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PREVIEW

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS

Special post-conference issue:
23rd IGC ASEG-PESA 2013 epilogue

24th IGC ASEG-PESA 2015 announcement

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FRONT COVER

Mosaic capturing moments of the ASEG-PESA 2013 conference held in Melbourne (see article beginning p. 19; individual images courtesy of the respective Conference Organising Committee).

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John A. Theodoridis

Two subsections of this post-conference issue of *Preview* serve as an epilogue to the ASEG-PESA 2013 23rd International Geophysical Conference (IGC). The *Executive Brief* contains updates from the Research Foundation and History Standing Committees, a 'Communiqué to members' reports the outcomes of the ASEG Council meeting and the 'ASEG Strategic Plan for 2013–18' outlines, among other items, three aspirational goals of the society pertaining to education, membership and proactivity in geoscience debates within the broader community. In *Conferences and Events*, Jarrod Dunne (Petroleum Co-Chair) recounts events whilst issuing final acknowledgements and farewells. Andrew Mutton follows with the 'ASEG Honours and Awards Citations' and we conclude with the 'ASEG-PESA 2013 Conference Awards'.

Michelle Salmon and Natalie Balfour of the Australian National University discuss the Australian Seismometers in Schools (AuSIS) programme launched in May 2012. The government-funded AuSIS network, comprised of research quality seismometers, is part of the Geophysical Education Observatory established by AuScope. Connecting students, schools and scientists alike, AuSIS engages beyond geoscience, with many schools reporting authentic learning opportunities for students studying physics, geography and social science. Needless to say, volunteers are crucial to expanding and sustaining this innovative programme.

The 2013 Careers in Geoscience evening proved a big success. Anne Tomlinson reports on the valuable opportunities this event offers students, from both schools and universities, to learn about the geoscience sector and network with industry representatives.

In a two part mini-series, Robert Watchorn presents his case for an impact structure interpretation of large circular features observed within gravity data acquired from the Yilgarn region of WA. Dating estimates suggest these impacts occurred circa 2.7–2.64 Ga, placing them in the Eratosthenian period of the Selenological time scale. Drawing on additional data derived from Landsat images, magnetics and ultimately specimens of shatter cones procured from field trips, Watchorn assembles evidence to raise the existence of these rings above that of mere 'digital artefacts'. On a more philosophical level, Watchorn proceeds to discuss the ramifications of his interpretations for future impact structure identification and the subsequent relationships of such structures to lithology and mineralisation.

Continuing our historical features, Roger Henderson (ASEG History Committee chair) recounts a preliminary assessment of geophysical prospecting, prepared for the N.S.W. Department of Mines 1927 annual report, by Government Geologist E.C. Andrews. This article offers significantly more than one's initial expectations of glimpses into outmoded 1920s geophysical practices. Instead, readers may find themselves smirking at the scatterings of Andrews' little gems of witty prose: canvassing the philosophical nature of geophysics itself, quaint advice for developing a good ear for discerning geophysical signatures, and profound caveats for those seeking to undertake this new technology. In one instance, Andrews' strikes at the heart of the ongoing geological-geophysical schism as he belittles geophysicists for lacking the 'wherewithal' to comprehend the true geological reality of ore-bodies, as they construct artificial interpretations derived from mere physical constants.

In announcement of an exciting ASEG initiative, Wendy Watkins outlines the launch of the ASEG Specialists Travelling Education Programme (OzSTEP), a programme that offers separate one-day courses devoted to geophysics within the minerals and petroleum industries respectively.

As one conference ends, preparations for another begin: Andrew Long (Co-Chair Petroleum) announces the conference organising committee for the ASEG-PESA 2015 24th IGC (Perth, WA), which is aptly themed 'Geophysics and Geology together for Discovery'.

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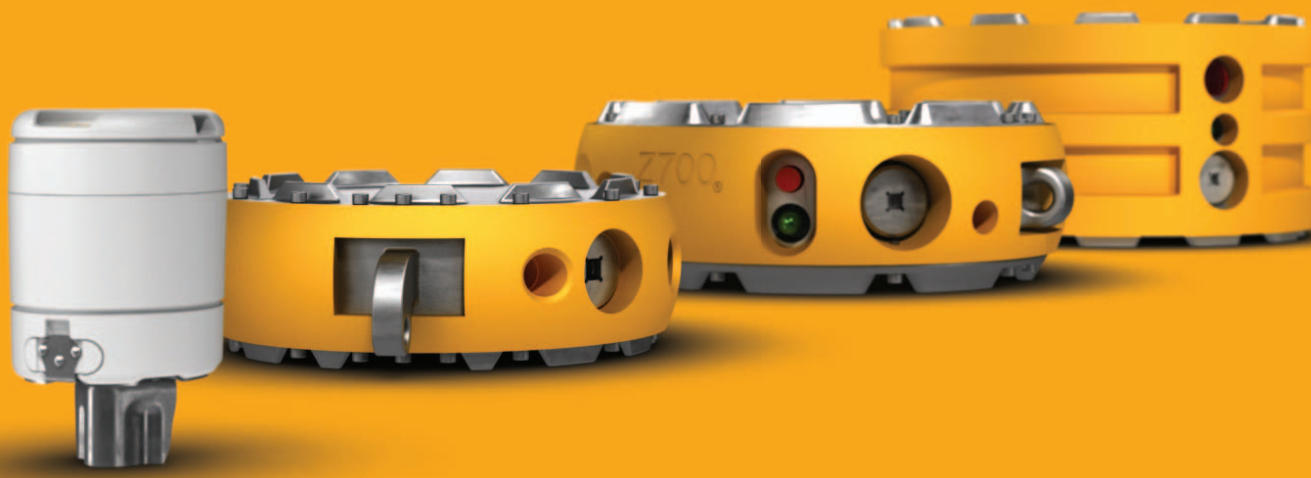

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Over the hill and far away

I am sitting in my home office rather relaxed after the conference in Melbourne. That was a wonderful event. Some feedback I heard was excellent. The venue was good, particularly the short distance between the session rooms and the exhibition hall; the organisation went smoothly; the technical content was of high standard; the workshops were well attended; and there were plenty social functions. What more could we expect? Well, we had an unexpected news item from the conference organising committee (COC): a larger than expected number of delegates, which brought a surplus larger than expected.

The organisation of a conference like this is not easy. The COC spent nearly two years planning and arranging a lot of things, and the execution is not free of worry. I went to the Convention Centre around 7.30 in the morning. The PCO crew and COC members were already there preparing the registration desk and having a last-minute briefing for the day's routine. I admire these hard-working people, particularly the COC members doing this on a voluntary basis. Big thanks to the COC. Now their climax has passed and they are busy writing reports. This is always hard to motivate. Writing reports for a good outcome is not too bad, though.

Considering this prompts me to a resemblance to exploration programmes. In my background in petroleum exploration (and perhaps minerals exploration is not much different), a project starts from literature review, followed by planning the survey location, negotiating with government, land owners and other stake holders, getting quotes and scheduling many survey crews together. By the time the field crew arrives, more than half of the work is done. The field operation is one of the peaks of the project. Then data processing and interpretation follow. This is another build-up phase. When a prospect is worked up and finally drilled, it is really a climax of exploration. Regardless of whether a well is a discovery or dry, the follow up and reporting are not as exciting. Yet, writing a report of discovery is more of a pleasure than a chore.

The conference is an opportunity to meet people. It is a rare occasion for ASEG Federal and State Branch executive and committee members to be at one place. Starting from the Council meeting, we had a series of committee meetings to report the activities of the past 18 months and to discuss plans for the next. One of the important issues discussed for the future activity is our strategic plan. Our strategy will focus on three areas: education, membership base and representation to geoscience issues. These are outlined by our Hon. Secretary, Barry Drummond, in this issue (see p. 10).

The treasurer reported a healthy financial position of the ASEG. This allows us to increase membership service. The first two OzSTEP courses are now organised (see p. 17). We are seeking ways to support geophysicists who have difficulty in attending conferences and meetings. We are on the way to establishing several specialist groups who may enhance information flow among members by newsletters, discussion forums and perhaps organising mini-symposia between conferences. The present education system in geophysics is a concern for university staff. We are trying to improve this through the Australian Geoscience Council and Science and Technology Australia, but there is a long way to go. So after the climax of the conference, we have a lot on the table to continue servicing the society.

Since April, I travelled several times for the ASEG: visiting state branches and universities, gave a congratulation speech at SEGJ's 65th anniversary conference in Tokyo, EAGE convention in London and Near-Surface Geophysics Asia-Pacific Conference in Beijing before our own conference in Melbourne. I always feel strange making a speech in Japan representing the ASEG. It is not too bad if it is an international symposium spoken in English, but this speech at the 65th anniversary of the SEGJ was in Japanese; it is not because I am uncomfortable in Japanese language, but I felt the situation was somewhat cumbersome. At the EAGE conference I saw old friend Stewart Greenhalgh, a long-standing ASEG member, former professor of Flinders and Adelaide Universities now in ETH Zurich, receive the Ludger Mintrop Award from HRH Prince Andrew (*Preview*, issue 165, p. 5). The conference in Beijing focussed on near-surface geophysics: a minor but growing subsection of exploration geophysics. There are two sorts of interests in near-surface geophysics: one is concerned with the near-surface itself for engineering and environmental application and the other wants to resolve near-surface problems to image deeper targets better. These subjects seem to progress hand-in-hand. This will be an

ASEG booth at EAGE's London 2013 conference. (L to R) Roald van Borselen, EAGE Membership Officer; Koya Suto; Asbjorn Christensen; Gladys Gonzalez, EAGE President; Clive Foss and Marcel van Loon, EAGE Manager Publications and Communications.

area of geophysics both in development and application.

For the ASEG and myself, the conference in Melbourne was the largest event of the year. But we still have a few conferences of our associated societies to participate in after ours: SBGf (Rio de Janeiro, August), SEG (Houston, September), SAGA (Mpumalanga, October), SPG India (Kochi, November) and SEGJ International Symposium (Yokohama, November). Fortunately, we can share the workload among active participants of the ASEG. After the pinnacle of the events of the ASEG conference, the ASEG recognises a lot to strive towards. The climax is not the end; we have a long way to go.

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Communiqué to members

This article is to advise members of the outcomes of the recent meeting of the ASEG Council.

The Council of the Australian Society of Exploration Geophysicists met in Melbourne on Sunday 11 August 2013, prior to the Conference and Exhibition.

The Council advises the Federal Executive on matters concerning the running of the Society. Council consists of officers, officers-elect, Branch office bearers, Committee Chairpersons and all Past Presidents.

Council meetings are a venue for the two-way flow of information between the Federal Executive and those members of the Council who are not members of the Federal Executive.

The resolutions, recommendations and conclusions of the Council are not binding on the Federal Executive but are nevertheless persuasive, and the Federal Executive gives regard to any such matters brought to its attention by Council.

This year the Council meeting was in two parts.

In the first part of the meeting, President Koya Suto reported to Council on the activities of the Federal Executive and its Committees since the last Council meeting and the plans of the Executive for the next year. The Treasurer presented a statement on the financial health of the Society, which is quite rosy.

The Branches then gave their reports. They had been asked to address three topics: what the branches have done since the last Council meeting; what they plan to do in the next year; and what things would they like to see changed and improved in the Society. The last issue was a lead into the second part of the meeting – a discussion on the Society's new strategic plan and its implementation. It raised a number of issues, most of which were relevant to the strategic plan, as well as several that were related to improvements in the administrative arrangements for the Society.

All reports were in both written and presentation formats; written reports will be placed on the website for members to read.

The Executive Board began a process of strategic planning late last year. The Society's previous strategic planning exercise was over 10 years ago. A draft plan was prepared, discussed and iterated within the Executive, and then circulated to the branches for input. An updated plan was then brought to Council for endorsement, which was given. The new strategic plan will be placed on the website and published in *Preview*.

The strategic plan looks forward 5 years and has three aspirational goals:

1. Implement strategies to help address the issue of geophysics education.
2. Strengthen and broaden our membership base.
3. ASEG to be more proactive in geoscience debates.

Geophysics education

Geophysics was talked about as a strategic science – it underpins much of what makes Australia wealthy. The ASEG is one of several societies that are trying to determine how many geophysicists (or other kinds of geoscientists) are actually needed in Australia. We do not have a snapshot of what teaching is actually done, either as a geophysics major or as a service course for other geoscientists who will undoubtedly encounter geophysics data in their everyday jobs. What does it mean if someone says they are a geophysicist, in terms of their level of training and the content of their course?

The meeting also discussed a number of initiatives already in place for providing ongoing professional development courses for Members, including the Society's new OzStep workshops. See more information on OzStep (p. 17) in this issue of *Preview*.

Discussion on this topic was then suspended pending a meeting that the President had scheduled with university lecturers at the conference later in the week, during which issues with the teaching of geophysics would be teased out.

The Federal Executive will now consider a number of options for progressing this issue. One option may be to undertake a survey of industry and other employers of geophysicists to try to determine future needs, and of university courses to map out what is available and where.

Membership

The Society has around the same number of members that it did 10 years ago. The age profile of our members is getting older and many of our members are likely to retire from active geophysics in the next 5 years. Furthermore, people who leave the industry during downturns do not all come back. The number of younger members is small relative to the number who might retire.

The Society needs to broaden its membership base.

Council set up a small working party to bring a paper to Federal executive with options for strengthening our membership base. The members of the working party are: Katherine McKenna, Kim Frankcombe, Greg Street and Anne Tomlinson. To send your comments or to get involved with this working group please email Members.wg@aseg.org.au.

The younger membership contingent expressed concerns over what services the society could provide above and beyond what it was already doing in order to make it more attractive to transfer student members into associate members. Tanya Dhu, Koya Suto, Millie Crowe and Heather Carey will form a working group to bring an issues paper to the Federal Executive. To send your comments or to get involved with this working group please email Services.wg@aseg.org.au.

Career retention in the face of the economic downturn, challenges with cultural diversity and the impact of family pressures on career advancement were raised in the feedback from a number of branches. Carina Kemp, Anne Tomlison and Koya Suto will form a working group to bring an issues paper to the Federal Executive. To send your comments or to get involved with this working group please email Retention.wg@aseg.org.au.

Representation in debates on geoscience issues

Discussion on this topic covered a lot of ground, from the Society's role in the Australian Geoscience Council, our ongoing role in the UNCOVER initiative, the need for apolitical material on a range of hot topics (such as fraccing, land access and the impact of geophysical

techniques on fauna) and how the Society promotes itself in public forums such as student careers nights.

The Federal Executive will formulate a policy on how members should go about producing material that can be used in the Society's name.

Ann Tomlinson will engage a designer to develop a style guide to be used when using the Society's name in promotions.

Take home message

The Society is embarking on several new initiatives that arose from the strategic planning process. The names of the people who are taking a lead in aspects of these initiatives are listed above. If you want to participate, please feel free to contact them.

Updates from the ASEG Standing Committees: Melbourne 2013

ASEG Melbourne Conference a 'Eureka Moment' for the Research Foundation

Thank you to everyone who supported the ASEG Research Foundation at the conference dinner. We raised sufficient money to cover one annual research grant and had a bit of fun doing it.

The ASEG Research Foundation supports students to carry out practical research as part of their studies towards an undergraduate or postgraduate degree. The funds are made available over and above any other scholarship for the specific purpose of enabling them to carry out essential fieldwork or laboratory work, thereby encouraging a practical approach to the development of their professional skills.

Funding for the Foundation comes from several different sources including donations from ASEG members, corporations involved in the industry both as members of the ASEG and as service providers and grants from the ASEG itself.

The Foundation was formed in 1990 and although it has relatively modest goals, since that time it has supported around 100 student projects with cumulative expenditure approaching $1 million. In the current year, the Foundation is supporting six projects that cover topics related to minerals and petroleum exploration. This is in addition to several carry over projects from the previous years' grants.

At the Melbourne ASEG conference dinner Professor Geoffrey Blainey, eminent Australian historian, entertained us with some of his reflections on the history of Australia's mining industry and the role our profession has played in its success. The Foundation raffle is now a tradition at conference dinners: this year we awarded two bottles of premium Australian red wine as prizes, while raising $2200 for the Research Foundation. Generous matching donations from Scintrex, Rio Tinto and a $500 pledge from Geosoft further supported the money raised.

Thank you to everyone who gave generously and I ask that you continue to support the Research Foundation with regular donations that are tax deductable and can be made at any time through the ASEG executive or annually at membership renewal time.

Phillip Harmon,
Research Foundation Chairperson
research-foundation@aseg.org.au

History Committee makes progress

As this is the first report on the newly established History Committee, some 'history' is appropriate as well as describing the recent initiatives.

Following an inaugural meeting in 2010, the committee was re-established by Roger Henderson in 2012 with Anne-Marie Anderson-Mayes as the first Chairperson. The first meeting was held at the Brisbane conference in February 2012 and the main result was to establish a History page on the ASEG website. It was decided then that this page will contain papers and articles of historical interest. The first paper posted documents the formation of the Society in 1970. A list of historical subjects from all articles in *Preview* was then compiled, such as the 'Geophysical Anniversaries' series and others by Doug Morrison, together with all obituaries (all rich with history) and other occasional items, with the intention of loading them to the site. As this proved to be a very long list, only the list itself will be added to the website giving reference to each item with hyperlink to the original article were possible. These activities are ongoing. Also, a repository of old issues of *Preview*, *Exploration Geophysics* and other material has been established at Kim Frankcombe's shed in Perth.

At a second meeting at the Melbourne conference with Roger Henderson as the replacement Chairperson for Ann-Marie, the main outcome was a decision to start a collection of old exploration instruments to be accompanied by their 'story'. It is yet to be decided if this collection will be housed in an existing museum or elsewhere. Also, the history of methods such as seismic recording in Australia will be compiled.

If you would like to receive continuing news of the committee or know of old equipment that can be part of the collection, please contact Roger Henderson directly by email.

Roger Henderson,
History Committee Chairperson
History@aseg.org.au

Australian Society of Exploration Geophysicists Strategic Plan 2013–18

Mission statement

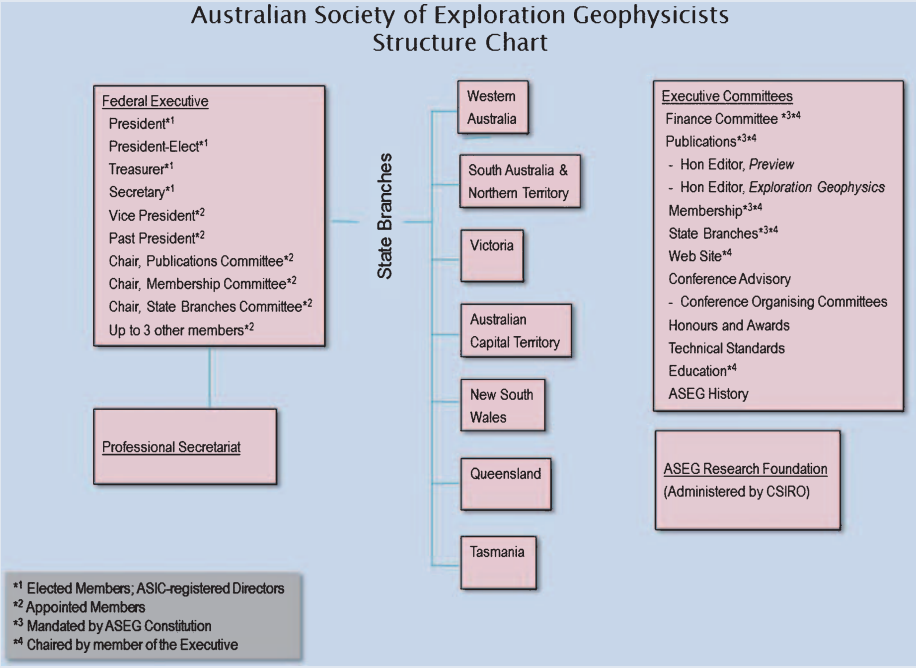
To provide an environment for the science of applied geophysics to grow for the benefit of its members and the wider community.

Who we are

The ASEG is a society of professional geophysicists founded in 1970. Its aims are:

- to promote the science of geophysics, and specifically exploration geophysics, throughout Australia
- to foster fellowship and co-operation between geophysicists
- to encourage closer understanding and co-operation with other earth scientists
- to assist in design and teaching of courses in geophysics and to sponsor student sections where appropriate.

The Society is a company incorporated under and regulated by the provisions of the Corporations Act (2001). It has a Federal Executive and seven state branches (see structure chart). It supports the ASEG Research Foundation. Its members live and work within Australia and in many other countries.



Structure chart.

What we do

The activities of the Society are defined in its Constitution:

The objectives of the Society are the promotion and advancement of geophysical sciences, especially the knowledge, and its application and continuous professional education, in the areas of exploration geophysics and related sciences.

In particular, but in no way limiting the Society, the Society may:

(a) hold meetings of members of the Society, and visitors introduced by them, for the purpose of hearing and discussing communications from members of the Society and others on subjects related to exploration geophysics;
(b) sponsor meetings of members of the Society and others for the purpose of advancing exploration geophysics through the creation of branches, committees or specialist groups throughout Australia and elsewhere;
(c) promote fellowship and co-operation among people, firms and corporations who are interested in geophysical exploration including the holding and participation in exhibitions, industry forums and conferences;
(d) promote good standing of the geophysical profession;
(e) promote closer co-operation and understanding between geophysicists and other Earth science and related disciplines;
(f) publish communications on geophysical exploration subject matter, which in the opinion of the Federal Executive of the Society are worthy of publication;
(g) distribute the publications of the Society among the members and other people and institutions, both in Australia and overseas, and sell the publications of the Society to the public;
(h) make grants and donations in aid of geophysical research or the publication of exploration geophysical works;
(i) encourage exploration geophysical education by the award of scholarships or prizes or otherwise including the design and teaching of courses in geophysics, the formation and sponsorship of student sections;
(j) form or join in the formation of any society, club, association or other legal entity for the purpose of carrying out any of the above objects that and the Federal Executive of the Society may delegate to such legal entity such of the powers and duties the Federal Executive has in relation thereto; and
(k) provide advice to federal and state governments on issues relating to the geosciences.

How we operate

The operation of the Society is defined by its Constitution. The Constitution can only be changed by a vote of the Members. The Society's governance structure is shown in the chart.

The Federal Executive is the peak body governing the Society. Four members of the Federal Executive are elected by the Members (President, President-Elect, Treasurer and Secretary) and are registered with the Australian Securities and Investments Commission as Directors. Up to eight other members of the Federal Executive are appointed.

The Society provides services to its members in a number of ways.

The Federal Executive, through its Publications Committee and independent editors, is responsible for the publication of the Society's bi-monthly magazine *Preview* and its quarterly scientific journal *Exploration Geophysics*. It establishes conference organising committees to run its Conferences and Exhibitions on an 18 month schedule. It has other committees that focus on, among other things, the financial health of the Society, technical standards for exploration geophysics, geophysics education, the ASEG Research Foundation and making recommendations for honours and awards. All Committees have a member who is also on the Federal Executive; several of the Federal Executive members are Chairs of Committees. This ensures that all committees have direct links with the Executive.

