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PREVIEW

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS

NEWS AND COMMENTARY

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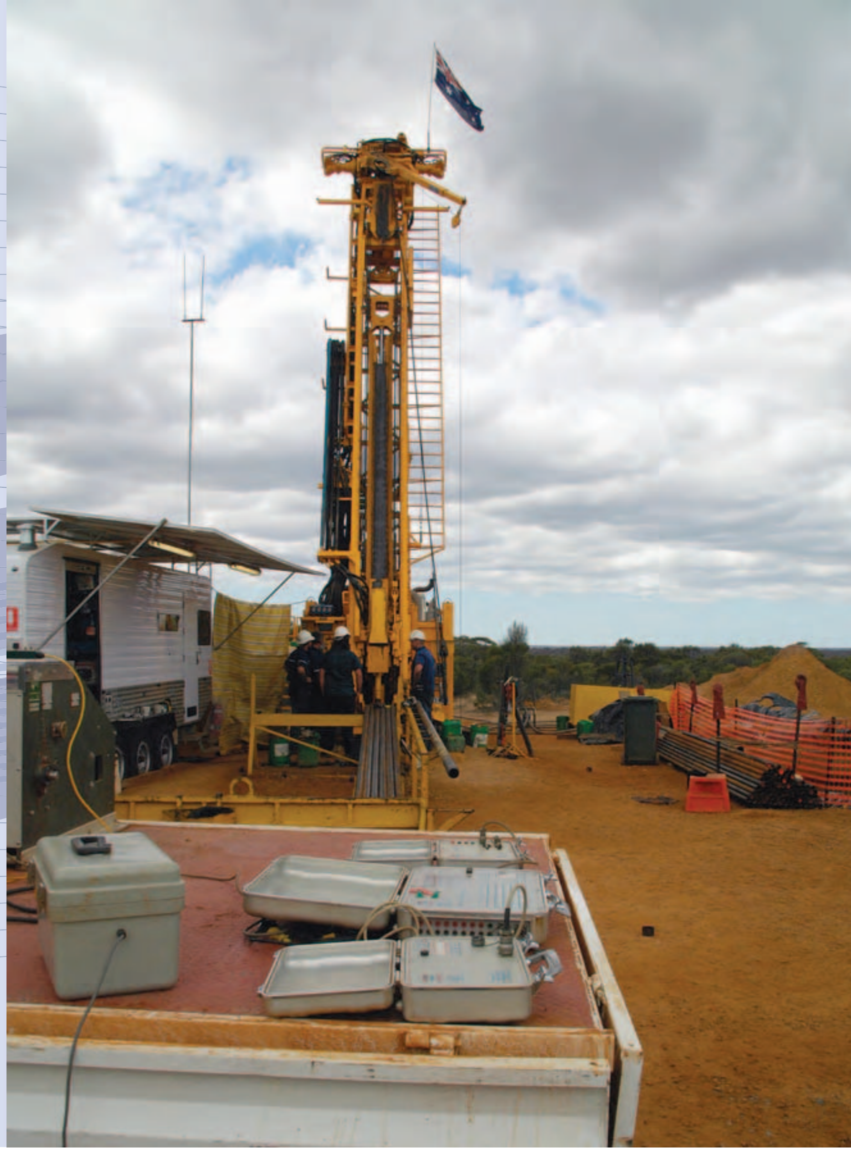

PREVIEW

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2009 ASEG CORPORATE MEMBERS

CORPORATE PLUS MEMBERS

Elliott Geophysics International Pty Ltd
Vale Exploration Pty Ltd
Velseis Pty Ltd

CORPORATE MEMBERS

Archimedes Financial Planning
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BHP Billiton Limited
CGG Veritas
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Seismic Asia Pacific Pty Ltd
UTS Geophysics Pty Ltd
Vale Exploration Pty Ltd
Velseis Pty Ltd
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FRONT COVER

Helicopter en route to Ekati, NW Canada for a combined Falcon, DIGHEM and magnetic survey in 2006. Photo courtesy of Fugro Airborne Surveys, see p. 33.

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Ann-Marie Anderson-Mayes

Have you ever wondered about the process that ensures *Preview* lands on your desk every two months or so? Before I took over as Editor, I gave very little thought to the nuts and bolts of the editorial and printing process. Now, I find myself looking at all sorts of printed materials and wondering just how many people and processes it took to produce yet another magazine or brochure.

The process for *Preview* is a two-monthly cycle. As the latest glossy edition arrives on your desk or though your letterbox, we are just gearing up production of the next issue. An army of regular contributors (over thirty at last count) receives an email to remind them that in a month or so their regular contribution is due, via email, to me. Usually the copy deadline is mid-month, a full month before the printed magazine will be despatched to you, the readers. A week before my copy deadline, they get another reminder email to make sure that we get as much content as possible. In the meantime, feature articles are being sourced and written.

For any given article, large or small, the text and graphics arrive with me for editing. After any changes are finalised, the article is forwarded to our Production Editor at CSIRO Publishing, Helena Clements. Helena starts by collating material into sections – ASEG News, Branch News, etc. Then each section is sent electronically to India for typesetting, along with page layout instructions and established style specifications for each section. The typeset proofs are returned to Helena who then distributes them for checking – usually to me and/or a feature article's author.

The tricky part is then fitting the whole thing together. Helena needs to make sure that all the advertisements are included in the layout at the size purchased by the advertiser; the total page count needs to be taken into consideration (it must be a multiple of 4, preferably 36 or 40 in total); a cover needs to be constructed; cross-referencing between page numbers (including the table of contents) needs to be added and checked; and final versions of the digital proof checked and double-checked. During this time, a steady stream of emails is making its way between Perth (me), Melbourne (Helena), India (our typesetter), and all the different parts of Australia and the world where our contributors might be located.

Finally, the digital edition is ready. At this time you will receive an early alert email to let you know that *Preview* has been published online, and the printing process is ready to commence. CSIRO Publishing collaborates with a Melbourne-based printer to ensure that the printed magazine is a high quality product. First, the print content is sent electronically to the printer. Then it is taken through a three-stage process to check colour balance, ink distribution, symbol rendering, text position, page order, etc. These checks are time consuming, but every now and again we are reminded as to their necessity. In the last issue, a printing problem was detected, delaying the print run by several days but ensuring that all table headings were in fact legible in the printed version. You may have noticed that Issue 141 was later than usual arriving on your desk, despite the online edition being published on time.

The production of *Preview* is an excellent example of modern technology and the flat earth in action. (If you want to read a wonderful book on this subject, have a look at *The World Is Flat* by Thomas L. Friedman.) Most of the magazine development takes place electronically via email transfer of Word documents and PDF files. As Editor, I almost never use a printer – all editing and proofing is done on-screen. Perhaps it will not be many years before you will be choosing to read *Preview* online using web-based e-reading software.

I do hope you enjoy reading this issue. I was in the happy position of feeling almost overwhelmed by the number and variety of contributions I received. In particular, there are feature articles on the Deep Exploration Technology CRC; education programs TESEP and ESWA; electrokinetics; and airborne gravity. Web Waves is back with a look at the SEG website; Book Reviews have returned with a look at two texts; and there is plenty of ASEG News and Industry News to be perused.

Call for papers

Future Discoveries are in our hands

Invitation

On behalf of the Australian Society of Exploration Geophysicists (ASEG) and Petroleum Exploration Society of Australia (PESA), we cordially invite you to participate in the **21st International Geophysical Conference and Exhibition** to be held in Sydney, at the Sydney Convention and Exhibition Centre, NSW during 22-26 August 2010.

The conference theme: '**FUTURE DISCOVERIES ARE IN OUR HANDS**' reflects that well-applied geophysical strategies will be needed to find the next world-class resources and contribute to new wealth creation. The collaboration of two of Australia's premier geoscientific bodies promises to make this conference a stand out forum for the resource exploration geophysics community.

Program Outline

The conference will commence with the icebreaker reception on Sunday, 22 August 2010 and then follow with up to four concurrent technical streams from Monday through Wednesday and a seminar day of three concurrent themes on the Thursday.

Call for Papers

Abstract submissions are invited for Conference technical presentations. Authors may elect to present a paper or a poster. Each submission should be associated with a technical area. No commercial promotion or overt advertising of techniques and services will be permitted. The Technical Papers Sub-Committee will make the final decision regarding the acceptance of papers and posters. Initial abstracts or extended abstracts for all presentations will be published in the conference proceedings.

Conference Secretariat

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Tel: +61 2 9437 9333
Fax: +61 2 9901 4586
Email: aseg-pesa2010@conferenceaction.com.au
Web: www.aseg-pesa2010.com.au

Key Dates

- **ABSTRACT SUBMISSION:**
  Friday, 13 November 2009
  Note: All submissions will be acknowledged. If you have not received acknowledgement of the receipt of your abstract within two weeks of submission, please contact Conference Action.
- **NOTIFICATION OF ACCEPTANCE:**
  Friday, 18 December 2009
  Note: Guidelines for short papers will be provided with advice of acceptance.
- **SUBMISSION OF EXTENDED ABSTRACTS FOR REVIEW:**
  Friday, 26 March 2010
  Note: Papers that do not meet the guidelines will not be published on the conference CD.

Submission of Initial Abstracts

- Abstracts are to be submitted online by Friday, 13 November 2010 at **www.aseg-pesa2010.com.au**
- Authors will be asked to upload their abstract via the conference website.
- Further abstract information including formatting details can be downloaded from www.aseg-pesa2010.com.au or requested by email from aseg-pesa2010@conferenceaction.com.au.

Initial Abstract Specifications

- **ABSTRACT:** The abstract should be a condensation and concentration of the essential qualities of the paper or poster presentation. Do not include acknowledgements, figures or references.
- **LENGTH:** up to 250 words.
- **TECHNICAL AREA:** identify the preferred technical area from the suggestions below. Presentation: indicate preference for paper or poster submission.

Presenter Profile

A brief personal profile of the presenter (maximum 100 words in sentence format) is required to be submitted online with your abstract submission.

PLEASE NOTE:

- Presenters are expected to register and pay for the day of presentation or the full time program at least one month before the conference.
- All costs to attend the conference, including travel and accommodation, must be met by presenters.
- All correspondence should be directed to the ASEG 2010 Secretariat at: aseg-pesa2010@conferenceaction.com.au.

Technical Areas

Seismic Data Processing

- Latest tools in seismic interpretation
- More efficient computing in the oil and gas industry
- 3D technologies
- Inversion breakthroughs
- Global partnerships in oil field R&D

Oil and Gas Exploration

- Coal seam gas exploration – How useful are traditional methods?
- Finding oil in complex geological terrains (eg PNG)
- Seismic attribute interpretation – distinguishing fluid and lithology signatures
- Seismic attribute interpretation – direct hydrocarbon detection update
- Emerging non-seismic techniques in oil field delineation (eg CSEM)
- Case histories in oil and gas discovery

Minerals Exploration

- Deeper penetration (More power, greater precision, better interpretation software)
- Satellite deposit detection
- Transferring oilfield technologies to mineral exploration
- Technology developments in mineral exploration
- Uranium exploration update
- Case histories of successes and failures of exploration under cover in major Australian mineral exploration domains including the Yilgarn, the Gawler, the Lachlan Fold Belt, etc – could include identifying new mineralised provinces, as well as exploration for gold, base metals, diamonds, iron ore & mineral sands

Engineering and Community

- Geophysics role in increasing innovative engineering opportunities
- Geophysics role in addressing major human crises
- Better delineating groundwater resources
- Case histories in environmental geophysics

The Discipline of Geophysics

- Greater clarity in imaging geology
- Discipline integration
- Education, experience and technology
- Exploration in China (with a geophysical focus)

Economics/Big Picture Topics

- Optimisation of "Greenfields" acreage acquisition
- The carbon trading/carbon reduction scheme
- Oil and gas supply/demand projections for the next decade/century?
- Supply/demand projections for gold/copper/nickel for the next decade/century?

Maintaining our individuality while seeking strength in teamwork – II

If asked, would we join a team bound for the Olympic games?

Last month I wrote about potential synergies which the ASEG is exploring with our sister society PESA. This month I want to talk about our involvement with the Australian Geoscience Council (AGC), which is an entity consisting of representatives from eight Australian geosciences-related societies (see table below).

The item of highest interest on the AGC agenda at present is putting together teams, budgets and programs for the 34th International Geological Congress (IGC), to be held in Brisbane on 2–8 August 2012. This conference is the Olympic games of earth sciences, held over 8 days in a different location every 4 years. The AGC is the legal entity staging the conference, and Geoscience Australia is strongly backing the effort with both sponsorship and contribution of staff time. We have a once-in-a-generation opportunity to be part of this international event, but it also entails particular care in financial planning since we are only a small part of the decision and organisational structure. If we fold our traditional conference into 4 days of the IGC we must gain financially in order to continue our existing publication and other programs. Andrea Rutley, who holds the Conferences portfolio on our Federal Executive, is on the IGC finance sub-committee and working hard for our interests as well as the Conference as a whole.

A recent activity of immediate importance to the ASEG has been the preparation of a submission to the Minister for Innovation, Industry Science and Research (Senator Kim Carr), and to the Australian Research Council, on the new Excellence in Research for Australia ranking of scientific journals (see p. 11 of this issue for the full text of the letter sent to Kim Carr). Rankings for geosciences-related journals as released this year have the effect of downgrading applied science journals in resource-related geophysics, economic geology and hydrology, relative to journals catering to a more academic readership. The potential effect on geoscientists' careers is quite significant since the intention is that access to ARC grants and university promotions will be influenced by journal ranking regardless of the quality of a learned paper. Our society journal *Exploration Geophysics* is in the fourth (lowest) rank despite its position as a repository of mining geophysics papers ahead of all other geophysics journals. This comes at a time when the teaching of economic geology and applied geophysics is demonstrably in decline around the country. The AGC obtained input from several university departments, CSIRO and the Academy of Technological Sciences and Engineering in preparing the submission and we are hopeful for some improvement.

A third area where AGC matters are important to the ASEG is in geoscience education and education of the public; these are two generic areas of interest in the Objectives of the AGC. The Teacher Earth Science Education Program originated by PESA is supported by AGC (see article on p. 25 of this issue) and the ASEG is encouraging geophysicists who have moved into secondary school science teaching to have some input into this program.

In each of these areas, our only limitation is the energy of our membership. If these issues matter to you, then you have the opportunity to make a difference.

Member groups of The Australian Geoscience Council	No. of members in 2009
The Australasian Institute of Mining and Metallurgy (AUSIMM)	2600
The Geological Society of Australia (GSA)	2031
The Australian Institute of Geoscientists (AIG)	1642
The Petroleum Exploration Society of Australia (PESA)	1364
The Australian Society of Exploration Geophysicists (ASEG)	1142
The International Association of Hydrogeologists Australia (IAH)	493
The Association of Applied Geochemists (AAG)	132
The Australian Geoscience Information Association (AGIA)	53

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

FedEx meetings

The Federal Executive meets with a telephone hook-up once a month for up to 2 hours. In that time we have to consider and make decisions on the main issues affecting the ASEG. To provide some flavour to these meetings let me outline four of the matters discussed at the meeting held on 27 August 2009.

Publications

Issue: Can we expand the impact of *Exploration Geophysics* by co-operating more closely with our colleagues in the Western Pacific such as SEJG and KSEG.

Actions: Prepare options and meet with SEJG and KSEG officers in October 2009.

Membership

Issue: Increase the number of Active Members in the ASEG.

Actions: Revise the Constitution so that we have a better process for attracting Active Members. At present only Active Members can serve as Officers of the Society and we have too many Associate Members who are ineligible to serve as officers. Amendments to the Constitution to be prepared for consideration at the 2010 AGM.

Conferences

We have in place a strong Organising Committee led by Mark Lackie for the next Conference, to be held in Sydney from 22 to 26 August 2010. This will be another event hosted in co-operation with PESA and if you go to the website http://www.aseg-pesa2010.com.au, you will be able to see what will be an exciting Convention.

In 2012 the 34th International Geological Convention will be held in Brisbane from 2 to 10 August. The ASEG is working with our sister societies in the Australian Geoscience Council to ensure that this event will provide a platform to showcase Australian resource exploration and deliver a successful international multidisciplinary geoscience event. FedEx is working to ensure this outcome.

Unemployed members

The Global Financial Crisis has impacted on resource exploration in Australia and some of our members may have lost their jobs. If any members are experiencing severe financial difficulties as result of the Global Financial Crisis, there is provision in the Constitution for the Federal Executive *to waive or reduce annual fees for those members where it believes circumstances warrant.*

If any member has lost their job and believes they have a good argument for paying reduced fees for 2010, they should contact the Chairman of the Membership Committee, Cameron Hamilton at cameron.hamilton@originenergy.com.au.

David Denham

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ASEG News

New South Wales

In August, Mike Asten, the President of the ASEG, gave us an overview of the ASEG for 2009 and briefly discussed the goals and challenges of the society. Then Mike spoke about electromagnetic induction detection and discrimination of unexploded ordnance using an array of fluxgate magnetic sensors. Mike outlined how the location of unexploded ordnance amidst scrap metal is a major world-wide environmental problem and how the use of fluxgate magnetometers as a vector sensor in EMI metal detection will assist in UXO target discrimination, especially for situations where target UXO responses are perturbed by ancillary scrap, or the response of magnetic soils in the earth. Many technical questions followed Mike's presentation.

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

The deadline for initial abstracts is 13 November 2009.

An invitation to attend NSW Branch meetings is extended to interstate and international visitors who happen to be in town at that time. Meetings are held on the third Wednesday of each month from 5:30 pm at the Rugby Club in the Sydney CBD. Meeting notices, addresses and relevant contact details can be found at the NSW Branch website.

Mark Lackie

South Australia

The South Australian Branch of the ASEG is happy to announce the winning selections for the Annual ASEG Wine Offer. As usual, the competition was fierce, with underdogs knocking off more fancied competitors in the blind tastings. The red selection was Morgan Simpson 2006 New Territories Shiraz, while the winning white wine was Coriole 2009 Chenin Blanc. The tasters, comprising committee members and supporters of the local branch, found these wines were both of excellent value and great drinking. The order form can be found in this copy of *Preview* (see p. 48). The wines will be delivered to all capital cities in early December, in time to provide some Christmas cheer.

Upcoming SA events include the annual Industry Night in mid-October, the ever popular Melbourne Cup Luncheon at the National Wine Centre and the Student Night, with honours geophysics presentations in mid-November.

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

Luke Gardiner

Victoria

On 29 July Victorian ASEG branch members enjoyed a very fine evening of micro-brews, finger-food and cross-disciplinary banter at the Midwinter Social Evening at the Portland Hotel in Melbourne's CBD. The event, which was a joint meeting of the Victorian branches of PESA, SPE and ASEG, was a great success, and a repeat event later in the year is now being considered.

On 26 August the Annual General Meeting for the ASEG Victorian Branch saw the following positions elected for 2009–2010: Asbjorn Christensen, President; Richard MacRae, Secretary; and Phillip Skladzien, Treasurer.

Following the AGM the Spring Victorian Branch program of technical talks commenced in earnest with Michael Asten (ASEG President, Flagstaff GeoConsultants and Monash University) presenting 'Overview of ASEG 2009 – Goals and Challenges' followed by the technical presentation 'Electromagnetic Induction Detection and Discrimination of Unexploded Ordnance using an Array of Flux-gate Magnetic Sensors'. Many thanks to Michael for two interesting talks sparking a number of audience discussions ranging from whether the journal *Geophysics* warrants a 'B' rating in terms of publication index, and to what degree three-component magnetic field measurements reduce ambiguity in inversion of TEM data.

On 5 October, at the Kelvin Club (at 6:00 pm for 6:30 pm), Dr Tim Rawling from Geoscience Victoria, Department of Primary Industries, will present '3D Modelling and Model Management at GeoScience Victoria'.

On 25 November, at the Kelvin Club (at 6:00 pm for 6:30 pm), the ASEG Victorian Branch will be hosting the Annual Student Night, giving local graduating geophysics students the opportunity to present their research in a professional forum.

Asbjorn Christensen

ASEG Treasurer, David Cockshell, tests the 'nose' of a fine white.

SA Branch members enjoy a convivial evening of wine tasting.

200 people attend geosciences student careers event

More than 150 students from seven schools and five universities in Perth, Western Australia, attended the fourth geosciences careers evening on 12 August. Attracted by the opportunity to gain the latest information from the universities and mining and petroleum companies students, teachers and parents were briefed on courses, career opportunities, lifestyle, and job satisfaction. Four geoscience professional bodies, the Australian Society for Exploration Geophysicists (ASEG), Petroleum Exploration Society of Australia (PESA), the Australian Institute of Geoscientists (AIG), and the Geological Society of Australia (GSA), combined forces to coordinate this very successful student careers event.

Attendees were able to meet and discuss career opportunities with representatives from Curtin University of Technology, Murdoch University, and University of Western Australia; ASEG, PESA, AIG, and GSA; Apache Energy, Atlas Iron, Woodside, PGS, and Fugro. This mix of course providers, professional organisations and potential future employers ensured that those attending could find out about all aspects of following a career in the geosciences.

