
Tel: (08) 8303 3080
Email: mark.tingay@adelaide.edu.au

Immediate Past President & Membership:
Dennis Cooke
Tel: (08) 8338 7335
Email: dennis.a.cooke@gmail.com

Past President & 1st AGC Representative:
Michael Asten
Tel: 0412 348 682
Email: michael.asten@sci.monash.edu.au

Secretary: Barry Drummond
Tel: (02) 6254 7680
Email: barrydrummond@bigpond.com

Treasurer: Reece Foster
Tel: (08) 9378 8023
Email: reece.foster@groundprobe.com

Publications: Phil Schmidt
Tel: 0410 456 495
Email: phil@magneticearth.com.au

State Branch Representative: Philip Heath
Tel: (08) 8463 3087
Email: philip.heath@sa.gov.au

Webmaster: Carina Kemp
Tel: 0412 514 075
Email: asegwebmaster@gmail.com

Honours and Awards & 2nd AGC Representative:
Greg Street
Tel: (08) 9388 2839
Email: gstreet@intergeo.com.au

Chair people (not on FedEx) for Standing Committees

Research Foundation:
Philip Harman
Tel: (03) 9909 7655
Email: phil.harman@gop.com.au

ASEG History Committee:
Ann-Marie Anderson-Mayes
Email: ann-marie@mayes.com.au

Conference Advisory Committee:
Michael Hatch
Email: michael.hatch@adelaide.edu.au

Honours and Awards Committee:
Andrew Mutton
Email: andrew.mutton@bigpond.com

Technical Standards Committee:
David Robson
Email: david.robson@industry.nsw.gov.au

ASEG BRANCHES

ACT

President: Ron Hackney
Tel: (02) 6249 5861
Email: ron.hackney@ga.gov.au

Secretary: Marina Costelloe
Tel: (02) 6249 9347
Email: marina.costelloe@ga.gov.au

New South Wales

President: Mark Lackie
Tel: (02) 9850 8377
Email: mlackie@els.mq.edu.au

Secretary: Bin Guo
Tel: (02) 8079 1205
Email: bguo@srk.com.au

Queensland

President: Fiona Duncan
Tel: (07) 3024 7502
Email: fiona.duncan@bg-group.com

Secretary: Kate Godber
Tel: (07) 3010 8951
Email: kate.godber@groundprobe.com

South Australia & Northern Territory

President: Philip Heath
Tel: (08) 8463 3087
Email: philip.heath@sa.gov.au

Secretary: Michael Hatch
Tel: 0417 306 382
Email: michael.hatch@adelaide.edu.au

NT Representative: Jon Sumner
Tel: (08) 8999 7816
Email: jonathan.sumner@nt.gov.au

Tasmania

President: Michael Roach
Tel: (03) 6226 2474
Email: michael.roach@utas.edu.au

Victoria

President: Asbjorn Christensen
Tel: (03) 9885 1378
Email: asbjorn_n_christensen@yahoo.com

Secretary: John Theodoridis
Tel: 0427 103 398
Email: jthe1402@bigpond.net.au

Western Australia

President: Anne Tomlinson
Tel: (08) 6254 5000
Email: anne@sgc.com.au

Secretary: CASM
Tel: (08) 9427 0838
Email: asegwa@casm.com.au

The ASEG Secretariat

Centre for Association Management (CASM)
36 Brisbane St, 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 13 new individual members (see table) and one new corporate member to the Society. These memberships were approved at the Federal Executive meetings held in May and June 2012.

Name	Organisation	State/Country	Member grade
William Philip Hagger	The University of Adelaide	SA	Student
Keith Peter Fisk	Geotech Airborne Pty Ltd	WA	Active
Barbara Liss	Newexco Services Pty Ltd	WA	Active
Maria Gabriela Montanez Camacho	Urdanelagazprom	Venezuela	Associate
Terrance John Lee		ACT	Retired
Sofia Alexandra Correia Lopes	Curtin University	WA	Student
Jeridene Rosanna Foreman	University of Adelaide	SA	Student
Romana Dew	University of Adelaide	SA	Student
Jeremy William Hooper	GroundProbe Geophysics	WA	Active
Matthew Kovacevic	Curtin University	WA	Student
Mahesh Raghvani	Curtin University	WA	Student
Lynelle Marie Beinke	Mithril Resources	SA	Active
Hayan Nasreddin	Santos Ltd	SA	Active

Take a closer look. When we say cable free, we mean it.

Seismic cables create big risks, both human and environmental, especially in treacherous terrain like this. That's why you should know about our true cable-free ZLand® nodes, the only completely self-contained seismic nodes out there. With absolutely no external components of any kind, your crews work faster and much more safely, recording high-resolution data anywhere on earth. No one else gives you this kind of flexibility, productivity and safety, in one neat little industry-changing package.

fairfieldnodal FairfieldNodal.com

SYSTEMS ACQUISITION LICENSING PROCESSING IMAGING

New South Wales

In May, Peter Hatherly, the 2012 SEG Pacific South Honorary Lecturer, from Coalbed Geoscience Pty Ltd Sydney gave a talk on 'A role for geophysical methods in meeting the resource requirements of the 21st century'. Peter outlined how the geophysical methods used by the Australian coal mining industry provide an excellent example of the emerging role for geophysics in assisting mining companies in meeting the resource requirements of the 21st century. Peter illustrated the varied applications of geophysical methods in coal mining, including those in important new areas such as estimation of greenhouse gas emissions; as well as giving insights into the future directions of mining and the significant roles that geophysics is likely to play in that future. This provoked much discussion.

In June, Steve Collins from ARCTAN Services gave a talk entitled '10 000 line km or bust – logistics of Australia's largest IP survey'. Steve spoke about the undertaking of a broad-scale gradient array induced polarisation near Orange NSW. Steve highlighted the practical difficulties of running such a survey in an area around a major regional city with many thousands of land owners, and associated infrastructure. The talk also briefly covered some of the results to date. Over 50 people attended this talk and much discussion followed the presentation.

An invitation to attend our 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 within the Sydney CBD. Meeting notices, addresses and relevant contact details can be found on the NSW Branch website.

Mark Lackie

South Australia/Northern Territory

On 22 May we welcomed Peter Strauss from AusGeos in Adelaide who presented 'Azimuthal processing of a conventionally acquired Cooper Basin 3D survey'. A full house of 30 people attended, and it was great to see some new faces at the meeting.

On 26 June it was a pleasure to welcome John Hughes from John R Hughes Geophysical Pty Ltd who presented his 2011 ASEG keynote address 'Seismic surveys and marine life: given the positive science and track record, what's the problem?'. With over 30 people attending, it was another full event. The talk was very well received and generated much discussion.

The SA/NT branch is helping sponsor two students to attend the International Geological Congress (IGC) in August 2012. Look out for a summary of their work in a future edition of *Preview*!

We hold technical meetings monthly, usually on a Tuesday or Thursday, at the Coopers Alehouse in Adelaide beginning at 5:30 pm. New members and interested persons are always welcome. For further details, or if you are interested in presenting a talk to the local group, please contact Philip Heath (philip.heath@sa.gov.au). If you are a SA/NT member and are not receiving emails regarding events, please update your details through aseg@casm.com.au.

John Hughes presenting at the Coopers Alehouse. The slushy machine in the background is switched off!

Peter Strauss presenting at the Coopers Alehouse.

Philip Heath

Victoria

On 27 June, Justin Ward from ModernMag presented 'Ground magnetic surveying: economics, equipment, practice and advancements'. Justin provided the attending ASEG Victorian Branch members with great insight into new developments and practises of ground magnetic surveying with very illuminating case studies from both gold and mineral sands exploration.

On 2 August, the ASEG Victorian Branch will host the technical presentation 'Integrating well log, seismic, and CSEM data for reservoir characterisation' by Lucy Macgregor, SEG 2011 Honorary Lecturer, Europe, from Rock Solid Images.

Later in August it is yet again time for the annual PESA–SPE–ASEG mid-winter social evening. This is always a great opportunity to network and socialise with members from our sister societies. Watch out for email flyers specifying the date and venue.

On 13 September, Graeme Beardsmore from Hot Dry Rocks will present 'Geophysical applications of precise temperature measurements' covering recent developments in rapid earth temperature and heat-flow measurements.

All technical meetings are held at the Kelvin Club within Melbourne's CBD. We look forward to seeing many ASEG Victorian Branch members at the coming meetings.

Asbjørn Nørlund Christensen

Western Australia

On 13 June, the WA branch held a joint technical night with the WA Branch of IAH Australia. Geoff Pettifer of GHD presented a talk entitled 'Groundwater catchment characterisation – Bundaberg Integrated Hydrogeology/ Hydrogeophysics Investigation'. In the technical meeting held on 11 July, Andrew Greenwood of Curtin University presented his recently completed doctoral research, 'Hydrophone VSP imaging in hard rock environments'.

ASEG member Chris Wijns represented the geophysics profession on behalf of the society at the miningoilandgasjobs.com expo held at the Burswood Convention Centre on 25 May. Our branch is also looking forward to attending the Hale and St Mary's Schools Careers Expo in a joint geoscience effort with the AIG and PESA.

The WA ASEG branch shall host the European SEG Honorary Lecturer, Dr Lucy Macgregor, on Monday 30 July.

ASEG News

Dr Macgregor shall be presenting her lecture entitled 'Integrating well log, seismic, and CSEM data for reservoir characterisation'. This will be held at our usual venue at the City West Function Centre – Plaistowe Mews, West Perth from 5:30 pm onwards.

Perth will be hosting the EAGE Education Tour 7 (EET7) on 21 August. This one-day workshop is entitled 'Environmental geophysics: everything you ever wanted (needed!) to know but were afraid to ask!', and is presented by Professor Peter Styles of Keele University in the UK. Registration and venue details will follow shortly. More information on the workshop and presenter can be found at http://lg.eage.org/index.php?evp=6922.

Remember, applications for the ASEG WA Award for WA university students are now open. Email asegwa@casm.com.au for award guidelines and an application form.