The Federal Executive is responsible for liaising on behalf of the Society with sister societies in Australia and overseas. The Federal Executive has representatives on the Executive of the Australian Geoscience Council, Australia's peak geoscience body. The Society has Memoranda of Understanding with sister societies in Korea, Japan, Brazil, South Africa, India, as well as the Society of Exploration Geophysicists (SEG) (the Society has representatives on the SEG Council), the Environmental and Engineering Geophysical Society (EEGS) and the European Association of Geoscientists and Engineers (EAGE), through which the societies share opportunities to provide services to their members.

The Society currently has seven state and territory branches. Branches are the main mechanism whereby most members interact directly with other members in the Society. Branches hold regular technical meetings (usually monthly) and social functions. They take turns planning and running the Society's Conferences and Exhibitions. Branches also organise workshops and conferences on topics of interest to their local members.

Aspirational goals for 2013–18

The Society has adopted the following aspirational goals to ensure that it retains vitality and relevance in an exploration industry that is continually changing.

Implement strategies to help address the issue of geophysics education.

The Society is concerned at the depth of quantitative geophysics being taught to today's and tomorrow's new geoscience practitioners. The discipline of Geophysics is used in all aspects of geoscience endeavour. However, the funding model for university departments means that not all departments can support enough staff to present a dynamic programme of geophysics courses.

New thinking is required.

The Society is aware of new initiatives from our sister societies overseas, which may not be visible to individual lecturers in geoscience departments if they are not members of those societies.

New technologies such as the National Broadband Network will provide opportunities to support geophysics education.

The Society needs to identify impediments to implementing new ways of teaching and lobby for solutions to remove them.

Strengthening our Membership Base

We are a small society. Our future viability depends on a strong and participative membership.

However, our membership numbers have remained almost static since 2000.

We need to attract new members from among practising geophysicists. Current incentives to attract new members have not had long-lasting impacts on our numbers.

We need to find new ways for our members to participate in the running of the Society. We need to publicise the society in new ways and to different audiences.

ASEG to be more proactive in geoscience debates

To ensure the relevance and viability of our society, we need to be at the table when matters relevant to the future of our industry are being discussed.

The Society is a member of the Australian Geoscience Council, Australia's peak geoscience society. We provide input to broader geoscience issues through the AGC, and we need to ensure that all other forums are identified and used.

We can be influential; we have done this in the recent past. We have members in all sectors of the industry – industry, academia and government. We need to become pro-active in making sure our members' expertise is directed to resolving issues that are in the national interest.

Measures of success

1. Our key activities continue to be well supported:
   - Our branches have comprehensive programmes of technical meetings and vibrant social programmes that ensure that their members engage enthusiastically with the Society.
   - Our conferences are well supported by a broad cross-section of the geophysics community, including those overseas.
   - Our scientific publications have a growing (and measureable) Impact Factor.
   - The Society remains financially viable.
2. The Society identifies and helps to implement new ways of delivering geophysics education to a broader base.
3. The Society attracts and retains new members from a broader base of companies, universities and government agencies.
4. The Society becomes a preferred source of advice on matters affecting our industry.

Trade & Investment Resources & Energy

Geological Survey of New South Wales

Gridded and image data sets

new frontiers new south wales

Geophysical data sets

— 1:250 000 Series DVDs

Image and gridded sets of geophysical data have been generated for each 1:250 000 scale sheet within NSW. All 58 sheets are complete and these suites of grids and images (with metadata) are available on DVD for each sheet.

The data imaged in GDA94, MGA, and NSW GDA94 Lambert for each 1:250 000 sheet includes:

Aeromagnetic data

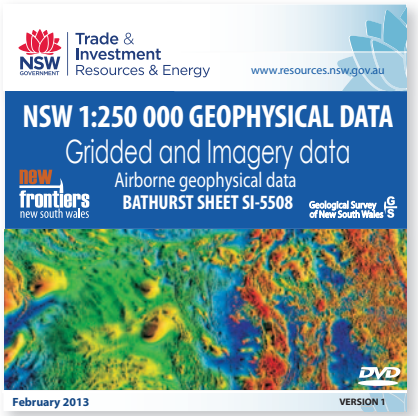
TMI, TMI RTP, 1VD TMI, 1VD TMI RTP, 2VD TMI, Greyscale TMI, Greyscale TMI RTP Tilt Filter, and TMI RTP Over TMI RTP Tilt Filter

Gravity data

Bouguer Gravity, Isostatic Bouguer Gravity, Greyscale Isostatic Bouguer Gravity Tilt Filter, and Isostatic Bouguer Gravity Over Isostatic Bouguer Gravity Tilt Filter

Radiometric data

Ternary K/U/Th



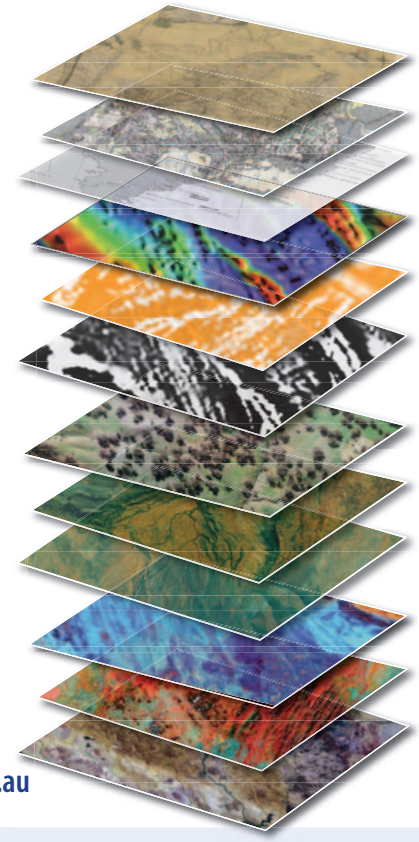
Additional

DEM, Landsat-7 Principal components 1, 2 & 3

The imagery for each sheet was compiled in the following formats:

- Gridded Data (.ers)
- ECWs
- Geo-rectifed Tiffs (GeoTiffs), and
- Geo-rectified JPEGs

For further enquiries, please contact:
geophysics.products@industry.nsw.gov.au



statewide data sets

Maps and data sets of statewide geophysical coverage are available as digital data (4 DVD set), and in hardcopy as flat posters or as folded maps at 1:1 500 000 scale.

Statewide data sets

dvds

Pricing

- Statewide grids and images for aeromagnetic, radiometric, gravity and SRTM (elevation) data are available as 4 DVD set $110
- Hardcopy statewide images $19.80 each

Available through shop.nsw at
www.shop.nsw.gov.au
or complete the order form on the back page

New members

The ASEG extends a warm welcome to the 22 new individual members approved by the Federal Executive on 22 August 2013 (see table).

Name	Organisation	Country	Member grade
Nikolce Aleksieki		Australia	Student
Jonathan Conti		Australia	Student
Nicholas Gale		Australia	Student
Kiran Grewal	Western Geo/Schlumberger	Australia	Active
William Hsin		Australia	Student
Sandy Jones		Australia	Student
Jack Kavanagh		Australia	Student
Duy Kieu		Australia	Student
Anthony Lanati		Australia	Student
Trisna Lea		Australia	Student
Hilary Mau		Australia	Student
Colleen McMahon		Australia	Student
Mateus Meira		Australia	Student
Janenie Mohgan		Australia	Student
Daniel Ogburn		Australia	Student
Simon Owen		Australia	Student
Benjamin Patterson		Australia	Student
Lynn Pryer	Frogtech	Australia	Active
Matthew Scroggs	Energeo	Australia	Active
Lachlan Smith		Australia	Student
Aaron Tomkins		Australia	Student
Justine Wheeler		Australia	Student

ASEG News

Australian Capital Territory

Wow how time flies. The ACT Branch has been busy trying to dodge political debates while staying active. We had a team compete in the combined societies Quiz Night in July. Unfortunately we didn't do too well as only one round was comprised of geoscience questions. A number of ACT Branch members attended the ASEG conference in Melbourne and thoroughly enjoyed the technical content and catching up with interstate colleagues. The ACT Branch doesn't get the opportunity to host an International Geophysical Conference and Exhibition because we are so small but we are always keen to help the other branches wherever we can. Five members from the ACT Branch assisted the Melbourne Conference Organising Committee by comprising the majority of the technical committee and assisted with sifting through hundreds of expressions of interests and coordinated the reviewing of the extended abstracts.

In late August we were privileged enough to have the SEG Fall Distinguished Lecturer Carl Regone present to us on 'Acquisition modelling: expect the unexpected'. We were very impressed with his work and came away from the presentation very jealous of the modelling codes and computer capabilities that Carl has at his disposal.

By the time this edition of *Preview* goes to print we will have hosted the EAGE Short Course on 'Seismic surveillance for reservoir delivery' by Olav Inge Barkved. Final course registration now sits at 16 attendees, which is better than expected for a small Branch like the ACT.

Coming up we have a technical night in October and then the OzSTEP courses by Dennis Cooke and Michael Asten scheduled for November. We have also challenged Dennis and Michael to a debate on the advantages of having a career in Minerals over Petroleum to entertain and enthuse the students while they are in Canberra. Watch this space for the outcome. We might all learn something!

Carina Kemp

New South Wales

In July, we held our annual dinner. Once again, it was held in a steakhouse; we ate lots of steak, drank lots of red and discussed lots of geophysical and non-geophysical topics. We had a good turnout and a great time was had by all.

In August, we did not hold our regular meeting, but had a joint lunchtime meeting with PESA where Carl Regone the SEG Distinguished Lecturer spoke about seismic acquisition modelling. The lunch and talk were enjoyed by the 40 or so who attended.

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

Mark Lackie

Queensland

The Brisbane Branch has several events coming up in the next couple of months. We are hosting our first OzStep course, 'Introduction to geophysics for explorationists', on 2 October. In November we have SEG HL Valentina Socco and in December Randal Taylor and Stewart Fletcher will be presenting their Conference Presentations to the Queensland Branch.

The Brisbane Branch is always on the lookout for presenters to fill our Technical programme. We invite anybody willing to present to please contact Fiona Duncan (qldpresident@aseg.org.au) and extend this invitation to those passing through Brisbane.

Fiona Duncan

South Australia/Northern Territory

In July, Bronwyn Camac from Santos presented 'Microseismic and 3D VSP for infill evaluation in Greater Tindilpie, Cooper Basin, Australia' at the SA branch technical meeting. This topic was well received as this is a relatively new technique being used for onshore Australian basins.

The ASEG conference was held in Melbourne during August and it was a great opportunity to learn about new techniques and technologies being implemented by geophysicists. Also, it was a good time to network with fellow geophysicists from Australia and around the globe. Back in Adelaide later in August we hosted the SEG distinguished lecturer Carl Regone at a technical luncheon. His talk was titled 'Acquisition modelling: expect the unexpected'.

The wine tasting for this year has also taken place. This was an excellent social evening for ASEG members and sponsors. The two winning entries were the 2010 Pertaringa 'Understudy' Cabernet/Petit Verdot and the Sevenhill 2012 lnigo Riesling. To order, simply fill out the order form in *Preview* (see p. 52) or order through the ASEG website.

Upcoming events include the SA/NT branch Industry Evening in September, which this year will be focused on unconventional resources with representatives from Beach Energy, Santos, Petrofrontier and DMITRE. In October the SA branch will be hosting the OzSTEP course, 'Interpreting seismic amplitudes', which will be presented by Dr Dennis Cooke.

The Queensland Branch recently enjoyed a visit by SEG DL Carl Regone.

Everyone is invited to our upcoming events and for further details please check out the ASEG website www.aseg.org.au or contact sa-ntpresident@aseg.org.au. Also, if you have a presentation that you would be interested in giving to the SA branch please feel free to contact us.

Erin Shirley

ASEG Victorian Branch Technical Meeting with Carl Regone at The Kelvin Club, Melbourne.

Victoria

For the past 18 months the majority of the efforts of the ASEG Victoria Branch Committee have been focussed on the planning and execution of the ASEG-PESA 2013 conference, with the entire Branch Committee each having roles as co-chairs and sub-committee chairpersons on the ASEG-PESA 2013 conference organising committee!

Nevertheless, in the same period the ASEG Victoria Branch has hosted 15 events – of these 12 were technical meetings and three were joint PESA-SPE-ASEG social events. In addition, we have worked closely with the PESA Victoria/Tasmanian Branch, offering reciprocal joint access to our respective monthly meetings, whenever these have been on a geophysical petroleum theme. Approximately six of the monthly PESA lunch meetings have been hosted jointly in the past 18 months.

On Thursday 16 May 2013 we welcomed Federal ASEG President Koya Suto presenting 'Multichannel analysis of surface waves and its applications in Australia' at RMIT, Melbourne City Campus.

On Wednesday 7 August 2013 the ASEG Victorian Branch co-hosted the 'Annual ASEG-PESA-SPE Mid-winter Social' with drinks, nibbles and plenty of networking opportunities at Renzo's Bar in Melbourne's Docklands.

Following the ASEG-PESA 2013 conference, on Thursday 22 August 2013 visiting SEG Distinguished Lecturer Carl Regone presented 'Acquisition modelling: expect the unexpected' for a crowd of geophysical enthusiasts at The Kelvin Club.

We look forward to seeing many ASEG Victorian Branch members at the upcoming meetings of the 2013 Spring season:

In early October Theo Aravanis from Rio Tinto Exploration will be presenting an introduction to the work of the Ground Geophysical Survey Safety Association (GGSSA).

On Wednesday 30 October 2013 we plan to run the two OzSTEP one-day courses, 'Interpreting seismic amplitudes' by Dennis Cooke and 'Introduction to geophysics for explorationists' by Michael Asten at the Crowne Plaza Hotel in Melbourne's CBD.

On the evening of Wednesday 30 October 2013 it is time again for the 'Annual Student Night'! Come in and learn what the next generation of exploration geophysicists from The University of Melbourne, Monash University and RMIT are getting their teeth into for their Honours and PhD projects. This is one night when we expect to see many ASEG Victorian Branch members, as the students put tremendous efforts into these presentations.

Asbjorn Norlund Christensen

Western Australia

It's been a busy few months since the last WA update back in May. Suddenly August was upon us and it was off to Melbourne for the ASEG-PESA 2013 conference. Congratulations to Asbjorn, Jarrod and the Victorian team for a highly successful event. Organising for Perth 2015 is now full steam ahead. The confirmed dates are 15–18 February 2015; think about booking your accommodation early! The website was launched at the Melbourne closing ceremony so check it out now and make sure you register your interest to receive all of the conference updates: www.conference.aseg.org.au.

We've had a run of seismic-related Tech Nights since June. Greg Turner from HiSeis presented on hard rock applications of seismic, which was followed in July with Vincent Kong of WesternGeco talking about Seismic illumination on tight reservoir fractures and faults. Thank you to both HiSeis and WesternGeco for kindly sponsoring these talks.

In August, we took the opportunity to have SEG Distinguished Instructor David Johnston (ExxonMobil) give an evening lecture on 'Generating opportunities and deriving value with 4D seismic data' ahead of his short course 'Making a difference with 4D: practical applications of time-lapse seismic data' the following day, which was well attended by over 50 people. Thank you to the generous sponsorship from Woodside Energy for sponsoring David's lecture and the workshop. We wrapped up August with another touring SEG Distinguished Lecturer, this time Carl Regone who presented on acquisition modelling.

The WA Branch has been actively getting involved with students at both high school and university level. We hope to build the profile of exploration geophysics and showcase all the fantastic career opportunities out there. In late June, I attended the Girls Day at this year's Get Into Mining event held at Central TAFE in Perth. At this event, high school students get to hear from a wide range of mining professionals as well as get involved in interactive activities related to the various disciplines. In July, we teamed up with the WA branches of the AIG and PESA at the Hale–St Mary's Careers Night for the second year running. However, the careers event of the year was on 26 August with the Careers in Geoscience night. This was an amazing afternoon and evening with record numbers of students attending the new venue at Technology Park near Curtin University (see p. 30). We'll be posting updates for the 2014 event on the ESWA (Earth Science WA) events website (http://www.earthsciencewa.com.au/course/view.php?id=30).

For good measure, we're rounding off the year with just a few more seismic-related talks with Milovan Urosevic from

ASEG News

Curtin University presenting several case studies on hard rock seismic applications on 11 September and Tobias Mueller from CSIRO on Seismic rock physics and poroelasticity theory for our final Tech Night for 2013 in October. But don't worry fellow minerals and near-surface geophysicists, we'll be sure to schedule some talks for you in 2014. You can of course always let us know if you have any suggestions or would like to present something yourself. Just drop me a line at wapresident@aseg.org.au.

But before we completely wrap up 2013, which will be over pizza and a few end-of-year drinks at City Farm in East Perth this year, we'll hear from our young up and coming geophysics students at the November meeting who'll present on their Honours and Masters research topics.

For all our upcoming talks and events, check out the calendar here. Events are also posted on the ASEG website. And to make sure you never miss out, sign up to the WA mailing list at http://eepurl.com/nleOD or follow the QR link below to receive notifications and online registration details for WA news and events.

Anne Tomlinson

Date	Event	Presenter	Time	Venue
9 October	Tech Night: Seismic rock physics and poroelasticity theory	Dr Tobias Muller, CSIRO, Perth	1730–1930	City West, West Perth
30 October	Annual Student Night		1800–2000	Melbourne
13 November	Student Presentation and ASEG WA Awards Night		1730–1930	City West, West Perth
11 December	AGM and Christmas Party		1730–2030	City Farm, East Perth

ASEG introduces OzSTEP!

To promote further education and give better value to our members, the ASEG is proud to launch the OzSTEP (Specialists Travelling Education Programme) in October–November 2013. These are one-day training courses presented by local experts on topics relevant to those working within the geophysics industry in Australia. There will be two courses on offer: one presenting topics relevant to the petroleum industry and the other relevant to the minerals industry in geophysics. Courses will be offered to all state branches to host for their members as appropriate, in addition to non-members at an additional cost and promoted to students at subsidised rates.

To kick-off the OzSTEP inaugural year, our presenters this year will be Dennis Cooke, Petroleum, and Michael Asten, Minerals (see table below and OzSTEP flyer next page). Most of the courses will be offered in October and November this year. If you want to do a course and your branch is not offering it, please contact them to register your interest! As our presenters are local the courses can be offered at other times by arrangement.

Requests from members for 2014 topics or presenters are encouraged. Please send suggestions to continuingeducation@aseg.org.au. For further details of this year's courses please check the ASEG website (http://www.aseg.org.au/) or contact your local ASEG state branch.

State	Michael Asten: Introduction to Geophysics for Explorationists	Dennis Cooke: Interpreting Seismic Amplitudes	Cost[A]	Course venue
ACT	Wed 20 Nov 2013	Tue 19 Nov 2013	ASEG member: A$220	Geoscience Australia: corner Hindmarsh Drive and Jerrabomberra Avenue, Symonston
QLD	Wed 2 Oct 2013	No	ASEG member: A$270	Irish Club: 175 Elizabeth Street, Brisbane
SA	No	Thu 17 Oct 2013	ASEG member: A$295	Hotel Richmond: 128 Rundle Mall, Adelaide
VIC	Wed 30 Oct 2013	Wed 30 Oct 2013	Non-ASEG member: A$549 ASEG member: A$399 Student ASEG member: A$99	Crowne Plaza Hotel: 1–5 Spencer Street, Melbourne
WA	No	Tue 8 Oct 2013	A$300	Technology Park Function Centre: 2 Brodie-Hall Drive, Bentley, Perth

[A]Non-member pricing and subsidised student rates are available. Non-member price includes 1-year membership via application.

ASEG Specialist's Travelling Education Programme (OzSTEP)

ASEG one-day short course: Minerals

Introduction to Geophysics for Explorationists

Instructor: Professor Michael Asten

To book, please contact your local ASEG State Branch or visit the ASEG website: www.aseg.org.au.

Instructor biography

Professor Michael Asten is a consulting geophysicist and Partner with Flagstaff Geo-Consultants in Melbourne, and holds a part-time academic position as Professorial Fellow at Monash University. He majored in physics, geology and geophysics at the University of Tasmania before entering postgraduate study at Macquarie University in 1972. After excursions into magneto-tellurics and DC electrical methods he gained a PhD in geophysics on the topic of using micro-seismic waves as a tool for studying sedimentary basins. In 1977 he took up an appointment lecturing and coordinating a MSc (geophysics) programme at Ahmadu Bello University in Nigeria. He then joined BHP Minerals in 1979 and worked in coal and base-metal exploration in Australia, East Africa and North America. He has been active in EM research, initiated the airborne gravity gradiometer project in BHP and has conducted numerous industry short courses on EM methods at various levels. He is a Past President of the ASEG (2009–2010) and an Associate Editor for the SEG.

Who should attend?

Geophysicists seeking to add breadth to and geologists wanting basic insights of their understanding of geophysical methods.

Topics include:

Session 1:
- Opening discussion: background to course and scope
- Introduction to physical properties of rocks and geophysics
- Magnetic methods
- Problems with remanence and low latitudes

Session 2:
- Gravity methods
- Airborne gravity gradiometer
- Radiometric methods

Session 3:
- Resistivity methods and induced polarisation
- Gradient array IP
- Gradient array MMR (SAM)
- CSAMT

Session 4:
- Introduction to electromagnetic methods
- Ground EM surveys
- EM interpretation exercise
- Conductivity-depth images and map images
- Air EM: methods and case histories
- Borehole EM methods and examples

ASEG one-day short course: Petroleum

Interpreting Seismic Amplitudes

Instructor: Dr Dennis Cooke

To book, please contact your local ASEG State Branch or visit the ASEG website: www.aseg.org.au.

Instructor biography

Dr Dennis Cooke has accumulated over 25 years of experience in the oil and gas industry, working in research, seismic acquisition, technical service provision and as an interpreter doing field development and new ventures. His experience includes interpretation projects in North America, the Gulf of Mexico, Indonesia and South-East Asia, Alaska, Australia and New Zealand. At present, he divides his time between consulting, the University of Adelaide and research into unconventional reservoirs at the Australian School of Petroleum. Dr Cooke is Past President of the ASEG and is currently serving as Vice President of the SEG.

Who should attend?

Oil and gas prospect generators who want to interpret lithology and reservoir fluids from seismic amplitudes and amplitude versus offset (AVO) attributes.

Topics include:

- Acoustic impedance and impedance contrasts
- Reflection coefficients and the convolutional model
- Polarity conventions
- Thin beds and seismic tuning
- Reservoir porosity and seismic amplitude
- Soft-over-hard reservoirs versus hard-over-soft reservoirs
- Amplitude and phase spectra of seismic source wavelets
- Enhancing frequency content in processing
- Expanding frequency content in acquisition
- Optimising colour display of seismic amplitudes
- How oil and gas replacing water changes reservoir impedance and Poisson's ratio
- Amplitude maps from 3-D surveys and the importance of conformance between amplitudes and structure
- Interpreting reflectivities versus interpreting impedances
- Post-stack seismic inversion: inverting for acoustic impedance
  - Phase rotation/run-sum inversion
  - Model-based inversion
- Relative versus absolute impedances
- Pre-stack seismic inversion: inverting for acoustic impedance and Poisson's ratio (or other similar properties)
- Making sense out of 'competing' AVO techniques
  - gradient and intercept/fluid and lithology factors/AI and PR/AI and SI/$\lambda\rho$ and $\mu\rho$/elastic impedance/extend elastic impedance
- Two-term and three-term AVO
- Depth trends for acoustic impedance and Poisson's ratio

Prerequisites

This course aspires to be as non-mathematical as possible by using figures rather than equations to explain concepts. Instruction includes numerous examples of modern 3-D seismic data. Also includes a review of basic concepts and discussion of advanced concepts of seismic inversion and AVO.