Fantastic door prizes, kindly provided by the evening's sponsors, added to the excitement of the event. All participants, even those who did not win a prize, felt that they had gained from the experience. It was a great opportunity for anyone contemplating a career in geoscience to investigate the options.

The professional bodies and the industry sponsors all recognise the importance of attracting high calibre students into the profession. The economy of Western Australia is based on the mining and petroleum industry, and we need to ensure a continued flow of enthusiastic students into the profession to maintain our capability and lifestyle. Some of the most daunting problems facing the future of society, including climate change, greenhouse gas mitigation, soil degradation, and security of energy supply, will need the expertise of the next generation of geoscientists.

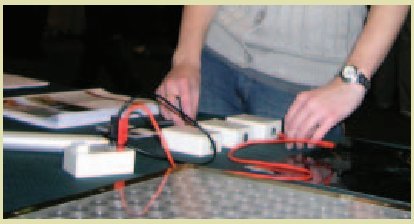
Jim Leven

L–R: Jim Leven, Oil & Gas Services, Department of Commerce; Howard Ng, laptop door prize winner, Kent St Senior High School; and Suzy Urbaniak, geologist and earth and environmental science teacher, Kent St Senior High School.

Getting them interested

Dominic Howman is well known to geophysics students at Curtin University. As Senior Technical Officer in the Department of Exploration Geophysics, he comes into contact with nearly all the students at one time or another, especially in organising field activities. Dom is also coordinator of the Department's marketing activities and thus was a key presenter at the Geosciences Careers Evening. Curtin's Exploration Geophysics stand was very popular with a constant stream of students gathering around to test out the small experiment that Dom has built. In Dom's own words, here is how it works.

The photo shows one of my best promotional toys. In three boxes I have put sand, iron, and brass. I attached bolts that touch the samples inside but are also sticking out of the boxes. The idea is to find which box contains the metal brass without taking off the lid. Students have two 'instruments' to help them – a magnet and a continuity tester. By touching the bolts on the outside of the boxes with the continuity tester they check which samples pass current – eliminating sand. Then they put the magnet on top of the boxes to check if the samples are magnetic. Immediately they are forced to think if brass is magnetic or not. I can then easily lead the conversation onto the fact that they have just done some small scale geophysics. You don't need to take the lid off the box (i.e. scrape away a lot of earth) if you know something about the physical properties of the substance you are looking for Brilliant!



Dominic Howman's 'finding the metal brass' experiment.

Anthony R. (Tony) Barringer – 20 October 1925 to 15 August 2009

Tony Barringer died peacefully in Golden, Colorado at the age of 84. He is survived by Jean, his wife of 60 years, their five children and currently four grandchildren.

A study of Tony's career is to be made aware of the large number of inventions by this very intellectual man; inventions ahead of their time, totally innovative and usually starting an entirely new field of endeavour. Tony had great vision, enthusiasm and boundless energy which often exhausted his collaborators. He authored over 80 papers.

If you have heard of Tony Barringer for only one reason, as a geophysicist the chances are that it will be for the airborne geophysical system, INPUT. This was the first of his many new, ground-breaking inventions which flew commercially from 1960. Standing for Induced Pulse Transient EM, INPUT was the first airborne EM system to operate with a pulsed transmitter. Before that, in these early times for AEM in Canada and elsewhere, AEM systems all used continuous wave transmission. The INPUT method overcame many of the difficulties inherent in the earlier methods and was able to be much more powerful. Its invention is solely attributed to Tony when he worked for Selco Exploration in Toronto, his first employment after obtaining a PhD from Imperial College, London in 1954. Having being credited in the discovery of at least 25 major ore bodies throughout the world, INPUT was an undoubted success and still is today through the many variants it has spawned including SALTMAP here in Australia.

INPUT was followed by COTRAN, standing for Correlation of Transients, an advanced idea for its time using digital processing to enhance the received signal by curve-matching in real time. Also in the field of airborne geophysics was RADIOPHASE, which measured the magnetic components of very low frequency (VLF) transmissions as a source field to map geology but it was unique in using the vertical electric field as a reference. A spin-off of RADIOPHASE was another of Tony's unique inventions, E-PHASE, measuring the e-field of VLF, local radio and TV transmissions to obtain ground resistivity from aircraft, until then a method thought to require ground contact. More than one frequency at a time allowed for discrimination of layering. Invariably, the main inventions were improved by subsidiary inventions which resulted in Tony having over 70 patents. (Tony retained a personal patent attorney.)

If you are a geochemist you would most probably also have heard of Tony Barringer as many of his inventions were in the field of exploration geochemistry. They involved measuring airborne vapours and particulates as trace indicators of minerals. One such instrument was the Barringer Airborne Mercury Spectrometer, an electro-optical device detecting the atomic absorption characteristics of mercury vapour. Tony was a strong believer in these indicators of mineralisation and sped up the sampling process by installing a mini geochemical laboratory in a plane and later, to deal with terrain, in a helicopter. So we were given AIRTRACE and because it worked so well in the air it was also used on the ground as SURTRACE. Remote sensing was always the driver. COSPEC was a unique electro-optical 'telescope' which measured SO_2 and NO_2 pollutants by optical correlation of their absorption lines. This was sometimes used by pollution regulators to measure the SO_2 emanating from factories without having to gain entry to their premises. Once, the SO_2 plume from the Mt Isa smelter was detected 1000 km away in Western Australia. GASPEC was used by NASA to measure the world-wide distribution of CO_2 in the atmosphere from satellites, once again in the forefront of technology at the time. Tony also learnt that airborne particulates flaking off people's skin could reveal if they had recently handled drugs or explosives, and as this was not unlike his detection of natural particulates so evolved another new business activity and Barringer IONSCAN units were installed at airports as security and forensic devices.

Tony's passionately held belief in oil and gas field plumes reaching the surface and then into the overlying atmosphere and oceans led him to develop ways to cause the natural oil slicks to fluoresce and be distinguishable from refined oil spills, resulting in FLUOROSCAN and LASERTRACE. Even when approaching the age of 80, Tony devised a new airborne EM system, 'Tellurex', which was designed to measure the resistive halo around some oil fields. Somewhat akin to magneto-tellurics, and harking back to E-PHASE, it measured the natural magnetic and electrical components simultaneously. Unfortunately the illness that eventually led to his death didn't allow him to pursue this development personally. Much of the funding for these projects was raised by Tony personally due to his great knowledge being ably conveyed to funders with much persuasiveness and polite charm.

Tony was the recipient of many prestigious awards, including, at the age of 55, the Virgil Kauffman Gold Medal of the Society of Exploration Geophysicists for INPUT. This gold medal 'is awarded to a person who has made an outstanding contribution to the advancement of the science of geophysical exploration as manifested during the previous 5 years'. The author of the citation (Dr Harry Seigel), noted that the 'committee might equally have decided to award this medal to Tony for...RADIOPHASE and E-PHASE... or had the SEG been able to recognise chemical achievements, for...COSPEC, and particulate analysers such as AIRTRACE and SURTRACE'. In 1985, Tony was awarded the Daniel C. Jackling Award by the American Association of Mining and Petroleum Engineers 'for his leadership in development of new geophysical techniques; for his successful application of geophysics in mineral exploration, leading to many important ore discoveries; and for his lecture, "Developments in Airborne and Satellite Exploration"'. Tony was inducted into the

Canadian Mining Hall of Fame in 1997 by the Mining Association of Canada and approximately 100 well-wishers attended a salute to Tony for his 80th birthday, including many former employees of Barringer Research who have since gone on to generate further advances in geophysics of their own.

I had the privilege of being an alumnus of the Barringer Research 'University' from 1974 to 1977 and have followed Tony's outstanding career ever since. In 1974, in England, we surveyed with E-PHASE using broadcasts from BBC TV. I used COSPEC in the highly polluted environment of northern Europe; helped to promote E-PHASE for finding road gravel under glacial cover in northern USA; conducted feasibility tests of the use of magnetics and resistivity over oil fields (once just with Tony); and in 2002 was asked to be involved in the Tellurics project.

Further information on these inventions and Tony's awards can be found online at: http://en.wikipedia.org/wiki/Anthony_Barringer. With the approval of Tony's family, donations in honour of Tony Barringer may be made to the KEGS Foundation where Tony is among the list of KEGS Pioneers (http://www.kegsfoundation.org).

Roger Henderson
Email: rogah@tpg.com.au

New members

The ASEG welcomes the following 32 members to the Society. Their membership was approved at the Federal Executive meetings held on 30 July and 27 August 2009.

Name	Affiliation	State	Membership category
Luisa D'Andrea	Rio Tinto	WA	Active
Victoria Dharmarajah	Ahava Energy Ltd	SA	Associate
Jesse-lee Dimech	Curtin University	WA	Student
Rumlan Dwiyatno	Ahava Energy Pty Ltd	SA	Associate
Anthony Richard Hallam	University of QLD	QLD	Student
Lachlan Hennessy	RMIT University	VIC	Student
Sean Christopher Herbert	Curtin University	WA	Student
Uthai Inthisaeu	Austhai Geophysical Consultants Ltd	Thailand	Associate
Martin Kim	Woodside Energy Ltd	WA	Associate
Yusen Ley Cooper	RMIT	VIC	Active
Rebekah Manley	Woodside Energy Ltd	WA	Associate
Allan Miles	Woodside Energy Ltd	WA	Associate
Anne Morrell	Southern Geoscience Consultants	WA	Active
Thangapandian Muthupandia	BHP Billiton	WA	Active
Alan Nanini	Woodside Energy Ltd	WA	Associate
Thomas Paten	Curtin University	WA	Student
Mark Pay	Woodside Energy Ltd	WA	Associate
Matthew Charles Pfahl	ANU	ACT	Student
Chris Piggott	Curtin University	WA	Student
Shahid UR Rahman	Fugro-Jason	WA	Associate
George Reynolds	Metrics Consulting	Ireland	Active
Suba Rorham	Schlumberger	WA	Active
Jeffrey Shoffner	Colorado School of Mines	Colorado	Student
Lee Tasker	Coffey Geotechnics	NSW	Active
Mark Thompson	Woodside Energy Ltd	WA	Associate
Glen Torr	Geoscience Australia	ACT	Associate
Federico Tovaglieri	University of WA	WA	Student
William Tran	Curtin University	WA	Student
Stephanie Marie Tressler	Curtin University	WA	Student
Kardawaz Umair	Curtin University	WA	Student
Damien Van Brink	RMIT	VIC	Student
Ung Sing Wong	Woodside Energy Ltd	WA	Associate

Keeva Vozoff wins the SEG's 2009 Reginald Fessenden Award

Warmest congratulations go to Keeva Vozoff who has been awarded the 2009 Reginald Fessenden Award by the SEG. The Reginald Fessenden Award is given to a person who has made a specific technical contribution to exploration geophysics, such as an invention or a theoretical or conceptual advancement, which, in the opinion of the SEG Honors and Awards Committee and the Executive Committee, merits special recognition. The award will presented at a special Honors and Awards ceremony on 25 October as part of the SEG International Exposition and 79th Annual Meeting in Houston, Texas.

Keeva's research interests range throughout the entire electrical geophysical area including EM, IP, magnetotellurics and tellurics. In 1951 Keeva was awarded a research fellowship at MIT (Massachusetts Institute of Technology) by IBM and the Morse Committee to do a PhD on applications of computers to geophysics. At the time, there was some scepticism as to the potential role for computers. For example, Thomas Watson (founder of IBM) said he thought there might be a market for five or six computers in the whole world. Keeva's research at MIT included the first (crude) computer resistivity modelling in 1, 2 and 3 dimensions, the first numerical inversion, and the first seismic surface wave dispersion curves for multilayers. A long and distinguished research career has followed and Keeva is highly respected for the leadership he has shown in research and postgraduate teaching of geophysics in Australia.

In 1985, Keeva was awarded SEG Honorary Membership. In the citation for that award, Roger Henderson wrote, 'Keeva is a brilliant professional constantly striving to promote the cause of geophysics in both the academic and commercial worlds'. Over 20 years later, this is still a very apt description for a very distinguished member of our geophysics community.

Letter from AGC to Senator Kim Carr re ranking of scientific journals

The following is the full text of a letter to Senator Kim Carr about the implications of the new Excellence in Research for Australia (ERA) ranking of scientific journals. The letter is referred to in Michael Asten's President's Piece in this issue (p. 4) and has been included here on the recommendation of past ASEG President, Mike Smith. The issue is of vital importance to the health of geoscience research in Australia and thus I thought it worthy of inclusion in Preview. *–Ed.*

7 September 2009

Senator the Honourable Kim Carr
Minister for Innovation, Industry Science and Research
Parliament House
Canberra ACT

Dear Senator Carr,

I am writing on behalf of the member societies of the Australian Geoscience Council regarding the unintended consequences of the journal ranking scheme published by the Australian Research Council (ARC), under the Excellence in Research for Australia (ERA) Initiative, for the future of applied research in the geosciences at Australian universities.

As I am sure you are aware, geoscience is a discipline of national strategic importance in Australia. Despite the economic significance of the resources industries, Australian resource groups are suffering a major shortage of geoscience professionals. Although the current downturn may have temporarily relieved this pressure, there is a general consensus that this problem will re-emerge as the global economy strengthens.

To a greater degree than most developed nations, Australia's economy and ability to sustain society requires solutions that arise in the geosciences. There is now widespread concern within the geoscience community and major employer groups about the health of geoscience education in Australia and the demise of earth science educational opportunities, university earth science teaching departments and staffing levels. Our independent surveying shows that the higher educational system will not provide the number of appropriately trained geoscientists required by the economy and Australian society.

The Australian Geoscience Council (AGC) has determined that over the last 10 years, the number of geoscience departments in Australia's universities and their staffing levels has decreased and the number of graduates has reduced, particularly at the Honours level where numbers have halved. We believe the recent government announcements in higher education have the potential to mitigate this problem in part, but time will tell.

Whilst our recent focus has been on undergraduate teaching, the other side of the demise of earth science departments is the impact on research in support of the resources sector and particularly in specialist disciplines such as applied geophysics, economic geology, petroleum geology and hydrogeology. These represent important components of the geoscience research discipline and although small they are of fundamental importance to the national economy. It is our view that these areas of applied research will suffer major adverse impacts from the ERA process as currently formulated. We wish to offer two recommendations which we believe will have significant impact in strengthening such research and these are provided below.

The AGC welcomes the Australian Government initiatives announced in the 2009 Australian Government Budget and the Innovation Paper 'Powering Ideas – An Innovation Agenda for the 21st Century' where a clear link is made between innovation and research and future prosperity and is major policy driver for the government's investments – a concept with which AGC is in full agreement.

It is therefore most unfortunate that in the ranking of journals by the ARC, applied research journals of international standing, which represent the highest ranking publications in their fields, have been consistently ranked as B, in particular:

Geophysics B
(Society of Exploration Geophysicists)
Economic Geology B
(Society of Economic Geologists)
Hydrology Journal B
(International Society of Hydrogeologists)
AAPG Bulletin B
(American Association of Petroleum Geologists)

In addition we have the situation of the applied science journals produced in Australia, in particular *Exploration Geophysics* (Australian Society of Exploration Geophysicists) which is ranked C, and which compares unfavourably with the ranking of similar (but more pure geoscience) national journals:

Australian Journal of Earth Sciences A
(Geological Society of Australia)
New Zealand Journal of Geology and Geophysics B
(Royal Society of New Zealand)

Have these rankings occurred because the majority of geoscientists in Australian universities are not applied geoscientists? There does not appear to have been any serious consideration of submissions made on behalf of the applied geoscience community. Our concern is that, through time, this will bias the selection of research topics in universities to the detriment of applied geoscience research and to the resources industry, which is such a major part of the Australian economy, and will exacerbate the human capital problem which is already evident. The absence of any applied geoscience journals in the top rated class of journals is simply not rational.

Recommendation 1. We recommend an urgent review of rankings of applied science journals, to include input from relevant professional societies in Australia.

Although we note there are other criteria that can be brought to bear on evaluation of applied researchers, they appear to be very narrow and related specifically to patents, registered design, commercialization income, etc. Much applied research relates to standard research outcomes that are published in journals. It is simply not credible that there are no applied geoscience research journals in the top rank of journals. We are aware that there is an opportunity to review the ERA process and journal ranking at the end of the trial period and we will be making appropriate submissions closer to that time.

However, it appears that there is a fundamental policy problem in the way research papers related to applied geoscience topics are handled compared with more academic matters. This is where applied research papers, regardless of their content, will necessarily be lower ranked irrespective of merit simply because the journals in which such work is published are not highly ranked for reasons that are unclear. As mentioned above, we believe this situation will be detrimental to applied geoscience research in the longer term and is counterproductive to the aims laid out in the Innovation White Paper.

We believe it is crucial to the future of applied geosciences in Australia that immediate steps are taken to develop a two-axis method of evaluation of applied research, the first being publications, and the second being impacts on the resources and water industries, where those impacts must include input from end users (e.g. State Geological Surveys, mining and petroleum companies).

Recommendation 2. We recommend that the Physical, Chemical and Earth Sciences Research Evaluation Committee include membership and input from the end users of applied geoscience.

We would be happy to discuss these matters further in any manner you deem appropriate.

Yours sincerely,
Dr Michael Leggo
President, Australian Geoscience Council

ASEG web site member functionality goes live!

The ASEG web site is entering a new phase with membership logon functionality delivering new and updated services to members. With this functionality recently turned on, it is appropriate to discuss not only the functionality that is available but also the plans for forthcoming functionality and services.

History

First a bit of history to set the scene and to help explain the current development direction.

The first ASEG web site was developed using HTML pages and did not have any database functionality. Federal Webmaster Voya Kissitch did a huge job writing pages, many of which are still there. He also coordinated a team of state webmasters who also developed pages in HTML.

In 2006, the ASEG contracted a third party to use their database functionality whereby members could update their details on-line and could look up other members' details. Content still had to be largely developed using HTML and the database functionality was somewhat unreliable. Many states did not have webmasters to develop content so only a few branches regularly updated member event pages. Special events such as the WA Branch golf day and SA Branch wine offer still had to be customised and another third party developed these separately.

Part of the problem with this model was that the functionality used by the ASEG was also used by more than 20 other organisations. Therefore customisations had to fit into this broad architecture and priorities were dependant on the collective benefits.

When I volunteered for webmaster in 2007, I undertook a review of functionality and set up a vision of how I thought the ASEG web site should function. This not only included functionality for members and the public such as event notices, but also functionality for federal committees and state branch committees.

Part of this review included an option for developing our own site or commissioning development of the site by a consultant. However, in 2008 our third party provider discovered our discussions in the ASEG federal committee minutes (which were posted on the site) and he just turned off the web site with less than 2 weeks notice.

The site was resurrected as a static site within the 2 weeks and is now hosted on a commercial web server in Australia (www.WebHostForASP.net.au).

Design and architecture

To restore database functionality and to move the site forward, a number of scenarios were considered.

Several open source packages including DotNetNuke (www.dotnetnuke.com) and Joomla (www.joomla.org) were considered. However, upon further consideration of our requirements, there were several serious limitations which precluded using these open source products.

The biggest drawback in all these systems was that they required ALL members to have email and to use email as the only communication medium. The ASEG has over 100 members who do not have email listed in their contact details. We could not manage these members using these systems and would have had to develop a parallel system to handle these cases.

While these open source systems could have been customised to accommodate this limitation, I discussed this with a professional site developer specialising in DotNetNuke development and he recommended us to develop the site functionality from scratch.

Another consideration was having an architecture that would allow volunteers to gain useful skills. Having DotNetNuke skills would not allow people to generate customised geophysical solutions.

The site has therefore been developed on SQL Server 2005 using ASP.Net 2.0. Development languages include HTML for the front pages and C# (C sharp) or VB (Visual Basic) for the back end functionality.

The design is database centric whereby content providers do not need to know any technical details. They simply log on and fill in an on-line form. All formatting of the content is done automatically. This format also allows for automatic removal of past events since the database record has a date attached which is compared to today's date.

This design cuts down on the amount of day-to-day work required by the webmaster and allows individual content providers to manage their own content.

Site development

The next question was whether to write our own code or to contract someone to develop it for us. While a commercial development would probably have produced a result earlier, developing our own code was chosen for the following reasons.

Supervising contract development must extensively happen during working hours. With the amount of effort required in design liaison and testing, I felt it was inappropriate to expect my employer to give up this amount of my time. Developing the system ourselves could occur after hours and have little impact on regular employment tasks.

Setting up a scenario of always using contractors to develop site functionality would create limitations in the longer term that would prevent the site progressing as envisioned. Having an understanding of our own system will allow a team of volunteers to produce functionality at a faster pace in the longer term. Development of site functionality will also not need to compete with other ASEG spending priorities. ASEG volunteers can be trained in the basics and produce improved functionality on a continuous basis.

