Preview

Australian Society of Exploration Geophysicists

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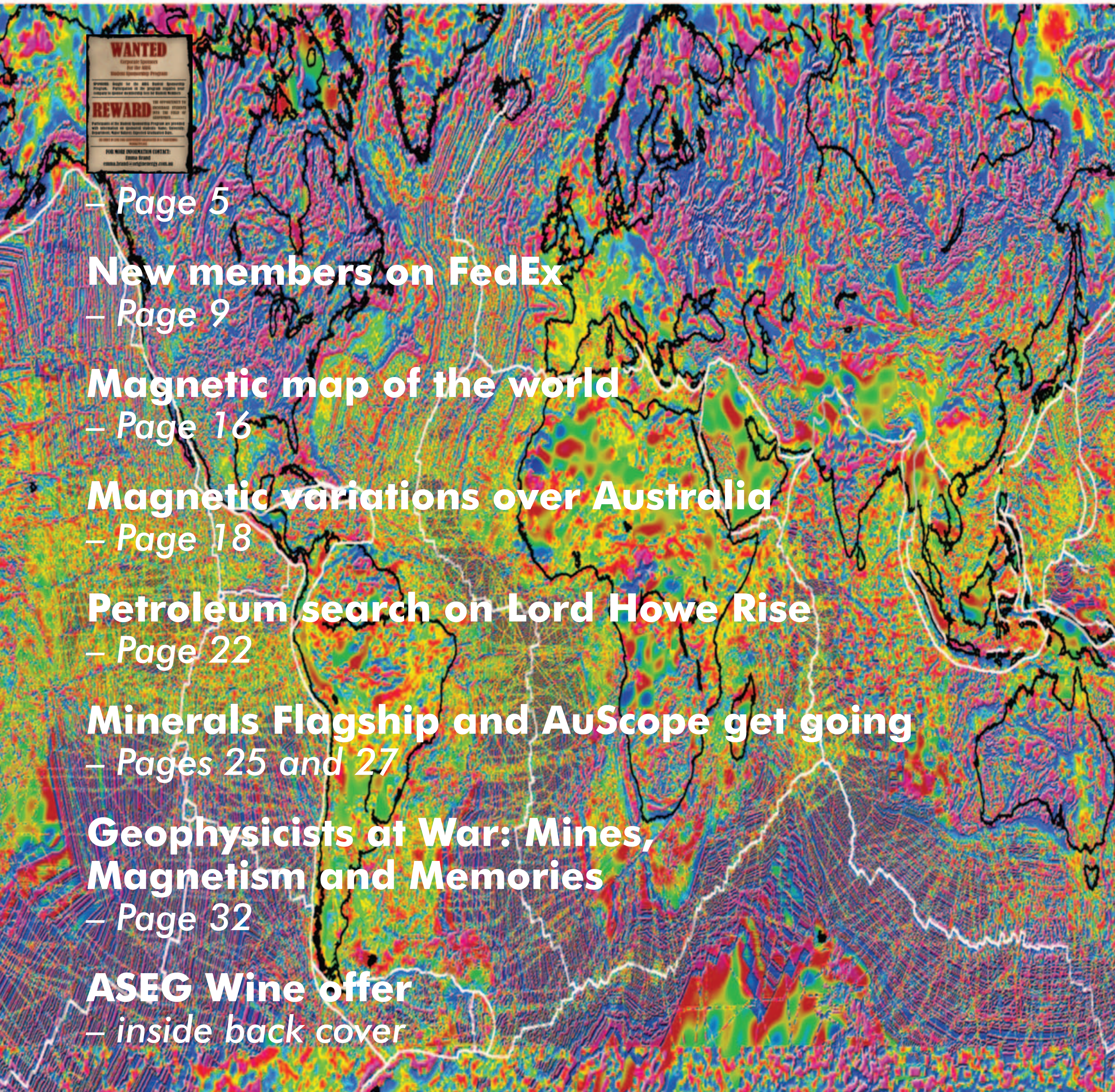

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ASEG 2007 WINE OFFER

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

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

Hardys Nottage Hill 2006 Cabernet Shiraz

The Nottage Hill 2006 Cabernet Shiraz is dark crimson with a red rose hue, this wine displays bright cassis and dark cherry notes with subtle hints of bay leaf mixed with cigar box oak on the bouquet.

