AUGUST 2009 • ISSUE 141
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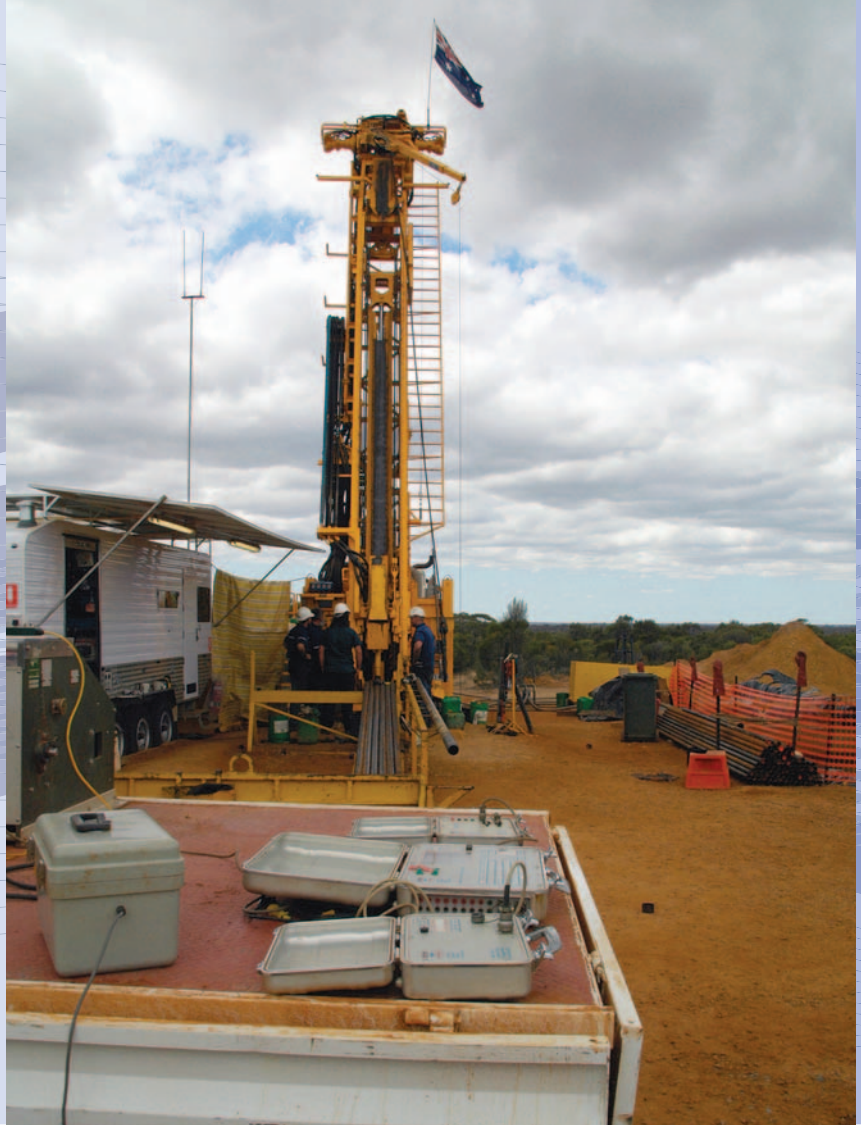
PREVIEW

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS

NEWS AND COMMENTARY

FEATURE ARTICLES



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PREVIEW

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FRONT COVER

Emma Young, Danny Markey and Ian Moffat from the Department of Archaeology, Flinders University download magnetometer data as part of investigations to locate Aboriginal fireplaces near the Woolgar River, northwest Queensland. Image: Lynley Wallis.

Preview is available online at
www.publish.csiro.au/journals/pv
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Call for papers

Future Discoveries are in our hands

Invitation

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

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

Program Outline

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

Call for Papers

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

Conference Secretariat

Conference Action
PO Box 576, Crows Nest NSW 1585
Tel: +61 2 9437 9333
Fax: +61 2 9901 4586
Email: aseg-pesa2010@conferenceaction.com.au
Web: www.aseg-pesa2010.com.au

Key Dates

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

Submission of Initial Abstracts

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

Initial Abstract Specifications

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

Presenter Profile

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

PLEASE NOTE:

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

Technical Areas

Seismic Data Processing

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

Oil and Gas Exploration

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

Minerals Exploration

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

Engineering and Community

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

The Discipline of Geophysics

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

Economics/Big Picture Topics

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

Ann-Marie Anderson-Mayes

I recently bought a secondhand book by Michio Kaku called *Visions: How Science Will Revolutionize the 21st Century and Beyond*. Dr Kaku is a theoretical physicist, prolific and bestselling author, and well known populariser of science in the USA. *Visions* was published in 1998, and thus is now over 10 years out of date, a long time in the era of rapidly advancing science and technology. However, the book still makes fascinating reading as the information gleaned from scientists of various disciplines is used to make predictions relating to the impacts of the computer revolution, the bimolecular revolution and the quantum revolution out to the years 2020, 2050 and 2100.

In the opening chapter, Kaku loosely characterises the 20th century as the scientific era of reductionism, where scientists became intensely specialised as they probed deeper and deeper into their subdisciplines. By contrast, he says the 21st century will be characterised by 'synergy'. In his book he is particularly focussed on the gains to be made by cross-fertilisation between computer technology, biomolecular developments and the quantum revolution. I am a generalist by nature, so the notion that scientists from vastly different disciplines can come together to make something that is 'more than just the sum of the parts' is very attractive.

I was struck by the notion that exploration geophysicists are pretty good at synergy already. Whilst our core knowledge is related to the measurement of physical properties of the earth, we usually combine this with an excellent understanding of computer technology; knowledge of the geological scenarios in which the geophysics is being applied; a general knowledge of the wide variety of problems to which geophysical surveys can be applied; and perhaps even some economic understanding of targeting an exploration budget for the best outcomes.

Many of us are also keenly interested in the global warming/climate change debate. Our professional training and experience gives us some knowledge that may be helpful when trying to assess the merits of both sides of the argument. Michael Asten, current ASEG President, has been commenting in the media on this topic recently. He wrote an opinion piece for *The Australian* (http://www.theaustralian.news.com.au/story/0,25197,25680666-7583,00.html) and subsequently gave an interview on ABC Radio National's *Counterpoint* (http://www.abc.net.au/rn/counterpoint/). If you are interested in this debate, these pieces are worth reading.

As I edited this edition of *Preview*, the diversity of topics which may be of interest to exploration geophysicists became very obvious. In this issue we have articles on archaeological geophysics; microgravity for subterranean water channels; the relationship between gold/base metal prices and the valuation of the US dollar; and the implications of the latest Federal budget for the geosciences. There is also an interesting Guest Editorial by John Gater which discusses the popularisation of archaeological geophysics in the UK as a result of the well known TV show, *Time Team*. I hope at least one of these diverse articles captures your interest!

In the next issue...

The National Science Curriculum covers all school years from Kindergarten to Year 12 and is expected to be implemented – along with other national curricula covering English, Mathematics and History – from 2011. The National Curriculum Board has decided to make Earth and Environmental Science a major study stream alongside Physics, Chemistry and Biology for Years 11 and 12 – and to keep Earth Science as a major study stream alongside Biology, Physics and Chemistry for Years 7 to 10. As a consequence, I plan to cover a range of Earth Science education programs in the next issue of *Preview*. For example, the ASEG has recently agreed to sponsor TESEP, the Teacher Earth Science Education Programme. If you know anything about these programs, or would like to contribute an article or letter about your personal experiences with promoting earth science education in our schools, please send me an email at preview@mayes.com.au.

Dr John Gater
Director, GSB Prospection Ltd
Time Team *Geophysics Consultant, Channel 4*

In the past 16 years, or so, dramatic things have happened in archaeology in the UK. The subject has become 'sexy', especially in television terms. One programme in particular, *Time Team* (*TT*) on Channel 4, has had a major impact on viewers' perception of archaeology. The programme has continued over the years to regularly attract 3+ million viewers and research has shown it has a 'reach' of some 15 million, or over 25% of the UK population. Following on from its success, *TT* is now broadcast on numerous digital channels throughout the world.

In essence the programme involves a group of archaeologists 'faced with a challenging mission, having just three days to unlock some secrets and sort out questions about an archaeological site in Britain, or abroad'. The programme is presented by Tony Robinson – originally the character *Baldrick* in the comedy series *Blackadder* – who works with a regular cohort of archaeologists led by Prof. Mick Aston and Dr Phil Harding, who have become 'stars' in their own right. Perhaps somewhat surprisingly, a major component of the series has been the role of geophysics in the archaeological investigations; in fact the techniques and the findings have become key to the success of many of the programmes.

Sixteen years ago very few people outside of the profession had heard of archaeological geophysics; now, largely as a result of *TT*, the subject can boast one of the highest public profiles of any specialist scientific discipline. In fact, the subject has coined its own language: *geophys* or *geofizz* has become a widely recognised term, not only in the programme but in wider public parlance. As a consequence, albeit tongue in cheek, Prof. Timothy Darvill of Bournemouth University advocated that the word should be included in the Oxford English Dictionary. At geophysical conferences we have attended, delegates have expressed their envy of the exposure archaeological geophysics receives; we have even featured on the front cover of a magazine (albeit in *New Electronics*!).

When we appeared on the first *TT* programme back in 1993 and revealed the lost church and monastery at Athelney (Fig. 1), we had little idea that our 'success' would have such long term implications. We now have completed over 175 *TT* shoots and during that time there has been a tremendous growth in the number of geophysical surveys carried out in archaeology. The expansion of geophysics in archaeology has been largely developer-led and numerous archaeologists – be they consultants or in curatorial positions – have expressed the view that in the past 16 years it has become easier to argue the case for geophysics being part of an evaluation, simply by citing the use of the techniques on *TT*. It is fair to say that in the archaeological profession, geophysics is seen as one of the most positive aspects of the programme. In England we have reached the stage where some developers actually demand that a geophysical survey is carried out in advance of their proposals.

Outside commercial-led archaeology, amateur groups have become involved in geophysics and many local societies have purchased their own equipment. Whether we consider professional or amateur survey, there is now an unprecedented amount of geophysics at all levels; while *TT* cannot take all the credit for this, it has awakened the interest.

A big difference between *TT* and our normal evaluation work is that we get to see *instant* results – our interpretations are put to an immediate test and we get feedback; this is very important to us and has helped considerably with our understanding of the geophysical responses associated with a wide range of differing archaeological features. In 'real life' it is very rare for archaeologists to send us information on the results of their evaluation trenches – in fact, the only time we can guarantee to hear anything is if we get our interpretations wrong!

Although the majority of viewers believe that we only use a couple of geophysical techniques, we have used everything short of dowsing. We try to introduce new instruments where possible – but it's rare that experimental work which is done on the programme makes the final edit. *TT* want tried and tested techniques as the programme is about what is possible, rather than what might be possible. Times have changed however, as we have gradually used GPR more frequently and now process huge quantities of data into time-slice images within a matter of minutes – something the software and computing power simply didn't permit even 5 years ago (Fig. 2).

Occasionally we have been criticised for dumbing down the subject – one remark about presenting results to

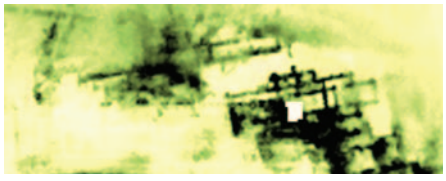

Fig. 1. *Twin-probe resistance survey at Athelney, Somerset. Survey area: c. 1.25 ha. Readings logged at 1.0 m × 1.0 m using a mobile probe separation of 0.5 m. High resistance readings = black, low = yellow.*

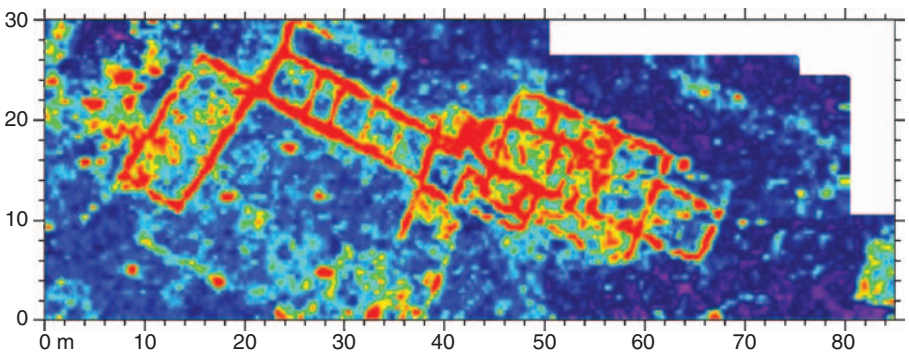

Fig. 2. *Ground Penetrating Radar survey at Caerwent, South Wales. Noggin SmartCart with 250 MHz antenna. Readings logged at 0.05 m along transects spaced 0.5 m apart.*

'*Beano* readers' has stayed with us from programme one. A few geophysicists don't seem to accept that we are not an Open University programme and that if we tried to give explanations of complex matters the majority of viewers who watch *TT* would probably turn off. Thankfully the majority do approve of what we are doing. Writing in *New Scientist* in 1994, Andrew Chitty compares *TT* to another television programme called *Big Science*:

'Big Science *and* Time Team *take very different approaches to televising science. Science is Big, but it is also irritatingly complex*. Big Science *acknowledges the complexity, excites the audience visually, but is telling us about science. The* Time Team *tells us a story, but actually does science. By drawing us in, setting us problems, we the audience do science too.'*

He further writes at another point in the article:

> *'And joy of joys, they sometimes get it wrong. In one episode, team leader Mick Aston convinces the geophysics team to spend a whole day mapping a field trying to find a Dark Age settlement. He explains his theory, ditches are dug, maps are made. The result? A total blank.'*

Such are the delights of geophysics on *Time Team*!

This article is an adaptation of a Paper originally presented to the Institute for Archaeologists Annual Conference in 2004.

About the author

Dr John Gater BSc HonDSc FSA MIFA is a:

- Fellow of the Society of Antiquarians.
- Assistant Editor of the Journal *Archaeological Prospection.*
- Co-author of *Revealing the Buried Past: Geophysics for Archaeologists* published by Tempus in 2003.

In 2006 he was awarded an Honorary Doctorate by the University of Bradford for his 'distinguished contributions to the field of archaeological geophysics'.

Maintaining our individuality while seeking strength in teamwork – I

Australia has at least eight professional societies addressing the interests of geoscientists, where the term 'interests' is a broad term extending from making representations to government, to maintaining professional standards, and from publishing technical papers through to providing opportunities to gather for a drink or two and some gossip.

Our societies are organic – they evolve to suit the circumstances and the interests of members, and they are only as strong as their members' enthusiasm. Among the eight, the ASEG ranks fifth (see table below) but we have a level of activity which few groups of our size can emulate; conferences every 18 months, a professionally produced news magazine *Preview*, a peer-reviewed journal (*Exploration Geophysics*) publishing papers from an international authorship and readership, a Research Foundation supporting graduate-student projects, and state branches organising meetings and training seminars.

There is discussion among our Australian peer societies aiming at amalgamation which might create strength and efficiencies through numbers. The Geological Society of Australia and the Australian Institute of Geoscientists have a working group developing such an amalgamation between those two societies. An alternative to amalgamation is collaboration between societies; ASEG has a strong record in this approach. Our closest sister society in terms of geoscientists with a resource-industry outlook is the Petroleum Exploration Society of Australia, and we have a long record of collaboration in joint ASEG–PESA conferences. Four more areas of synergy suggest themselves:

- Complementary articles and news in our respective magazines – both are online free so this is a policy-free decision, so browse www.pesa.com.au and check out for example the set of articles on the future of geothermal, coal seam gas, oil and gas energy reserves in Australia. No doubt a few PESA members will have downloaded our last *Preview* via the link at www.aseg.org.au to access Robert Day's excellent article on coal seam gas in eastern Australia. (The ASEG Federal Executive recently received a request for permission to circulate this article to shareholders of a registered company. Obviously we should be paying our journalistically inclined contributors larger fees!)
- Websites: the two societies have similar needs – can we collaborate to drive our resources further? FedEx will be looking at this possibility later this year.
- Combined secretariat/office functions; is there an area of synergy in our needs?
- Joint badging of seminars and meetings; the Vic branches of ASEG and PESA have an agreement to advertise functions to both groups as ASEG–PESA and PESA–ASEG activities respectively, most recently the talks by visiting SEG Honorary Lecturer Dr Andrew Long.

Next issue I will talk about our role on the Australian Geoscience Council, and some of the synergies and opportunities generated within that team.

By the end of this month I will have visited and spoken at Tas, Vic and NSW State Branches. I look forward to visiting other State Branches at least once over this next year, to discuss matters of high policy. Or just for a drink or two. Your suggestions and feedback are always welcome.

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

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

Fugro Airborne Surveys
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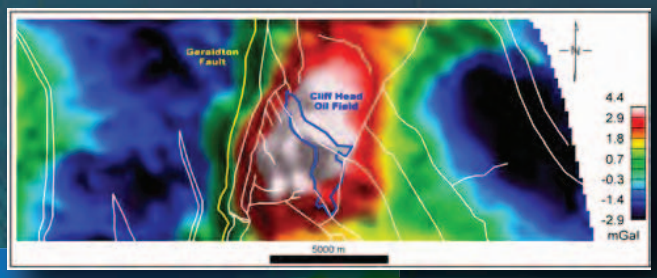
Geophysical Solutions



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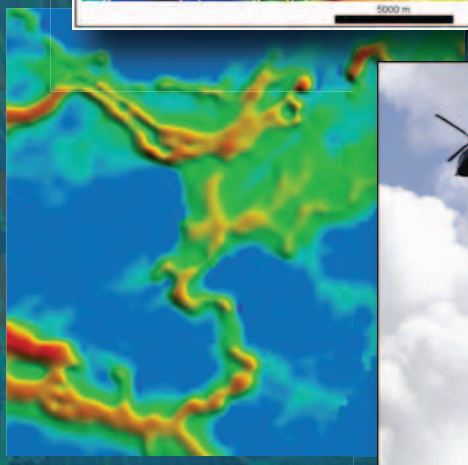

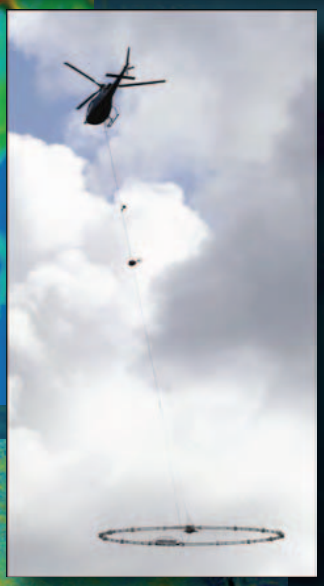

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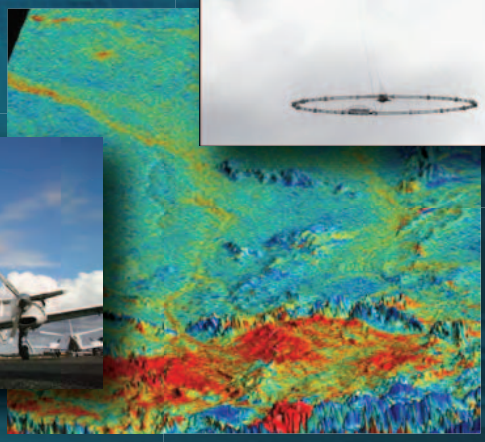

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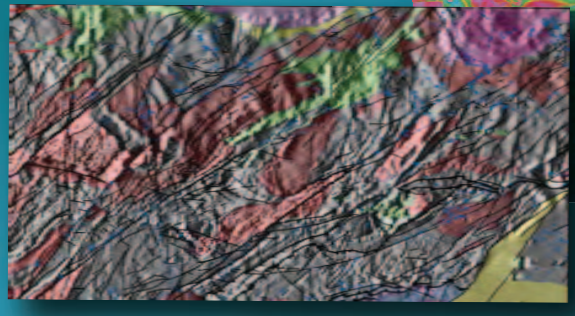

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FUGRO

ASEG News

ASEG Committees

There are essentially five key drivers of the ASEG: all the Members, the Branches, the Federal Executive, and the Standing and *ad hoc* Committees.