ASEG-PESA 2013 post-conference epilogue

The 23rd ASEG-PESA Geophysical Conference and Exhibition has finally been and gone and from the feedback we've received it sounds like the attendees had a very enjoyable week of geophysical learning. Certainly in combing through the many photographs taken, I was struck by the many smiling faces and have tried to combine a few happy snaps into a montage to provide a little memento of the week.

As a 'seismic' person, I was also impressed by the noise levels encountered at the evening social functions, which I 'interpret' to mean that much positive networking was also done. Our notorious weather barely showed, but we're sure that the umbrellas given as speaker gifts will come in handy next time you visit Melbourne.

Some quick statistics from the event, for those who missed it:

- 876 participants from 35 nations (by residency)
- 82 exhibitors
- 197 oral papers and 56 posters (now available via http://www.publish.csiro.au/nid/267.htm)
- 24 keynote presentations
- 18 workshops (including three field classes)
- 6 social events
- 17 scheduled society or business meetings.

Some personal highlights were the inaugural presentation of the Shanti Rajagopalan memorial award, the technical programme (especially the keynotes that were clearly well appreciated, judging by how quiet the exhibition area became when they were on) and the gala dinner talk by Professor Geoffrey Blainey at the NGV. It was also great to see some very high-tech kit on display in the exhibition hall (some examples can be seen in the montage).

View across the Yarra of the conference venue (exhibition hall to the middle right) ahead of the icebreaker. Not a cloud to be seen!

The compact nature of the venue helped to increase delegate interaction and the healthy lunches also showed some culinary flair. But most of all, I was impressed that so many people came and supported the conference given the relatively tough times for the minerals sector and a poorly consolidated conference landscape on the petroleum side.

The conference came together through the efforts of a large group of volunteers working in conjunction with our professional conference organiser Arinex. Several members of our committee took on significant workloads in order to directly improve the financial bottom line of the conference, which had initially looked quite grim. We were able to minimise the price of workshops and the gala dinner by taking on the full burden of the logistical effort. These efforts were rewarded by the high levels of attendance achieved at these events.

Members of the ACT branch helped to shape the technical programme after a record number of 'expressions of interests' were received. This also provided a wider pool of expertise for construction of the programme than would have been possible otherwise. Invited keynotes and session chair people volunteered their time and effort without hesitation when requested. The conference would not be sustainable without the support of our many sponsors and exhibitors, and I'd like to particularly acknowledge our platinum sponsor WesternGeco and our gold sponsors Rio Tinto and CGG.

The Technical Program Committee ASEG-PESA 2013, ACT Branch. (L to R) Yvette Poudjom Djomani, Carina Kemp, Peter Milligan, Ron Hackney and Ross Costelloe. Melbourne Committee members (not shown): Michael Asten (Chairman) and Jarrod Dunne.

I would like to thank those referred to above for their efforts in serving or supporting the ASEG and PESA. So it's over and out from Melbourne! Best of luck to the Perth organising committee!

See you in Perth in 2015!

Jarrod Dunne (Co-chair Petroleum)

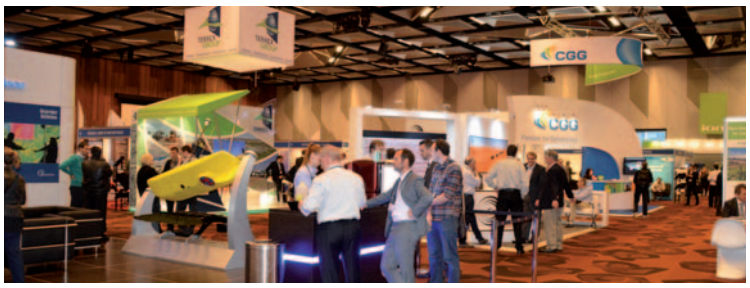
The Melbourne conference organising committee relaxing (finally!) after the closing ceremony. (L to R) Jarrod Dunne (Co-chair), Theo Aravanis (Finance), Merrie-Ellen Gunning (AV), Suzanne Haydon (Publicity), Justin Ward (Conference CD), Mark Dransfield (Sponsors), Séda Rouxel (Social), John Theodoridis (Social), Asbjorn Christensen (Co-chair), Michael Asten (Technical). Absent: Bob Smith (Workshops), Mark McLean (Workshops), Richard MacRae (Exhibition) and Jim Macnae (Students).

ASEG-PESA 2013

'THE EUREKA MOMENT'

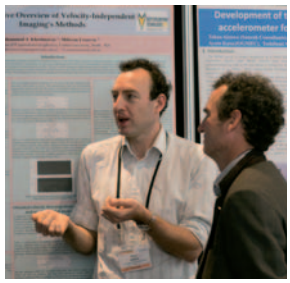
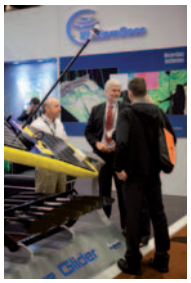
11-14 AUGUST 2013 • MELBOURNE, AUSTRALIA











ASEG Honours and Awards citations

Honorary Membership of the ASEG: Michael Asten

Honorary Membership of the ASEG, for distinguished contributions by a member to the Society and the profession over many years, has been awarded to Michael Asten. Michael is well known to most members of the ASEG through his professional and research work, and his contributions to the ASEG for over 20 years, in particular for his work on the Federal Executive and ASEG Publications.

Michael is currently Professor (Research) in the School of Geosciences at Monash University, and Consultant with Flagstaff Geoconsultants, prominent both in academia and the industry. He is a graduate of University of Tasmania and received a PhD from Macquarie University. His past positions include Lecturer at a university in Nigeria and Senior Principal Geophysicist at BHP.

Mike's interest in geophysics is broad. His expertise includes potential fields, electric, magnetic, electromagnetic and passive seismic methods. He is a regular presenter at ASEG conferences, in which he was awarded the Laric Hawkins Award for most innovative paper on two occasions.

Mike's service to the ASEG is extensive. The list includes:

- Technical Co-Chairman of the 1989 ASEG conference in Melbourne
- ASEG Federal Executive 1992–1995; as Vice President during this time, he took the role of Publications Chairman
- Co-Chair of the 1998 ASEG conference in Hobart
- Sponsorship Chairman for the 2006 Conference in Melbourne
- ASEG Federal Exec 2008–2013, including a term as President 2009–2010
- Technical Chairman for the 2013 Conference in Melbourne.

Mike has been an Associate Editor of SEG's journal *Geophysics* for a number of years, and served as the volume editor of SEG's Monograph 12, 'The microtremor survey method'. More recently he assisted with the joint SEG-ASEG publication of the Isles-Rankin publication *Geological Interpretation of Aeromagnetic Data*.

During his second period on the Federal Executive, Mike continued working on publications and liaised with our partner societies. He negotiated with SEG for a digital cumulative index and internet access to papers in *Exploration Geophysics*, and was instrumental in initiating the joint publication of the journal with SEG Japan and Korean SEG. He has been a driving force in establishing *Exploration Geophysics* as an internationally recognised journal with a steadily increasingly impact factor.

For his long-standing contributions to and achievements in research and practice of geophysics and the long-term commitment to the ASEG, Mike is a most worthy and distinguished recipient of Honorary Membership of the ASEG.

Honorary Membership of the ASEG: Phillip Harmon

Honorary Membership of the ASEG, for distinguished contributions by a member to the Society and the profession over many years, is conferred upon Phillip Harman.

Phil has been an active member of the ASEG since its founding in 1971 and has served the society well over his 40-plus years of membership. He holds an Honours degree in geology and geophysics from the University of Sydney. Phil has also achieved high status in the Australian business community and is a member of the Australian Institute of Company Directors.

Phil was Chief Geophysicist at BHP Minerals during 1982–1989, notable for his coal-related seismic R&D largely carried out for BHP coal companies in NSW. As Chief Geophysicist he scoped and led the development of the BHP proprietary precursor system to the Intrepid software package, the development of which was the direct result of his passion to make geophysical interpretation more geological. He held a variety of exploration management positions in BHP including: Exploration Manager Western Australia 1989–1992; Manager Exploration South America 1992–1997; Manager Exploration Services 1997–1999; and Manager Falcon Deployment 1999–2001. Phil played an influential role in the commitment by BHP Billiton to the R&D programme, which resulted in the development of the FALCON Airborne Gravity Gradiometer. He was subsequently responsible for commercialising the technology out of BHP Billiton into Gravity Capital Limited, from which a number of companies were created. He has substantial experience in the junior exploration sector and holds a number of company directorships.

Phil's contributions to the development of the profession through his work with the ASEG Research Foundation (ASEGRF) are especially noteworthy. The ASEGRF was established in 1989 to address the decline in student enrolments in exploration geophysics. The overall aim of the ASEGRF is to attract high-calibre students into exploration geophysics and thus ensure a future supply of talented, highly skilled geophysicists for industry. Phil has served as Chairman of the ASEGRF for over 12 years from 2001 to the present. He has been a very effective spokesman for the Foundation resulting in continuing funding support from industry and individuals, as well as the ASEG itself. This funding has been essential for the functioning and success of the Foundation.

Phil has also served on the ASEG Federal Executive, including President in 2010–2011. In addition to this, Phil has been an effective ASEG Representative to the Australian Geoscience Council for the years 2010 and 2011. He is also a Director of the Deep Exploration Technologies Cooperative Research Centre (DET CRC) where he has the role of advancing the commercialisation of DET technologies that will effectively open up new exploration search space at depth.

Phil is known as a persuasive and straightforward communicator and is thereby highly respected in the geophysical and resource community. The ASEG is pleased to acknowledge Phil's significant contributions to the Society and the profession with the award of Honorary Membership of the ASEG.

The Lindsay Ingall Memorial Award: James Patrick (Pat) Cunneen

The Lindsay Ingall Memorial Award honours the memory of Lindsay Ingall for his capacity to cross geoscience boundaries and for his enduring commitment to assist geoscientists across Australia. It is awarded to an individual who has actively promoted geophysics to the wider community.

The Lindsay Ingall Memorial Award for 2013 is made to Pat Cunneen, who is well known to all Australian geoscientists primarily as a corporate leader and innovator in airborne geophysics, but he is just as well known through the broader community as a passionate advocate and

promoter of geophysics and the resources industry.

Pat commenced his career in geophysics at age 20 working on geophysical ground crews as a field technician. He soon found a keen interest in the potential of airborne geophysics through his work with AMEG and Scintrex. This led to creation of Aerodata in 1977 where he was Managing Director. The company became a world leader in airborne geophysics acquisition and interpretation. Pat was passionate about the use of airborne geophysics for all sorts of applications, not just the mineral industry. He projected this passion as well as innovation and a can-do attitude to staff, clients and the wider community, which created a strong innovative culture at Aerodata and its subsidiary World Geoscience Corporation.

In 1995 Pat was responsible for bringing together leading airborne geophysical companies into the International Airborne Geophysics Safety Association (IAGSA), a non-profit association supported by its members, and whose mandate is to promote and enhance safety in the airborne geophysics survey industry.

Pat also strongly advocated the promotion of geophysics to students. When asked to sponsor the 1995 ASEG Conference, Pat instead offered to create and sponsor the first ASEG student day. This student day has since continued at every conference and helped fulfil Pat's ambition to promote geophysics to young people for the future development of the profession.

Environmental work especially saw Pat promoting the value of geophysics to politicians, governments, the media and environmentalists. Pat never missed an opportunity to talk to the media. Perhaps the classic moment was a well-publicised offer to survey Muroroa Atoll for radioactive fallout following the French nuclear tests. His offer was debated in Federal Parliament and reported on the nightly news. The French declined the offer, but the British nuclear test site at Maralinga was flown, with the startling radiometric results published in full colour in *The Age* newspaper.

Throughout the years at World Geoscience Pat projected his passion for the use of geophysics in the fight against salinity. He would harangue scientists, farmers as well as state and federal politicians on the benefits of airborne geophysics to map the causes of salinity. He also saw the advantages of geophysics in the search for fresh water and spoke to numerous governments on how airborne geophysics was a tool for water exploration. Pat saw no limit to the use of geophysics and recognised the lack of utilisation of airborne geophysics in the oil and gas industry in the 1990s.

Throughout his career, Pat has been devoted to the development and promotion of airborne and ground geophysics to the non-geophysical community. He has promoted the science endlessly across the world to a diversity of people, from the geologist to the student, the farmer, the media, the engineer, the hydrologist and the environmentalist, as well as to politicians and governments, and even to the person quietly sitting having a beer at the bar. And every time they would get a lesson in geophysics and how it could be used to help benefit their lives; new ways geophysics could be applied or solve a problem they may have.

Through Pat's leadership, his companies Aerodata Holdings and World Geoscience Corporation received numerous community awards, including: Western Australian Company of the Year 1993; Western Australian Exporter of the year (Services) 1994; Australian Exporter of the Year (Services) 1994; Australian Landcare Research Award 1995; and Diggers and Dealers Technical Services Award 1996.

Pat was awarded the Cecil Green Enterprise Award in 2002 by the SEG, recognising the importance of an individual enterprise to the economic vitality of our industry. It is now fitting that, through the Lindsay Ingall Memorial Award 2013, the ASEG acknowledges Pat Cunneen's significant achievements to our profession and his continued support and promotion of geophysics to the broad community.

The Lindsay Ingall Memorial Award recipient, James Patrick (Pat) Cunneen (L), with ASEG President, Koya Suto (R).

Early Achievement Award: Cara Danis-Jacques

The Early Achievement award has only been awarded one other time since its inception in 2007. Its purpose is to acknowledge significant contributions to the profession at an early stage in a person's career by way of publications in *Exploration Geophysics* or similar reputable journals.

The Early Achievement award is made this year to Cara Danis-Jacques. Cara, at a relatively young age, has published two papers in *Exploration Geophysics* and another four in the *Australian Journal of Earth Sciences*, all during or immediately following her PhD. Her two papers in *Exploration Geophysics* are respectively the 5th and 6th most read papers in that journal, showing that she is very effectively communicating her research findings.

Cara gained a high First Class Honours for her undergraduate degree at Macquarie University in 2007. During this time she was awarded two academic prizes, one for 'Best Performance in Geophysics' and the other for 'Best Performance in the Study of Natural Hazards'. Cara was also awarded the DI Groves Medal in 2012 for Best Paper by a Young Author in the *Australian Journal of Earth Sciences*.

Cara completed a PhD at Macquarie University in 2012, submitting a thesis entitled 'The thermal structure of the Sydney Gunnedah Bowen Basin Eastern Australia'. Cara's publications, either solely or with others, are not only on the topic of her PhD but also on the implication of 2.5-D structure to retrograde metamorphism and the geothermal state of the Sydney Basin. Thus, they show a breadth as well as depth to her interests.

Cara has presented her work at conferences both in Australia and overseas, including the ASEG conferences in Sydney in 2010 and Brisbane in 2012, the Groundwater 2010 conference in Canberra, as well as international conferences such as the AGU conference held in San Francisco in 2010. In 2010, Cara won the Best Student Presentation at the Sydney ASEG conference.

Cara is a dynamic young scientist who has already developed an excellent track record and it is hoped that gaining this award will encourage her to forge an outstanding career in exploration

geophysics. Cara is a most worthy recipient of the ASEG Early Achievement Award.

Grahame Sands Award: Malcolm Cattach, Keith Mathews, Michael Swensson, Edward Campbell and Symon Bouwman (Gap Geopak Pty Ltd)

This award is based on an endowment made by members of the ASEG and the geoscience profession in memory of the late Grahame Sands, who was tragically killed in the prime of his life in an aircraft crash in 1986, while developing and testing new equipment for geophysical survey aircraft. Because of Grahame's abilities to turn scientific theory into innovative application, the award is made for innovation in applied geophysics through a significant practical development of benefit to Australian exploration geophysics in the field of instrumentation, data acquisition, interpretation or theory.

The Grahame Sands Award for 2013 is made to Malcolm Cattach and his team from Gap Geopak Pty Ltd for the development of the HPTX-70 high-power geophysical transmitter. The project team comprises Malcolm as Project Leader, Keith Mathews (Chief Engineer), Michael Swensson (Principal Electronics Engineer), Edward Campbell (Software Engineer) and Symon Bouwman, who was responsible for much of the intricate manufacture of the HPTX-70.

The HPTX-70 has been an innovative and practical development in terms of performance and safety and is likely to have an important role in the future of exploration geophysics as safety compliance and the need for deeper exploration become greater requirements for companies to operate successfully. Users of the transmitter have been impressed with the level of engineering and the attention to detail in the design that has set a new benchmark for safe and efficient operation.

The large increase in power provided by the HPTX-70 has resulted in improved acquisition times and data quality and companies that have used the system claim it has been integral in the discovery of a number of deep zones of massive sulphide hitherto undiscovered beneath known ore deposits.

The HPTX-70 is now acknowledged as a large step forward for mineral exploration in terms of safety, efficiency and exploration success at greater depths. The ASEG is pleased to present the Grahame Sands Award for 2013 to Malcolm Cattach and his team of researchers, engineers and technicians.

ASEG Service Medal: Peter Priest

The 2013 ASEG Service Medal, for outstanding and distinguished service to the ASEG, has been awarded to Peter Priest.

Peter is an Adelaide-based practising accountant who has provided many years of service on a voluntary basis to the ASEG as Honorary Treasurer of the ASEG Research Foundation. He has continued this role since the inception of the Research Foundation in 1989 to the present, a period of nearly 25 years.

Peter is well known to many ASEG members and initially became involved through a personal friendship with two former ASEG Presidents, Bob Smith and Terry Crabb. Peter helped to establish the ground rules under which the Research Foundation would function, in particular those relating to tax, and since then he has steadfastly maintained the Foundation's books for compliance purposes and has managed the banking along with the payment of grants to recipients.

On an entirely voluntary basis, Peter has attended the majority of general meetings of the Research Foundation that are held to coincide with the ASEG's conferences. Peter has also ensured that the Research Foundation has lived entirely within its means, not an easy job in the face of an enthusiastic committee.

The Award of an ASEG Service Medal in this case is somewhat unusual because Peter is not a member of the ASEG. However, largely due to Peter's much understated and invaluable contribution to the Research Foundation over many years, and the strong endorsement by all those who have worked closely with Peter in the Research Foundation – current and previous Chairmen Phil Harman, Joe Cucuzza and Bob Smith, and Doug Roberts who has served as Secretary since the formation of the Foundation – the Federal Executive decided during 2012 to allow non-members to be eligible under exceptional circumstances for ASEG service awards. It is most fitting that the first non-member to receive this award is Peter Priest, who deserves our recognition and whole-hearted thanks.

ASEG Service Medal recipient: Peter Priest (centre). Foreground (L to R): Nick Sheard, Terry Crabb and Robert Smith. Celebrations at the Conference Dinner.

ASEG Service Certificate: Andrea Rutley

An ASEG Service Certificate for distinguished service by a member to the ASEG is awarded to Andrea Rutley. The award is made primarily for Andrea's significant contributions to the organisation and running of ASEG conferences over many years, and her contributions to the ASEG Federal Executive.

Andrea was a member of the 2001 ASEG Brisbane Conference Organising Committee (COC). As is the tradition, one member of the most recent COC joins the Conference Advisory Committee (CAC). This role fell to Andrea in 2001 and she continued as a member of the CAC for 10 years to 2011. Andrea also served on the ASEG Federal Executive from 2008 to 2011 as Vice-President in charge of conferences.

During this time she had the difficult job of being the interface between the Federal Executive and the organising committees of the 2009 Adelaide and 2010 Sydney conferences. Andrea used her excellent inter-personal skills to facilitate good interaction between the COC, CAC and Federal Executives, all of which present different interests and priorities for the organisation and outcomes of the conferences.

Initially the ASEG had not planned to hold its own conference in 2012 due to the International Geological Congress (IGC34) planned for Brisbane that year. Andrea became the ASEG representative to the IGC34, attending numerous organising meetings. When it became clear that it would be worthwhile for the ASEG to host its own conference in Brisbane in early 2012, Andrea also became Co-chair of the ASEG 2012 Conference, which involved more input due to the shorter preparation time allowed.

As Co-chair she was responsible for negotiating on a regular basis with the professional conference organiser and many other stake holders. She and fellow co-chair Wayne Mogg led the Brisbane 2012 COC to a very successful conference. The ASEG 2012 conference was also a financial success, bringing a good surplus to the ASEG's funds.

Andrea has enthusiastically supported and contributed to the ASEG for many years and is a worthy recipient of the ASEG Service Certificate.

ASEG Service Certificate: Patrick (Pat) Hillsdon

An ASEG Service Certificate for distinguished service by a member to the ASEG is awarded to Patrick Hillsdon for his valuable contributions over many years to ASEG conferences, as Chairman or Co-Chairman of the Exhibition Sub-Committee at ASEG conferences held in Sydney. Pat also served on the Federal Executive as an ASEG 1st Vice President 1981–1982, and has been an active member and supporter of the NSW Branch for over 30 years.

Pat started his career in geophysics with BHP's Exploration Division, undertaking a wide variety of surveys throughout Australia. He then joined Tony Cram at Engineering Computer Services in Bowral for 26 years of innovative geophysical data processing, marketing and training. During 2005 and 2006, Pat worked in Indonesia and Mozambique with SRK Consulting, before illness led to retirement to his home in Bowral, NSW.

Pat served on the organising committees for ASEG-PESA conferences held at the Sydney Conference and Exhibition Centre, taking on the onerous role of Co-Chair or Coordinator of Exhibitions on no fewer than four occasions: 1991, 1997, 2004 and 2010. The conferences are a major source of revenue for the ASEG and the Exhibition is always a substantial contributor to financial success. Pat had a strong understanding of the fine details of exhibition management and always sought to ensure that exhibitors saw every ASEG event as both personally and commercially rewarding. The ASEG mechanism for priority of booth allocation is a complex and sensitive process and Pat always brought consistency to this challenging task, further contributing to exhibitor satisfaction. He also maintained strong working relationships with the Professional Conference Organisers to ensure smooth running of bookings, payments, notices, instructions and all logistic arrangements.

Dave Pratt noted that Pat never sought the spotlight or accolades because he has always been a private, but welcoming member of our community. Nothing was ever a problem for him, the only thanks he wanted was a quiet beer at the local pub.

Pat Hillsdon has been a great ambassador for the ASEG and the award of the ASEG Service Certificate is but a small thanks for the valuable contributions Pat has made to the ASEG over many years.

Inaugural Shanti Rajagopalan Memorial Award: First Recipient – Cara Danis-Jacques

At the 2013 Conference Opening Ceremony, ASEG President Koya Suto had much pleasure in announcing and presenting the inaugural Shanti Rajagopalan Memorial Award in memory of the late Dr Shanti Rajagopalan.

The award is to be presented at each ASEG conference for the best paper published by a student in *Exploration Geophysics* in the period prior to each ASEG conference. President Suto outlined the background to the naming of the award in memory of Shanti, who passed away in 2010 at age 49 after a long battle with cancer. Shanti was one of the best known and respected members of the ASEG and was well known within the geophysical profession for her outstanding contributions and service to the profession and the ASEG.

Shanti was a major contributor to the advancement of the Society in many ways. She was President of the Victorian branch in 2001 and 2002 and was involved in organising the first ASEG conference held in Hobart. As well as being an Associate Editor of *Geophysics* from 1998 to 2009, she took on the role of Managing Editor of *Exploration Geophysics* in 2000 and 2001.