The date has also been set for the event entitled 'A practical one-day workshop on airborne electromagnetics'. This will be held on Wednesday 7 November at the City West Function Centre. This event is targeted at both geologists and geophysicists and will be a seminar series focussed on practical near-surface and minerals applications of AEM. It will include practical theory, case studies and a review of recent and future developments. Registration details will be available in the coming months.

Anne Tomlinson

ASEG–PESA 2013: 23rd International Geophysical Conference and Exhibition 11–14 August 2013, Melbourne, Australia

The Melbourne Conference Organising Committee is very pleased to announce that this conference will be jointly hosted by ASEG and PESA.

We have secured a booking with the Melbourne Conference and Exhibition Centre (MCEC): 'the centrepiece of Melbourne's new South Wharf development'.

The Professional Conference Organiser selected by the committee is Arinex. We will be dealing with locals based in a Melbourne office and accessing Arinex's national network of in-house specialist services.

The committee will be inviting industry experts to deliver keynote papers to cover topical and important subjects and we will be encouraging case history papers that demonstrate the application of exploration geophysics, particularly those relevant to our theme of the 'eureka moment'. Any members who are willing to help in reviewing submitted papers are invited to contact Mark Dransfield (mdransfield@fugroairborne.com.au).

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

The committee will also be inviting sponsors and exhibitors to join us in making this conference a success and are working on developing attractive sponsorship and exhibition packages.

Expressions of interest may be registered through the conference website: www.aseg-pesa2013.com.au.

Suzanne Haydon
Publicity Subcommittee Chairman

ASEG response to UNCOVER Exposure Draft

The following is a letter to Fiona Leves of the Australian Academy of Science, representing the ASEG in response to the Exposure Draft of 'Searching the deep Earth: a vision for exploration geoscience in Australia'. The reader may view the UNCOVER draft in the 'science policy' section of the Academy's web portal: www.science.org.au. In addition, the reader is invited to recap the four initiatives outlined in the previous issue of Preview *(see Issue 158, p. 20) and the introduction by the ASEG President, Kim Frankcombe, to this letter within the President's Piece of this issue. -Ed*

31 May 2012

Dear Fiona,

Thank you for your invitation to the ASEG to comment on 'Searching the deep Earth: a vision for exploration geoscience in Australia'.

The draft sets out a plan to map the geology of Australia where it is obscured by thick cover rocks. As such it will focus on a large part of Australia where the potential for resources and energy is largely unknown. Should it succeed, the UNCOVER initiative could contribute significantly to the economic well-being of the country.

Within Australia, the role of government geological surveys is to bring new insights into the prospectivity of new areas, and to open them up for exploration by the private sector. The ASEG notes that the UNCOVER initiative is already bringing a focus to the work of the geological surveys, CSIRO and to the programs of some of Australia's leading academic researchers.

The Academy is therefore to be commended for sponsoring the UNCOVER initiative.

Mapping geology under cover is a role that will depend significantly on geophysical expertise. The UNCOVER document acknowledges the role that geophysical data sets will have to play. Geophysical techniques are also the first to be applied to areas under cover during exploration.

The ASEG is the professional society representing the interests of geophysicists in Australia. Our members come from all sectors: industry, government and academic. They will be responsible for putting into practice the scientific disciplines that will be used in the program set out in the UNCOVER initiative, and also in any subsequent exploration under cover.

The ASEG feels sure that the UNCOVER initiative will lead to new insights into the geology of areas under cover that are largely under explored. As a consequence, they are under-drilled and under-sampled geologically. UNCOVER may therefore trigger some industry interest at the area selection stages of their exploration strategy.

However, the ASEG is concerned that as it is currently written, the UNCOVER

Program lacks a particular research focus that will allow industry to explore at the mineral system and prospect scales.

The Australian industry has been successful at exploring under cover. Exploring under cover is expensive, and in the past has largely been done by or with the assistance of major companies that had both the financial capacity and staff resources to explore under cover, persevere and succeed.

However, the industry has changed, with majors pulling out of research and development and relying more on purchasing deposits from small and medium explorers. Small and medium explorers do not have access to large budgets.

Initially exploration under cover must be conducted by using geophysical tools. Only when a drill hole intersects the rocks will the geology and its chemistry be known. Targeting the drill will be done using geophysical anomalies. The anomalies will probably be subtle because of the depths of the targets. Knowing what anomalies to drill will be essential because the drill holes will have to be deep and therefore expensive.

Geophysical tools have been used in resource exploration for decades, and the industry has been successful in developing more sensitive and accurate data gathering tools, data processing algorithms and interpretation tools. The ASEG believes that the gaps that exist in the research set out in the UNCOVER document are: (i) at the regional scale, research that works out how to predict with confidence the geology under cover from regional geophysical data sets; and (ii) the reverse case at the mineral system scale, of turning geological models of mineral systems into models of physical parameters that can be used predictively under cover. These can be interpreted in a sentence here and there, but are not presented coherently and therefore may not in fact be what is intended.

Being able to turn geological knowledge into predictive geophysics at the mineral system scale is very important because empirical exploration under cover is prohibitively expensive, and is not given a priority today and will not be given a priority in the future in Australia over exploring more cheaply in other countries.

Turning geological knowledge into predictive geophysics is an area of research that is beyond the capacity of any exploration company to fund and get returns on its expenditure. It is not a specifically defined role for the geological surveys or CSIRO. It is not undertaken as a coherent program in any university centre of excellence, or across any group of universities. It is an area of market failure.

No systematic, mineral system-based research into physical properties of ore systems based on geological models that can be used predictively by the industry, and especially by small and medium explorers, is being done in Australia. It is not a focus for the Deep Exploration Technologies CRC. It was addressed partly in the former Predictive Mineral Deposits CRC. However, results there were incomplete and not immediately available to the industry as a whole, and initially only to company sponsors of the CRC. As the results reach the open scientific literature they are not in a coherent form useful to small and medium companies.

Therefore, if the UNCOVER initiative is to reach its full potential in stimulating exploration under cover, as implied in its title, it should include a theme that

bridges the gap between geological knowledge of mineral systems and physical property models in a way that can allow predictive exploration using geophysics to target drilling. Only then will the research set out in the fourth theme – The National Distal Footprints Map – be able to prosper. Should the theme we are recommending be included, it is likely to bring a focus to much of the relevant research presently undertaken in Australia in what is presently a disjointed and often invisible way.

It might also help address another concern of the ASEG that is relevant to the future success of UNCOVER, that of declining numbers of geophysicists being educated in Australia, particularly as our national stock of senior geophysicists ages.

The ASEG notes that in addition to the four themes, or maps, set out in the exposure draft for UNCOVER, the original Theo Murphy Think Tank recommended A National Exploration Research Network and an Education and Technology Transfer Program, but these are missing in the UNCOVER exposure draft. Should these be re-instated, they would go some way to addressing the society's concerns. However, to properly address the gaps described above, the research network would have to be directed to mission-driven rather than curiosity-driven research to ensure relevance.

In summary, the UNCOVER initiative will stimulate interest in areas of Australia under cover, but it will not help exploration beyond the initial area selection stage. Parallel research is needed firstly to ensure that the under cover maps are reliably predictive, and secondly to turn new insights derived from the undercover maps into exploration success and economic benefits for the nation. The current CRC model does not seem to be filling this gap.

If you wish to discuss these comments further, please contact either myself or Barry Drummond.

Yours sincerely,
Kim Frankcombe
President, Australian Society of Exploration Geophysicists

Update on Geophysical Survey Progress from the Geological Surveys of Queensland, Western Australia, Northern Territory and New South Wales (information current at 15 July 2012)

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

Table 1. Airborne magnetic and radiometric surveys

Survey name	Client	Contractor	Start flying	Line (km)	Spacing AGL Dir	Area (km^2)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
South Officer 2 (Waigen – Mason)	GSWA	Thomson	28 Jun 10	113 000	400 m 60 m N–S	39 890	100% complete @ 5 Jan 11	6 Jun 12	148 – Oct 10 p24	Data released via GADDS on 28 June 2012
Grafton – Tenterfield	GSNSW	GPX	16 Jun 11	100 000	250 m 60 m E–W	23 000	100% complete @ 6 Nov 11	11 Jul 12	151 – Apr 11 p16	QA/QC of final data in progress
West Kimberley	GSWA	UTS Geophysics	29 Jun 11	134 000	800 m 60 m N–S Charnley: 200 m 50 m N–S	42 000	100% complete @ 11 Dec 11	TBA	150 – Feb 11 p20	TBA
Perth Basin North (Perth Basin 1)	GSWA	Fugro	11 Jun 11	96 000	400 m 60 m E–W	30 000	100% complete @ 18 Dec 11	3 Jul 12	150 – Feb 11 p20	QA/QC of final data in progress
Perth Basin South (Perth Basin 2)	GSWA	Fugro	22 Mar 11	88 000	400 m 60 m E–W	27 500	100% complete@ 7 April 12	TBA	150 – Feb 11 p20	TBA
Murgoo (Murchison 1)	GSWA	Thomson	28 Feb 11	128 000	200 m 50 m E–W	21 250	100% complete @ 16 Nov 11	25 Jun 12	150 – Feb 11 p20	QA/QC of final data in progress
Perenjori (Murchison 2)	GSWA	GPX	21 Oct 11	120 000	200 m 50 m E–W	20 000	100% complete @ 12 Jan 12	1 Jun 12	150 – Feb 11 p21	Data released via GADDS on 21 June 2012
South Pilbara	GSWA	GPX	13 May 12	136 000	400 m 60 m N–S	42 500	22% complete	TBA	150 – Feb 11 p21	TBA
Carnarvon Basin South (Carnarvon Basin 2)	GSWA	GPX	29 Mar 12	128 000	400 m 60 m E–W	40 000	100% complete @ 15 Jun 12	TBA	150 – Feb 11 p21	TBA
Corrigin (South West 2)	GSWA	GPX	12 Jan 12	120 000	200 m 50 m E–W	20 000	100% complete @ 29 Jun 12	25 Mar 12	150 – Feb 11 p22	Data released via GADDS scheduled on 26 July 2012
Cape Leeuwin – Collie (South West 3)	GSWA	Fugro	25 Mar 11	105 000	200/400 m 50/60 m E–W	25 000	100% complete @ 23 Dec 11	TBA	150 – Feb 11 p22	TBA
Mt Barker (South West 4)	GSWA	GPX	24 Apr 11	120 000	200 m 50 m N–S	20 000	22.2% complete @ 11 Mar 12	TBA	150 – Feb 11 p22	Survey resumed 11 February 2012
Galilee	GSQ	UTS Geophysics	11 Aug 11	125 959	400 m 80 m E–W	44 530	100% complete @ 10 Jun 12	TBA	151 – Apr 11 p15	TBA
Thomson West	GSQ	Thomson	14 May 11	146 000	400 m 80 m E–W	52 170	100% complete @ 20 May 12	TBA	151 – Apr 11 p15	TBA
Thomson East	GSQ	Thomson	14 May 11	131 100	400 m 80 m E–W	46 730	100% complete @ 20 May 12	TBA	151 – Apr 11 p16	TBA