Every *Preview* lists the FedEx and Branch Office Bearers but readers may not be aware what committees we have and who convenes them. So here is the current main list of national committees (in alphabetical order) and contact emails.

If you have a problem, a suggestion or an issue to raise on any of the topics covered by these committees, please contact the convenors. The convenors/chairpeople drive these committees and they are usually very busy people. So, if you think you can provide useful input to any of them, just send them an email and indicate what you can help with.

David Denham

Committee	Convenor/Chairperson	Contact
ASEG History *ad hoc* Committee	Barry Long	blong@jafss.com
ASEG Research Foundation	Phil Harman	phil.harman@mindev.com.au
Conference Advisory Committee	Andrea Rutley	andrea_rutley@urscorp.com
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Web Committee	Wayne Stasinowsky	stazo@bigpond.com

NB: The ASEG Research Foundation is not a committee of the ASEG, but it has been listed here for completeness.

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Fax: (08) 9427 0861
Email: asegwa@casm.com.au

New Members

The ASEG welcomes the following 47 members to the Society. Their membership was approved at the Federal Executive meetings held on 30 April, 3 June and 29 June 2009.

Name	Affiliation	State	Membership Category
Jonathan Akers	Curtin University	WA	Student
Adrian Costar	Dept of Water, Land & Biodiversity Conservation	SA	Active
Brenton Crawford	Monash University	VIC	Student
Carol Finn	US Geological Survey	O/S	Active
Hillary Gumbo	HN Gumbo & Associates Pty Ltd	O/S	Active
Philip Mill	EcoPhyte Technologies Pty Ltd	SA	Active
Jeremy Smith	Curtin University	WA	Student
Adrian Young	Gaffney Cline & Associates	O/S	Active
Laurent Ailleres	PGN Geoscience & Monash University	VIC	Active
Sahereh Aivazpour Porgou	Monash University	VIC	Student
Wayne Anderson	Ncssubser (Australia) Pty Ltd	WA	Associate
Jutharat Boonyakitsombat	Santos Ltd	SA	Active
Min Chua	CGG Veritas	WA	Associate
Charles Funk	Oz Minerals	VIC	Associate
Philip Gunn	Seabird Exploration	O/S	Active
Ping Hu	Institute of Geophysical & Geochemical Exploration MLR	O/S	Active
Anthony Kalinic	Maquarie University	NSW	Student
Grant Koch	Independent – Koch Geoservices	QLD	Active
Dmitry Kostyuk	BHP Billiton Ltd	WA	Associate
Jessica Little	Maquarie University	NSW	Student
David Lumley	University of WA	WA	Active
Tariq Rahiman	Golder Associates Pty Ltd	QLD	Active
Ronnen Rosengart	Oil Hunters	WA	Associate
Victoria Siboni	Oil Hunters	WA	Associate
Alexander Simons	Maquarie University	NSW	Student
Vicki Stamoulis	Chrysoar Exploration	SA	Active
James Tomlinson	OHM Rock Solid Images	O/S	Associate
Donald Baillie	Maxwell Drummond Australia	WA	Associate
Gregory Ball	Chevron	WA	Associate
Neville Brown	GSS	O/S	Associate
Ian Cameron	Khumsup Pty Ltd	O/S	Associate
Michael Clennell	CSIRO Petroleum	WA	Associate
Amanda Crehan	BHP Billiton – Illawarra Coal	NSW	Associate
Nagenbrababu Gadela	Atomic Minerals Dirctorate	O/S	Associate
Timothy Hoff	University of Queensland	QLD	Student
Kate Lawson	Woodside	WA	Associate
Steven Lewis	Geoscience Australia	ACT	Active
Ashley Moran	Ellemby Resources	NSW	Associate
Chris Nind	Scintrex Ltd	O/S	Active
Matthew Ralston	Parallel Geoscience Corp	NSW	Associate
Sean Simpson	Curtin University	WA	Student
Vanessa Starcher	Santos	SA	Active
Michael Steel	Curtin University	O/S	Student
Lee Tasker	Coffey Geotechnics	NSW	Associate
Kazimierz Trofimcztk	Anglo American – Anglo Technical Division	O/S	Active
Llewellyn Vincent	OMV Australia Pty Ltd	WA	Active
Yun Wang	Institute of Geology and Geophysics	O/S	Associate

ASEG News

The ASEG congratulates the following four members whose Membership was upgraded at the meeting of the Federal Executive held on 3 June 2009.

Name	Affiliation	State	Membership Category
Reece Foster	Geoforce Pty Ltd	WA	Active
Luke Gardiner	Beach Petroleum	SA	Active
Marion Rose	Retired	VIC	Emeritus
Andrew Svalbe	Retired	WA	Emeritus

Dietmar Müller awarded 2009 Australian Laureate Fellowship

Congratulations to Dietmar Müller, Professor and Head of the School of Geoscience at The University of Sydney, who on 22 June 2009 was one of the 15 scientists (and the only geoscientist) awarded an Australian Laureate Fellowship for 2009. The Fellowships for 2009 were selected from an international field of 148 candidates.

The Australian Laureate Scheme supports research of national and global significance, by researchers of international repute. Up to fifteen five-year fellowships are awarded under the scheme each year, with each fellowship worth up to $3 million over the five years. The fellowships enable researchers to develop not only their own skills and capacities, but also those of the research teams they will lead. These teams will be made up of postdoctoral and postgraduate researchers, who will also be funded by the scheme.

Dietmar's topic is 'The Virtual Geological Observatory: a four dimensional view into the Earth through deep-time data-mining'.

He aims to reveal the underlying processes of plate tectonic cycles, palaeogeography, sea-level change and the formation of ore deposits and hydrocarbon resources since the explosion of life during the Cambrian period. This project will build on the AuScope National Collaborative Research Infrastructure and the EarthByte research project to create an international virtual geological observatory.

Dietmar obtained his PhD in Earth Science from Scripps Institution of Oceanography. After receiving his PhD, he moved to Australia and established The University of Sydney Institute of Marine Science and was the Director until 2005. He has also been involved in building the international EarthByte e-research group.

Dietmar has co-authored several papers presented at ASEG conferences and in 2004 published a paper in *Preview* (Issue 109) with Scott Dyksterhuis on 'Modelling the contemporary stress field of the Australian continent'.

For more information contact Dietmar at d.muller@usyd.edu.au.

Dietmar Muller being congratulated by Kim Carr, Minister for Innovation, Industry, Science and Research.

Scientists in Schools program

The Scientists in Schools (SiS) program is currently seeking scientists to participate in their program. SiS is an Australian Government initiative designed to bring together scientists and teachers with the aim of enhancing science education in our schools. It is a voluntary program for both the scientist and teacher. The style of partnership varies from hands-on activities in the classroom to long distance relationships using information and communication technology. In each case, students are engaged and motivated in their learning of current, contemporary science and develop an increased awareness of the types and variety of exciting careers available. SiS currently has over 1000 partners across Australia and each one is different. The program is open to research scientists and engineers; post-graduate science and engineering students and people involved in applied sciences, such as doctors, vets, park rangers and so on. You can read more on the website at www.scientistsinschools.edu.au.

Michael Leggo new AGC president

At the Annual General Meeting of the Australian Geoscience Council (AGC) on 27 May 2009, Michael Leggo was elected as the AGC's President for a two year term. He has served on the Council as President-Elect since May 2008.

Dr Leggo is a Fellow of the AIG, a Fellow of the AusIMM, a Fellow of the Association of Applied Geochemists and a Member of the Environmental Institute of Australia and New Zealand. He holds a BSc (Chemistry, Geology), MSc (Geology), PhD (Geology – Pure Geochemistry) and a Diploma of Imperial College (Applied Geochemistry).

He served as the President of the Australian Institute of Geoscientists from 1991 to 1993 and an AIG Councillor from 1990 to 1994. He is currently a member of the Registration Board of the AIG, a role held since 1997 and was a member of the Joint Ore Reserves Committee for several years.

The AGC is the Peak Council of geoscientists in Australia. It represents the following eight major Australian geoscientific societies, with a total membership in excess of 7000:

- The Association of Applied Geochemists (AAG) Australian Division
- The Australasian Institute of Mining and Metallurgy (AusIMM)
- The Australian Geoscience Information Association (AGIA)
- The Australian Institute of Geoscientists (AIG)
- The Australian Society of Exploration Geophysicists (ASEG)
- The Geological Society of Australia (GSA)
- The Australian National Chapter, International Association of Hydrogeologists
- The Petroleum Exploration Society of Australia (PESA)

Each body is represented on the Council by the President or Chief Executive Officer of the Member Society, or by another senior executive of the Member Society as proxy for the President or Chief Executive Officer.

Michael heads up the AGC at a critical time for geosciences in Australia. The AGC's specific objectives are to:

- Provide expert apolitical advice to governments on matters involving the geosciences and their application;
- Promote the development of scientifically sound policies for effective geoscience education and research; and
- Provide the Australian public with a greater appreciation of the economic, environmental and cultural values of the geosciences.

The AGC's budget is small and it relies on volunteers to serve on the Council. Nevertheless, it can rely on the intellectual capacity and dedication of its members to make a real difference in Australian Geoscience.

Michael sees the principal role of the AGC 'as providing effective advocacy at a national level for both the broad field of geoscience and the role of geoscientists in the Australian context'.

He 'believes that the role of the President of the AGC is to identify and present to AGC members initiatives in support of its advocacy role, and also to facilitate consensus within the AGC on activities proposed by its members'. At this early stage he identifies the two main issues for the AGC as:

- Preparing for the 34th International Geological Congress (for which the AGC is contractually responsible), which will be held in Brisbane in 2012; and
- Providing support for the development and implementation of the National Science Curriculum.

As well as leading the AGC, Michael is the Managing Director of Silver City Mining Limited.

Previously (1997–2008), he served variously as Technical Director and earlier as a Non-Executive Director of Pegmont Mines Limited in Sydney. During 1995 to 2006 he held the position of General Manager, Environmental Services at Boral Limited. He also worked as Manager – Quality, Safety and Environment at Burns, Philp & Company Ltd from 1992 to 1995, Senior Outplacement and Career Management Consultant with Davidson & Axmith Pty Ltd, Director of Mineral Resources with Pennant Holdings Limited, Visiting Scientist with CSIRO's Division of Exploration Geoscience, General Manager, Minerals Exploration and Development Group at CSR Limited and Project Manager, Senior Geologist and Geochemist for AMAX Exploration Inc.

This vast range of experience will serve him well as President of the Australian Geoscience Council and the ASEG welcomes him to this position.

Queen's Birthday Honours for Geosicentists

Congratulations Bruce Hobbs and Kurt Lambeck, who both received the Officer of the Order of Australia Award in the 2009 Queen's Birthday Honours list.

Bruce's award was 'For service to science, particularly in the field of structural geology as a leader in the development of innovative research centres and mineral exploration technologies.'

And Kurt's 'For service to science through the development of policy, the promotion of educational programs and as a researcher and educator in the field of geoscience.'

Both scientists have made major contributions to Australian geosciences, particularly in the application and development of geophysical techniques.

ASEG News

Australian Capital Territory

The last few months have seen an unusually full program of talks for the ACT Branch. There was also an impromptu student night organised on 21 May. About eight students from the ANU second year geophysics course came to hear about the geophysics careers of several local and international geophysicists. Thanks to Ned Stolz (GA), Michelle Salmon and Ian Moffat (ANU), and Hans-Juergen Goetze (Professor of Geophysics, University of Kiel, Germany) for sharing their experiences as a geophysicist.

On 17 June, Denis Shephard, a former curator at the National Museum of Australia, gave a talk on the museum's geophysical instrument collection (http://www.nma.gov.au/collections-search/results?search=adv&ref=coll&collname=Bureau+of+Mineral+Resources+collection+no.+1). For some this appeared to be quite a nostalgic talk and there was much discussion of the history of particular instruments and the fate of not-so-notable instruments – for museum management to agree to the retention of old instruments, it seems they have to come with a story of historical significance. If you are visiting Canberra before the end of the year, you might like to pay a visit to the museum where several instruments, including an Oetling gradiometer, are currently on display. The ACT committee may look at getting access to some of these instruments for display at upcoming international conferences.

On 26 June, Dr Karen Weitemeyer from Scripps Institution of Oceanography gave a talk on marine electromagnetic methods. She presented results from her recently completed PhD on gas hydrate characterisation using marine EM methods. Karen also touched on some tantalising first results from marine EM studies of the Scarborough gas field (http://marineemlab.ucsd.edu/Projects/Scarborough/index.html).

Most recently, the ACT Branches of ASEG and PESA hosted another SEG lecturer. This time Andrew Long from PGS visited Canberra on 9 July to give his Honorary Lecture for the SEG, Pacific South. Andrew presented a thorough and clear overview of what can be gained from the full spectrum of multi- and wide-azimuth seismic methods – there was plenty of MAZ, WAZ, RAZ and FAZ. The magnitude of industry efforts in these areas remains mind-boggling! Following discussions over a light lunch, Andrew made the most of his first visit to Canberra in a long while and spent the afternoon getting an impression of geophysical-focussed activities at Geoscience Australia.

The forward program is a little quieter in the coming months, but a talk by Ian Moffat (ANU) on geophysics in archaeology is currently scheduled for 12 August. If the last few months are any indication, other speaker opportunities may well present themselves unexpectedly in the near future!

Ron Hackney

New South Wales

In May, Simon Williams gave a very interesting talk about using GPR to locate mine shafts in Charters Towers. Simon outlined how the Queensland Department of Mines and Energy are currently responsible for the location and capping of the shafts in the Charters Towers Shaft Repair Program (CTSHARP). In 2006, GPR was utilised on 20 sites, which were located in locations as diverse as the yards and gardens of private dwellings, horse paddocks and even currently trafficked streets. Simon discussed how the GPR data was used to both accurately plot the shaft location and give the anomaly a rating of 1–5 with 5 being the highest potential for collapse. As a postscript to the survey, Simon showed that many of the results have been verified by later ground truthing and an actual collapse during heavy rains early in 2007.

In June, Peter Gunn spoke about his success in applying ideas and techniques that are not commonly appreciated by explorationists. Peter discussed a number of mineral and hydrocarbon discoveries and even the occasional near miss highlighting using magnetic and gravity data to generate projects for a private mineral exploration company and consulting work applying gravity and magnetic methods to hydrocarbon exploration.

In July, we held a joint meeting with PESA, and Andrew Long, the SEG Pacific South Honorary Lecturer spoke about Multi-azimuth (MAZ) and Wide-azimuth Seismic (WAZ): Foundations, Challenges, and Opportunities. Andrew highlighted that in areas affected by challenges to seismic imaging; interest is rapidly turning to the acquisition and processing of complementary source-receiver azimuths. Andrew pointed out that while survey cost has historically been a high-profile issue, the pursuit of efficiency gains has stimulated innovations in the execution of MAZ and WAZ seismic. Many technical questions followed Andrew's presentation.

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

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

Mark Lackie

Queensland

The Queensland branch met in June at the Irish Club to hear a lively presentation from Nick Sheard on Carpentaria Exploration's successful exploration programme for iron ore near Broken Hill, NSW. It was great to see so many of our local minerals geophysics community at the meeting. Many thanks to Nick and Carpentaria for this presentation.

In July we co-hosted the SEG Pacific South Distinguished Lecturer, Andrew Long, with PESA. Andrew presented a stimulating review of developments in wide and multi azimuth seismic acquisition and processing. Thanks to Andrew and SEG for making this possible.

Wayne Mogg

South Australia

The SA Branch has held two recent events. The first was a well attended presentation from Russell Korsch, of the Onshore Energy and Minerals Division of Geoscience Australia. Russell's talk included results of recent data acquired by Geoscience Australia as part of the Onshore Energy Security Program (OESP), in its efforts to encourage energy exploration in South Australia.

In mid-July, we hosted the 2009 SEG Pacific South Honorary Lecturer, Andrew Long of PGS, who presented 'Wide-azimuth and Multi-azimuth Seismic: Foundations, Challenges and Opportunities'. A small but attentive crowd took the opportunity

to quiz Andrew on many aspects of advances in marine seismic acquisition methodology.

The SA Branch holds technical meetings monthly, usually on a Thursday night at the Historian Hotel, from 5:50 pm. New members and interested persons are always welcome. Please contact Luke Gardiner (luke.gardiner@beachpetroleum.com.au) for further details.

Luke Gardiner

Victoria

Following an extended summer break the ASEG Victorian Branch reconvened at the Kelvin club on 5 May for the thought-provoking technical presentation 'Potential modelling with prisms – can we learn from history?' by Dr Horst Holstein from Aberystwyth University, Wales, and Intrepid Geophysics, Melbourne.

May 2009 also saw the start of a cooperative arrangement between the Victorian branches of ASEG and PESA. We now issue invitations to members from both branches to all events organised by the two organisations. This is in recognition of the potential overlap in the topics presented by the respective branches.

On 21 May visiting SEG Honorary Lecturer Andrew Long from Petroleum Geo-Services (PGS), Perth, entertained ASEG and PESA Victorian branch members at University of Melbourne with the very informative technical presentation 'Multi-azimuth and Wide-azimuth Seismic: Foundations, Challenges, and Opportunities'. Andrew successfully repeated this performance for another 30 attendees at a joint PESA–ASEG Victorian Branch lunch on 14 July at the Victoria Hotel.

By the time this issue of *Preview* has been distributed, Victorian ASEG branch members will also have enjoyed the Midwinter PESA, SPE and ASEG Social Evening on 29 July at the Portland Hotel.

The Spring 2009 ASEG Victorian Branch program of technical talks will commence on 26 August, when Michael Asten (ASEG President, Flagstaff GeoConsultants and Monash University) will present 'Overview of ASEG 2009 – Goals and Challenges' followed by the technical presentation 'Electromagnetic Induction Detection and Discrimination of Unexploded Ordnance using an Array of Fluxgate Magnetic Sensors'. The 26 August meeting will also host the Annual General Meeting for the ASEG Victorian Branch. The branch committee is now receiving calls for nominations for positions for 2009–2010. The following nominations have already been received: Asbjorn Christensen – President; Richard MacRae – Secretary; and Phil Skladzien – Treasurer.

On 5 October, Dr Tim Rawling from Geoscience Victoria, Department of Primary Industries, will present '3D Modelling and Model Management at GeoScience Victoria'. On 25 November, the ASEG Victorian Branch will be hosting the Annual Student Night, giving graduating geophysics students the opportunity to present their research in a professional forum.

Victorian branch meetings take place at the Kelvin Club located in the heart of Melbourne's CBD on Flinders Lane. Meetings are scheduled at 6:00 pm for 6:30 pm start. We are looking forward to seeing many ASEG Victorian branch members at the technical meetings this spring.

Asbjorn Christensen

Congratulations Andrew Long on a very successful Australian leg of the 2009 Pacific South Honorary Lecture tour. Andrew's talk, titled *Multi-azimuth and Wide-azimuth Seismic: Foundations, Challenges, and Opportunities*, has been well received at all ASEG Branches in recent months. The photos shown here were taken at the Canberra and Perth presentations.

Andrew Long presenting at the Parmelia Hilton Hotel in Perth. (Photo courtesy of Brian Wickins, Resolutions.)

Andrew Long and his wife, Ros, speaking with Bruce Goleby and Chris Nicholson, President of the ACT Branch of PESA. (Photo courtesy of Ron Hackney.)

