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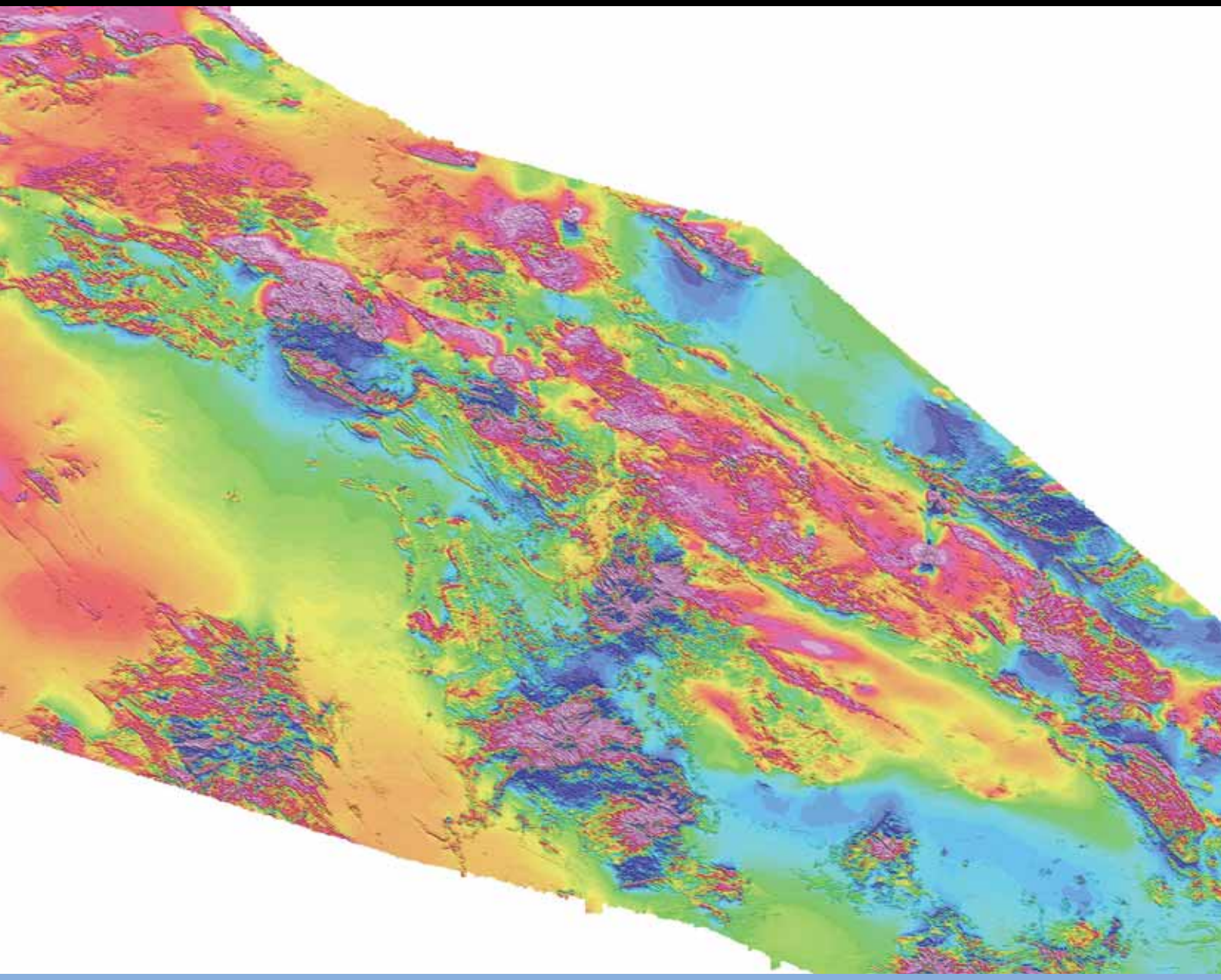
PREVIEW

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS



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FRONT COVER

Image of reduced-to-pole total magnetic intensity in colour over sun-shading in greyscale – PNG Highlands and Papuan Peninsula Survey, Mineral Resources Authority, PNG (see p. 18 of this issue).

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Ann-Marie Anderson-Mayes

Do you have a position on global warming? Is it a topic about which you hold strong views or are you perhaps in 'wait and see' mode? Up until I began preparation of this issue, my attitude was ambivalent at best. This was largely guided by the fact that I simply do not know enough about the topic to make a well-informed decision. Furthermore, the task of becoming better informed (by reading well researched scientific texts and not just the media sound bites) was something that I had put into the pigeonhole labelled 'When I have more time'.

However, then David Denham's article on 'The future of people on planet Earth: challenges for geophysicists' arrived. This piece is based on David's keynote address at the Opening Session of the 9th SEGJ International Symposium in October 2009. David examines the interdependence of five key factors that impact on the survival of the human species – population, food (including water), energy, climate and human behaviour. This article makes for very interesting reading, and I hope leaves you thinking about your role in this world as both a human and a geophysicist.

Michael Asten's President's Piece arrived in my Inbox about a week later. Please make sure you read it – Michael's article presents an excellent, big picture look at why climate change science is such a difficult topic to fully understand. The complexity and breadth of the science is matched by a bewildering array of responses and opinions in sociological, economic and political arenas. It is the latter which seem to frequently find air time on our major media outlets.

It is fair to say that David and Michael hold different views on anthropogenic global warming. My knowledge of the topic is restricted to what I have heard and read in the media, albeit through hopefully reputable media outlets such as the ABC and science magazines. The articles I had received provoked a guilty conscience – I really needed to become better informed, especially if my role as Editor was going to bring more pieces on this topic into my Inbox.

And thus came the most surprising discovery of all. Having decided to make myself better informed, my first stop was the local library. To my surprise, and dismay, more than 80% of the library's texts on climate change science were sitting on the book shelf, ready for me to borrow immediately. Even if this is the critical challenge for our times, there is not an overwhelming need to know more amongst the members of my local community. But who am I to judge – because up until a few weeks ago I hadn't looked for those books at the library either!

So, I still do not hold a position either way. Our family is conscious of reducing greenhouse gas emissions without being obsessive. We have solar hot water, grow some of our own fruit and vegies, walk the children to school, reuse and recycle, etc. I suspect this is driven more by a desire to be conservative in our consumption and model this for our children, rather than any specific fear of global warming. However, I am slowly becoming better informed about climate change science, and perhaps after reading the articles mentioned above, you will be similarly inspired.

Other articles in this issue of *Preview* include an interesting piece by Bruce Dickson about the importance of correct calibration for total count logging; a look at the challenges of a major airborne magnetic and radiometrics survey in Papua New Guinea; the movements in major commodity prices during 2009; a worrying review of the web pages associated with geosciences at Australian universities; everything you need to know about the ASEG's AGM in April; and the usual array of news and information.

Don't forget – *Preview* is *your* magazine for *your* professional society. If you have something to say, a story that should be shared with your colleagues, don't just think about it. Say it! Send me an email at preview@mayes.com.au.

Nominate

a colleague for an ASEG Honour or Award

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- Service to the ASEG

Announced at:

- ASEG Sydney Conference 22–26 August 2010

Nomination guidelines:

- This edition of *Preview* (see p. 9)
- ASEG website www.aseg.org.au/awards

Submissions by 31 June 2010:
Phil Harman
Chairman, ASEG Honours and Awards Committee
Email: phil.harman@bigpond.com.au

On climate change, the elephant, tusk and tail

Some members may have noticed in recent months that I, very much as a fool among angels, have ventured into the climate change debate via a series of Opinion pieces in *The Australian*. The odyssey was first inspired by my noticing the phase relation between changes in concentration of atmospheric carbon dioxide and global temperature through 800 000 years and eight ice-age cycles; the phase relationship can be studied using the same time-series coherency analysis as we use for magneto-telluric and seismic array data analysis, and the result has implications in the debate on cause and effect of climate change.

In reading further into climate change science, two features quickly emerged. Firstly, the science is incredibly broad, calling on an understanding of the physical chemistry of greenhouse gases; the physics of atmosphere and oceans for the capture and movement of heat; and an understanding of botany, archaeology, geochemistry and palaeontology for deducing the history of climate change at scales ranging from decades to eons. Add in an understanding of planetary motion, solar physics, interplanetary magnetic fields and cosmic rays in order to quantify the variable heat flux affecting the Earth, and follow up with in-depth knowledge of complex numerical modelling of all of the above and how it applies to fitting the past and predicting the future, and we are ready to contribute to the debate. Having mastered the science, we might then move on to the wider sociological, economic and political debate. The reality is that no single scientist can begin to span all of these fields.

The second feature apparent in informal and sometimes formal debate is the level of scorn commonly poured upon those who venture an opinion, by those who hold contrary views. In 38 years of involvement in R&D I have not encountered any comparable instances in science where debate degenerates to personalities and abuse as does this debate. (The nearest comparisons I can offer would be political debate from the Vietnam War years of the 1960s, perhaps the creation science debate in southern states of the US over the past decade, and the commonly free-flowing discussion between geologists and geophysicists in the second hour of a long evening spent in the Wet Canteen.) The phenomenon is most obvious in blog discussions by many commentators and some scientists of both sides in for example websites 'Real Climate' and 'Watts up with that' which respectively specialise in comment pro and con anthropogenic global warming, although I must add that there are also many well-argued contributions in these forums to be found at http://www.realclimate.org and http://wattsupwiththat.com.

On occasion the less than objective attitudes reach further into formal scientific literature such as an editorial in *Nature Geosciences* (January 2010) which commences: 'The illegal hack into the computers of the world-renowned Climatic Research Unit in Norwich, UK has brought the dwindling fringe of climate change deniers a rare flurry of media attention...'. I trust that authors who publish in the prestigious journal *Nature* and its stable-mates take a more objective approach to science.

Climate change, in particular global warming attributable to the burning of fossil fuels, is often described as the 'elephant in the room' of our civilization. The poem by John Godfrey Saxe telling the ancient Indian fable of six blind men and the elephant is an apposite reminder of the hazards of forming an unshakeable conviction from a partial understanding of the whole truth.

Does this relate to geophysics? Whether we see climate change as a great moral issue, a political issue, or as a scientific issue, we cannot escape the fact that government actions will probably have a huge effect on our industry over the next decade, whether it be via disincentives to coal mining, incentives for the location of rare-earth elements for advanced electric battery storage, a need for new engineering site evaluations for wind-farms and (dare I add) nuclear power stations, or development of new geophysical methodologies for application in hydrology and land management.

As scientists we are trained to read reports, check facts, and go back to sources (how often have we learned something new by re-examining fundamental facts in a piece of drill core!). The same methodology will,

The Blind Men and the Elephant

It was six men of Indostan
To learning much inclined,
Who went to see the Elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind

The First approached the Elephant,
And happening to fall
Against his broad and sturdy side,
At once began to bawl:
"God bless me! but the Elephant
Is very like a wall!"

The Second, feeling of the tusk,
Cried, "Ho! what have we here
So very round and smooth and sharp?
To me 'tis mighty clear
This wonder of an Elephant
Is very like a spear!"

The Third approached the animal,
And happening to take
The squirming trunk within his hands,
Thus boldly up and spake:
"I see," quoth he, "the Elephant
Is very like a snake!"

The Fourth reached out an eager hand,
And felt about the knee.
"What most this wondrous beast is like
Is mighty plain," quoth he;
" 'Tis clear enough the Elephant
Is very like a tree!"

The Fifth, who chanced to touch the ear,
Said: "E'en the blindest man
Can tell what this resembles most;
Deny the fact who can
This marvel of an Elephant
Is very like a fan!"

The Sixth no sooner had begun
About the beast to grope,
Than, seizing on the swinging tail
That fell within his scope,
"I see," quoth he, "the Elephant
Is very like a rope!"

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong!

Moral:
So oft in theologic wars,
The disputants, I ween,
Rail on in utter ignorance
Of what each other mean,
And prate about an Elephant
Not one of them has seen!

John Godfrey Saxe (1816–1887)

if we choose, allow us to be informed contributors who channel the climate change debate rather than drift with it.

I wish us all an intellectually challenging new year.

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

Post Script

A few references I can recommend from the available thousands are:

(a) A book by one of the founding fathers of climate change science Wally Broecker and journalist Robert Kunzig, *Fixing Climate*, Profile Books Ltd (a very readable account of the history of science behind development of the concept of anthropogenic global warming).

(b) A book by Garth Paltridge (a climatologist and former CSIRO Chief Scientist) *The Climate Caper*, Connorcourt Publishing (provides a cautionary view of both science and politics of current anthropogenic global warming debate).

(c) A lengthy essay by American Chemical Society Senior Editor Stephen K. Ritter on the two sides of the current global warming debate, 'Global Warming And Climate Change', *Chemical and Engineering News*, v. 87(51). Online at http://pubs.acs.org/cen/coverstory/87/8751cover.html

(d) Online articles and books by top British journalists George Monbiot and Chris Booker who take strong positions pro and con anthropogenic global warming respectively.

(e) Opinion pieces and other articles published in *The Australian* are accessible online at http://www.theaustralian.com.au; type the author's name in the global search box, e.g. Michael Asten, Bjorn Lomborg, or Garth Paltridge.

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Notice of 2010 AGM

The ASEG's AGM will be held on Tuesday 13 April 2010 at 5.30 pm in the City West Function Centre, 45 Plaistowe Mews, West Perth.

The Agenda for the AGM, the voting forms for the proposed changes to the Constitution, the proxy forms, and the detailed changes being proposed will be sent to members and will also be posted on the ASEG website. Nominations must be lodged with the Secretariat no later than COB Monday 15 March 2010 and must be supported by a proposer and a seconder.

We plan to make some changes to the Constitution at the AGM to stream line the operations of the Society, to encourage more Active Members, and to bring the Constitution up to date with current practice.

The changes we are proposing have been fully discussed at the Federal Executive during the year and all the ASEG Branches have been consulted on these proposals. The details will be posted on the web-site in the near future but it is appropriate for me to summarise these changes and why they are being proposed. The full proposals will also be emailed to all members.

6.1 Changes to Section 3: Objects

The proposed changes involve the addition of a clause (k) and an expansion of clause (d) so that it is clear that the ASEG should aim to influence governments and the general community on the importance of resource exploration. This change will emphasise these issues in the Constitution and also bring the Constitution into line with recent actions of the ASEG.

(d) promote good standing of the geophysical profession to our peers and the general community;

(k) provide advice to federal and state governments on issues relating to the geosciences.

6.2 Changes to Sections 4 and 5: Composition and membership

The changes to these Sections are being proposed for three main reasons.

(1) In the present Constitution only Active Members can vote and be Office Bearers of the Society. Furthermore to become an Active Member requires the equivalent

of 8 years experience in geophysics. As a result many young energetic members are prohibited in taking a full part in the Society's activities – because they can currently only be Associate Members. The proposed changes aim to correct this situation.

(2) Active Members are the life-blood of the Society. We must make the process of becoming an Active Member as simple as possible, without compromising the requirement that all members are enthusiastic about geophysics. The more Active Members we have, the more we will have to offer our Members and the more influential and successful our Society will be.

(3) We must also try to engage our student members and provide them opportunities to increase their participation in the Society.

The main changes needed to achieve these goals are listed below.

4. Composition (*Amended Section*)

The Society shall consist of the following classes of members, namely (i) Honorary Members, (ii) Associate Members, (iii) Active Members, (iv) Corporate Members, (v) Corporate-Plus Members, (vi) Retired Members and (vii) Student Members.

5.3 Active Membership (*Re-written and simplified*)

To be eligible for election to Active Membership an applicant must be actively engaged in practicing or teaching geophysics or a related scientific field. Conditions for Active Membership include a relevant academic qualification. Any person who does not have such academic qualifications, but who has been actively engaged in the relevant fields of interest of the Society for at least 5 years shall also be eligible for membership upon the discretion of the Federal Executive Committee.

5.9 Voting rights (*New Clause replaces 5.9.13–5.9.15*)

Active Members, Associate Members, Student Members, Honorary Members, Retired Members, Corporate and Corporate-Plus Members have full voting rights and the right to speak at Society meetings.

5.10 Office Bearers (*New Clause replaces 5.9.13–5.9.15*)

Active Members, Honorary Members, Retired Members, Corporate and Corporate-Plus Members shall be eligible to hold any office, to vote on all matters submitted to the membership, to petition the Federal Executive on any matter, and to publish their affiliation with the Society.

For the purposes of the above, Corporate and Corporate-Plus Members may nominate a representative who will act on the Member's behalf from time to time, by notice in writing to the Society.