Although the cost could have been carried by the ASEG, developing our own code has saved considerable expense.

What does it do?

At present, the site allows members to log on and update their contact details. These are used for branch meeting notices via email and posting of publications. Members can also enter and update industry and affiliation details on-line to assist in generating membership statistics.

Members can view their membership status and renew their subscriptions on line. Fees are individually calculated dependant on your membership level and location and can be paid by either printing out an invoice to send to the secretariat with a cheque or credit card details or this amount can be paid on-line by credit card using a secure third party specialising in on-line payments (eMatters).

Corporate members can post employment notices and can update their displayed details without going through the secretariat. They only need to log on and go to the Edit Corporate Details page.

Branch Committees can log on and post their own meeting and event notices without having to know any HTML, use a webmaster or use the secretariat. This should enable all branches to keep their own event notices up to date.

Security has been a large consideration with members being assigned various web roles that enable them to perform particular on-line functions or access on-line content. In addition, some pages recognise individual members and only allow that member to edit their own data, e.g. personal details and corporate member display details can only be edited by that member or an administrator. The date of birth field is only visible to you and is not available to anyone else, even administrators. This information can be collated for statistics but individual privacy is protected.

Once logged on, members can also access ASEG content that is not available to the public, e.g. ASEG federal or state branch reports such as financial summaries.

What will it do later?

The vision for functionality to come includes:

- You will be able to nominate which branch meeting notices you receive. You will be able to receive notices from as many branches as you wish or none. You will set these in your on-line preferences.
- Member search functions. Members will be able to search for other members' contact details. This will be limited to a small number within an elapsed time period so mailing lists cannot be built from this.
- A more comprehensive event registration function whereby branch committees can set up the structure and members will not only be able to register but also pay for that event on-line.
- Forums will be available for a number of uses including committee meeting discussions (to reduce the email traffic) and discussions about resolutions requiring member input and feedback, e.g. the CEO motion prior to the last AGM. Whether forums will be used more widely is still to be discussed, e.g. having members debate geophysical solutions or points about published papers.
- A Wiki is a set of reference pages that any member can edit to add or revise content. A Wiki may be used to collate information about all manner of geophysical theory and practise. This would make the ASEG web site a useful reference site not only for members but also to attract visits from non-member professionals and the public.
- It is also currently envisioned to have Geophysical Utilities available on the site. Companies or individuals can make these utilities available for public or member use to assist with geophysical understanding or interpretation. These could be as simple as a units converter or as complicated as a modelling program using data input by the user. Obviously there will need to be some limits here but if the demand is there, we can always improve the server capacity. It is currently envisaged that these utilities will be free to members after logging on. Companies and individuals would have a benefit in having their name associated with the utility and the good will this generates.

Moving forward

The model proposed for moving the site development forward includes two groups of volunteers.

A Web Strategy Committee is proposed to set the overall direction and priorities for web development. This is open to anybody with an opinion about the web. You do not need to have any technical knowledge to be part of this committee. Issues to be discussed by this group include whether to proceed with the above vision and the setting of policy such as how many member searches can be carried out within what time period. Recommendations from the Web Strategy Committee will be put to the Federal Executive for endorsement.

A Web Development Team will also be needed. Any interested volunteers will be trained by the ASEG in web development using free software. The skills gained can then not only be used to develop the ASEG site but also used by these volunteers in their own employment to develop their own custom solutions. The skills learnt will be directly applicable to developing geophysical and other business solutions and are widely applicable. The Web Development Team will implement the strategy as outlined by the Web Strategy Committee and provide feedback to this committee as to the feasibility of developing content suggested by them. The Web Development Team can also suggest ideas for content and functionality.

Any member of the ASEG (or public) can also suggest ideas for content and functionality which will be considered by the Web Strategy Committee.

If you are interested in participating in either of these, or have ideas for content and functionality, please contact the ASEG webmaster using the Feedback form on the site.

Finally I would like to say that we appreciate your feedback about the design and functionality, particularly when functionality is not working as expected (e.g. an error is generated or a link is broken). However, please keep in mind that the site has been developed on a voluntary basis and it may take some time to correct problems, particularly at this time when the site is new and being used extensively. Your patience and understanding is appreciated.

Wayne (Staz) Stasinowsky
ASEG Webmaster

Deep Exploration Technologies CRC shares in $243 million new funding

In August, the Minister for Innovation, Industry, Science and Research, Senator the Hon Kim Carr, announced funding of $243 million for world-class collaborative research and innovation under the Australian Government's Cooperative Research Centres (CRC) Program.

Ten CRCs have been successful in the 11th selection round. These include two new CRCs and eight extensions to existing Centres. These were selected from a total of 24 applications from both existing and new CRCs. The resource sector has done well in this round of applications, with all but four of the centres approved having links to geophysics. A summary of the successful Centres is shown below and an article by Joe Cucuzza gives more details on what is planned for the new Deep Exploration CRC (see p. 16).

Deep Exploration Technologies CRC (New)

Established to address a significant challenge to the future of the Australian minerals industry – the reduction in the mineral resources inventory due to high production and low mineral exploration success. The CRC's research will focus on developing new technologies to explore to greater depths and under terrain cover in the vast areas of Australia that are known to be prospective for minerals. Government funding: $28.0 million.

Contact: Joe Cucuzza; Tel: 03 8636 9958; Email: joe.cucuzza@amira.com.au

CRC for Greenhouse Gas Technologies (Extension)

Focused on carbon capture and storage technologies. Through the CRC, more than 100 researchers work on the capture of carbon dioxide from stationary industrial sources, its compression, transport and storage in deep geological reservoirs. Government funding: $20.0 million.

Contact: Peter Cook; Tel: 02 6120 1600; Email: info@co2crc.com.au

CRC for Spatial Information (Extension)

Will bring collaboration on all critical research and education issues that involve a spatial aspect, and by doing so accelerate the take up of spatial science in key end-users. It will create a coordinated national network of satellite system reference stations to permit real-time positioning to two centimetre accuracy; and establish a fully functioning market place for spatial information. Government funding: $32.2 million.

Contact: Peter Woodgate;
Tel: 03 8344 9200;
Email: pwoodgate@crcsi.com.au

CRC Mining (Extension)

Will develop technologies to assist the Australian mining industry reduce its CO2-e footprint. The Centre's activities are structured around four research programs. Three programs address emissions reduction by improving operational efficiency of mining systems and individual mining machines. The fourth program addresses emissions reduction by developing a novel drilling system to more effectively capture fugitive emissions from coal mines. Government funding: $12.0 million.

Contact: Michael Hood;
Tel: 07 3365 5640;
Email: info@crcmining.com.au

Energy Pipelines CRC (New)

Will enable Australia to meet the increased demand for gas transportation arising from the need to decrease greenhouse gas emissions. The safe and cost efficient maintenance and expansion of the energy pipeline infrastructure requires some major technological challenges to be addressed. Research will focus on welding research, pipeline manufacture, corrosion control and public safety. Government funding: $17.5 million.

Contact: Ann-Krisitin Larsson;
Tel: 02 6273 0577;
Email: alarsson@apia.asn.au

CRC for Antarctic Climate and Ecosystems (Extension)

Focuses on critical uncertainties in the world's understanding of climate change.

These uncertainties, highlighted by the Intergovernmental Panel on Climate Change, limit Australia's, and the global community's, ability to respond effectively to the challenges of climate change. Research projects focus on the Antarctic and the Southern Ocean. Government funding: $20.1 million.

Contact: Tony Press; Tel: 03 6226 7888; Email: enquiries@acecrc.org.au

For completeness, the non-geophysics/resource CRCs are:

Dairy Futures CRC (Extension): Government funding: $28.0 million
Oral Health CRC (Extension): Government funding: $31.6 million
Poultry CRC (Extension): Government funding: $28.0 million
Aboriginal Health CRC (Extension): Government funding: $25.5 million
For more information go to: https://www.crc.gov.au/Information/default.aspx

Renewable energy target of 20% approved by Senate

After the Senate failed to pass the combined Renewable Energy and Carbon Pollution Reduction Scheme legislation, the Bills were split and the Renewable Energy Bill was passed in August. The Carbon Pollution Reduction Scheme is stalled waiting for a Double Dissolution or some hard bargaining with the Liberal Party.

According to Penny Wong, the Minister for Climate Change, 'The renewable energy target will ensure that 20% of Australia's electricity comes from renewable sources by 2020 and in 10 years time the amount of electricity coming from sources like solar, wind and geothermal will be around the same as all of Australia's current household electricity use'.

This will be a formidable challenge but it is certainly a step in the right direction. Waste methane gas from coal mining will be classified as a renewable source, and although this is not strictly true, it may as well be used as wasted.

According to the Australian Conservation Foundation, this Bill should lead to about 26 000 new jobs and up to $30 billion of new investment. However, the road map to achieve these outcomes has not been drawn and until there is a price for carbon or a cap on emissions it may be difficult to provide sufficient incentives to meet these targets.

Continued on p. 18

Deep Exploration Technologies CRC: an exciting new research platform that will substantially expand the exploration industry's capability

Joe Cucuzza

Joe Cucuzza[1], Graham Carr[2] and Tom Whiting[3]

[1]*Director Project Delivery, AMIRA International. Email: joe.cucuzza@amira.com.au*
[2]*Chief Scientist, CSIRO Exploration and Mining. Email: graham.carr@csiro.au*
[3]*Consultant. Email: twhiting@ozemail.com.au*

On 7 August the Minister for Innovation, Industry, Science and Research, Senator the Hon Kim Carr, announced that the proposed Deep Exploration Technologies Cooperative Research Centre (DET CRC) had been granted $28 M funding under the Cooperative Research Centres Program. This grant was offered on the back of industry partners' pledge to contribute about $20 M in cash and about $50 M in-kind from the research partners. The submission of the DET CRC was the culmination of almost 2 years work involving financial support from eight companies and the CSIRO. This process gave these organisations a unique opportunity to identify the science and design the CRC from scratch. It will draw on the nation's pre-eminent research talent and is the best vehicle to assemble the teams needed to conduct a multi-pronged end-user focused research in a realistic time-frame.

Although many important exploration challenges were addressed by the recent exploration-focused CRC, e.g. *pmd**CRC and CRC LEME, both of which terminated in July 2008, the perceived maturing nature of the Australian exploration environment in comparison to other areas of the world is putting Australia at a comparative disadvantage. As Figure 1 shows, with much of Australia covered by highly weathered regolith, opportunities to find outcropping deposits are decreasing and thus greenfields' and brownfields' exploration is increasingly directed towards discoveries at greater depth. At the same time exploration here is becoming more expensive, with a marked increase in the unit cost of exploration drilling. This includes many existing mining operations, where the cost and effectiveness of deep exploration drilling is becoming a barrier to effective future mine development. The CRC has been designed to address these important issues.

The potential for significant advances will be in deeper exploration through the discovery of ore body extensions, improved ore delineation, more thorough mapping and definition of ore body characteristics, and importantly, through reduction in development costs as well as shortening development time. Most importantly, such innovations will allow the full long term resource potential (net present value) of existing operations to be realised earlier by allowing for greatly improved 'life of mine' planning. In the medium to long term, breakthrough drilling and associated technologies can not only deliver zero loss time accidents, but also permit companies to explore cost effectively in areas of greater cover; and drill more and deeper holes for a given exploration budget.

The outputs from the DET CRC will have a very high impact on mineral resource discovery in Australia. Industry

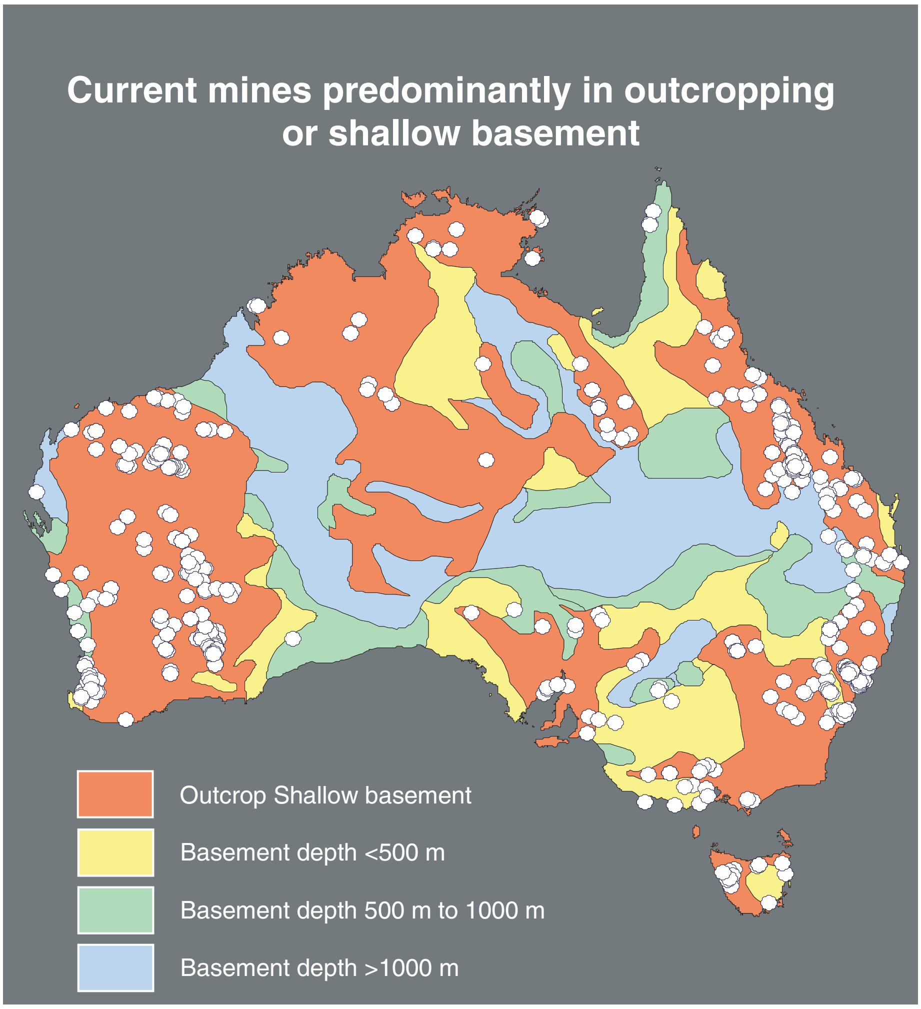


Fig. 1. *Depth to basement with operating mines/deposits. Courtesy of Geoscience Australia.*

has been willing to invest in the CRC because it expects that these outputs will lead to greater mineral discovery success, improved safety, and reduced adverse environmental impacts from exploration drilling. Evidence that technology improvement leads to exploration success is found in an example from the petroleum industry. An increase in the accessible search space made possible through improvements in drilling and 3D seismic technology increased production from the Gulf of Mexico from 80 million barrels of oil equivalent (BOE) per year in 1961 to 1450 million BOE 40 years later (http://ngm.nationalgeographic.com/ngm/0406/feature5/map2.html).

The strategic objectives of this industry-driven CRC are:

- Significant reduction in time and improvement in effectiveness of drilling;
- Significant improvement in drilling safety and environmental impacts;
- Significant improvement in the quality and timeliness of down hole information;
- Cost effective discovery by developing tools for deeper targeting; and
- Develop techniques to use available 3D knowledge obtained from copious amounts of data currently collected for project management and life of mine planning purposes.

To achieve these objectives, the CRC will undertake research in three interrelated areas:

1. Drilling Technology Program: the development of radical, new hard rock drilling technologies. To be lead by Jock Cunningham, CSIRO Exploration and Mining. Key projects include:

- *Fundamentals of Rock Fragmentation* research will develop predictive models for the interaction between bit and rock under different conditions demonstrated in different bit designs and methods of bit excitation. The discoveries made in this program will inform the developments in the remaining two projects.
- *Drilling Optimisation* will focus on optimisation (including automation) of current drilling systems. This research will develop sensors that can be used for measuring the performance of a drill bit and control systems that can then be used to automate the drilling process and enable it to adapt automatically to changing rock conditions.
- *Next Generation Drilling Systems* will develop new-concept composite/flexible drill strings with embedded sensors, long-life drill bits, steerable drill bits and instruments to allow bit localisation, control and data communication between a local or remote control station.

2. Data Fusion Program: down-hole and on-site surface technologies that enable data acquisition in real time. To be lead by Anton Kepic, Curtin University of Technology (Centre for High Definition Geophysics, Department of Exploration Geophysics Environmental Sciences). Key projects include:

- *In-Front-of-Bit Imaging* will develop down-hole tools/sensors and geo-imaging software to help the driller to respond quickly to changes in the nature of the ground being drilled.
- *Sensors for Rapid Down-Hole Rock Characterisation* will develop tools for generating on-site information about ore mineralogy characteristics.
- *Joint Inversion of 3D Seismic Data and Magnetotelluric Data* will develop software to produce 3D representations combining geometrical and mineral information.

3. Deep Targeting Program: improving imagery of the rock volume at depth. To be lead by David Giles, The University of Adelaide (Centre for Mineral Exploration Under Cover, School of Earth and Environmental Sciences). Key projects include:

- *Lower Cost, More Effective 3D Seismic Exploration* for hard rock environments including optimised hardware and methods for hard rock seismic data acquisition and visualisation, combining data from surface and borehole techniques.
- *Defining and Sampling the Cover*: tools that utilise data generated from usage of outputs from Programs 1 and 2 in conjunction with alteration models to facilitate timely decision making in mineral exploration.

The University of Western Australia (Centre for Exploration Targeting, School of Earth and Geological Sciences) and Geoscience Australia are also collaborating institutions.

The CRC will be an Incorporated Entity, driven by collaboration between mineral exploration end-users, industry service providers and Australian and international R&D providers.

The core industry partners of the CRC are:

- Barrick Gold
- BHP Billiton
- Boart Longyear
- Goldfields Australia
- Newcrest
- Vale Exploration.

The SA Government through PIRSA is also an important partner having pledged significant resources both in cash and in-kind. A significant element of the latter is access to a disused mine in the Adelaide Hills, which will house the National Drilling Testing and Training Facility that the CRC will manage. Boart Longyear with its research facilities in Adelaide will also provide important in-kind contribution towards this facility.

In addition to the above organisations, all of the State and Territories Geological

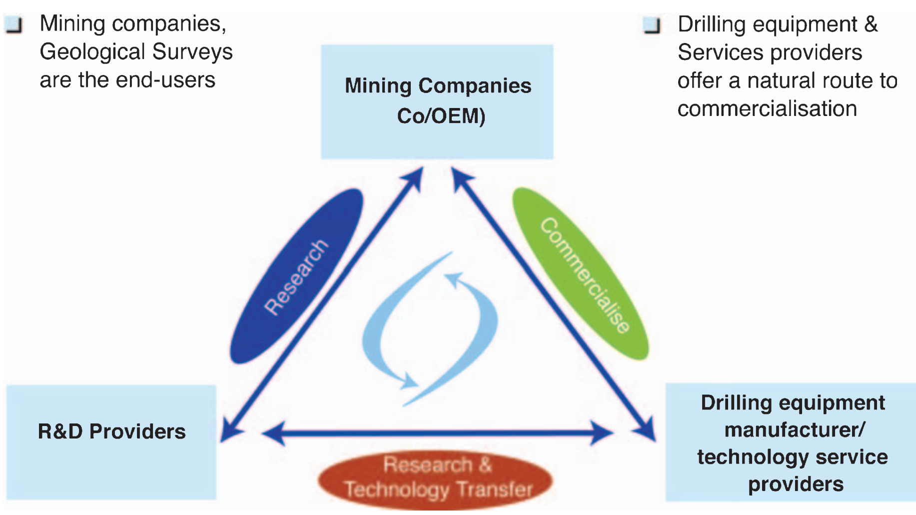


Fig. 2. *The CRC partners will provide a strong path to industry adoption.*

Surveys, along with the following companies, have indicated their interest in participating as affiliate partners of the CRC:

- Minotaur Exploration Ltd
- Air Drill Pty Ltd
- Australian Drilling Solutions
- Barminco Limited
- Deepcore Drilling Pty Ltd
- Globaltech Corporation
- ioGlobal Pty Ltd
- Imdex Limited
- Intrepid Geophysics
- Mitchell Energy
- Swick Mining
- Sandvik
- Teakle Composites.

As Figure 2 illustrates, the affiliate partners will be a crucial resource for the CRC not only in providing an end-user perspective to the proposed research; they will also provide multiple avenues for the commercialisation of the resultant technologies. Although each of the affiliate partners will be making a modest annual financial contribution, their most significant contribution will be in-kind. The CRC's aim is to build up the number of affiliate partners prior to start up in early 2010. Drilling contractors, equipment manufacturers, and junior mining companies are eligible to participate. The opportunity exists also for additional mining companies to join as core partners.

A very important part of the CRC will be the education and training program. This will encompass higher education as well as Vocational Education & Training (VET) through collaboration between the two Universities, the TAFE sector, the Resource and Engineering Skills Alliance (RESA) and the Australian Drilling Industry Training Committee (ADITC), a Registered Training Organisation. It is expected that other Registered Training Organisations will also be involved in the VET delivery.