RV Roger Revelle tour: marine electromagnetic profiling on the NW Shelf

The ASEG WA Branch coordinated a very successful tour of the RV Roger Revelle on Wednesday 20 May. Over 85 members spent the morning swarming over the ship, from the engine room to the bridge, from the EM dipole source module to the autonomous EM recorder units, and everywhere in between. The ship's tour was organised by Prof. Steve Constable and his team from Scripps.

The RV Roger Revelle is an 84 m oceanographic vessel owned by the US Navy, and operated by agreement of the Office of Naval Research by Scripps Institution of Oceanography. Steve Constable explained that this cruise on the North West Shelf is seen as being vitally important for the developing Controlled Source Electromagnetic (CSEM) industry, as it is the first time that a scientific test of the capability of the modern CSEM technique will be conducted and the results made public. Australia's North West Shelf has been chosen for this trial because the open file geotechnical data allows the design of a program that will test the limits of the technique. The trial will be conducted over a gas field having both one- and three-dimensional structure along profile.

The tour concluded with a drink and lunch at 'Little Creatures' – a well known Fremantle venue. We wish Steve and his team smooth seas and the best of luck with their cruise.

Reece Foster

Fig. 1. *RV Roger Revelle berthed in Fremantle, WA.*

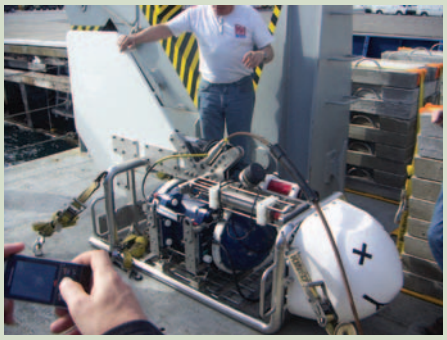

Fig. 2. *On deck viewing the EM dipole source unit.*

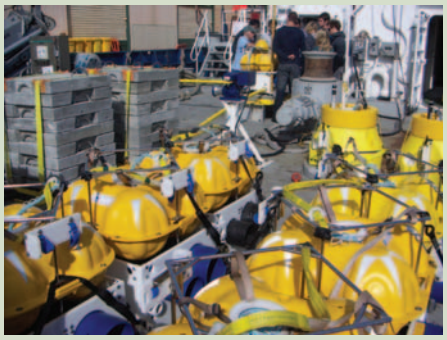

Fig. 3. *On deck with receivers in the foreground.*

The Society for Underwater Technology (SUT)
&
The Australian Society of Exploration Geophysicists (ASEG)
Present their 1st Joint Technical Seminar

Geophysics and Geohazards
Defining Subsea Engineering Risk

Thursday 25th March 2010
Perth Convention Exhibition Centre, Perth, Western Australia

One Day Seminar

The SUT and ASEG will be presenting its 1st International Seminar on Geophysics and Geohazards on 25 March 2010 in Perth in conjunction with the Australian Oil and Gas (AOG) Exhibition.

Geophysical methods are a key means for identifying geohazards in the marine environment. Whether drilling a wildcat or installing a wind turbine, engineering geophysics provides for an effective assessment of the potential risk for subsea operations.

This one-day workshop has been designed to appeal to operators, contractors, consultants and academics, and will bring to the forefront the importance of understanding geophysical methods, their strengths and weakness. It will demonstrate the power of well designed surveys and data integration.

Interested authors are invited to submit abstracts of 200 - 300 words by email to Joyce Bremner j.bremner@sut.org by 30 October 2009.

Authors of accepted abstracts will have the option to submit extended abstracts by the 5 February 2010.

Suggested Themes:
- Geohazard Risk Assessment
- Tophole prognosis; drilling hazards and constraints
- Data Interpretation and integration
- Underwater Acoustics
- Geotechnics
- CSEM
- Marine Refraction and Resistivity
- Advances in technology
- Marine Archaeology
- Unexploded Ordinance
- Environmental Impacts

Pictures courtesy of Fugro Survey Pty Ltd. & RPS Australia

For further information on this event, please contact Joyce Bremner, j.bremner@sut.org

V1 www.sut.org.au www.aogexpo.com.au www.aseg.org.au

SEISMIX 2010 – Cairns

SEISMIX 2010, the 14th International Symposium on Deep Seismic Profiling of the Continents and their Margins, will take place in Cairns, Australia from Sunday 29 August to Friday 3 September, 2010. As in previous symposia, the focus will be on resolving the architecture of the crust and upper mantle using controlled seismic sources and also on the use of passive seismic imaging techniques to resolve fine structural detail.

The Geological Society of Australia, through its Specialist Group in Solid Earth Geophysics (SG2), together with partners, Geoscience Australia and IGCP Project 559, invite expressions of interest from those proposing to attend the symposium and make oral and/or poster presentations to seismix10@ga.gov.au.

Further information, including a second circular later in 2009, will be posted on the symposium web site at www.earthscrust.org (and follow the links), and emailed directly to those who submit expressions of interest.

2009 a good budget for Science

In spite of the Global Economic Crisis, the 2009 Federal Budget was good for Science and Innovation with the total government investment increasing by 25% from $6.9 billion in 2008/09 to $8.6 billion for 2009/10.

As President of the Federation of Australian Scientific and Technological Societies Ken Baldwin said '*This is an exceptional budget for science and innovation, well above expectations. The 2009/10 expenditure with the 25% increase on expenditure in 2008/09, the highest annual increase since records began.*'

'*New funding for higher education, science and innovation is worth an additional $5.7 b over four years and demonstrates the Government's recognition of the critical importance of universities, science and research for long-term growth and prosperity.*'

Kurt Lambeck, President of the Australian Academy of Science, also '*Welcomed the Government's clear recognition that adequate and sustained investment in science, research and innovation is integral to our economic recovery.*'

Table 1 (taken from numbers in the budget papers) and Figure 1 show the changes in government investment as a percentage of government expenditure and as a percentage of GDP over the last 11 years. The government investment as a percentage of GDP is now close to where it was in the mid-1990s (1993/94, 0.75%; 1994/95, 0.73%; 1995/96, 0.74%).

Most of the increase has been allocated to special projects, rather than to the established government research agencies.

The trend for government spending over the past 10 years or so is to invest more in short-term specific projects rather than to channel funding through established government agencies. An analysis by Bradley Smith, CEO of FASTS, illustrates this trend, summarized in Table 2. The agencies' share of Commonwealth outlays has fallen from more than 50% in 1981 to less than 20% in this year's budget. The big growth over the years has been programs to support industry R&D and multisector programs such as CRCs, Renewable Energy, New Car and Clean Coal projects.

For example, in the Department of Energy and Tourism (RET) the budget for special projects has increased by more than a factor of five from last year (see Table 3). This approach provides the government with more flexibility and provides a whole lot more media opportunities for Ministers, but it does not necessarily provide the job security that top quality research scientists need.

Table 4 shows how the main agencies fared. CSIRO, ARC and the NH&MRC achieved significant increases and the NH&MRC now has a larger allocation than either CSIRO or the ARC. Geoscience Australia's allocation was reduced, but this is consistent with the forward estimates and indicates the end of one or more programs that were specially funded.

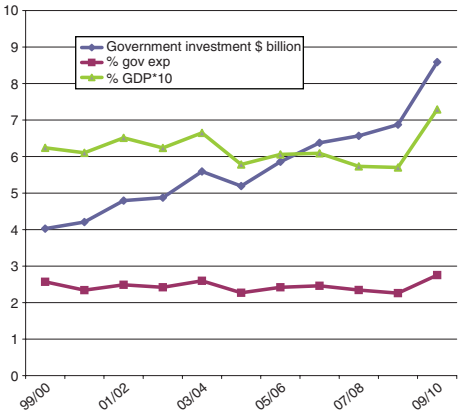

Fig. 1. *Changes in government investment in Science and Innovation over the last 11 years. The left hand axis shows investment in $billion (blue); as a % of GDP × 10 (green); and as a % of total government expenditure (brown). Note the huge increase from 2008 to 2009.*

Table 1. Australian Government Investment in Science and Innovation

Year	Government investment $ billion	% of Gov. expenditure	% GDP	GDP $ billion
99/00	4.02	2.57	0.62	645
00/01	4.21	2.34	0.61	689
01/02	4.79	2.49	0.65	736
02/03	4.88	2.42	0.62	782
03/04	5.59	2.60	0.66	841
04/05	5.19	2.27	0.58	898
05/06	5.86	2.42	0.61	967
06/07	6.38	2.46	0.61	1047
07/08	6.57	2.34	0.57	1146
08/09	6.87	2.26	0.57	1206
09/10	8.59	2.75	0.73	1178

Table 2. Structural changes in government investment in R & D in last 30 years

Year/%	1981/82	1990/91	2000/01	2009/10
Public sector agencies	51	34	26	20
Higher Education	40	37	42	27
Business	2	21	20	25
Multisector support for science and technology	7	8	12	28

Table 3. Some of the new Science and Innovation money in RET in $ millions

Program	2007/08	2008/09	2009/10
Advanced Electricity Storage Technologies	6.1	7.8	4.4
Clean Energy Initiatives	0.0	0.0	300.0
Energy Innovation Fund	0.0	6.0	49.8
Global Carbon Capture and Storage Institute	0.0	87.7	100.0
Low Emissions Technology Demonstration Fund	54.6	0.0	119.5
National Clean Coal Initiative	0.0	25.2	86.2
Otway Basin Pilot Project	2.0	0.6	0.0
Renewable Energy Fund	0.0	4.9	50.0
Second Generation (Gen 2) Biofuels Technology R & D	0.0	0.0	5.0
Total	$62.7M	$132.2M	$714.9M

Table 4. Appropriation from Government for key science agencies

Agency	Appropriation from Australian Government in $ million							
Year	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
CSIRO	577	594	610	663	676	704	717	728
ARC	482	582	575	577	586	650	717	775
NH&MRC	369	403	474	566	628	724	734	748
DSTO	314	349	406	401	427	433	399	407
CRC Program	194	208	189	212	183	200	152	
BoM	191	211	214	235	245	251[1]	261	265
ANSTO	111	118	142	153	164	155	153	152
Geoscience Australia	102	107	125	145	139	130	123	100
Antarctica	87	101	102	107	105	118	108	105
AIMS	22	23	24	27	28	28	29	29

[1]*The Bureau of Meteorology was also allocated an additional $94.7 million over 4 years to upgrade forecasting equipment.*

Obama proposes funding surge for Research and Development

Meanwhile in the US, President Obama has submitted to Congress a 2010 federal budget that includes a huge boost for science agencies. It comprises US$147.6 billion for research and development, an increase of $555 million over FY2009 as well as a $18.3 billion stimulus package.

Climate Change Science gets $2.03 billion (up from $1.98 billion); NASA $18.69 billion, an increase of $904 million; and the USGS gets $1.1 billion, an increase of $54 million.

In addition the Geoscience component of the National Science Foundation increases to $909 million, a 13% increase over 2009 levels. Tim Killen, the NSF's assistant director for geosciences, was reported as saying in the 2 June *Eos*: '*the FY 2010 budget proposal is unprecedented and would preserve the President's plan for Science and Innovation.*'

And all this in an environment where the US public debt is about US$11.5 trillion dollars (http://www.brillig.com/debt_clock/) or ~$37 500 per person.

In comparison the Australian Public debt is about A$40 billion (http://www.budget.gov.au/2009-10/content/bp1/html/bp1_bst9-01.htm) or about A$2000 per person. We are positively frugal!

Eristicus

For the record

Many thanks to Doug Finlayson whose eagle eyes picked out an error in Figure 1 on page 27 of the last issue of *Preview* (Issue 140). The names of the Cooper and Eromanga Basins have been switched on this drawing.

News

Update on Geophysical Survey Progress from the Geological Surveys of Queensland, Western Australia, Northern Territory and Geoscience Australia (information current at 16 July 2009)

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

Table 1. Airborne magnetic and radiometric surveys

Survey Name	Client	Contractor	Start Flying	Line (Km)	Spacing AGL Dir	Area (km^2)	End Flying	Final Data to GA	Locality Diagram (*Preview*)	GADDS release
Cape York	GSQ	GPX	23 Apr 09	239 180	400m, 60 m E/W	59 480	38.4% complete @ 12 Jul 09	TBA	139 – Apr 09, p. 21	TBA
Seemore (Eucla 1)	GSWA	Thomson Aviation	6 June 09	88 300	200 m, 50 m E-W	15 810	37.3% complete @ 12 Jul 09	TBA	This issue	TBA
Cornish – Helena (East Canning 2)	GSWA	Thomson Aviation	6 June 09	121 100	400 m, 60m N-S	43 270	18.3% complete @ 12 Jul 09	TBA	This issue	TBA
Yampi – Derby (North Canning 2)	GSWA	GPX	30 June 09	66 700	400 m, 60 m N-S	23 720	5.6% complete @ 12 Jul 09	TBA	This issue	TBA
Crossland – Noonkanbah (East Canning 1)	GSWA	GPX	Mid July	116 700	400 m, 60 m N-S	41 720	TBA	TBA	This issue	TBA
Central Canning	GSWA	Fugro	10 June 09	91 700	800 m, 60 m N-S	64 900	48.6% complete @ 12 Jul 09	TBA	This issue	TBA
Naretha (Eucla Basin 3)	GSWA	Fugro	11 June 09	123 100	200 m, 50 m E-W	22 090	16.7% complete @ 12 Jul 09	TBA	This issue	TBA
Broome (North Canning 1)	GSWA	UTS	Mid July	76 000	400 m, 60 m N-S	26 370	TBA	TBA	This issue	TBA
Mt Anderson – McLarty Hills (North Canning 3)	GSWA	UTS	3 July 09	98 200	400 m, 60 m N-S	34 860	7.1% complete @ 12 Jul 09	TBA	This issue	TBA
Eucla Coast (Eucla Basin 6)	GSWA	UTS	Early September	117 451	200 m (onshore); 400 m (offshore); 50 m N-S	27 400	TBA	TBA	This issue	TBA

Table 2. Airborne electromagnetic surveys

Survey Name	Client	Contractor	Start Flying	Line (Km)	Spacing AGL Dir	Area (km^2)	End Flying	Final Data to GA	Locality Diagram (*Preview*)	GADDS release
Pine Creek (Kombolgie)	GA	Geotech Airborne	21 Aug 08	9350	1666 & 5000 m for GA; 200–1000 m company infill; E/W flight lines; flying height 30 m	30 710	100% complete @ 16 Oct 08	TBA	133 – Apr 08, p. 21	TBA
Pine Creek (Woolner & Rum Jungle)	GA	Fugro	11 Oct 08	20 825	1666 & 5000 m for GA; 200–1000 m company infill; E/W flight lines; flying height 120 m	44 689	75.0% complete @ 10 May 09	Data acquisition resumed 15 April for completion by June 09	133 – Apr 08, p. 21	Data for Pine Creek (Woolner) released via free-download via the GA website and on DVD on 10 July 2009. All requests to the GA Sales Centre

Table 3. Gravity surveys

Survey Name	Client	Contractor	Start Survey	No. stations	Station Spacing (km)	Area (km²)	End Survey	Final Data to GA	Locality Diagram (*Preview*)	GADDS release
Cunderdin	GSWA	Daishsat	28 Jan 09	10744	50–250 m, 500 m, 2 km	22500	100% complete @ 16 Apr 09	July 09	139 – Apr 09, p. 22	TBA
Cape York	GSQ	Daishsat	12 May 09	10315	4 km regular	171900	27% complete @ 12 Jul 09	TBA	139 – Apr 09, p. 21	TBA
Barkly	NT	Atlas Geophysics	4 June 09	7268 in Area A & a possible 3875 in Area B	4 km regular	178230	31% complete @ 12 Jul 09	TBA	140 – Jun 09 p. 17	TBA
South Yilgarn Margin	WA	Fugro	Mid July	6500	2.5 km regular	39240	TBA	TBA	140 – Jun 09 p. 17	TBA

TBA: to be advised

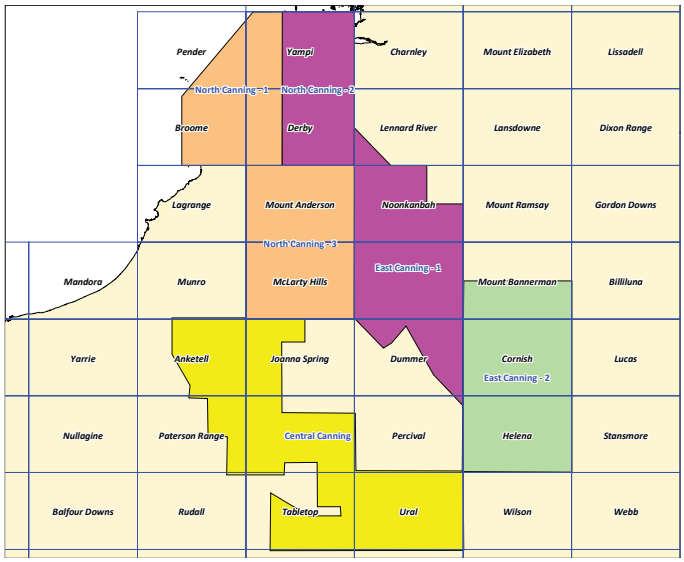

Fig. 1. *Location diagram for the WA Exploration Incentive Scheme Airborne Magnetic & Radiometric Surveys in the Canning Basin (see Table 1 for details).*

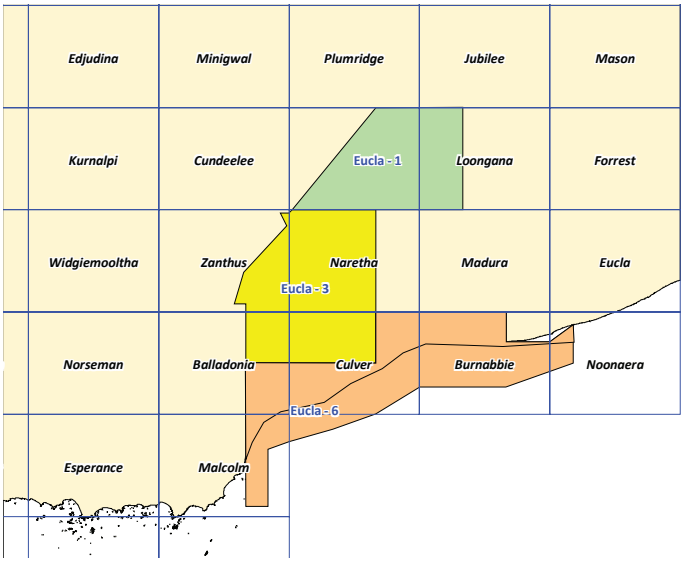

Fig. 2. *Location diagram for the WA Exploration Incentive Scheme Airborne Magnetic & Radiometric Surveys in the Eucla Basin (see Table 1 for details).*

The new surveys listed in this issue are all airborne magnetic and radiometric surveys initiated under the WA Exploration Incentive Scheme (see *Preview* 140, p. 18). There are nine new surveys in total. The surveys are located in two regions – the CanningBasin in the north and the Eucla Basin in the south. The six Canning Basin surveys (Figure 1) cover an area of ~235 000 km² with a total of ~570 000 line km, predominantly with 400 m line spacing and some 800 m line spacing data. The three Eucla Basin surveys (Figure 2) cover an area of ~65 000 km² with a total of ~329 000 line km at line spacings of 200 m onshore and 400 m offshore.

Geoscience Australia's Onshore Energy Security Program: onshore seismic acquisition update

Processed data releases

Isa–Georgetown–Charters Towers Survey (07GA-IG1, 07GA-IG2, 07GA-GC1 and 07GA-A1)

During May to October 2007 Geoscience Australia (GA), in collaboration with the Geological Survey of Queensland, conducted the Isa–Georgetown–Charters Towers seismic surveys (Figure 3). These surveys consisted of acquiring deep seismic reflection, gravity and magnetotelluric data along three traverses, 07GA-IG1, 07GA-IG2 and 07GA-GC1. Funding for these surveys was obtained through Geoscience Australia's Onshore Energy Program and Queensland's Smart Mining – Future Prosperity Program with the aims of imaging the Earth's crust from the eastern edge of the Mt Isa Province across the Georgetown Province and south-east through the Charters Towers region into the Drummond Basin.