It is particularly noteworthy in the context of this new award that Shanti came to the attention of many ASEG members in 1987 when, as a student member, she was awarded the inaugural Laric Hawkins

Inaugural Shanti Rajagopalan Memorial Award ceremony held in memory of the late Dr Shanti Rajagopalan. Present are Shanti's husband Andrew (centre) and daughter Janaki (L). Award recipient, Cara Danis-Jacques (front L), with ASEG President, Koya Suto (front R).

Shanti Rajagopalan Memorial Award and Early Achievement Award recipient, Cara Danis-Jacques (L), with ASEG President, Koya Suto (R).

Award for the most innovative use of a geophysical technique from a paper presented at the ASEG conference. It is therefore very appropriate that an award to encourage technical excellence by our student members should be named in honour of Shanti, thus recognising not only Shanti's enormous contribution to our profession, but also the example she set to all young geophysicists.

It was particularly pleasing that Shanti's husband Andrew and daughter Janaki were present at the award ceremony to present the inaugural Shanti Rajagopalan Memorial award.

The recipient of the Shanti Rajagopalan Memorial Award for 2013 and cash prize of $1000 is Cara Danis-Jacques of Macquarie University for her paper published in *Exploration Geophysics* in 2012, entitled: 'Sydney–Gunnedah–Bowen Basin deep 3D structure' (*Exploration Geophysics*, Vol. 43, No. 1, pp. 26–35). Cara was also commended by the adjudication panel for her paper published in *Exploration Geophysics*, Vol. 43, No. 1, pp. 8–25, with co-authors Craig O'Neill and Mark Lackie, entitled: 'Building 3D geological knowledge through regional scale gravity modelling for the Bowen Basin'.

Terence Kratzer of RMIT University was awarded the $250 runner-up prize for Best Student Paper for his paper published in *Exploration Geophysics*, Vol. 44, No. 1, pp. 6–15, with co-authors James Macnae and Paul Mutton, entitled: 'Detection and correction of SPM effects in airborne EM surveys'.

ASEG-PESA 2013 Conference Awards

Best Paper: Minerals Geophysics

James Goodwin, Tim Jones, Russell Korsch, Terry Brennan and Malcolm Nicoll: 'Regional geodynamic study of the Yilgarn-Officer-Musgrave region: investigating the deep crust using forward modelling and 3D inversion'.

Best Paper: Energy Resources Geophysics

Randall Taylor, Simon Cordery, Sebastian Nixon and Karel Driml: 'Unexpected HTI velocity anisotropy: a wide-azimuth low fold 3D seismic processing case study'.

Best Paper: Engineering-Environmental Geophysics

Elliot Grunewald, David Walsh, Rosemary Knight, Katherine Dlubac, Andrew Parsekian, James J. Butler Jr, Steve Knobbe, Edward Reboulet and Mercer Barrows III: 'Integration of surface and logging NMR data to map hydraulic conductivity'.

Best Paper: Student Paper (two awards)

(1) Millicent Crowe,Graham Heinson and Tania Dhu: 'Unconformity-type uranium exploration using a combined AEM and MT approach'
(2) Stewart Fletcher,Steve Hearn and Shaun Strong, 'Deconvolution of correlation noise in coded-impact seismic systems'.

Best Poster

Darcy McGill, Tom Woolrych, Wayne Stasinowsky, Kevin Killin and Jonathan Rudd: 'Delineating the Kitumba IOCG deposit with the ORION 3D DCIP/MT system'.

Laric Hawkins Award (for Innovation)

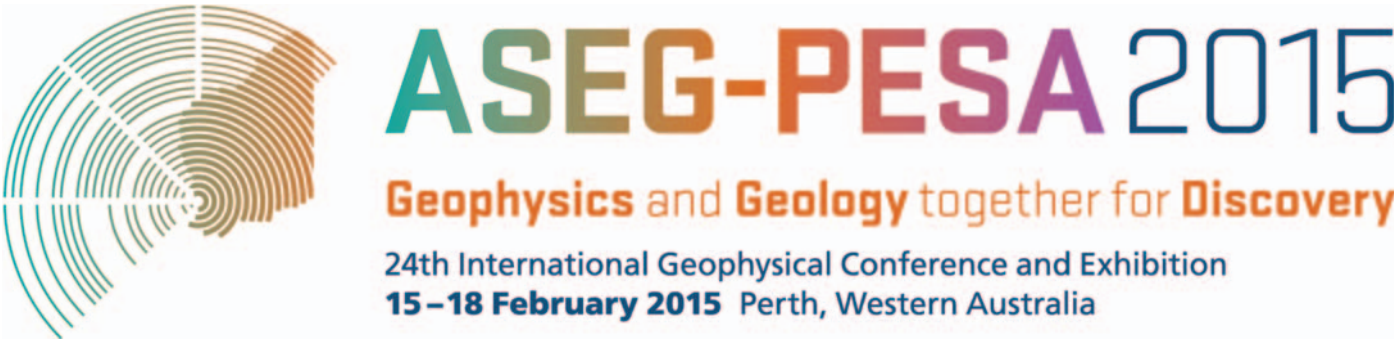
P. Kovesi, E.-J. Holden and J. Wong: 'Interactive multi-image blending for data visualisation and interpretation'.

Best Exhibitor Awards

- **Best Overall Exhibit:** Terrex Seismic
- **Best Small Exhibit:** Geoscience Australia
- **Best Large Exhibit:** WesternGeco

News

ASEG-PESA 2015 in Perth, Western Australia



First, a word of congratulations to the committee team behind the recent ASEG-PESA 2013 conference held in Melbourne. A great effort all round!

The 24th International Geophysical Conference and Exhibition for the ASEG will be held in Perth, Western Australia on 15–18 February 2015. The ASEG will once again partner with PESA, hence the event is hereafter referred to as 'ASEG-PESA 2015'. The conference website can be found at http://www.conference.aseg.org.au and is already taking expressions of interest.

Our conference theme is 'Geophysics and Geology together for Discovery'. Case study papers describing the process of discovery, the geology behind the geophysics and pragmatic efforts to integrate geoscience data are particularly encouraged. Collectively, we all face growing challenges discovering non-renewable resources.

Naturally, technical papers are also welcome. Student participation is particularly invited, and our conference organising committee (COC; see table) is discussing various options to facilitate greater student attendance at ASEG-PESA 2015. Dedicated Facebook (http://www.facebook.com/ASEGPESA2015) and Twitter (http://www.twitter.com/ASEGPESA2015) accounts have been built to encourage involvement and interest in the lead up to February 2015. For LinkedIn users, an ASEG-PESA 2015 group is also available.

ASEG-PESA 2015 conference organising committee

Co-chair Minerals	Chris Wijns	Chris.Wijns@fqml.com
Co-chair Petroleum	Andrew Long	Andrew.Long@pgs.com
Finance	Anne Tomlinson	Anne@sgc.com.au
Sponsorship	Katherine McKenna	Katherine.McKenna@gpxsurveys.com.au
Exhibition	Michael Lees	Michael@the-lees.org
Technical Papers	Mike Dentith (Minerals)	Michael.Dentith@uwa.edu.au
	Tim Dean (Petroleum)	Tdean2@slb.com
	Ian James (Near-surface)	Ian@asst.com.au
Publicity	Brian Wickins	Brian@resolutions-group.com.au
Workshops	Tim Munday	Tim.Munday@csiro.au
Social Events	Amanda Carreno	Amanda.Carreno@woodside.com.au
Students Coordinator	Adrian Noetzli	Adrian.Noetzli@gpxsurveys.com.au
Conference CD Editor	David Annetts	David.Annetts@csiro.au

And last but not least, we want ASEG-PESA 2015 to be fun! Summer in Perth is a glorious time for being outdoors, including the Perth International Arts Festival (http://www.perthfestival.com.au/), countless sporting events and various other cultural activities. Take a few additional days, hire a car and see some of our expansive state. Swim with whale sharks on Ningaloo Reef, see the Super Pit in Kalgoorlie and explore the magnificent winery regions of the Great South or Swan Valley close to Perth. Our COC is also exploring options to host the traditional Gala Dinner in an outdoor setting, embracing an informal but memorable event that will be fondly remembered for years to come.

Please join us in Perth in February 2015 and in the meantime keep checking http://www.conference.aseg.org.au and our social media sites for regular updates. The Call for Papers will go out later in 2013. Sponsorship and Exhibition opportunities are ready to be discussed now with Katherine McKenna and Michael Lees, respectively.

Andrew Long
Co-chair Petroleum
www.conference.aseg.org.au

- Twitter: www.twitter.com/ASEGPESA2015
- Facebook: www.facebook.com/ASEGPESA2015
- LinkedIn: Group 'ASEG-PESA2015'
- YouTube: Channel 'ASEG-PESA2015'
- Web site: **conference.aseg.org.au**

Science downgraded in Abbott's Ministry

For the first time since 1931, apart from the war years, there is no dedicated science minister in the Australian Government.

Professor Les Field speaking on behalf of the Australian Academy of Science, said:

> *The Academy is surprised and disappointed that Prime Minister Abbott has not announced a minister for science. We hope that he might make such an announcement within the next few days. Science reaches into so many areas of our lives and is so important to informing and shaping the world in which we live and work – it is integral to health, industry, food and water security, transport, defence, IT and much more. A scientifically literate society is a society which is equipped to hold informed debate and make intelligent decisions about big issues that affect us all.*

In the resources sector Ian Macfarlane, who was Minister for Industry, Tourism and Resources in the Howard Governments during 2001–2007 is now Minister for Industry, which includes resources, Geoscience Australia (GA), CSIRO and ANSTO. Macfarlane knows the resource industry very well and should welcome a return to his former portfolio. In the other science ministries, Greg Hunt is responsible for the Bureau of Meteorology (BOM) and the Antarctic Division and The Australian Research Council will have Christopher Pyne as its Minister.

At the time of writing it appears that the BOM and GA will report to Parliamentary Secretaries (Senator Simon Birmingham and Bob Baldwin MP, respectively), but these arrangements will be clarified in the near future. Incidentally, on the day before he was appointed, Bob Baldwin said on his Twitter: 'Well what a day, lawns mowed, front garden beds weeded and mulched, irrigation system fixed & wife happy (back not though) time for a Shiraz.'. You can't say he's not down to Earth!

How science and technology will be co-ordinated within the new government only time will tell. And what will happen to the Chief Scientist – Professor Ian Chubb? In the 'good old days' the Chief Scientist reported to the Prime Minister. That will clearly not happen under Mr Abbott's watch.

Eristicus

David Denham
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Getech's Multi-satellite Altimeter Gravity Project

Getech, a world-leading geoscience consultancy, has commenced its three-year Multi-satellite Altimeter Gravity Project, which will combine altimeter data from five satellites to significantly increase the accuracy, resolution and reliability of satellite gravity data, enhancing the role of satellite-derived gravity data as an offshore exploration tool.

Until very recently, gravity maps of the world's oceans relied on the data from two geodetic mission satellites (Geosat and ERS-1, which flew in the 1980s and 1990s). These satellites used radar altimeters to accurately map our planet's surface. The surface of the Earth's seas might be considered as an equi-potential surface, influenced by the Earth's gravity field, and therefore the gravity field can be calculated from a map of ocean surface elevation. In 2004, Getech undertook a major R&D study to do just this for the continental margins of the world. Furthermore, in 2008, a version of satellite gravity known as Trident was generated by 'stacking' the Getech 2004 solution with two other independently derived solutions of free-air gravity.

Getech's solution has improved the generation of satellite gravity data through use of two proprietary methodologies:

- moving window re-tracking: simultaneous measurements of 40 radar waveforms and associated waveform parameters
- micro-levelling: correcting for orbital variations without loss of short wavelength sea surface heights.

Currently, there are a further three satellites, Cryosat-2, Jason-1 and HY-2A, that have either completed or are planned to complete, geodetic missions. This presents the opportunity to significantly improve on the quality of gravity maps for the world's continental margins. A pilot study in 2012 by Getech showed that the addition of the data from just one extra satellite significantly improved the resolution of the derived gravity. It also showed that the free-air gravity can be determined much closer to the shoreline than previously possible.

Getech has now commenced the Multi-satellite Altimeter Gravity Project to integrate the geodetic mission data of all five satellites, with the aim of significantly improving the accuracy, resolution and reliability of the satellite-derived gravity data. The study is also systematically improving the bathymetry model of the continental margins so that important derivatives (the Bouguer and Isostatic anomalies) are as accurate as possible.

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Giving sight to shootblind cableless operations

The International Seismic Company (iSeis Co.) is the Oklahoma-based developer of the Sigma continuous cableless record acquisition system. Operated around the word on the widest range of active and passive seismic acquisition, Sigma's unique ability to be used side-by-side with cabled recorders now also has additional applications. iSeis announces that it is being marketed and already employed by contractors with cableless instruments that otherwise are unable to provide any level of communication between their deployed ground units and the central system.

Described as 'giving sight to shootblind cableless systems', Sigma channels can be deployed on crews using cableless recorders that either have no means of communication or some means that cannot reliably be used in all environments. Adding Sigma to such operations allows data conveniently to be transmitted wirelessly from the line to the observer using the internationally acceptable ISM licence-free band. The only hardware required is the Universal Encoder 2 from iSeis's sister company Seismic Source Co., and the number of Sigma channels that the crew operator judges is appropriate.

One major advantage of this approach is the rapid provision for quality control (QC) ensuring that data is of the highest quality, for example, in terms of vibroseis sweep parameters or number of pops from impulsive sources. Therefore, operators of shootblind equipment no longer need to risk low-quality or noise-contaminated data, which may be difficult to process or not meet contractual requirements. In all cases, being able to check some or all the active spread at varying spatial densities also allows remote monitoring of any evolving situation that could affect production, data quality or equipment security.

The basic Sigma recorder includes a 'LoMesh' mesh radio network capability that, in its native stand-alone mode, has proved itself capable of working even in the toughest environmental conditions, including jungles, areas of significant elevation change and radio interference. Sigma's LoMesh wirelessly returns all system, battery, GPS and sensor health, status, data security, QC and noise information from all deployed channels for immediate graphical display on the observer's MS Windows computer.

Where greater transmission bandwidth is required, for example, the real-time provision of full seismic records, the 'hyMesh' (TM) option from SRD Innovations can simply be plugged in to Sigma ground units, to provide high data rate communications in locations where other cableless systems have difficulty.

For the first time, any level of wireless data communication link can be set up for use with any shootblind cableless recorder, or with any cabled system that needs operational flexibility, but does not want to take on the risk of blind data acquisition.

Robert Heath
Technical Marketing Manager
Seismic Source Co & iSeis Company
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In the field with the iSeis Co. Sigma continuous cableless record acquisition system.

Mineral exploration peaks, but petroleum powers ahead

Minerals

Mineral exploration, which peaked in the March quarter of 2012, continues to decline. According to figures released by the Australian Bureau of Statistics in September 2013, the trend estimate for total mineral exploration expenditure fell by $57.5 million (7.8%) to $681.0 million in the June quarter 2013. This is 30.0% lower than the June 2012 estimate.

Figure 1 shows mineral exploration levels from 1986 to June 2013. It indicates that although the recent peak has passed, the level of expenditure is still well above the long-term average over the past 25 years. Another good sign is that the ratio of expenditure on 'new deposits' to 'existing deposits' has increased from 51% in June 2012 to 71% in June 2013. In other words, although the total amount spent on exploration has declined by 30%, resource companies are still investing in new areas rather than relying on existing deposits.

In the past year, base metal exploration declined from $220 million in June 2012 to $125 million in June 2013, gold declined from $215 million to $150 million, iron ore from $336 million to $204 million and coal from $212 million to $120 million.

As expected, the largest decline was in Western Australia, where expenditure fell from $437 million to $403 million. Next in line was Queensland with $140 million and none of the other States or Territories exceeded $50 million. However, 59% of Australia's mineral expenditure takes place in Western Australia, so it is well and truly still the Premier State for minerals.

Petroleum

The petroleum situation is very buoyant. Figure 2 shows the quarterly petroleum exploration numbers from 1986 to June 2013. Since 2006, conventional and mainly offshore exploration has dominated, but in the past three years exploration for coal seam gas and shale oil and shale gas has boosted onshore exploration. For example, in the past year (June 2012–June 2013), the ratio of onshore to offshore exploration has risen from 34% to 54%.

Western Australia is also the Premier State for petroleum. In June 2013 it accounted for 70% of Australia's total expenditure of $1137 million. Furthermore, the minerals expenditure of $681 million is now significantly less than the petroleum number.

Stock market

The market capital of resource companies listed on the ASX is another indicator of the health of Australian-listed resource companies.

Figure 3 shows the All Ords Index from July 2000 to August 2013, the total market capital of all the resource companies listed in the ASX top 150 and the market capital listed with the ASX of BHP Billiton and Rio Tinto (all curves adjusted to the CPI value at August 2013).

Since 2009, the All Ords Index has remained relatively flat at approximately 5000 despite displaying considerable volatility. Whereas resource stocks rose, peaked at the beginning of 2011, then fell into steady decline ever since.

I do not pretend to be a forecaster of stock market behaviour; it is for the reader to estimate the future – at this time, however, resource companies could be a good investment.

David Denham

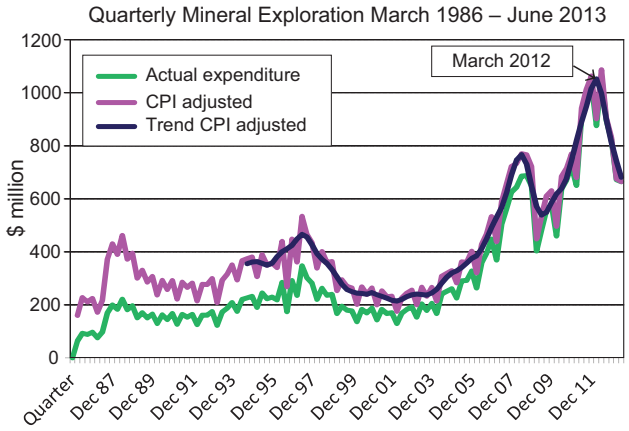

Fig. 1. *Actual and trend quarterly mineral exploration investment for the period 1986–2013. The CPI-corrected data have been adjusted to June 2013 dollars. The trend peak in the March quarter of 2012 was $1022.2 million.*

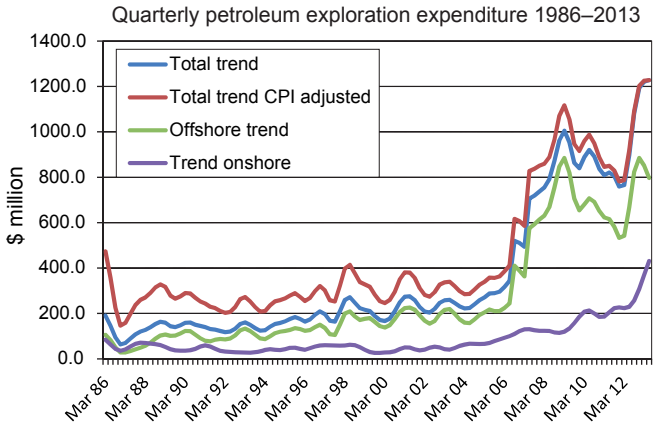

Fig. 2. *Quarterly petroleum exploration from 1986 to June 2013. The CPI-corrected data have been adjusted to June 2013 dollars. Notice how the onshore exploration has increased, primarily as a result of the coal seam gas and shale oil and shale gas exploration.*

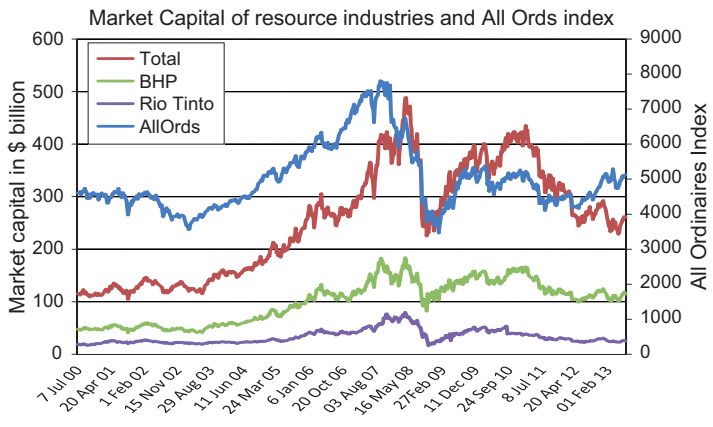

Fig. 3. *The blue curve shows the All Ords Index from July 2000 to August 2013; the red curve shows the total market capital of all resource companies listed in the top 150 ASX companies and the other curves show market capital listed with the ASX of BHP Billiton and Rio Tinto. All curves have been adjusted to the CPI value at August 2013.*

2013 Careers in Geoscience: a big hit!

On Monday 26 August the annual Careers in Geoscience night was held at the Tech Park Function Centre, Bentley. This booth-style careers event is run by the Australian Society of Exploration Geophysicists (ASEG), the Australian Institute of Geoscientists (AIG), the Petroleum Exploration Society of Australia (PESA) and the Geological Society of Australia (GSA), with support from ESWA.

This year drew quite a selection from the industry with BHP Billiton, ConocoPhillips, the Geological Survey of WA, Schlumberger, Woodside, Chevron, UWA, Curtin University, Newmont Resources, Petroleum Geo-services, Southern Geoscience Consultants, Terrasearch and Fortescue Metals Group represented, as well as Atlas Iron Ltd, Digirock, Aker Solutions and GHD.

The first session kicked off at 4 pm with over 40 high school students from Canning College, Chisholm Catholic College, Churchlands SHS, Como SHS, John Forrest Secondary College, Kent St SHS, Mercy College, Perth Modern, Scotch College and Willetton SHS joining exhibitors to find out about the many exciting opportunities in this sector. They heard from WA Scientist of the Year (2012), Professor Peter Quinn, and then embarked on a networking competition that ultimately led to a lucky student being awarded an iPad mini.

At 6–7:30 pm, over 100 university students relished the opportunity to interact with potential employers and inspirational people, including Geologist and Mining Entrepreneur David Flanagan (Atlas Iron) and representatives from BHP Billiton. After plenty of networking, with yummy food and drinks, a raffle draw gave us another lucky winner of an iPad mini.

Student feedback

Positive feedback started rolling in the day after the event, including:

> *A big thank you for putting on the event I thought you did an awesome job...The ability to have small quick chats with various people is much better than having too many speeches...The best part of this event from a geology students point of view was how many companies were there that were actually looking for geologists. Too many other events are focused around engineers or other disciplines; this one is special in this regard.*

Phil, University Student

> *The event went nicely and the people at the stands were nice, friendly and talkative. They answered all the questions we had and thanks to them I now know what the options are for my future. I would like to say thank you for holding this event and I would come back next year.*

Tiffany, High School Student

For more information about the Careers in Geoscience initiative please contact the ASEG WA Events coordinator via email (events@casm.com.au) or visit the events page on the ESWA website (http://www.earthsciencewa.com.au).

Anne Tomlinson, WA Branch President









The Australian Seismometers in Schools network: engaging students and communities in earth science around the nation

Michelle Salmon and Natalie Balfour

The Australian Seismometers in Schools (AuSIS) programme aims to inspire the next generation of geoscientists by providing students with 42 state-of-the-art research quality seismometers and allowing them to watch seismic waves arrive in real time. This will engage students in hands-on earth sciences and connect them with other students, schools and scientists around the world.