Anyone interested in learning more about DET CRC should contact Joe Cucuzza, Graham Carr or Tom Whiting.

Continued from p. 15

Unfortunately the government does not want to tackle one of the most significant factors in reducing carbon emission – namely population. At present Australia's population is rising at 1.9% per year, mainly due to skilled migration and the baby bonus. As a result, if this rate of increase continues, we are going to have about 30 million people in the country by 2025.

So if we just reduce our per-capita fossil fuel emissions to 1990 levels, we will be producing about 40% more emission per year than at present. In other words the number of people in Australia is a very significant factor – and it is not being considered by the Government.

We still have a long way to go.

Tax offset changes to boost research & development

The Research and Development (R&D) expenditure cap for the R&D Tax Offset has now been increased from $1 million to $2 million for the 2009–10 financial year. The cap is the maximum amount a firm can spend on R&D and be eligible for the Tax Offset. This change should boost investment in private sector R&D, particularly that carried out by the larger companies. Hopefully we will see the benefits of this change in the resource industries.

Gorgon Expansion approved

The giant Gorgon gas project has now been approved by the Australian government and contracts have been signed to export almost 3 million tonnes of LNG per year until 2039 with Japan and Korea. This is in addition to previous agreements to sell a similar amount to China over the next 20 years. According to media reports, this leaves another 2.7 million tonnes to sell for the project to operate at full capacity.

There seems to be only one possible hurdle to the success of Gorgon, and that is Qatar. This is a very small island state (~10 000 km^2) literally and actually, sitting on 14% of the world's gas reserves (after the Russian Federation 23% and Iran 16%). Australia, for example, only has reserves of ~2% according to the BP Review of World Energy for 2008.

Qatar gas is produced at a rate of about 40 million tonnes per year and is simply extracted and processed at the surface by one of the five mega trains. It does not, like Gorgon, have to be piped from 130 to 200 km offshore, and can therefore be sold more profitably on world markets. So Qatar could turn out to be a serious competitor.

Eristicus

News

Update on Geophysical Survey Progress from the Geological Surveys of Queensland, Western Australia, Northern Territory, and Geoscience Australia (information current at 11 September 2009)

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

Table 1. Airborne magnetic and radiometric surveys

Survey Name	Client	Project Management	Contractor	Start Flying	Line (km)	Spacing AGL Dir	Area (km²)	End Flying	Final Data to GA	Locality Diagram (*Preview*)	GADDS Release
Cape York	GSQ	GA	GPX	23 Apr 09	239 180	400 m, 60 m E/W	59 480	74.0% complete @ 6 Sep 09	TBA	139 – Apr 09 p. 21	TBA
Seemore (Eucla 1)	GSWA	GA	Thomson Aviation	6 June 09	88 300	200 m, 50 m E-W	15 810	100% complete @ 6 Sep 09	TBA	141 – Aug 09 p. 19	TBA
Cornish – Helena (East Canning 2)	GSWA	GA	Thomson Aviation	6 June 09	121 100	400 m, 60 m N-S	43 270	73.9% complete @ 6 Sep 09	TBA	141 – Aug 09 p. 19	TBA
Yampi – Derby (North Canning 2)	GSWA	GA	GPX	30 June 09	66 700	400 m, 60 m N-S	23 720	100% complete @ 3 Sep 09	TBA	141 – Aug 09 p. 19	TBA
Crossland – Noonkanbah (East Canning 1)	GSWA	GA	GPX	10 Aug 09	116 700	400 m, 60 m N-S	41 720	21% complete @ 6 Sep 09	TBA	141 – Aug 09 p. 19	TBA
Central Canning	GSWA	GA	Fugro	10 June 09	91 700	800 m, 60 m N-S	64 900	100% complete @ 18 Aug 09	TBA	141 – Aug 09 p. 19	TBA
Naretha (Eucla Basin 3)	GSWA	GA	Fugro	11 June 09	123 100	200 m, 50 m E-W	22 090	39.2% complete @ 6 Sep 09	TBA	141 – Aug 09 p. 19	TBA
Broome (North Canning 1)	GSWA	GA	UTS	14 July 09	76 000	400 m, 60 m N-S	26 370	74.9% complete @ 6 Sep 09	TBA	141 – Aug 09 p. 19	TBA
Mt Anderson – McLarty Hills (North Canning 3)	GSWA	GA	UTS	3 July 09	98 200	400 m, 60 m N-S	34 860	67.7% complete @ 6 Sep 09	TBA	141 – Aug 09 p. 19	TBA
Eucla Coast (Eucla Basin 6)	GSWA	GA	UTS	Late Sep 09	117 451	200 m (onshore); 400 m (offshore); 50 m N-S	27 400	TBA	TBA	141 – Aug 09 p. 19	TBA

HyLogging South Australia

In May 2009 PIRSA received a HyLogger through the AuScope National Virtual Core Library project funded by the National Collaborative Research Infrastructure Strategy. The HyLogger (see Figure 1) uses reflectance spectroscopy, along with imaging and laser profiling tools for the semi-automatic scanning, logging and interpretation of drill core and chips. The CSIRO-developed tool employs a spectrometer covering the electromagnetic spectrum from visible-near-infrared to shortwave-infrared wavelengths (400–2500 nm). This spectral information is then used to create mineralogical logs combined with spatially co-registered images of core. PIRSA currently has projects engaged in studying regional alteration patterns. HyLogger derived semi-quantified mineralogy will form part of the data used to underpin the regional studies.

NCRIS Funds are used to establish national infrastructure for collaborative research. In this case each State Geological Survey will be provided with a $400 000 HyLogger with the aim of populating a digital National Virtual Core Library accessible over the internet. The main source of core for scanning will initially be legacy collections of core stored in Government warehouses. Companies will also have some access to the technology. The creation of the National Virtual Core Library forms part of a project

Table 2. Airborne electromagnetic surveys

Survey Name	Client	Project Manage-ment	Contractor	Start Flying	Line (km)	Spacing AGL Dir	Area (km²)	End Flying	Final Data to GA	Locality Diagram (*Preview*)	GADDS Release
Paterson South (Western Areas Infill) TEMPEST AEM	Western Areas	GA	Fugro	8 Sep 07 (for the entire Paterson AEM survey)	861	286, 333 and 400 m; Southwest/ Northeast; 120 m agl	294.3	100% complete @ 14 Sep 08 (for the entire Paterson AEM survey)	Jan 09 (for the entire Paterson AEM survey)	130 – Oct 07 p. 30	Data released via free download on the GA website and on DVD on 11 Aug 2009. All requests to the GA Sales Centre
Pine Creek (Kombolgie)	GA	GA	Geotech Airborne	21 Aug 08	9350	1666 & 5000 m for GA; 200–1000 m company infill; E/W flight lines; flying height 30 m	30 710	100% complete @ 16 Oct 08	TBA	133 – Apr 08 p. 21	TBA
Pine Creek (Woolner & Rum Jungle)	GA	GA	Fugro	11 Oct 08	20 825	1666 & 5000 m for GA; 200–1000 m company infill; E/W flight lines; flying height 120 m	44 689	100% complete @ 23 May 09	Data acquisition resumed 15 April for completion by June 09	133 – Apr 08 p. 21	Data for Pine Creek (Rum Jungle) released via free-download via the GA website and on DVD at the end of Sep 2009. All requests to the GA Sales Centre

Table 3. Gravity surveys

Survey Name	Client	Project Manage-ment	Contractor	Start Survey	No. of Stations	Station Spacing (km)	Area (km²)	End Survey	Final Data to GA	Locality Diagram (*Preview*)	GADDS Release
Cunderdin	GSWA	GA	Daishsat	28 Jan 09	10 744	50–250 m, 500 m, 2 km	22 500	100% complete @ 16 Apr 09	July 09	139 – Apr 09 p. 22	Data (500 m & 2 km spacing) released via GADDS on 3 Sep 09
Cape York	GSQ	GA	Daishsat	12 May 09	10 315	4 km regular	171 900	94% complete @ 6 Sep 09	TBA	139 – Apr 09 p. 21	TBA
Barkly	NT	GA	Atlas	4 June 09	7268 in Area A & a possible 3875 in Area B	4 km regular	178 230	80% complete @ 6 Sep 09	TBA	140 – Jun 09 p. 17	TBA
South Yilgarn Margin	GSWA	GA	Fugro	24 July 09	6500	2.5 km regular	39 240	17% complete @ 6 Sep 09	TBA	140 – Jun 09 p. 17	TBA

TBA: To be advised

to characterise the top 2 km of the Australian crust. This will enable geoscientists to gain a better appreciation of geological processes happening in the Australian continent.

For more information please contact alan.mauguer@sa.gov.au or visit http://www.pir.sa.gov.au/minerals/data/hylogger.

Fig. 1. *John Keeling, Principal Geologist with PIRSA, with the Hylogger in action.*

Significant NSW discovery for Carpentaria Exploration

Carpentaria Exploration Ltd has announced the discovery of a large tonnage-potential magnetite-iron mineralisation at the Hawsons Iron Project. Hawsons is located 60 km southwest of Broken Hill and occurs within the Neoproterozoic Braemar Iron Formation. Three RC drill holes comprising 606 m in total have intersected 115 m at 18.0 wt% recovered Davis Tube Recovery (DTR) concentrate grading 69.8% Fe, including 27 m in excess of 21% DTR. These good concentrate grades are matched by low levels of deleterious elements. These results come from only one of five parallel magnetic units comprising the 'core anomaly' (see Figure 1). Other large untested aeromagnetic anomalies outside this core provide additional tonnage potential (see Figure 2).

The Hawsons Project covers two exploration licences – EL 6979 to the north is a joint venture with Perilya and EL 7208 to the south is 100% controlled by Carpentaria. The licences were taken up with a view to exploring for iron oxide-copper-gold targets. The area is dominated by an intense magnetic anomaly up to 7000 nT over a large aerial extent, which is well covered by the Broken Hill Initiative airborne magnetic survey. A literature search revealed that Enterprise (the early CRA Exploration group) had sampled iron there in 1960 but dropped the project to move onto the Pilbara after the Hamersley discoveries. Carpentaria modelled the airborne magnetics in 3D and concluded that a large coherent highly magnetic source dipping to the south-west was the source of the anomaly. Field work which included geochemical assaying, susceptibility mapping and Niton in-situ XRF field analysis together with two ground magnetic traverses was conducted over area. It should be noted that there is only limited outcrop. The magnetic data suggested that the highest magnetic anomaly was under cover and thus more 2D and 3D modelling was done to target three drill holes to test magnetic Unit 3 (see Figure 1).

Executive Chairman of Carpentaria, Nick Sheard, is well known to many ASEG members. When asked to comment on the project he said the following:

> *Carpentaria was floated in November 2007 and our aim was to become a mining company through either discovery or acquisition. Hopefully we can now do it through the former.*
>
> *This project is a good example of the dexterity of small companies. Good research evaluating previous work and integrating geological and geophysical data allowed us to evaluate this region rapidly. As a Junior we had to be careful how we approached the evaluation, but given the quality of the airborne data backed by ground truthing we were able to drill three holes to test the magnetic source to give us thickness and enough material for metallurgical tests.*
>
> *As always, it is incredibly exciting to be at the start of a discovery and perhaps more so as a Junior Company as this has the potential to be Company maker. Also having lived and worked in Broken Hill and witnessed the reduction in mining there, a project such as this could be of significant advantage to the region.*

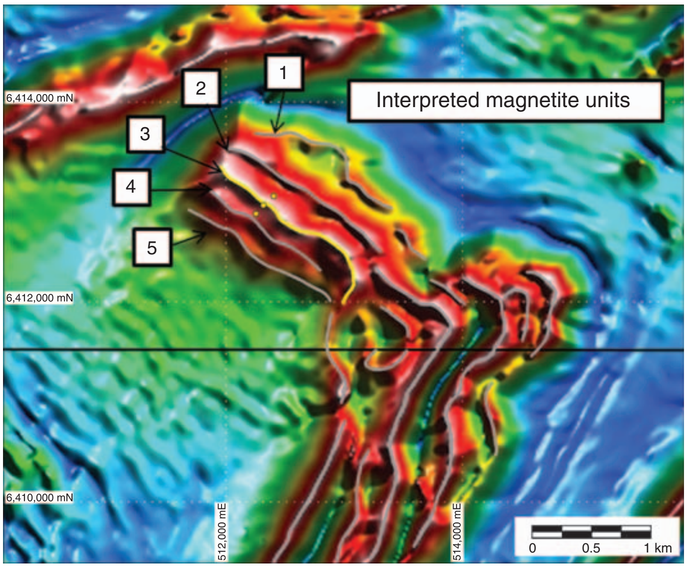


Fig. 1. *'Tilt' filter of aeromagnetic data over 'core anomaly' showing interpreted magnetite units with drill holes marked in yellow.*

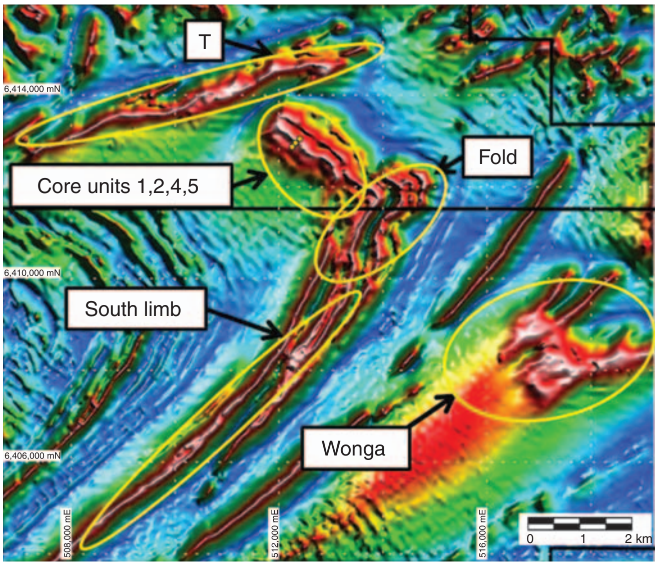


Fig. 2. *'Tilt' filter of aeromagnetic data – highlights magnetic units interpreted to be magnetite units.*

Sandfire resources: Doolgunna copper–gold discovery

Share prices in Sandfire Resources NL have had a spectacular year. At the beginning of 2009 they were trading around the 0.10c mark; from May onwards they began to climb going above $2.50 in late July, then retreating with the market, before increasing again to be $3.61 in late September. Speculative shareholders have been delighted!

All the excitement has been generated by a high-grade volcanogenic massive sulphide-style copper–gold discovery at Sandfire's 100% owned Doolgunna Gold Project. The Doolgunna Project is located in the Meekatharra region of Western Australia, approximately 900 km north of Perth. Initial RC drilling intersected significant mineralisation beneath a previously discovered oxide gold zone at the DeGrussa Prospect. A subsequent ground EM survey identified a very large conductive body immediately north of DeGrussa, subsequently known as Conductor 1.

In an announcement on 23 September, Sandfire reported that 19 out of 21 diamond drill holes had all intersected massive sulphide mineralisation, including a total 119.7 m in one hole and 50.3 m in another. Furthermore, assay results included best intersections of 42 m @ 6.6% Cu, 2.4g/t Au; 40.7 m @ 4.6% Cu and 3.0g/t Au; and 50.1 m @ 8.4% Cu, 2.9g/t Au, 1.6% Zn and 30.8g/t Ag. An airborne EM survey has now been undertaken to cover prospective stratigraphic horizons along strike from DeGrussa, from which a number of conductive targets have been identified for further investigation.

Record resource export earnings in 2008–09, but production declines

In 2008–09, Australia's export earnings from mineral and energy resources increased by 37% to a record $159.7 billion, according to ABARE's Deputy Executive Director Terry Sheales, when releasing the June quarter 2009 edition of *Australian Mineral Statistics*.

'The record earnings reflect a 16% depreciation of the Australian dollar and higher contract prices for bulk commodities in the first 9 months of the financial year,' noted Dr Sheales.

However, Australian production of energy and mineral commodities declined in 2008–09, with the index of mine production falling by 1%.

'In particular, production of nickel, iron and steel, zinc, gold and black coal declined in 2008–09,' said Dr Sheales. In effect the increase in commodity prices outweighed the small drop in production.

There were significant increases in export earnings in 2008–09 for: metallurgical coal, up $20.7 billion (129%) to $36.7 billion; thermal coal, up $9.5 billion (114%) to $17.9 billion; liquefied natural gas, up $4.2 billion (72%) to $10.1 billion; iron ore, up $13.7 billion (67%) to $34.2 billion; and gold, up $5.2 billion (48%) to $16.1 billion.

Commodities recording significant declines in export earnings in 2008–09 included: nickel, down $3 billion (53%) to $2.7 billion; zinc, down $1.5 billion (45%) to $1.9 billion; petroleum refinery products, down $541 million (41%) to $782 million; lead, down $424 million (21%) to $1.6 billion; crude oil, down $1.7 billion (16%) to $8.8 billion; copper, down $964 million (14%) to $5.8 billion; and liquefied petroleum gas, down $161 million (14%) to $1 billion.

For more details see: http://www.abareconomics.com/corporate/media/2009_releases/10sept_09.html

Mineral exploration declines

Mineral exploration continues to decline despite a global recovery in commodity prices, according to figures released by the Australian Bureau of Statistics in September 2009. They show that the trend estimate for total mineral exploration expenditure fell by $51.5 million (10.7%) to $461.1 million in the June quarter 2009. This is 32.3% lower than the June 2008 estimates.

Figure 3 shows the expenditure estimates for the last 8 years and it clearly indicates the continuing decline in exploration investment.

In original terms, exploration on areas of new deposits rose $33.3 million (22.4%), while expenditure on areas of existing deposits rose $46.8 million (18.4%), making a total of $483.5 million. However, when seasonally adjusted, the estimate of mineral exploration expenditure fell $27.6 million (5.6%) to $464.8 million in the June quarter 2009. The largest falls this quarter were in Queensland (down $11.8 million or 14.0%) and Western Australia (down $9.9 million or 3.6%).

Western Australia still dominates exploration activity with a 57% share ($274.8 million) of the total expenditure ($483.5 million). Queensland is a distant second with $78.6 million or 15%. In terms of commodities $139 million or 29% was spent searching for iron ore, with gold showing a pleasing revival by increasing to $98.8 million or close to 20%; coal was third with $76.6 million.

In seasonally adjusted terms, the total metres drilled rose 4.4% in the June quarter 2009 to 1615 km. In original terms the total metres drilled rose 29% to 1720 km. Drilling in areas of new deposits rose 54% to 521 km and drilling in areas of existing deposits rose 35% to 1159 km.

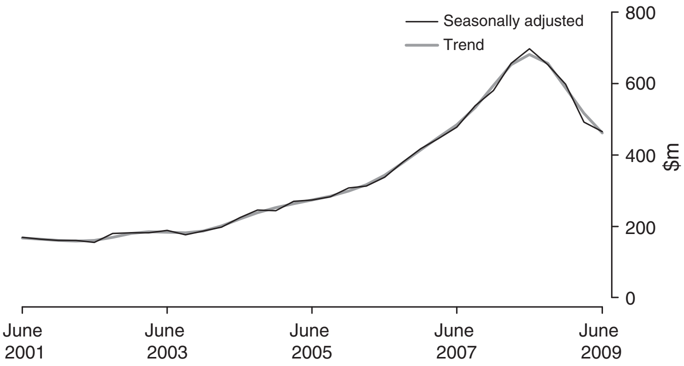


Fig. 3. *Trend and seasonally adjusted quarterly mineral exploration expenditure from June 2001 through June 2009 (provided courtesy of the Australian Bureau of Statistics).*

Figure 4 shows the longer term trends from March 1986. It indicates that in real terms the exploration levels are still very high and there is an indication that the rate of decline has diminished.

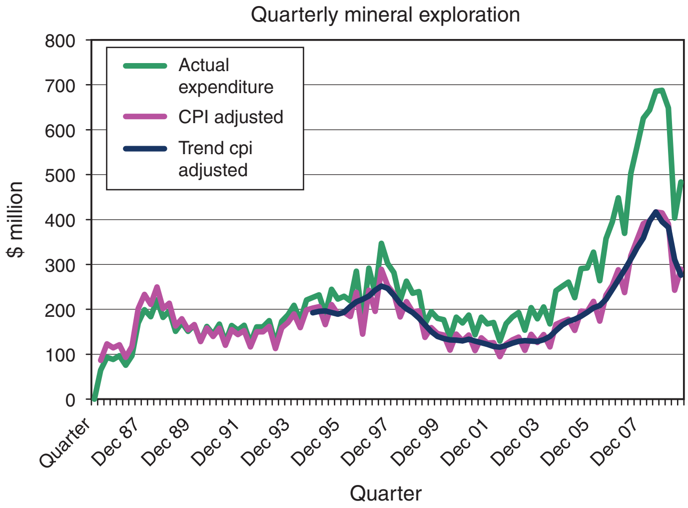


Fig. 4. *Quarterly 'actual' mineral exploration expenditure from March 1986 through June 2009 (from Australian Bureau of Statistics data). The green curve represents actual dollars spent, the purple curve shows the CPI adjusted numbers to 1998–99 levels and the black line is the trend line (Australian Bureau of Statistics data).*

Petroleum exploration still exceeds $1 billion

Expenditure on petroleum exploration for the June quarter 2009 rose $18.8 million (1.9%) to $1017.4 million and is now more than double the amount spent on mineral exploration.