A fourth traverse (07GA-A1) was funded by AuScope, an initiative established under the National Collaborative Research Infrastructure Strategy to characterise the structure and evolution of the Australian continent (Figure 3). This line imaged from Mareeba to Mt Surprise across the Palmerville Fault–Tasman Line.

A total of 1387 km of 2-D seismic reflection data were collected over the four lines and the results of these surveys including the interpreted processed seismic data and the magnetotelluric data, were released in June at a workshop in Townsville during the North Queensland Exploration and Mining Conference.

Gawler–Curnamona–Arrowie Seismic Survey (08GA-G01, 08GA-C01 and 08GA-A01)

Geoscience Australia undertook acquisition of deep seismic reflection in South Australia as part of the Onshore Energy Security Program in June/July 2008. This survey consisted of three traverse lines, one across the Gawler province (08GA-G01, 253 km), one across the Curnamona province (08GA-C01, 262 km) and one in the Arrowie Basin (08GA-A01, 60.4 km), as shown in Figure 4. Magnetotelluric (MT) data were acquired along the Gawler and Curnamona traverses at 10 km station spacings.

Processing of the Arrowie traverse has been completed and the un-interpreted processed data are now available. Geoscience Australia's geophysicists are continuing processing of the Gawler and Curnamona lines and it is planned that the processed data will be released by the end of 2009. The unprocessed seismic and MT data for all of these lines are also available.

Unprocessed data releases

Curnamona–Gawler Link Seismic Survey (09GA-CG1)

In January 2009 seismic data were acquired along a traverse that crossed from the Gawler Craton to the Curnamona Province (09GA-CG1; see Figure 4). This survey was jointly funded by Primary Industry and Resources South Australia (PIRSA) and Geoscience Australia through the Onshore Energy Security Program. A total of 145 km of

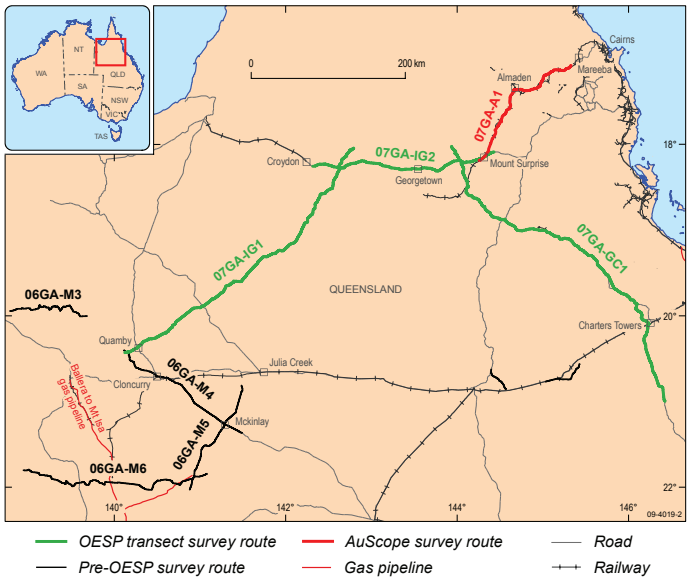

Fig. 3. *Location of the Isa–Georgetown (07GA-IG1 and 07GA-IG2), Georgetown–Charters Towers (07GA-GC1) and AuScope (07GA-A1) seismic traverses in Northern Queensland.*

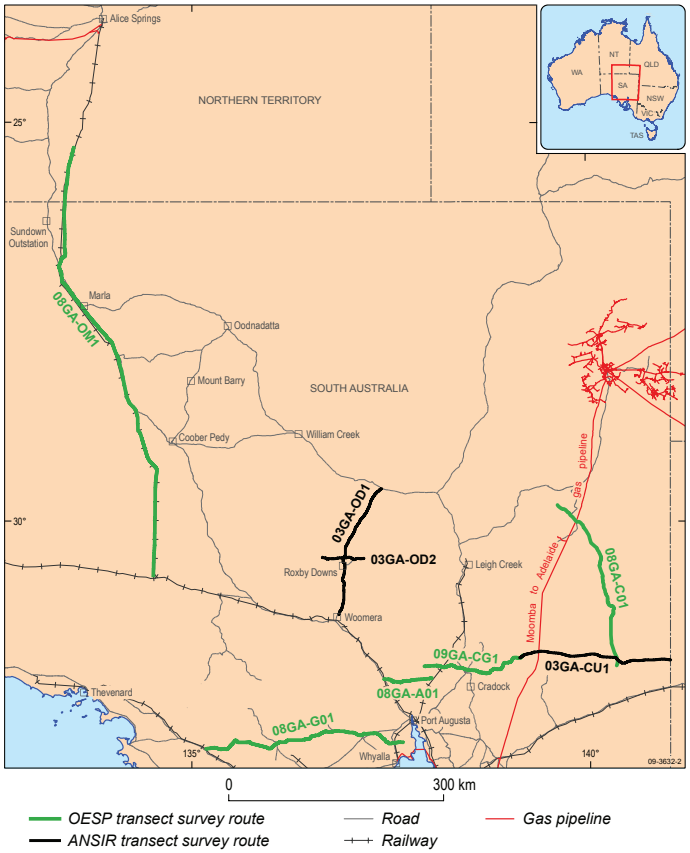

Fig. 4. *Location of the Arrowie (08GA-A01), the Gawler (08GA-G01), the Curnamona (08GA-C01) and the Curnamona–Gawler Link (09GA-CG1) seismic traverses in South Australia.*

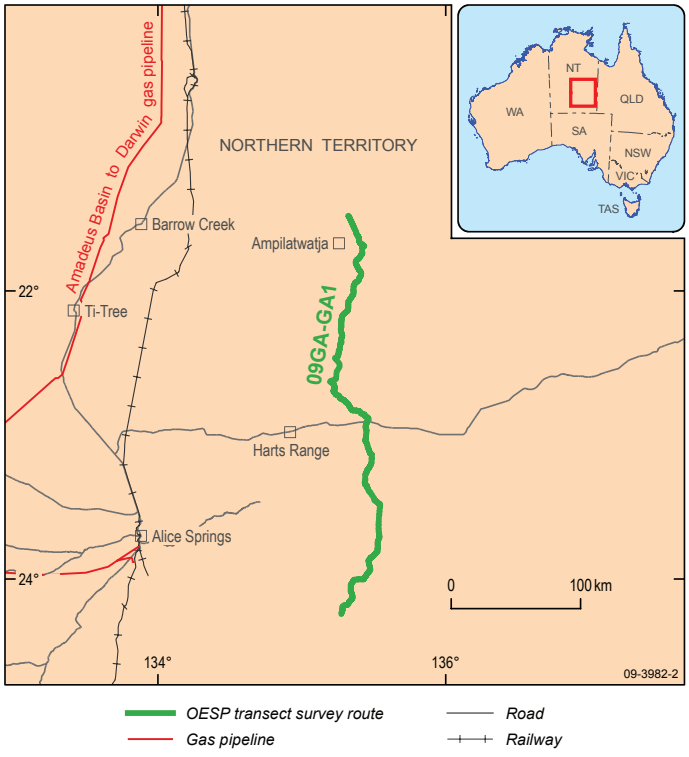

Fig. 5. *Location of the Georgina Basin–Arunta Inlier (09GA-GA1) seismic traverse in the Northern Territory.*

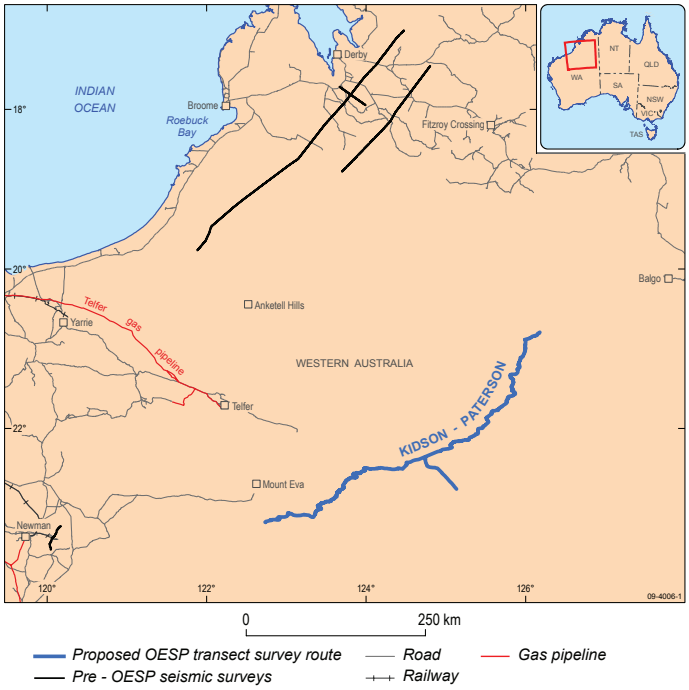

Fig. 6. *Proposed location of the seismic traverse for the Kidson–Paterson survey in Western Australia.*

new seismic data were acquired. The line joins onto a previously acquired traverse of the Curnamona Province that was conducted in 2003/2004. The unprocessed seismic data are now available through GA and the gravity data collected by PIRSA are available from the Geophysical Archive Data Delivery System (GADDS). Processing of these data has commenced and is expected to be completed by the end of the year.

Recently completed surveys

Georgina Basin–Arunta Inlier Survey (09GA-GA1)

Geoscience Australia and the Northern Territory Geological Survey conducted a deep seismic survey across the Georgina Basin and into the Arunta Inlier and Amadeus Basins during June and July 2009. This survey was funded through the Onshore Energy Security Program. This 373 km traverse commenced just north of the Sandover Highway and concluded near Todd River Downs (Figure 5). The aims of this survey are to assist in enhancing the knowledge of the petroleum potential of the Georgina and Amadeus basins and the Uranium mineralisation within the Arunta Inlier.

Upcoming surveys

Kidson–Paterson Survey (10GA-KP1)

Geoscience Australia and the Western Australian Geological Survey plan to acquire deep crustal seismic data along a traverse across the Kidson Sub-basin and into the Paterson Province in mid 2010 (Figure 6). Scoping for this survey has commenced with the objective to image this under-explored sub-basin of the Canning Basin and investigate the crustal relationship with the Paterson Province.

To obtain more information on this survey or to obtain survey data contact Jenny Maher, Project Leader Seismic Acquisition and Processing, phone 61 2 62499896 or email jenny.maher@ga.gov.au.

Sixteen new offshore exploration permits granted

Sixteen new offshore petroleum exploration permits in the Western Australia and Territory of Ashmore and Cartier Islands offshore areas have been granted. The minimum guaranteed work program commitments for the awarded permits are valued at $214 million, with options to invest another $528 million. Table 1 lists the successful bidders and summarises their proposed work programs. Notice that several of the companies plan to carry out CSEM surveys.

These new permits result from the first round of the 2008 Acreage Release that closed on 9 October 2008. All permits will be jointly administered by the Australian Government and the respective State and Northern Territory Governments.

Exploration permits in Australia's offshore areas are awarded under a work program bidding system for an initial term of six years, with a maximum of two renewals each of five years. Under this system, applicants are required to nominate a guaranteed minimum 'dry hole' exploration program for each of the three years of the permit term and a secondary program for the remaining three years. Each component of the program must be completed in the designated year or earlier.

Release of 33 offshore petroleum exploration leases in 2009 bidding cycle

Commonwealth Resources Minister Martin Ferguson, announced the release of 31 new offshore petroleum exploration areas and two special areas in Commonwealth waters at the APPEA conference in Darwin in June 2009 (see Figure 1).

The 2009 release areas are located across five basins off the Northern Territory, Western Australian, South Australian and Victorian coastlines. The release also includes two special release areas that are known to contain hydrocarbons. These special areas are located over the Turtle and Barnett discoveries in Western Australia and Northern Territory offshore areas. Six of the 2009 release areas have been selected as Designated Frontier Areas, which are eligible for the extended frontier exploration incentive of 150% uplift for Petroleum Resource Rent Tax.

Bids for 18 of the new areas and the two special release areas close on 3 December 2009, with bids for the remaining 13 areas closing on 29 April 2010. All bids are assessed under the work program bidding system and will be awarded for an initial term of six years.

These released areas cover a full range of water depths, range from frontier to mature in exploration status and offer opportunities for exploration companies of all sizes. Government initiatives, such as the provisions of high quality pre-competitive data by Geoscience Australia and the improved speculative seismic data acquisition policy aim to make exploration in Australia more attractive.

Further information on the 2009 acreage release is available at www.ret.gov.au/petexp.

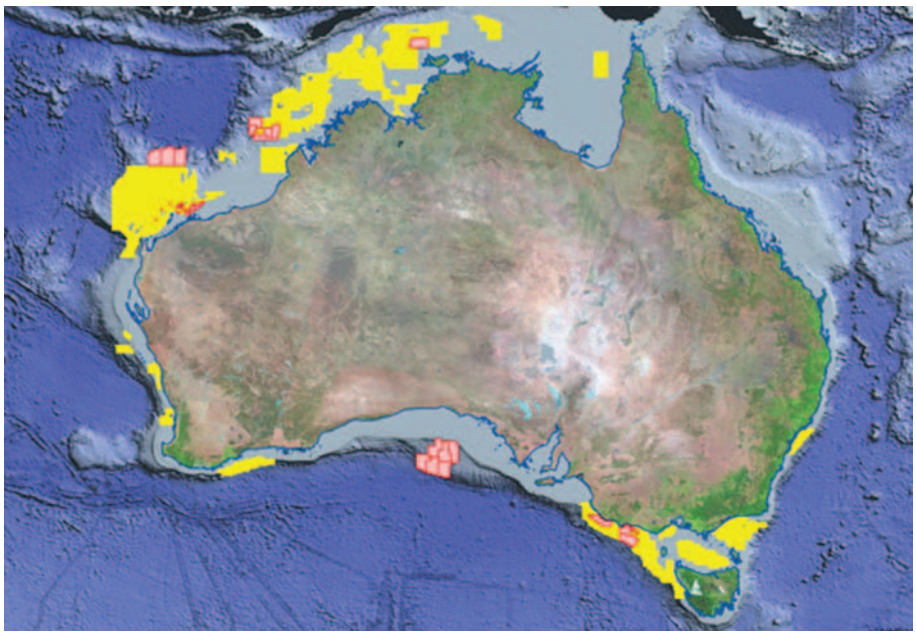

Fig. 1. *Map showing the locations (in red) of the offshore areas released for petroleum exploration in 2009.*

Table 1. Permit areas, operating companies and work programs

Permit area, number of bids	Operating companies	Exploration programs
AC/P46 (released as AC08-4) in the Bonaparte Basin in the Territory of Ashmore and Cartier Islands. No other bids.	Tata Petrodyne Ltd.	A guaranteed work program of a new 300 km 2D seismic survey, a new 300 km^2 3D seismic survey and geotechnical studies to an estimated value of $4.8 million. A secondary work program of a CSEM survey, one exploration well and geotechnical studies to an estimated value of $16.3 million.
AC/P47 (released as AC08-1) in the Bonaparte Basin in the Territory of Ashmore and Cartier Islands. One other bid.	Bengal Energy Ltd.	A guaranteed work program of 985 km of 2D seismic reprocessing, a new 750 km^2 3D seismic survey and geotechnical studies to an estimated value of $11 million. A secondary work program of one exploration well and geotechnical studies to an estimated value of $28 million.
AC/P48 (released as AC08-8) in the Browse Basin in the Territory of Ashmore and Cartier Islands. There were four other bids for this area.	Woodside Energy Ltd (Operator) and Mitsui E&P Australia Pty Ltd.	A guaranteed work program of 600 km of 2D seismic reprocessing, 1098 km^2 of 3D seismic reprocessing, a new 505 km^2 3D seismic survey and geotechnical studies to an estimated value of $9.6 million. A secondary work program of one exploration well and geotechnical studies to an estimated value of $42.4 million.
AC/P49 (released as AC08-2) in the Bonaparte Basin in the Territory of Ashmore and Cartier Islands. There were no other bids for this area.	Silver Wave Energy Pte Ltd.	A guaranteed work program of 500 km of 2D seismic reprocessing, the licensing of existing multi-client 2D seismic data, a new 1000 km 2D seismic survey and geotechnical studies to an estimated value of $6.7 million. A secondary work program of one exploration well and geotechnical studies to an estimated value of $33 million.
AC/P50 (released as AC08-5) in the Bonaparte Basin in the Territory of Ashmore and Cartier Islands. There was one other bid for this area.	Silver Wave Energy Pte Ltd.	A guaranteed work program of 1000 km of 2D seismic reprocessing, 250 km^2 of 3D seismic reprocessing, a new 200 km^2 3D seismic survey and geotechnical studies to an estimated value of $10.5 million. A secondary work program of one exploration well and geotechnical studies to an estimated value of $33 million.
AC/P51 (released as AC08-6) in the Bonaparte Basin in the Territory of Ashmore and Cartier Islands. There was one other bid for this area.	Silver Wave Energy Pte Ltd.	A guaranteed work program of 1000 km of 2D seismic reprocessing, 250 km^2 of 3D seismic reprocessing, a new 1000 km 2D seismic survey and geotechnical studies to an estimated value of $7.4 million. A secondary work program of a new 1000 km 2D seismic survey, one exploration well and geotechnical studies to an estimated value of $35.2 million.
AC/P52 (released as AC08-7) in the Bonaparte Basin in the Territory of Ashmore and Cartier Islands. There were four other bids for this area.	Finder Exploration Pty Ltd.	A guaranteed work program of licensing 800 km^2 of 3D seismic reprocessed data, a new 320 km^2 3D seismic survey and geotechnical studies to an estimated value of $4.5 million. A secondary work program of one exploration well and geotechnical studies to an estimated value of $35.3 million.
WA-425-P (released as W08-8) in the Browse Basin off Western Australia. There was one other bid for this area.	Hunt Oil Company (Operator) and SK Energy Co., Ltd.	A guaranteed work program of purchasing 640 km of reprocessed 2D seismic data, 2675 km of 2D seismic reprocessing, a new 400 km 2D seismic survey, a new 744 km^2 3D seismic survey, and its reprocessing, and geotechnical studies to an estimated value of $19.5 million. A secondary program of two exploration wells and geotechnical studies to an estimated value of $62 million.
WA-426-P (released as W08-17) in the Carnarvon Basin off Western Australia. There was one other bid for this area.	Apache Northwest Pty Ltd.	The company proposed a guaranteed work program of a new 162 km^2 3D seismic survey and geotechnical studies to an estimated value of $2.3 million. A secondary program of one exploration well and geotechnical studies with an estimated value of $30 million.
WA-427-P (released as W08-16) in the Carnarvon Basin off Western Australia. There was one other bid for the area.	Apache Northwest Pty Ltd (Operator) and Kufpec Australia Pty Ltd.	A guaranteed work program of a new 162 km^2 3D seismic survey and geotechnical studies to an estimated value of $2.7 million. The secondary program consists of one exploration well and geotechnical studies to an estimated value of $30.4 million.
WA-428-P (released as W08-19) in the Carnarvon Basin off Western Australia. There were two other bids for this area.	Woodside Energy Ltd (Operator) and Mitsui E&P Australia Pty Ltd.	A guaranteed work program of 100 km of 2D seismic reprocessing, a new 240 km^2 3D seismic survey, a CSEM survey and geotechnical studies to an estimated value of $5.3 million. A secondary program of one exploration well and geotechnical studies to an estimated value of $30.6 million.
WA-430-P (released as W08-20) in the Carnarvon Basin off Western Australia. There were three other bids for this area.	Woodside Energy Ltd (Operator) and Mitsui E&P Australia Pty Ltd.	A guaranteed work program of 175 km of 2D seismic reprocessing, a new 560 km^2 3D seismic survey, a CSEM survey and two exploration wells to an estimated value of $71.5 million. A secondary program of 280 km^2 of 3D seismic reprocessing, one exploration well and geotechnical studies to an estimated value of $30.4 million.
WA-431-P (released as W08-10) in the Browse Basin off Western Australia. There were two other bids for this area.	Hunt Oil Company (Operator) and SK Energy Co., Ltd.	A guaranteed work program of the purchase of 1099 km of reprocessed 2D seismic data, 850 km of 2D seismic reprocessing, a new 300 km 2D seismic survey and geotechnical studies to an estimated value of $0.7 million. A secondary program of one exploration well, a new 500 km^2 3D seismic survey and geotechnical studies to an estimated value of $54.2 million.
WA-432-P (released as W08-7) in the Browse Basin off Western Australia. There were two other bids for this area.	Woodside Energy Ltd (Operator) and Mitsui E&P Australia Pty Ltd.	A guaranteed work program of 1505 km of 2D seismic reprocessing, purchase of 140 km^2 of 3D seismic data, a new 305 km^2 3D seismic survey to an estimated value of $6.9 million. A secondary program of geotechnical studies and one exploration well to an estimated value of $30.6 million.
WA-429-P (released as W08-9) in the Browse Basin off Western Australia. There were no other bids for this area.	Woodside Energy Ltd (Operator) and Mitsui E&P Australia Pty Ltd.	A guaranteed work program of 1505 km of 2D seismic reprocessing, a new 125 km^2 3D seismic survey and geotechnical studies to an estimated value of $3 million. A secondary program of a new 250 km^2 3D seismic survey and geotechnical studies to an estimated value of $5.9 million.
WA-433-P (released as W08-18) in the Carnarvon Basin off Western Australia. There were four other bids for this area.	Woodside Energy Ltd (Operator) and Mitsui E&P Australia Pty Ltd.	A guaranteed work program of 350 km of 2D seismic reprocessing, a new 880 km^2 3D seismic survey, a CSEM survey and one exploration well to an estimated value of $47.9 million. The secondary program consists of 440 km^2 3D reprocessing, one exploration well and geotechnical studies to an estimated value of $30.5 million.