Table 1. *Continued*

Survey name	Client	Contractor	Start flying	Line (km)	Spacing AGL Dir	Area (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Thomson Extension	GSQ	UTS Geophysics	22 Jun 11	47 777	400 m 80 m E–W	16 400	100% complete @ 10 Aug 11	TBA	151 – Apr 11 p16	QA/QC of final data in progress
Thomson North	GSQ	Thomson	11 Mar 12	21 900	400 m 80 m E–W	7543	100% complete @ 20 May 12	TBA	157 – Apr 12 p32	TBA

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
East Amadeus	NTGS	Atlas Geophysics	26 May 12	7560	4 km regular with infill at 2 km and 1 km	101 090	66% complete @ 8 Jul 12	TBA	158 – Jun 12 p22	TBA
Esperance	GSWA	TBA	TBA	TBA	2.5 km and 1 km along roads/tracks	TBA	TBA	TBA	158 – Jun 12 p23	TBA
West Murchison	GSWA	TBA	TBA	TBA	2.5 km	TBA	TBA	TBA	158 – Jun 12 p22	TBA

TBA, to be advised.

Queensland Greenfields magnetic and radiometric surveys

Collection of the airborne magnetic and radiometric data for the Thomson and Galilee surveys is now complete. The data collection for the Galilee survey was completed on 9 June 2012, and the Thomson survey was competed on 21 June 2012. The data for both these surveys is currently undergoing processing and quality checking. This data is expected to be released to the public in September 2012.

Report from the Australian Geoscience Council (AGC)

Dr Neil Williams PSM
Honorary Professorial Fellow, University of Wollongong
President: Australian Geoscience Council
President: 34th International Geological Congress, Brisbane, 5–10 August 2012

Members of the Australian Geoscience Council include the following bodies: Association of Applied Geochemists; Australasian Institute of Mining and Metallurgy; Australian Geoscience Information Association; Australian Institute of Geoscientists; Australian Society of Exploration Geophysicists; Geological Society of Australia; International Association of Hydrologists (Australian Chapter); and Petroleum Exploration Society of Australia.

The incumbent President, Dr Neil Williams, reviewed the accomplishments of the Australian Geoscience Council (www.agc.org.au) during the past 12 months in his report to the Annual General meeting in June 2012. The following text details the key activities of the AGC during 2011–12 as reported to the AGC AGM.

Introduction

The period from 2011 to 2012 has been another prosperous year for the energy and mineral resource sectors of the Australian economy, unlike the other parts of the economy that are slowing in response to continuing concerns about the state of the global economy, particularly in the Euro-zone component. As this Annual Report is being written, some pessimism is beginning to creep into the Australian resource sector due to a number a factors. These include a possible slowing down of growth in the Chinese economy, the introduction of the Carbon Tax in July 2012, recent Federal Government antipathy towards mining and petroleum companies, labor shortages that are slowing planned projects, and infrastructure bottlenecks that are threatening Australia's international competitiveness.

Despite these concerns, there remains a strong demand for geoscientists in not only the resources industry, but also in the public sector where geoscientists are not only needed for resource-based activities, but also for environmental, engineering, water and hazard management.

34th International Geological Congress (IGC)

The IGC is the major focus of AGC activities and promises to be the biggest and most impressive geoscience event ever seen in Australia. As the Australian Geoscience Council is the legal entity for the Congress, the work of the Council over the last year has become increasingly focussed on ensuring that the Congress is successful, both financially and scientifically. Details are available at www.34igc.org.

With only 60 days left to the Congress we now have for the first time a good indication of the size and content of the Congress. Author registration closed on 31 May and 3168 authors had registered by that date. Total registrations now stand at 4856 indicating the final number of registrants at the Congress will be in the low 5000s. This outcome is well above the Council's initial estimates and, provided the IGC budget is carefully managed over the next 2 months, we can anticipate a good financial outcome. As well as a diverse and interesting scientific program having an emphasis on Australian resources, the Congress will also have a large and vibrant exhibition featuring 129 exhibitors from universities, companies and government agencies from around the world, and a range of pre- and post-congress field excursions that will showcase Oceania's amazing geological features. With the scientific program about to be released, all Australian geoscientists are encouraged to examine the wide range of exciting and relevant presentations over the 5-day event and to make the decision to attend.

A lot of work has gone into reaching this positive point in the almost decade-long history of the 34th IGC and I would like to thank all the numerous members of the Organising Committee and of its various subcommittees for all their efforts to make the IGC a reality. While reluctant to single out individuals for special mention, the President did acknowledge the huge effort being put in by IGC Secretary General Ian Lambert, the IGC Deputy Secretary General Paul Kay, and the IGC Treasurer Miriam Way. The AGC also appreciates all of the efforts of our Professional Conference Organiser, Carillon Conference, led by Ashley Gordon. Ashley and his colleagues have been successful in obtaining the majority of our Congress sponsorship, which now totals a little under $1 million in value, and they have driven a long but fruitful IGC promotion effort. Their advice and conference administration experience is proving invaluable and will be critical during the last hectic days leading into the Congress itself.

The AGC video series promoting Australian Geoscience

Building on the AGC Touring Speaker idea developed last year, the Council took a decision during the year to embark on the development of a series of educational and promotional videos under the theme of 'Geoscience in Australia'.

The first of these was recorded on 19 January 2012. The presenter was Professor Geoffrey Blainey and he spoke on the subject of how Australia, past and present, has been shaped by mineral discoveries. Professor Blainey is a most engaging and interesting speaker and he was very ably supported by well-known media personality Peter Couchman, who introduced the video and asked lots of interesting questions during the relaxed and informal presentation. The video is an excellent introduction to Council's video series and can be viewed at: www.agc.org.au/index.php/geoscience-in-australia. The video will also be aired in the Geotheatre at the 34th IGC, along with many other videos of interest to a wide range of geoscientists. During the presentation Professor Blainey touches on a number of themes that the Council hopes to develop in more detail in subsequent recordings.

News

AGC newsletter *GeoEdLink*

In May the Council reappointed Greg McNamara to the position of Editor of the AGC e-newsletter *GeoEdLink* (see www.geoed.com.au/AGCnletter/archive.html). Greg continued his excellent work in producing *GeoEdLink*, with three editions released in 2011 and one to date in 2012, all containing valuable educational resources for high school science teachers as well as interested members of the public.

Australian Curriculum, Assessment and Reporting Authority (ACARA)

Following a lot of activity with ACARA last year, little has taken place this year. However, the Council was advised by ACARA on 10 May this year of the release of the draft senior secondary Australian curriculum for English, Mathematics, Science and History, and we have been invited to comment on the draft, which can be viewed at: http://consultation.australiancurriculum.edu.au/.

The draft is open for discussion until 20 July 2012 and the Council, through Past President Michael Leggo, will be providing comments on the document.

The Australian Learning and Teaching Council

Just after Dr Williams was elected President of the AGC, he became involved in the committee 'Science Discipline Reference Group', which was part of a project being undertaken by the Australian Learning and Teaching Council investigating Learning and Teaching Academic Standards for Science (LTAS) across Australian universities. The Geosciences were also represented by Dr Ian Fitzsimons from Curtin University. Ian focused his attention on the learning and teaching side of university science standards while Dr Williams' focus was on the employer's side. Unfortunately, just as the LTAS initiative was getting somewhere, the Federal Government shut it in early 2012. However, all was not lost as Ian Fitzsimons continued the good work of the Group through a university geoscience initiative called Geoscience Learning and Teaching. The Council agreed to support Ian's work in April 2012, which is now being progressed with the support of a small group of volunteers from member Societies. This committee will follow the guidelines provided by a recently created Australian Government agency called the Tertiary Educational Quality and Standards Agency (TEQSA) that is continuing the work started under LTAS, with the aim of establishing standards for tertiary Earth Science teaching.

Teacher Earth Science Education Program (TESEP)

The AGC made a one-off contribution to TESEP to support two activities. The first is enhanced promotion and accessibility to TESEP as it moves into Stage 2. The second is support for the development of excursion descriptions to enable the ESWA Year 11 and 12 Earth Science textbook to be used as a national text. TESEP is strongly supported by many of the AGC member societies and we encourage the continuation of that support.

International Earth Science Olympiad (IESO)

The AGC provided financial assistance to four high school students to help them represent Australia at the IESO held in Italy. The students provided a report on their experience for inclusion in society newsletters.

Concluding remarks

In closing his report, Dr Williams expressed his thanks to Past President Michael Leggo, Chairman Mike Smith, Secretary Brigette Hendersonhall and the team at the AusIMM, who manage all the Council's financial affairs.

Dr Neil Williams

GGSSA – Ground Geophysical Surveys Safety Association

Ground Geophysical Surveys Safety Association (GGSSA) was formed in 2011 with the aim of developing an Australian Standard for high-voltage geophysical surveys. The formation of the Association was in response to NSW Government concerns around IP surveying and the failure to adhere to NSW State Legislation and Australian Standards AS/NZ 30000 and AS3007, particularly around electrical protection, and isolation and insulation.

The aim of the association is to:

- promote the safe operation of ground geophysical surveys
- develop a set of recommendations for the safe operation of ground geophysical surveys
- have these recommendation accepted by Standards Australia
- assist in getting the standard accepted in each states' legislation.