This Cabernet Shiraz blend enters the palate with intense, yet smooth, dark berry fruits of blackcurrant and cherry. These primary fruit flavours are integrated with hints of mint and vanillin oak characters. The fruit sweetness carries through the palate to merge with balanced, velvety tannins. Overall, this is a well balanced wine with integrated fruit sweetness, oak characters and fine tannin structure

3 medals won on Australian Wine Show Circuit **Retails at around $150/case**

Chain of Ponds 2005 "White Fig" Adelaide Hills Viognier

White Fig Adelaide Hills Viognier is pale straw in colour with brilliant green hues. The wine is rich and full flavoured showing ripe fig and grapefruit through the initial palate, followed by citrus and green melon towards the end. The sweet nutty oak influence is well integrated with fruit flavours producing a well balance style perfect with antipasto, white meat dishes or Asian cuisine. The finish lingers on for several minutes with a creamy yet crisp aftertaste.

International Wine Challenge 06 – Silver Award.

Retails at around $200/case

2007 ASEG WINE OFFER: orders close NOVEMBER 9th 2007

Please supply:

Number of dozens	Wine	Price per Dozen	Total
	Hardys Nottage Hill 2006 Cabernet Shiraz	**$120**	
	Chain of Ponds 2005 "White Fig" Adelaide Hills Viognier	**$110**	
		TOTAL	

Name: ______________ Daytime telephone: (___) ______________ Email address ________________________

Address: ____ Capital city for collection: ______________

I would like to pay by: [ ] Cheque – payable to ASEG SA Wine Offer (enclosed)

Through on-line ordering and credit card payment at www.aseg.org.au (click on Wine Offer on Home Page); or

[ ] Visa [ ] Mastercard Card Expiry date: __ __ / __ __

Card Account number: __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ Signature: ___________________

Note: this offer is only available to ASEG Members

Order and payment by mail or fax to:

ASEG Wine Offer, c/o David Cockshell, PIRSA, GPO Box 1671, Adelaide, 5001.

Telephone: 08 8463 3233, Fax: 08 8463 3229, email: cockshell.david@saugov.sa.gov.au

Enquiries: Jasi Watson, Fax: 08 8116 7258, email: jasi.watson@santos.com

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Seismic Asia Pacific Pty Ltd
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Woodside Energy Ltd
Zonge Engineering & Research Organisation

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The front cover shows a somewhat distorted version of the World Digital Magnetic Anomaly Map, released earlier this year. See Peter Milligan's article on page 16 for more details and a more conventional image of the map.

David Denham

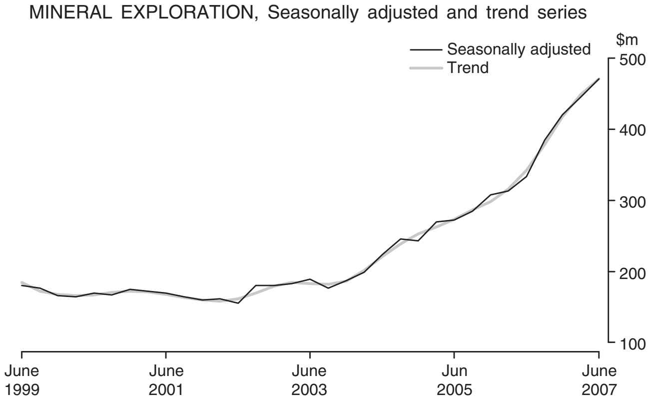

Fig. 1. Trend and seasonally adjusted quarterly mineral exploration expenditure from June 1999 through June 2007 (provided courtesy of the Australian Bureau of Statistics).