6.3 Changes to Section 8: Federal Executive

These changes are aimed at clarifying who is a Director of the Society for the purposes of the 2001 Corporations Act and increase the size of the FedEx to 12 people to bring the Constitution in line with current practice. This means that the four elected members of the FedEx will be Directors for the purposes of the Act.

6.4 Changes to Clauses 14.1.3 and 14.2: right to vote and general meetings

These changes are necessary for consistency with the changes proposed to Sections 4 and 5 above.

David Denham
Secretary, ASEG

Invitation for candidates for the Federal Executive

In accordance with Article 8.2 of the ASEG Constitution '…*Each member of the Federal Executive is a Director of the Society for the purposes of the Act.*'

The Federal Executive shall comprise up to 10 members, and shall at least include:

(i) a President
(ii) a President Elect
(iii) a Secretary
(iv) a Treasurer

These officers are elected by a general ballot of members.

In addition the following offices are required:

(i) First Vice President
(ii) the Immediate Past President (unless otherwise a member of the Federal Executive)
(iii) the Chairman of the Publications Committee
(iv) the Chairman of the Membership Committee
(v) the Chairman of the State Branch Committees
(vi) One other to be determined by the Federal Executive

These officers are appointed by the Federal Executive but nominations are very welcome.

Please forward the name of the nominated candidate and the position nominating for, along with two members eligible to vote, to the Secretary:

David Denham
c/- ASEG Secretariat
PO Box 8463, Perth Business Centre
WA 6849
Tel: +61 8 9427 0838
Fax: +61 8 9427 0839
Email: secretary@aseg.org.au

In accordance with Article 14.3.8 of the ASEG Constitution '…*The Secretary will cause publication, at least* ***two*** *months prior to the Annual General Meeting, in one of the Society's publications and on its Web-Site in a prominent location an invitation from members for suitable candidates for any of the office positions on the Federal Executive. Any such nominations must be received no later than four weeks preceding the date of the Annual General Meeting and must be proposed by two members eligible to vote…*'

Therefore nominations must be received via post, fax, or email **no later than COB Monday 15 March 2010**. Positions for which there are multiple nominations will then be determined by ballot of Members and results declared at the Annual General Meeting.

New South Wales

In December, Andy Green, spoke on 'The Stopping Problem in Mineral Exploration'. His talk addressed the question 'What is the right amount of money to spend on an exploration area before you give up and look elsewhere?' Andy introduced the methodology, spoke about what are reasonable assumptions and some probability theory, and then discussed how correct decisions are critically dependent on the way we rank targets and our ability to reject the false positives associated with geological noise. Andy then went through an example using geophysical data from diamond exploration. Andy's talk invoked much discussion and some reflection in the audience.

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

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

Mark Lackie

South Australia

The SA Branch ended 2009 in style with a Christmas Party at the Coopers Alehouse. The event was well attended and we are happy to announce that the Coopers Alehouse is now the venue of choice for the SA Branch.

2010 is already looking like a busy year for technical meetings, with an SEG Distinguished Lecture, an Honorary Lecture and a Distinguished Instructor Short Course (DISC) already confirmed. The first will be a joint AGM and South Pacific Honorary Lecture on Thursday 25th February at the Coopers Alehouse. Ben Clennell from CSIRO will present 'Electrical Properties of Sedimentary Rocks From DC to Dielectric Frequencies'. As ever, we are looking for nominations for the Branch Committee and welcome new additions to help with running the many local events.

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

Luke Gardiner

Western Australia

ASEGWA would like to announce their 2010 Committee:

President:	Reece Foster
Secretariat:	CASM
Treasurer:	Mark Tingay
Committee:	Jim Leven, Brett Harris and Anne Morrell

The Committee would like to extend their thanks to those who made all the 2009 events possible, as well as to our sponsors without whom we would not be able to provide quality events at a discounted rate.

2010 is shaping up to be an even busier year with a full calendar of events almost confirmed. Some of the events that will be held throughout 2010 include monthly technical talks, DL Patrick Connolly (May), DISC presenter Colin Sayers (August) and the Golf Day (October). We will also be hosting the 2010 Student Careers Evening at a date yet to be determined but likely to be in August. We are also supporting the following events in 2010: Geophysics & Geohazards – Defining Subsea Engineering Risk Seminar (March); Seismic Ansiotrophy Workshop (April).

The WA branch would like to wish everyone a very prosperous 2010 and look forward to seeing you at our events throughout the year.

Reece Foster

Andrew Long SEG lecture online

A full videotaped version of Andrew Long's SEG lecture, titled 'Multi-azimuth and Wide-azimuth Seismic: Foundations, Challenges, and Opportunities', is due to appear on the SEG web site in January (it should be there by the time this issue of *Preview* is printed). Andrew's tour journal can also be found at http://www.seg.org/SEGportalWEBproject/portals/SEG_Online.portal?_nfpb=true&_pageLabel=pg_gen_content&Doc_Url=prod/SEG-News/News-Education/longjournal.htm. A related article will be published soon in *The Leading Edge*.

Andrew said, 'After 20 locations and about 1180 attendees, I simply want to say thank you to everyone that hosted me, and made my journeys possible. The reception in each location was quite overwhelming, and according to the SEG, the total attendance in the Pacific South was reportedly the most per meeting of the six Honorary Lecturer global regions. I visited a few new places, made a lot of new friends, and learned quite a lot. I can only hope a few people were provoked by what I said, and can extract some kind of benefits'.

The PDF version of Andrew's lecture is available if you do not have a copy (~15 MB), as is a set of relevant journal publications (~120 MB). Both can be sent via a secure FTP link. Please contact Andrew at Andrew.Long@pgs.com.

New members

The ASEG welcomes the following eight members to the Society. Their membership was approved at the Federal Executive meeting held in December 2009.

Name	Affiliation	State/Country	Membership category
Dominic Robin Fell	WesternGeco	WA	Active
Paul Moorfield	Santos	SA	Active
Daniel Erik Scheuch	Macquarie University	NSW	Student
Justin Dedric MacDonald	University Adelaide Australian School of Petroleum	SA	Student
Jake Gordon Berryman	Royal Holloway	UK	Student
Amanda K. Nicholls	CGG Veritas	WA	Associate
Alberto Cementon		NSW	Associate
Ian James	Geoforce	WA	Associate

The ASEG congratulates the following six members whose membership was upgraded at the Federal Executive meeting held in December 2009.

Name	Affiliation	State/Country	Membership category
Philip Pik	Retired	NSW	Emeritus
Steve Webster	Retired	NSW	Emeritus
Devin Trussell	Retired	VIC	Emeritus
David Moore	Retired	VIC	Emeritus
Miroslav Bosnar	Retired	Canada	Emeritus
Tristain Aiden Kemp	Geoforce	WA	Active

Nominate a colleague for an ASEG Honour or Award for 2010

An exciting and important role of the ASEG is to acknowledge the outstanding contributions of its individual members both to the profession of geophysics and to the ASEG. The society has a number of different Honours and Awards across a range of categories. These are normally presented at each ASEG conference and we are looking forward to the next, coming up in Sydney, 22–26 August 2010.

The true relevance of these awards is that they are made through nominations of the membership, not some arbitrary selection process. Details of the various available awards are set out below and members are therefore invited to submit nominations for the next round according to the 'Nomination Procedure' also set out below. Some of the awards carry considerable prestige in the eyes of the ASEG and therefore require quite detailed documentation to support the nomination.

Recipients selected from these nominations will be presented with their award and citation at the forthcoming Sydney conference.

ASEG Gold Medal

For exceptional and highly significant distinguished contributions to the science and practice of geophysics by a member, resulting in wide recognition within the geoscientific community. The nominee must be a member of the ASEG.

Honorary Membership

For distinguished contributions by a member to the profession of exploration geophysics and to the ASEG over many years. Requires at least 20 years as a member of the ASEG.

Grahame Sands Award

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 nominee does not need to be a member of the ASEG.

Lindsay Ingall Memorial Award

For the promotion of geophysics to the wider community. This award is intended for an Australian resident or former resident for the promotion of geophysics (including but not necessarily limited to applications, technologies or education), within the non-geophysical community, including geologists, geochemists, engineers, managers, politicians, the media or the general public. The nominee does not need to be a geophysicist or a member of the ASEG.

Early Achievement Award

For significant contributions to the profession by way of publications in *Exploration Geophysics* or similar reputable journals by a member under 36 years of age. The nominee must be a member of the ASEG and have graduated for at least 3 years.

ASEG Service Medal

For outstanding and distinguished service by a member in making major contributions to the shaping and the sustaining of the Society and the conduct of its affairs over many years. The nominee will have been a member of the ASEG for a significant and sustained period of time and will have at some stage been one of the following: Federal President, Treasurer or Secretary, State President, Conference Chairperson or Standing Committee Chairperson, Editor of *Exploration Geophysics* or *Preview*. Honorary Members are not eligible.

ASEG Service Certificate

For distinguished service by a member to the ASEG, through involvement in and contribution to State Branch committees, Federal Committees, Publications, or Conferences. Honorary Members or holders of the ASEG Service Medal are not eligible.

Nomination Procedure

For the first five award categories, any member of the Society may nominate applicants. These nominations are to be supported by a seconder, and in the case of the Lindsay Ingall Memorial Award by at least four geoscientists who are members of an Australian geoscience body (e.g. GSA, AusIMM, AIG, IAH, ASEG or similar). Nominations for the ASEG Service Medal and the ASEG Service Certificates are to be proposed through the State and Federal Executives with their backing.

Nominations must be specific to a particular award and all aspects of the defined criteria should be addressed. To gain some idea of the standard of nomination expected, nominees are advised to read past citations for awards as published in *Preview*.

Nominations including digital copies of all relevant supporting documentation are to be sent electronically to:

Phil Harman
Chairman, ASEG Honours and Awards Committee
Email: phil.harman@bigpond.com.au

The absolute deadline for applications is 30 June 2010.

$130M for seven new CRCs

A new Cooperative Research Centre (CRC) for Optimising Resource Extraction to transform mineral deposit evaluation and extraction has been awarded a $17.5 million grant from the Australian Government.

Senator Kim Carr, Minister for Innovation, Industry, Science and Research, announced grants totalling $130 million on 16 December 2009. These are to fund seven new CRCs in the CRC Program's latest selection round.

The successful CRCs are for:

Advanced Composite Structures ($14 million): will connect Australian small and medium enterprises in manufacturing, materials supply and engineering to international value chains.

Infrastructure and Engineering Asset Management ($12 million): to increase the availability, productivity and useful life of defence assets (including combat aircraft and ships), and of railways and power and water utilities.

Environmental Biotechnology ($4 million): to commercialise biotechnologies that use natural biological systems to transform waste into useful products and green energy, and rapid microbial monitoring platforms.

Optimising Resource Extraction ($17.5 million): to transform mineral deposit evaluation and extraction, to significantly enlarge Australia's mineral resource and generate a more sustainable mining industry.

Remote Economic Participation ($32.5 million): to support the Government's commitment to close the gap on Aboriginal disadvantage and develop economically sustainable communities in remote areas.

Wound Management Innovation CRC ($28 million): to improve wound healing and quality of life for people with wounds, and provide cost-effective wound care that lessens burdens on our healthcare system.

Vision CRC ($22 million): to deliver revolutionary vision care treatments and products for sufferers of eye problems like myopia and cataracts.

Centre for Optimising Resource Extraction

cOREx will focus on improving the processes to extract ore and deal with the environmental impacts of mining.

Over the last 30 years, the average grade of Australian ore bodies has halved while the waste removed to access the minerals has more than doubled. In the last eight years, the industry's energy consumption has increased by 70% with further projected growth to meet future demands. Without action, the environmental cost of mineral production will increase.

cOREx's vision is to transform the evaluation and extraction of mineral deposits, to significantly enlarge Australia's mineral resource and to generate a more sustainable mining industry. It will achieve this through new methods of characterising, extracting and valuing the ore in the ground. This will allow the geologically complex and lower grade ore deposits now being encountered to be economically and sustainably mined.

cOREx has three integrated research programs.

- Program 1 will provide new technologies to characterise the complex mining, processing and environmental properties of rock.
- Program 2 will develop techniques to improve extraction performance across the mineral production chain, taking into account the different ore properties, and thereby reducing energy and water consumption.
- Program 3 will leverage the advanced characterisation data and extraction models into a mine wide evaluation approach, based on novel financial models that incorporate both geological and market uncertainty.

The development of cOREx technology, software and methodologies will enable the integration of energy efficiency and environmental impact into the mining sector's daily business. It will equip mining companies to meet emerging environmental challenges, societal expectations and regulatory regimes for the ongoing benefit of Australia.

The Core Partners: AMIRA International Ltd, Anglo American, BHP Billiton, FEI Company, Mass Mining Technology, Newcrest Mining Limited, Queensland University of Technology, The University of Queensland, University of Tasmania.

Congratulations to Alan and his team. There may even be a place for geophysics for environmental monitoring and rock property analysis.

For more information contact Professor Alan Bye, Chief Executive Officer, COREx at a.bye@uq.edu.au. Alan was formerly Director of the WH Bryan Mining & Geology Centre at University of Queensland.

Eristicus

ASEG and PESA Conference 2010 Update – Sydney, 22–26 August 2010

The organisation for the next ASEG Conference is progressing well and by the time this article is published, the call for papers will have been completed and the successful abstracts selected. To date the response from potential presenters has been excellent, with 300 abstracts received, and the range of papers is such that the technical component of the conference will be exciting and cover many different fields. Also, we have been encouraged by the level of support for the conference, but we are still actively seeking additional sponsorship. The demand for exhibition space has been very strong, with 45 booths already taken up, so if you are thinking about taking up a booth do not delay any further. More details of the conference such as available workshops and the technical programme will be available soon on the website.

For more information please consult the website: http://www.aseg-pesa2010.com.au

Mark Lackie and Phil Cooney
(Co-Chairs)

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change
sustainability
vulnerability
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In July 2010 an outstanding selection of national and international speakers, industry leaders, and key decision makers will be meeting in Canberra in the scenic Eastern Highlands, just a few hours drive from Australia's major ski fields.

Plenary speakers include:

Martin Brasier,
Professor of Palaeobiology, Oxford University

Patrick De Deckker,
Professor, and 2010 Mawson Medalist and Lecture, Australian National University

Rob Hough,
CSIRO Exploration & Mining

Belinda Robinson,
CEO of Australian Petroleum Production & Exploration Association Limited (APPEA)

Keynote speakers include:

Graham Begg,
GEMOC, Macquarie University

Kliti Grice,
Applied Chemistry Department, Curtin University

Jennifer Heldmann,
NASA Ames Research Centre, USA

Louis Moresi,
School of Mathematical Sciences, Monash University

Dietmar Müller,
School of Geosciences, University of Sydney

Mike Sandiford,
School of Earth Sciences, University of Melbourne

Tim Stern,
Victoria University of Wellington, New Zealand

Mark van Zuilen,
Centre for Geobiology, Bergen, Norway

Jim Zachos,
Department of Earth & Planetary Sciences, University of California Santa Cruz, USA

KEY DATES:

CONFERENCE DATES:
4-8 July, 2010

CALL FOR ABSTRACTS OPEN:
15 June 2009

SPEAKER ABSTRACT DEADLINE:
15 January 2010

AUTHOR NOTIFIED:
19 February 2010

- Resource Security: Supporting the Nation
- Earth's Environments: Past, Present and Future
- Geoscience in the Service of Society
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- Life and the Solar System
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News

Update on Geophysical Survey Progress from the Geological Surveys of Queensland, Western Australia, Northern Territory, New South Wales and Geoscience Australia (information current at 14 January 2010)

Tables 1–3 show the continuing acquisition by the States, the Northern Territory and Geoscience Australia of new gravity, airborne magnetic and radiometrics, and airborne EM over the Australian continent. All surveys are being managed by Geoscience Australia. There is one new survey and one amended survey reported in this issue.

The Southeast Lachlan airborne magnetic and radiometric survey was reported in the last issue of *Preview* (No. 143 – December 2009) but now has a significantly different survey boundary (see Figure 1). The survey area has been increased to approximately 24 660 km^2 with E–W flight lines at a spacing of either 250 m in NSW or 500 m in the ACT. The increased survey coverage now includes most of the Cobargo, Bega and Eden 1 : 100 000 map sheets.

The Gascoyne North gravity survey (Figure 2) will cover an area of approximately 45 410 km^2 with 7400 stations on a regular 2.5 km grid.