The founding members of GGSSA are Fugro Ground Geophysics, GPX Surveys, Search Exploration Services and Zonge.

A draft of the Standard for IP surveys has been completed and is presently being reviewed by electrical engineers. The next stage, in August, is to circulate the draft to GGSA members for review before final submission to Standards Australia.

The Standard, based on robust risk management principles, will provide guidance in the following key areas:

- survey design and risk analysis
- training and competency
- equipment inspection and maintenance
- equipment safety features
- loop and electrode safety
- audit structure
- safety sign register
- fuel storage, handling and decanting
- insulation for electrical ground geophysical surveys
- geophysical transmitter operational procedure.

If you are an interested in becoming a member, please contact GGSSA (info@ggssa.org.au). Membership of GGSSA will be open to all Contractors, Government Agencies and Mining Companies.

The Association plans to develop further standards for high-risk geophysical surveys. Members can nominate to join the Technical Committee, which will be tasked with drafting appropriate Standards.

Katherine McKenna

Feature Paper

Reassessment of the grades of the Adelaide model logging pits

Bruce Dickson

Honorary Research Fellow, CSIRO Earth Science & Resource Engineering, North Ryde, NSW
Email: bruce.dickson@optusnet.com.au

International efforts made in the early 1980s to cross-calibrate the grades of model pits used in the calibration of total-count gamma-ray logging tools for uranium were never applied to bring the Australian, Canadian and USA pits into agreement. Recent studies on calibration revealed problems with the Australian pits and data from the 1980 studies has been re-evaluated to give new grades for the Adelaide pits of 0.210, 0.983, 0.051 and 0.18 eU_3O_8% for pits AM1, 2, 3 and 7, respectively. These changes ensure the four pits are in relative agreement with logging results and gamma-ray transport modelling. The absolute grade is more difficult to assign definitely but indications are that AM1, through being twice sampled by coring and analysis, is more likely to be correct than pits whose grades are solely based on analysis of poorly handled samples. The changes in the grades actually have little effect on the grades in U deposits determined using the Adelaide model pits for calibration as the error with AM2 acted as a compensation for the Z-effect in that pit.

Keywords: assigned grades, calibration, gamma-ray, logging, model pits, uranium.

Introduction

Total-count logging probes are used by uranium (U) miners and explorers to assist with ore estimates. The theory of the operation of such probes was established in the 1960s (Dodd and Eschliman, 1971). The relationship between the U grade in a thick zone in a model pit to the count-rate in a field drillhole, for U contents below a few percent, as given by George (1982b) is

$$G_d = K\ F_m\ F_z\ F_w\ F_c\ F_d\ r \qquad (1)$$

where G_d = dry grade commonly expressed as weight-percent eU_3O_8,
K = a constant of proportionality, determined at a calibration facility,
F_m = Moisture Factor to correct for differences in formation water (100 – % water in calibration model)/(100 – % water in formation),
F_z = Z-effect[1] Factor to correct for the presence of U itself, which is a function also of R,
F_w = Water Factor for differences in the fluid between test-pit and field drillhole,
F_c = Casing Factor to correct for hole rod or casing material,
F_d = Dead-time Factor, also a function of r, and
r = Observed count-rate.

As indicated by the factor K, the existence of a set of model pits in which to perform calibration is essential for the quantitative use of gamma-ray logging. In Australia such a set of pits was constructed in the late 1970s in Adelaide and is now maintained and run by S.A. Department for Water. The design of the AM2 pit is shown in Figure 1. There are four pits suitable for calibration of total count tools as detailed in Table 1.

The assigned grades in Table 1 are based on laboratory analyses (Wenk and Dickson, 1981). In the early 1980s, questions were raised about the grades in these pits not being correct and two groups, one from Canada (Bristow *et al.*, 1982) and one from the USA (George, 1982b), brought probes to Adelaide and cross-calibrated the Adelaide pits against their own. These results were presented at an OECD/NEA meeting in Paris in 1982 and published in the conference proceedings. But for unknown reasons there was no resolution to the conflicts that were apparent in the different grade estimates.

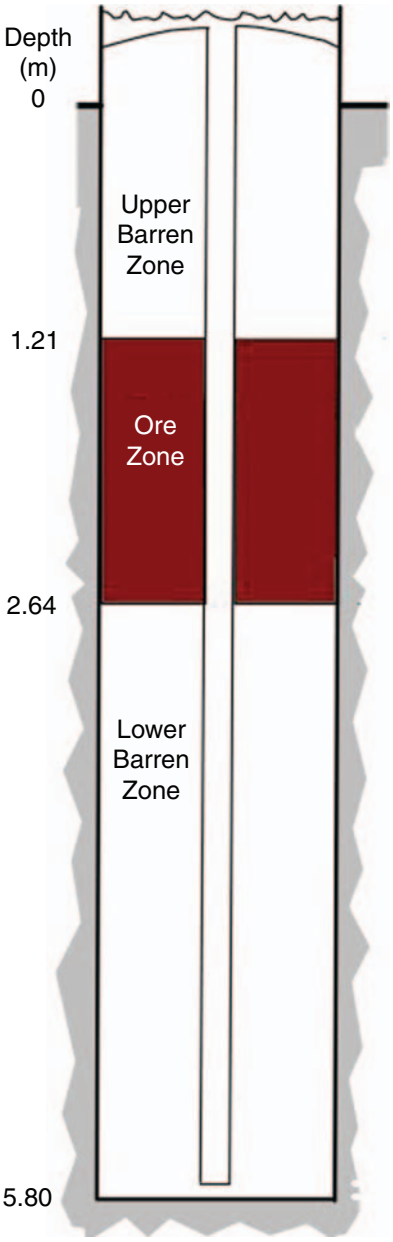


Fig. 1. *Design of the AM2 pit at Adelaide.*

[1]The Z-effect refers to the increasing adsorption of low-energy gamma-rays (<600 keV) due to the increased photoelectric adsorption of higher Z elements, such as U itself.

Table 1. Data for Adelaide pits AM1, AM2, AM3 and AM7

	AM1	AM2	AM3	AM7
Assigned grade (%eU_3O_8)	0.209 ± 0.006	0.920 ± 0.018	0.054 ± 0.002	0.17
Diameter (m)	1.22	1.22	1.22	2.16
Ore-zone thickness (m)	1.41	1.43	1.43	1.68
Porosity %	17	19	18	23.4
Wet density ($g.cm^{-3}$)	2.31	2.33	2.35	2.21

More recently, studies using Monte-Carlo gamma-ray transport codes to derive correction factors for different logging scenarios revealed that a determination of F_z from data collected in the AM pits did not give consistent values. This identified a need to revisit the data of the cross-calibration studies to determine if a consistent set of grades could be assigned to these pits.

The George (1982) Study

In 1981, Dr D.C. George of Bendix Field Engineering Corporation undertook an international cross-calibration of total-count logging pits in Australia and the USA. His methodology essentially used equation (2) recast as the ratio of two pits, that is:

$$G_x = G_s F_{zx} (F_{mx} R_x/(F_{ms} R_s))/F_{zs} \quad (2)$$

where subscript s = standard pit and x = unknown. R_s (= $F_d r$) are dead-time corrected count-rates. Calibration was done with the holes dry so no other corrections were necessary but the formation moisture, F_m, correction was included.

A report was initially issued (George, 1982a) in which the grades of the pits were determined as 0.254, 1.186 and 0.620 eU_3O_8% for pits AM1, 2 and 3, respectively. These grades were calculated relative to USDOE pit N3, which was assigned a grade of 0.240 eU_3O_8%. It was acknowledged that this pit was itself at that time undergoing revision of its grade. All these grades are stated to be 'dry-weight basis'.

George revised his analysis and presented his results at the 1982 OECD/NEA conference (George, 1982b), but although all the data was presented, the calculations for the AM pits were not explicitly made. Those calculations are presented in Table 2.

These results showed the grade of N3 decreased to 0.218% eU_3O_8 while the grades of AM1 and AM3 were barely changed from the assigned values (Table 1). AM2 was increased to 1.02%eU_3O_8, a 10.5% increase. This increase in grade for AM2 actually has little or no effect on calculated *in situ* grades because the low value for AM2 relative to both AM1 and AM3 acts as a self-correction for the Z-effect (as shown below).

Table 2. Recalculation of AM grade using data and methodology outlined in George (1982b) where R_{oc} is dead-time and Z-effect corrected count-rate

	N3	AM1	AM2	AM3
Counts	24088	25612	118957	6227
Fz	1.050	1.054	1.250	1.013
R	22926.6	24303.0	95152.9	6146.5
Moisture %	13.2	7.4	8.1	7.7
R_{oc}	27751.2	27646.6	129469.5	6743.5
Grade	0.218	0.217	1.016	0.053

The Bristow *et al.* (1982) study

Members of the Canadian Geological Survey also visited Adelaide around the same time to undertake a comparison of BU6 (the primary Canadian model pit) with N3 and AM1 (Bristow *et al.*, 1982). Their results were also reported at the 1982 OECD/NEA conference and indicated grades of 0.116, 0.2184 and 0.2216%eU_3O_8, for BU6, N3 and AM1, respectively, using water-filled holes. Thus, they obtained the same grade for N3 as George (1982b, Table 2) but a higher value for AM1. Although AM2 and AM3 were also logged, the data for those were not presented.

A final adjustment or not?

Efforts continued in the USA after the 1982 conference to standardise their model pit collection and a year later George *et al.* (1983) reported results from a cross-calibration involving 45 pits. The results and full details of the pits are given in Leino *et al.* (1994). This work adjusted the grade of N3 to 654±23 pCi/g(Ra^{226}), which equates to 0.231 ± 0.008%eU_3O_8 and implies that the grades of the Australian AM pits have to be increased by another 6.0%.