The AuSIS network is part of the Geophysical Education Observatory set up by AuScope, which is a government-funded programme started by the Howard government. AuSIS is one of several programmes funded by the Commonwealth government's Education Investment Fund (EIF) designed to provide technology to explore the surface and subsurface of the Australian continent. AuSIS also received additional funding for extra instruments from the NSW government Department of Trade and Investment.

Fig. 1. *Installation of Guralp CMG-6TD at Ayr State High School. The seismic vault was made as part of a project by the schools construction class.*

A pilot programme began in 2011 with two Canberra schools that volunteered to install the equipment. They soon saw that the benefits ranged well beyond earth science providing students with real-world context for physics, geography and social science. The instruments chosen for the programme are Guralp CMG-6TD and combine a broadband (30 s) seismometer and digitiser into a single package (Figure 1). The instruments are network ready with both Ethernet and Wi-Fi capabilities so that the data can be streamed continuously from the school to our servers at The Australian National University (ANU) in Canberra. The seismometers were installed in low traffic areas in the schools and one reference site in the Mt Stromlo seismic vault that houses a GEOSCOPE seismometer for comparison. Despite initial doubts that school sites would be too noisy to be useful, local, regional and teleseismic earthquake data is well recorded at the schools. In 2011 the school seismometers recorded the explosions from a factory fire and in 2012 the ML 3.7 Wee Jasper earthquake was recorded (Figure 2), providing additional constraints for the location of this event. We have also clearly recorded a regional Mw 5.4 in South Australia and many large teleseismic events. The pilot programme demonstrated that although there is some cultural noise on the instruments, a well-chosen site within the schools has the potential to provide excellent seismic data. Noise levels do increase during school hours but local, regional and teleseismic data is still well recorded by the instruments.

After the launch of AuSIS by Senator Kate Lundy (Figure 3) in 2012 we opened applications to schools around the country. Over 125 schools applied to be part of the programme. Schools to

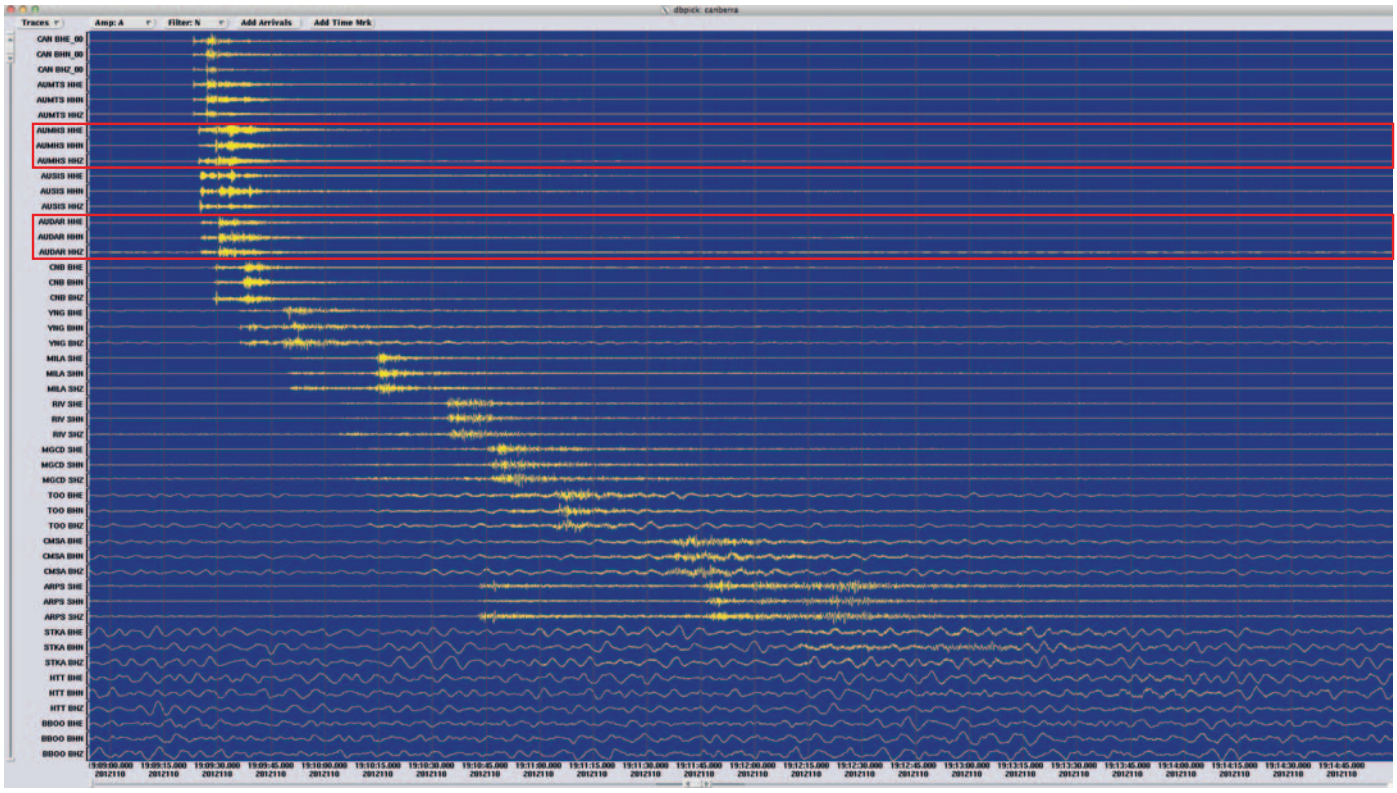

Fig. 2. *Wee Jasper earthquake recorded with the pilot school's seismometers (outlined in red) and the national network instruments.*

Fig. 3. *Students from Melrose High School explaining the recordings from their seismometer to Senator Kate Lundy at the AuSIS launch.*

host a seismometer were chosen based on their enthusiasm, geographical location and community impact. In each of the main centres the schools chosen have a track record of sharing their facilities and skills with surrounding schools, but the main emphasis was on rural schools that often miss out on this sort of opportunity. Schools are often a focal point for rural communities and therefore provide additional community engagement.

Schools that miss out on hosting a seismometer will hopefully remain engaged in the programme. We offer to help schools who miss out on the option to purchase a cheaper alternative. We have been testing the slinky seismometer that schools can either buy pre-made or build from a kitset (Figure 4). Although these single component instruments are far less sensitive than the Guralps, they are great for showing students how a seismometer actually works and also pick up local and large teleseismic earthquakes.

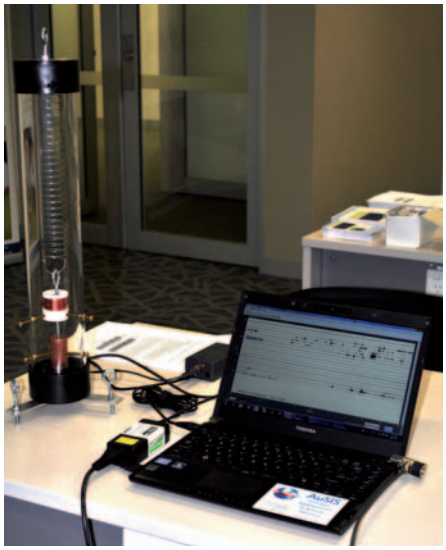

Fig. 4. *Slinky Seismometer developed by Boise State University and its output to a laptop (see http://cgiss.boisestate.edu/bsu-network/).*

Fig. 5. *From left to right, Hassan Bhatti (Roxby Downs Area School), Goran Boren (University of Adelaide) and Michelle Salmon (ANU) installing a seismometer at Roxby Downs school.*

In April this year we began the process of installation starting in Victoria. With the help of volunteers from Universities (Figure 5) and industry over half of the instruments have already been installed and by the end of September the majority of the instruments will be live. The success of the programme hinges on maintaining the engagement of participating schools and one way of doing this is in partnership with local geoscientists who can provide some support for the schools and mentorship for the students.

Data collected at the schools is streamed live to ANU where we send it onto the Incorporated Research Institutions for Seismology (IRIS) in the US for archiving and near real-time public access. The data is being made freely available so that researchers, industry and schools alike can all access the data collected (network code S, station codes begin with AU). Hopefully this will provide an incentive for geoscientists around the country to get involved with the programme. We also set up a live feed of the data at the school so that they have the opportunity to monitor the seismic activity recorded. With a brief introduction to the software, teachers and students are able to identify earthquakes in their data and when things go bump in the night they can look it up to see if it was recorded the next day. Earthquake events that make the international news are usually easily identified on the school data feeds.

As part of the programme we are continuing to develop teaching modules to help teachers integrate the seismometer into their classes. With the introduction of earth science into the National Science Curriculum, many teachers are struggling to find resources to help them. We have been engaging with teachers

Fig. 6. *Teachers at the National Youth Science Forum learning about the properties of seismic waves using a slinky.*

around the country with workshops at Australian Sciences Teachers Association conferences and the National Youth Science Forum (Figure 6). We hope that the teaching modules will help to provide an interactive and relevant way to introduce earth sciences and specifically tectonics and natural hazards to the classroom.

The AuSIS website www.ausis.edu.au is still under development, but will provide teaching resources and access to data feeds from the seismometers. In the meantime we keep teachers, students and amateur seismologists informed about seismic events we record, installations and progress using our facebook page www.facebook.com/ausisnetwork. Data is available in near real time directly from IRIS, but it can also be downloaded in a number of formats from the AuScope Discovery Portal portal.auscope.org.

Next year we hope to provide professional development courses for teachers to expand their skill base in earth science. Eventually all schools will be able to access the data recorded by the network, connecting students and teachers and scientists around Australia. We are also working on connecting with similar programmes run in other countries so that we can share data and experiences in educational seismology. We would also like to expand our network of volunteers who can provide some support for schools in their area. This mostly involves the occasional talk at the school or helping out with student projects and mentorship.

If you are interested in supporting this programme please contact us at ausis@anu.edu.au.

Update on Geophysical Survey Progress from the Geological Surveys of Western Australia, South Australia, Northern Territory and WA Department of Water (information current at 10 September 2013)

Tables 1–3 show the continuing acquisition of the airborne magnetic, radiometric, gravity and AEM data of the Australian continent respectively. Accompanying locality maps for Tables 2 and 3 can be found in Figures 1–3. All surveys are being managed by Geoscience Australia (GA). Further information on these surveys is available from Murray Richardson at GA via email at Murray.Richardson@ga.gov.au or telephone on (02) 6249 9229.

Table 1. Airborne magnetic and radiometric surveys

Survey name	Client	Contractor	Start flying	Line (km)	Spacing AGL Dir	Area (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Marree	GSSA	UTS	29 Oct 12	130 473	400 m 80 m N–S	46 169	100% complete @ 10 May 13	24 Jul 13	160 – Oct 12 p16	TBA
Browse Basin	GA	Thomson Aviation	21 Aug 13	189 361	800 m 80 m asl N–S	123 187	24% complete @ 8 Sep 13	TBA	164 – Jun 13 p19	TBA
Menzies North	GSWA	GPX Surveys	7 Aug 13	93 386	100 m 50 m N–S	8200	22.7% complete @ 8 Sep 13	TBA	165 – Aug 13 p11	TBA
Kalgoorlie East	GSWA	Thomson Aviation	5 Aug 13	122 000	100 m 50 m N–S	8200	26.4% complete @ 8 Sep 13	TBA	165 – Aug 13 p11	TBA
Widgiemooltha North	GSWA	UTS Geophysics	25 Jul 13	92 000	100 m 50 m N–S	8200	21.0% complete @ 8 Sep 13	TBA	165 – Aug 13 p11	TBA

TBA, to be advised.

Table 2. Gravity surveys

Survey name	Client	Contractor	Start survey	No. of stations	Station spacing (km)	Area (km²)	End survey	Final data to GA	Locality diagram (*Preview*)	GADDS release
Esperance	GSWA	Atlas Geophysics	30 Jun 13	7850	2.5 km and 1 km along roads/tracks	TBA	3 Sep 13	Preliminary data to GA on 4 Sep 13	158 – Jun 12 p23	TBA
Woomera Prohibited Area	DMITRE	Daishsat Pty Ltd	2 May 13	34 500	1 km/2 km regular grid	TBA	82% complete @ 4 Sep 13	TBA	163 – Apr 13 p17	TBA
North Perth – Gingin Brook	WA Dept of Water	Atlas Geophysics	9 Apr 13	1230	1.5 km regular grid	TBA	100% complete @ 7 Jun 13	29 Jul 13	163 – Apr 13 p17	TBA
Southern Wiso Basin	NT	Atlas Geophysics	11 Jul 13	3856	4 km regular grid	61 700	100% complete @ 18 Aug 13	TBA	165 – Aug 13 p11	TBA
Southern McArthur Basin	NT	TBA	TBA	6270	4 km regular grid with 2 km infill in 2 areas	74 380	TBA	TBA	This issue	TBA
Goldfields, WA	WA	TBA	TBA	8100	2.5 km regular grid	TBA	TBA	TBA	This issue	TBA

TBA, to be advised. See Figures 1 and 2 for locality maps of the Southern McArthur Basin and Goldfields, WA Surveys respectively.

Table 3. AEM surveys

Survey name	Client	Contractor	Start flying	Line (km)	Spacing AGL Dir	Area (km²)	End flying	Final data to GA	Locality diagram (*Preview*)	GADDS release
Swan/Scott Coastal Plain and Albany/ Esperance	WA Dept of Water	Fugro Airborne Surveys	25 Mar 13	8607	300/600 m	TBA	100% complete @ 15 May 13	30 Aug 13	163 – Apr 13 p17	TBA
Capricorn Orogen	WA	TBA	TBA	30 000	5 km N–S	146 300	TBA	TBA	This issue	TBA

TBA, to be advised. See Figure 3 for locality map of the Capricorn Orogen survey.

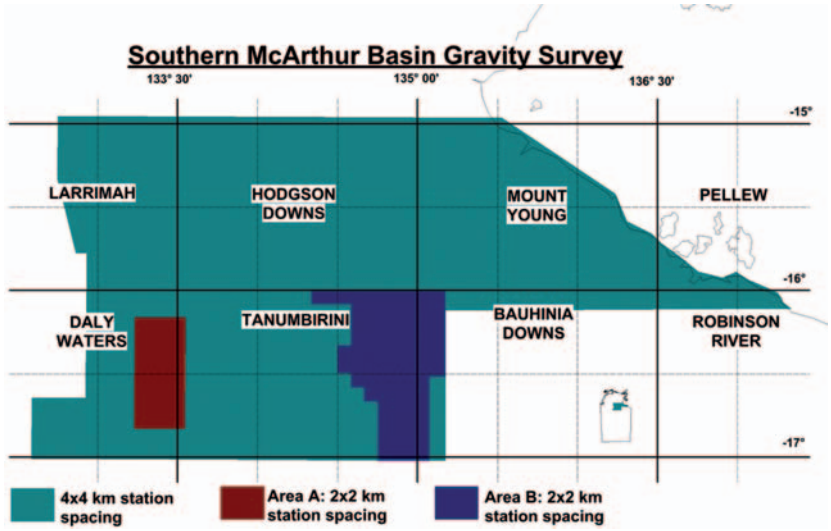

Fig. 1. *Locality map outlining the Southern McArthur Basin gravity survey (detailed within Table 2).*

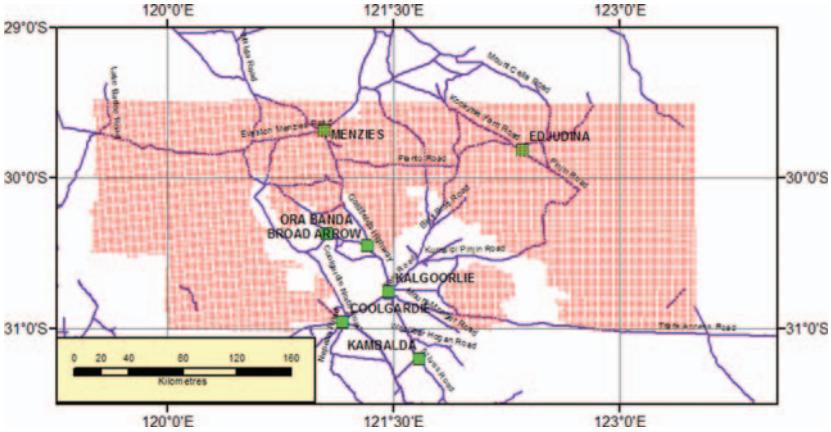

Fig. 2. *Locality map outlining the Goldfields WA gravity survey (detailed within Table 2).*

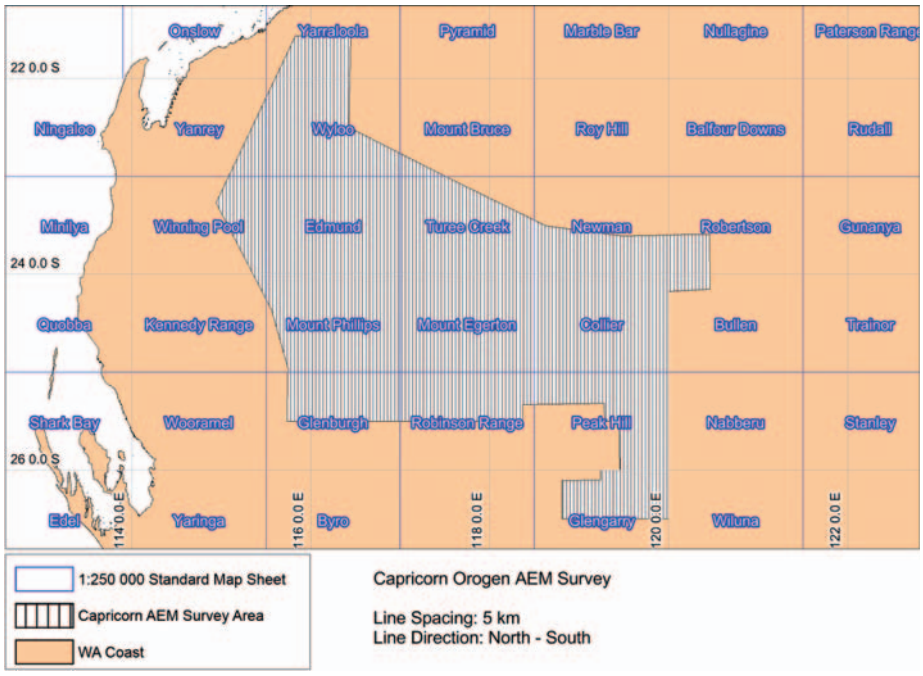

Fig. 3. *Locality map outlining the Capricorn Orogen AEM survey (detailed within Table 3).*

Meteorite impacts to gold and nickel deposits

The discovery of *prima facies* evidence for impact structures in the Eastern Yilgarn, Western Australia

Robert (Bob) Bingley Watchorn

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A large circular feature was observed by the author in gravity data of the Yilgarn region of Western Australia in May 1999. The discovery in August 2013 of *prima facies* evidence on many of the documented rings associated with this structure confirmed it to be of impact origin. The rings of this impact structure, the Watchorn Impact Structure (hereafter termed WIS), extend 560 km north–south and 480 km east–west diameter. From the impact structure's relationship with geological features the age of the impact is estimated at between 2.7–2.64 Ga. This is one of the largest and oldest impact structures worldwide. There are numerous other probable impact structures observable right across the Yilgarn from Mount Magnet to the Albany Frazer Tectonic zone east of Norseman.

In the Eastern Yilgarn there is an empirical correlation between the largest nickel, gold, copper, silver–lead–zinc and rare earth deposits and the rings of WIS and other probable impact structures. The age of the mineralisation is between 2.72 Ga and 2.60 Ga.

These relationships means a paradigm shift is required for identifying impact structures and reworking the lithological, structural and mineralisation history in the Yilgarn. This may apply to Archaean Cratons worldwide.

This paper is divided into three sections:

A. Examination of impact structures in the Yilgarn.
B. Q&A: areas for discussion and further study.
C. Exploration trip to verify ring morphology and find *prima facies* evidence for impact structures.

Due to space considerations, Sections B and C shall be deferred until the next issue. In the interim, the author welcomes feedback from readers (Note: opportunity exists for select queries and replies to be published within section B). – Editor

A. Examination of impact structures in the Yilgarn

General observations. The surface of the Moon, Venus and Mars illustrate the important role impact cratering plays in the geological process. However, on the Earth's surface, only about 170 impact craters have been recorded (Koeberl and Anderson 1996). Very few have been positively identified by the observation of meteorite debris and shock structures, as most of these craters are masked by periods of erosion and sedimentation and the meteoritic material is widely dispersed (Dentith *et al*. 1999).

Large ring structures of proven impact origin are Vredefort in South Africa (ca 300 km diameter, 2.02 Ga age), Sudbury in Canada (ca. 250 km diameter, 1.85 Ga age) and Chicxulub in the Gulf of Mexico (180 km diameter, 65 Ma age).

In Australia there are 35 confirmed impacts, 22 unconfirmed impacts and 10 sites with identified impact ejecta (spherules).

Evidence in the Archaean Pilbara Craton of several impact spherulite ejecta horizons confirm that large impacts occurred around 2.5, 2.63, 2.7 and 3.4 Ga adjacent to the Pilbara Craton (Hassler and Simonson 2001; Byerly *et al*. 2002).

Only one verified Archaean impact structure has so far been found in the Yilgarn, Yarrabubba (30–70 km diameter, 2.65 Ga age) located 70 km SW of Meekatharra (Mc Donald *et al*. 2003).

According to Blewett *et al*. (2012) the Eastern Yilgarn Craton is characterised by short duration, even catastrophic crust forming events between 2.775 Ga and 2.655 Ga.

Megascopic evidence of multiple probable impact structure discoveries in the Eastern Yilgarn, Western Australia

Gravity. In May 1999 the author was using a gravity database to examine the Eastern Yilgarn Craton for large basement tapping structures as a source of mineralisation. A 250 km diameter circular feature (plus smaller central circular features) was consistently observed on the images when the 1st horizontal derivative of the gravity data was examined on the ER Mapper software program (Watchorn 1999). The data was examined using various sun angles at different azimuths to highlight fault and circular features. It was generally found that steeper sun angles gave a deeper view of the crust. This hypothesis was checked using the known geological features interpreted from the seismic traverse in figure 52, p. 92 in Blewett and Czarnota (2007).

The centre of the feature is located at an approximate longitude of 121°25′E and latitude 28°25′S, 50 km north of the town of Leonora.

The circular feature was examined on topographic, fact geology, interpretive geology, magnetics and Landsat images.

At mid depth (5–10 km) depths on the 1st horizontal derivative gravity data there is observed the larger 250 km diameter outer ring with a central high (Figure 1).

Looking deeper (10–15 km) the Yilgarn rift structures are observed as are two concentric rings with diameters of 55 km and 95 km respectively in the centre of WIS (Figure 2).

There is strong evidence of central rings and some outer rings of four other probable impact structures extending from Leonora to Mt Weld south of Laverton. There is a less well developed, or earlier, central ring near Kookynie which is the centre of the 500 km diameter ring described by O'Driscoll and Campbell (1997). This ring structure I have named the O'Driscoll probable impact structure in honour of a mentor Tim O'Driscoll.