The resources boom continues

It seems that nothing can stop the resources boom. With gold now over US$700/oz and oil at ~US$80/bl, is there any wonder that our industry is prospering as never before. Both minerals and petroleum exploration are powering ahead to record levels. So we should have a great meeting in Perth in November, where we can boast of our successes, hide our secrets and mingle with our colleagues. A summary of the latest exploration statistics shown below exemplifies the current situation.

Minerals exploration grows more

Figures released by the Australian Bureau of Statistics in September 2007 show that the trend estimate for total mineral exploration expenditure increased by $22.3M (5.0%) to $470.8M in the June quarter 2007. The estimate is now 37.4% higher than the June quarter 2006 estimate. Furthermore the level of expenditure, after CPI adjustments are made to 1998–99 dollars, is at $319M, well above all previous records.

Figure 1 shows the exploration expenditure from June 1999 through June 2007. Both the trend and the seasonally adjusted numbers are powering ahead. Figure 2 shows the longer term trends from March 1986. These indicate that in real terms (CPI adjusted) the expenditure levels are at their highest ever.

The largest contributions to the increase in the June quarter were in Western Australia (up $17.1M or 7.8%) and South Australia (up $7.2M or 9.8%). New South Wales showed the largest decrease, and that was only $1.7M or 4.7%. In actual dollars spent, the WA number of $251.8M was more than half the national total of $502.5M. Western Australia was followed by South Australia with $84.1M, Queensland with $80.0M and NSW with $33.5M.

In seasonally adjusted terms, the total metres drilled increased by 0.8% in the June quarter. In original terms the total metres drilled increased by 30% to a massive 2320 km, which is the highest ever. Greenfield drilling was listed as 814 km or about 35%. This is a significant fall in the 40% recorded in the March quarter. However, with these sort of numbers it is not surprising that the new CSIRO Minerals Down Under Flagship is focussing on cheaper drilling technologies.

In terms of commodities, gold led the way with $123.0M (24% of the total), followed by iron ore ($88.8M) and copper at $77.1M. Uranium exploration continues to rise with a total of $89.4M over the last three quarters.

So the mineral exploration boom just keeps on going.

Petroleum exploration surges ahead

If you thought mineral exploration was doing well take a look at Figure 3, which shows that petroleum exploration has just taken off. Expenditure in the June quarter 2007 increased by $271.8M (59.0%) to $732.1M. This strong growth in petroleum exploration was helped by a recovery from adverse weather conditions in the previous quarter.

Expenditure on production leases increased by $23.3M to $155.3M while exploration on all other areas increased by $228.6M to $576.9M. Offshore expenditure increased by $246.5M to $596.5M and onshore by $25.3M to $135.6M. The main increase was in offshore drilling which reached a massive $406.9M in the June quarter.

Western Australia continued to dominate with $525.4M invested, or nearly 72% of the national total exploration expenditure. It was followed by a very distant Northern Territory at $53.8M.

It is evident that the government's Big New Oil initiative and the increase in the price of oil are working very well together to boost exploration investment in Australia.

Amazing results from Ramelius Resources

Every day one reads about good drilling results and how good discoveries and even better prospects are being realised all over the country. The most impressive I have seen recently was an announcement by Ramelius Resources on super high gold grades. On 27 August they issued a statement giving the results of drilling from its Wattle Dam open pit mine. This is 25 km west of Kambalda and within the company's Spargoville Belt regional project area.

The results include gold grades of 6.8 kg/t and 3.7 kg/t as well as intersections of several hundred grams per tonne (g/t).

The best intercepts included:

16 m at 482 g/t Au (uncut) from 123 m down hole depth including 1m at 6.77kg/t Au and,
9 m at 454 g/t Au (uncut) from 132 m down hole depth including 1m at 3.687 kg/t Au.

With results like that, no wonder the Ramelius share price went up!