But should this change be applied? The difficulty in accepting the grades of the USA and Canadian pits as correct is that their grades are based on samples taken at the time of construction. In both cases very non-standard methods compared with concrete-industry standards were used. For the USA, 1.9 L samples were placed in ice-cream cartons and allowed to air dry. George *et al.* (1983) recognised that this was not an optimum procedure and stated 'if additional samples are collected (say by coring), or if additional information becomes available on the present unknowns (the difference, if any, between the concrete in the samples … and the concrete in-situ in the models), then the assignments could change'. As this quote indentifies, the sampling technique used by the USA could give biased results as the concrete in the sample containers was not cured properly and may contain far less water of crystallisation than a properly cured concrete, as in the pits. This sampling methodology could have introduced a systematic error with all the results being high.

This problem was examined using a batch of concrete that was sampled in three different ways (Dickson, 1983). The methods were a sample of wet mix sealed in a 300 mL can (the Canadian method), a 2 kg mix placed in an open 4 L plastic container (the USA method), and a 1.5 kg sample placed in a steel circular mould, 104 mm diameter and 280 mm long. After 24 h curing the mould was removed and the concrete cylinders kept over a water bath at 22°C for 1 month (the concrete industry method). Analaytical results obtained for U for the three methods were 277 ± 15, 254 ± 6 and 257 ± 11%eU_3O_8, respectively, which clearly suggests that the pit grades for the Canadian pits could be over-estimated relative to a properly cured concrete.

The most reliable method for analysing the U grade of the pits would be to use the methods familiar to the exploration and mining industry, i.e. drill a core from the pits and analyse those samples. This was how the original grades for the AM pits were obtained. In 1983, pit AM1 was re-drilled with a core removed from the edge. The original samples were re-analysed and gave

0.210 ± 0.0.008%eU_3O_8. The new samples gave almost the same result, 0.212 ± 0.008%eU_3O_8. On this basis, AM1 should be taken as containing 0.210%eU_3O_8. Both AM2 and AM3 require that their grade also be adjusted to 0.983 and 0.051%eU_3O_8, respectively, based on the logging results in Table 1.

The astute reader will notice that the earlier claim that drilling, coring and analysing is the optimum sampling method is not supported by the need to adjust grades for both AM2 and AM3, grades which were originally based on coring and analysis. The same goes for AM7 (see below) as well. Why AM2 should require such a large change is puzzling and no explanation is offered at this time. But it does suggest the sampling and analysing of these concretes is not well defined and doubts must remain over the grade assignments of all pits. An independent method of grading the pits not involving sampling would be most welcome.

Confirmation of grade change for Adelaide pits

A confirmation of the relative changes in grades for the AM pits can be obtained by determination of F_Z, using both data collected in the model pits and through calculations using Monte-Carlo transport codes. This latter method is described in Dickson and Beckitt (unpublished report) and involves the use of the code GEANT. A geometry is established modelling that of the calibration setup in the AM pits and spectra of the gamma-ray radiation received in a detector within the pit are calculated. Total-counts above a selected threshold may then be obtained.

Values for F_Z may be calculated from the ratio of the grades and counts for two pits using:

$$F_{ZH}=(G_H F_{ZL} R_L)/(G_L R_H) \quad (3)$$

where subscripts H and L refer to high and low grade pits, Rs are dead-time corrected count-rates and the two pits are assumed equal in all other aspects. For a very low grade pit, e.g. AM3, F_{ZL} can be assumed as 1 and F_{ZH} readily calculated. Table 3 illustrates some F_Z data determined for AM1 and AM2 with AM3 as reference with a variety of detectors.

The set 1 data in Table 3 was measured by George (1982a) and shows that the F_Z value for AM2 with the original grades was below 1, but with the new grades the value 1.24 is very close to the measured value of 1.23. For all other probes, Table 3 shows that, with only one exception (set 4), there is little difference in F_z between AM1 and AM2 with the original grades. With the adjusted grades, the F_Z values for AM2 obtained with seven detectors are now all greater than the values for AM1 and are of the expected magnitude.

Table 3. Values of the Z-effect correction factor FZ for a variety of detector types. All detectors are unshielded. Detector sizes are length x diameter in cm

Set	AM1	AM2	AM1	AM2	AM2 (modelling)	Detector
	OLD grades		*NEW grades*			
1	1.02	0.91	1.04	1.24	–	NaI, 3.9 x 3.8
2	1.00	1.06	1.06	1.19	1.21	NaI, 4.4 x 1.25
3	1.00	1.05	1.06	1.19	1.21	NaI, 4.4 x 1.25
4	0.99	1.15	1.05	1.30	–	NaI, 5.0 x 2.5
5	0.98	1.03	1.03	1.20	–	NaI, 5.0 x 2.5
6	0.97	1.05	1.03	1.18	1.18	BrilLanCe 2.5 x 2.5
7	0.97	1.05	1.03	1.21	1.18	BrilLanCe 10 x 2.5

Values of F_Z for AM2 were determined by modelling for four of the detectors. The modelled values (Table 3) are dependent on the setting in the detectors of a low-energy threshold, which is set to prevent noise from the detector entering the electronics. This setting is generally low but unknown and the values shown are calculated with estimates of the thresholds. The agreement of the F_Z values between those calculated using the new grade value and modelled for AM2 gives a degree of confidence that the new grade values are relatively correct. Unfortunately this analysis only applies to the relative grades because the F_Z calculation involves a ratio of grades and cannot be used to justify the absolute values of the grades. For the moment our confidence in these grade reassignments must rest on the good agreement of the AM1 grades of the two sets of cored samples.

Grade for pit AM7

Pit AM7 is larger in diameter than pits AM1–AM3 and accommodates five drillholes of sizes BQ, NQ, PQ, HQ and 108 mm (same as AM1–AM3) to enable water factor corrections to be determined. The grade of this pit is assigned 0.17%U_3O_8. This grade requires adjusting in line with the other pits.

Some logging data made available for this study (Table 4) was used to calculate the grade of AM7 with the assumption that F_Z and formation moisture for AM1 and AM7 were the same and using the moisture data in Table 1. This gave a new grade value of 0.18%U_3O_8 (Table 4). Further work is recommended to refine this value, which should include modelling to take into account the larger diameter but lower density of the U-zone in this pit, relative to the other three.

Conclusion

The grades for the total count calibration pits in Adelaide should be changed to 0.210, 0.983, 0.051 and 0.018 eU_3O_8% for pits AM1, 2, 3 and 7, respectively. This change ensures the four pits are in relative agreement with logging results and gamma-ray transport modelling. The absolute grades are more difficult to confirm but indications are that through being twice sampled by coring and analysis, AM1 is more likely to be correct than those pits whose grades are solely based on analysis of poorly handled samples. The recommended changes in the grades actually have little effect on the grades in U deposits determined using the Adelaide model pits for calibration as the error with AM2 compensated the Z-effect in that pit. These changes leave the Australian pits some 6% lower than the USA and Canadian pits and there is clearly a need to determine a method to analyse the true grades of these concrete pits before this issue can be finally resolved.

Acknowledgements

Mr Geoff Beckitt, formerly of Cameco Australia, is thanked for his interest, support and encouragement in pursuing a study of better calibration for logging. The support of Cameco Australia

Table 4. Data used to obtain grade for AM7

Pit	AM1	AM2	AM3	AM7
Grade (%U_3O_8)	0.210	0.983	0.051	0.190
Counts (cps)	9300	37507	2338	8425
Fz	1.033	1.199	1	1.033

in this work, and permission to use their data, is gratefully acknowledged. Mr Duncan Cogswell, Wireline Logging, is also thanked for supplying some data for this study. All conclusions remain the responsibility of the author. The Sydney Undermining Committee is acknowledged for their contribution to the mental relaxation and subsequent recognition of the pit calibration problem by the author.

References

Bristow, Q., Killeen, P. G., and Mwenifumbo, J. C. (1982). Comparison of standardized gamma-ray log calibration measurements: Ottawa, Adelaide and Grand Junction. In *Uranium Exploration Methods, Proc Symposium Paris*: Nuclear Energy Agency, Organisation for Economic Co-operation and Development, 715–726.

Dickson, B. L. (1983). Grade assignment of gamma-logging model test-pits: Restricted Investigation Report 1395, CSIRO Division of Mineral Physics.

Dodd, P. H., and Eschliman, D. H. (1971). Borehole logging techniques for uranium exploration and evaluation. In *Uranium Prospecting Handbook*, S. H. U. Bowie and others, eds., Proc. NATO-Sponsored Advanced Study Institute London, Inst. Mining and Metallurgy Trans., pp. 244–276.

George, D. C. (1982a). Comparison of gamma-ray logs for United States and Australian calibration models: Bendix Field Engineering Corporation Report BFEC-1982-2.

George, D. C. (1982b). Total count gamma-ray logging: correction factors and logging model grade assignments. In *Uranium Exploration Methods, Proc Symposium Paris*: Nuclear Energy Agency, Organisation for Economic Co-operation and Development, 729–751.

George, D. C., Heistand, B. E., and Krabacher, J. E. (1983). Grade assignments for models used for calibration of gross-count gamma-ray logging systems. Bendix Field Engineering Corporation Report GJBX-39(83).

Leino, R., George, D. C., Key, B. N., Knight, L., and Steele, W. D. (1994). Field calibration facilities for environmental measurement of radium, thorium, and potassium. DOE/ID/12584-179; GJ/TMC-01 (Third Edition). RUST Geotech, Inc., Grand Junction, CO, 1994.

Wenk, G. J., and Dickson, B. L. (1981). The gamma-logging calibration facility at the Australian Mineral Development Laboratories. *ASEG Bulletin* **12**, 37–39.

3D EM inversion: an update on capabilities and outcomes

James Macnae

James Macnae[1,4], Ken Witherly[2] and Tim Munday[3]

[1]*School of Applied Sciences, RMIT University, Melbourne, Vic., Australia*
[2]*Condor Consulting Inc, Denver, CO, USA*
[3]*CSIRO Exploration and Mining, Perth, WA, Australia*
[4]*Corresponding author. Email: james.macnae@rmit.edu.au*

As part of the recent 2012 ASEG conference in Brisbane, a workshop was held that focussed on the state-of-the-art in 3D electromagnetic inversion (3DEMI) entitled '3D EM inversion: an update on capabilities and outcomes'. An all-day event, held on Thursday 1 March 2012, it was one of the last official segments of the conference, with over 90 registrants. The aim of this workshop was to have a close, unbiased and community-wide look at EM inversion methodologies, with a strong focus on technology capabilities, practical applications and user experiences. The workshop chairs were Professor James Macnae (RMIT), Tim Munday (CSIRO) and Ken Witherly (Condor Consulting Inc.).