There are arcuate features located 50 km NE through to 50 km NW of Kalgoorlie that suggests an earlier cluster of impact structures, as they are dismembered by the NNW rift fault zones. These structures are visible in the deeper gravity data (Figures 1 and 2), but unlike the WIS are not visible in the shallower gravity data (Figure 3). This lack of surface expression may mean that they impacted during the early stages of volcanism

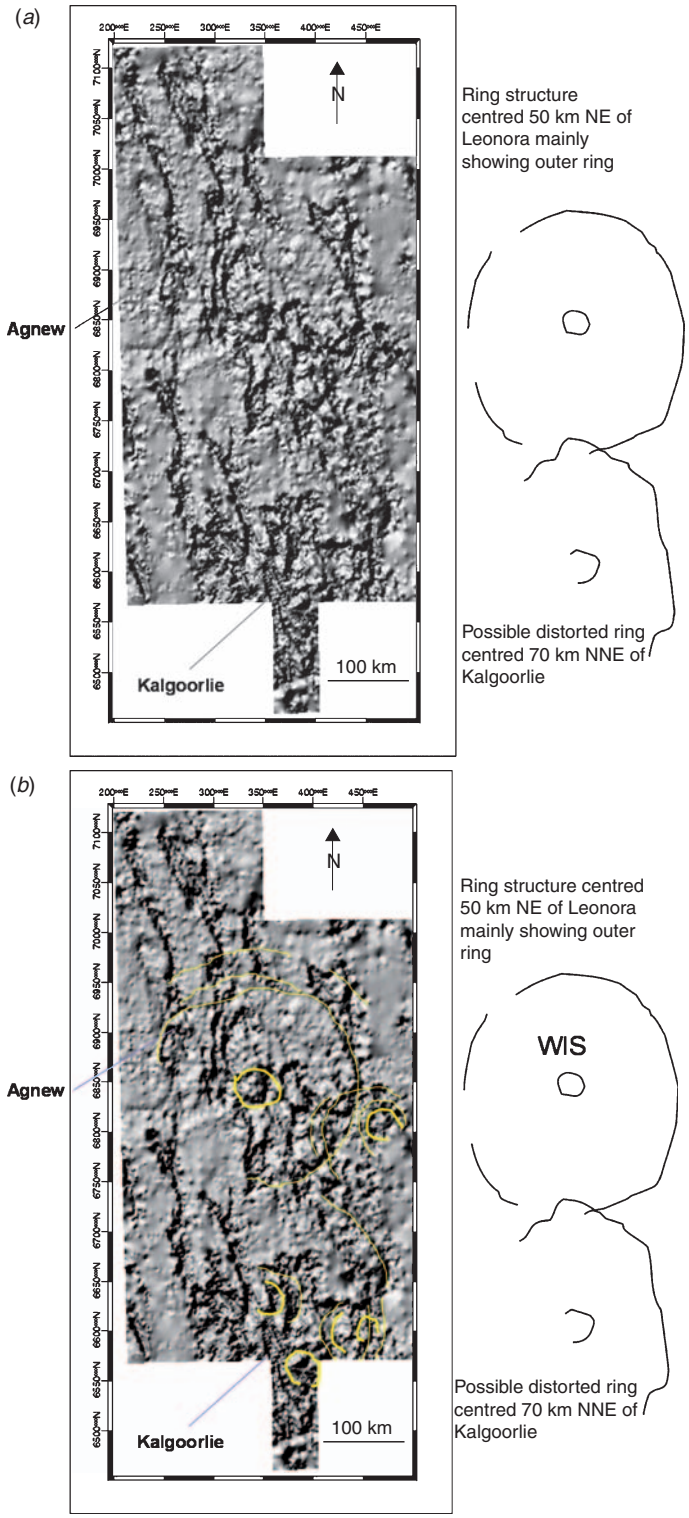

Fig. 1. *(a) Gravity image showing the mid depth ring structures (5–10 km) in the Eastern Yilgarn. (b) Gravity image showing annotated mid level ring structures in the Eastern Yilgarn.*

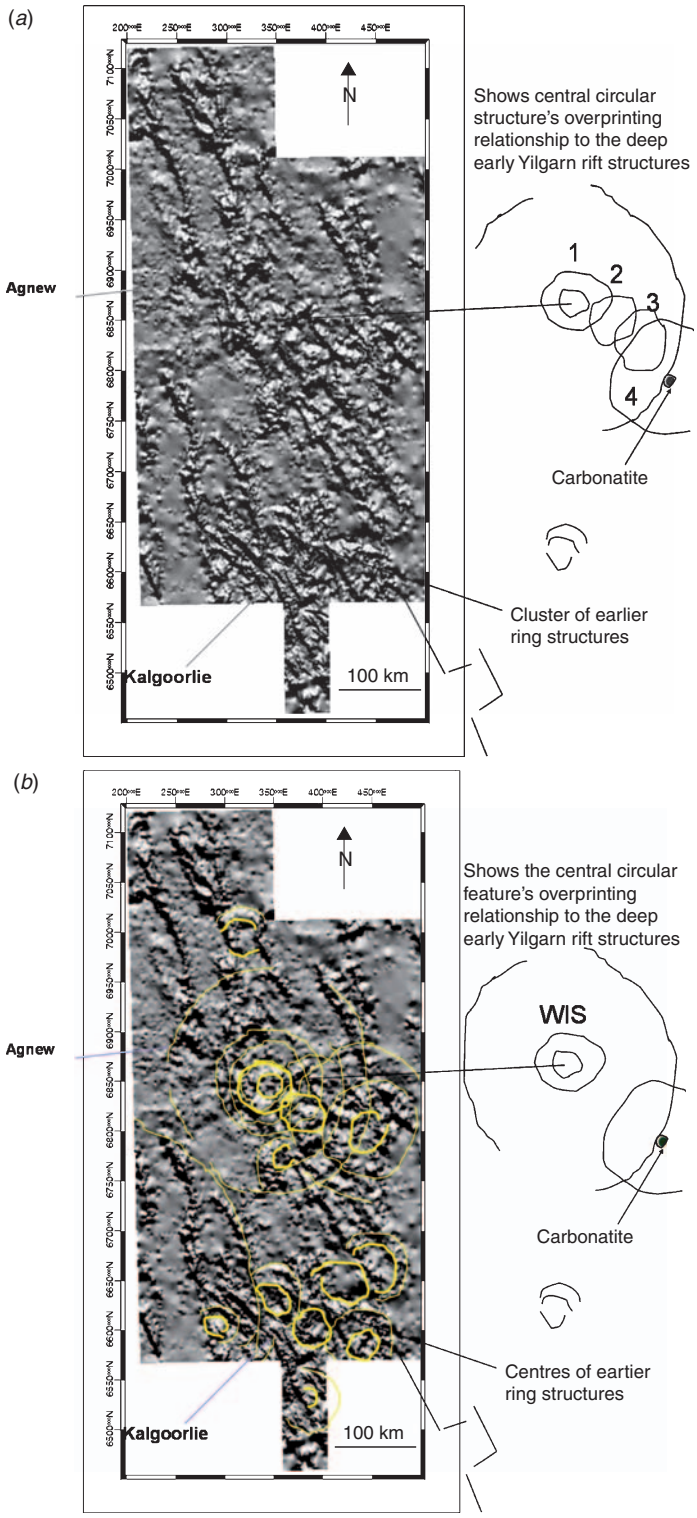

Fig. 2. *(a) Gravity image showing deeper ring structures (10–15 km) in the Eastern Yilgarn. (b) Gravity image showing annotated ring structures in the Eastern Yilgarn.*

and precipitated the extrusion of the deeply sourced Kambalda Komatiites and subsequent stratigraphy. They may also have provided the mineralisation as did the Sudbury impact.

The outer Gravity ring of the WIS is clear on the gravity image highlighting the shallower (0–5 km) features (Figure 3).

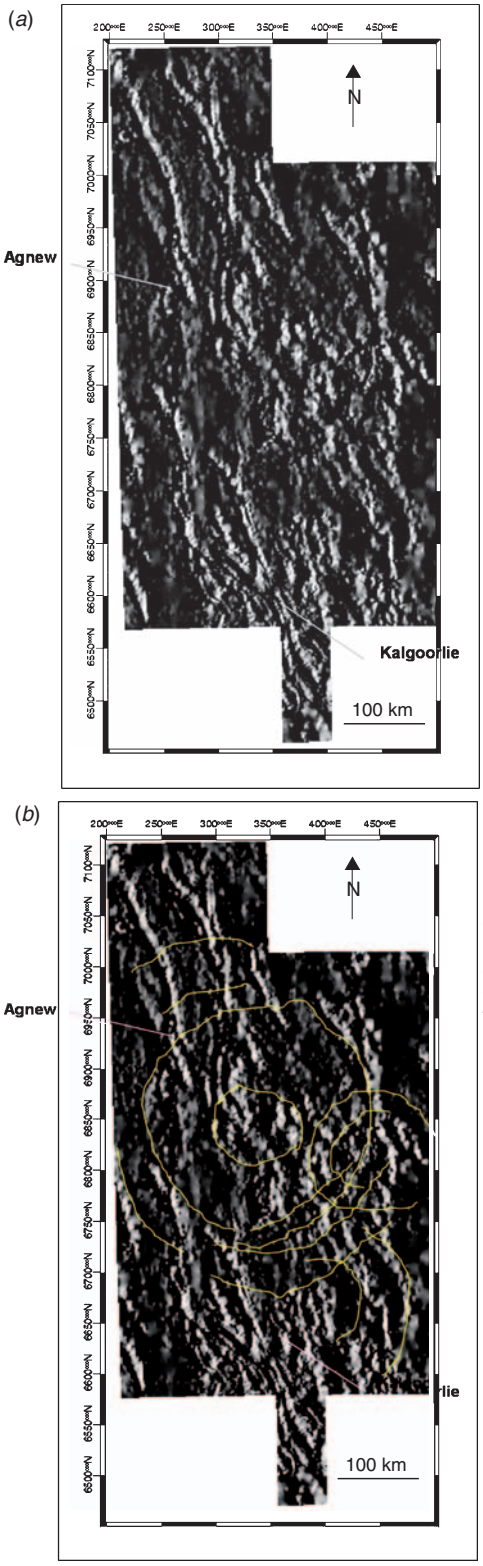

Fig. 3. *(a) Gravity image showing shallow ring structures (0–5 km) in the Eastern Yilgarn. (b) Gravity image showing annotated shallow ring structures in the Eastern Yilgarn.*

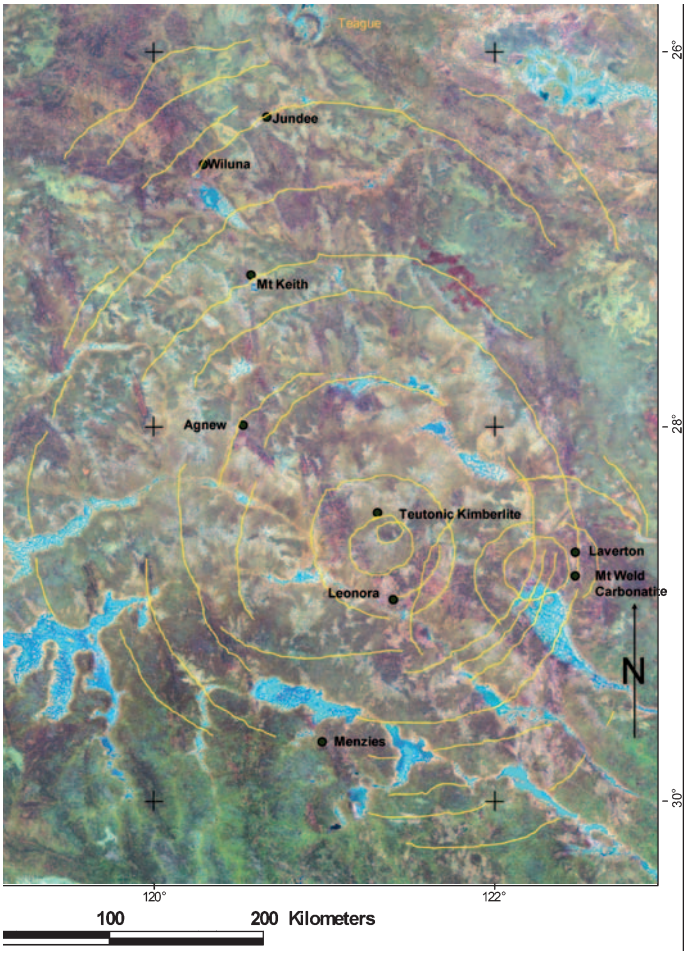

Fig. 4. *Landsat image of the Eastern Yilgarn showing interpreted arcuate features.*

Landsat. There are many arcuate features observed on the Landsat image. The most northern ring passes north of Wiluna and Jundee and arcs down to the east of Laverton and the southern edge passes south of Menzies. The *prima facies* evidence discovered suggests these Landsat rings represent the maximum dimensions of the WIS with dimensions 560 km NS and 480 km EW (Figure 4).

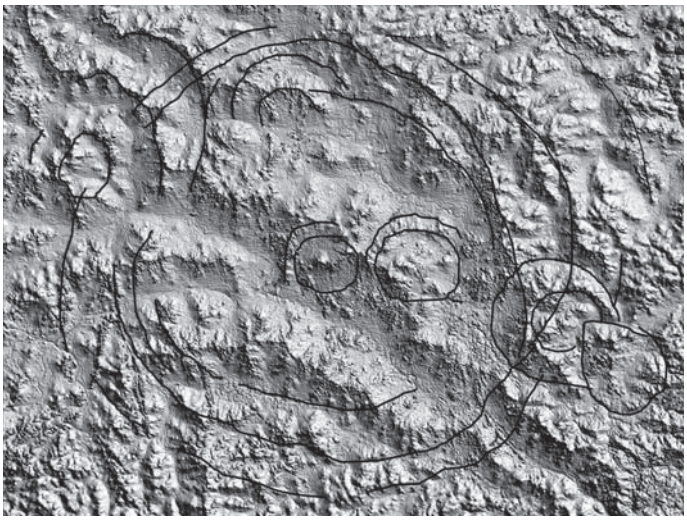

Fig. 5. *Detailed topographic image of the Eastern Yilgarn showing interpreted ring and arcuate features.*

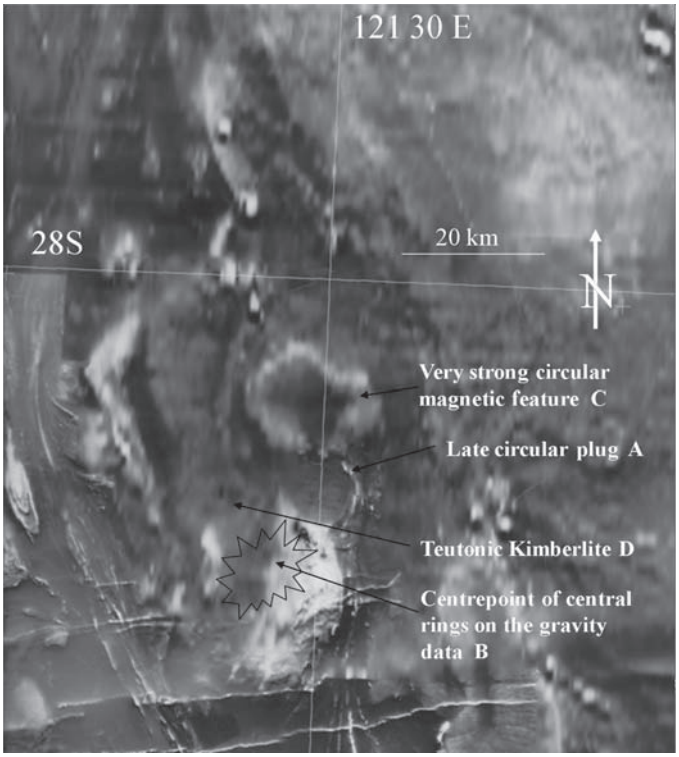

Fig. 6. *TMI aeromagnetic image showing the magnetic ring structures at C, the centre of the gravity ring structures at B and the EW Proterozoic dykes near the bottom of the image.*

Geography. The WIS has a topographic imprint that is still observable. The last major period of erosion on the Yilgarn was the Permian ice sheet glaciation that over-deepened areas of weaker rock, which later became lakes, river systems and finally the salt lake system seen on the Landsat and DEM images. The centre and rim of the WIS are now topographic highs 50–100 m above the surrounding plains and the mid area is of lower elevation. Many of the salt lake systems and subsidiary creek systems still follow the impact ring structures (Figures 4 and 5).

Topography. Digital Elevation Model (DEM) was examined on ER Mapper using sunangles to highlight the WIS rings. The north and northeast rim stood out clearly and about 50 percent of the rest of the rim was visible in the more elevated topography between the lake systems. Numerous other circular features are evident (Figure 5).

Magnetics. The circular feature observed within the gravity data correlates with the magnetics, in terms of the locality, to that of highly magnetic, contorted granite, at the south area of the Bundarra Dome at B (Western Terraces). In addition two concentric ring structures were visible in the magnetic data. These rings, termed the Mt Redcliffe Magnetic Ring Structure (C), have a diameter of 50 km and are centred about 20 km north of the centre point of the WIS (B). Between and partially overlapping the centre points of the gravity and magnetic rings is a very sharp later circular feature (A). Adjacent to these circular features is the Teutonic Kimberlite dyke, evidence of mantle tapping fracture systems.

The EW Proterozoic dykes (below B) place a minimum age on the Impact structures of approximately 2.4 Ga (Turek and Compston 1971) (Figure 6).

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The first official recommendation to establish exploration geophysics in institutions in Australia: providing some insights into the status of exploration geophysics worldwide up to 1927

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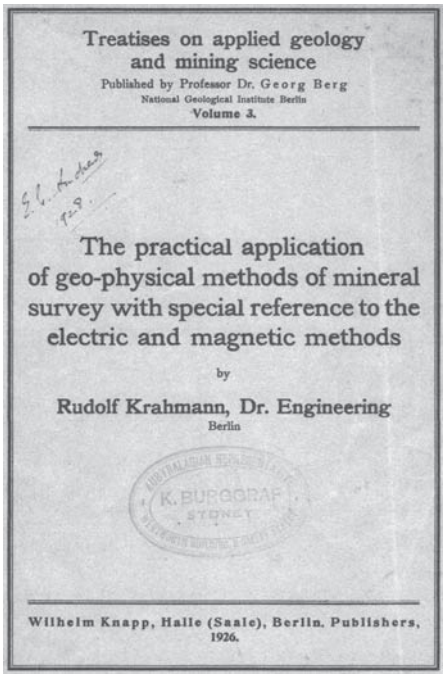
In 1927, E. C. Andrews, then Government Geologist to the N.S.W. Dept. of Mines, titled his contribution to the Department's Annual Report for 1927, 'Preliminary Report on Geophysical Prospecting for Ore Bodies' (Andrews 1928). In it he makes some general comments about the value of geophysics; describes the methods of geophysical prospecting that had come to his attention by then; their manner of use and costs to survey; suggests their applicability to Australian conditions and makes recommendations for their adoption in NSW and Australia, generally. Alan Day in his comprehensive review of the development of geophysics in Australia (Day 1966) claimed that '**official** interest in this new technique' (of geophysics prospecting) was aroused by this time and Andrews 'investigated geophysical methods while overseas in 1927 and reported favourably, **recommending the institution of geophysical facilities** by the New South Wales Geological Survey'.[1] It was in this report by Andrews (1928) that these recommendations were made and it is therefore an important source document in relation to the formal establishment of geophysical exploration in NSW and Australia, generally.[2]

As to Andrews' overseas travel, his biography by G. P. Walsh (1979) informs us that in 1908, 'Earnest Clayton Andrews' travelled to the USA and also visited Canada, England and Europe. At that time very little exploration geophysics was known but in 1927, according to Walsh (1979), 'he gave the Silliman lectures at Yale University'. By this time several methods were in routine use and it is likely that it was only during this later visit that he learned about the geophysics on which he reported.

In 1965, in my one year as a geophysicist in the NSW Geological Survey, I was fortunate to save a copy of Andrews'


Treatises on applied geology and mining science
Published by Professor Dr. Georg Berg
National Geological Institute Berlin
Volume 3.

The practical application of geo-physical methods of mineral survey with special reference to the electric and magnetic methods

by

Rudolf Krahmann, Dr. Engineering
Berlin

K. BURGGRAF SYDNEY

Wilhelm Knapp, Halle (Saale), Berlin, Publishers, 1926.

Fig. 1. *The front cover of Krahmann (1926) showing 'E. C. Andrews 1928' and also the stamp of K. Burggraf, the 'Elbof' agent in Sydney.*

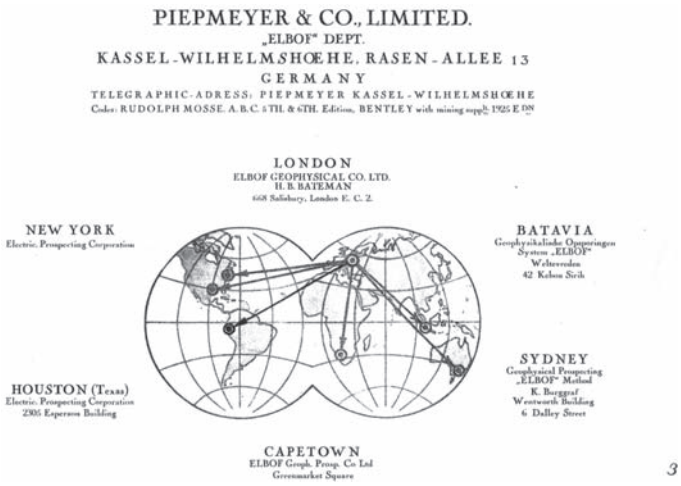
report, possibly his own copy, from being discarded. In addition, I was also able to retrieve a 3-page, typed occasional paper entitled 'Electrical Prospecting' signed by Andrews and dated 5/3/1925 (more on that later) and some reprints of papers and a company booklet, each apparently belonging to Andrews as they have his name and a date in 1928 handwritten on them. All were published in 1926 or 1927. Figure 1 is an illustration of the front cover of one such reprint showing the 'ownership' marking. The authors of the papers are prominent geophysicists of the period. As some are published in the USA, Andrews may have acquired these during his visit there in 1927. The company booklet is from 'Elbof' Geophysical Co. Ltd., a German contractor, and shows that they had offices in various countries including one at 6 Dalley Street, Sydney (Figure 2). These papers are all listed in the References and distinguished from other references by special notation. It is clear that this is where Andrews obtained much of the material for his report as parts of them are marked up, presumably by him. In themselves, they give further insight to the state of the profession at this time.

One reprint authored by Krahmann (1926) and published in Germany has an oval stamp on the front cover with 'K. Burggraf, Sydney' in the centre and around the perimeter, 'Australian Representative. Wentworth Building, 6 Dalley Street' (see Figure 1). In the 'Elbof' booklet, Burggraf is listed as the Sydney representative of the 'Elbof' Company (see Figure 2). This suggests to me that Andrews might have been given this copy of Krahmann's not easily obtainable paper, by Burggraf.

Because of the interesting insights that Andrews' report gives into the status of exploration geophysics at the time,

[1]Here, 'geophysical prospecting' is distinguished from observatory geophysics and regional surveys conducted by Nuemayer and others from 1860.