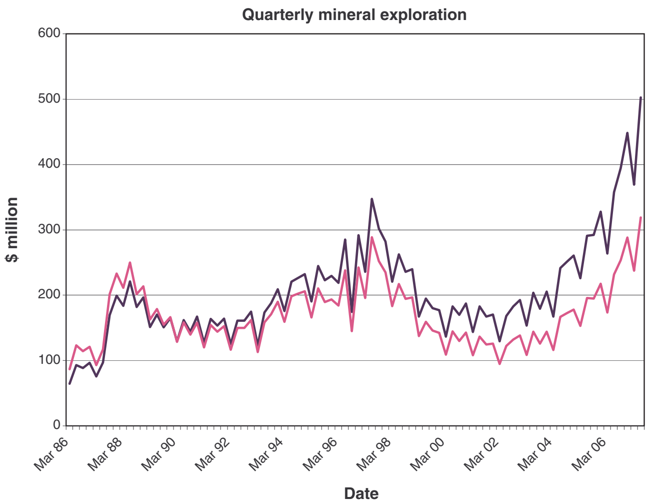

Fig. 2. Quarterly 'actual' mineral exploration expenditure from March 1986 through June 2007 (from ABS data). The black curve represents actual dollars spent in each quarter and the purple curve shows the CPI adjusted number to 1998–99 levels (ABS data).

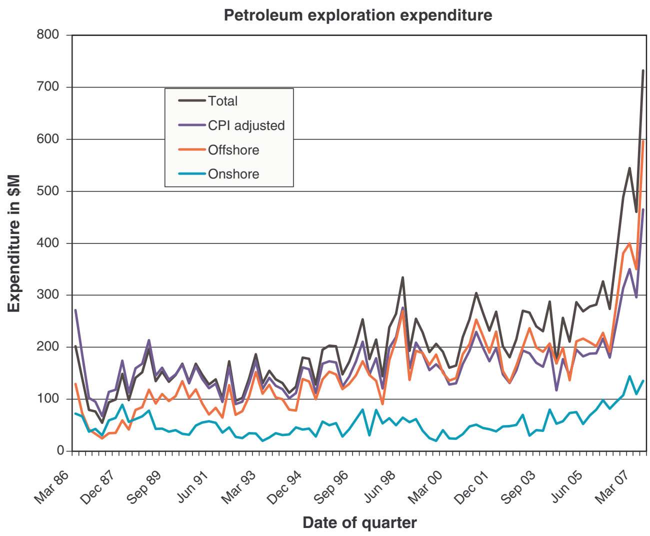

Fig. 3. Quarterly petroleum expenditure from March 1986 through June 2007. The individual offshore and onshore numbers are actual numbers spent at the time, not CPI adjusted. The black graph shows the contemporary dollars spent and the blue curve shows the CPI adjusted number to 1989–90.

Welcome to Perth

The ASEG's 19th International Geophysical Conference and Exhibition is all ready to go in Perth. It will feature about 250 presentations and, having read the short abstracts, I can vouch for the technical excellence that will be on display at the meeting. There will be something for everyone and of course one will always want to be at least two sessions at the same time.

I will be hunting for contributions for future Previews, so if anyone has anything that they think may be of general interest, please contact me at the meeting.

The Organising Committee have done a wonderful job, particularly Brian Evans and Howard Golden who have led their hardworking team since the 2006 meeting in Melbourne and Kim Frankcombe, Andre Gerhardt, and Greg Street, who have been compiling the technical program.

PROMACO, the conference organisers, have been responsible for the mechanics of the meeting and as usual will be delivering a first class product.

All I can say now is: 'Enjoy the Convention, enjoy Perth' and 'See you there.'

Joe Cucuzza
joe.cucuzza@amira.com.au

The Cooperative Research Centres (CRC) Program

Continuing the theme of R&D this month I thought it useful to communicate to the membership some information on the Australian Cooperative Research Centres (CRC) Program. This has been put forward as an example of successful industry–researcher collaboration.