This is only the second quarter that expenditure on exploration for petroleum has exceeded $1 billion (see Figure 5). Investment on production leases rose $91.3 million (43.6%), while exploration on all other areas fell $72.5 million (9.2%) this quarter. Offshore exploration fell $44.9 million (4.9%) in the June quarter 2009, while onshore exploration expenditure rose $63.7 million (73.9%).

Exploration expenditure in Western Australia increased by $28 million to a massive $817.4 million, which is 80% of the Australian total; Queensland came next with $76.5 million, a mere 7.5%.

Figure 6 compares the levels of petroleum and mineral exploration over the last 20 years. It shows that for most of the 23 year period the two curves tracked each other every well. However, after the Global Financial Crisis in mid-2008 they diverge significantly. This indicates that investors are forecasting a higher demand for petroleum than any of the other commodities. We will follow the trends in the next few years to see whether this is a permanent feature or just a temporary blip.

In summary, petroleum exploration is very healthy; it looks like the rate of decline in mineral exploration is reducing and that the minerals industry can look forward to a better second half of 2009.

David Denham

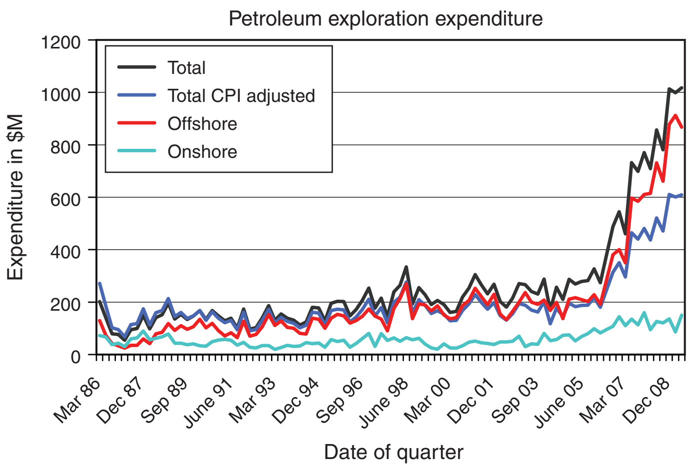


Fig. 5. *Quarterly petroleum expenditure from March 1986 through June 2009. The individual offshore and onshore numbers are actual numbers spent at the time, not CPI adjusted. The black graph shows the contemporary dollars spent and the blue curve shows the CPI adjusted number to 1989–90 dollars for the total of the petroleum exploration expenditure.*

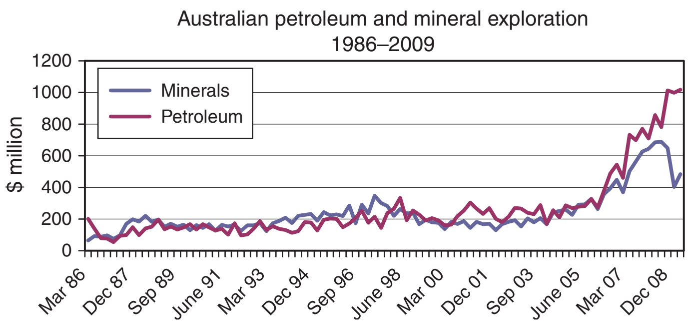


Fig. 6. *Quarterly estimates for mineral and petroleum exploration, March 1986 through June 2009. Notice that the two curves follow each other quite closely until the Global Financial Crisis in mid-2008. The dollars are not adjusted for inflation.*

Earth Science explores teacher's targets

Greg McNamara

TESEP Executive Officer.
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In an initiative designed to encourage students to pursue further education and careers in the Earth Sciences a group of geoscience professionals have joined with the Australian Science Teachers Association (ASTA) to set up and run the Teacher Earth Science Education Programme (TESEP). TESEP is designed to help middle school (upper Primary and lower Secondary) teachers make better use of their time teaching Earth Science in their classrooms through the provision of:

- Professional Development workshops,
- Updates to existing resources,
- New resources,
- Ideas for field trips, and
- Access to teachers experienced in this field.

While aimed at middle school teachers, teachers from all school levels will benefit from attending the programmes on offer, especially now that a National Curriculum is under development that will see the creation of a new national Years 11–12 Earth and Environmental Science subject.

The TESEP initiative is directed towards teachers through Professional Development (PD) workshops rather than at students through school incursions because of the powerful multiplier effect and the value for money this approach affords. On average a teacher attending a workshop will apply new ideas, resource and teaching skills for 5 years before their classes are in need of a 'refresher'. It is also reasonable to assume that an average middle school teacher will, through multiple classes, teach around 100 students and that they will share their learnings with at least two other teacher colleagues with similar teaching loads. Thus, assisting one teacher improve their Earth Science delivery in the classroom will produce approximately 1500 improved student experiences and a PD that trains just 10 teachers can produce at least 15 000 improved student experiences. Through this estimate TESEP can already claim to have improved the learning outcomes for some 300 000 students across six states and territories over the next 5 years.

TESEP operates under the auspices of the ASTA and is funded through donations from a wide variety of partners. While partnering groups may have a vested interest in promoting TESEP activities it is essential that TESEP is, and is seen to be, an independent and impartial organisation. Consequently, donations from organisations seeking to influence TESEP workshop content are not accepted. TESEP activities are managed through the ASTA head office with oversight by the TESEP Chairperson, Jill Stevens, the TESEP Executive Officer, Greg McNamara, and an advisory board comprising personnel from ASTA and key industry, government and professional societies. TESEP is managed at a state level by experienced teacher coordinators.

TESEP's first series of professional development workshops, entitled 'The Challenging Earth', is now underway. The topics for the workshops were selected from those nominated in an Australia wide survey of teachers. They reflect topical issues and teacher needs and are designed to mesh with existing curriculum requirements in all states. The eight topics to be rolled out over the next 3 years are:

PD1: Round and Round with Rocks (the rock cycle, ore bodies and crustal geology)
PD2: Riding the Climate Roller Coaster (the geoscience of climate science)
PD3: Greening Coal (carbon capture and storage)
PD4: Fossil Sunlight (the hydrocarbon story)
PD5: Hot Rocks (geothermal energy)
PD6: Wet Rocks (ground water)
PD7: Powerful Stuff (the uranium debate)
PD8: Our Place in Space (the Earth in space)

Workshops are being offered across all eastern states, with the first four fully developed and presently being rolled out. The second group of four is currently under development and will be rolled out over the next 2 years. In Western Australia, because of the prior establishment of the successful Earth Science Western Australia group (ESWA – see p. 27 of this issue) and the programme of curriculum restructure under way as a result, there is no need for TESEP to duplicate ESWA's work. However, TESEP and ESWA have a resource sharing

Fig. 1. *Greg McNamara (blue cap) waxing lyrical about an outcrop with teachers attending an Adelaide PD.*

Fig. 2. *Len Altman (TESEP SA coordinator) discusses the finer points of rocks in the classroom with teachers attending an Adelaide PD.*

Fig. 3. *Teachers come to grips with the scale of open cut mining in brown coal at a Victorian PD held in Gippsland.*

arrangement which allows for the use and sharing of materials for the benefit of teachers across the nation.

Workshops are regularly offered in all capital cities and key regional areas in an attempt to allow as many teachers as possible to attend. TESEP offers teachers incentives to attend the workshops including:

- Travel costs covered (within limits),
- Overnight accommodation provided for those who need it,
- Meals provided,
- Excursions provided where appropriate,
- Release funding for casual stand in teachers for the first six teachers to register,
- All presentations provided on CD, and
- A vast array of useful teaching resources including posters, CDs, DVDs and other materials produced by third parties but deemed appropriate by TESEP.

At a recent workshop in Tasmania, ASEG representative, Mike Roach of the University of Tasmania, added further value to the meeting by giving a fabulous demonstration of hands-on methods of explaining aspects of geophysics to students and provided some excellent pointers to on-line resources as well.

Feedback from all workshops to date has been overwhelmingly positive and teachers are clearly enthusiastic to take their new knowledge and resources back to school and begin applying it immediately. However, TESEP is committed to a culture of continuous improvement. In addition to refining and improving the workshops and sourcing even more materials to accompany the workshops, TESEP plans to follow up participants over the next few years to establish how and to what degree the materials are being used down the track. This information will be vital to informing future TESEP developments including how and when digital resources are uploaded and made available via the TESEP and Geoscience Pathways websites.

TESEP website: http://www.tesep.org.au/default.htm
Geoscience Pathways website: http://www.geosciencepathways.org.au/

TESEP continues to seek additional funding partners to ensure its ongoing success and to improve its ability to maximise the number of teachers able to attend workshops. If you are able to assist in any way please contact Jill Stevens, TESEP chairperson (jill.stevens@exxonmobil.com), or Greg McNamara, TESEP Executive Officer (eo@tesep.org.au), to discuss your proposal.

Earth Science WA

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Earth Science WA (ESWA) was established in 2005 to support and encourage the teaching of Earth and Environmental Science topics at all levels in WA schools, although its initial objective was to support the new EES (Earth and Environmental Science) course at senior secondary level introduced into WA schools in 2007. Figure 1 shows that prior to the introduction of the new EES course only five schools in WA were offering TEE Geology to their Year 11 and 12 students. In 2009 there are now over 30 schools offering EES with around 150 Year 12 students due to sit the external exam in 2009. The EES course was first examined externally in 2008 with around 105 Year 12 students taking the exam. ESWA hopes that additional schools will offer EES in 2010 and all indications so far is that this will indeed be the case.

ESWA is funded by sponsorship from more than 40 different organisations as shown in Figure 2. Sponsorship ranges from the purely financial to valuable in kind support to help teachers and students on excursions and by providing input to the course textbook that ESWA is currently compiling. Our sponsors include the DMP (Department of Mines and Petroleum), CSIRO, Scitech, professional bodies such as the Geological Society of Australia (especially the WA branch), oil and mining resource companies who see the need to encourage WA students to consider careers in the important resource sector and both the University of Western Australia and Curtin University. All are united in their common belief that WA students of all ages should understand the importance of both Earth and Environmental Sciences to the future of their state, their country and globally. Our aim is to ensure that the next generation has

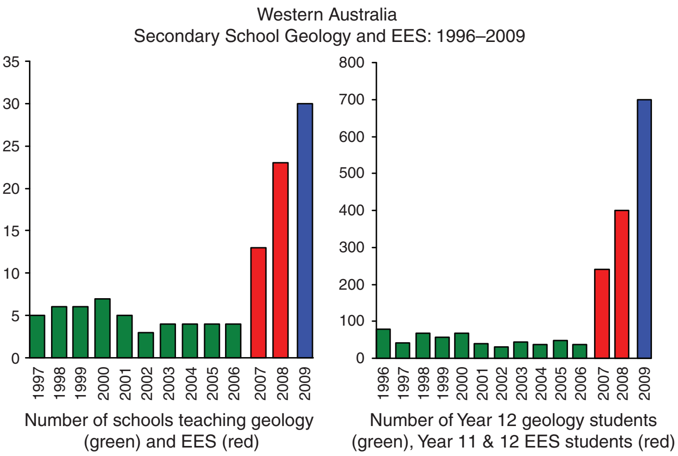

Fig. 1. *Participation in geology and EES (Earth and Environmental Science) by number of schools and number of TEE students for Western Australia.*

Fig. 3. *A group of Kent Street Senior High School students doing field work at a road side exposure.*

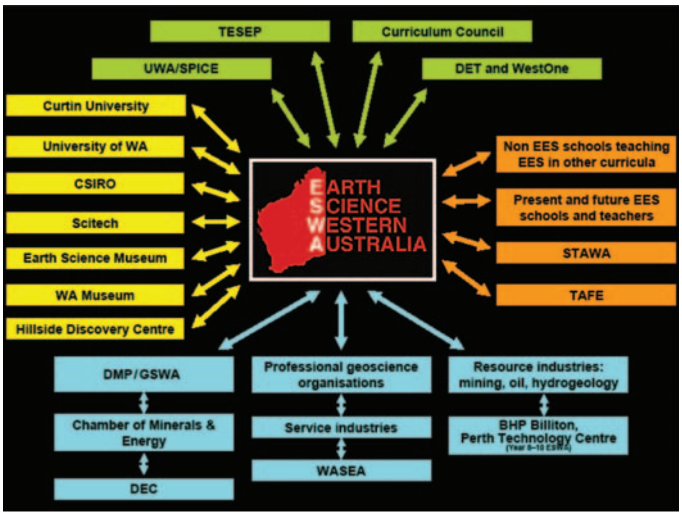

Fig. 2. *Diagram showing the range of organisations that contribute sponsorship and support to ESWA.*

Fig. 4. *A group photograph of Woodvale Senior High School students at the Super Pit Lookout on a field trip to Kalgoorlie.*

Continued on p. 44

Electrokinetic geophysical methods for hydrocarbon exploration

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Introduction

One of the papers in the inaugural volume of *Geophysics* concerned the measurement of the electric field generated when an explosive source was detonated (Thompson, 1936). This phenomenon was suggested as an alternate method of receiving seismic energy and was termed the seismic-electric effect. It is now more commonly referred to as the seismoelectric method. Measuring the seismic signals generated when an electric source is used is referred to as the electroseismic method. Although the two terms are often used interchangeably in the literature a convention is appearing where the first half of the term describes the type of source and the second the type of receiver. Collectively they are referred to as electrokinetic methods as the signals recorded result from the electrokinetic effect.

Studies utilising electrokinetic methods, particularly the seismoelectric method, have predominantly had groundwater or mineral targets. Studies concerning hydrocarbon exploration are more limited but have produced promising results. In this article we will briefly describe the physical basis of the methods including the source of the effects. We will then summarise previous studies and outline field techniques. We finish with a summary of where we see the greatest potential for the use of electrokinetic methods in hydrocarbon exploration.

The electrokinetic effect

When an electrolytic fluid comes in contact with rock grains some of its anions are chemically adsorbed into the wall thus creating an excess of cations near the fluid-solid contact. Ions within the fluid are distributed to neutralize this excess charge within a region that encompasses the electric double layer or EDL (Figure 1). The first layer of cations within the EDL is bound to the anion layer by both van der Waals and electrostatic forces. The electric potential within the EDL declines with increasing distance from the rock grain until it reaches a limit at the slipping plane, called the Zeta potential. The zone beyond the slipping plane where all the ions are considered to be mobile is called the diffuse layer. An excess of mobile cations is present in the diffuse layer next to the slipping plane; beyond that the fluid is electrically neutral.

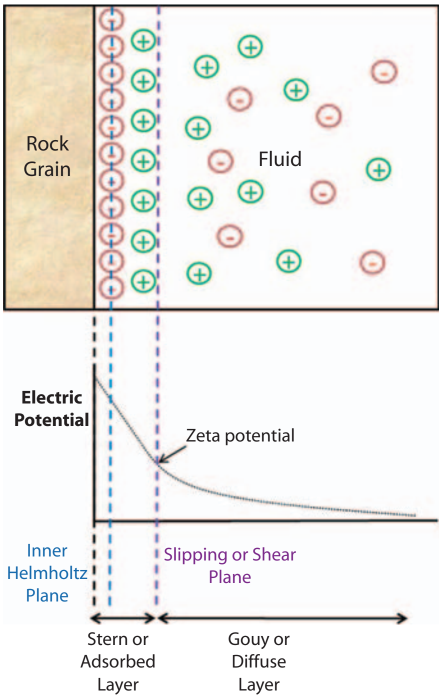

Fig. 1. *Diagram of the electric double layer. The electric potential declines with distance from the rock grain. Once the potential goes below the Zeta potential then the ions are mobile. Adapted from Reppert and Morgan (2002).*

When an electric field is applied to the rock the excess of mobile cations in the diffuse layer are displaced. Viscous forces in the fluid pull the fluid of the diffuse layer along, creating a global fluid displacement. Similarly a seismic wave passing through the rock will cause the excess of mobile cations in the diffuse layer to move and thus induce a small electric field, see Figure 2. The strength of the resulting field will depend on the degree to which fluid can flow through the rocks, i.e. rock porosity and permeability and fluid viscosity, and the conductivity of the rock fluids. Thompson *et al.* (2007) consider the latter to have the greatest influence on the amplitude of the signal and estimate that 20% oil saturation will increase the electroseismic signal amplitude by a factor of 10. Thus the electrokinetic response is considered to be a direct hydrocarbon indicator.

The conversion mechanisms vary depending on the source type used. In seismoelectric surveys three different sources of electromagnetic arrivals have been identified:

- The *direct field* – This is analogous to the seismic direct wave and is a result of the use of impact sources. The impact of the source pushes fluid out from beneath the plate in a predominantly vertical direction. As a result of the electrokinetic effect a small electric field is created which continues until the soil beneath the plate returns to its relaxed state.
- The *coseismic field* – An electric field that is generated by, and travels within, the seismic wave as it propagates.
- The *interface response* – When a p-wave encounters an interface between units of differing electric or mechanical properties the charge separation is disturbed and results in what Haartsen and

Pride (1997) approximate to an oscillating electric dipole. This in turn generates a small electromagnetic disturbance.

Figure 3 is a synthetic seismogram which shows the three main types of arrivals. As the direct field is generated directly beneath the source it appears at the beginning of the record. As it is relatively weak it is restricted to the near offsets and has a short duration. The coseismic energy is consistent with the first arrivals on a seismic record. The interface response is generated at the first Fresnel zone directly beneath the source and given the extremely high propagation speed of the electric field arrives at the sensors almost instanteously. The opposite polarity of the signals on either side of the source is typical for seismoelectric records.

Electroseismic experiments have identified additional conversion mechanisms. The response due to the electrokinetic effect is

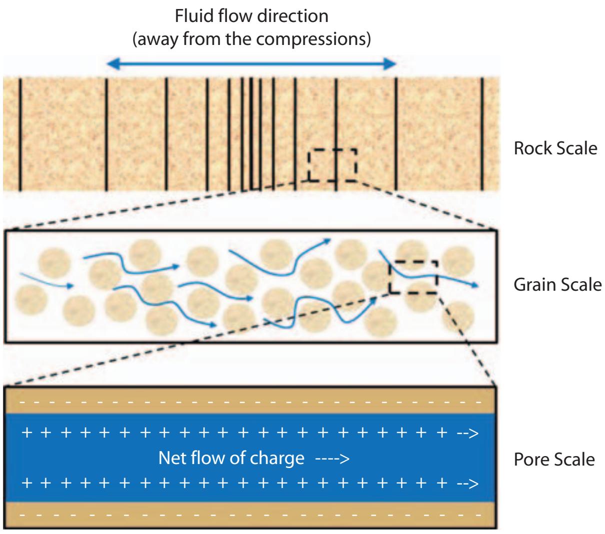

Fig. 2. *Schematic diagram showing the mechanism of the creation of an electric field from the Electrokinetic effect. Regions of positive and negative charge will occur at the areas of the P-wave's peaks and troughs. Adapted from Haines (2004).*

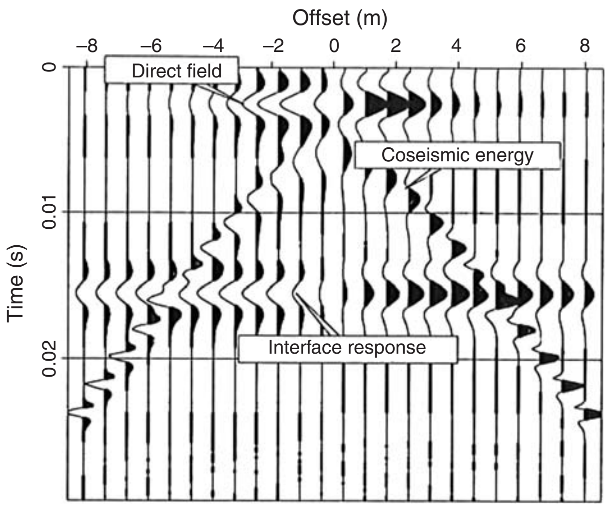

Fig. 3. *A synthetic seismoelectric record showing how the three different sources appear on a record. The sledgehammer source is in the centre of a single line of electric receivers. The coseismic response from the interface is not shown as it would obscure the interface response. Reproduced from Haines (2004).*

commonly referred to as the linear electroseismic response (Thompson *et al.,* 2007). Other responses are collectively known as the nonlinear response and have been partially attributed to electrostriction (Hornbostel *et al.,* 2003). When an electric field is applied to the rock the domains align. As the domains are aligned the opposite sides of the domain then attract each other and this causes the rock to contract. This is the inverse of the piezoelectric effect which has been used for seismoelectric surveys of quartz bodies (Russell *et al.,* 1997). Other possible sources of the nonlinear response are not currently fully understood.