[2]As Section 7 of his report is titled 'Application to Australian Conditions', Andrews was thinking of applications not only in NSW.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„ELBOF" DEPT.
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ELBOF GEOPHYSICAL CO. LTD.
H. B. BATEMAN
668 Salisbury, London E. C. 2.
NEW YORK
Electric Prospecting Corporation
BATAVIA
Geophysikalische Opsporingen
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42 Kebon Sirih
SYDNEY
Geophysical Prospecting
„ELBOF" Method
K. Burggraf
Wentworth Building
6 Dalley Street
HOUSTON (Texas)
Electric Prospecting Corporation
2305 Esperson Building
CAPETOWN
ELBOF Geoph. Prosp. Co. Ltd
Greenmarket Square
3

Fig. 2. *Page 3 of Elbof (1927) listing an office in Sydney with K. Burggraf the representative.*

including its practice and some famous practitioners, and his recommendations for its establishment in Australia, I have, in the following, discussed the parts of most historical interest and in some cases quote verbatim from the report. Where appropriate, I also quote from the reprints that were in his possession, for further clarification. As the report has no figures, I have included some illustrations relevant to the time taken from some of the other papers Andrews possessed and other sources.

Andrews' report has the following section headings: 1. General; 2. Sources of Information; 3. Brief Statement of Processes; 4. Prices of Apparatus; 5. Costs of Geophysical Surveys; 6. Patents Covering the Methods; 7. Application to Australian Conditions; and 8. Conclusions and Recommendations.

In section 1, '*General*', Andrews proves to be a true geologist in not wanting to give geophysics all the credit with his very first two sentences: 'The various geophysical aids to prospecting, as at present known, **do not furnish royal roads** to the detection of commercial ore deposits. They merely furnish clues to, or indications of, the existence of certain masses of material in the field of operation which are relatively conductive or non-conductive'. Andrews is, in this instance, referring only to electrical methods and he goes on to explain how 'non-commercial material (such as "graphite schist") may yield extremely "favourable" [geophysical] indications'. Here, at least with electrical methods, Andrews is alluding to their inability to discriminate economic ore from worthless minerals on the basis of electrical properties. With regard to the use of other methods 'whether gravitational, electric, magnetic, seismic, or sonic', he still only allows that 'all that can be discerned by the geophysicist in this connection is that an ore-body…exerts a disturbing influence...'. After further enlargement on this theme with more examples, he concludes, 'that the assistance of the geologist is **indispensable**' and '...it is the province of the geologist to interpret the indications from the knowledge of the associated geology'. 'He [the geologist]…most materially, assists in giving definite form and colour to the final picture'. The indispensability of the geologist is repeated two times here and altogether five times in the report. One could say that he is not exactly making a strong case for the use of geophysics. He goes on, 'Each does excellent service in his special sphere'. However, 'neither [physicist nor geologist] can be expected **to spring full grown** into the other's work'. These days there is not this strict division and a good geophysicist will take account of the geology in his or her interpretation. Andrews does concede that while '**great skill** is needed in the continuous adjustment necessary ... for the proper evaluation of the various ...indications'. Is this some praise, at last, for the work of the geophysicist?

After some 650 words so far on this general theme, Andrews feels obliged to provide yet another analogy and for 300 more words describes the great value of the geologist in the construction of a 'hydro-electric power scheme', with no mention of geophysics. It is puzzling as to why this is in a report on geophysical prospecting for ore-bodies. He then goes on to suggest another analogy, '…the analogy of **sounds or of languages** is not inapplicable to the case of this geophysical work'. Then he refers to the 'peculiar sounds produced in his [the geophysicist's] head phones', and 'It is the province of the geophysicist, in electrical methods, …not to confuse **the roaring of a power-line**...with the **whistle of the ore body**…'.[3] Then, 'He [the geophysicist] proceeds to interpret these languages, but it is **the geologist** who interprets the ambiguous phrases and **the more difficult sentences**'. So the geologist comes to the rescue again.

Andrews finishes this section acknowledging that 'the accompanying report…is not complete, having been prepared by a geologist possessing **a slight acquaintance only** with mathematical and physical principles'.

Section 2, '*Sources of Information*'. Here, Andrews lists the 'names of the companies and individuals **interviewed** in connection with this geophysical enquiry'. The 'interviews' could have been conducted by correspondence and perhaps in preparation for his visit to the USA. Alternatively, all but one of the contacts could be found in the USA at this time so he could have met them there in 1927. 'Mr D. Mouchketov' from the 'Geophysical Survey of Russia' is unlikely to have been interviewed in Russia given the difficulty of international travel at the time (see Historical Context below). It is possible that he was also visiting the USA when Andrews was there. In Section 5 of his report, Andrews states: 'In south-western Wisconsin **which was visited by me**…'. He makes no mention in the report of his travelling anywhere other than to Wisconsin. However, there are also three references in the report (in Sections 4, 5 and 6) in relation to seismic, of further information (to do with prices and patents) being obtained 'after a visit to Oklahoma and Texas'. It is not clear if this trip is intended to be made later by Andrews or by another person.

Andrews' list is as follows:

i) Representatives of the 'Swedish American Prospecting Corporation', including 'H. Lundberg' ('H' being 'Hans'), no doubt of the 'Lundberg method' of Surface Potential referred to later, and 'Sundberg', most likely Karl Sundberg who Andrews later attributes to employing the Induction method he describes;
ii) 'Mr E. L. DeGolyer', said here by Andrews to be using gravity and seismic methods for locating salt domes in

[3]Andrew's biographer (Walsh 1979) says he 'never lost his youthful and schoolmasterly habits: in his papers, often prolix, he used apt classical allusions, once felicitously likening the geologist to "Antaeus of old, who must draw strength from continual contact with the Earth"'.

Oklahoma and Texas.[4] Also, according to Barton (1928) (one of the reprints I retrieved as belonging to Andrews), DeGolyer was President of Rycade Oil Corporation when a survey by Rycade discovered the Nash salt dome in Texas using the Eötvös torsion balance, in 1924. This is usually accepted as the first discovery of an oilfield by any geophysical method. Also, according to Barton (1928), DeGolyer was President of Amerada Petroleum Co. when the torsion balance was used to map structure on the oilfields in Oklahoma; [5]

iii) 'the Physical Exploration Corporation', including 'Messrs. M. Mason (President Chicago University), L. B. Slichter' and others.[6] One of the other publications I retrieved with Andrews' report was a reprint by Dr Max Mason (Mason 1927) from which it would appear Andrews gained much of his information, particularly about the magnetic and induction methods;

iv) 'Messrs A. L. Day and F. Wright of the Carnegie Geophysical Laboratory.' 'F. Wright' is presumably the Dr Fred Wright referred to later in Section 4 – Prices, in relation to a new type of gravity meter. Apart from this reference to Dr Wright, Andrews made no further mention of the Carnegie Geophysical Laboratory (CGL), which is one of the six research departments of the Carnegie Institution of Washington (CIW) created in 1905 and still very active today, concerned with research in the earth sciences. Another of the six departments of the CIW, the Department of Terrestrial Magnetism, was founded in 1904, originally to map the geomagnetic field of the Earth. The CIW made regional and observatory type magnetic measurements in Australia from 1906 to 1920. Day (1966) gives a detailed account of these surveys, which were not intended for purposes of prospecting.[7] This may be why Andrews did not refer more to the CIW.

v) 'Messrs E.G. Leonardon, Sherwin F. Kelly and Hoover representing the Schlumberger Electrical Prospecting Methods.'[8] Note that this is not actually a company but there was the Schlumberger Company of France (founded by Conrad and Marcel Schlumberger) which according to Day (1966) took out patents in Australia (see Andrews' Section 6 below);

vi) 'Mr D. Mouchketov… Director of the Geophysical Survey of Russia'. Mouchketov is referred to later, in the section on Prices of Apparatus, then as 'Dr.' Mouchketov.

[4]Clark (1999) claims that DeGolyer imported an Eötvös Torsion balance into the US for his company's use in 1924 and financed the formation of Geophysical Service Inc. (GSI).

[5]DeGolyer received the inaugural Honorary Membership of the SEG in 1930. Also in that same year, Donald Barton was the first President of the SEG and he received the SEG Honorary Membership award, posthumously, in 1940.

[6]Louis B. Slichter was awarded Honorary Membership of the SEG in 1959.

[7]At times some of the regional observation points were noted as being very anomalous, such as at Mt Magnet, W.A. which were then attributed to banded iron. For a colourful account of the CIW's use of camels in the desert and some excellent old photos, see Morrison (2005).

[8]Both Leonardon and Kelly subsequently published papers in the transactions of the Am. Inst. of Min. Metal. Engs. (AIMME) Transactions; Leonardon (1932) on electrical methods applied to problems in civil engineering and Kelly (1932) on a uniform expression for resistivity.

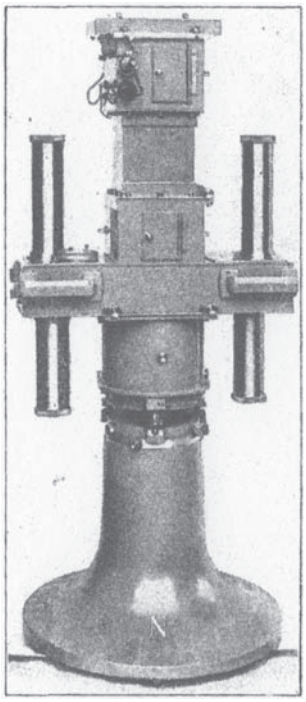

Fig. 3. *One type of torsion balance. (From Elbof (1927), p. 34).*

Section 3, '*Brief Statement of Processes*' is by far the largest section of the report in which Andrews describes seven exploration geophysical methods he knew to be available at the time. In the first, the '*Gravity Balance Method*', he describes the Eötvös torsion balance, first invented by Lorand Eötvös in 1890 and which was in routine use in the 1920s. Figure 3 is an illustration of one of the many versions of a torsion balance. Figure 4 shows a torsion balance in its housing to minimise

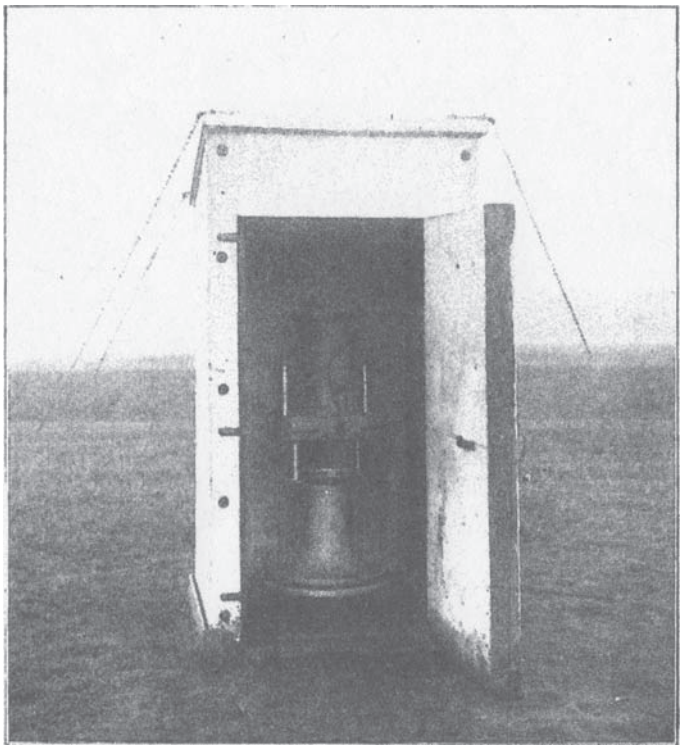

Fig. 4. *A torsion balance in a housing to protect it from atmospheric fluctuations particularly of temperature. (From Elbof (1927), p. 36).*

temperature changes during a measurement which usually takes 6 hours at each site.[9] Andrews states that 'the balance appears to have been successful in Texas and Oklahoma in the location of oil domes under great horizontal plains.' However, 'In areas of rough topography and in areas also containing only relatively **small ore bodies** under deep cover… the balance could not be expected to be very useful'. This is a reasonable conclusion by Andrews given that a) the balance was extremely sensitive to changes in topography in its proximity (within a radius of 100 m and more) and b) the relative insensitivity to small bodies.[10] Not surprisingly then, the torsion balance lost favour in the mid 1930s to the faster-to-read and easier-to-use suite of gravity meters as we know them today. Indeed, Andrews might have sensed this as he mentions two new types of gravity meter under development in his Section 4 on Prices of Apparatus. (More detail on this later.)

The next two processes, '*Seismic Method*' and '*Sonic Method*', Andrews states 'for the purpose of this report… may be considered together', apparently since they both involve 'a charge of explosive' ('Sonic' is synonymous with 'Acoustic', being sound waves with a higher frequency than most seismic waves). Andrews deals with these two methods together throughout the report; however, it is more likely that the sonic waves for sub-surface exploration are generated by mechanical vibration, for example, a 'sledge hammer' (Heiland 1968, p. 959). Mason (1927), whose paper Andrews follows a lot, does also deal with these two methods together. Mason claims that 'the acoustic method – which is, broadly speaking, the study of echoes reflected by ore bodies from incident sound waves – early proved rather disappointing'. In this, the shortest section of all methods described, Andrews alludes to the two method's 'ready application' in Texas and Oklahoma 'where salt domes occur more or less regular in shape'. However, he is here, I believe, suggesting their unsuitability in areas of intense structure, or 'many irregularities', as might occur around ore-bodies.

In the '*Self Potential Method*' Andrews gives a reasonable description of the, by now, well accepted process whereby the existence of currents flowing in ore bodies makes this method useful for their detection. In practice, the 'apparatus used consists of two electric cells on separate staffs, the two being connected by a wire, and one of the portable staffs carrying a potentio-meter with sensitive galvanometer'. Figure 6 is an illustration of the typical electrodes used in this period. Here he adds some history: 'Messrs, R. W. Fox and W. C. Henwood, in Cornwall about 1830, are reported to have been the first to investigate this method, while Carl Parus [sic] of the United States Geological Survey is reported to have employed it in 1882 at Comstock Lode'.[11]

The fifth method is called '*The Surface Potential Method*', a term not familiar to me. It is better known as the 'equipotential method' consisting of establishing an electrical field between ground contact electrodes and mapping distortions in the electric field due to anomalous conductivity. Andrews refers later in this section to the 'distortion of the **equipotential curves**'. Mason (1927) used this term 'surface potential' to involve the injection of current and observing 'the nature of the current distribution at the surface'. In his 3-page paper on electrical prospecting which I retrieved, Andrews describes, at some length, this 'equipotential' method using input electrodes and 'a telephone' to determine the null point between two search electrodes. He starts the paper with: 'The literature of prospecting for ore bodies by electrical methods is becoming quite voluminous, dating from 1907 onwards'.[12] As examples of its applicability he quotes at length from the 1922 Year Book No.16 of the Geological Survey of Sweden. This was all known to Andrews before he wrote his 1927 report.

First, Andrews briefly describes what he calls the 'Schlumberger method' whereby, 'current may be sent into the earth at two points by means of metal spikes or electrodes', but this is all he says specifically of this method here. Later in the section on Patents it is then referred to as the 'Schlumberger Process'. Mason (1927) also only says that 'Professor Schlumberger made creditable contributions to the study of artificial current distribution at the surface as influenced by ores'.

Andrews then describes the 'Lundberg method' where 'the current is passed into a great loop or coil, from which metal spikes or electrodes carry the current into the earth. In this method an area may be marked out, say 3,000 feet by 2,500 feet…occupied by two wires or extended electrodes, grounded at intervals'. (These are more or less exactly the words Mason (1927) used to describe the method he attributes to 'Hans Lundberg'.) Andrews continues with 'The occurrence of a definite conductor within the area examined is detected readily by the…points of minimum sound as detected in the head telephones used by the operators'. While he doesn't mention how the current is generated, later in the section on Prices to do with the Surface Potential method he refers to 'apparatus for production of **kilowattage**' [sic]. Krahmann (1926) in his paper, a copy of which was owned by Andrews, describes these two methods as 'the "Iso-Potential" method' and using 'a sensitive voltmeter connected between two searcher sondes' (electrodes).

After listing six conductive minerals and 11 poor or non-conductive ones, Andrews reintroduces the indispensability of the geologist to 'make a commercial interpretation of the **physicist's** observations' and to distinguish the worthless responses from an ore deposit, 'because the **geophysicist has not the wherewithal** to distinguish the conductive characteristics of these various occurrences'.[13] The indispensability of the geologist mentioned here for the fourth time, is also given prominence in the final conclusions. These

[9]Other illustrations of equipment and practice at this time are in Rayner (2007).

[10]Many such examples of the unsuitability of the method for ore-bodies are given in Barton (1928) which are heavily marked up in Andrews' copy.

[11]'Parus' is certainly a misspelling of Barus as Mason (1927) has it correctly as C. Barus who, as I know, published a paper 'On the electrical activity of ore bodies', (Barus 1882).

[12]The second sentence (from indistinct old typing copy) gives some famous names: 'The name of Professor C. Schlumberger Chief Inspector of Mines for France, Mr. G. Bergstron , Geological Survey, Sweden, H. Lundberg, H. Nathorst, and S. F. Kelly United States, are prominent in this connection'.

[13]Andrews uses 'physicists' interchangeably with 'geophysicists' and if there was any distinction in his mind, the physicist is usually mentioned in connection with the use of equipment and its operation and the 'geophysicist' more with interpretation of the observations. Sometimes Andrews recognised mathematics as being involved together with physics.

mentions are always accompanied by even more references to the inabilities of the geophysicist. So far he is not making a good case to recommend the inclusion of geophysics in the search for ore-bodies. Yet, he then refers to the ability of this method 'to detect the dip and strike of sediments underlying alluvium….and to locate faults', that is, structure as well as ore-bodies. And, 'Herein, there lies a great future for suballuvial and **submarine** geological surveying'. This is the only mention made of marine operations and it is not expanded on. However, he is now making a very important observation of 'the possibilities of **geological surveying by geophysical** methods when the various methods are employed together'.

It is intriguing that Andrews made no reference to the 'Resistivity method', where, by measuring the strength of the current as well as the potential difference, the physical property of conductivity is determined. Nowhere in the report is the term 'resistivity 'or indeed 'apparent resistivity' mentioned. Yet, this four-electrode method of resistivity prospecting was described as early as 1912 by Conrad Schlumberger (1915) and by Frank Wenner (1915), the latter being popular in the USA where Andrews might well have heard of it. There are cases of the use of the resistivity method before 1928 of which Andrews may have heard. For example, in 1925, Rooney and Gish (1927) carried out some resistivity depth soundings near Watheroo Observatory, W. A. Very soon after Andrews wrote his report, the resistivity method saw rapid growth and especially the theory and methods of interpretation (see Postscript).

The sixth method is '*The Induction Method*', the non-contact method using alternating electromagnetic fields. Andrews states that 'This method is "reported" to be the outcome of the early work of H. R. Conklin, and others…'. As Mason (1927) mentions H.R. Conklin as deserving 'credit, both for the early recognition of the possibilities of this method and for contributions toward its practical development', this is likely to be the 'report' Andrews refers to. To date I have not been able to find a reference for Conklin. Andrews attributes its use to 'Sundberg of the Swedish American Prospecting Company [as does Krahmann (1926)] and by the Physical Exploration Company'. As this method does rely on listening to specific frequencies of fields in headphones, Andrews strangely describes the frequency 'usually of 1,000 cycles per second with an acoustic effect somewhat resembling the whistle heard at times **at a peanut stand**' [?]. 'Higher frequencies giving sounds somewhat resembling **a sparrow chirp**'[14]. Figure 5 is an example of the receiving equipment for the Inductive method at the time.

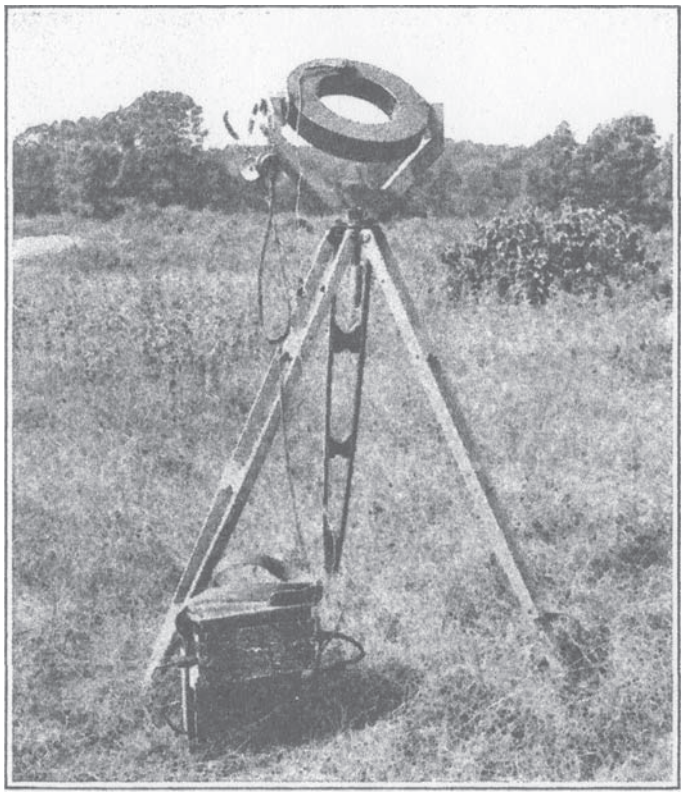

Fig. 5. *An example of the receiving equipment for the inductive method. (From Mason (1927), fig. 6).*

The seventh method is '*The Magnetic Method*', in which Andrews states 'This method appears to give great promise indeed in geological surveys. One State geological survey, at least, in the United States, namely, Wisconsin, has

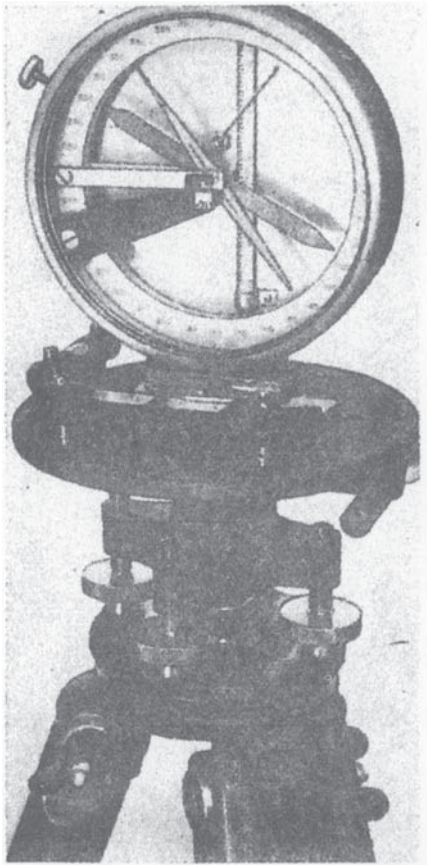

Fig. 6. *A Hotchkiss superdip. (From Heiland (1968), fig. 8–27).*

[14]In a similar way, Mason (1927) was not averse to anthropomorphising, claiming that 'If, then, the fundamental procedure is to shout down questions in the hope that an orebody will hear and answer back to us, it is clear that a large part of the expert's study must relate to the kind of questions best suited to the **temperament and intelligence of orebodies**'. [!] Also, 'In other cases…the ore is **too polite** to talk unless spoken to, and we therefore have to stimulate it with an individual field'. And, 'One must know in what language the ground will speak, how to distinguish the **Chinese of the surface soils from the Greek of the ore**'.