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Geophysics in archaeology: a scrapbook of worldwide data

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Introduction

Cultural heritage sites are usually mapped for either anthropological pursuit, or as required by government planning policy. High-resolution geophysics can be employed to rapidly image buried archaeological sites, to help guide the labour-intensive excavations or even to defer the need to disturb the site. Ground Penetrating Radar (GPR) is commonly used for the 3D information which can be achieved (Conyers and Goodman, 1997). Typical frequencies employed range from 50 MHz, which has a resolution and depth penetration of about 50 cm and 5 m respectively, to 450 MHz with resolution/penetration of about 5 cm/1 m. Other popular methods are magnetics (usually gradiometry), electrical and electromagnetics. Here a suite of geophysical images is presented from sites in Japan, China, the Americas and Pompeii.

Fig. 1. *Reconstructed kofun and burial chamber. From http://travel.webshots.com/photo.*

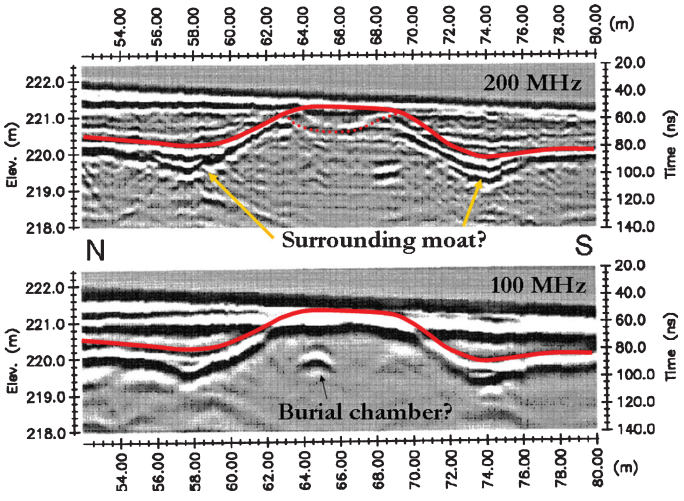

Fig. 2. *GPR profiles over a buried kofun at Komochi village.*

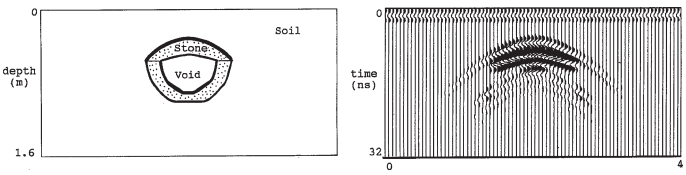

Fig. 3. *Simulated radar response from the air-filled cavity of a stone tomb (Goodman 1994).*

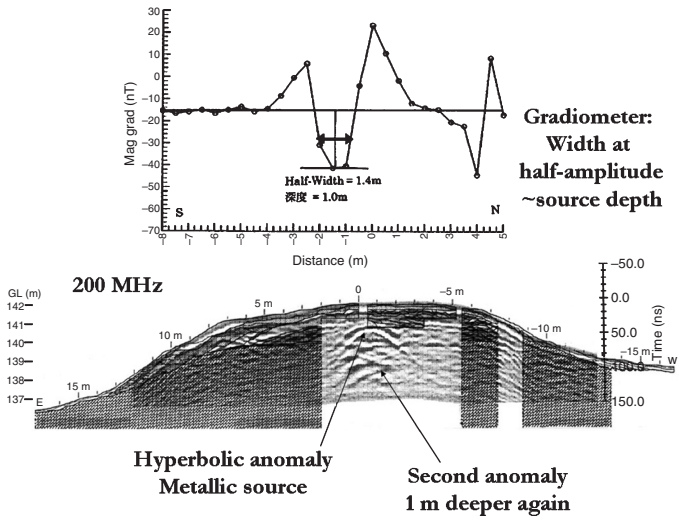

Fig. 4. *200 MHz GPR section at Mount Zoubi, the radar depth correlating with the gradiometer half-width rule.*

Japan

The period 300–600 AD in Japan is known as the *kofun jidai*, after the kofun (burial mounds) found throughout the country. They range in size from circular mounds of a few metres in diameter to giant keyhole shapes, hundreds of metres in length.

A reconstruction of an average sized kofun and the typical burial chamber is shown in Figure 1. Komochi village in Gunma prefecture is known as the 'Pompeii of Japan', where numerous kofun were buried by over 4 m of volcanic ash in the 6th century AD. Figure 2 shows both 200 MHz and 100 MHz GPR profiles recorded over a sealed road, clearly showing the topography of a buried mound and clear internal features. The anomaly in the 100 MHz data is potentially an air-filled cavity, as shown in the modeling of Figure 3.

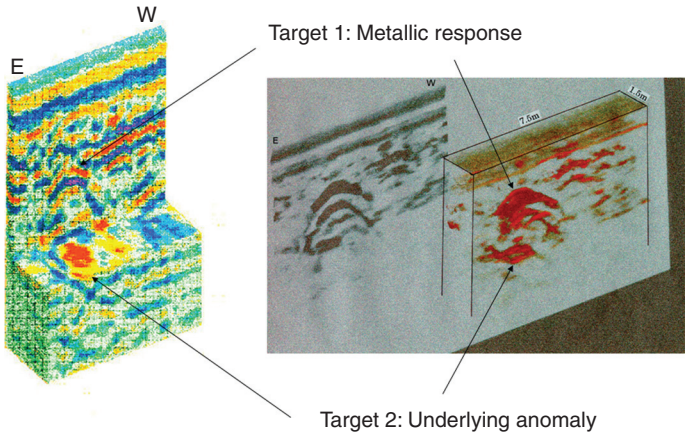

Fig. 5. *3D GPR results showing the diffraction from the buried ferrous object and a second deeper radar anomaly.*

At Mount Zoubi in Yoro Town, Gifu prefecture, are some of the oldest kofun of the period. Being at a major strategic east-west junction, many military leaders are entombed here, dating from the start of 300s AD. A fluxgate magnetometer survey and 200 MHz GPR survey (Figure 4) shows coincident anomalies, due to a buried ferrous object. The GPR source was calculated to be at 1 m depth, by fitting a hyperbola to the radar diffraction (Powers and Olhoeft, 1995), which also correlated with the depth from the magnetic 'half-width' rule. Of more interest to the archaeologists was the second, deeper anomaly. This prompted a 3D GPR survey, which clearly shows both shallow and underlying anomalies (Figure 5). Guided by the geophysics, the mound was excavated and a number of heavily corroded swords were discovered at 1 m depth. The deeper anomaly was not excavated.

Ema Castle in northern Gifu prefecture was built by a lord of the area in the early 1400s and destroyed by fire in 1582. Excavations in the 1970s revealed Chinese and Japanese pottery from the 1200–1500s and evidence of triangular cross-section

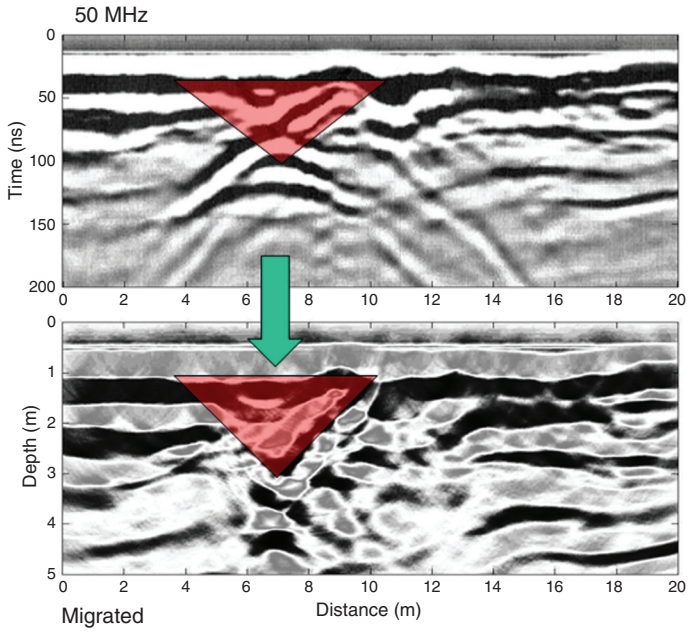

Fig. 6. *Raw and migrated 50 MHz GPR sections at Ema Castle.*

Fig. 7. *Photo of the excavated V-shaped moat.*

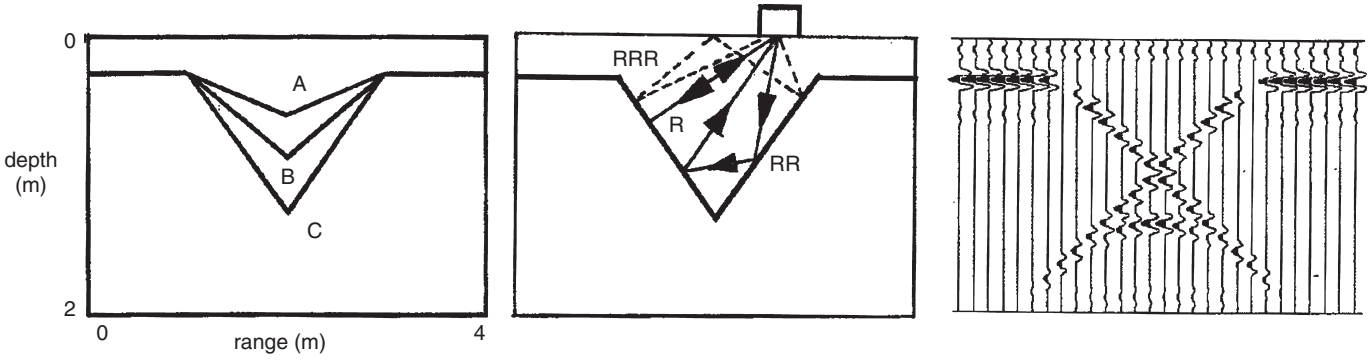

Fig. 8. *Synthetic radar modeling of a V-trench model (Goodman 1994).*

Fig. 9. *Resistance mapping procedure using 0.5 m mobile electrode spacing.*

defence moats called *yagenbori*. A 50 MHz radar survey (Figure 6) over an unexcavated area showed a complex diffraction pattern but migration of the data shows the structure as a steep-sided V-shaped trench, and proven by excavation (Figure 7). The 'bow-tie' response arises due to multiple reflections (Figure 8).

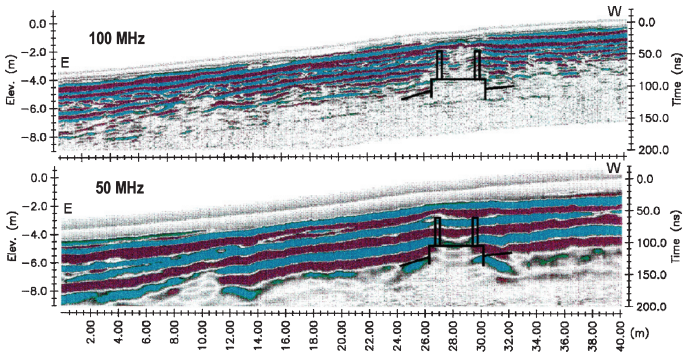

Fig. 11. *GPR profiles at 100 MHz and 200 MHz at Joya de Ceren.*

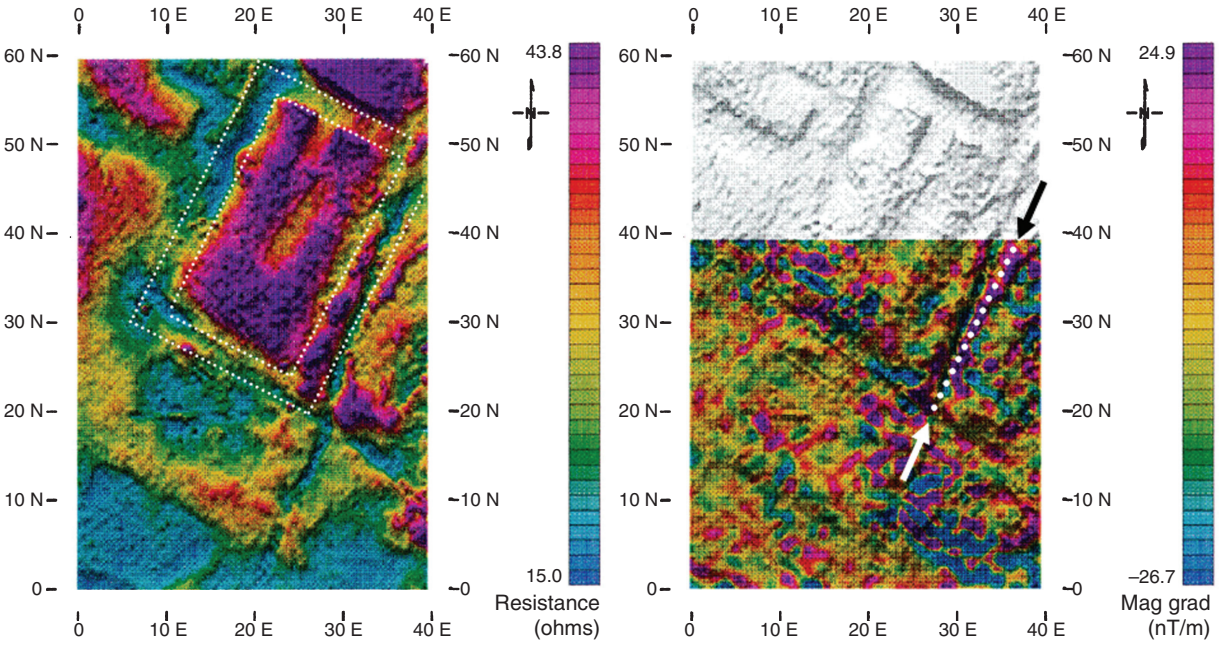

Fig. 10. *Resistance and magnetic images of the Kaminaljuyu site (resistance shading overlain on the magnetic gradient colour map).*

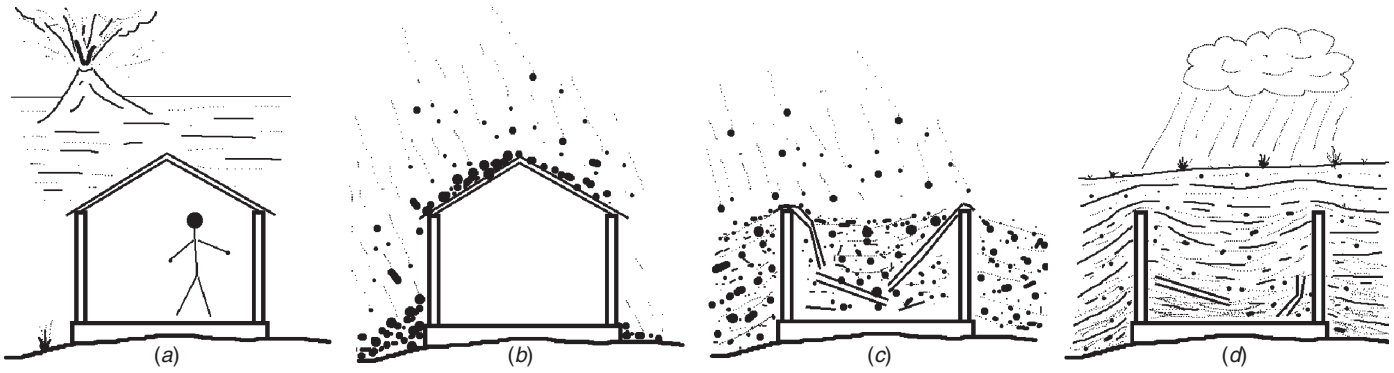

Fig. 12. *A cartoon speculating on the demise of a typical clay-walled house buried by volcanic ash.*

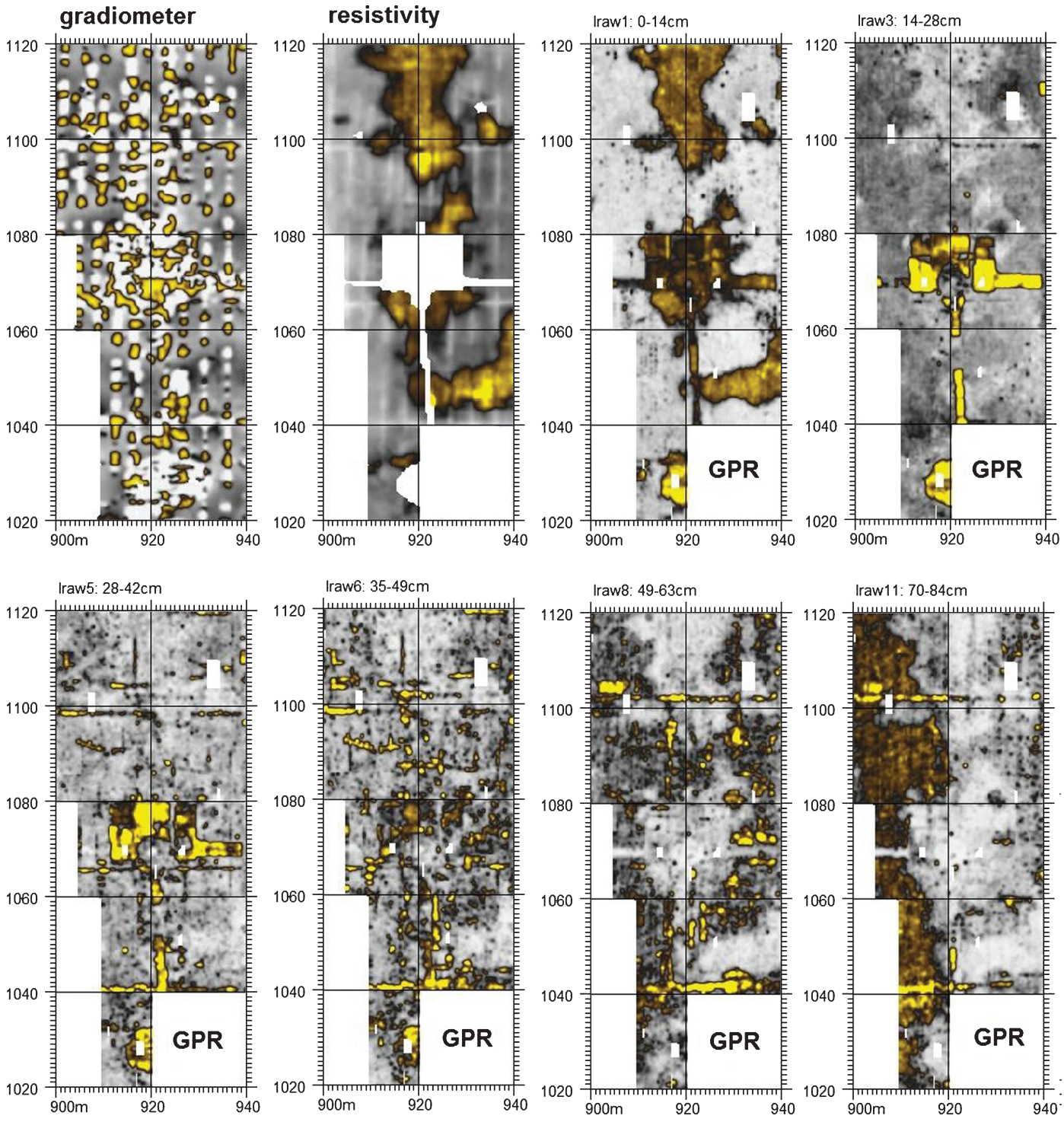

Fig. 13. *Magnetic gradient, resistivity and series of GPR timeslices at the Presidio fort in San Francisco.*

Americas

In Guatemala City, El Salvador, sites of Mayan civilization were buried by volcanic ash some time after about 1000 AD. Figure 9 shows the resistance mapping equipment being used with 0.5 m current-potential (A-M) electrode spacing. The geometry relative to the remote electrodes (B-N) is not regular, so the measurement is in resistance, not resistivity. Figure 10 shows the electrical resistance and fluxgate gradiometer maps from the central part of the Kaminaljuyu site. The edges of the buried foundations are clearly discernable, and the coincident resistance and magnetic anomalies suggest there may be construction with magmatic or basaltic rock, or some induced magnetism in an earthen foundation.