Table 1. Airborne magnetic and radiometric surveys

Survey Name	Client	Project Management	Contractor	Start Flying	Line (km)	Spacing AGL Dir	Area (km^2)	End Flying	Final Data to GA	Locality Diagram (*Preview*)	GADDS Release
Cape York	GSQ	GA	GPX	23 Apr 09	239 180	400 m, 60 m E–W	59 480	100% complete @ 12 Oct 09	27 Nov 09	139 – Apr 09 p. 21	22 Dec 09
Cornish – Helena (East Canning 2)	GSWA	GA	Thomson Aviation	6 June 09	121 100	400 m, 60 m N–S	43 270	100% complete @ 25 Oct 09	27 Nov 09	141 – Aug 09 p. 19	17 Dec 09
Crossland – Noonkanbah (East Canning 1)	GSWA	GA	GPX	10 Aug 09	116 700	400 m, 60 m N–S	41 720	100% complete @ 20 Nov 09	TBA	141 – Aug 09 p. 19	Anticipated for release 4 Feb 10
Central Canning	GSWA	GA	Fugro	10 June 09	91 700	800 m, 60 m N–S	64 900	100% complete @ 18 Aug 09	26 Nov 09	141 – Aug 09 p. 19	17 Dec 09
Naretha (Eucla Basin 3)	GSWA	GA	Fugro	11 June 09	123 100	200 m, 50 m E–W	22 090	100% complete @ 4 Nov 09	TBA	141 – Aug 09 p. 19	Anticipated for release 4 Feb 10
Broome (North Canning 1)	GSWA	GA	UTS	14 July 09	76 000	400 m, 60 m N–S	26 370	100% complete @ 19 Sep 09	9 Nov 09	141 – Aug 09 p. 19	3 Dec 09
Mt Anderson – McLarty Hills (North Canning 3)	GSWA	GA	UTS	3 July 09	98 200	400 m, 60 m N–S	34 860	100% complete @ 29 Sep 09	9 Nov 09	141 – Aug 09 p. 19	17 Dec 09
Eucla Coast (Eucla Basin 6)	GSWA	GA	UTS	24 September 09	121 645	200 m (onshore); 400 m (offshore); 50 m N–S	27 400	100% complete @ 26 Dec 09	TBA	141 – Aug 09 p. 19	TBA
Southeast Lachlan	GSNSW	GA	Fugro	Summer 09/10	107 037	250 m (NSW) 500 m (ACT) E–W	24 660	Quotation Request closed 26 Nov 09	TBA	This issue	TBA

TBA: To be advised

Table 2. Airborne electromagnetic surveys

Survey Name	Client	Project Management	Contractor	Start Flying	Line (km)	Spacing AGL Dir	Area (km^2)	End Flying	Final Data to GA	Locality Diagram (*Preview*)	GADDS Release
Pine Creek (Kombolgie)	GA	GA	Geotech Airborne	21 Aug 08	8780	1666 & 5000 m for GA; 200–1000 m company infill; E–W flight lines; Flying height 30 m	30 710	100% complete @ 16 Oct 08	12 Nov 09	133 – Apr 08 p. 21	GA data for Pine Creek (Kombolgie) released via free-download via the GA website and on DVD on 4 December 2009. All requests to the GA Sales Centre

TBA: To be advised

Table 3. Gravity surveys

Survey Name	Client	Project Manage-ment	Contractor	Start Survey	No. of stations	Station Spacing (km)	Area (km²)	End Survey	Final Data to GA	Locality Diagram (*Preview*)	GADDS Release
Cape York	GSQ	GA	Daishsat	12 May 09	10315	4 km regular	171 900	100% complete @ 16 Sep 09	24 Nov 09	139 – Apr 09 p. 21	22 Dec 09
Barkly	NTGS	GA	Atlas	4 June 09	7268 in Area A & 2525 in Area B	4 km regular	178 230	100% complete @ 28 Sep 09	22 Oct 09	140 – Jun 09 p. 17	15 Dec 09
South Yilgarn Margin	GSWA	GA	Fugro	24 July 09	6500	2.5 km regular	39 240	100% complete @ 22 Oct 09	TBA	140 – Jun 09 p. 17	TBA
Southern Cross	GSWA	GA	Atlas	Anticipated start date of 17 Jan 10	7000	2.5 km regular	41 250	TBA	TBA	143 – Dec 09 p. 21	TBA
Gascoyne North	GSWA	GA	TBA	QR closes on 11 Feb 10	7400	2.5 km regular	45 410	TBA	TBA	This issue	TBA

TBA: To be advised

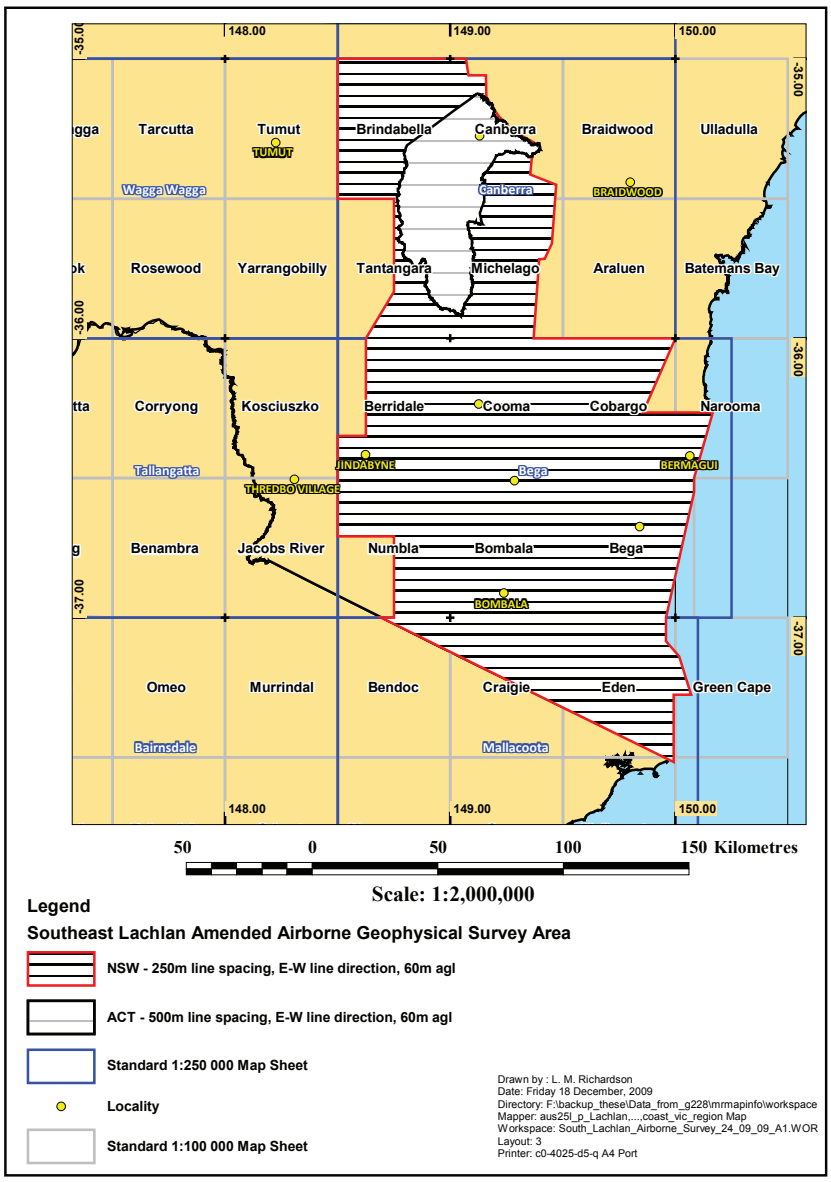

Fig. 1. *Location diagram for the amended boundary of the Southeast Lachlan airborne magnetic and radiometric survey.*

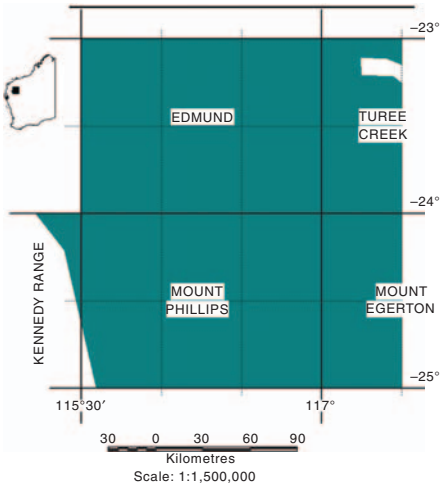

Fig. 2. *Location diagram for the Gascoyne North gravity survey.*

2009 very good for gold and resource stocks

2009 was a year of good recovery for resource stocks on the ASX. After the collapse of the market in 2008, there has been a good rebound in 2009. Figure 1 shows what happened to the All Ordinary's Index (AOI) as well as the market capital of the main resource companies listed on the ASX. In retrospect, it is interesting to observe that the resource companies were the last to crash (June 2008) and first to rebound (December 2008). The AOI crashed in December 2007 and did not start to recover until February 2009.

However, during 2009, resource stocks rose by a very impressive 49%, while the AOI only rose by 34%. BHP managed a 41% increase from $103 billion to $145 billion, whereas Rio Tinto increased its value by a massive 125% by more than doubling its value in 12 months! It started the year at $20 billion and finished at $45 billion – quite spectacular.

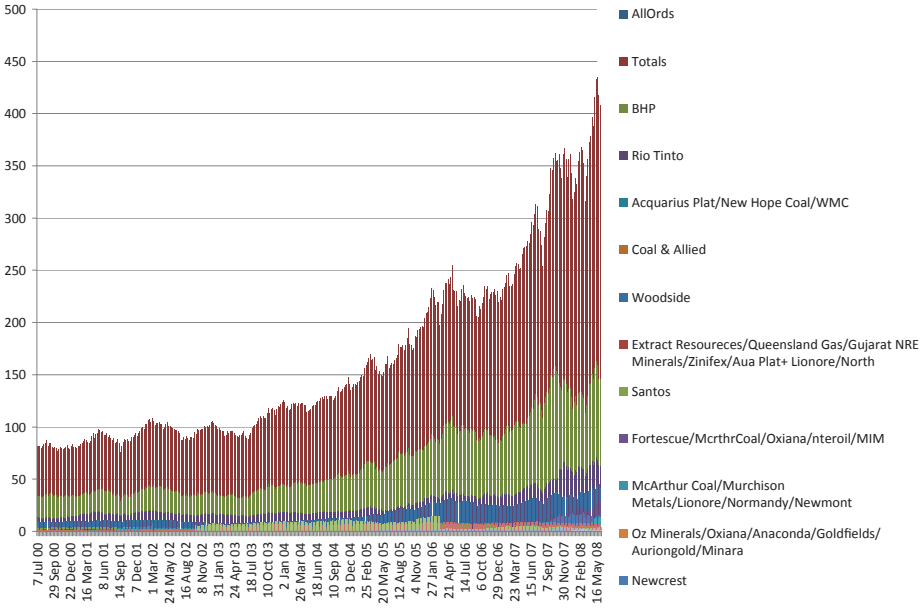

Fig. 1. *Total market capital (in $billions – left hand axis) of the resource companies in the top 150 listed companies on the ASX (red), together with a history of the top two; BHP Billiton (green) and Rio Tinto (blue), and the All Ordinaries Index (AOI) (right hand axis). Notice that the resource stocks crashed well after the AOI did and they recovered more rapidly in 2009.*

Oil price on road to recovery

The oil price is still recovering from its low of US$39 a barrel in February 2009. After the dizzy heights of US$134 a barrel in June 2008, it still has a long way to go. However, during 2009 it has climbed back to US$75 and is likely to continue it's rebound. Figure 2 shows the plot of the oil price in US and Australian dollars since 1990. These data have been CPI adjusted to December 2009 and they indicate that in the long run the price has gradually increased in real terms since 2000. It looks like we will be paying more for our fuel at the petrol bowser in 2010.

Gold powers ahead

Gold was a standout performer in 2009. After an essentially unchanged price of US$500 ± 100 from 1990 through 2005 it has gradually surged to pass the US$1000/oz in October 2009, as shown in Figure 3. At the beginning of January 2009 the gold price was US$858 and at the end of the year it had risen to US$1134. However, one has to be careful to consider changes to the CPI and the exchange rates for any detailed comparison. At the beginning of 2009 one Australian dollar was worth about US67c and by the end of the year it had risen to about US90c – a very significant change.

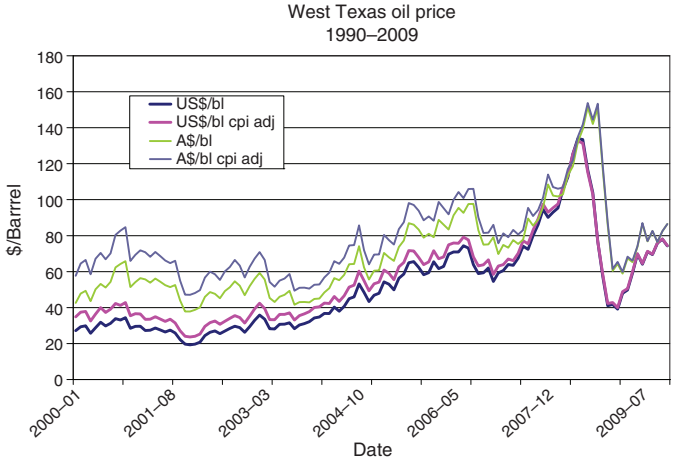

Fig. 2. *Price of West Texas Crude from 2000 through 2009 in US$ and A$. The CPI adjustment is to the December 2009 US$ and A$ values. Notice the gradual increase in the oil price – even in Australian dollars – since 2000.*

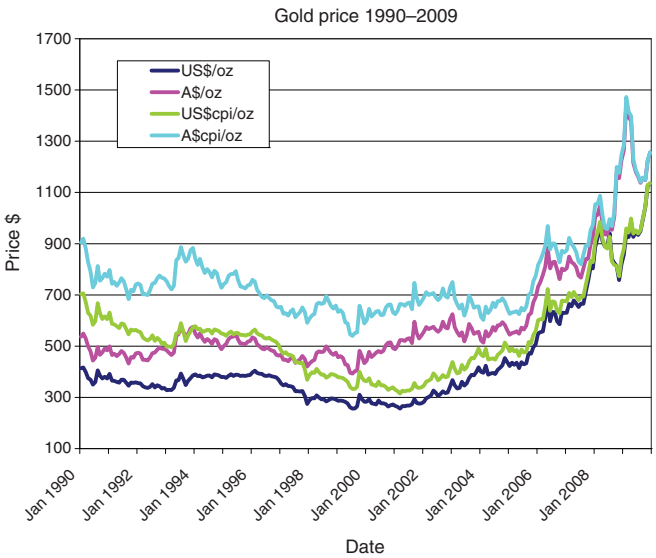

Fig. 3. *Gold prices in A$ and US$ per oz, with and without CPI adjustments. The CPI adjustments are normalised to December 2009. The changes to exchange rates of the US/Australian dollars were very significant during 2009.*

Other metals still recovering

Figure 4 shows the variation in prices for a selection of the six other main non-ferrous metals during 2006–09. Most metals are depressed from the 2008 values, with nickel performing the worst and copper the best. There is clearly a long way to go to reach the 2008 values.

Look out for takeovers in 2010

Surprisingly, the main takeover activity waited until the value of resource stocks started to rise. One would have thought that the smart people would have been buying up big when the stocks were really depressed. This did not happen. At the end of 2009 there were two major takeovers by overseas companies.

On 15 December Canadian-based **Eldorado Gold** completed its purchase of Sydney-based **Sino Gold Mining Limited**. Sino Gold was focussed on gold exploration and mining in China. At the time of the takeover it had a market capital on $2.37 billion.

Sino Gold's flagship operation was the Jinfeng gold mine which has reported Mineral Resources of 150 tonnes of gold and Ore Reserves of 100 tonnes. Jinfeng is China's second largest gold mine and is now producing gold at approximately 5.5 tonnes per annum.

The Company's White Mountain Gold Mine started gold production in January 2009. The plan is to produce approximately 2.0 tonnes per annum once the operation is ramped up to design rates. White Mountain has a mine life of more than 10 years. In April 2009, Sino Gold's Board of Directors approved the development of the Company's third mine at East Dragon – a high-grade deposit that is forecast to produce an average of 2.75 tonnes per annum.

Sino Gold was also assessing the potential of the Beyinhar Project to be developed into an open-pit, heap-leach operation. With China currently placed as the world's leading gold producer, it will be interesting to see how the Canadian takeover will go. Eldorado is now registered on the ASX to the value of $1.8 billion. It also has gold mines in Turkey and Brazil.