The program started off with Professors James Macnae (RMIT) and Doug Oldenburg (UBC) setting the scene with assessments of how 3DEMI has developed and how this methodology can be related to current state-of-the-art 1D and 2D approaches. This was followed by presentations from a group of major EM processing and interpretation service providers who were asked to outline their capabilities. The morning session was then closed off by some animated discussion on the issues raised by a number of the speakers. In the afternoon, 10 groups who had made use of 3D inversion methodology presented case histories that described their experiences. A final open discussion session helped to clarify the perceptions of workshop participants. As a wrap-up for the workshop, a survey of the delegates was requested of the day's presentations. Based on the delegate feedback, 3DEMI was given a passing grade, with slightly more than half those surveyed believing the method was valuable, and/or intending to use the method in the next year.

Introduction

Professor Macnae kicked off the workshop, showing that in areas with geological dips ≤30°, stitched 1D inversions were more than adequate over any conductive layers. However, Professor Macnae did note that stitched 1D inversions do suffer from edge effects at lateral discontinuities. For isolated conductive targets, stitched 1D solutions are adequate if the target's lateral dimensions exceed depth of burial, or if the target is located within a conductive host. For isolated targets in resistive hosts, parameterised inversion (e.g. plate and sphere) was useful to obtain quantitative estimates of depth, size and dip adequate for defining drill targets. The only real need for 3D electromagnetic inversion (3DEMI) level technology, as described by Professor Macnae, are when dips are greater than 30°, or for isolated targets that could not be well fitted by a parameterised model.

Professor Oldenburg then described the requirements of 3DEMI to obtain stable solutions when the number of model cells exceeds the number of data. These requirements are best expressed mathematically. In words, the process requires minimisation of a composite error (A+B), where (A) is the normalised difference between data and model prediction and (B) is a scaling parameter β times the difference from a pre-defined model. The pre-defined model can use known geology, known conductivity values, or simply assume a uniform half-space. Professor Oldenburg outlined the main difficulties of 3DEMI:

a) the data is as inherently variable as EM systems themselves
b) defining the error in the data and the error in (imperfect) forward modelling
c) defining a good starting model and providing bounds on parameters
d) determining the trade-off parameter β.

Multiple inversion runs are needed to ensure stability of the final result. Finally, the geological suitability of the final outcome cannot be judged on mathematical criteria alone.

Service providers

The service provider presentations were started by Professor Michael Zhdanov (TechnoImaging) and Professor Eldad Haber (Computational Geoscience); both presented their views on the state-of-the-art of their respective group's software developments, with each firmly convinced their approach was the best. Further presentations from Nigel Phillips (Mira), Efthymios Tartaras (Western Geco) and Andrea Viezzoli (Aarhus Geophysics) followed. A planned presentation by Don Watts (Fugro EM) was withdrawn due to unforeseen circumstances.

Quotes extracted from the submitted workshop abstracts summarise these capabilities:

TechnoImaging

'TechnoImaging has developed the comprehensive suite of software and workflows for the large-scale (mega-cell) 3D inversion of airborne, land, and marine electromagnetic (EM) data for mining, hydrocarbon, and environmental applications. TechnoImaging's software package EMVision® is based on the use of focusing regularisation, which recovers 3D earth models with sharper contrasts and boundaries than can be recovered by traditional means. The developed software is capable of rigorous 3D inversion of entire airborne EM (AEM) surveys, and this is based on the novel moving sensitivity domain methodology.'

Computational Geoscience Inc.

'Computational Geoscience Inc. (CGI) uses the state-of-the-art modeling techniques, based on adaptive mesh refinement in order to obtain geological information from EM data sets. In this talk we discuss the underlying techniques used in order to efficiently solve EM forward and inverse problems and show that these methods work well for field data. We concentrate on a large (greater than 50 million cells) ZTEM survey, an airborne EM survey and a ground large-loop survey. We show that using our software tools we have managed to effectively recover geologically feasible models of the earth.'

Mira-AGIC

'The Mira Geoscience Advanced Geophysical Interpretation Centre provides three-dimensional electromagnetic, forward and inverse, modelling services in the following areas: time- and frequency-domain, airborne, ground, marine, and down-hole, and controlled- and natural-sources. In order to deliver the best interpretational value from electromagnetic data, good collaboration with project geoscientists and acquisition companies must be established to communicate important survey information, geologic setting, and well defined exploration objectives. Careful data quality-control, exploratory data-analysis, and processing are essential to ensure successful modelling.'

WesternGeco

'Inversions can be either unconstrained (i.e. smooth inversions using only the EM data as input) or constrained using seismic and other available G&G information to constrain and 'guide' the solution. Our proprietary 3D inversion code is fully parallelised and can invert various types of EM data (MT, CSEM, etc.). It utilises the full datasets as input (full tensor, multiple frequencies) and includes detailed topography in the model to compute correct, full responses as seen in the measured data. It is also fully anisotropic, allowing us to invert for both horizontal and vertical resistivity, when the geology requires and the data contains the required information.'

Aarhus Geophysics

'Presents the capability of laterally and spatially constrained inversion of the Aarhus workbench to recover moderate 3D targets from AEM data. Synthetic modelling shows that adding constraints in the model space increases significantly the resolving capability of inversions based on 1D forward response, with respect to SBS inversions. Complex 3D structures are satisfactorily imaged until the slopes become excessive. Inversion results of real AEM data illustrate further the capability of constrained inversion to recover 3D structures. Inaccuracies in the preparation of the data for inversion will produce artefacts in the output.'

Fugro EM

'Fugro EM provides a full range of marine, land and airborne MT and EM services, including feasibility studies, acquisition, QC, processing and inversion, integrated interpretation and consultancy. Proprietary 3D modelling and inversion codes, parallelised for use on both clusters and on multi-core PCs, use Finite Integration techniques for both MT and controlled-source EM, the latter in both time and frequency domain. As part of the modelling and interpretation products, ancillary information including geological and geophysical data (surface, airborne and borehole) is integrated to provide a geologically reliable product, rather than a purely numerically driven one.'

Users

Ten user presentations followed after lunch. The summary below has been extracted from a combination of the submitted abstracts and the speaker's presentations.

Andrew Fitzpatrick (Cameco)

1D-3D inversion of AEM data over the Kintyre Uranium deposit, Western Australia

Andrew Fitzpatrick compared 1D and 3D imaging at non-optimum flight direction over the Kintyre Uranium deposit, WA. His conclusions included: 1D and 3D inversions are complementary; 1D appears to have higher vertical and lateral resolution for near surface regolith and unconformity targets; 3D inversion appears to be more conservative and quite smooth, but interpretations are likely to be trusted particularly over dipping/vertical conductors. Practical 3D modelling is now a reality from an industry's perspective.

Stefan Thiel (University of Adelaide)

Three-dimensional magnetotelluric inversion: a new way of looking at electrical structure

Stefan Thiel presented three-dimensional inversion examples of magnetotelluric data across the entire Gawler Craton and small-scale mineral exploration targets. The complex geometry of subsurface targets often results in three-dimensional responses of MT data requiring careful treatment in 2D inversions. These complications are circumvented in 3D modelling but come at a price of reduced model resolution. Nevertheless, the example of the Gawler Craton shows large-scale and deep-seated mantle features previously unrecognised that are spatially correlated with zones of enhanced prospectivity near the surface.

Daniel Sattel (EM solutions)

Comparison of 2D and 3D outcomes for ZTEM-D

Daniel Sattel discussed ZTEM data. Excellent agreement is observed between 2D and 3D responses for structures with long strike lengths. Using the 2D inversion algorithm on synthetic 3D responses indicates artefacts being introduced when limited strike length is present: the conductivity of structures such as resistive hills and conductive structures is underestimated. 2D and 3D modeling results of ZTEM survey data showed good agreement at Forrestania, WA and little agreement at a site in the Athabasca Basin, Sask.

Yusen Ley Cooper (CSIRO /Musgrave minerals)

Comparison of quasi and full 3D inversion of AEM data for targets in the Musgraves, SA

Yusen Ley-Cooper presented results from a comparative investigation of conductivity-depth transforms (EMFlow), full non-linear 1D, quasi-3D (spatially constrained inversion), and full 3D inversion methods applied to VTEM and TEMPEST data for an area in the western Musgraves of South Australia. Using a steeply dipping target (Valen) clear in VTEM and just evident in TEMPEST, and further defined by ground EM and modelling, they concluded that: Valen was identifiable in EMFlow and 1D inversion sections, but that the conductor is not apparent in the single pass of 3D inversion attempted.

Mike Webb (Anglo American Exploration)

3D inversion of SPECTREM and ZTEM airborne electromagnetic data from the Pebble porphyry copper deposit

Mike Webb presented results from a study over Pebble deposit in Alaska. 3D inversions of SPECTREM and ZTEM produced broadly similar results that mapped conductive alteration systems associated with the mineralisation. The 3D inversion results are in general terms similar to that from 1D conductivity images; however, 3D inversion of SPECTREM data has 'mapped' a number of conductors not visible in 1D inversions and CDI's. A comparison between 2D and 3D inversions of ZTEM shows a larger difference between the results. Lack of reliable resistivity information from the drilling completed over many years in the area makes it difficult to determine which airborne method and which processing technique is giving the most accurate result.

Jaco Smit (Anglo American Exploration)

Multi-dimensional inversion of SPECTREM data

Jaco Smit presented a case history from Australia. The initial target detected by SPECTREM was modelled using a plate approximation taking the overburden conductance into account. The data was also processed with TechnoImaging's 3D inversion code. The acquired ground low-temperature SQUID TEM data was used to plan the exploration drill holes. The data was inverted to a 3D conductivity model using the H3DTDinv code developed by the GIF at the UBC. The methodology shows that exploration under cover is possible with a powerful AEM platform in combination with state-of-the-art ground TEM data, and new advanced 3D inversion code.