Seismoelectric surveys

Although numerous seismoelectric surveys have been conducted for mineral and groundwater targets, to our knowledge only one (Thompson and Gist, 1993) has addressed a hydrocarbon target. Their study employed 0.5 metre stainless steel electrodes as used for most mineral and groundwater studies but with a larger spacing (12 vs 5 metres). As for nearly all modern seismoelectric surveys amplifiers were used to increase the signal strength. Data is usually recorded using standard seismic recording instruments. Only 26 channels were recorded by Thompson and Gist (1993) as they were limited by the number of available amplifiers, but this is a typical channel count for mineral and groundwater targets. The signal of interest is generally the interface response, so signals from geophones are usually recorded simultaneously to enhance interpretation and to aid in the removal of the coseismic field. Being the horizontal component of the electric field that emanates from a – usually – horizontal electric dipole located at the conversion zone, the interface response is strongest when the dipole is offset from the source approximately by the order of the depth of the target (Garambois and Dietrich, 2001); for larger offset the amplitude falls off at 1/offset^4 (Butler *et al.,* 1996). Thus for deep targets (that sought by Thompson and Gist (1993) was at only 234 m) this represents a significant number of channels

The sources used in seismoelectric surveys have been almost solely limited to sledgehammers and explosives although a Betsy seisgun, a weight-drop and an electromagnetic vibrator (found to generate too much electrical noise) have been trialled. Interestingly, as far as we are aware, a large industrial vibrator has never been used for a seismoelectric survey. Given their ability to impart large amounts of energy into the ground the level of depth penetration could be dramatic and when coupled with a high channel count recording system offers the potential for exploration at the typical depths of shallow hydrocarbons.

The main problem in processing seismoelectric data is the removal of the coseismic field which generally dominates any interface response. Various techniques have been trialled, most based on seismic processing methods, and a good summary can be found in Haines *et al.* (2007a).

In their experiment Thompson and Gist (1993) acquired a response from depths up to 300 metres. Although successful they state that the most appropriate application for the technique is 'aquifers, cultural artifacts, or for pollution monitoring'. This is indeed the area within which work has concentrated, typically on targets at depths of 10 metres or less. Even with such shallow targets Haines *et al.* (2007b) consider that most published seismoelectric data 'can be considered observations of phenomena rather than applications of the method to a particular geophysical problem' although recent work, especially for hydrogeological applications (e.g. Rosid and Kepic, 2004) has been promising.

Electroseismic surveys

Significant investment by ExxonMobil and its predecessors into the use of the electroseismic method for hydrocarbon exploration has enabled the construction of specialised hardware and the development of relatively mature field and processing procedures. The typical layout consists of two parallel electrodes of opposing voltages laid out on the ground with a spacing and length at least equal to the target depth. A linear array of vertical pipes can also be used. Accelerometers (conventional geophones are susceptible to noise resulting from the large magnetic fields of the source) are then laid just outside the area enclosed by the two electrodes, as shown in Figure 4.

The transmitted signal is typically about 60 seconds long and consists of a predetermined frequency content, typically between 0 and 25 Hz, to ensure maximum depth penetration. The transmitter or 'power waveform synthesizer' requires significant power (up to three megawatts, enough to power about 2500 US homes) and repeated 60 second readings at each location can give a total recording time of up to a week (Hornbostel and Thompson 2007) which at today's prices is about $80 000 worth of electricity! Although standard power lines can be used, Hornbostel and Thompson (2007) used eight customised generators each being about 2 metre × 2 metre × 3 metre and weighing 2700 kilograms. However, measurable responses could be gained using only two generators.

Electroseismic data processing consists of removing noise traces (found by Hornbostel and Thompson (2007) to be 30% of the total, a figure far higher than that acceptable for most commercial seismic surveys), correlation with the source wavefield and then stacking the many records. Near-surface responses are then identified by their horizontal nature and removed. The final stages of processing are consistent with standard seismic processing procedures such as band-pass filtering and wavelet shaping.

Of the three tests published by ExxonMobil (Thompson *et al.*, 2007) the maximum target depth was around 1500 metres. Interestingly, the signal level recorded was up to several orders of magnitude larger than that expected from modelling.

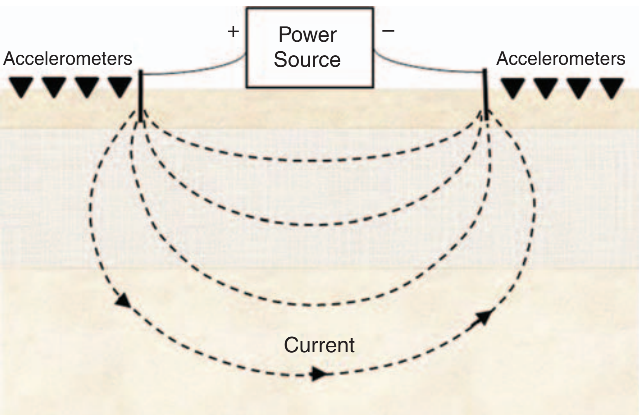

Fig. 4. *Diagram of the typical field configuration for an electroseismic survey. Adapted from Hornbostel and Thompson (2007).*

Downhole surveys

The obvious way to increase sensitivity and/or reduce source effort is to put the sources and/or receivers closer to the target, i.e. down hole. Electrokinetic logging (source and receiver in the same borehole) has been around for at least 10 years (e.g. Mikhailov *et al.,* 2000) but is not currently offered commercially by the major oilfield service companies. Such a tool would only give a limited depth of penetration, however, it is promising for filling in the 'gaps' in the results from other logging tools, particularly related to fracture count and permeability estimation. The seismoelectric method could be used in logging while drilling where the noise of the drillbit is utilised as a seismic source.

Discussion

The most theoretically promising electrokinetic method is electroseismic as the conversion is more efficient (Deckman *et al.,* 2005) and the dominant expression of the electrokinetic effect (the coseismic field) in seismoelectric is noise. From the previous sections (summarised in Table 1 below) it is clear that surface surveys are impractical for the target depths typical to hydrocarbon exploration. Seismoelectric surveys are unsuitable due to limited depth penetration, although this could be improved through the use of higher energy sources. Electroseismic surveys suffer from the economic implications of the time and power needed to make successful measurements. Both methods utilise standard seismic recording systems which are not designed to record electrical signals (amplifiers are generally required) and the sample rate is generally much lower (typically around 0.5 milliseconds vs 2 milliseconds for seismic surveys).

There is much interest currently on methods that enable measurements to be made across a section of the reservoir rather than just adjacent to the borehole, especially with regards to water front monitoring from injection programs. Currently commercial technology exists for crosswell electromagnetic surveys (e.g. Levesque, 2006) and crosswell seismic surveys (www.z-seis.com) and it should therefore be relatively straightforward to combine the two methods to enable crosswell electroseismic and/or seismoelectric surveys. Indeed recent surveys by Z-Seis have identified an electroseismic response, the source cable acting as an electromagnetic transmitter when the piezoelectric seismic source is fired. Downhole seismoelectric surveys have a particular advantage over surface surveys as there is no interference from the coseismic field (the electric field generated at an interface of interest arrives almost instantaneously at the sensor whereas the seismic wave travels at a far lower velocity and thus arrives later) as shown by

Table 1. A summary of the advantages and disadvantages of surface electrokinetic surveys
The red colour denotes a particular disadvantage, the green an advantage, and the blue neutral. We consider accelerometers to be more readily available than non-commercial electrical amplifiers

	Electroseismic	Seismoelectric
Recording time	High (days)	Low (seconds)
Source effort	High (megawatts)	Low (sledgehammer)
Penetration depth	High (up to 1500 m)	Low (<100 m)
Specialised sensors	Accelerometers	Electrodes with amplifiers

Haines *et al.,* (2007b) in experiments using trenches. In addition, downhole electric receivers benefit from a much quieter environment as most of the cultural noise originating from surface is strongly attenuated at typical reservoir depths. Downhole seismoelectric surveys also have an advantage that highly resistive surface layers will not limit penetration, and given that the response from layers drops by r^4 (Haines *et al.,* 2007b) the closer the receivers are the better. The drawback of downhole recordings are the inability to resolve horizontal layers although this could be overcome through integrated acquisition with crosswell seismic surveys or the use of non-vertical wells. Laboratory experiments (Zhu and Toksöz, 2003) have shown that crosswell seismoelectric measurements may be capable of mapping fractures, a particularly attractive application for carbonate reservoirs.

Another possibility is the use of surface-to-borehole techniques with the source at the surface. These have the dual advantages of only requiring a single borehole and of overcoming the lack of resolution for horizontal layers. Dupuis and Butler (2006) and Dupuis *et al.* (2007) have carried out small-scale experiments using a hammer source which have proved promising, the amplitudes measured downhole being four times that at the surface. As part of one of their tests Thompson *et al.* (2007) recorded downhole data using hydrophones and this proved to be more successful than surface recordings, although the strongest responses were from discontinuities in the subsurface or near-borehole properties and the detection of hydrocarbons was uncertain.

The theoretical background of electrokinetic methods is well developed and laboratory measurements conform well to theoretical waveforms but not to magnitudes (Charara *et al.,* 2009). Further efforts are required, however, to generate realistic models. Given the unsuitability of existing developed methods, usually surface-based, for hydrocarbon exploration there is significant practical work required to identify suitable applications and develop the required hardware and data processing procedures.

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About the authors

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A review of results from the Falcon airborne gravity gradiometer for mineral exploration

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The ASEG thanks AIG for permission to publish this paper which was first presented at the AIG-SMEDG Symposium entitled 'Recent Practical Advances in Mineral Exploration Technologies' held in Sydney on 11 September 2009, the full proceedings of which are published in AIG Bulletin No. 50.

A collaborative project between BHP (now BHP Billiton) and Lockheed Martin led to the development of the Falcon gravity gradiometer. In October 1999, BHP flew the first airborne gravity gradiometer survey over the Bathurst Camp, New Brunswick. Since that first survey, the number of operating gravity gradiometer systems has grown. Fugro has purchased the Falcon technology from BHP Billiton and now operates four systems worldwide. To date, application of the systems by Fugro has been limited under the sale conditions to petroleum exploration. In April 2010 the Falcon system will become available for general use by mineral explorers for the first time, offering explorers a new tool in search for mineral deposits. This paper is a review of some of the more significant mineral exploration successes of the Falcon system to date.

Introduction

Airborne gravity gradiometry has been in use for 10 years (Dransfield, 2007). Thomson (2007) stated that it was one of the top five developments in advancing airborne geophysics in the last decade. DiFrancesco *et al*. (2008) reviewed the range of deployed gravity gradiometer systems operating in various configurations and on various platforms. The Falcon airborne gravity gradiometer (AGG), now owned and operated by Fugro, uses the rotating, gravity gradiometer instrument developed by Lockheed Martin mounted in fixed wing aircraft or helicopter.

The Falcon system originated from an agreement between BHP Billiton and Lockheed Martin to develop US Navy technology into practical instrumentation for deployment in a survey aircraft. Construction of two instruments commenced in 1996, the first system flew in 1997 and was deployed on survey work in 1999. The second instrument followed in 2000. BHP Billiton used Falcon exclusively or with exploration partners. In 2008 Fugro purchased Falcon technology from BHP Billiton following US government approval. Since that time Fugro has carried out Falcon surveys for petroleum exploration throughout the world, but particularly in terrain difficult for seismic exploration. Under the terms of the purchase Fugro will be able to offer Falcon to the mineral exploration industry from 1 April 2010.

The Lockheed Martin gravity gradiometer has accelerometers with tangential sensing axes mounted on a slowly rotating wheel and measures differential curvature gradients. These non-intuitive components are transformed into the more common vertical gravity (Gz) and vertical gravity gradient (Gzz) during data processing to form maps.

Falcon delivers measurements of the gravity field from the air at a sensitivity and spatial resolution dramatically better than airborne gravimetry. At 3 km wavelength and a survey speed of 120 knots, the Falcon AGG has a gravity error along a single survey line of about 0.2 mGal (Boggs and Dransfield, 2004); an airborne gravimeter in these circumstances cannot do better than 1.4 mGal.

The total noise on a LaCoste and Romberg ground gravity meter is around 1 μGal (Ander *et al*., 1999). Cook and Carter (1978) measured errors for 4 LaCoste gravity meters in a survey of Roosevelt Hot Springs and found an RMS error of between 0.004 and 0.024 mGal with an average RMS error close to 0.01 mGal. However, this is for a detailed ground survey with careful handling of the meter. Typical regional ground gravity surveys have a standard deviation of around 0.05 mGal. Errors in elevation measurements can also introduce considerable errors into calculation of ground gravity anomalies.

Most of the early airborne gravity gradiometer surveys were for mineral exploration. Airborne gravity gradiometers have been of considerable value in both direct detection and in geological mapping for a large variety of mineral commodities and deposit styles. Diamonds have been the biggest single target with numerous kimberlites directly discovered by Falcon including the diamondiferous Impala Pipe in the Ekati field (Northern Miner 20/8/2009) and the Abner pipes discovered by Gravity

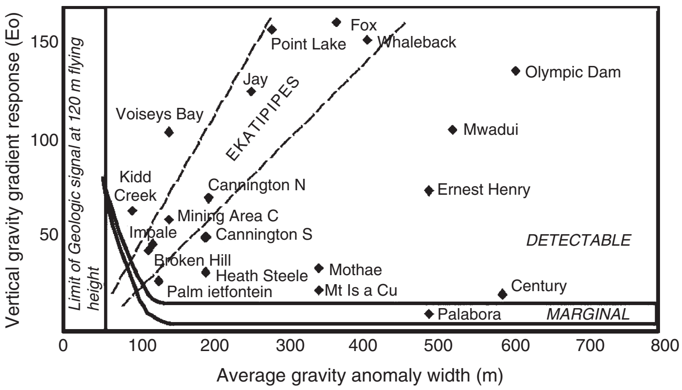

Fig. 1. *Capability of Falcon system to detect various mineral exploration targets. (Source: Harman, 2001.)*

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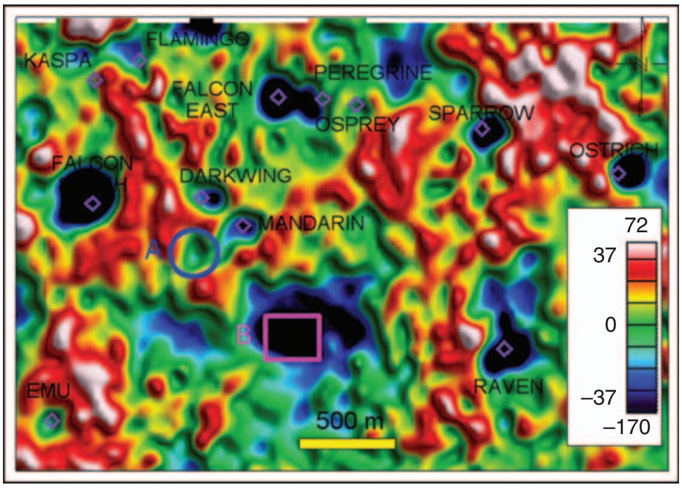

Fig. 2. *Vertical gravity gradient. All the pipes (diamond symbols) shown here, with the exception of Kaspa, are associated with gravity gradient anomalies. The anomaly due to the pipe is accentuated by the presence of lakes over most of the deposits. (Source: Rajagopalan et al., 2007.)*

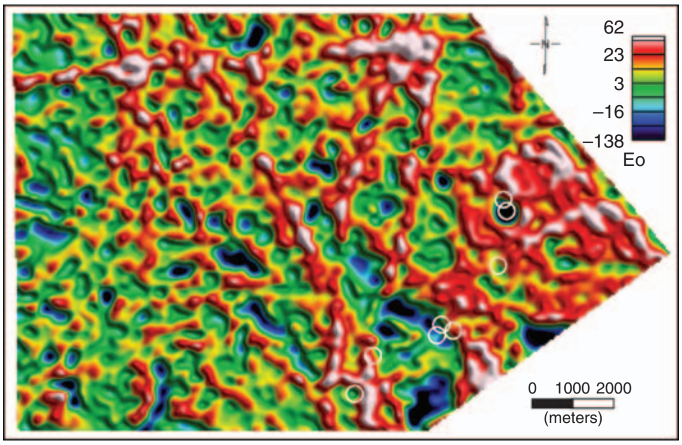

Fig. 3. *A portion of the data from the Falcon Ekati survey showing known kimberlites (white circles). These data were acquired by a fixed-wing aircraft in 2000 and reprocessed in 2004. This area was reflown as a heliborne Falcon survey in 2006 (see Figure 4). (Source: Dransfield, 2007.)*

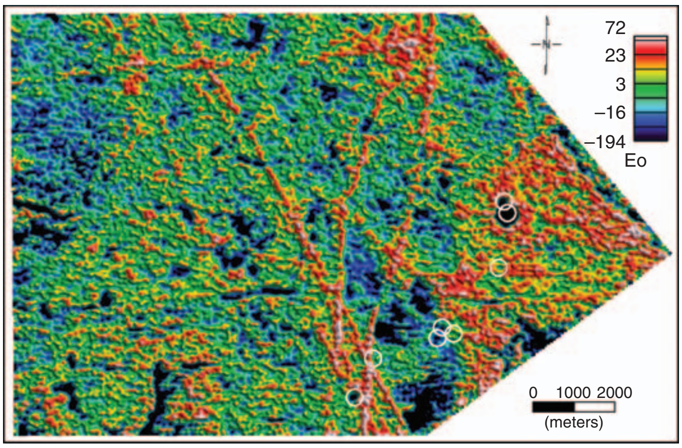

Fig. 4. *The Falcon Central Ekati survey vertical gravity gradient from helicopter survey. Known kimberlites are indicated by white circles. The spatial resolution is dramatically improved in comparison to the fixed-wing survey (see Figure 3) due to the slower flight speed and lower flight height. (Source: Dransfield, 2007.)*

Diamonds in 2005 in the Northern Territory. In addition, at the 2008 World Diamond Conference, Tawana Resources reported the Daniel diamond-bearing palaeochannel was a Falcon discovery. Airborne gravity gradiometry has also proved useful in the search for base metals in iron oxide–copper–gold deposits, porphyries, Broken Hill type deposits and volcanogenic massive sulphides, iron in massive haematite, nickel sulphides and gold. The Santo Domingo Sur copper deposit in Chile is the most advanced project that is a gravity gradiometer discovery and work is proceeding on the discoveries by Blackthorn Resources in Zambia. Figure 1 (from Harman (2001)) shows the detection capability of the Falcon system for a range of well known mineral deposits.

The noise characteristics of the Falcon gravity gradiometer make it an ideal system for mineral exploration (Figure 1). In this review some of the more significant mineral exploration successes to date of the Falcon system will be briefly summarised.

Ekati Diamond Pipes – NW Canada

Rajagopalan *et al*. (2007) reported the use of Falcon to detect kimberlite pipes in the Ekati Diamond Field in the Northwest Territories of Canada. Figure 2 shows the vertical gravity gradient. Almost all the known pipes are associated with gravity gradient anomalies. The nature of weathering in this environment has resulted in a deeper weathered zone over the pipe often filled with clay sediment that is both conductive and has a low gravity signature detectable with Falcon. Not all the pipes have a magnetic anomaly.

In May 2006 a helicopter-borne digital AGG system surveyed part of the Ekati areas that were previously flown with a fixed wing Falcon system (Dransfield, 2007). Survey specifications were for a 50 m line spacing flown at a nominal 50 m ground clearance and 30 m/s ground speed. Filtering is to a 0.3 Hz bandwidth. Images of the resulting vertical gravity gradient data over the Central Ekati block are shown in a comparison with the original Ekati survey data after reprocessing in 2004 (Figures 3 and 4).