The Program was established in 1990 to improve the effectiveness of Australia's research and development effort. It links research institutions with industry to focus research efforts towards industry needs. Although all CRCs are somewhat unique the current objective of the Program is:

> *To enhance Australia's industrial, commercial and economic growth through the development of sustained, user-driven, cooperative public-private research centres that achieve high levels of outcomes in adoption and commercialistion.*

An important element of the Program is its role in stimulating education and training through the involvement of universities in education programs and by offering degree and non-degree courses and training focussed on industry needs.

The Australian Government awards $20–40 million in funding to CRCs over a 7 year period. This funding must be matched by cash and/or in-kind contributions (such as expertise and research facilities) from CRC participants.

Since the inception of the Program a total of 158 CRCs have been established, for periods of 7 years each in the first instance. During the same period Program stakeholders have committed $11.1 billion (cash and in-kind) to CRCs. This includes $2.7 billion from the CRC Program, $2.9 billion from universities, $2.1 billion from industry, $1.3 billion from State Governments, $1.2 billion from CSIRO and $0.8 billion from other sources.

A 2006 study by Insight Economics found that the CRC Program is delivering strong net economic benefits for Australia. In particular, as a result of research, training, commercialisation and utilisation activities of CRCs, Australia's GDP has been increased by almost $2.7 billion since the Program began. The return to GDP for each dollar invested in the Program is $2.16.

According to CSIRO, the largest single participant in the CRC Program, CRCs have maintained over 2600 patents in Australia and over 3400 patents overseas since the start of the Program. CSIRO participate in 49 of the approximately 56 active CRCs.

There are currently 56 CRCs operating in six industry areas:

- manufacturing technology (8),
- information and communications technology (5),
- mining and energy (7),
- agriculture and rural based manufacturing (15),
- environment and tourism (13),
- medical science and technology (8)

The current mining and petroleum related CRCs are:

- CRC for Coal in Sustainable Development
- CRC for Greenhouse Gas Technologies (CO_2CRC)
- CRC for Landscape Environments and Mineral Exploration (CRC LAME)
- CRC for Predictive Mineral Discovery (*pmd**CRC)
- CRC for Sustainable Resources Processing
- CRC Mining Australia
- Parker CRC for Integrated Hydrometallurgy Solutions

As from 1 July 2008 the only two mineral exploration-focused CRCs will cease to exist:

- CRC Landscape Evolution and Mineral Exploration
- CRC Predictive Mineral Discovery

Collectively these two CRCs attracted a total of $38 million of funding from the Commonwealth Government which was leveraged by contributions from industry, other parts of government and by research institutions to a total spend of $190 million over their seven year lifetime. CRC LEME has provided explorers with hitherto unavailable expertise in understanding and sampling of the regolith and in particular is at the vanguard of developing new geochemical exploration capability particularly relevant to covered Australian terranes.

The *pmd**CRC has had major success in developing predictive mineral discovery software based on geological modelling. This software is now used by the industry sponsors of the CRC and it is planned to further embed the technology as a broad industry capability through a commercialisation process.

The CRC LEME and *pmd**CRC combined will have produced 86 PhD and 10 MSc graduates by the time they close.

Since 1991 two other exploration-focussed CRCs were created:

- CRC Australian Mineral Exploration Technologies (CRC AMET)
- Australian Petroleum CRC (APCRC)

The CRC AMET was established in 1991 and closed in 1997. This CRC was the only one that focussed on mineral exploration geophysics. It was instrumental in developing the then new airborne system, known as TEMPEST. The system was commercialised by the then World Geoscience Corporation Ltd one of the CRC's participants. TEMPEST was used widely for salinity mapping.

The APCRC also started operations in 1991 and finished in 1997. The research programs pursued by the APCRC focused on petroleum exploration and production. Other than the current CO_2CRC which largely focuses on CO_2 geosequestration the APCRC was the last CRC whose principle objectives focussed on exploration and production and only a small part of the research program focussed on geophysics, i.e. improved seismic imaging.