Joya de Ceren in El Salvador was an agricultural village of 40–50 families, buried by up to 6 m of volcanic ash from the nearby Loma Caldera in ~590AD. Excavations reveal clay structures with thick walls and foundations. Radar has been applied here from its earliest inceptions (Conyers and Goodman,

Fig. 14. *100 MHz GPR survey being conducted at Turpan.*

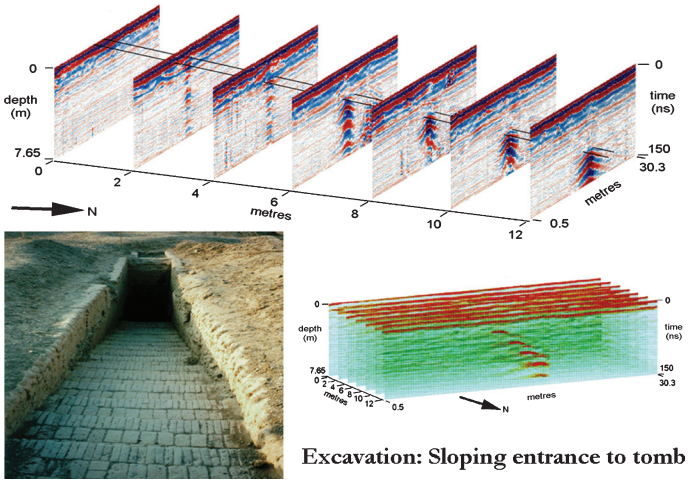

Fig. 15. *The 100 MHz GPR results and an excavated entrance to a buried tomb at Turpan.*

1997). The GPR data show a disruption in the encumbering ash, interpreted to be the standing walls of a house (Figure 11). The cartoon of Figure 12 speculates how this unfortunate event may have progressed.

The Presidio in San Franciso is the area next to the Golden Gate Bridge where the first fort was built by the Spanish in 1776. Gradiometer, resistivity and GPR were used in a study to detect old adobe walls of the fort, the comparison images shown in Figure 13. The gradiometer and the shallow resistivity were very effective in detecting old drainage at the site. Note how the top GPR time slice looks very similar to resistivity, but the deeper radar timeslices clearly show the old adobe foundations.

China

The tombs of Turpan in far northeast China on the 'Silk Road' date from the 1st century BC. Early excavations in the 1930s unearthed hundreds of artefacts. A GPR survey was conducted adjacent to an unexcavated tomb cluster (Figure 14) and the results clearly show the sloping tomb entrance (Figure 15). The accurate 3D radar positioning helps guide excavations to minimize chance of disturbing the targets.

Pompeii

Possibly the most famous site to have been buried by a volcanic event, Pompeii was encumbered by up to 5 m of scoria and ash

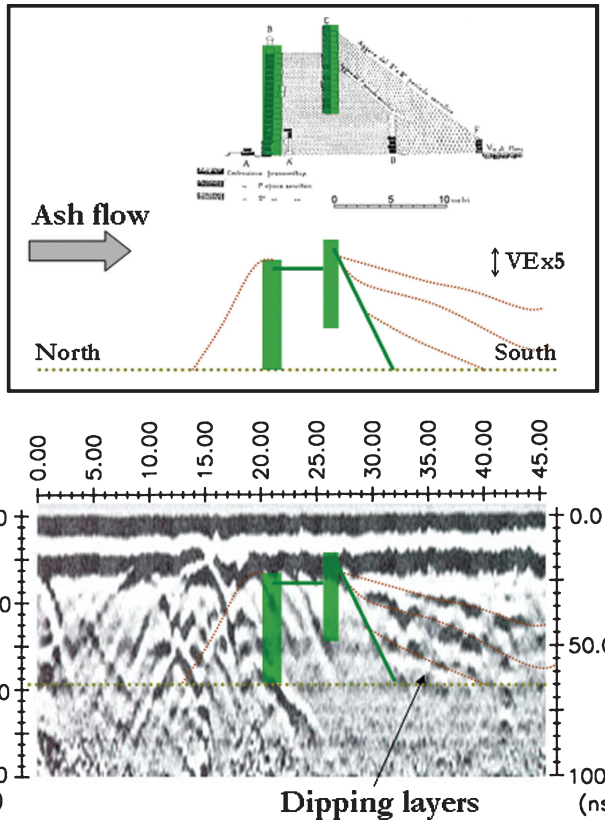

Fig. 16. *50 MHz GPR section over the northern fortification wall at Pompeii and cartoon of the interpretation.*

in the 79 AD eruption of Mt Vesuvius, some 10 km to the north of the city. Much of the site has been excavated, although the northern Porta di Capua fortification walls remain under modern farmland. GPR survey results over the anticipated wall location are shown in Figure 16. When compared to an already excavated section of the wall, the radar interpretation is supported by the diffractions from the tops of the rocks walls and the sloping ash on the downwind side. Dipole–dipole resistivity simulation and field data at a nearby location show good correlation to support the interpretation of a buried twin-wall (Figure 17).

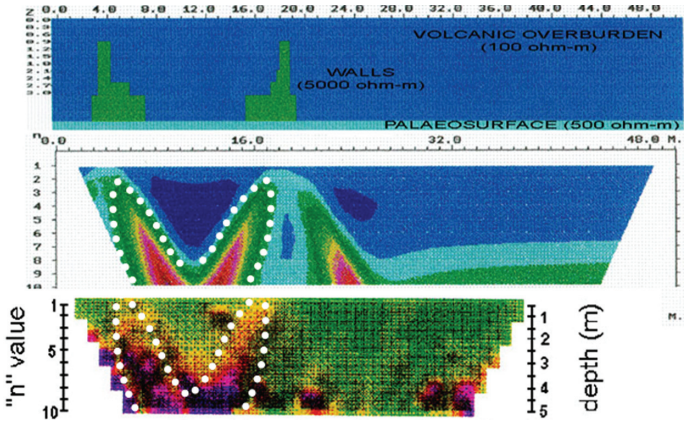

Fig. 17. *Dipole–dipole resistivity simulation and field results over a twin-wall fortification.*

Summary

The use of geophysics in archaeology has a high rate of success. If the target and encumbering soils have high contrast in physical properties, and the soil is dry and/or evenly layered, the images will invariably be good. Most important is to survey before excavations, where obstructions and noise are minimal. In general, radar will always provide the most useful results, for its speed of acquisition and 3D imaging. However, a variety of radar frequencies, or the use of at least two methods is always recommended.

This work was compiled while A.O. was employed at Tanaka Geological, from Sep. 1996 to Jan. 1999. The San Francisco case study can be found on Dean Goodman's homepage: www.gpr-survey.com.

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Delineating the subsurface tunnels (Ghanats) in an urban area using microgravity data

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Abstract

A microgravity investigation was conducted in an urban area and in residential buildings to delineate the old subsurface tunnels (Ghanats). These subsurface cavities (tunnels, wells) threaten the stability of the building and are a great danger to the people living in these buildings.

The relative negative anomalies representing the probable location of old water tunnels and cavities have been detected by Bouguer anomalies. To delineate the negative anomalies that are mostly linear, an effective filter named Sun Shading is applied. The depths of these anomalies have also been determined by the Euler method. Some of these shallow accessible anomalies have been confirmed in the field by excavation. For processing the data, Encom (PA, Version 7) and Geosoft (Version 7) are used.

Key words: microgravity, linear anomaly detection, depth estimation.

Introduction

Delineation of subsurface anomalies such as cavities is one of the most frequently cited applications of microgravity. Cavities have been the most common target. Detection by microgravity plays a vital role whereas cavities present a very difficult objective for other geophysical methods (Butler, 1977; Franklin *et al.,* 1980). The cavities can be natural such as solution cavities in limestone or man-made such as tunnels or mines and may be air-filled, water-filled or filled with some secondary geological material.

Butler (1984) presented a pioneer job in detection of shallow surface cavities and tunnels which have a vital role in the stability of the foundation and concludes that microgravity is the most promising surface method when shallow negative and positive anomalies are targeted. To delineate the man-made cavities have rarely been considered. In one of the primary efforts the location and the depth of a single Ghanat tunnel were estimated by Ardestani (2003).

Ghanats

There are many ancient and old water tunnels in Iran called Ghanats. These Ghanats are excavated in arid areas in Iran to collect underground water. A simple section of a Ghanat is shown in Figure 1. Ghanats have a main tunnel and several secondary tunnels which branch out from the main tunnel. The shape of the tunnels is close to cylindrical with a diameter of about 1 metre and up to 2 metres in adjoining to the wells. The tunnels are expanded where they adjoin the wells. Moreover these tunnels may expand because of their collapse and cause large cavities. So in the places where these tunnels adjoin to the wells or their roofs collapse large cavities can be formed.

These Ghanats are sometimes covered and hidden in urban area by new constructions. These covered tunnels and wells may cause problems for these constructions. Ghanats are the main reason for causing unexpected holes in some urban areas.

Site character and geology

The site presented in this paper is located in an urban area in a town (Baharestan) close to Isfahan in the centre of Iran. The area under investigation is a residential area close to a main Ghanat tunnel with north-south direction and several probable secondary tunnels (Figure 2a). A few holes have appeared in the site suddenly (Figure 2b) which were probably caused by these secondary tunnels.

The locations of the secondary tunnels are based on some old maps and uncertain information in the area. On the other hand the unexpected holes, one of which is shown as a hole in Figure 2a, are not in the passage of the secondary tunnels. Therefore to delineate the secondary tunnels the first need is to fill in the gaps in the old mapping.

The site is formed from horizontal layers of alluvium with a loose cement and low compactness with similar size grains.

Field procedures

The gravity grid consists of 1700 measurement points over an area with dimensions about 70 by 150 metres. Some of the measurement points are located in the basements. A basic grid dimension of 2 metres was used. Data were collected with a CG3-M gravimeter with a sensitivity of approximately 1 μGal.

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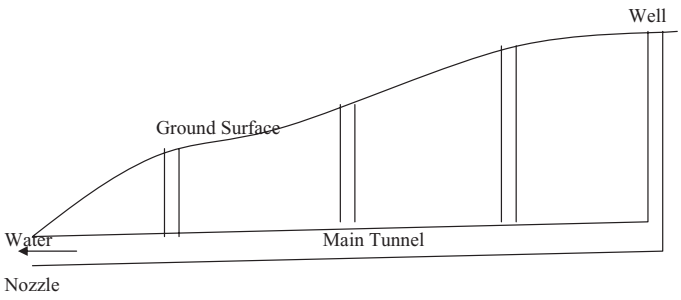
Gravity corrections

After selecting a base point, all points are measured and corrected relative to this point. The long-term drift of the gravimeter was removed by using the cycling mode of the gravimeter over several days at the office in Tehran. For removing the short term drift the gravity was measured on the base several times during the work day. The short term drift was computed and applied to the data by downloading the data to the computer and using *Geosoft* (*Oasis version* 5.1.5). Then the data were corrected for effects caused by variations in latitude, elevation, and topography. Free-air and Bouguer corrections are computed through related equations and considering the relative heights of the points to the base point.



Horizontal scale: 1/100 000
Vertical scale: 1/1000

Fig. 1. *Ghanats.*

The average density required for Bouguer correction had been defined by prior information and site investigation equal to 1780 kg/m^3. The terrain correction is the most sensitive stage in reductions. The effects of the buildings are computed through related equations for computing the gravity effects of a rectangular prism (Banerjee and Gupta, 1977).

$$g_{\text{par}} = f\sigma\left[\left[\left[\, x1\ \text{n}(y+r) + y1\ \text{n}(x+r) - zarctg\,\frac{xy}{zr}\right]_{x2}^{x1}\right]_{y2}^{y1}\right]_{z2}^{z1} \qquad (1)$$

where g_{par} is the vertical gravitational attraction of the prism bounded by the planes X=$x1$, X=$x2$, Y=$y1$, Y=$y2$ and Z = $z1$, Z = $z2$; σ is the density of the prism; f is the universal gravitational constant; and $r=\sqrt{x^2+y^2+z^2}$.

The effects of all buildings in this residential area (radius about 200 metres) are considered as topographical effects and computed by Eqn 1. The average density of the buildings in this residential area is estimated by considering the density of walls and roofs and foundations using the Reinforced Concrete Designer's manual (Naderpor, 1985) and the furnishings (about

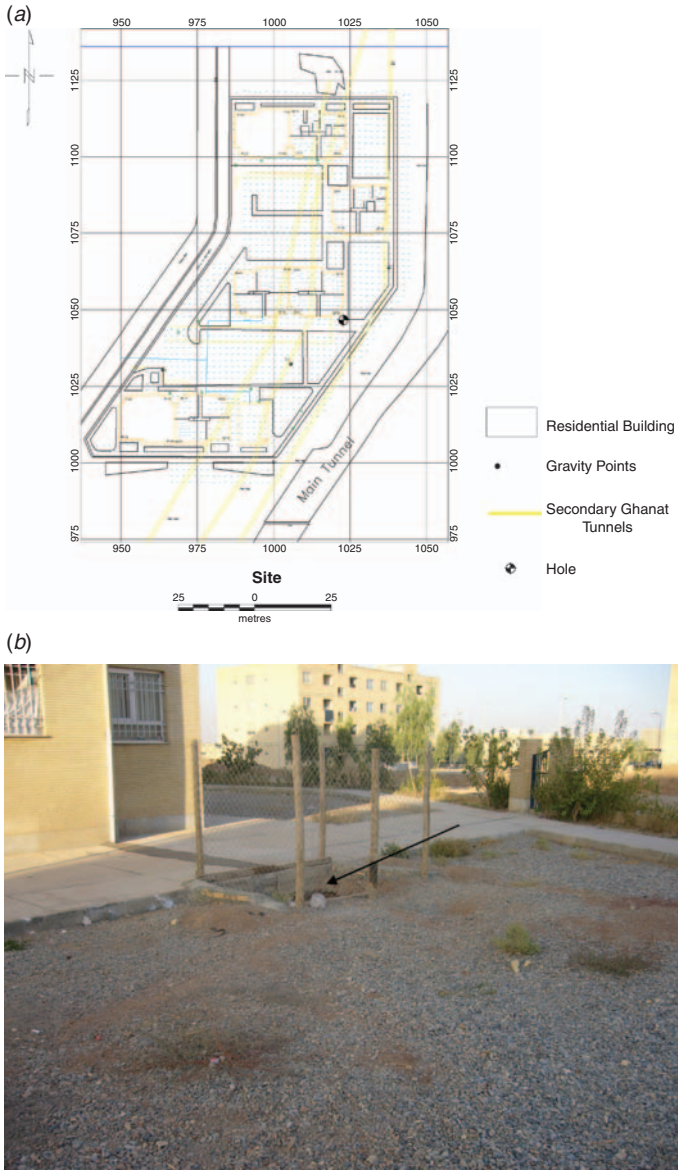


Fig. 2. *(a) The plan of the site. (b) The unexpected hole.*

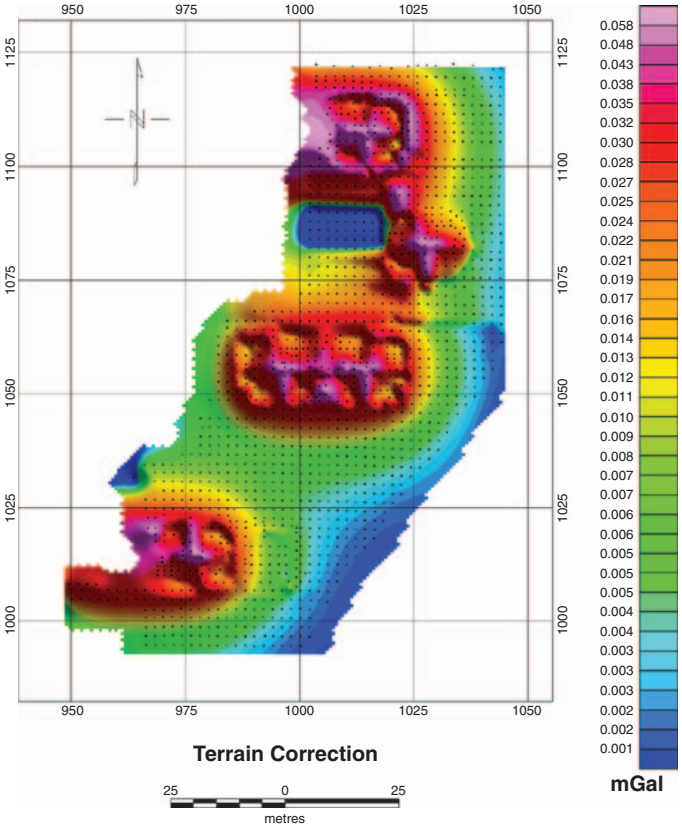


Fig. 3. *The terrain corrections (mGal).*

0.7 to 0.9 gram per cubic metre). The gravity effects of the buildings are shown in Figure 3.

Interpretation

A test area

In a test area at the Institute of Geophysics in Tehran a part of the Ghanat tunnel between two wells is selected and a microgravity survey is done. The depth of the roof of this tunnel is known to be about 3 metres from ground level. The depth of the tunnel is estimated by applying the Euler method to residual gravity anomalies and is shown in Figure 4 (Ardestani, 2003). As the shape of the tunnel is close to a cylinder with finite dimension, the structural index equal to 2 gives good results for the depth of the roof of the tunnel. The Euler depth over the linear negative anomaly shows the correct depth of the roof of the tunnel particularly in the middle of the distance between the wells (Figure 4).