Cannington Ag-Pb-Zn Deposit

Christensen *et al*. (2001) showed results from Falcon surveys of the Cannington Ag-Pb-Zn deposit in NW Queensland. In that study six test surveys were conducted to demonstrate the capabilities of the AGG instrument by comparison with ground gravity data (Table 1). Various altitudes were flown and noise levels of the AGG system calculated. They found that the Falcon data compared favourably with upward continued ground data and clearly delineated the Cannington ore body. They found that a body such as Cannington was detectable from a flying height

Table 1. Survey parameters for the six airborne gravity gradiometer surveys over Cannington (from Christensen *et al*., 2001)

Survey	A	B	C	D	E	F
Clearance (m)	120	120	170	220	320	120
Bearing	NS	EW	NS	NS	NS	NS
Line spacing(m)	100	100	200	200	200	100
No. of lines	120	120	60	60	60	120
Line (km)	1750	1750	870	870	870	1750

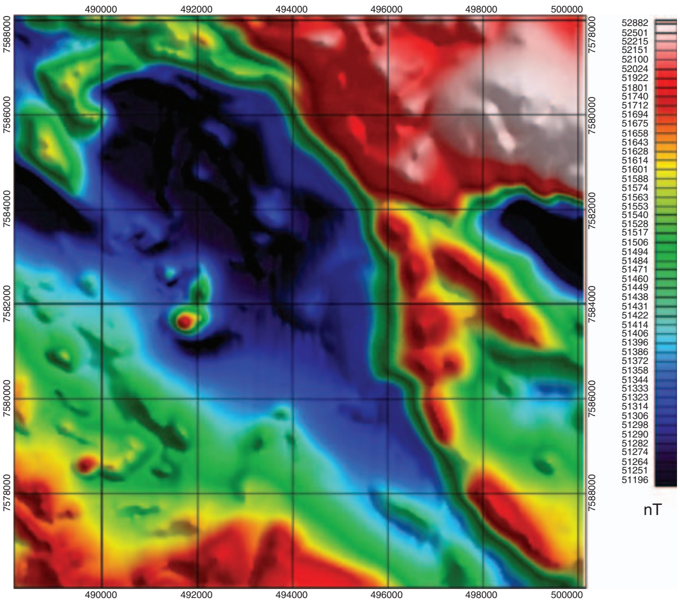

Fig. 5. *Total Magnetic Intensity data from the Cannington survey area. (Source: Christensen et al., 2001.)*

of 120 m below 130 m of regolith. Total magnetic intensity data is shown in Figure 5, Bouguer ground gravity data in Figure 6 and Falcon gD in Figure 7. A comparison of upward continued ground gravity and Falcon data is shown in Figure 8.

Prominent Hill

The Falcon AGG system was flown over the Prominent Hill Iron Oxide–Copper-Gold (IOCG) deposit in South Australia. Line spacing was 200 m and flying height 100 m mean terrain clearance. A comparison between ground gravity acquired over several years and the Falcon data acquired in 2 weeks is shown in Figure 9. The Falcon data shows better structural detail due to higher spatial sampling.

The components measured by the Falcon system can be transformed to other components of the full gravity gradient tensor to aid interpretation (see Figure 10). This can be carried out by three different methods to assist in validating the data. The main tensor component used for interpretation is G_{DD}, the vertical gravity gradient. A vertical gravity (g_D) image is derived by integrating the vertical gradient and this product is also used routinely for interpretation.

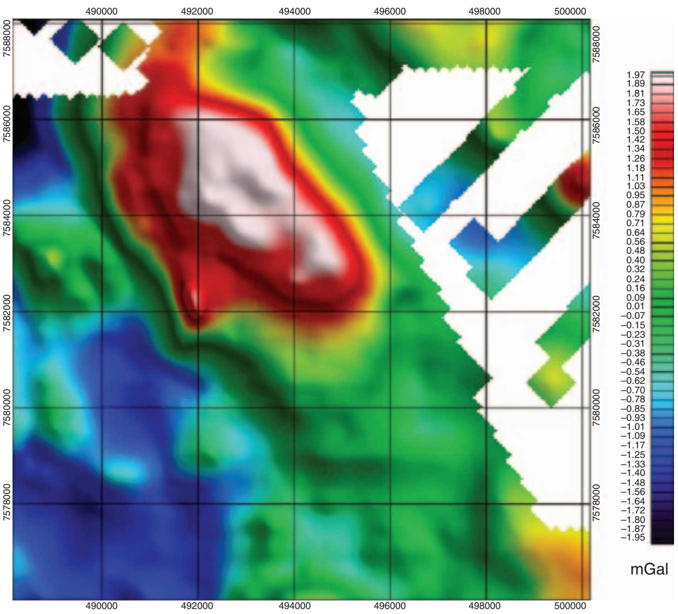

Fig. 6. *Residual Bouguer corrected ground gravity (gD) data after removal of the second order polynomial term and upward continuation to 120 m above ground level. (Source: Christensen et al., 2001.)*

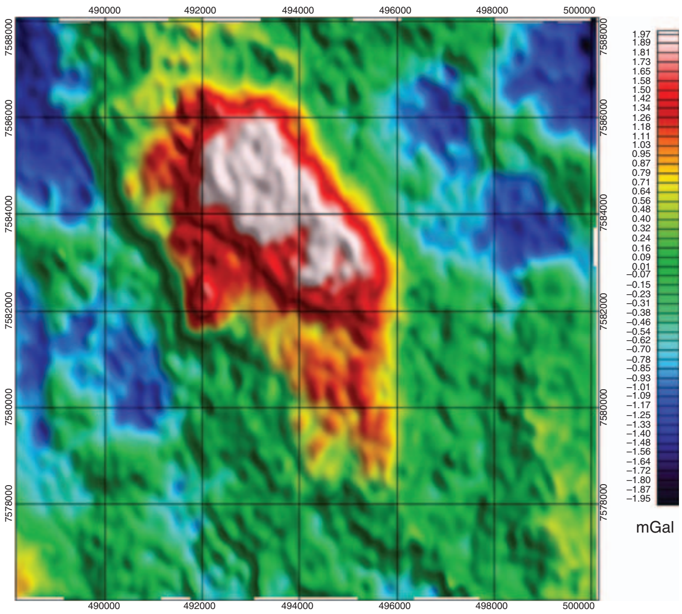

Fig. 7. *Falcon gD data from survey A flown at 120 m above ground level. The Cannington ore bodies are associated with the discrete gravity and magnetic features to the left of the centre at (492 000E, 7 582 000N). (Source: Christensen et al., 2001.)*

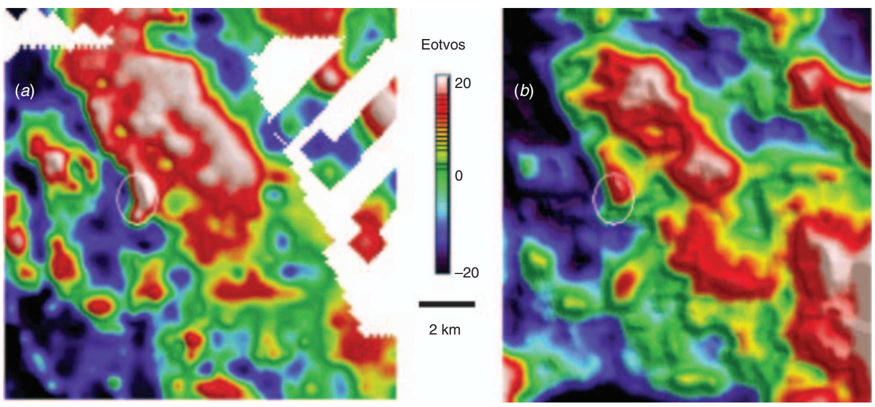

Fig. 8. *Vertical gradient of gravity for the Cannington region. (a) From ground gravity measurements upward continued to the nominal altitude of the Falcon survey. (b) Falcon survey data for the same altitude. The location of the Cannington deposit is circled.*

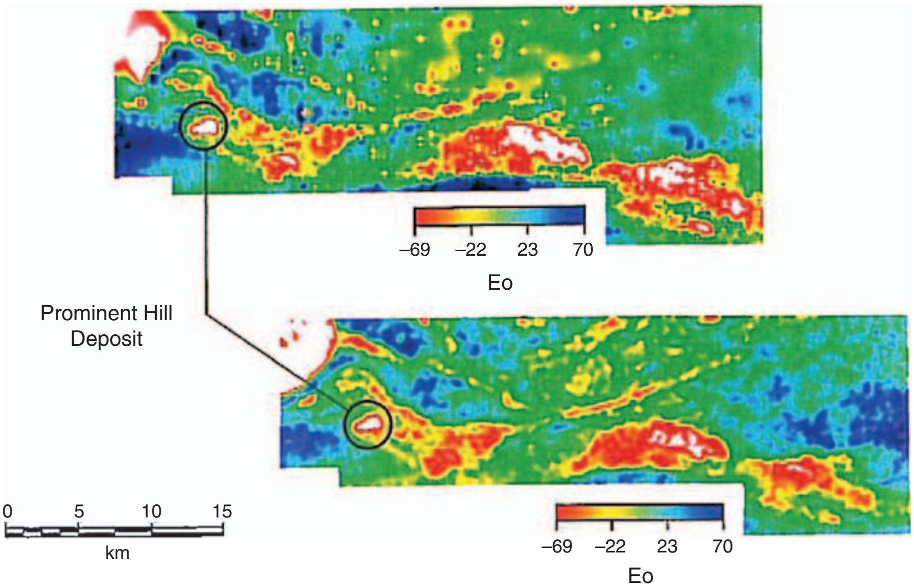

Fig. 9. *Prominent Hill IOGC deposit – upper image is ground gravity data and lower image is Falcon GDD survey data.*

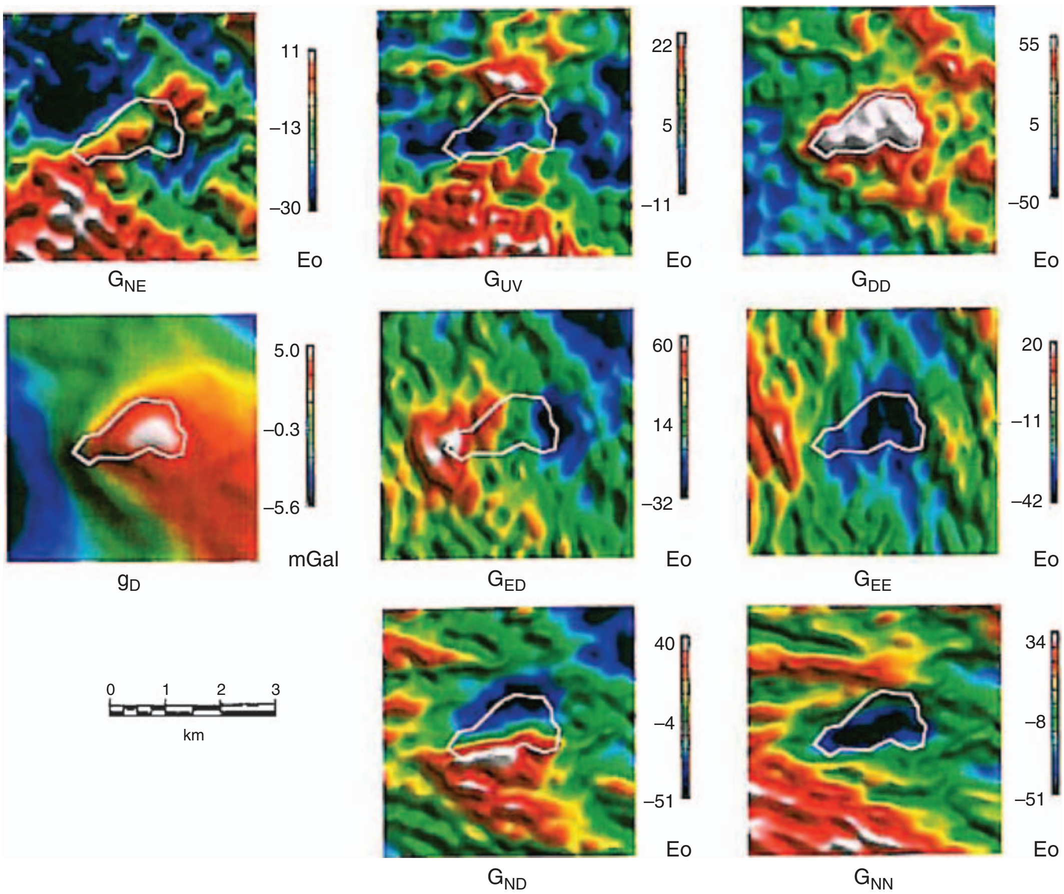

Fig. 10. *These images show all the components of the gravity gradient tensor over Prominent Hill. The top row shows the two components measured by the Falcon airborne gravity gradiometer system (G_{NE} and G_{UV}), where $G_{UV} = (G_{NN} - G_{EE})/2$ and the vertical gradient (G_{DD}). The second and third rows show the vertical gravity (g_D) and the remaining independent gravity gradient tensor components.*

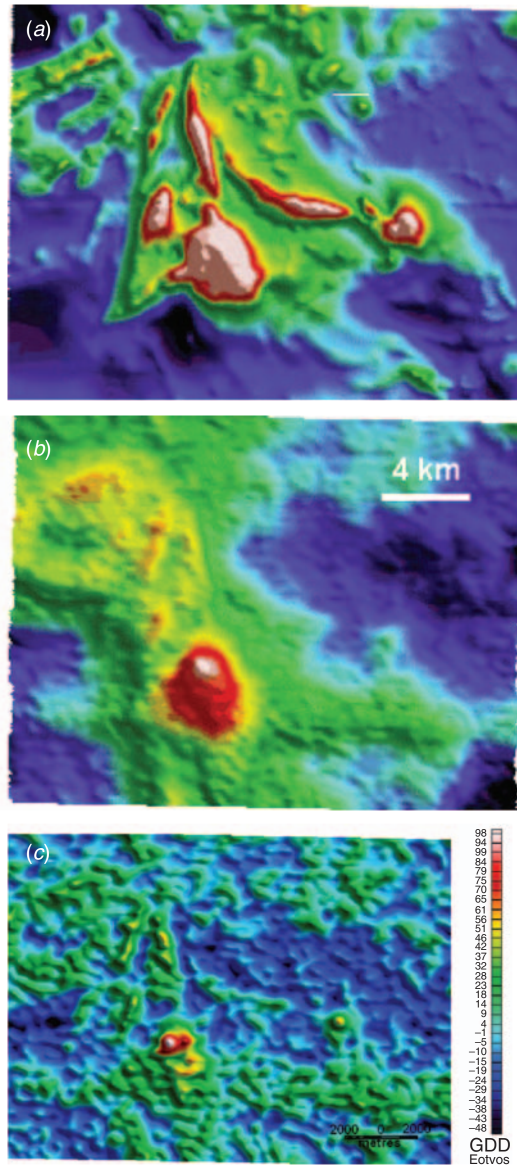

Fig. 11. *Falcon survey results for the King George anomaly, Spencer's Gulf, South Australia. (a) Total magnetic intensity with the King George anomaly being approximately 8000 nT. (b) Vertical component of gravity gD at the flight surface, 120 m above sea level. (c) The vertical gradient or GDD response. The King George anomaly is 5 mGal and 50 Eotvos. (Adapted from Lee et al., 2001 and Mahanta et al., 2001.)*

King George Gravity Anomaly

Mahanta *et al*. (2001) reported the survey of a possible IOCG target in shallow water off the coast of South Australia. King George is a high priority magnetic anomaly that was identified within regional aeromagnetic data. The anomaly is located in 20–30 m of water in the Spencer Gulf, South Australia, adjacent to the Moonta–Wallaroo mining field. Regional geology indicates that this area is highly prospective for IOCG style deposits.

IOCG deposits are expected to have a high gravity signature with possible association of magnetic anomalism, the latter being dependent on magnetite content. In March 2000, the Falcon AGG system was flown over the King George anomaly, previously inaccessible to conventional gravity measurement techniques. The survey showed a 7 mGal gravity anomaly coincident with the 10 000 nT magnetic anomaly, making the anomaly a high-priority drill target (Figure 11).

Modelling of the airborne gravity and magnetic data indicated that two closely spaced bodies 200 m below the surface produced the observed anomaly. Vertical gravity g_D was used during the modelling exercise. The Falcon AGG system measures the quantities G_{NE} and G_{UV} from which vertical gravity gradient G_{DD} and vertical gravity g_D are derived. To verify the gravity model, the G_{NE} and G_{UV} responses were also computed and compared with actual quantities measured by the Falcon AGG system. A good match between the measured and the modelled components was obtained.

Latrobe Valley

The use of airborne gravity gradiometry in coal seam mapping in the Latrobe Valley, south-east Australia was described by Mahanta (2003). The coal seam, mapped as a vertical gravity gradient low in Figure 12, terminates where exposed along its southern edge and where the vertical gravity gradient reaches its lowest values. The seam then dips shallowly to the north-west under gravel cover, resulting in a gradual reduction in the amplitude of the gravity signal. Typical thicknesses of this seam are around 30–50 m at dips a little below 10°. The detectability of coal seams will generally be favoured by greater seam thickness and dip. Mahanta (2003) shows that the Falcon AGG can detect seams of greater than 10 m thickness at dips greater than 10°.

Middleback Range

The Middleback Ranges are the source of ore for the OneSteel steelworks at Whyalla, South Australia. The southern Middleback Ranges contain a number of haematite deposits which have been assessed as extensions to the reserves to supply the steelworks. The deposits are long, narrow and small tonnage with ground gravity anomalies of 0.5–2 mGal.

Figure 13 (from Lee *et al*., 2001) compares the results of the ground gravity survey collected at 50 m station spacing on 150 m spaced lines, with data from a Falcon survey at 200 m line spacing. The ground data are upward continued to the same surface as the Falcon data.

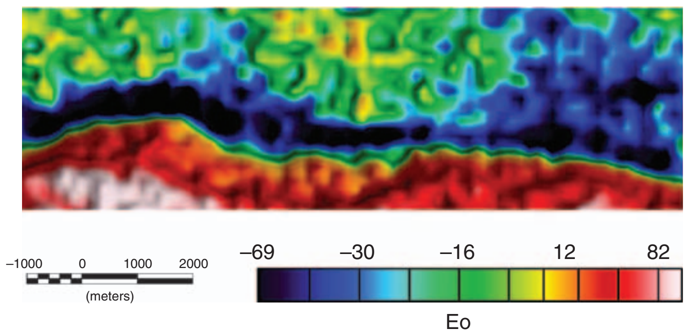

Fig. 12. *Mapping a coal seam in the Latrobe Valley with airborne gravity gradiometry. The data are from a survey flown in 2002 at 200 m line spacing and a ground clearance of 130 m. The low density of the coal produces a gravity low, truncated sharply at the Nosedale Monocline to the bottom of the image and dipping shallowly under gravel cover to the top left. (Source: Mahanta, 2003.)*

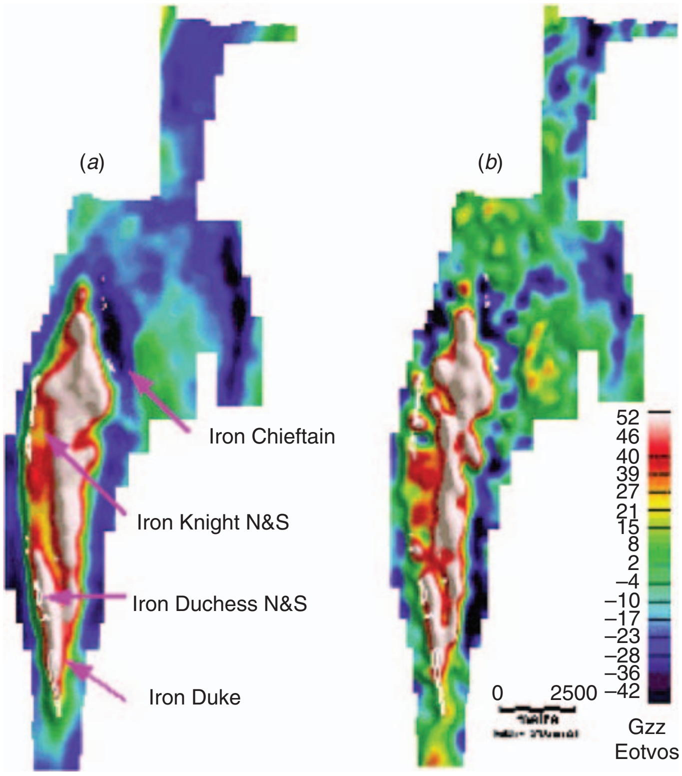

Fig. 13. *Vertical gradient of gravity for the southern Middleback Ranges, South Australia. Known haematite deposits are indicated by a white outline. The amplitude range is 100 Eotvos. (a) Bouguer ground gravity measurements, upward continued to a level surface 500 m above sea level. (b) Falcon survey results for the same surface. (Source: Lee et al., 2001.)*

The Falcon data were collected in high turbulence and the survey area includes relief of over 300 m, both factors increasing the demands of the survey. A terrain correction was applied with an assumed density of 2.67.

Santo Domingo

In 2002 Far West Mining and BHP Billiton formed a Strategic Alliance to explore for IOCG deposits in northern Chile's IOCG belt (Figure 14). The IOCG belt is one of the most prospective IOCG provinces in the world and hosts numerous copper deposits including Candelaria (470 Mt @ 0.95% Cu) and Manto Verde (350 Mt @ 0.75% Cu).

A 10 700 line-km Falcon survey was flown over the Candelaria Copper Belt in 2002. In July 2003 Far West announced that the first hole into a Falcon target intersected IOCG mineralisation averaging 2.5% copper and 0.33 g/t gold over a 60 m interval.