So what does this all mean? When Australia's two existing (mineral) geoscience-focused CRCs cease operating in July 2008, not only will industry lose these important centres of geoscience research, but the $30M in direct Government investment and an equal amount of institutional support will no longer be available to the industry. Thus there is an opportunity for the mineral industry to be proactive and drive the development a new exploration focused CRC.

Currently there is a proposal for industry to take collective action through AMIRA International to fund the preparation of a bid for a new geoscience CRC to start in 2009. The new CRC, provisionally called the CRC for Deep Exploration Technologies, may include the following science and technology themes:

- Deep-targeting geophysical methods
- Deep-probing geochemistry
- 3D GIS and other innovative data fusion techniques
- Better safer and higher value drilling technologies

This proposal will give industry a major say in the designing the direction and focus of the new CRC. CSIRO has agreed to collaborate with AMIRA International on this initiative.

It is hoped that industry will come to the party.

Notice to ASEG Members

After over 10 years without a membership fee increase, the ASEG Executive has decided to have a small increase in membership fees to cover increased costs. The structure of the ASEG Membership Fees will also change for 2008. For the first time ASEG members will be able to pay for up to three year's membership and a discount will apply to members that pay their dues before 31 January. The new fee structure for members renewing for 2008 will be as follows:

Payment Made Prior to 31 January 2008

	Australia and New Zealand*	Rest of the World**
1 Year Membership Fee:	$82.50	$125.00
2 Year Membership Fee:	$165.00	$200.00
3 Year Membership Fee:	$247.50	$275.00

Payment Made After 31 January 2008

	Australia and New Zealand*	Rest of the World**
1 Year Membership Fee:	$99.00	$140.00
2 Year Membership Fee:	$181.50	$215.00
3 Year Membership Fee:	$264.00	$290.00

All prices are in Australian Dollars
* Payments include GST.
** Payments exclude GST but include $50 overseas mailing charge.

News from the ASEG 19th International Geophysical Conference and Exhibition

The more things change, the more they stay the same. During the International Geophysical Year 50 years ago in 1957, scientists from 67 nations discussed the big issues of the day relating to earth physics. Ocean floor soundings were revealed, and mid-ocean rifts identified. Improved gravity measurements for mineral exploration were announced. Focus was also on solar-terrestrial phenomena during a near sunspot minimum.

The project led to the setting aside of Antarctica as a non-military region to be used for international scientific purposes including collection of information on the presence and effects of carbon dioxide on the atmosphere.

The IGY, in 1957, was the largest and most important international scientific effort to date. Now, 50 years later, another important gathering of scientists will occur at the Perth Convention and Exhibition Centre on 18–22 November, 2007.

In addition to the largest ever collection of oral and poster presentations, a not-to-be missed discussion of the future of worldwide production and consumption of petroleum will feature at the opening ceremony.

Record numbers of sponsors and exhibitors are in place to tap into the large number of international attendees expected to gather at the new Perth Conference and Exhibition centre on the Swan River. The convention Platinum Sponsors, Shell Development (Australia) and Curtin University of Technology, are generously contributing along with many cooperating sponsors to make this year's conference a very special one.

The Conference Committee is to be commended for outstanding work in the run-up to the ASEG Conference. No opportunity has been overlooked to ensure that, in particular, the technical content of the event will be wide ranging and topical. Registration is open, and we encourage all geoscientists to register early so as not to miss the highlight of the 2007 geo-calendar.

Brian Evans and Howard Golden
Co-chairs, Perth 2007 ASEG Conference and Exhibition

Melbourne to host IUGG meeting in 2011

Not to be outdone by Brisbane hosting the 34th International Geological Congress in 2012, Melbourne will host the 25th International Union of Geodesy and Geophysics from 19 June through 1 July in 2011.

Australia did well at the 24th IUGG held in Perugia, Italy early this year. Not only did we earn the right to host the 25th IUGG, but Tom Beer, a senior scientist with CSIRO Marine and Atmospheric Research and an expert in environmental risk, has been elected President of the IUGG until the Melbourne meeting.