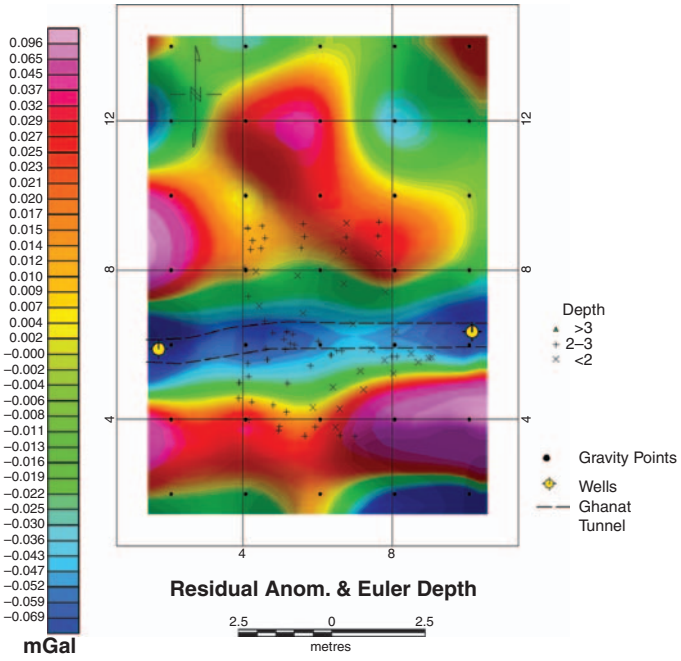


Fig. 4. *The residual anomalies of test site.*

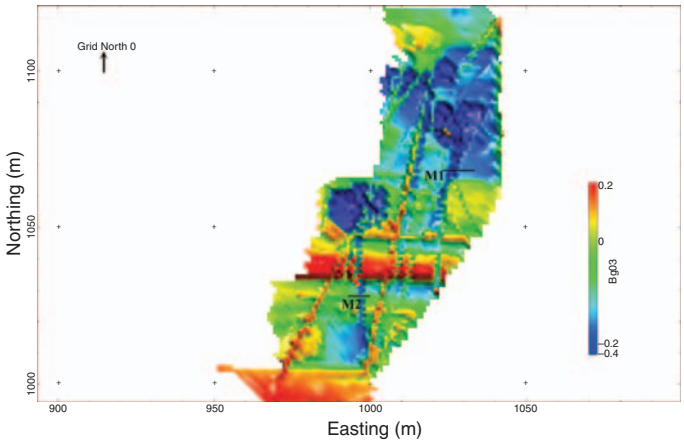


Fig. 5. *The Bouguer anomalies (mGal).*

The maximum negative residual gravity anomalies reach to about –70 µGal over the tunnel in this test site (Figure 4), where no expanding or collapse of the tunnel occurred. It can be expected that in the case of expansion of the tunnels adjoining the wells or their collapse, large cavities may be generated with several hundred µGal of gravity effects.

Site

After gravity corrections including the effect of the buildings as terrain correction (Figure 3) the Bouguer gravity anomalies are computed using Encom software and shown in Figure 5. The linear negative gravity anomalies are demonstrated quite well in this figure. The positive gravity anomalies are also shown and caused by positive density contrasts. The linear positive

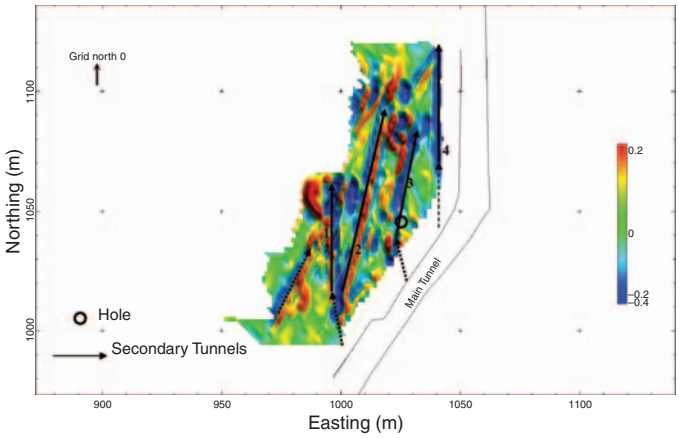


Fig. 6. *The Sun Shaded Bouguer anomalies.*

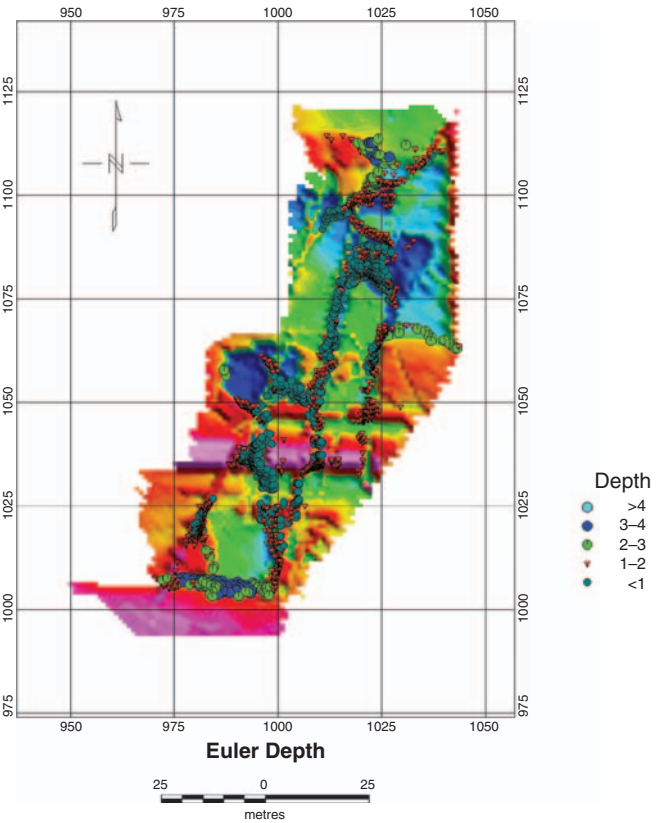
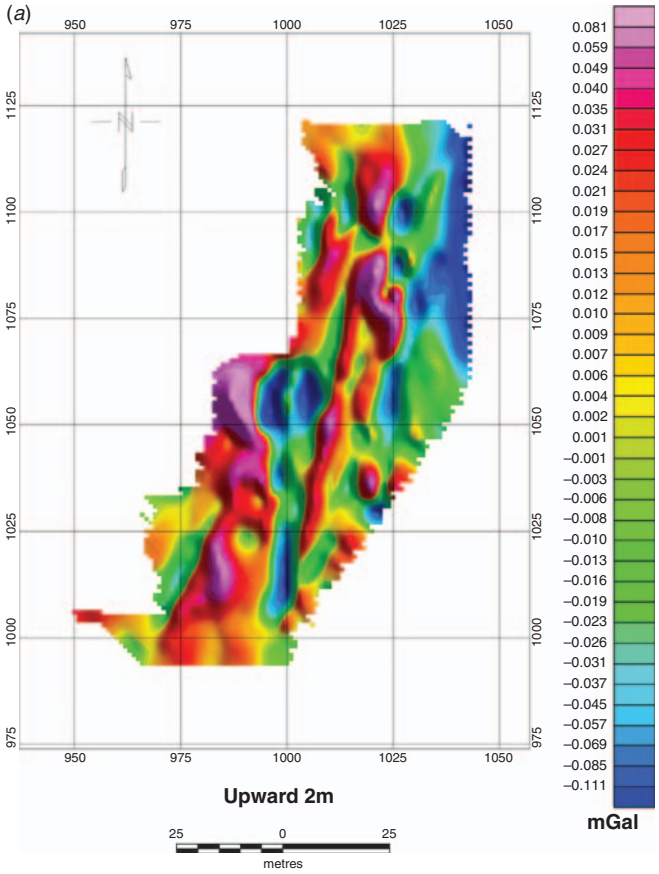


Fig. 7. *The Euler depths.*



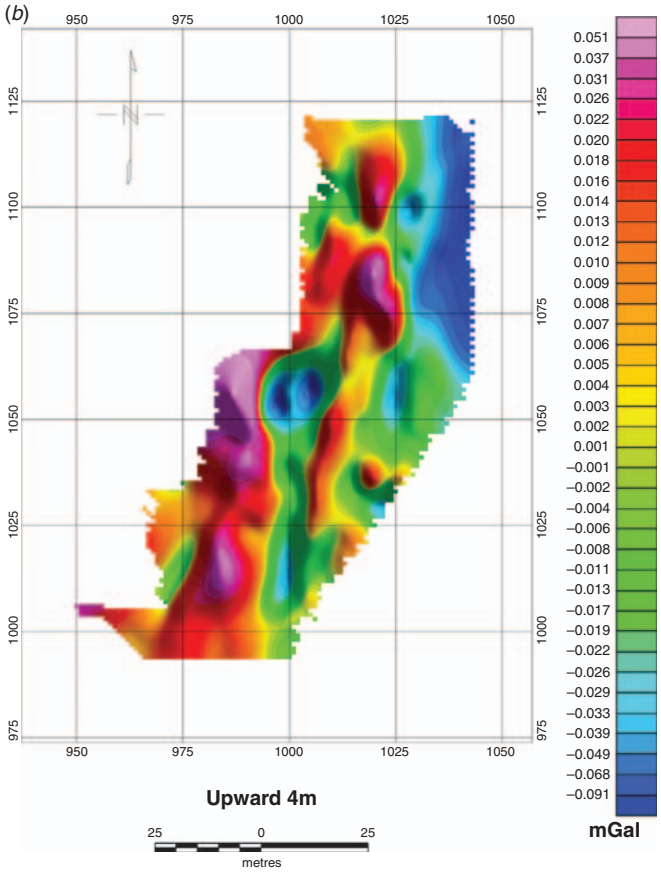


Fig. 8. *The Sun Shaded Bouguer anomalies with upward continuation to the level of (a) 2 metres, (b) 4 metres and (c) 6 metres.*

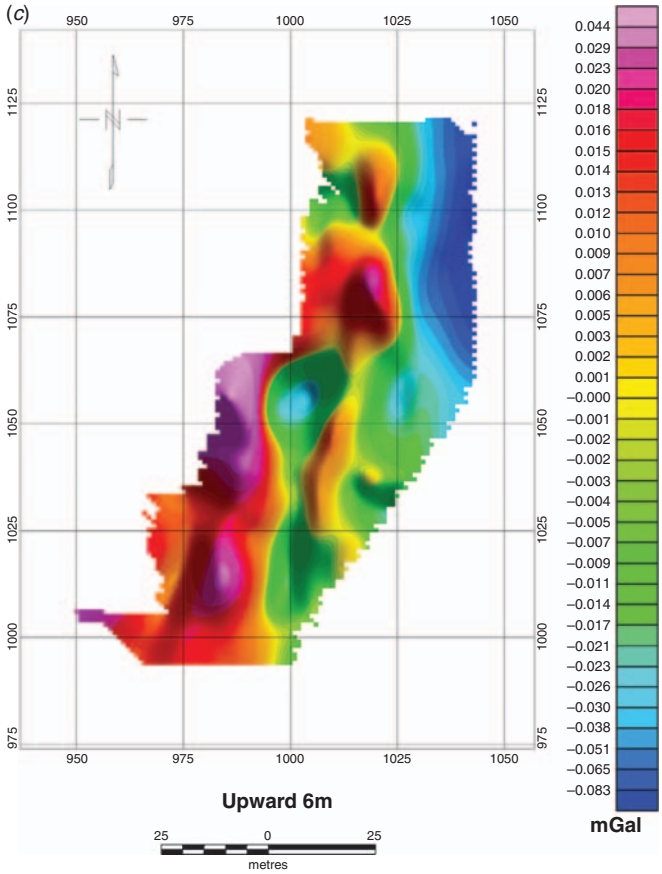


Fig. 8. (*continued*)

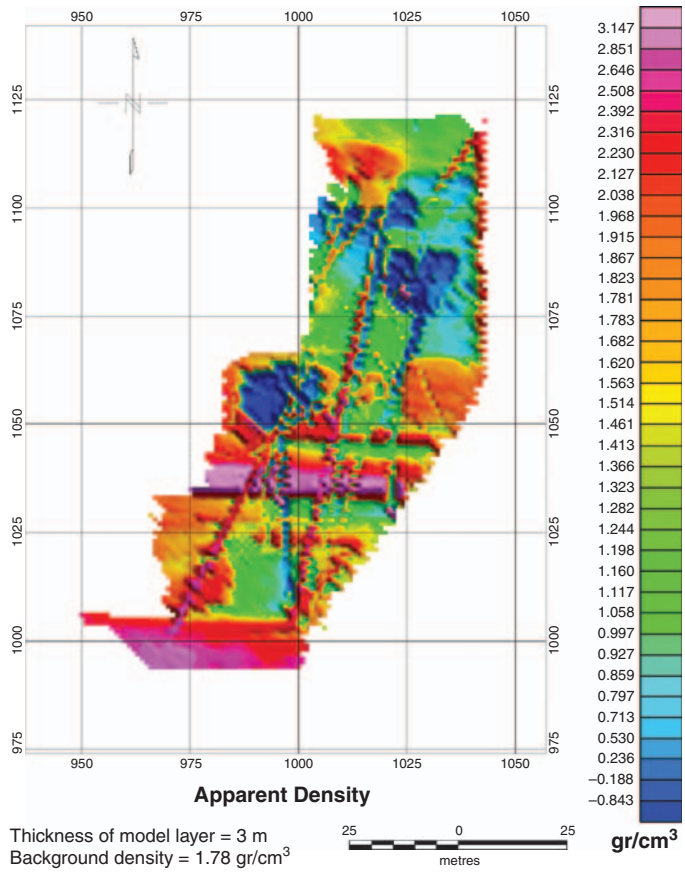


Fig. 9. *Apparent contrast densities.*

anomalies parallel to the linear negative ones are caused by injection of concrete into the old expected tunnels (Figure 2a). However the injection of concrete for filling the tunnels has been only partly successful and there are still empty spaces which are represented by linear gravity anomalies in Figure 5.

Using the Sun Shading filter in Encom (PA) these linear negative anomalies appear in Figure 6. Applying this filter confirms the negative linear anomalies seen in Figure 5. The sun shaded Bouguer anomalies (Figure 6) shows the true locations of the secondary tunnels which show a good correlation with linear negative anomalies.

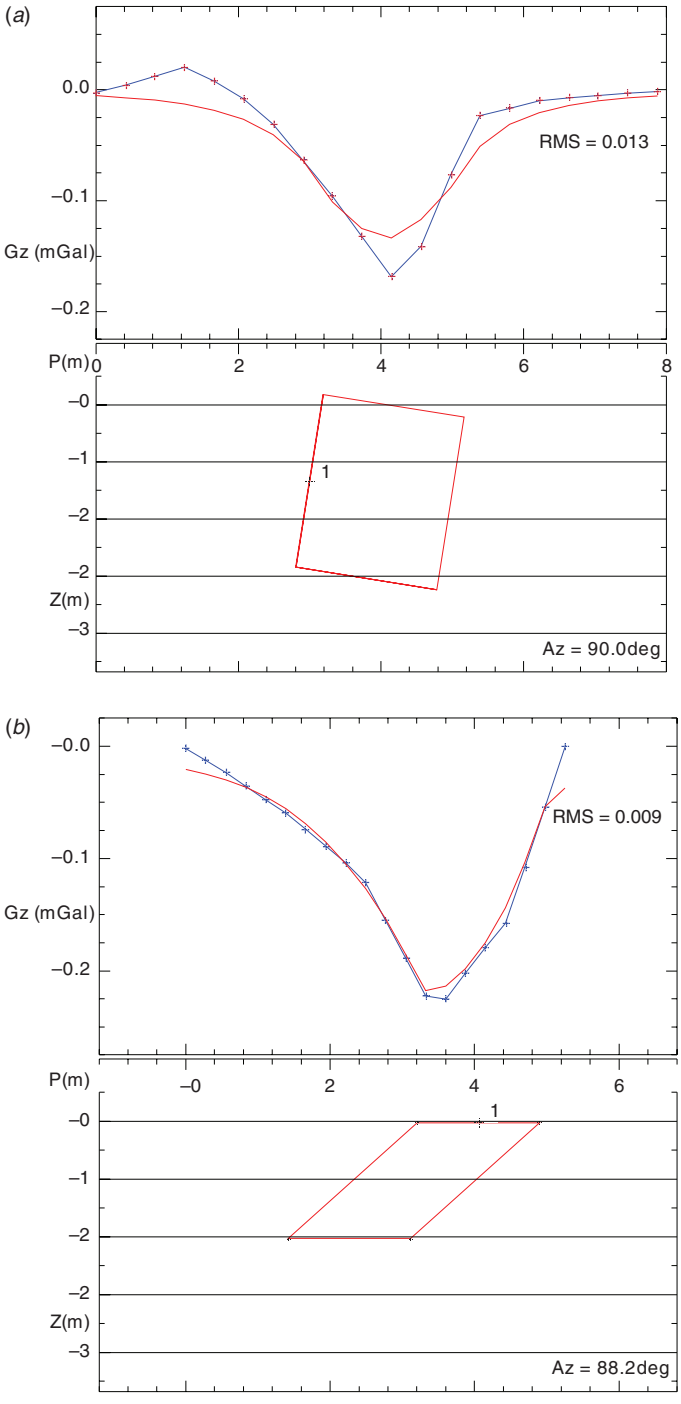


Fig. 10. *2-D modelling along (a) M1 and (b) M2.*

Table 1. Comparison of depth calculations for gravity profiles M1 and M2

Profile	Depth (Euler)	Maximum depth (upward)	Minimum depth (2D modelling)	Maximum depth (2D modelling)
M1	1–2 m	~2 m	<1 m	~2.5 m
M2	<1 m	2–3 m	<1 m	~2.0 m

To estimate the minimum depth of these linear negative anomalies, the Euler method is applied and the results are shown in Figure 7. The minimum depths of these linear anomalies are mostly from less than 1 metre and up to 2 metres. Considering the dip of the ground surface (about 5%) and the nozzle of the main tunnel which is very close to the survey area (about 10 metres from the border of the gravity network in the east and 35 metres from the border of the gravity network in the south (Figure 2a), the depth of the axis of the secondary tunnels must be about 2 to 3 metres. Of course the Euler depths can also belong to the collapsed zone around the main tunnels.

For estimating the maximum depth of these linear negative anomalies, upward filters are used. The principle derived by Jacobsen (1987) is applied to form a relation between the amount of upward continuation and the depth of the anomalies. The principle says that, for example, 4 metres upward continuation of data from ground surface shows the anomalies deeper than 2 metres from the ground surface. Figure 8 shows the anomalies at depths more than 1 metre, 2 metres and 3 metres respectively. As these figures show, the maximum depths of these linear anomalies are mostly less than 3 metres.

Obtaining a rough estimation of the density contrasts of these anomalies, an apparent density map is provided and shown in Figure 9. For confirming the results concerning the depths of the anomalies and particularly the linear anomalies, two profiles (M1 and M2) are selected as shown in Figure 5. Along these profiles a 2-D inversion program (Potent Q) is used in Geosoft and the results are shown in Figure 10. In these models the contrast density obtained from the apparent density map (Figure 9) has been applied as the constraint.

The minimum depths of the models match the results of the Euler depths quite well. The depths derived through the Euler method and upward continuation and 2-D modelling for the negative anomalies along these profiles (M1 and M2) are reflected in Table 1. Considering the depths shown in Table 1, we can conclude that these linear anomalies (tunnels) must be investigated and probably filled by some bore holes to maximum depths of 3 or 4 metres.