On 6 September 2007 the Company released resource estimates for three of the deposits discovered by drilling based on Falcon results. The Indicated Resource at Santo Domingo Sur is 171.5 Mt grading 0.57% Cu and 0.08 g/t Au. Iris has an Indicated Resource of 31.2 Mt grading 0.46% Cu and 0.06 g/t Au and Estrellita has an Indicated Resource of 31.7 Mt grading 0.53% Cu and 0.05 g/t Au. The Indicated Resources at the Santo Domingo Project combine for a total of 2.85 billion lb of copper estimated at a 0.3% Cu cut-off.

Figures 15 and 16 show the relationship between Falcon gravity data and drilling.

Fig. 14. *Location of Chilean IOCG belt. (Source: http://www.farwestmining.com.)*

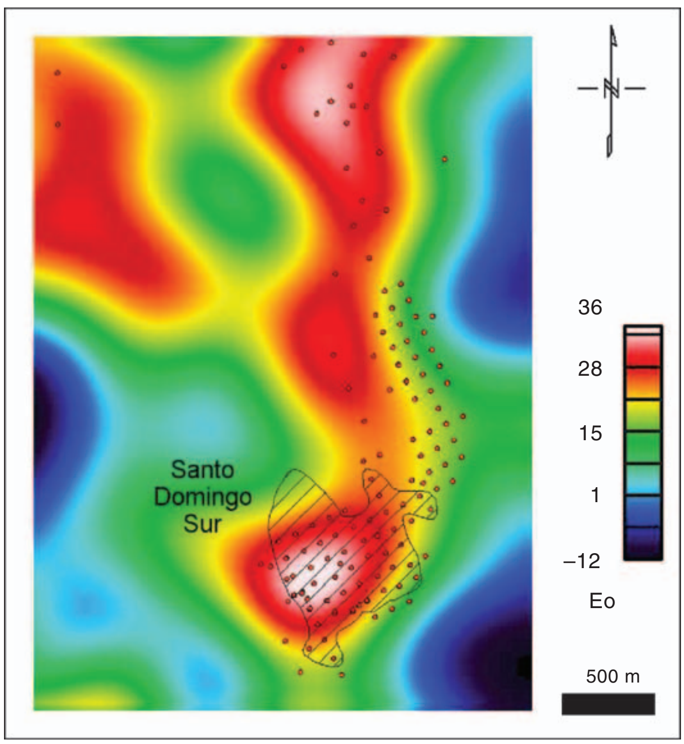

Fig. 15. *Regional Falcon gravity data for Santo Domingo shows close correspondence between mineralisation mapped by drilling and gravity signature.*

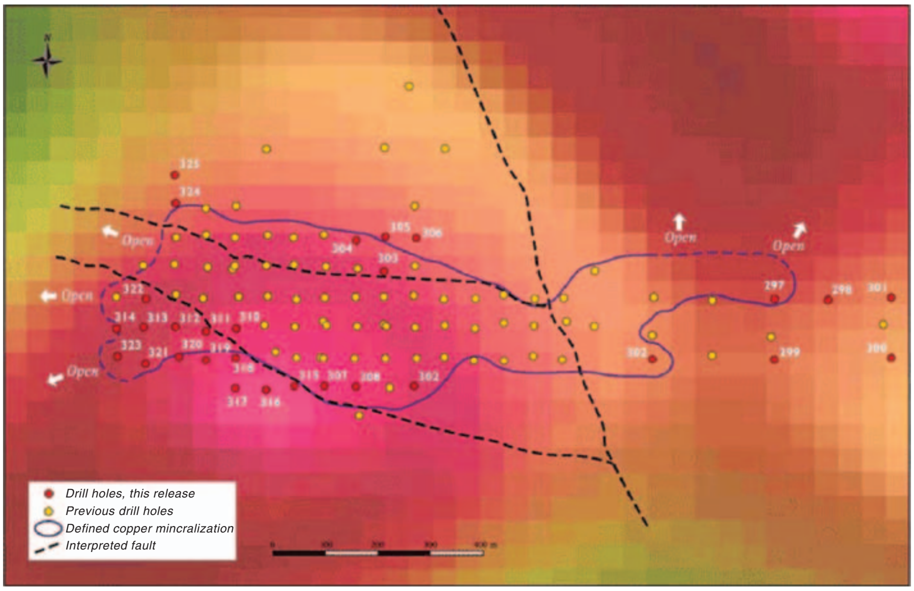

Fig. 16. *Detailed drilling and defined copper mineralisation over gravity anomaly at Estrellita Deposit. (Source: http://www.farwestmining.com, 14 August 2007.)*

Mumbwa, Zambia

The Mumbwa JV, located in west central Zambia, approximately 200 km west of the country's capital, Lusaka, covers an area of approximately 1000 km^2. The tenements are being explored with by Blackthorn Resources and BHP Billiton for IOCG style mineralisation.

Within the Mumbwa tenement there are three large scale anomalies: the Kitumba, Mushingashi, and Mutoya anomalies identified in a Falcon survey commissioned by Blackthorn Resources in 2004.

At Kitumba, the discovery hole intersected significant copper and gold mineralisation over a 655 m interval grading 0.46% Cu including:

- 317 m @ 0.79% Cu,
- 18 m @ 0.20 g/t Au,
- 42 m @ 2.01% Cu, including
- 4 m @ 5.56% Cu.

As follow up to this significant mineralised drill intersection at Kitumba, Blackthorn Resources completed 8000 m of cored drilling from 18 holes. A total of 16 holes returned copper and/or gold mineralisation above the nominated 0.25% Cu and 0.25 g/t Au cut-off grades (for more information go to http://www.blackthornresources.com.au).

Discussion and conclusion

Airborne gravity gradiometry has been shown to be an alternative to regional ground gravity and can cover large areas at a relatively low cost compared to ground crews. AGG surveys have assisted significantly in discovery of a range of targets including diamonds, IOCG, iron and coal. It is now in widespread use for petroleum exploration, particularly in areas where access is difficult and geology complex.

Further developments of airborne gravity systems are underway but any decrease in instrument noise levels will be most likely offset by the noise from terrain corrections. Dransfield (2007) already suspects that terrain correction noise may be more significant than instrument noise in some surveys.

Further investment in systems also has to be justified by the market place. The release of Falcon AGG for mineral exploration in April 2010 will offer the mineral exploration industry fast repeatable gravity over large areas at low costs.

Acknowledgements

The material for this paper has been drawn from various authors including Dransfield, Lee, Mahanta, Rajagopalan and others as well as company websites of Far West Mining and Blackthorn Resources. A bibliography of references follows for those who wish to research this topic in more detail.

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The solid earth: an introduction to global geophysics, 2nd edition

by C. M. R. Fowler

Publisher: Cambridge University Press, 2005

RRP: AU$130, ISBN: 0 521 89307 0 (paperback)

The book begins with a reminder of what the subject of crustal plates and plate tectonics is all about; and to those of us to whom the subject of plate tectonics is new, this is a clear and concise summary of the current state of knowledge.

This is followed by a series of very readable chapters as to how the study of the Earth's magnetic field, the gravity field and seismological measurements have assisted in our understanding of plate tectonics and the planet's slow but inexorable evolution in to what we know it to be today.

In each discipline there is plenty of explanatory detail. For instance, the magnetic potential, declination, inclination and secular variation are all explained in clear mathematical detail prior to a discourse as to how each is measured and then used to determine past plate movements. The Earth's gravity field is explained in detail and goes far beyond the traditional 'oblate spheroid'. Similarly, the section on seismology explains the basic physics before applying the data obtained from earthquakes to the derivation of the most likely constituents of the Earth's interior. Radioactivity and geothermal studies are also investigated and used to further evaluate the planet's structure, composition and history.

The results and implications of these geophysical characteristics are integrated in the second part of the text to explain our current understanding of the Earth's interior, plate movements, subduction zones, triple junctions and many other planetary features. Not only is the present day status addressed, but also the planet's history and how it evolved to become what it is today.

The text has been well researched and is wonderfully presented. The references are extensive and the many appendices provide the detailed mathematics and physics which many of us will have forgotten.

I wholeheartedly recommend this text to all students of geophysics and to those who are experienced geophysicists but have an interest in the crustal aspects. Beyond geophysics, it is an excellent text for all earth scientists and many others, who are interested in the history of the planet we inhabit.

Reviewed by Hugh Rutter

Aeromagnetic surveys: principles, practice & interpretation

by Colin Reeves

e-Published by GEOSOFT (http://www.geosoft.com/knowledge), 2005, 155 pp.

This book review departs from tradition in several important ways. First as a review it has not been solicited by the publisher, in the usual manner of sending a complimentary copy of the book to a society (such as the ASEG) to encourage a review to be published in the society columns. Second, the book carries the publication date of 2005, now several years ago. Third, it is an e-book, available as a 'free download'. In this characteristic it may very much be an introduction to the literature of the future.

If not particularly recent the book has, however, just recently come to the attention of this reviewer, and possibly to others, in an email circulated to ASEG members from the book's publisher, GEOSOFT. Perhaps others, like this reviewer, have taken the opportunity of the free download (http://www.geosoft.com/knowledge) and so already have the book electronically on their computers. Perhaps some already have printed a hard-copy. Nevertheless, a description of the book may be useful to those who have not yet taken such a step, and for whom aeromagnetics is important.

And, in fact, for whom is aeromagnetics not important? It is surely one of the big success stories of geophysics in the second half of the twentieth century, a period when the number of geophysical success stories is impressive indeed.

The author Colin Reeves will be well known to many ASEG readers, though the reviewer was surprised to realize that it is now almost twenty years since Dr Reeves was employed in Australia by the Bureau of Mineral Resources (which became the Australian Geological Survey Organisation and then Geoscience Australia). His career has specialized particularly in aeromagnetics, in many parts of the world, and in all aspects of the subject, from survey operations, to interpretation, to teaching and training students internationally. This text reflects that wide experience. Also the book has the smooth flow of those good text books that have benefitted, in draft form, from much teaching work. Students contribute invaluably in their questions and discussion, revealing gaps and perhaps correcting mistakes.

Aeromagnetics, at one level, can be a geologist looking qualitatively at an aeromagnetic map of a field area, and qualitatively associating geological units and boundaries with aeromagnetic patterns. There are many who use aeromagnetic maps to great effect in this way, with no deeper understanding of what underlies their production.

However, if one is involved in actually carrying out an aeromagnetic survey, one will very soon come up against a wide range of questions which beg the understanding of much of geomagnetism. Questions arise which concern the characteristics of the geomagnetic field as a dipole, to its geologic history of reversals, to the origins of the magnetic daily variation, and to the character of micropulsations and of magnetic storms. For people meeting these topics for the first time, they are fundamental and very fascinating physics, on a grand scale. The experience behind the book is evident where, in the first five chapters, Reeves introduces all these matters thoroughly, including the subject of the magnetic properties of rocks.

Then, a survey flown, data reduction and interpretation tasks come next, and the five chapters comprising the second half of the book take us through these tasks, with clarity. There is a context of rigour, with critical assessment regarding where the limitations of potential methods lie, and where benefits come from combining different geophysical methods.

The book has been in development for some decades, and its tone of thoroughness will hopefully be a counter measure to an at times distressing current trend of proceeding in geophysics by 'pressing a button', to apply someone else's computer program to data provided by someone else again. It may be hoped the book will help to balance such 'blind computing' fashions. For example it is salutary for all to remember the art of contouring maps by hand, with the recognition that arbitrary contouring can affect the final results. Also, it is instructive to remember how by measuring the slopes of profiles by hand, one can obtain a sense of the subject which is not obtained by other means.

As its title clearly states the book is a manual for the practice of aeromagnetic surveying and it deals with what is established. However the foundation it provides may encourage the interested reader to explore many active and related research topics. These topics may be as diverse as electromagnetic induction in the Earth and oceans by natural source fields; the mapping of the geomagnetic field from space; and the magnetic fields of other planets.

In a foreword to the book, the author advises that it is still work in progress. A benefit of such e-publication is that revisions and updates can, in principle, be made easily, should the author wish to do so in the future. The book represents a generous and valuable sharing by the author of his accumulated experience. It is a distinctive resource for the geophysical profession and the wider public generally, including students of all levels.

Reviewed by Ted Lilley
ted.lilley@anu.edu.au

Calling all book reviewers

If you are interested in writing a Book Review for *Preview* please contact our Book Review Editor, Hugh Rutter at hughrutter@flagstaff-geoconsultants.com.au. The ASEG sometimes receives free copies of texts from publishers for review. If you are able to review one of these texts, you will be rewarded by being able to keep the review copy. Alternatively, you may have read a text recently that you think will be of interest to ASEG readers. A short review would be most welcome.

The SEG website reviewed

As described at http://www.seg.org the Society of Exploration Geophysicists (SEG) is a not-for-profit organization that promotes the science of applied geophysics and the education of geophysicists. SEG, founded in 1930, fosters the expert and ethical practice of geophysics in the exploration and development of natural resources, in characterizing the near surface, and in mitigating earth hazards. With more than 35 000 members in 138 countries, the historically USA-centric SEG is actively seeking to become a truly global professional organization.

To the uninitiated, the SEG website is a vast labyrinth of resources and information, much of it restricted to SEG members; no doubt to the chagrin of anyone wanting to browse the site to assess its possible value.

SEG membership includes free access to the vast online library of digital publications. The SEG publications *Geophysics*, the bimonthly collection of peer-reviewed technical papers, *The Leading Edge*, the monthly journal for general SEG membership, and Expanded Abstracts from annual SEG meetings, are all accessible in PDF format. It may be worth noting that the very first *Geophysics* paper in 1936 was titled 'Black magic in geophysical prospecting'! The 'Digital Cumulative Search Index', found under the 'Publications' tab on the front page, provides a comprehensive search facility of all SEG material, including material published by the ASEG, CSEG, EEGS and EAGE. In addition, the *Encyclopedic Dictionary of Geophysics* is also available online. Note that only the SEG annual abstracts are downloadable to non-members of the SEG.

The SEG website tries to promote the benefits of membership by also offering (secure) access to various databases, resource collections, and various multimedia material. Once logged in to 'My SEG', SEG members can buy discounted reference books from the vast library at the SEG Book Mart, perform detailed Membership searches for colleagues, and access most of the technical resources.

A strong element of the SEG is its altruistic objectives. The SEG Foundation supports cutting-edge programs that benefit SEG members, the corporations for which they work and the communities in which they live. Together with SEG, the SEG Foundation has developed a bold response to two of the most pressing challenges facing the geoscience community – a growing demand for innovative technology and the need for visionary young talent. This response, Advancing Geophysics Today and Inspiring Geoscientists for Tomorrow, is a plan for the future that will raise SEG and the professions its serves to a new level of excellence. Through its partnership with corporate investors and individual donors, the SEG Foundation will accelerate the pace of scientific advance and attract more students into the geosciences. Two programs of note are 'Carrying the torch' and 'Geoscientists without borders', the program mission of which is to 'Connect universities and industries with communities in need through projects using applied geophysics to benefit people and the environment around the world'.

I strongly encourage all students to join the SEG. A growing trend around the world is the formation of SEG student chapters in each region or location. Various travel grants are available upon application to assist participation at the annual SEG meetings. This information is also lined from the 'SEG Foundation' tab on the home page. Once formed, student chapters receive considerable multimedia resources and reference material, and insider access to the vast SEG global resources. Other resources in this area include leadership opportunities, resources for schools and teachers, 'The Anomaly' quarterly newsletter to students, and a 'Virtual Geoscience Center' that is worth a look for anyone.

One of the best resources can be found under the 'Education' tab on the front page, where libraries of interactive resources can then be found under 'Continuing Education', 'Professional Development', and 'Forums & Workshops'. The Professional Development area includes video lectures from the Honorary and Distinguished Lecture programs, various SEG conference papers, and other special events. No doubt, these online lectures will become a key educational forum in the future; for schools and industry alike, not just the SEG.

Although increasingly seismic-centric, the SEG still embraces all non-seismic geophysical disciplines, so all industries and academia should bookmark the SEG web page. The examples above are only a snapshot of the ever-increasing resources at http://www.seg.org so I hope many people become motivated to join the SEG. Happy surfing!

Andrew Long
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Continued from p. 27

the knowledge to be a generation of good decision makers based on their understanding of these issues.

ESWA has many different projects. The Earth Science Across Western Australia project produces resources for teachers and students in Years 8 through 10 to support the Earth and Beyond Curriculum. In 2009 this program is reaching down into primary schools based on our firm belief that it is never too early to introduce these topics to students. Much of this project, run by Julia Ferguson who is an ESWA employee based at Scitech, involves school visits throughout WA to either deliver the materials in the classroom or train teachers in their delivery. In addition ESWA encourages and sponsors field excursions, also run by Julia, as we believe that EES topics are a field based discipline and this is an extremely important part of the course.

For senior secondary school ESWA provides classroom and teacher professional development for the EES syllabus as well as being involved in the ongoing curriculum development for the subjects. Teachers are often unfamiliar with parts of the syllabus, especially the Earth Science based topics, and we believe that upskilling teachers is one of our main functions. ESWA also sponsors and runs field excursions specifically for Year 11 and 12 students to cover the essential field skills such as mapping, rock sample identification and structural geology that are an important component of the syllabus. Figures 3 and 4 show photos of secondary school students participating in two different field excursions. Both trips were partially sponsored by ESWA and run by highly experienced teachers. ESWA is currently compiling a textbook for the course as this was identified as something teachers urgently needed, which should be available to schools for 2010.

With Earth and Environmental Science designated as one of the four core sciences for the senior science National Curriculum and the underpinning Year 8–10 syllabus ESWA hopes to further encourage Australian teachers and students to offer these topics in schools so that national skills shortages can be met, the next generation can be scientifically informed citizens and lead Australia into an ever brighter and prosperous future.

If you require any additional information about ESWA please contact:

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November			**2009**
15–18 Nov	EAGE: Subsalt Imaging Workshop http://www.eage.org	Cairo	Egypt
December			**2009**
14–18 Dec	American Geophysical Union, Fall Meeting http://www.agu.org/meetings	San Francisco	USA
February			**2010**
1–3 Feb	8th International Conference and Exposition on Petroleum Geophysics http://www.spgindia.org	Hyderabad	India
March			**2010**
7–10 Mar	GEO 2010: 9th Middle East Geoscience Conference and Exhibition http://www.eage.org	Manama	Bahrain
24–26 Mar	Australasian Oil & Gas Exhibition and Conference http://www.aogexpo.com.au	Perth	Australia
25 Mar	Geophysics and Geohazards: Defining Subsea Engineering Risk (see *Preview* 141, p. 15)	Perth	Australia
April			**2010**
5–8 Apr	EAGE: Saint Petersburg 2010 http://www.eage.org	St Petersburg	Russia
11–15 Apr	SAGEEP 2010 http://www.eegs.org	Keystone	Colorado
May			**2010**
2–7 May	European Geosciences Union (EGU) General Assembly 2010 http://meetings.copernicus.org/egu2010	Vienna	Austria
24–27 May	Oceans '10 IEEE Sydney Conference and Exhibition http://www.oceans10ieeesydney.org	Sydney	Australia
June			**2010**
14–17 Jun	72nd EAGE Conference and Exhibition incorporating SPE EUROPEC 2010 http://www.eage.org	Barcelona	Spain
22–25 Jun	2010 Western Pacific Geophysics Meeting http://www.agu.org/meetings/wp10	Taipei	Taiwan
August			**2010**
8–13 Aug	2010 Meeting of the Americas http://www.agu.org/meetings	Iguassu Falls	Brazil
22–26 Aug	ASEG–PESA: 21st Conference and Exhibition http://www.aseg.org.au/Events/Conference	Sydney	Australia
29 Aug–4 Sep	Seismix 2010 – 14th International Symposium on Deep Seismic Profiling of the Continents and their Margins http://www.earthscrust.org/earthscrust/seismix2010.htm	Cairns	Australia
September			**2010**
5–10 Sep	11th IAEG Congress http://www.iaeg2010.com	Auckland	New Zealand
October			**2010**
17–22 Oct	SEG International Exposition and 80th Annual Meeting http://www.seg.org	Denver	USA

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Please note that this is a non-profit activity carried out by the ASEG SA Branch committee only for ASEG members. The prices have been specially negotiated with the wineries and are not available through commercial outlets. Compare prices if you wish but you must not disclose them to commercial outlets.

Morgan Simpson 2006 New Territories Shiraz

Big alcohol and big fruit. A 'boofy' big McLaren vale Shiraz with plenty of sweet ripe dark fruit: plums, cherries and forest berries. Hints of mossy earth with a glimpse of background (American) oak. Grainy tannins tapering into a long finish.

The grapes are harvested exclusively from the Simpson family's *Clos Robert* vineyard which was established in 1972. The wine is a blend of fruit from two blocks on each side of the Breakneck Creek which runs through the centre of the vineyards.

The wine is made on site by winemaker Richard Simpson. It is matured in barrel and then bottle aged (approx 12 months) before release.

ASEG Price $110/case (usually retails at around $180/case)

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