Joel Jansen (Teck)

1-2-3D inversion at the Red Dog deposit

Joel Jansen studied airborne FDEM to map high-conductivity groundwater seepage from the Red Dog mine waste dump. Four such sites along a 2 km long path were ultimately detected, such that the water could be pumped to the treatment plant before entering the tailings pond. The RDI (resistivity-depth-image) approximation proved overly smooth, but the EM1DFM code 'nailed it' in that it mapped conductive zones at the base of relatively porous and unconsolidated waste rock material in the waste dump. The 3D EM inversion identified the main conductors and added some new ones; however, there are ongoing questions as to their provenance. He concluded that 3D was probably overkill for the situation discussed and that 1D inversion is probably sufficient.

Chris Wijns (First Quantum)

What happened to the phyllite? – the conductivity mystery

Chris Wijns discussed inconsistencies between AEM inversions and the drilled locations of phyllite associated with copper ore, which were resolved by the later identification of distinct graphite-rich and poor facies. The shallowly dipping environment is conducive to the use of CDIs or LEIs, but there were some unresolved differences with the 3D inversion. EM, whether inverted with 1D or 3D algorithms, maps the graphite-rich portion of phyllite (Figure 1), but only 3D inversion can be used to grossly predict geometry and thus an envelope of higher ore grades. However, structural interpretation can be done as easily via channel and tau maps, as inversion is a smoothing process.

Nigel Phillips (Mira)

Borehole 3D EM modelling: Sudbury

Nigel Philips presented the application of time-domain inversion to borehole UTEM data collected at Nickel Rim South, Ontario. Electromagnetic data are best modelled and interpreted in tight integration with physical property and geological information. Preparation was key to a successful result, e.g., ensuring full understanding of the data in this 3D environment. Forward modelling is an integral part of the whole process as it is needed to validate the inversion outcome and refine discretisation. An inversion strategy should efficiently progress from a coarse, quick inversion, to a detailed, accurate inversion.

Burke J. Minsley (USGS)

1D and 3D modeling of Resolve data for characterising permafrost distributions

Burke J. Minsley stated that in the Fort Yukon area, Alaska, 1D approximations are generally valid, but may be violated in areas of sharp lateral resistivity contrasts where low resistivity unfrozen sediments are surrounded by high resistivity permafrost. It is very difficult in these situations to quantify which features are 3D and which features are regularisation, parameterisation or data errors. You need to do a 1D forward response of the 3D model or many drill holes (Figure 2). However, in addition to differences in dimensionality, there are also differences in model parameterisation and regularisation between the various AEM inversion methods.

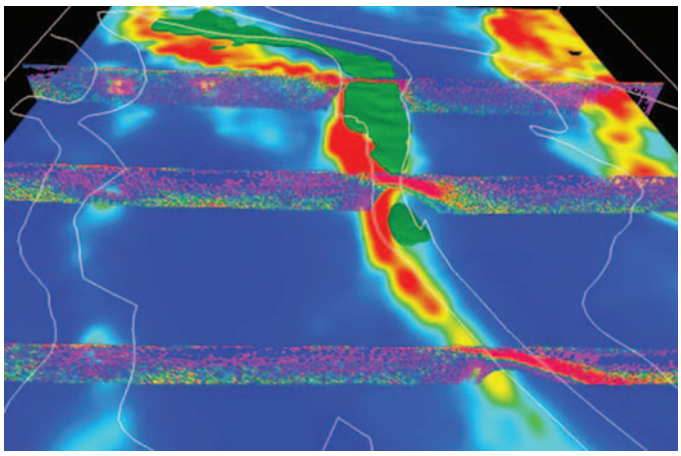


Fig. 1. *3D mapping example of graphite-rich shale.*

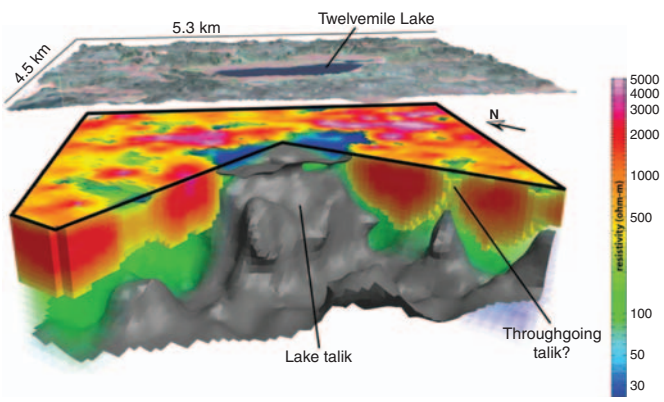


Fig. 2. *Permafrost mapping in Alaska through 3D inversion.*

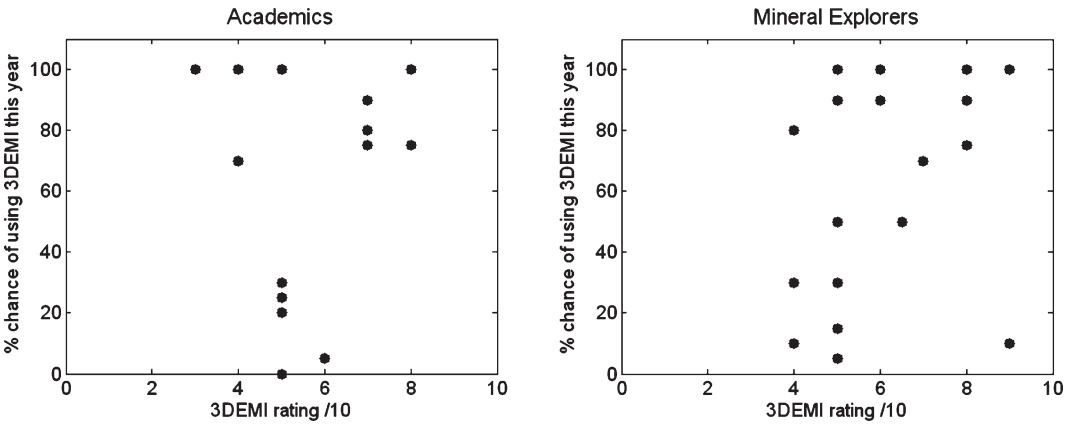


Fig. 3. *3DEMI rating out of 10 plotted against probability of use in the next year, separated into academic/research and mineral explorer categories.*

Participant survey

All delegates in the workshop were asked to fill in a questionnaire – partly during the presentations and partly at the end. The aim of this was to assess perceptions of those attending on the current and future importance of 3DEMI technology. A summary of these perceptions follows:

The first question asked the audience to estimate each presenter's rating of 3DEMI. Approximately 30 ratings were submitted by delegates for each of the presenters. The service providers appeared, to the audience, to rate 3DEMI highly (81%, averaged over five presenters). In contrast, the 10 users of the methodology were perceived to rate 3DEMI at an average of 66%. Finally, the 42 participants reported their own rating of 3DEMI, based on the whole of workshop, as being 56% (Figure 3).

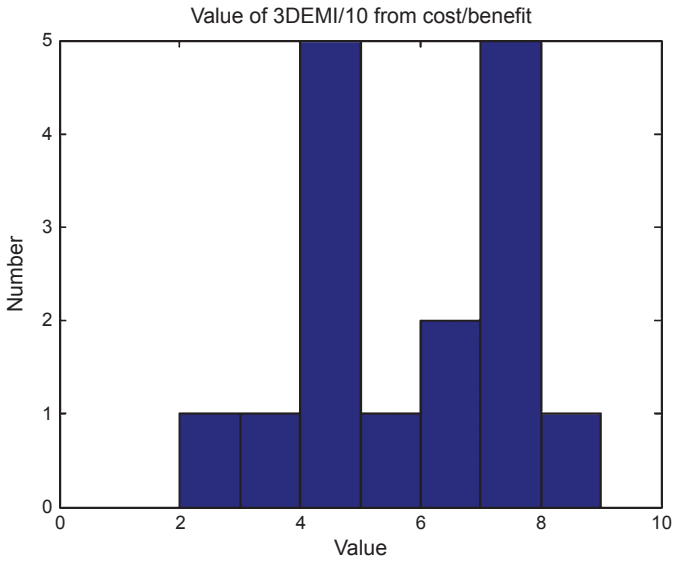


Fig. 4. *Value out of 10 of 3DEMI methods from those that had used them.*

Additional questions asked participants to rate cost vs benefit value and the probability of future use of 3DEMI. To further categorise the results we determined (from tick boxes in the questionnaires submitted) that approximately half the respondents were mineral explorers, and the other half were academic and research based. We then plotted the 3DEMI ratings against future use predictions for each of these two groups. Interestingly, there appeared to be little difference in perception between the groupings

Finally, participants who had used 3DEMI were asked to give a mark out of 10 for the value as estimated through benefit and cost. The histogram of these answers is plotted within Figure 4; most users are positive toward the new technology.

Conclusions

It is clear that underdetermined 'blocky' 3DEMI is now of sufficient quality to be useful in many cases where complex electromagnetic data interpretation is needed. The main caveats on its use appear to be that it should not be regarded as a one-pass black box that produces a 'correct' 3D model. Rather, with great care in defining the data and constraining the starting model (or models) and discretisation, multiple passes of 3DEMI can provide useful voxel models suitable for 3D visualisation that are consistent with data and geological knowledge. Increases in the perceived value of 3DEMI are likely as users and processors gain experience, and apply the methodology more appropriately in the future. Shared learning experiences, such as the current forum, are likely to facilitate the industry uptake on 3DEMI technology and enhance the value obtained from this technology.

Acknowledgements

The CSIRO-led Minerals Down Under Flagship sponsored this workshop, and without its support this workshop would not have been possible.

The World's Technological Capacity to Store, Compute and Communicate information that has already been created and does not need to be done again – 2012

Guy Holmes
Guy.Holmes@spectrumdata.com.au

On the weekend, I was doing some casual research on how much data there is in the world, and where it all goes.