Conclusion

Microgravity is an effective method to detect shallow anomalies. Exact coordinates and maximum depth of the sources provide engineers with valuable information about subsurface shallow anomalies which could produce instabilities in urban areas and subsequent construction. The man-made tunnels and wells can be detected as negative anomalies even in urban and residential areas.

Acknowledgment

The author is thankful to the authorities of the Institute of Geophysics and the University of Tehran.

Continued on p. 39

Base metals and gold prices: strong influence of US dollar valuation

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Executive summary

- Conventional view is commodity prices are controlled by resource supply and demand.
- However, major underlying control on prices is valuation changes of United States Dollar.
- Since United States Dollar valuation has just come off a very low valuation, it is more likely that commodity prices will remain stable, or even decrease, in the next 3–6 years.

Introduction

Accurate forecasts for medium-term commodity prices are essential when resource companies are committing to capital expenditures. Too often commodity forecasts tend to be extrapolations of current trends, invoking after the fact observations to justify a trend. Commodity forecasts for base metals and gold can do a lot better than this, if it is accepted that the primary control on medium-term prices is US Dollar valuation.

Conventional wisdom is that base metal prices are set primarily by the interaction of supply (existing and new production) and demand (global economic activity). Gold prices are set in accordance with inflation rates, exchange rates and the status of the global geopolitical situation. Since different factors affect these commodities, there should not be a link between prices.

This paper questions the relevance of such approaches, suggesting instead that the major underlying control on commodity prices is appreciation and depreciation of the United States Dollar. While this is not a new premise, it does not appear to be widely known in the financial and resources industries. If the premise is correct, any appreciation of the United States Dollar in the coming years will likely decrease, or hold stable, commodity prices. Such a prediction is unsettling for those working in the resources industry, but has to be faced.

Commodity prices and the US Dollar

In an April 2008 publication, the American Geological Institute presented data showing a strong link between oil and gold prices during 2000–08. The link between oil and gold prices has since been analysed by this author over the longer timeframe since 1980 and found to be valid (refer July issue of *Society of Petroleum Engineers News*).

Figure 1 shows the base metal and gold prices from 1980 to May 2009. The base metal US Dollar prices are derived from the Reserve Bank of Australia Commodity Index, detailed in Table 1. The proportions in this index reflect their share of Australian base metal exports. Note the recent price surge during 2006–08 for gold and base metals. While base metals have since retraced this gain, gold continues to maintain stratospheric prices.

This paper considers the effect that US Dollar valuation changes have on commodity prices for base metals and gold. If commodity prices are largely controlled by US Dollar movements, we should expect a constant ratio for gold price divided by base metal price. The ratio of 10 ounces of gold divided by base metal price is shown in Figure 1. The ratio is remarkably stable since 1982, averaging around 30±9. At end May 2009, the ratio of 55 is well above average, indicating either base metals could rise in price and/or gold fall in price. Analysis in this paper suggests the latter is far more probable.

Most of the recent commodity price rises were attributed to supply/demand and the industrialisation of China. However, consider this – since commodity prices are quoted by sellers in United States Dollars, how much of the change in prices could be attributed to a valuation change of US Dollar? Figure 2 shows the US Dollar exchange rate since 1980 against its major trading countries.

Table 1. Composition of the RBA base metals index

RBA base metals index	
Metal	**Proportion (%)**
Aluminium	51.6
Copper	17.8
Nickel	16.6
Zinc	9.6
Lead	4.5
Total	100

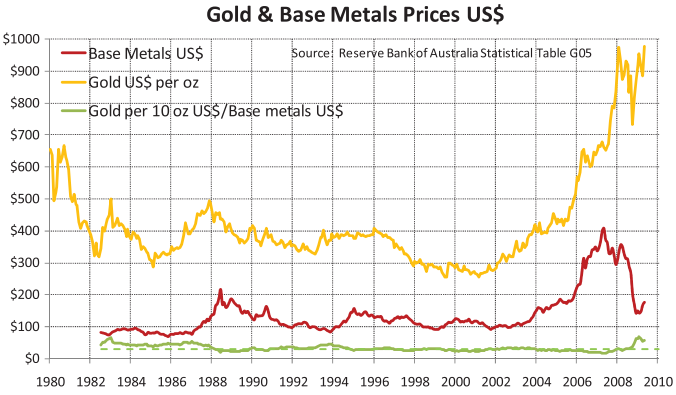

Fig. 1. *Base metals and gold price changes maintained a similar ratio during 1982 to 2009.*

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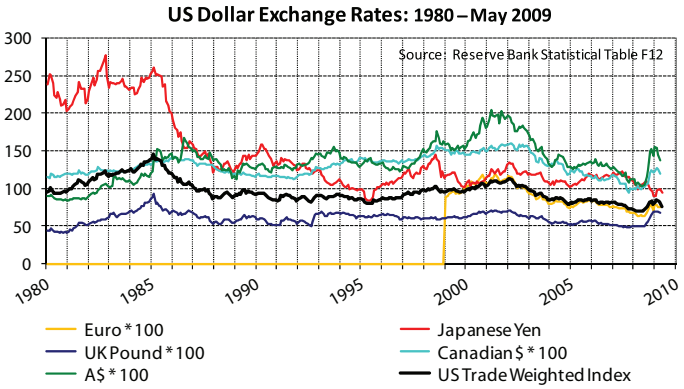

Fig. 2. *US Dollar exchange rates and Trade Weighted Index peaked in 1985; bottomed in mid 2008.*

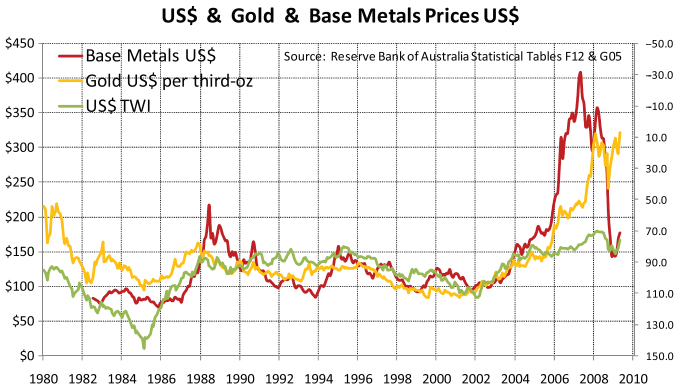

Fig. 3. *US Dollar Trade Weighted Index (inverted scale) closely matches commodity price trends during 1982–2009.*

Observe the US Dollar reached a 40-year high against other currencies in 1985; and a 40-year low in mid 2008. While it has since appreciated, note it is still well below the long-term median valuation.

Introducing the Trade Weighted Index

Next, we define the currency term *Trade Weighted Index* (TWI). This is the weighted average of exchange rates of a home and foreign currencies, with the weight for each foreign country equal to its share in trade with the home country. Those trading partners that constitute a larger portion of an economy's exports and imports receive a higher index. The TWI is a more comprehensive analysis than comparing two currencies, for example, the Australian Dollar and the United States Dollar. Higher TWI values indicate the home currency is appreciating in value, and vice-versa. Figure 2 shows the US Dollar TWI.

Figure 3 shows base metals and gold prices, with gold price plotted as one-third ounce, since 1980 with US Dollar TWI plotted as inverted scale on the right-hand side. An inverted scale demonstrates an opposite relationship between variables.

Observe:

- Strong appreciation in US Dollar from 1980 to 1985 was accompanied by a decline in gold price. (It will be demonstrated later that the magnitude of the 1985 currency appreciation was extremely anomalous. Therefore a close match between dollar and commodity prices may not be expected.)
- Strong depreciation in US Dollar from 1985 to 1987 was accompanied by an increase in commodity prices.
- Period of overall US Dollar stability from 1988 to 1995 was accompanied by overall stable commodity prices. Yes, there were short-term periods when prices varied, but this paper is examining medium term trends.
- Appreciation in US Dollar from 1996 to 2001 was accompanied by a similar decline in commodity prices.
- Depreciation in US Dollar from 2002 to 2005 was accompanied by a similar increase in commodity prices.
- Upward spike in base metal prices during 2006–08 has now been reversed for base metals. The US$180 base metal price index is now in line with the US Dollar TWI movements.

At present, gold appears to be over-priced based on currency considerations. The US Dollar TWI suggests a more appropriate price is around US$500 per ounce. Clearly speculators control short-term price movements. The global financial crisis has brought undone the base metal speculators, while gold speculators are facing a real test of nerves.

The overall close relationship during 1980–2009 for TWI and commodity prices suggests the parties setting the commodity prices want a stable return – as the US Dollar depreciated, prices of commodities rose commensurately and vice-versa.

Why should the US Dollar have so much influence?

Over half of the total amount of US currency outstanding is circulating abroad (*Regional Economist*, April 2006, see http://www.stlouisfed.org/publications/re/2006/b/pages/deficit.cfm). Put simply, the US economy is by far the world's largest and will remain so for at least decades. The current global financial crisis will pass, having weeded out many unsustainable business practices. The survivors of American businesses will emerge leaner and stronger, ready to continue their strong entrepreneurial activities.

If the US Dollar and commodity medium-term prices have an inverse relationship, then trend forecasts for commodity prices should be largely based on expectations of currency movement. To do this, we need an understanding of the magnitude and length of past appreciation and depreciation movements, together with health of the US economy.

Figure 4 shows the United States quarterly change in real GDP since 1970 and US Dollar TWI movements since 1973. Observe:

- US Dollar was surprisingly stable during the turbulent 1970s, when the world was in global recession (caused by inflation and OPEC oil shocks).
- From early 1980s, US Dollar appreciated very strongly (60%) while economy averaged 2.4% pa growth.
- During 1985–95, US Dollar depreciated (–45%), even though economy averaged 2.8% pa growth.
- During 1996–2001, US Dollar strong appreciation (40%) while economy averaged 3.2% pa growth.
- During 2002–08, US Dollar depreciated (–38%) while economy averaged 2.8% pa growth.
- Since April 2008, US Dollar appreciated by 8% while economy has been in recession.

Does economy affect currency?

These observations pose the question – how strongly is currency movement linked to economic health? It is expected that over the long-term, currency is a zero-sum result with appreciations and deprecations cancelling out. Economic growth is an overall positive result. Therefore correlation between currency and economy should not be high.

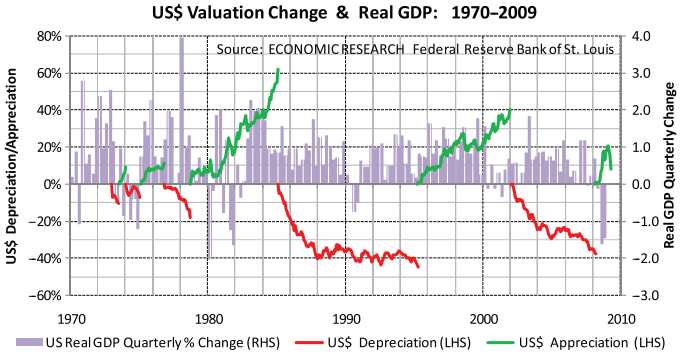

Fig. 4. *US Dollar movements are only weakly linked to economic health (GDP).*

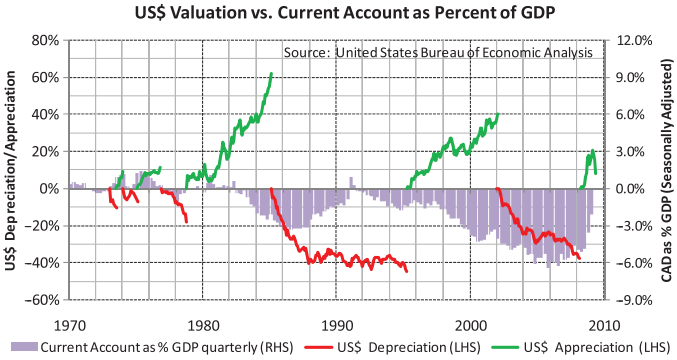

Fig. 5. *US Dollar movements do not closely follow change in Current Account as percentage of GDP.*

The correlation between US Dollar movement and economic performance is weak at best, as expected. Therefore confident predictions of US Dollar future movement, based on views of health of the US economy, are suspect (even though superficially plausible).

To return to the premise that commodity supply/demand does not underpin medium-term price trends, I contend the evidence is strong. Consider the near-constant ratio for price of base metals divided by gold since 1982 (Figure 1). These commodities have significant unrelated supply/demand factors – if so, why the near constant ratio? If demand for base metals were a significant factor, then why does price fall during the mid-late 1990s when economic activity was strong?

Does US Current Account affect currency?

Next we consider whether the US Current Account, the difference in import/export for trade in goods and services and earnings on investments, influences currency valuation. Figure 5 shows the currency monthly variation compared with quarterly values for Current Account as a percent of seasonally adjusted GDP.

Observations:

- During 1970–83, Current Account/GDP was a relatively low stable value. Currency variation was also quite stable until 1981, followed by strong appreciation during 1981–85.
- During 1985–87, Current Account/GDP worsened markedly and the US Dollar depreciated significantly.
- During 1988–91, Current Account/GDP improved markedly while the US Dollar remained at a stable low value.
- During 1992–2006, Current Account/GDP worsened significantly, yet the currency had a period of appreciation during 1995–2002, followed by significant depreciation during 2003–07.
- Since 2008, Current Account/GDP improved markedly while the US Dollar appreciated quite strongly.

Figure 6 shows the rolling 5-year correlation of US Dollar TWI with Current Account as percent of real GDP (seasonally adjusted). The correlation between the two variables, while very volatile, is overall negative indicating that currency has an underlying opposite relationship with Current Account as percent of GDP. Figure 6 also shows rolling 5-year correlation of base metal prices against economic GDP. The overall negative results of these two correlations will be a surprise to people prepared to postulate connections without checking the data.

Many economists are unconcerned about foreign investment in the United States, because the counterpart of the huge US current account deficit is an equally large US capital account surplus. The rest of the world is sending US goods and services now in exchange for claims on future income, such as stocks and bonds or real investment in assets like automobile factories. I conclude that forecasting currency movement based on expected future economic conditions and trade balances is imprecise, to say the least!

Predicting commodity prices in the short-term (up to 2 years) is a lottery because of momentum and speculative activity. However, we can predict the 3–5 year medium term with more confidence because an underlying trend has time to assert itself.

Predicting commodity prices in the medium term

I finish with an outlook for movement of the US Dollar and commodity prices over the medium term.

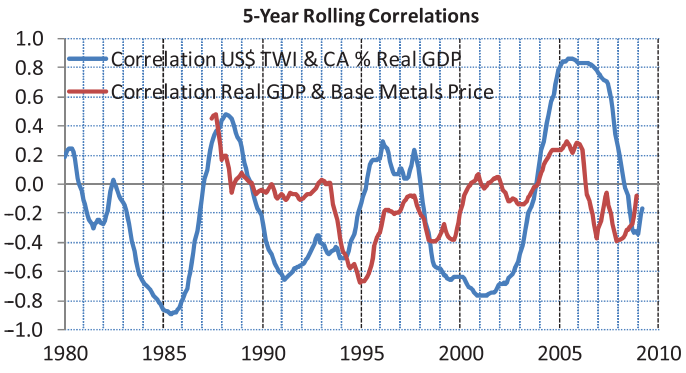

Fig. 6. *There is overall negative correlation between US Dollar and Current Account as percentage of GDP; base metal prices and economic GDP.*

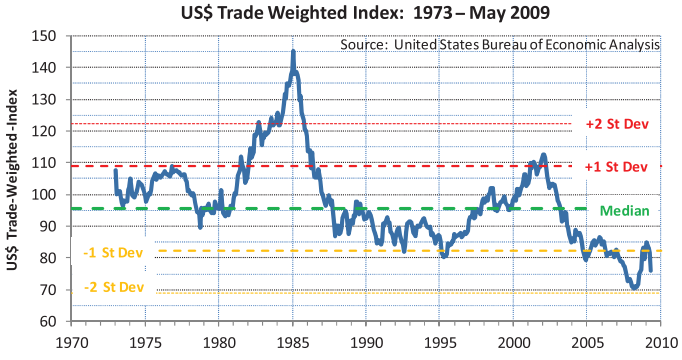

Fig. 7. *US Dollar TWI is currently more than one standard deviation below median valuation, indicating about very high probability of appreciation in the medium term.*

1. If the turbulent 1970s is a guide, the currency may not appreciate or depreciate significantly. If so, commodity prices will likely be stable.
2. Currency may appreciate quite strongly by around 30%. If so, there will be downward pressure on commodity prices.
3. Currency may depreciate quite strongly. If so, there will be upward pressure on commodity prices.

Which of these cases is the most likely on a probabilistic basis? Sadly, case 3 (rising commodity prices) is the least likely. Look at Figure 2. Observe since the US Dollar has just risen above a 40-year low, it must be more likely that the currency will appreciate, or remain stable, than depreciate significantly.

Separate analysis of the Trade Weighted Index shows that majority (more than 80%) of monthly values conform to a normal distribution. Figure 7 shows the median value, together with positions of one and two standard deviations. It is apparent that the 1985 high was an extremely low probability event; the 2008 low at two standard deviations was about a 3% probability. The current position of the Trade Weighted Index, at –1.5 standard deviation, indicates a very high probability of appreciation over the medium term.

I conclude that on the balance of probabilities, during the medium term (3–5 years), the Reserve Bank of Australia base metal price index likely could average around US$140; gold could fall to around US$500 per ounce. These predictions would be disappointing to people hoping for a speedy return to the heady days of 2006–08.

Predicting that commodity prices will not rise significantly over the medium term is contrary to that of most forecasters, who expect that increasing demand from the world economies will increase commodity prices! The trouble with this prediction is that economic health is only weakly linked to currency movement. There are other, more important, factors in play.

Note I am not dismissing the role of supply/demand in price setting taught in economics courses. Rather this paper contends there are two supply/demand mechanisms in play. There is the supply/demand for commodities, but there is also an independent, more important, supply/demand for the US Dollar. Simply considering supply/demand for commodities contains an error, because it ignores the other demand function. Say the supply/demand for commodities remained constant, but the supply of US Dollar increased – commodity prices should rise in apparent US Dollar terms, while really remaining constant.

Conclusions

Making accurate forecasts for commodity prices is always problematic, particularly with the current massive fiscal supply of printed money. The United States is being financed by foreigners, especially China and Japan. These parties (Russia included) are considering moving away from the US Dollar as a reserve currency. This is quite a threat. It could mean the end of the US Dollar as the world's reserve currency, with subsequent collapse in valuation. However, such a decline would reduce the real value of all foreign investments in the United States. If foreign holders of major assets tried to sell their holdings, large losses would result. This is a disincentive for foreigners to provoke the collapse of the US Dollar. The threat of loss of currency status may be sufficient to stop the US from continuing to run the printing presses.

My head hurts when pondering the range and complexity of factors controlling commodity prices. Therefore, a rational approach is to assign probabilities, based on US Dollar current valuation compared with long-term median, for predictions of increasing, stable or decreasing prices in the medium term. A probabilistic approach has been very successful in assessing merits of petroleum exploration and development projects, so why not extend the process to commodity prices?

In summary, supply and demand are important factors affecting commodity prices, but currency movements underpin medium-term price trends. It is instructive to have an historical view on past price trends with an understanding of US Dollar appreciation and depreciation movements. Short-term commodity price trends, such as the recent base metal surge and decline during 2006–08, are not controlled by currency but speculators.

Time will tell what impact valuation changes of the US Dollar will have on commodity prices in the next five or more years. On the balance of probabilities, the successful explorers and developers will be those who minimize subjective views and do not extrapolate current price trends. As always, we live in interesting times!

Continued from p. 35

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15–18 Nov	EAGE: Subsalt Imaging Workshop http://www.eage.org	Cairo	Egypt
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14–18 Dec	American Geophysical Union, Fall Meeting http://www.agu.org/meetings	San Francisco	USA
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March			**2010**
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