The second large takeover was by the Chinese **Yanzhou Coal Mining** for **Felix Resources**. The bid of $3.5 billion takeover of Felix was completed at the end of December 2009. Felix Resources' 2009 net profit was $267.43 million – so it is a good buy.

Felix had interests in four major coal mines in the Sydney/Bowen Basins. These were the Ashton underground and open cut operation near Singleton in the Hunter Valley NSW; the Yarrabee open cut mine about 40 km north west of Blackwater in the Bowen Basin Queensland; the Minerva open cut mine, about 45 km south of Emerald, also in the Bowen Basin and the Moolarben Project in the Hunter Valley 40 km east of Mudgee, which has yet to come on stream.

At the start of 2009 both Felix and Sino Gold had market capitals of approximately $1.4 billion. They would have both been real bargains then!

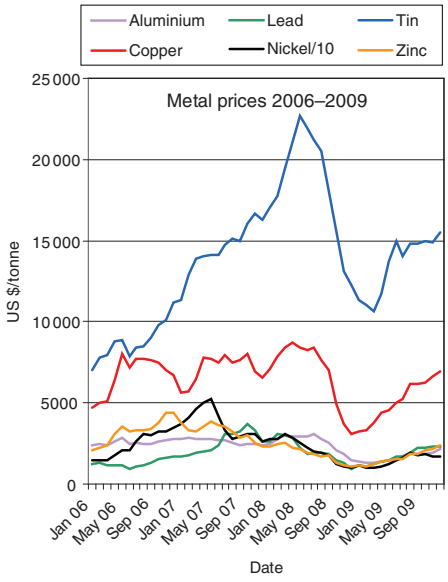

Fig. 4. *Metal prices for aluminium, zinc, copper, lead, nickel and tin, in US$/tonne except for nickel, where the price is ten times the plotted values. No CPI adjustments have been applied. Only the copper price has recovered to close to its 2008 price.*

Another Aussie commercial success

TerraTEM, the recipient of the ASEG's Grahame Sands Award for innovation in 2006, has gone on to be an outstanding commercial success. Seventy-one systems have been sold to date, in a period of only 4 years. This includes what must be a record for an Australian-made geophysical instrument, an order for 15 units from the Ministry of Water Resources of Tanzania. This follows the previous largest single order of five systems to a university in Libya. The predecessor of terraTEM, SIROTEM, sold almost 100 units but over a 20 year period. TerraTEM will, at the present rate of sales, have achieved that number in less than 6 years. Together with the 71 base units, 40 receiver coils have been sold in the less than 2 years they have been available, and nine orders have been received for the recently developed separate 50 A transmitter.

Roger Henderson
rogah@tpg.com.au

The terraTEM base unit

Airborne geophysical survey of the PNG highlands and the Papuan Peninsula

In three flying seasons between 2005 and 2008, two areas of the PNG highlands and the Papuan Peninsula have been surveyed by what was possibly the world's largest helicopter magnetic and radiometric survey. The project was conducted by the Mineral Resources Authority and funded under the EEC's 8th European Development Fund. The availability of these data in both digital and paper-map formats is expected to encourage and facilitate exploration in PNG by international mining companies. Fugro Airborne Geophysics was responsible for the data acquisition, processing and interpretation of the data.

Two large blocks (Areas 1 and 2, see Figure 5) were selected for the airborne geophysical coverage. Area 1, 'The Highlands', incorporated approximately 62 000 km^2 of the Central Highlands region and occupied portions of six 1 : 250 000 scale map sheets. Due to poor accessibility, very little aeromagnetic coverage had been attempted in this area. The major exception is the south-western portion, which hosts the Porgera Gold mine. Placer had conducted detailed helicopter aeromagnetic surveys in 1984 and 1988 in the vicinity of Porgera. As well, some larger scale oil industry coverage had been completed, with line spacings of 2 km or greater in the south-western region. Elsewhere, several small blocks of aeromagnetics have been completed by the exploration industry in areas around Kuta and the Crater Mountains. However, in total, only about 5% of Area 1 had any reasonable airborne geophysical coverage prior to this survey being undertaken.

Area 2, 'The Peninsula', is approximately 29 400 km^2 in size and also falls within six 1 : 250 000 scale map sheets. A 1967 regional aeromagnetic survey with 5 km line spacing incorporated almost 75% of Area 2. Due mainly to the wide line spacing, it is considered to be ineffective for mineral exploration purposes. Other prior aeromagnetic coverage consisted of six small survey blocks that were obtained by industry during the 1980s and 1990s. Five of the industry blocks are located in the northern sector of Area 2, including Aseki (1982), Bulolo (1985), Kupper Range (1990), and Wau (1982). These more recent aeromagnetic surveys in total cover some 10% of Area 2.

Three major factors affected the planning of this survey: the extreme terrain, the remoteness and the climatic conditions. Unlike other large regional surveys undertaken elsewhere in the world, which might contain some portions of remote and/or extreme terrain, the PNG regional survey was predominantly mountainous terrain, very often remote, often wet, and almost constantly cloud covered. These conditions created more challenges to a magnetic and radiometric survey than would be expected in most other surveys.

From the outset standard procedures for conducting a regional survey of this size had to be modified to fit the environment. The required 'drape' flight profile of this survey (survey to be flown at 100 m) in PNG's steep mountain slopes necessitated the use of an exceptional aircraft and very experienced pilots in order to meet Fugro's safety requirements and policy. The helicopter selected was the Aerospatiale AS350-B3 (see Figure 6), which has exceptional climbing capabilities and can be manoeuvred comfortably at altitudes above 10 000 feet. This survey ranged in altitude from sea level to the top of Mt Wilhelm (approx. 14 500 ft or 4509 m).

Area 1 included flight lines up to 150 km in length. Such lines are normally completed in one piece, and lines are rarely broken. In PNG, given the prevailing weather and cloud conditions, the survey lines needed to be split into smaller segmented sections. All sections were logged as they were flown. This also allowed survey operators to accurately navigate to segments of lines that were still to be flown. Area 1, consisting of some 1262 survey lines, was flown in 10 500 separate line segments. Fugro developed new software for monitoring all the individual line segments to allow viewing of the records of each individual line segment that had been flown, for logistical and reporting tasks.

The extreme nature of the country and the variable, rapidly changing weather

Fig. 5. *PNG survey area.*

Fig. 6. *Aerospatiale AS350-B3 helicopter at Mt Hagen.*

and remoteness of the survey operations required dedicated Search and Rescue staff to monitor both aircraft while the survey was in progress. A retired air traffic controller was employed full time for the duration of the survey with sole responsibility for the monitoring of the two aircraft positions. Both aircraft were equipped with Real Time Omnistar tracking systems and the Search and Rescue officer was able to liaise with local air traffic control and report the exact location of each helicopter from his screen. This monitoring proved very effective, especially with multiple aircraft working within close proximity.

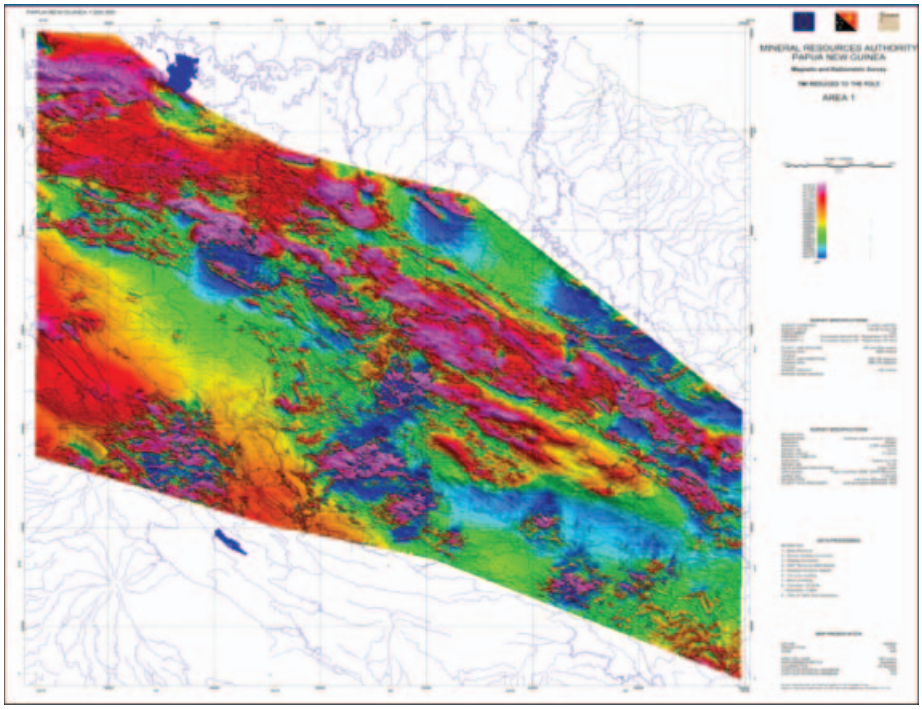

Fig. 7. *Reduced-to-pole total magnetic intensity over sunshading for Area 1, 'The Highlands'.*

The weather typically varies in the Highlands, from one valley to the next. Each base location was as close as possible to the area being flown. This enabled the local weather to be closely monitored and also made the daily test lines more representative of the local survey area.

As the survey drew to a close the last remaining sections were in the most difficult areas. The final 200 km took almost a month and the last 5 km a week to complete. Despite all the difficulties of working in this mountainous region, the survey was completed in less than the projected timeframe. One of the final images can be seen in Figure 7.

For further information, please contact Nathan Mosusu, Manager – Geophysics Mapping, Mineral Resources Authority, Papua New Guinea, email: nmosusu@mra.gov.pg. The MRA website is www.mra.gov.pg.

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'And some things that should not have been forgotten were lost', JR Tolkien Lord of the Rings

Introduction

Total-count gamma-ray logging probes are a well-established method of determining uranium resources in the ground. Such probes must first be calibrated and the standard way this is done is by using full-size calibration models. Such models are available in Australia at Adelaide (Wenk and Dickson, 1981) and are managed by the South Australian Department of Water, Land and Biodiversity Conservation. The Adelaide facility comprises three pits for total-count calibration: AM1, AM2 and AM3 with grades of 0.219, 0.92 and 0.054% eU_3O_8, respectively. These pits are 1.22 m diameter with ore zones of between 1.34 and 1.43 m length, with a vertical 108 mm hole. Construction of AM2 is illustrated in Figure 1. A fourth pit, AM7, with 0.17% eU_3O_8 provides holes of varying diameter (BQ, NQ, NQ, HQ and 108 mm) through one ore zone.

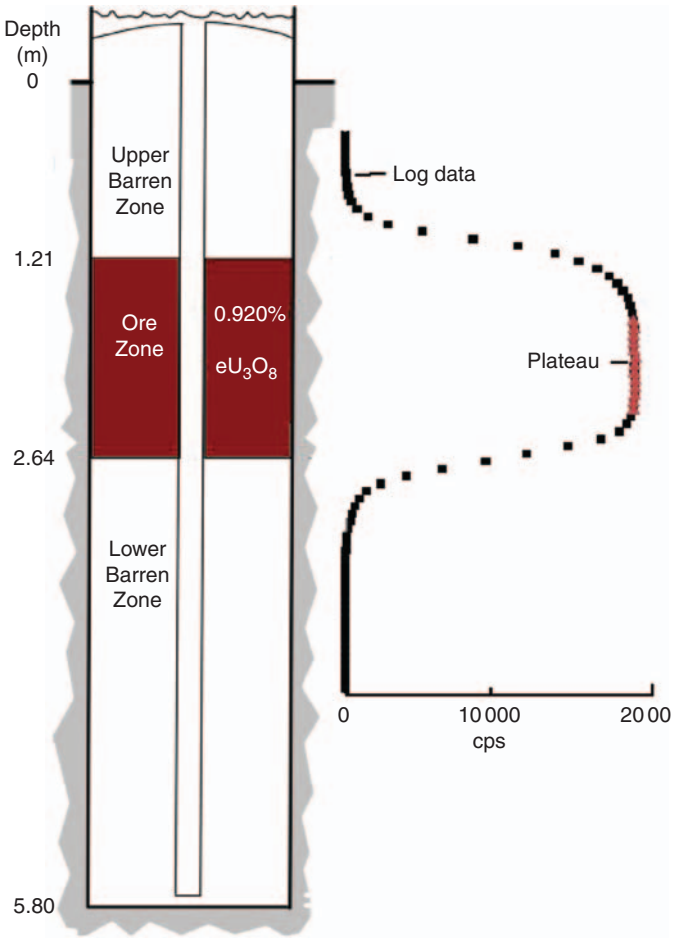

Fig. 1. *Schematic of Adelaide Pit AM2 with an example of a gamma-ray log.*

By the early 1980s the methods for calibration of such tools had been thoroughly developed and are probably best detailed in a paper by George (1982). However, this work seems to have been overlooked during the long dormant period for uranium exploration and older, incorrect methods continue to be used. Of most concern are the corrections that must be made for the instrumental dead time, the time each gamma-ray detected requires to be processed, and for the Z-effect. This effect arises where there are high ore grades (>0.3% U_3O_8). High Z elements, such as U, have much higher photoelectric adsorption than common rock-forming elements and preferentially adsorb low-energy radiation. Thus, as grade increases, the amount of radiation available to be detected is decreased.

Calibration

Calibration is based on the assumption that observed count rate is proportional to ore grade when ore grade is expressed as a weight fraction of its host rock, i.e.

$$G = K \times F_d(r) \times F_z(r) \times r$$

where G is the grade of ore zone, K is the constant of calibration known as the K-Factor, $F_d(r)$ is the dead-time correction, $F_z(r)$ is the Z-effect correction and r is the measured count rate.

The traditional dead-time correction is calculated using the expression $N = n/(1 - n \times \tau)$ where N is the true count, n is the measured count and τ is the dead-time. This expression has several issues. Firstly, detailed study of dead-time shows that is usually made of two components, a fixed time and an extendable time related to pulse length. Consequently, multiple measurements of τ are required at different count rates to fully calibrate the dead-time across varying count rates (George, 1982). Secondly, many total-count probes actually have an internal threshold to prevent noise being counted but the setting of the threshold can also filter off low-energy radiation. Thus, the actual counts received and processed may be lower than those interacting with the detector crystal. Some thresholds may reject up to 30% of the radiation, which is not properly accounted for in the dead-time estimation.

Similar issues arise with determination of the Z-effect. It is dependent on the U grade, which is related to the count rate. In practice, the two factors $F_d(r)$ and $F_z(r)$ may be combined into one factor so that the calibration equation is then written as

$$G = K \times (r + c_1 \times r^2 + c_2 \times r^3)$$

where G, grade, is known, r is the measured count rates in the ore zones and c_1 and c_2 are constants (George, 1982). Fitting a third order polynomial that passes through the origin to data from three or more pits will yield values for all three unknowns. The first coefficient is the K factor and dividing the second order and third order coefficients by the first order coefficient gives the two terms c_1 and c_2. Note this method does not require

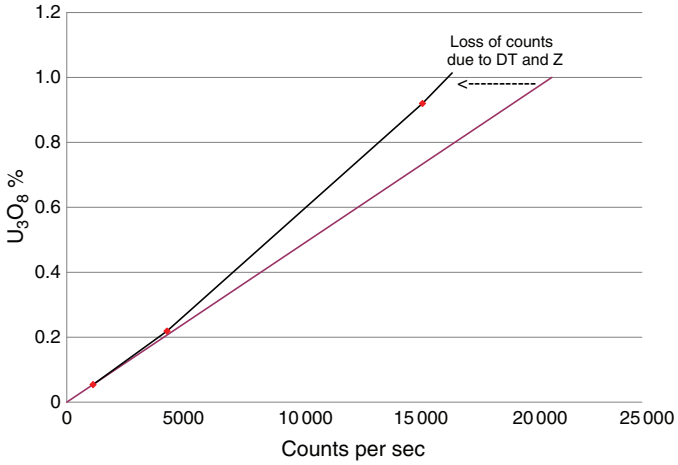

Fig. 2. *Example of grade-counts plot for Adelaide pits. Data has been fitted by third order polynomial. The red line shows a linear extrapolation through lowest grade pit to illustrate the combined effect of dead-time and Z-effect.*

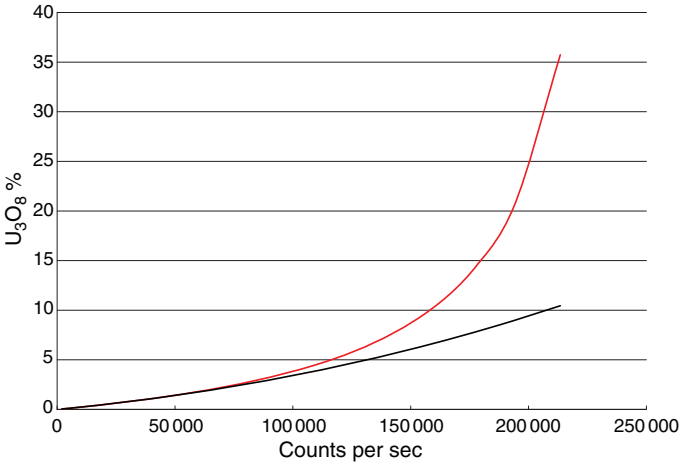

Fig. 3. *Comparison of values calculated by the recommended method (—) and Multipit method (—).*

or produce a separate dead-time correction and accommodates any variation in the behaviour of the instrument due to internal thresholds.