I came across some really great research and an interesting white paper entitled 'Methodological and Statistical Background on The World's Technological Capacity to Store, Communicate and Compute Information 2012', by Priscila López and Martin Hilbert. The paper covers everything from the storage of data on film, paper, data tapes, and optical media right through to camera memory cards, phones and solid state media. A truly riveting 302 pages of graphs and charts with statistics of every conceivable data storage medium dating from the 1960s to present day.

I would provide the link to the article, but only the nerdiest of readers would want to peruse it, and 95% of those readers (all two of them) would want to look it up and download it – so they can create a new piece of information that immediately makes the hard work of the above authors out of date (actually – see the end of this article for the link).

As I was reading the statistics in this article, it made me think back to all of the times that I have seen data get created multiple times for the same project, more often than not simply because of poor data management systems. Unfortunately, the Lopez/Hilbert paper did not cover anything on how much of the world's data was actually created in error, so here is my own paper entitled 'The World's Technological Capacity to Store, Compute and Communicate information that has already been created and does not need to be done again – 2012', by Guy C. Holmes. Please note the absence of 'Methodological and Statistical' in the title.

I wrote a similar article on unnecessary data duplication back in 2007, so technically this very paper meets the criteria of something that expresses the concept quite vividly – life imitating art, or something along those lines. Why am I re-writing this article? The main reason is that throughout my 15+ years in the data management industry, I've had the opportunity to bear witness to some pretty extreme, and often ridiculous, examples of data duplication.

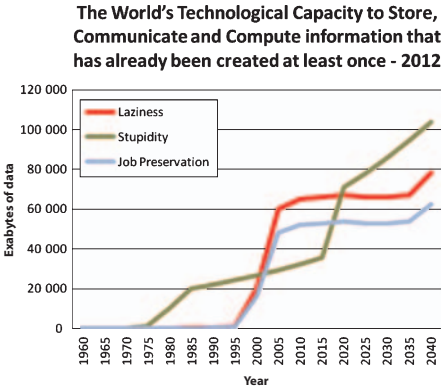
One particular example that comes to mind is the large multinational mining company doing survey work in South America. They had just completed a tender review for getting an airborne magnetic survey over a 1200 km^2 area flown and the award of the tender was imminent. However, somewhere else in the world in an office more than 4000 km away, a junior gung-ho geoscientist was looking at the corporate GIS data management system and discovered that much of the airborne survey outlined in the GIS system had been turned to transparent lines, making them very difficult (impossible really) to see. He casually changed them to black lines and went about continuing to search TripAdvisor.Com for his next vacation and getaway.

That casual change of line colour now revealed that a survey had already been flown over that same area in South America. Not only already flown, but the original survey was larger in scale, and done with higher specs than the one just about to be awarded.

Using the same concept as Lopez/Hilbert introduced in their article referenced above, I will now introduce some of my own observations and statistics, breaking down the reasons for redundant data creation (or unnecessary data duplication) into their three main categories:

1. **Data re-created due to laziness** – Data that was re-created because the individual involved was too lazy to look for the existing data, or too lazy to put what they did create into a system so that others could find it and not have to re-create it themselves.
2. **Data re-created due to stupidity** – Data that was created because someone was stupid.
3. **Data re-created to stay employed** – This is data that was re-created so that someone could justify their existence, their budget and keep their job. The data was similar enough to the original data set to be pretty much the same, but 'different' enough that the person was able to justify their time to recreate it and hence remain gainfully employed (i.e., someone spent time changing fonts and the colours in a graph or spreadsheet).

Through extensive research and lengthy interviews with Mabel, my spritely 81-year-old next door neighbour, Bazza, a young but dubious-looking guy that likes to hang out in front of my local BP service station, and a focus group of 4 year olds at the local kindergarten, I have compiled the following statistics:



As you can see from the data above, there is a very clear correlation and trend between all three categories. Some key observations and interesting things to note:

1. People seem to fluctuate between being lazy and stupid approximately every 20 years. It was unclear from my research if this was generational, or caused by some external factor such as changes in the Earth's four cycle biorhythm or horoscopes and astronomical phenomenon, as

suggested by Mabel. Bazza from the BP petrol station said that he had never had a job, so he could only pass comment on lazy and stupid. Given that stupidity was overtaken by laziness during the turn of the millennium, I surmise that it may in fact be generational – Generation Y?
2. In general, people were too lazy to preserve their job, and too stupid to know that the data they were duplicating could well have saved them from redundancy if they had just drawn it out a little longer.
3. It is expected that the level of stupidity in the work force will increase dramatically from 2020 onwards, due to most of my colleagues leaving the workforce and the introduction of the eyePad 7. The emergence of Generation Z into the workforce at this point in time might also be responsible for the sharp statistical incline (or decline – depending on how you look at it).

Now removing the tongue from the confines of my cheek, with the introduction of streamlined and easy to access data management systems to preserve and access data, should mean that we see a dramatic decrease in unnecessary data re-creation and duplication. People should be able to locate and access existing data and manipulate and re-process it to create enhanced, value-added data sets that enable organisations to improve their productivity, commercial opportunities and ultimately their bottom line.

I used the word 'should' because sadly, even in today's technological and digital age, the most advanced systems don't decrease the level of laziness and stupidity in the population. In fact there is some evidence that they increase both.

So, a few tips:

1. If you have a document control system – use it. An extra 10 minutes in that system will save days, probably weeks, of work.
2. Talk to the long-term employees in your company – they will probably know if something has already been created, where to find it, and probably how to create an extra few weeks work for yourself for job preservation purposes along the way.
3. If you think that someone must have already done the same work you are doing before you started – you are probably right.
4. Retire in 2019. The stupidity curve is about to go into a steep incline.

Link to article http://www.martinhilbert.net/LopezHilbertSupportAppendix2012.pdf

September			**2012**
3–5 Sep	Near Surface Geoscience 2012: 18th European Meeting of Environmental and Engineering Geophysics http://www.eage.org	Paris	France
10–14 Sep	EABS IV – Eastern Australasian Basins Symposium http://www.EABS2012.com.au	Brisbane	Australia
17–19 Sep	Istanbul 2012: Istanbul International Geophysical Conference and Oil & Gas Exhibition http://www.igcistanbul.com	Istanbul	Turkey
19–21 Sep	KSEG International Symposium on 'Geophysics for Discovery and Exploration' http://2012symp.seg.or.kr	Jeju	Republic of Korea
October			**2012**
8–10 Oct	ATCE 2012: Unconventional Wisdom: SPE Annual Technical Conference and Exhibition http://www.spe.org/atce/2012	San Antonio, Texas	USA
29–31 Oct	KazGeo 2012 http://www.eage.org	Almaty	Kazakhstan
November			**2012**
4–9 Nov	SEG International Exposition and 82nd Annual Meeting http://www.seg.org	Las Vegas	USA
December			**2012**
3–7 Dec	AGU Fall Meeting 2012 http://fallmeeting.agu.org/2012	San Francisco, California	USA
3–5 Dec	Arctic Technology Conference http://www.seg.org	Houston Tx	USA
March			**2013**
17–21 Mar	SAGEEP 2013 http://www.eegs.org/AnnualMeetingSAGEEP/SAGEEP2013.aspx	Denver, Colorado	USA
26–28 Mar	International Petroleum Technology Conference http://www.iptcnet.org/2013	Beijing	China
June			**2013**
10–13 Jun	London 2013: 75th EAGE Conference & Exhibition incorporating SPE EUROPEC2013 http://www.eage.org	London	UK
August			**2013**
11–14 Aug	ASEG-PESA 2013: 23rd International Geophysical Conference and Exhibition http://www.aseg-pesa2013.com.au	Melbourne	Australia
September			**2013**
8–11 Sep	Near Surface Geoscience 2013 http://www.eage.org	Bochum	Germany
October			**2013**
7–10 Oct	7th Congress of the Balkan Geophysical Society http://www.eage.org	Tirana	Albania
November			**2013**
24–27 Nov	2nd International Conference on Engineering Geophysics http://www.eage.org	Al Ain	UAE
June			**2014**
16–19 Jun	76th EAGE Conference & Exhibition incorporating SPE EUROPEC 2014 http://www.eage.org	Amsterdam	The Netherlands

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 preview@mayes.com.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 October 2012 issue is 14 September 2012. For the advertising copy deadline please contact Wendy Wild on (03) 9662 7606 or wendy.wild@csiro.au.

From rugged landscapes to stringent environmental standards, whatever your survey dishes out, the GSR can take.

The cable-free Geospace Seismic Recorder (GSR) is transforming the seismic industry from Tierra del Fuego to Turkey. It's allowing contractors to work quickly, safely and nondisruptively in terrain they never thought possible – with the smallest environmental footprint ever.

OYO GEOSPACE

www.oyogeospace.com

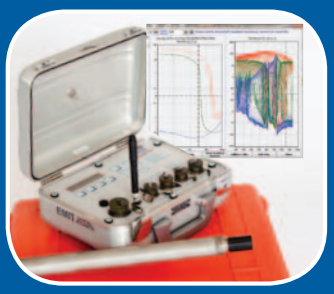
713.986.4444 USA

sales3@oyogeospace.com

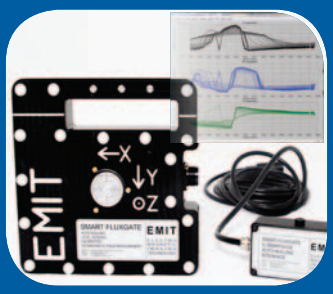
Is it down there?

Find out.

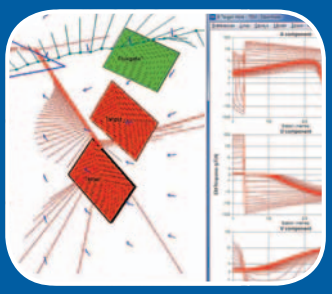
SMARTem24
16 channel, 24-bit electrical geophysics receiver system with GPS sync, time series recording and powerful signal processing



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 field, digital tilt measurement and auto-nulling



Maxwell
Industry standard software for QC, processing, display, forward modeling and inversion of airborne, ground and borehole EM 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