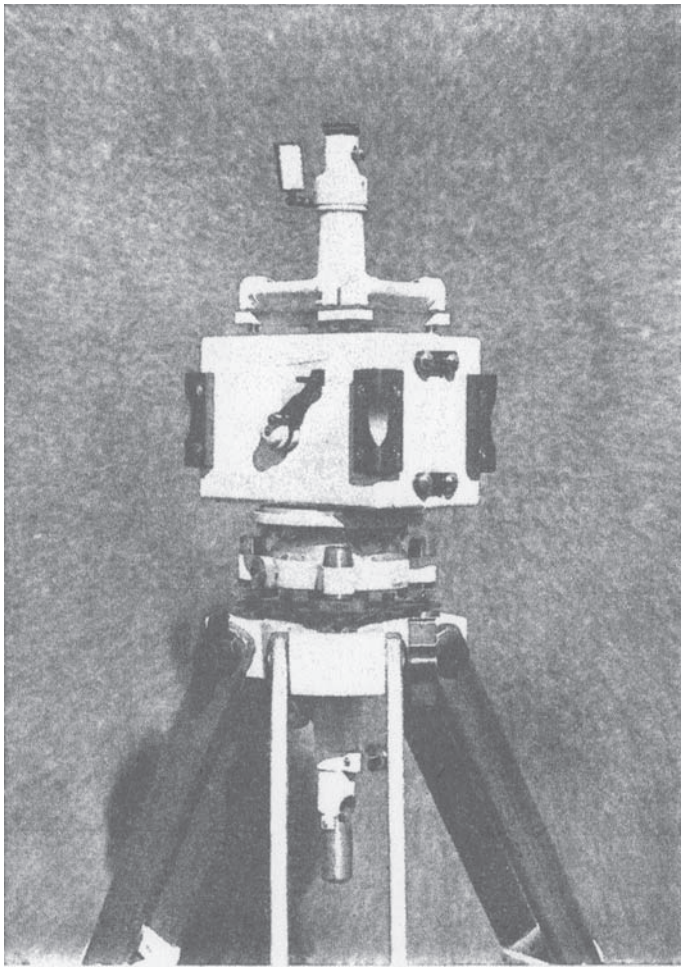

Fig. 7. *A Schmidt vertical balance magnetometer. (From Lewis and Blazey (1930), fig. 126).*

accomplished, and is accomplishing, splendid work by this method'. Only later, in Section 5, does Andrews reveal, 'In south-western Wisconsin, **which was visited by me**...'. He then describes three types of 'magnetic instruments' in use in the United States, namely, 'the Gurley Dip-Needle (with the Hotchkiss release), the Hotchkiss Needle and the Magnetometer. Of these the Gurley Needle is, by far, the simplest form, the Hotchkiss Needle being much more sensitive, but requiring much greater skill in its use'. Figure 6 is an illustration of the Hotchkiss superdip. 'The Magnetometer, of approved make, both of vertical and horizontal type, such as the **Askanie** [sic] balance made in Berlin, is extremely useful but very sensitive, and requires great skill and experience in the interpretation of the field observations'. As for 'Askanie', a misspelling he appears to have gained from Mason (1927), he is no doubt referring to Askania magnetometers, otherwise known at the time as 'Vertical and Horizontal Variometers' (Krahmann 1926 and Elbof 1927) or magnetic balances designed by Prof. Schmidt of Potsdam (the 'Schmidt Vertical Balance') in 1915 and manufactured by Askania Werke A.G. of Berlin. Figure 7 shows a typical Schmidt vertical balance.

Andrews has thus listed the three types in order of increasing complexity and skill required to use them. Apart from mentioning next the 'various magnetometers such as the Askanie [sic] and the Gepege' as needing 'Much greater care and skill…. with the employment of these delicate instruments.', he makes no further reference to magnetometers but rather more on dip-needles and their application to distinguishing various rock types, 'In skilled hands'. It would appear that he understands these better than magnetometers. Of course, dip needles had been in use as early as 1640 to map magnetite in Sweden (de Beer 2011). Andrews, later in Section 4 – Prices, refers to their poor sensitivity of 'about 5 x 10^{-2} Gausses' [sic] or 5,000 nT, whereas the sensitivity of the magnetometers 'is very great as it is down to down to 10^{-5} Gausses'. In fact, they had a sensitivity of about 10 nT and were in use for about 40 years. I have not previously known of the 'Gepege' magnetometer but once again, Andrews may be benefiting a little too much from his reading of Mason's 1927 paper who, in describing his Figure 2, illustration of 'Two types of portable magnetometers', states 'one is the Askanie [sic] balance, the other the Gepege', with no further mention of the Gepege. Later in Section 4, Andrews states; 'The Askanie and Gepege are in common use' and gives an address of where to obtain the Askanie but not the Gepege. In his section on the magnetic method, Mason (1927) states 'The pocket dip needle **of the geologist** has found increasing application in the rapid and cheap survey…', but 'where increased accuracy and sensitivity are desired, field instruments are now available which far surpass, in reliability, speed, and accuracy, those of a dozen years ago'. The more sensitive fluxgate magnetometer (0.2 nT) is yet to make itself known, at least to Andrews, having only been invented in Germany in 1928.

It is noted that Andrews did not include the *Radiometric method* in his list of methods. It was used at the time, but may be not much earlier and seemingly was not so well established. It is briefly described in Krahmann (1926), one year before his report. Krahmann gives only three references to the method, the earliest in 1910 and others in 1920 and 1921. The 'Elbof' booklet (Elbof 1927) owned by Andrews, also includes 'Radio-Activity Investigations' and gives one case study in Kahla, Germany.

Also, both Krahmann (1926) and 'Elbof' (1927) list another method which Andrews also doesn't mention, that of *Geothermics*. This method was very successful in South Africa in the early 1920s in predicting the temperature level in the deep mines of the Witwatersrand (de Beer 2011) and it is surprising if Andrews had not heard of it. Indeed, he made no mention at all of the growing use of geophysics in southern Africa in the early 1920s as reported by de Beer (2011).[15]

In Section 4, '*Prices of Apparatus*', Andrews comments on the costs of all the methods listed above and in some cases, gives more details on the equipment required. However, he prefaces this with 'Several of the processes are covered by patent, and for these the apparatus is prepared as it is needed by the companies interested'. He claims that the Sonic & Seismic, Self-Potential, Surface Potential, Inductive methods and the Hotchkiss needle were all patented, but not the Gravity and Magnetic methods. Here I was hoping to see at least a comparison of the prices for each method, even though they would be 1927 prices, but due

[15]Apart from geothermics, de Beer (2011) reports on 'a flurry of electrical prospecting activities' taking place from around 1925 largely to locate gold reefs, including by Conrad and Marcel Schlumberger and in the Zambian copper belt by Broughton-Edge (who later directed the IGES trials in Australia). Andrews was apparently unaware of this activity in Southern Africa otherwise he would surely have used it to support his recommendations.

to the patenting issue, Andrews gives prices for the 'Oertling Balance [a type of torsion balance], £900 in London'; 'Eötvös Balances £800 to £1,000 in U.S.A'; 'The Gurley needle with Hotchkiss release' – $25 (only, even then) from Gurley in New York, and the magnetometers: Askania type – $560 in Europe and about $900 in the USA.[16] To these prices, duty and transport costs would be added.

In this section 4, Andrews gives not only prices but some further detail on the type of instruments, their weights in some cases, some relative sensitivities in the case of magnetometers as we have discussed above, and also how they were used in the field. For some instruments, he gives detailed names and addresses from where they may be purchased. Here, he again mentions Dr Mouchketov, from Russia, who claimed to be perfecting a smaller, lighter and cheaper gravity balance than those from Hungary. Even more interesting I find, is reference to a Dr Fred Wright (most likely the 'F. Wright' of the CIW in Sect. 2) 'designing a tungsten wire, coiled in the form of two hollow cones which is designed to take the place in part at least of the gravity pendulums. In this method, however, the total pull of gravity is recorded whereas in [Balances], the variations alone in gravitational attraction are recorded'. Is this the beginning of the 'zero-length spring' invented by Lucien LaCoste in 1932 and of the gravity meter we now know was soon to replace the slow and laborious torsion balance?

Section 5, '*Costs of Geophysical Surveys*', commences with 'It is not customary to find surveys conducted with the use of one method only with exception of magnetic surveys such as those carried out by the Wisconsin Geological Survey', whereupon he gives some examples of combined methods. Not much of the rest of this section is of lasting historical interest as Andrews outlines courses and training sessions available from the companies and institutes active at the time as mentioned in Section 2. This section is divided into three sub-sections, the first being 'Wisconsin Magnetic Survey (Gurley needle)'. Even in those days, students were being used (exploited?) by their universities, such as the reported case of a 'raw student' in Wisconsin 'For the first month he receives **no pay** but transportation and subsistence costs are found'. The second sub-section entitled 'Gravimetric, Sonic and Seismic Surveys', referring to salt domes, is where he states: 'General costs will be supplied later **after the Oklahoma and Texas areas have been examined**' (by Andrews or whom?). The third sub-section is entitled 'Costs by the Schlumberger, the Swedish-American Prospecting and the Physical Exploration Companies', and he first examines the costs of the 'Schlumberger process', by supposing an area like Broken Hill with the nature of the area supplied by Andrews and costs prepared by E. G. Leonardon of the Schlumberger Co. of New York. A list of individual costs is provided including the 'Trip return **from New York** for one or two observers'! Travel was presumably by ship. No other useful comparisons of costs are given in the rest of this section.

Section 6, '*Patents Covering the Methods*', gives some of the patents current at the time. The only ones applying to Australia are, the 'Schlumberger process' patented in Australia in June 1913 (#9,378) and May 1914 (#13,132) and patents that Andrews attributes to 'The Swedish-American Process – The Lundberg Process and the Sundberg Process', and those covering Australia, with no dates, are #11,438 and #10,535. Day (1966) states these last two patents were taken out in 1913 by the 'Electrical Prospecting Company of Sweden (ABEM)'. Once again, Andrews says that information on patents for the 'Sonic and Seismic' methods will be obtained 'after a visit to Oklahoma and Texas'. He does not say by whom and when.

In Section 7, '*Application to Australian Conditions*', Andrews considers the application of geophysical methods to Australian conditions but not before another cautionary first sentence: 'Geophysical methods as applied to prospecting for ore deposits…only during quite recent times that they may be said to have conquered many of the initial difficulties'. He then examines two broad categories, first, 'Oil, Gas and Coal' and second, 'Other Minerals'. For oil he nominates 'The Greater Roma District' where he suggests applying every method he described previously, and 'the Tertiary rocks and sediments of southern Victoria and South Australia…' [where] 'there have been many assertions that these areas are oil bearing'. Thus Andrews was not only thinking of New South Wales. His suggestion of the potential of the Roma district certainly proved to be very prescient. As for coal, 'The coal measures of the Hunter River Basins appear well adapted to the….self-potential, surface-potential, inductive, and magnetic processes'. The 'magnetic processes' are presumably included for the interbedded 'lava flows'.

In 'Other Minerals' Andrews nominates, not surprisingly, the 'Broken Hill District' for '…various modified forms [?] of the electric and magnetic methods…'. Exactly what these modifications are, he does not say. He reveals here that electric methods would be appropriate as 'galena, the principal lode mineral, is a good electrical conductor'. Other areas nominated are 'The Greater Cobar District' (again no surprise here), 'The Lake George District' (could he be thinking of Woodlawn?), 'The west coast of Tasmania' (outside NSW again and once again, showing good foresight) and 'the Great Artesian Basin' generally. Interestingly, he confesses that 'The question of prospecting for **the gutters of deep leads** is occupying my attention' (this will be referred to by me again below) but, 'Much depends on the amount of conductive material (pebbles) occupying the gutter and the **relative** conductivities of these as compared with those of the (usually) hard bed rock'. Here he recognises the necessity for a difference in physical properties. He concludes this section with '…the several areas mentioned above will serve to illustrate **the advisability of securing geophysical methods in New South Wales and Australia at an early date as an aid to geological survey and to mining generally**'. Now (one might say, 'at last') he has made his case for geophysical methods to be adopted generally.

More specific recommendations and how Andrews thinks they should happen are given in the final section, '*Conclusions and Recommendations*'. However, he begins this section by once again reverting to the very first sentence of his report '…there is no royal road to prospecting, or to surveying**,** by geophysical methods', except that this time he has added 'surveying' as he now recognises the possibility of using geophysics for geological surveying as well as for direct search. It is as if he is understanding more as he writes his report. And yet again, for one final time, '…it is coming to be seen more and more how **indispensable are the geologist's services in the *interpretation* of the geophysical notes**…'. More importantly, the next sentence is; 'This class of work is taught in various

[16]Andrews makes no further mention of the Oertling Balance of which one was used by the IGES and is now on display in the National Museum of Australia. Read more on this in Rayner (2007). Also, Andrews may have mixed pounds and dollar symbols wrongly here.

colleges in Europe, and…has already been commenced in the United States, as at Golden, Colorado', thus recognising that courses at universities are required. The next short sentence, on its own, is 'It appears advisable also to introduce **it** into New South Wales and into Australia generally'. One presumes that the vague word 'it' is referring to the 'work' [of geophysical prospecting] but is he also including in his recommendation the teaching of it in universities in Australia? I feel that he knew it would be necessary here too. This aspect of the recommendation has not been suggested before by Day (1966) or others. There is support for this possible additional recommendation later on in his closing sentences where he once again mentions 'University geologists'.

Andrews then splits his specific suggestions for further action into two cases, 'New South Wales alone' and 'Australia Generally'. For New South Wales, 'In this case it would appear advisable to send a man of promise **and address** [?] to the United States at least, where so many leaders in geophysical methods are assembled, to learn the various processes, especially the gravimetric and the magnetic, and to visit various areas in which the several methods have been found to be especially applicable'. Has Andrews favoured gravity and magnetics perhaps because he has said before that these two methods are taught at 'Colorado Mining College at Golden'? Has he not specified any other methods, such as the inductive method because he didn't know of their being taught in the USA? Judging from his own 1925 paper on 'Electrical Prospecting' he may feel he knew this method well enough; also the self potential method is simple and he didn't have confidence in the seismic method for ore-body detection.

In the second case of 'Australia Generally', '…it appears advisable, as a preliminary, to obtain a report from some accredited person or persons as to the nature of the methods and progress made therein generally in the United States and in Europe.' Andrews doesn't say who might provide this report but he says that 'The Director of the Bureau of Mines in the U.S.A.' has been preparing one to which he has not had access. And then; 'This report…could be presented to a conference of Federal, State and University geologists, together with representatives of the **Federal Council of Science and Industry**'. First, note that Universities are included and not just Surveys. Also, the Council he refers to was the precursor of the CSIRO, only just formed in 1926.

Day (1966) claims 'Andrews' report…[contributed] to an approach by the Australian government to the Empire Marketing Board in 1927 concerning geophysical surveys'. A subsequent proposal that an extensive trial of the principal methods take place led to the formation of '**The Imperial Geophysical Experimental Survey' (IGES)**, in 1928. This is another exciting story well documented by Day (1966) and entertainingly described by Rayner (2007).

It is perhaps no coincidence that only two years after Andrews' recommendations were published, the first geophysicist was appointed to the NSW Dept. of Mines. This was J. M. Rayner, whom Day (1966) states was 'the sole geophysicist in permanent government service in Australia at the time'. Rayner was seconded to the scientific staff of the IGES in 1929.[17] With regard to my inference that Andrews was also recognising the need to have courses in exploration geophysics in universities, according to Day (1966), 'a University undergraduate geophysics course was not established until 1950' when Sydney University appointed as lecturer Dr H. I. S. Thirlaway, a graduate of Cambridge, to 'develop teaching and research in geophysics, both fundamental and applied'.

[17]Interestingly, the first report of many that Rayner was to publish (Rayner 1931) was on magnetic surveys over basalt-covered deep leads at Gulgong, the very 'gutters' that were occupying Andrews' attention as he stated in his report. A lot of interesting information about Jack Rayner is given in Rayner (2007).

Postscript

Just at the time Andrews was writing his report in 1927, radical new developments in geophysical instrumentation were beginning to appear and many of the methods he described were to become out-dated just a few years later. His 'magnetometers' or Variometers were soon replaced by the more sensitive fluxgate magnetometers, gravity meters of the type we use today were in routine use in 1929 and the torsion balance was no longer competitive by the mid-1930s (Clark 1999), the surface potential method was even at the time being replaced by the resistivity method (for example, Schlumberger (1915) and Wenner (1915)) and induction methods were to blossom into many variants and improve with better electronics (no more headphones!). The theory and interpretation of methods was also developing rapidly from the early 1930s. For example, from my own research in electrical methods, Tagg (1930) as one of his many papers over 30+ years, published on theoretical considerations of the resistivity method, Roman (1931), in one of many papers over 30 years, published on the computation of tables for determining the resistivity of layers, Kelly (1932) published on a uniform expression for resistivity, and Slichter (1933) on interpretation. Many other papers followed throughout the 1930s.

Historical context

It is interesting to consider the historical context of Andrews living in Sydney in 1927. One major change to life-style just beginning at the time was the growth of aviation which was then in its infancy. In 1919, the Smith brothers, Ross and Keith, had flown from London to Darwin in just under 28 days. Soon after, the continent was traversed by air from north to south and from east to west. In 1927, Charles Kingsford Smith and Charles Ulm circumnavigated Australia in what was then, only 10 days, before becoming the first team to cross the Pacific from San Francisco to Brisbane in May 1928.

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Are we really that special?

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'The oil and gas industry has always had unique data volume, access and retention issues' and 'No other industry in the world has the same issues as the oil and gas sector'. These two sentences above used to be so true, but times are changing and big data problems and technologies are now active parts of many large corporates outside the oil and gas sector like medical, advertising and online retailers.

For whatever reason, the oil and gas industry still has strongly held beliefs that their problems and the sheer scale of these problems are still unique or special in some way. The industry seems to prefer isolation from other industries instead of collaboration and dialogue.

After watching the past few years go by, and having seen completely new trends in data management and data storage enter the market, I am here to tell you that the oil and gas industry is not really all that special anymore, and isolation is nothing but a choice.

For instance, type 'Big Data' into Google and you will see the struggles, and now the many solutions, that have been created by other industries to solve similar problems and at similar scales to the oil industry.

Take the medical industry for instance. It is now using tools to analyse tens of millions of medical records for trends like who is at most risk of having a stroke or how complex interactions between drugs in patients in different countries will manifest itself. You could substitute these two examples above with oil and gas issues like tens of millions of seismic records or complex interactions with drill bits in certain geologies, but still use the same big data tools from the medical industry to solve them. Yet for whatever reason – we choose not to use big data tools. Heck, even online retailers can now crunch hundreds of millions of transactions to isolate as few as a hundred gullible, stay-at-home parents, so as to sell that last lot of stock.

In fact, the oil industry has the ability to do more than just use these tools to look for trends, it has the know-how and budgets to go from simple real-time monitoring (which it has done for years) to real-time prediction, which is an order of magnitude better. While some companies have managed to integrate non-oil and gas industry tools for big data into their businesses, many still remain sceptical and choose to stick with what has worked in the past, and of course remain happy to pay oil and gas industry prices for products that are really adaptations of another industry. Want to make more money selling software? Then change the name of your product to include the word 'Petro' in it.

Okay, so let's face the facts…the oil and gas industry is not really all that special. I mean, we do usually have pretty good end-of-financial-year parties and the wine at industry events is usually a cut above many other industries, but in the main we share a lot more problems with other industries than we think and it is probably time we started to share some of the solutions too.

I note in October in Houston there is a big data conference for the oil and gas industry. It is one of the first times I have seen such an event and I have to say it is very encouraging. The more we start to see how the other half lives, the sooner we will realise our full potential.

November			**2013**
12–13	The XIth International Seminar of Research and Applied Geophysics: Application of the modern electric exploratory technologies in prospecting of mineral deposits *Please contact Nina Pokrovskaya via email (geophysics@spmi.ru) for further information.*	St Petersburg	Russia
18–21	The 11th SEGJ International Symposium: Geophysics for establishing a sustainable secure society http://www.segj.org/is/11th/	Yokohama	Japan
23–25	Kochi 2013: 10th Biennial Conference and Exposition on Petroleum Geophysics http://www.spgindia.org	Kochi, Kerala	India
23–27	Second International Conference on Engineering Geophysics http://www.eage.org	Al Ain	UAE
28	10th SA Exploration and Mining Conference (SAEMC) http://www.saexplorers.com.au	Adelaide	Australia
January			**2014**
19–22	The 7th International Petroleum Technology Conference (IPTC) http://www.iptcnet.org/2014/doha/	Doha	Qatar
February			**2014**
25–27	SPE/EAGE European Unconventional Resources Conference and Exhibition http://www.eage.org/index.php?evp=1979	Vienna	Austria
March			**2014**
9–12	GEO 2014: 11th Middle East Geosciences Conference and Exhibition http://www.geo2014.com/	Manama	Kingdom of Bahrain
16–20	SAGEEP 2014 (The symposium on the application of geophysics to engineering and environmental problems) https://www.eegs.org/AnnualMeetingSAGEEP/SAGEEP2014.aspx	Boston MA	USA
April			**2014**
7–10	The 6th Saint Petersburg International Conference and Exhibition http://www.eage.org/index.php?evp=1979	St Petersburg	Russia
June			**2014**
16–19	76th EAGE Conference and Exhibition incorporating SPE EUROPEC 2014 http://www.eage.org	Amsterdam	The Netherlands
20–23	ICEEG 2014: 6th International Conference on Environmental and Engineering Geophysics http://tdem.org/iceeg2014/en	Xi'an	China
September			**2014**
15–17	EAGE Near Surface Geoscience 2014 20th European Meeting of Environmental and Engineering Geophysics of the Near Surface Geoscience Division of the EAGE http://www.eage.org/events/index.php?eventid=1013&Opendivs=s3	Athens	Greece
28 Sep–2 Oct	2014 Canadian Geotechnical Conference *Conference website pending. Please email cgs@cgs.ca for additional information or visit the CGS website (www.cgs.ca).*	Regina	Canada (Saskatchewan)
February			**2015**
15–18	ASEG-PESA 2015: Geophysics and geology together for discover 24th International Geophysical Conference and Exhibition http://www.conference.aseg.org.au/	Perth	Australia

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The ASEG SA/NT Branch is pleased to be able to present the following wines to ASEG members. These wines were found by the tasting panel to be enjoyable drinking and excellent value. The price of each wine includes GST and bulk delivery to a distribution point in each capital city in early December. Stocks of these wines are limited and orders will be filled on a first-come, first-served basis.

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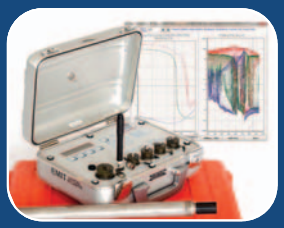

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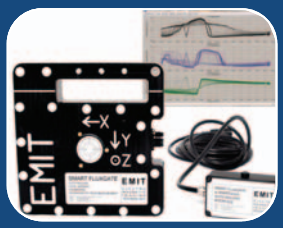

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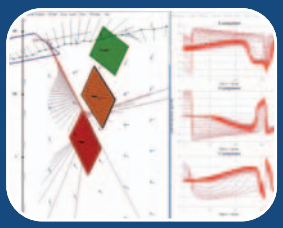

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