An example

A data set was collected by logging the Adelaide calibration pits upwards at least three times with a NaI detector. Repeat counts enable the reproducibility of the calibration to be established as well as ensuring spurious errors are detected. The count rates used in the calibration are the average over the count rate plateau in the ore zone (Figure 1). The results obtained are shown plotted in Figure 2.

The plot of the data shows a deviation from the expected relationship if the count rate observed for the lowest grade pit was linearly extrapolated to higher grades. The deviation from this line represents a loss of counts due to the combined effects of dead-time and the Z-effect.

Many users still make use of the Multipit method (Crew, 1979), which essentially fits a dead-time like equation $r/(1-r\times\kappa)$ to the grade-count-rate data. κ then combines the effects of both dead-time and the Z-effect. A comparison of the two methods is shown in Figure 3 using the data collected in Adelaide. The two methods differ by less than 1% up till ~2% U_3O_8 but, with increasing grade, the difference grows quickly with the Multipit method resulting in increasingly overestimation of the *in-situ* grade. By 6% U_3O_8, the two methods differ by ~42%. Purists might comment that extrapolating over two-times beyond the upper range of the calibration is dangerous but, as zones of high grade ore exist, the calibration method should be expected to cope with these reliably. Further, there are no facilities for calibrating tools for >1% U (Australia) or >3% U (North America) and so the only available option is to extrapolate. The Multipit method should never be used in such cases.

Conclusion

Total-count gamma-ray logging probes can provide accurate estimation of *in-situ* uranium provided they are calibrated and appropriate corrections are applied to the data. It is recommended that the method of correcting for both dead-time and Z-effect be based on fitting a third order polynomial to calibration data rather than the Multipit method. This is particularly the case if U grades above 2% may be met in the logging.

Acknowledgments

The author wishes to thank Mr Geoff Beckitt, CAMECO Aust., whose interest prompted a review of this subject and Mr John Stowell, Mt Sopris Instruments, Denver, CO, for assisting with understanding the performance of total-count probes.

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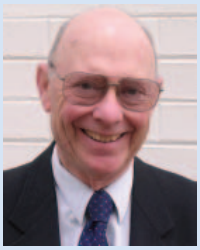
The future of people on planet Earth: challenges for geophysicists[1]



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Introduction

There are five main interrelated factors governing life on Earth by humans: population, energy, food (including water), climate and human behaviour (Figure 1). I will argue that we have the knowledge to manage these factors successfully and to prosper on Earth, but because of our past behavioural patterns, I doubt we have the wisdom.

Each of the five factors will be discussed and in particular the important roles that geophysicists have to play will be identified. As geophysicists, we can make significant contributions to our future and we should not shirk these responsibilities.

People

The Earth could sustain 5 billion people, but there are currently about 6.8 billion and by the end of 2100 there is likely to be close to 10 billion people on our planet. The Earth has existed for approximately 4.5 billion years and will continue to exist for at least another 4.0 billion years. It does not worry about us humans and it makes no moral judgements; it just keeps spinning round its axis and the Sun, obeying the laws of physics.

Although human remains have been found in Africa dating back over 1 million years, it is only in the last ~70 000 years that people have populated most of the planet (Jones, 2007). In the period 70 000–15 000 years bp all the continents except Antarctica were occupied. In other words we have occupied the planet for only ~0.001% of Earth's existence.

Furthermore, it is only in the last 200 years that our population has exploded, increasing from ~1 billion in 1804 to ~6.8 billion at the end of 2009. To put this in perspective in terms of the age of the Earth, this amounts to approximately 5 parts in 10^8 – not even a blink of an eyelid!

Figure 2 shows how the population has increased in the last ~2000 years. At the end of 2009 the annual increase was about 74 million per year and although the rate of increase is decreasing it will still be growing at 50 million per year in 2050. The population explosion has been caused by access to cheap

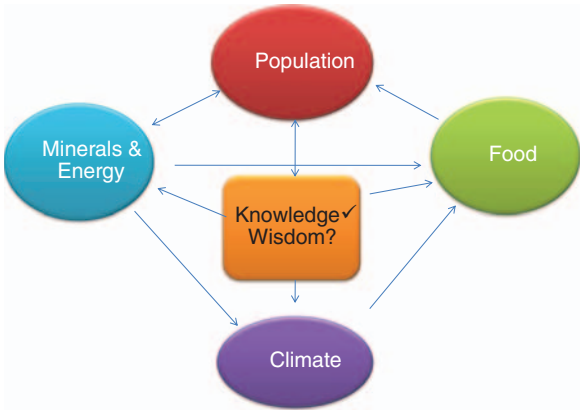
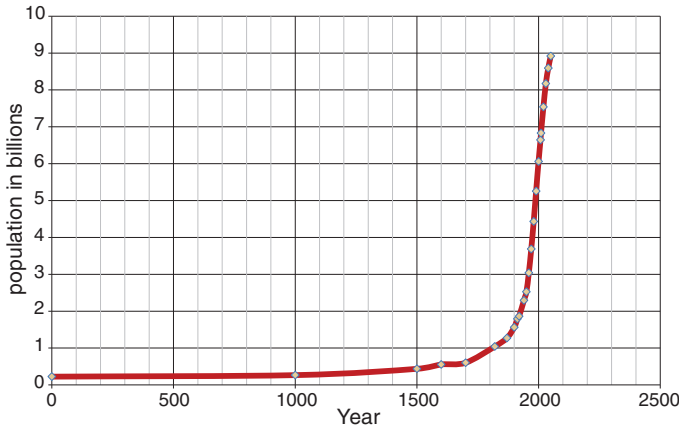


Fig. 1. *The key inter-related factors for humans on Earth.*



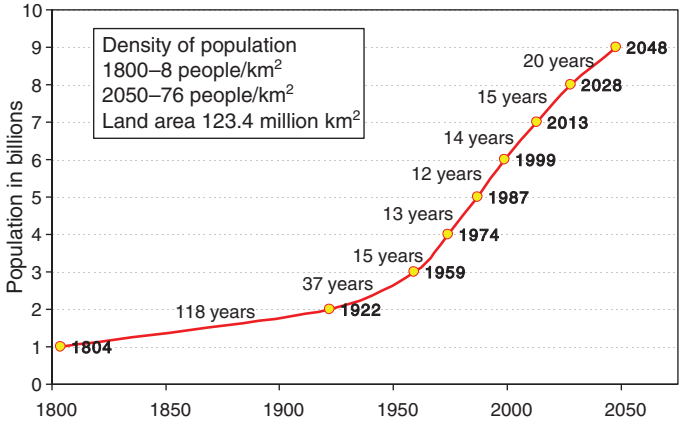


Fig. 2. *The increase of global population during the last 2000 years. Notice that the density of population will increase from 8 people per km² in 1800 to an expected density of about 76 people per km² in 2050. The total land area is the sum of the land areas of all the 233 countries on Earth. Greenland is included but Antarctica is not. Source: (top) http://www.ggdc.net/maddison/; (bottom) United Nations & US Census Bureau websites http://www.un.org/esa/population/publications/sixbillion/sixbilpart1.pdf and http://www.census.gov/ipc/www/idb. The land area includes Greenland but not Antarctica.*

[1]This article is based on the keynote address given by David Denham at the Opening Session of the 9th SEGJ International Symposium, Sapporo, Japan, October 2009. The views expressed are those of David Denham and do not necessarily represent the policy of the ASEG.

energy and cheap food as well as being assisted by the benign interglacial climate we have been experiencing during the same period. Humans are also striving for higher living standards and as a result we are using up our supplies of fossil fuels and are causing major environmental changes to the planet.

It is clear that we cannot keep on growing at this rate, otherwise the population density will be close to 100 people per km^2 early in the next century. Furthermore, we are now living beyond the sustainable capacity of the planet and are using up its reserves, so that our civilisation is under threat. One of the most important consequences of an increasing global population is that in the last 40 years the increase in per capita GDP has tracked the population increase and hence the global GDP is increasing faster than the population (Figure 3).

We are using more resources, using these more rapidly and putting strains on the sustainability of the planet. The 'ecological footprint' is a measure of human demand on the Earth's ecosystems. It compares human demand with planet Earth's ecological capacity to regenerate. It represents the amount of

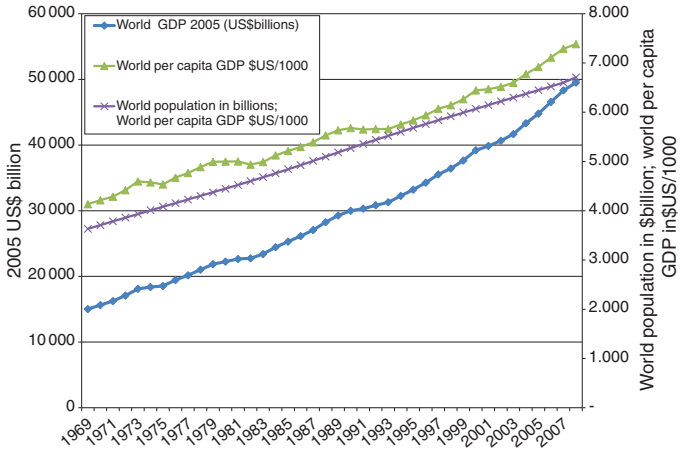


Fig. 3. *Global GDP in 2005 $US billions, 1969–2008 and per-capita GDP. Note how the per capita GDP tracks the population increase. People are getting wealthier on a global scale. The global GDP increased by 330% in the same period. The per capita GDP increased by 180%. Source: http://www.ers.usda.gov/Data/Macroeconomics/.*

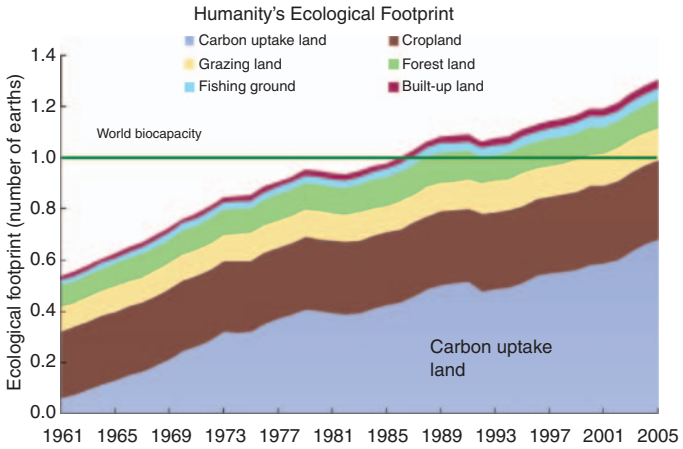


Fig. 4. *Living on our reserves. From the Living Planet Report 2008 (http://www.footprintnetwork.org/en/index.php/GFN/page/national_assessments/) The carbon uptake land corresponds to the equivalent area of forest that would be needed to replace the fossil fuels being burnt.*

biologically productive land and sea area needed to regenerate the resources a human population consumes and to absorb and render harmless the corresponding waste.

Figure 4 shows the results obtained from the Footprintnetwork and published in the Living Planet Report 2008 published by the World Wildlife Fund (http://www.panda.org/about_our_earth/all_publications/living_planet_report/). The url provides information on how the footprint is calculated and also the per capita footprints of individual nations. Australia has a footprint of 8 hectares per person and Japan, a more moderate 5 hectares. Notice that according to these calculations, the resource consumption of the world became unsustainable in 1985.

Population summary

- There are too many people on Earth.
- Everyone is demanding more resources – growth is Good and growth is God.
- The majority hope to achieve higher living standards.
- We are living beyond a sustainable Earth.
- The current situation cannot continue.
- Should we all follow Japan, which has had a constant population for the last 10 years?

Energy

Cheap energy from coal and oil has allowed humans to 'conquer' the world, and it has only taken about 2000 years for the conquest to be complete. The Romans only had wood, horses, primitive weapons and slaves. Napoleon only had wood, gunpowder, horses and people. In Europe and Japan, Bismarck and Emperor Meiji had coal, iron, railways, explosives and people. Now we can:

- Transport ourselves safely all over the world and go to the moon;
- All aspire to have cars, computers, cell-phones, holidays, TVs and air-conditioning;
- Eat good food all the year round;
- Communicate instantly all over the globe;
- Use the power of computers to store information and calculate like never before; and
- Exterminate ourselves with nuclear and other weapons of mass destruction.

Figure 5 shows how our insatiable demand for energy has continued in the last 40 years. The long term projections for energy demand published by the International Energy Agency (http://www.worldenergyoutlook.org/) show a continually increasing global demand for energy (http://www.worldenergyoutlook.org/docs/weo2008/WEO2008_es_english.pdf). The IEA estimates that between 2010 and 2030 world energy demand will increase by about 45%. The problem is that fossil fuels, represented by oil, coal and gas, will still amount to over 80% of the total, whilst renewables still form a very small part of the total demand.

The longer humans have to rely on fossil fuels the more we will have to confront Peak Oil, Gas and Coal. Oil will be the first to peak and Figure 6 shows those countries that have passed their peak. Notice that Australia reached its peak production in 2000 and UK in 1999. Notice also that the major global producers such as Saudi Arabia, Iraq, Iran and Russia have not yet passed their peak.

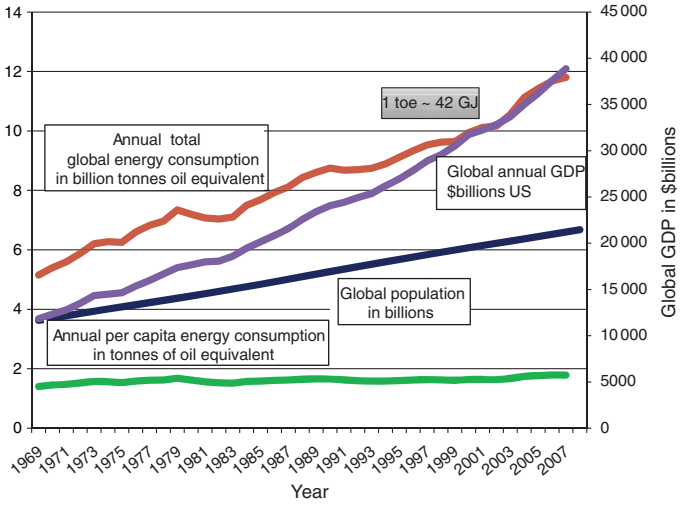


Fig. 5. *Growth in energy consumption, GDP and population from 1969 through 2008. Notice how well the global annual GDP and global energy consumption correlate from 2000 onwards. The data are normalised to 2005 $US. The left hand y-axis is used for all parameters except global GDP.*

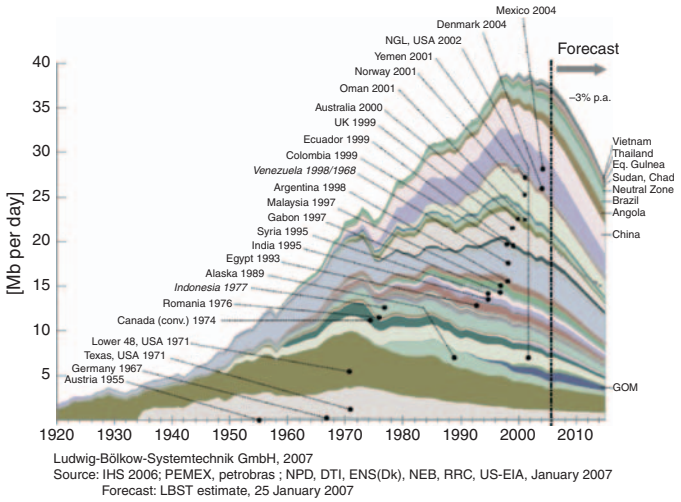


Fig. 6. *Oil producing countries that have passed peak production (Energy Watch Group 2007).*

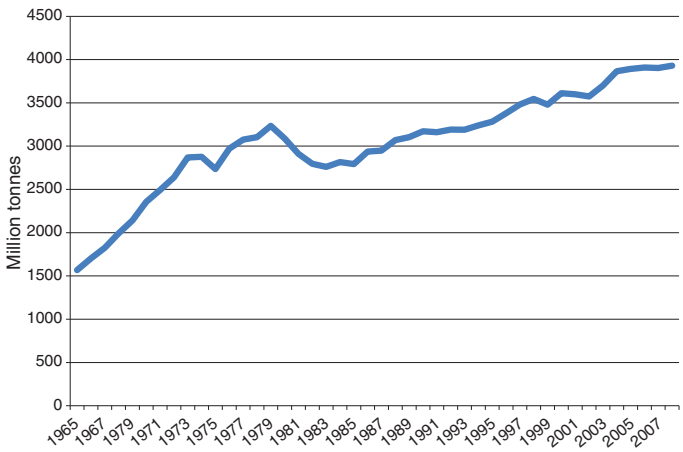


Fig. 7. *Annual world oil production from BP Statistical Review of World Energy. Source: http://www.bp.com/statisticalreview.*

Make no mistake, we are never going to run out of oil, it is just going to become more difficult, and hence more expensive, to find. However, global oil production is very close to peak value. Figure 7 shows a plot of the annual world oil production from 1965 to 2008. Peak production is definitely levelling off.

Furthermore, it is not just oil. Coal production peaked in the UK in 1915 and in Japan in 1960 (see Figure 8). Mohr and Evans (2009) forecast a global 'Best Guess' scenario of peak tonnage production for coal in 2034 and 2026 as the peak on an energy basis. They assumed that the global Ultimately Recoverable Resources (URR) ranged from 700 to 1243 Gt with a mean value of 1144 Gt. The key parameter in this analysis is the value of the URR.

Even gold exhibits peak production (Denham, 2009). Figure 9 shows the annual gold production from mines for the period 1960 through 2008. It is evident that production peaked early in the 21st century.

Energy summary

- To maintain our civilisation we need abundant cheap energy and mineral resources.

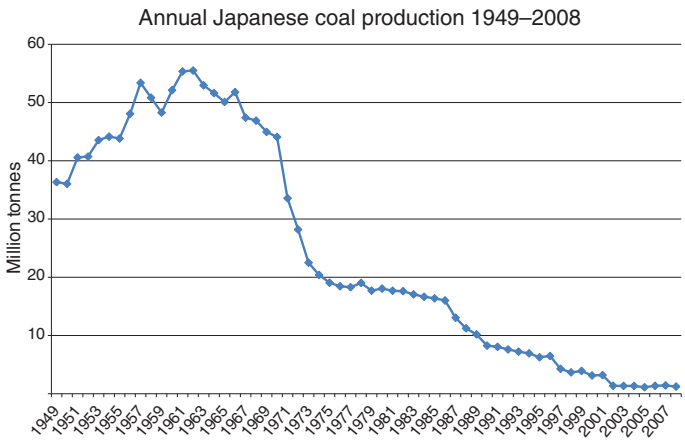


Fig. 8. *Japanese coal production from the USBM and USGS's yearbooks. Source: http://digicoll.library.wisc.edu/cgi-bin/EcoNatRes/EcoNatRes-idx?type=browse&scope=ECONATRES.MINERALSYEARBK.*

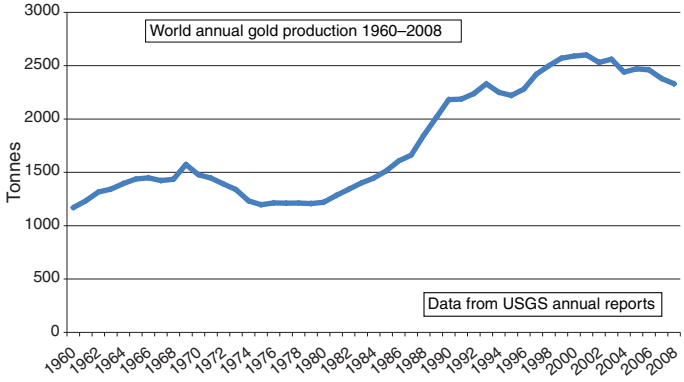


Fig. 9. *Annual gold production from 1960 to 2008 from USGS annual reports http://minerals.usgs.gov/ds/2005/140/gold.pdf. Although the South African production dominated the global production in the early part of the data set, there has not been a replacement producer to increase production levels.*

- There is increasing demand for fossil fuels.
- Difficult for renewables to fill the gap.
- Fossil fuels and other Earth resources are becoming harder to find.
- There will be pressure to meet this challenge – geophysicists will be essential to discover new resources.

Food

In the next 50 years we will need as much food as has been consumed in our entire human history. But, food is no longer a cheap commodity. Figure 10 shows the price variation of some staple foods on the world market.

Food is going to be more expensive because:

- There are more people to feed (an additional ~75 million every year).
- The increased cost of fuel and fertilizers (global fertilizer use has doubled in the last 35 years to 160 million tonnes).
- Farm subsidies, particularly to encourage farmers to feed cars rather than people – in 2008 approximately one-third of US corn was used to feed cars. Filling a car once with ethanol uses enough corn to feed one person for one year.
- Increasing demand for more and better food per capita as people become more affluent.

Ban Ki-Moon the Secretary General of the UN is calling for a 50% increase in food production by 2030 – if not ~100 million more people will fall into poverty. But he did not say how this was going to be done!

The *Guardian Weekly* of 21–26 August 2009 quoted from a UN report that forecast a need to invest hundreds of millions of dollars in better irrigation systems to cope with the burgeoning population. Unfortunately, some staple crops use huge amounts of water (cover of *New Scientist* 25 February 2006):

20 000 litres, 1 kg coffee
5000 litres, 1 kg cheese
11 000 litres, 1¼ lb hamburger
3000 litres, 1 kg sugar
7000 litres, 1 cotton T-shirt
1000 litres, 1 litre milk
1350 litres, 1 kg wheat
16 000 litres, 1 kg beef

The problem is three-fold. First, only ~0.007% of the Earth's water is accessible for direct human use – this is the water found in lakes, rivers, reservoirs and shallow underground basins. Only this amount is regularly renewed by rain and snowfall, and is therefore available on a sustainable basis. As the population has increased so has the demand for water for urban, industrial and agricultural use.

Second, the area of land being irrigated has not increased in recent years – see Figure 11. Irrigation accounts for about 80% of all global water consumption. Without irrigation, increases in agricultural yields that have fed the world's growing population would not have been possible. Irrigation is vital to food security and sustainability. Population and income growth will continue to boost the demand for irrigated water to meet food requirements and household and industrial water needs. In 1900, ~50 000 hectares were irrigated; by 2002 it had risen to ~280 000, but it has plateaued since then because the world is running out of new areas to irrigate.

Third, much of the arable land is being degraded as a result of dryland salinity, groundwater pollution, sodicity and loss of soil texture due to poor farming practices.

Surprisingly, both Australia and Japan use a similar percentage of water for irrigation. In Australia about 65% is used and in Japan ~66% for irrigation, ~15% for industry and 19% for domestic usage. Overall per-capita use in Japan is ~650 t/person while Australia uses about 850 t/person.

Food summary

Food is becoming more expensive because:

- More people to feed
- Shortage of sustainable fresh water
- Increasing land deterioration
- Increase in price of fertilizer
- More food grown to feed cars
- People demanding more and better food
- There is likely to be more conflict over water

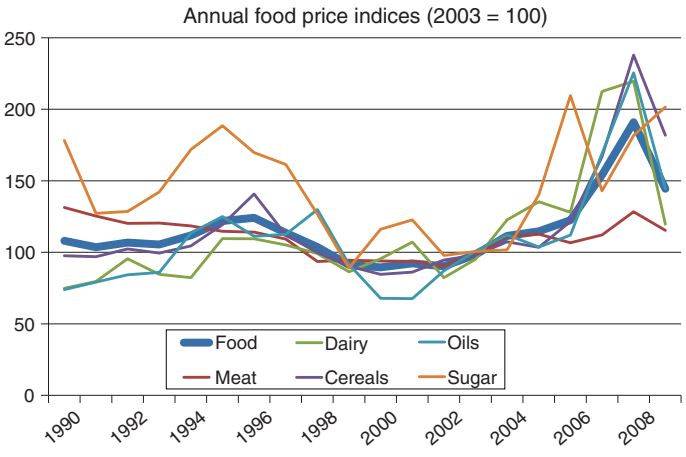


Fig. 10. *Annual food price indices from 1990 through 2008. The food index is the weighted average (thick blue line) of the other commodities plotted. Source: http://www.fao.org/worldfoodsituation/foodpricesindex/en/.*

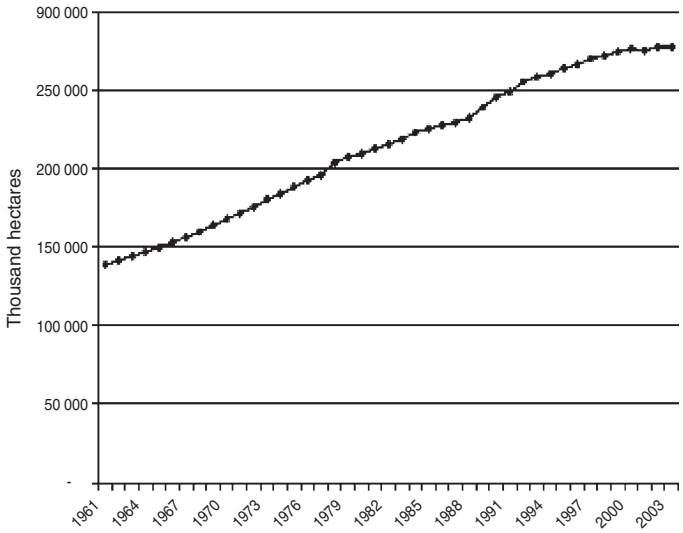


Fig. 11. *Total area irrigated from 1961–2003. Source: http://www.worldwater.org/data.html, table 16.*

Climate

For humans to prosper on Earth we need to have a 'friendly' climate. Over the last ~2000 years we have been blessed with a climate that is conducive to supporting humans and consequently humans have prospered. However, in the last ~100 years there is good evidence that the Earth's average temperature has been increasing and also that the greenhouse gases added to the atmosphere through the burning of fossil fuels have been the main contributors to this warming. There is not space here to fully analyse the global warming issue but some of the main points are given below.

Evidence for warming

Increased melting of glaciers

The melting rate of most of the world's glaciers has increased dramatically in the last 100 years. Figure 12 shows an example from the Upsala Glacier in Argentina. Glaciers have been melting for several hundreds of years, but that is because we are living in an interglacial period. The melting in the last 100 years has been at a significantly faster rate.

Observed average global temperatures

The instrumental record of global temperatures began in the 1850s. In addition, several researchers have compiled large-scale surface temperature reconstructions for the last 1000 years (NAS, 2006), using a variety of methodologies and a selection of proxies, as well as the instrumental record of global mean surface temperature.

The different curves show a good overall agreement for the data sets. They all show the Medieval Warm Period from 900 to 1200, when Norsemen inhabited Greenland and sailed to North America, and the Little Ice Age from 1500 to 1800. The more recent data from 1880 to the present all indicate significant rises in temperature at an increasing rate. In the last 100 years the average increase has been about 0.8 degrees and the rate of increase has risen to ~1.5°C/century during the past 30 years (see Figure 13). The surface temperatures of Earth are now higher than at any time during the last 120 000 years (http://www.daviesand.com/Choices/Precautionary_Planning/New_Data/).

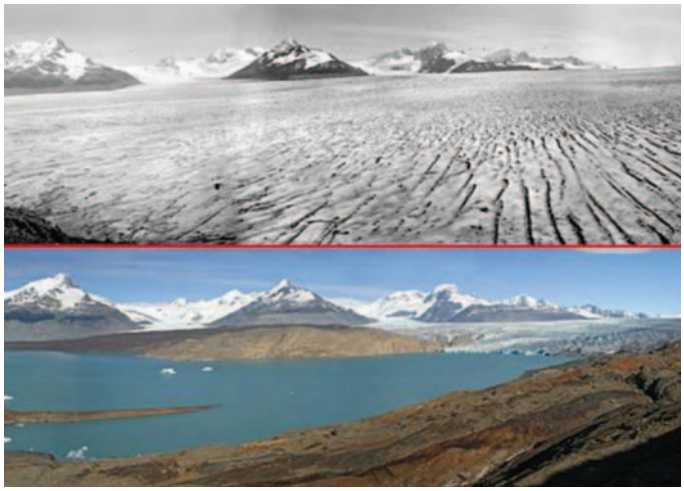


Fig. 12. *Upsala Glacier, Argentina (latitude 49 degrees south) 1928 (top) and 2004 (bottom), courtesy Greenpeace (http://www.greenpeace.org/international/photosvideos/photos/upsala-glacier-in-patagonia-1).*

Causes of recent global warming

Increased radiation from the Sun

The Sun controls the Earth's temperature and hence life on Earth. The main driver for climate change on Earth in the last million years has been variations in radiation intensity from the Sun, mostly due to the Milankovic cycles (Roe, 2006). However, in the last 60 years the change in solar intensity has been too small (~±0.05%) to be a major contributing factor (Solanki *et al.*, 2004).

Cosmic rays

Some researchers have correlated changes in cosmic ray flux due to changes in the Sun's magnetic field resulting from the 11 year Sunspot cycle (Ram *et al.*, 2009). However, although changes in intensity do correspond to the 11 year cycle, the observations do not indicate a longer term trend in, at least, the last 60 years.

Greenhouse effect

The greenhouse effect occurs due to the presence of CO_2 and other greenhouse gases in the atmosphere, such as methane and water vapour (Oxygen and Nitrogen do not absorb infra-red radiation). The absorption by greenhouse gases of infra-red radiation serves to keep heat near the surface of the Earth, effectively insulating it from the cold of space.

CO_2 is the most important greenhouse gas because it remains in the atmosphere for longer than water vapour (~100 years vs a few days) and it is much more abundant than methane (390 ppm vs 1.7 ppm). Consequently, as the concentration of greenhouse gases increases more heat will be retained in the atmosphere and this will result in an increase of minimum temperatures and a decline in evaporation rates. This is precisely what has been observed over most of the Australian continent and throughout the world during the last 50 years (Roderick and Farquhar, 2005).

Concentrations of CO_2 in the atmosphere have been measured accurately at several base stations throughout the world since the 1950s. The longest record is from Hawaii, which started in 1958. This record has been supplemented by analyses from several Antarctic ice cores (Etheridge *et al.*, 1998).

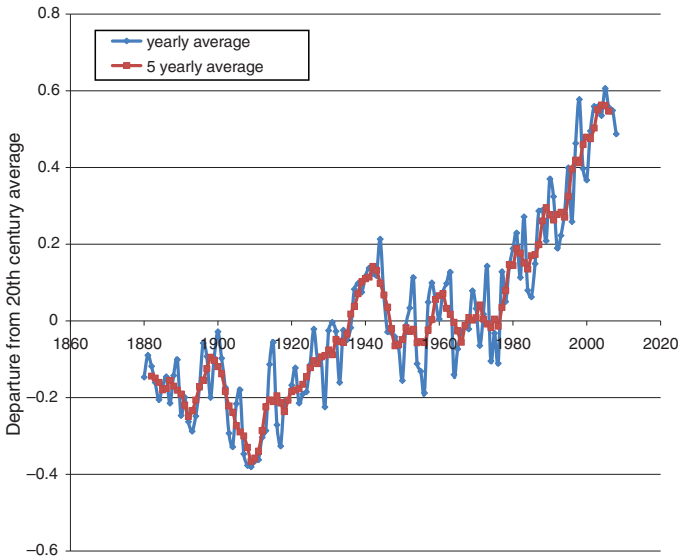


Fig. 13. *Average global temperatures 1880–2008. In the last 40 years the average global temperature has risen by ~0.6°C. Source: ftp://ftp.ncdc.noaa.gov/pub/data/anomalies/annual.land_and_ocean.90S.90N.df_1901-2000mean.dat.*

Figure 14 shows the results of the observations at Mauna Lao (Keeling *et al*., 2009) amalgamated with the pre-1958 data from Etheridge *et al.* (1998), to cover the period 1832–2006. Notice the increased rate of accumulation of CO_2 from 1950. For the 1000 years before 1832 the concentrations were remarkably constant and only varied between 275 and 285 ppm (Etheridge *et al*., 1998). The concentrations of CO_2 are now higher than at any time in the last 400 000 years (http://www.daviesand.com/Choices/Precautionary_Planning/New_Data/).

In addition to measuring the concentrations of CO_2 in the atmosphere, the Carbon Dioxide Information Analysis Center at Oak Ridge US has been compiling statistics on the amount of fossil fuel burnt from 1751 onwards. The results of this work are described by Boden *et al.* (2009), and shown in Figure 15. Since 1751 approximately 329 billion tonnes of carbon have been released to the atmosphere from the consumption of fossil fuels and cement production. Half of these emissions have occurred since the mid-1970s. The 2006 global fossil fuel carbon emission estimate, 8230 million metric tons of carbon, represents an all-time high and a 3.2% increase from 2005. Furthermore these numbers do not include the effects of forest fires. Notice that the temperature graph in Figure 13 also starts its steep upward trend at about the same time. The global per capita estimate was 1.2 tonnes per year in 2006 and this is the highest ever.

The evidence is strong that the increases in the burning of fossil fuels are the main contributor to the recent increases in CO_2 in the atmosphere and hence the warming of the planet.

One final piece of information. When discussing energy usage, we noticed that there was a very strong correlation between per capita GDP and per capita energy use. There is also a strong correlation between per capita carbon emissions and per capita GDP. Figure 16 shows the results for the top 20 countries in terms of gross emissions.

Climate summary

- The science linking global warming to fossil fuel emissions is now well established.

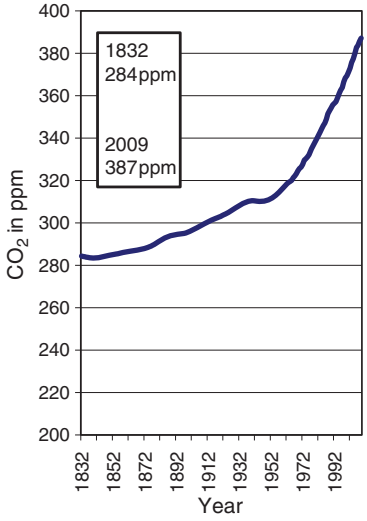


Fig. 14. *CO_2 concentrations in the atmosphere from 1958 to 2006 (Keeling* et al.*, 2009), supplemented by ice-core data (Etheridge* et al.*, 1998) for the period 1832–1957. The ordinate represents the CO_2 concentrations in the atmosphere in parts per million.*

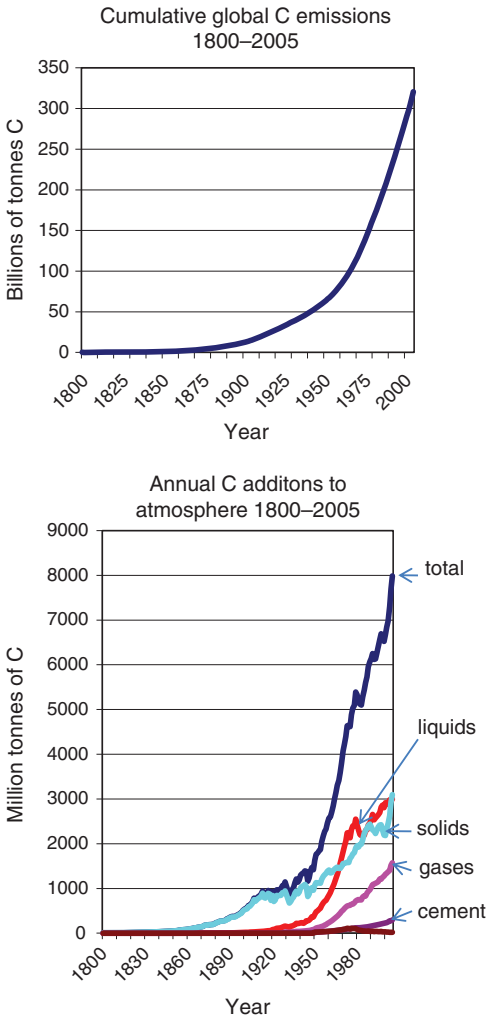


Fig. 15. *Cumulative global emissions of C (left) and the main contributors (right) for the period 1800–2005. The graphs show that near the end of the* 19th Century, *the burning of fossil fuels took off and has been climbing at a seemingly ever increasing rate ever since (Boden* et al.*, 2009). Notice how well the increase in temperature in Figure 13 and the CO_2 concentrations in the atmosphere shown in Figure 14 correspond to the fossil fuel burning curves.*

- Changing climate patterns will have an impact on a warming Earth, particularly on food production.
- A sea level rise of 1 m will affect 100 million people and inundate ~1 million km^2.

I do not intend to analyse here what we should be doing about the changing climate – that is a whole new topic – but I do suggest that we should aim to reduce our reliance on fossil fuels. This is not just to mitigate against global warming but also because fossil fuels will become increasingly expensive as they become harder to find and develop.

Knowledge and wisdom

Geophysicists provide knowledge

- In the last 50 years **all the gas, oil, uranium** and most of the other minerals we sometimes take for granted would not have been discovered without geophysics.
- We are going to need **more geophysicists in the future** because mineral and energy resources are getting harder to

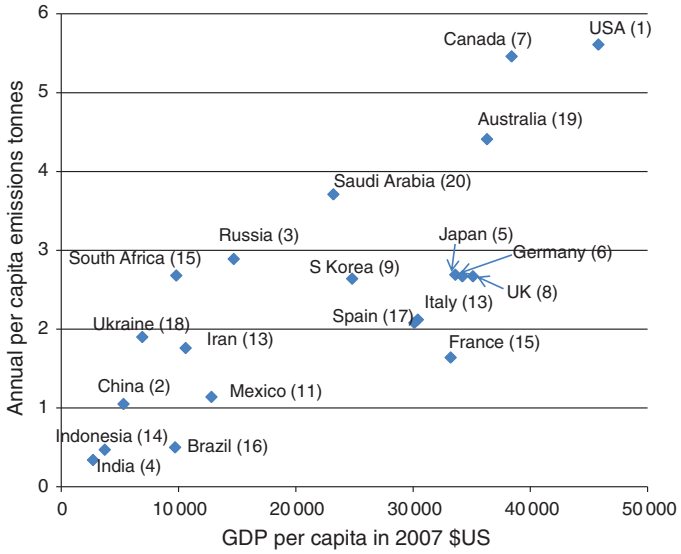


Fig. 16. *Per capita carbon emissions vs per capita GDP. (n) is the rank for total emissions in 2004. Note that USA, Canada and Australia are at the top of the heap. Source: http://www.ucsusa.org/global_warming/science_and_impacts/science/each-countrys-share-of-co2.html.*

find and there are new applications of geophysics to many environmental and engineering issues.

- **We should be proud of our achievements and contributions**.

Geophysics has provided impressive successes

Here are just a few examples:

Plate tectonics

Without the geophysical input to identify and interpret the magnetic stripes from the ocean floor, we would not have Plate Tectonics (Figure 17).

Airborne magnetics

In the last 50 years airborne geophysics has developed into one of the main tools for resource exploration and environmental management. We can now fly surveys as low as 50 m above ground level, at line spacings of 10 m, and with spatial accuracies better than 1 m. We can operate at a resolution of down to 0.001 nT, at sampling rates of 10 readings per second or greater, through a range of 20 000 to 100 000 nT (the strength of the Earth's magnetic field). And we can compile images like that shown in Figure 18.

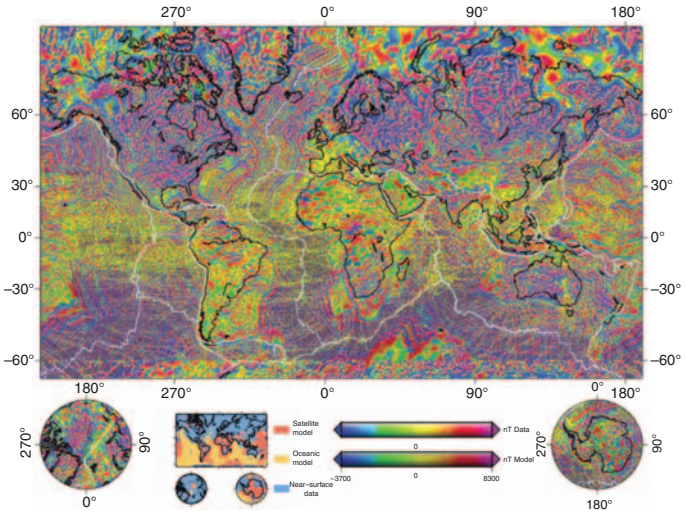


Fig. 17. *Magnetic map of the world showing very clearly the magnetic stripes on the ocean floor. Courtesy of Peter Milligan of Commission for Digital Magnetic Map of the World and Geoscience Australia.*

Seismic surveys

The capabilities of current seismic surveys are spectacular (Figure 19). Not only can we map the sedimentary basins, both on shore and offshore, but it is now possible to monitor how the oil/water, gas/water and other interfaces change over time as reservoirs are depleted.

Airborne gravity

Gravity gradiometry is one of the most significant developments in geophysics in the past 10 years. From being pie in the

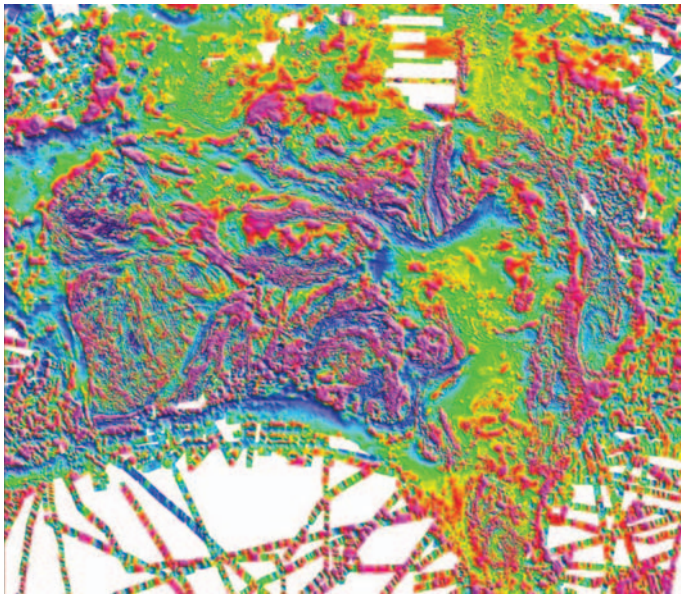


Fig. 18. *Magnetic anomaly map of the Australian continental region. Image provided by Geoscience Australia with assistance from Peter Milligan.*

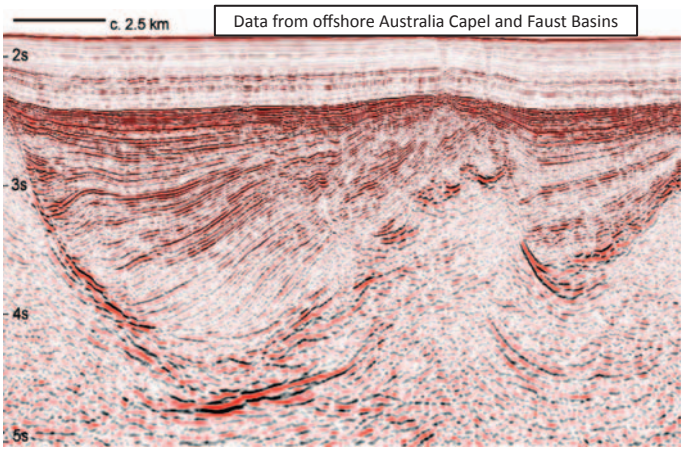


Fig. 19. *Typical 2D seismic survey over the offshore Capel and Faust Basins off the east coast of Australia – crossection provided by Geoscience Australia. The quality of the data enables reliable geological interpretations to be made, even though there may be few controls.*

sky to a reliable and valuable exploration tool has been one of geophysics main achievements. There are now several gradiometer systems operating globally on various platforms as contributions to exploration activities (DiFrancesco *et al*., 2008). The sensitivity of these instruments is quite remarkable and is now better than 10^{-9} per s^2. To put this into perspective, this was the sensitivity achieved by Eötvös in the early twentieth century, when he completed a series of 4000 measurement with instruments on a stable platform (http://en.wikipedia.org/wiki/E%C3%B6tv%C3%B6s_experiment).

Figure 20 shows some of the results that have been obtained by comparing fixed wing and airship observations with a ground gravity survey. They show clearly that the airship makes an excellent platform. However, it is slow to operate and cannot easily be transported around the world.

Airborne electromagnetic systems

In parallel with the development of airborne gravity systems, airborne electromagnetic systems have been another big success for geophysicists. Airborne electromagnetic systems are now

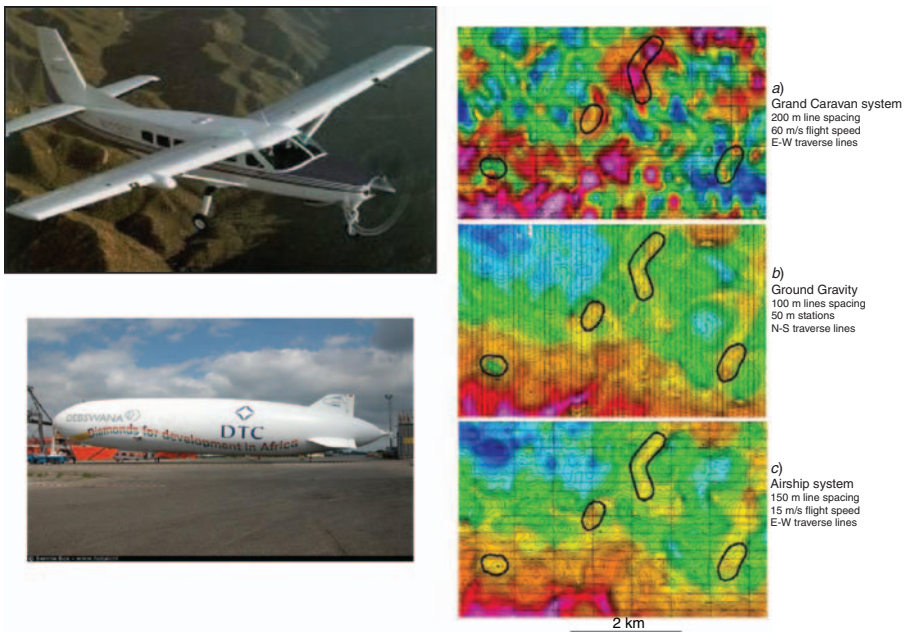


Fig. 20. *Comparison of fixed wing and airship results with ground gravity observations for diamond exploration in southern Africa (Hatch* et al*., 2007).*

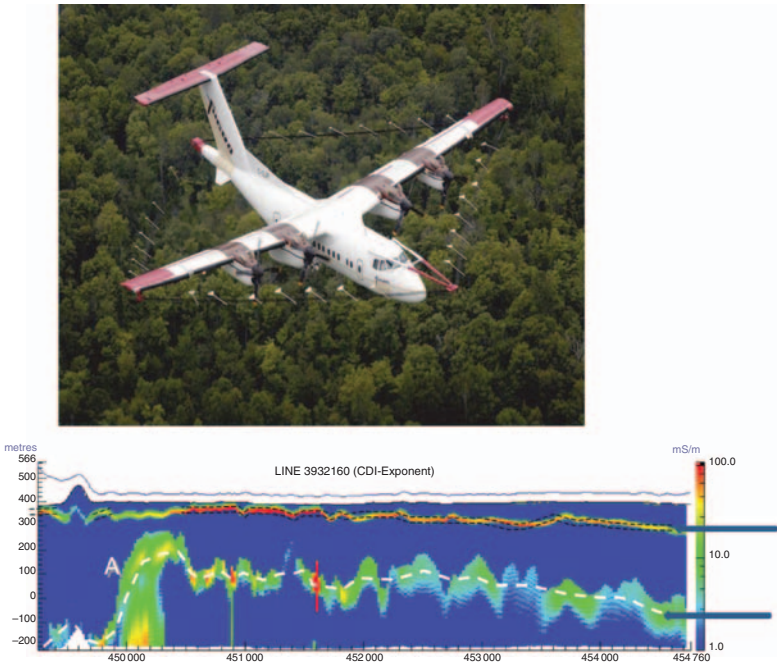


Fig. 21. *A Fugro aircraft showing the transmission loop, flying over thick jungle and a typical 2D model from a flight line in the Tanami region (Macnae, 2008).*

essential tools for a wide range of resource exploration and environmental mapping applications. Twenty years ago these systems were not commercially available. There are now a range of fixed wing and helicopter systems being used and a whole new suite of interpretational tools have been developed. Figure 21 shows a fixed wing platform and a typical 2D model derived from the observations.

There are many other success stories such as the advances in image processing, inversion techniques and 3D imaging, but I have just selected a few to indicate the innovation and output oriented characteristics of our leading geophysicists.

Challenges for geophysicists

- We will need fossil fuels and minerals for the foreseeable future so we must continue to develop better ways to find and extract these resources.
- We need to develop more geothermal and other clean sources of energy and manage our water resources better.
- We must apply and develop techniques to study land degradation so that we are better prepared to arrest the loss of arable land that is taking place throughout the world.
- We must lobby government and industry for appropriate geoscience-related research funding.
- Societies like the ASEG and the SEGJ must work harder to raise the profile of geosciences in government, business and the community.
- We must use our knowledge and skills to improve our nations' well being.

Challenges for everyone

- We must all work inside and outside our discipline to make a difference.
- Manage our resources better by using less fossil fuel and producing more food.
    - Energy and food R&D must be dramatically increased.
    - We should not tolerate a world where hundreds of millions of people live in poverty, when we have the knowledge to tackle the problem.
- Global population must be reduced.
    - This is the biggest single factor in generating greenhouse gases, burning fossil fuels, destroying biodiversity, polluting the environment, and threatening our civilisation.
    - The projected population rise to 9.2 billion at 2050 could be unmanageable.
- 'Growth' must be abandoned as the as the main economic goal.
    - GDP must not be used as a positive measure of wellbeing because depletion of resources – when an irreplaceable part of a nation's capital stock has been consumed – is regarded as positive.
    - GDP does not distinguish between green and polluting industries – environmental costs are not considered.
    - It does not measure a nation's wellbeing.

Do we have the wisdom?

I believe that we have the knowledge to achieve these goals and maintain our civilization on Earth, but doubt that we have the wisdom because we need to change our behavioural patterns too drastically. Let's briefly examine what we need to do.

- We tend to focus on short term issues, rather than planning on generation-length time scales. We must start working on longer time frames, but I doubt whether this is possible. Let's look at a few examples.
    - On Easter Island we chopped down all the trees and were stranded there. In New Zealand, we exterminated our most valuable resource, the Moa, and we exterminated the cod fish in the North Atlantic – even though we knew that the catch was rapidly diminishing. Short term gain won over the long term view.
    - In our 'democratic' political system the plans of our politicians are usually, at best, only 3–4 years long – looking at the next election!
- We have too easily resorted to violence to 'solve' problems.
    - The last century had more deaths from wars and conflicts, on a per capita basis, than any other century – in other words we have not learnt from history.
    - Examples such as World War I, which we stumbled into, World War II, which was really about resources, and Iraq must not be repeated.
    - We are hard-wired for war and yet we all want peace.
    - As Miles Franklin said in 1953: 'To contemplate war is to be defeated.'
    - We need to be more tolerant and understanding of our fellow humans and focus more on the longer term.
- And this is going to be difficult to achieve.

My conclusions

1. National and local issues usually win over global concerns. As there are now more nations than ever before (from ~45 in 1900 to 196 today) it will be more difficult to get agreement on issues relating to energy, food, climate change, water, population and weapons proliferation.

2. However, the issues we face relating to degradation of the Earth's environment and pressures on resources will be so critical that we will be forced to co-operate to meet these challenges. We will have to change to survive – and we are probably wise enough to recognise this.

3. Our knowledge and our ability to communicate across the globe will focus our actions. We are smart and cunning, and have a very strong instinct for survival. So I believe we will be able to manage the situation for the next ~200 years – but it is not going to be easy.

4. As geophysicists we must work to expand our knowledge but more importantly use this knowledge to the benefit of the society in which we live.

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Geosciences in Australian universities

One sobering experience from my SEG-sponsored tour last year was that geoscience departments in Australian universities are a shadow of their former selves, particularly on the geophysics side. Student intakes are generally small in the first year of undergraduate earth sciences courses, and dwindle to very small numbers by the Honours year. Why is this, when Australia is so rich in natural resources, and both petroleum and minerals professionals will tell anyone that the graduate intake is approaching crisis levels? Is it simply because there is a bounty of better paid and more appealing alternatives?

If the home page of most Australian university Geosciences departments is any indication, I suggest that an important factor is the appallingly boring and characterless way that geosciences are promoted to potential undergraduates. The material below probably reads like a repetitive rant, but inevitably, each home page is too frequently little more than a mechanical series of links to course options and units, sometimes supplemented by rather busy and irrelevant department 'news'. Earth sciences are rarely trumpeted as being an exciting career, or offering international travel opportunities, or of having any critical value to the national interest of Australia – a nation so dependent upon the extraction of its abundant natural resources.

I note that a common theme in earth sciences departments is their integration in recent years into larger 'environmental' (and other) science faculties. Indeed, it was a tough exercise trying to even identify whether some universities still had an earth science department. Would I find it within an environmental faculty, as was typically the case, or within a physical science faculty, as is the case for ANU? My superficial conclusion is that most earth science departments are simply awful at self promotion. If some home pages are any indication, earth science education in Australia is already dead.

Get some colour! Use some graphics! Use multimedia! Reach out and grab students – tell them why their life can be exciting and fulfilling in the earth sciences!

Another observation is that most earth science departments do not appear to target undergraduates. Most links appear to address post-graduate activities. I guess that is where the money is, or what remains of scholarship opportunities, but it is certainly unappealing to potential undergraduates and the casual visitor alike. We live in an age of short attention spans and information 'snapshots'. My simple message to earth science departments: Fix your web pages. Build a value proposition that makes its message in one page.

I hope my article upsets a lot of universities, and any aggrieved departments might take the opportunity to promote themselves in the next *Preview*…But first, I invite them to have a critical look at their own web pages. The following links are the universities I believe still offer earth science degrees. Apologies if I missed anyone off.

ADELAIDE – Flinders University – School of Chemistry, Physics & Earth Sciences (http://www.flinders.edu.au/science_engineering/cpes/home.cfm/index.html). Awful. Eventually found a few links to a list of degree options.

ADELAIDE – Adelaide University – The School of Earth and Environmental Sciences (http://www.ees.adelaide.edu.au/). One of the better home pages. Easy to navigate and uses some (minimal) graphics.

ADELAIDE – Australian School of Petroleum (http://www.asp.adelaide.edu.au/). Also reasonably easy to navigate, and includes a couple of 'Featured programs' on the home page. Alas, the site is still fairly low impact.

ARMIDALE (NSW) – University of New England – Division of Earth Sciences (http://www.une.edu.au/study/earth-sciences/). This is a concise home page containing pretty much everything important on the one page. A rare case where the importance of earth sciences is stated.

BALLARAT – University of Ballarat – School of Science & Engineering – Geology (http://www.ballarat.edu.au/ard/sci-eng/programs/geology.shtml). Quite concise links to descriptions of each degree, but suffers from tiny fonts and mechanical layout.

BRISBANE – Queensland University of Technology – School of Natural Resource Sciences (http://www.scitech.qut.edu.au/about/schools/nrsci/). Entirely missable. Almost tells the visitor to go elsewhere for anything interesting or informative.

BRISBANE – University of Queensland – Department of Earth Sciences (http://www.earthsciences.uq.edu.au/). A bare home page with a large PDF earth sciences slideshow that takes some time to download. When it arrived it was a photographic tour of the department and its people. I struggled to find anything enlightening in the layers of links below the home page, many of which alienated the visitor with messy titles and jargon. This reads like it is written for internal rather than external use.

CANBERRA – ANU College of Physical Sciences (http://cps.anu.edu.au/portals/earthsci/). Busy, but I like the way that links open new windows, making the site easy to navigate and digest. The home page asks rhetorical questions for prospective students – and answers why they should study at ANU. A comprehensive web resource.

CANBERRA – ANU Research School for Earth Sciences (http://rses.anu.edu.au/). Home page contains only links and no value proposition. I guess this is not targeted at prospective undergraduate students, so visitors are expected to dig around before they find anything informative.

HOBART – University of Tasmania – Geology Department (http://fcms.its.utas.edu.au/scieng/earthsci/). Standard hierarchy of links to quite a lot of information, but for a university perched on a wilderness wonderland, it is disappointing that no apparent effort is made to showcase this fact.

MELBOURNE – LaTrobe University – Department of Earth Sciences (http://www.latrobe.edu.au/geology/). Seems to prioritise its analysis (commercial) services over study options, as there is negligible information here of any nature, and no images.

MELBOURNE – Melbourne University – School of Earth Sciences (http://www.earthsci.unimelb.edu.au/). A busy home page leads to quite of a lot of information, but the pages are difficult to read because every word is underlined. No images anywhere beyond the home page, and terribly tiresome to wade

through. Again, appears to target post-graduate students and serve as an internal resource.

MELBOURNE – Monash University – Earth Sciences (http://www.geosci.monash.edu.au/). A bold home page that makes the statement 'We are Australia's leading school of Earth Sciences', and is unique in offering an overview of Employment Opportunities for all types of earth scientists. Some strong images, and easy to read.

MELBOURNE – Royal Melbourne Institute of Technology – Department of Civil and Geological Engineering (http://www.rmit.edu.au/browse;ID=4pscqhcscoyyz). Minimalist description of (engineering) degrees on offer.

NEWCASTLE – University of Newcastle – School of Environmental and Life Sciences (http://www.newcastle.edu.au/school/environmental-and-life-sciences/). Good luck if you can work out whether they have a geology department any more. Only obvious link is the Tectonics and Earth Resources Research Group.

PERTH – University of Western Australia – School of Earth and Environment (http://www.see.uwa.edu.au/). Links to the various groups and centers, and targets post-graduate students on the home page. Prospective undergraduates have to dig further, and the value proposition to study earth sciences is entirely forgettable. I am not sure who the key target audience is here. University or government administrators?

PERTH – Curtin University of Technology – School of Applied Geology (http://geology.curtin.edu.au/). All three Curtin web sites use a common template, and offer quite vast information for those prepared to dig through several layers. Quite well structured, and probably useful as a reference for school students studying the earth sciences. But, I argue that not enough effort is made to really engage the first time visitor and prospective undergraduate students.

PERTH – Curtin University of Technology – Department of Exploration Geophysics (http://www.geophysics.curtin.edu.au/). This offers a rather entertaining video linked to the home page, and again offers a vast information resource. Probably the best web resource of all the universities I visited. Possibly reflects the fact that Curtin has the largest student body in Australia.

PERTH/KALGOORLIE – Curtin University of Technology – Western Australian School of Mines (http://wasm.curtin.edu.au/index.cfm). Could do more to really showcase the grand scale of mining in Australia, and life as a mining geologist, but again contains a lot of information, if rather mechanical in delivery.

PERTH – Murdoch University – Mineral Science (http://www.cms.murdoch.edu.au/areas/extrmet/). Extremely minimalist. Makes no effort to say why prospective students should consider metallurgy as a career option.

SYDNEY – Macquarie University – Earth and Planetary Sciences (http://www.eps.mq.edu.au/). Quite informative, and contains many layers of structured information, but suffers from a small font and zero images. There are useful salary estimates and career guidelines, but I believe this should have a higher profile, and employ multimedia vehicles to 'grab' the attention of prospective students.

SYDNEY – University of Sydney – School of Geosciences (http://www.geosci.usyd.edu.au/index.shtml). Minimalist home page, and a reasonably well structured set of information. Again, no value proposition to prospective students (if there is, I missed it), and rather mechanical.

SYDNEY – The University of New South Wales – School of Geology (http://www.bees.unsw.edu.au/future/geoscience.html). Almost entirely comprises links to course units. Why study earth sciences at UNSW? A one liner in small font at the top of the page is not enough…

TOWNSVILLE – James Cook University – Department of Earth Sciences (http://www.jcu.edu.au/ees/). Again, and for the final time, contains all the essential information, but is mechanical and uninviting. Another example I feel of a web resource written to demonstrate competence to other academia and government, but forgets to appeal to prospective students.

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Calendar of Events 2010

March			**2010**
24–26 Mar	Australasian Oil & Gas Exhibition and Conference http://www.aogexpo.com.au	Perth	Australia
25 Mar	Geophysics and Geohazards: Defining Subsea Engineering Risk (associated with AOG Expo above)	Perth	Australia
April			**2010**
5–8 Apr	EAGE: Saint Petersburg 2010 http://www.eage.org	St Petersburg	Russia
6–9 Apr	13th Quadrennial IAGOD Symposium 2010: Giant Ore Deposits Down-Under http://www.alloccasionsgroup.com/IAGOD2010	Adelaide	Australia
11–15 Apr	SAGEEP 2010 http://www.eegs.org	Keystone	Colorado
May			**2010**
2–7 May	European Geosciences Union (EGU) General Assembly 2010 http://meetings.copernicus.org/egu2010	Vienna	Austria
10–14 May	Geocanada 2010: Working with the Earth http://www.geocanada2010.ca	Calgary	Canada
17–19 May	Developments in Land Seismic Acquisition for Exploration (EAGE North African Workshop 2010) http://www.eage.org	Tripoli	Libya
24–27 May	Oceans '10 IEEE Sydney Conference and Exhibition http://www.oceans10ieeesydney.org	Sydney	Australia
June			**2010**
14–17 Jun	Barcelona 2010: 72nd EAGE Conference and Exhibition incorporating SPE EUROPEC 2010 http://www.eage.org	Barcelona	Spain
14–17 Jun	ICEEG 2010 – 4th International Conference on Environmental and Engineering Geophysics http://www.iceeg.cn	Chengdu	China
22–25 Jun	2010 Western Pacific Geophysics Meeting http://www.agu.org/meetings/wp10	Taipei	Taiwan
July			**2010**
4–8 Jul	Australian Earth Sciences Convention 2010: Earth systems: change, sustainability, vulnerability http://www.aesc2010.gsa.org.au	Canberra	Australia
August			**2010**
8–13 Aug	2010 Meeting of the Americas http://www.agu.org/meetings	Iguassu Falls	Brazil
22–26 Aug	ASEG – PESA: 21st Conference and Exhibition http://www.aseg.org.au/Events/Conference	Sydney	Australia
29 Aug–4 Sep	Seismix 2010 – 14th International Symposium on Deep Seismic Profiling of the Continents and their Margins http://www.earthscrust.org/earthscrust/seismix2010.htm	Cairns	Australia
September			**2010**
5–10 Sep	11th IAEG Congress http://www.iaeg2010.com	Auckland	New Zealand
6–8 Sep	Near Surface 2010: 16th European Meeting of Environmental and Engineering Geophysics http://www.eage.org	Zurich	Switzerland
29 Sep–1 Oct	Geo-Computing 2010: 'Uses and Abuses' http://www.aig.org.au/events	Brisbane	Australia
October			**2010**
17–22 Oct	SEG International Exposition and 80th Annual Meeting http://www.seg.org	Denver	USA

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

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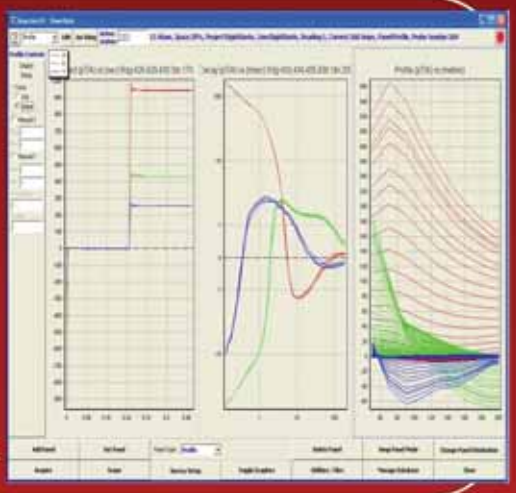

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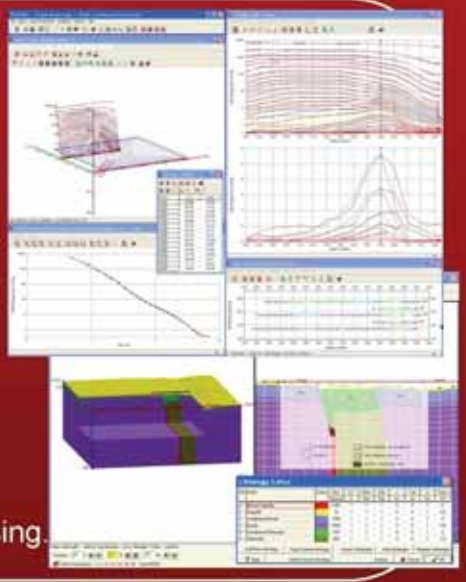

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