For those not familiar with the IUGG, it is essentially the Big Earth organisation and comprises eight Associations. These are in the fields of meteorology, oceanography, volcanology, seismology, hydrology, geomagnetic science, geodesy and cryospheric science. As Tom Beer said after his election "The union fosters collaborative research and information exchange between Earth scientists in 68 countries. It also encourages the application of this research to societal needs, such as mineral resources, mitigation of natural hazards and environmental preservation."

The Melbourne meeting is expected to attract more than 5000 scientists from around the world and should provide a real boost to Australian geosciences.

Calendar of Events 2007/2008

2007

18–22 November
ASEG's 19th International Conference and Exhibition
Venue: Perth, WA
Contact: Brian Evans (brian.evans@geophy.curtin.edu.au)
Website: http://www.promaco.com.au/2007/aseg
Email: promaco@promaco.com.au

25–29 November
5th International IAHS Groundwater Quality Conference
Venue: Fremantle, Australia
Contact: W. Whitford
Tel.: 61 8 9333-6273
Email: Wendy.Whitford@csiro.au
Website: www.clw.csiro.au/conferences/GQ07

10–14 December
American Geophysical Union, Fall Meeting
Venue: San Francisco, California
Website: http://www.agu.org/meetings

2008

14–16 January
Society of Petroleum Geophysicists, India 7th Conference & Exposition on Petroleum Geophysics
Venue: Hyderabad International Convention Centre, Hyderabad, India
Theme: Energy Security: Exploration, Exploitation & Economics
Website: http://www.spgindia.org/

6–9 April
2008 APPEA Conference & Exhibition
Venue: Perth Convention & Exhibition Centre
Contact: Julie Hood
Tel.: 07 3802 2208
Email: jhood@appea.com.au

6–10 April
21st SAGEEP meeting (Symposium on the Application of Geophysics to Engineering and Environmental Problems)
Theme: New Partnerships, New Discoveries
Venue: Marriott Philadelphia Downtown, PA, USA
Contact: http://www.eegs.org/pdf_files/sageep08_abstracts.pdf

9–12 June
70th EAGE Annual Conference & Exhibition
Venue: Rome, Italy
Website: http://www.eage.org/events/

20–25 July
19th AGC, The Australian Earth Sciences Convention 2008
Joint Geological Society of Australia and Australian Institute of Geoscientists Meeting, Perth, WA
Website: http://www.gsa.org.au/events/calendar.html

5–14 August 2008
33rd International Geological Congress
Venue: Oslo, Norway
Contact: A. Solheim, Norwegian Geotechnical Institute
Tel.: 47 2202 3000, Email: as@ngi.no
Website: www.33igc.org

14–17 September
EABS III Energy Security for the 21st Century
Venue: Sydney Convention & Exhibition Centre, Darling Harbour
Themes: 1. Energy & Environment, 2. Coal Seam Gas, 3. Petroleum Exploration Case Studies, 4. Frontier Exploration, 5. Cooper Basin Symposium, 6. PESA Queensland Symposium, 7. Development & Application of New Exploration/Production Technologies, 8. Student Sessions with a range of topics
Website: http://www.pesa.com.au/pdf/eabs_call_for_papers.pdf

9–14 November
SEG International Exposition and 78th Annual Meeting
Venue: Las Vegas, Nevada, U.S.
Website: http://seg.org/meetings/
Contact: meetings@seg.org

15–19 December 2008
American Geophysical Union, Fall Meeting
Venue: San Francisco, California
www.agu.org/meetings

Federal Executive 2007/08

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New Members

The ASEG welcomes the following new members to the Society. Their membership was approved at the Federal Executive meetings held on 31 July and 28 August 2007.

Name	Affiliation	State
Stephen Bayliss	Macquarie University	NSW
Lynelle Marie Beinke	Heathgate Resources	SA
Robert D Benson	Colorado School of Mines	USA
Andrew Buchel	Macquarie University	NSW
Duncan A Cogswell	Borehold Wireline Pty Ltd	SA
Marina Costelloe	Geoscience Australia	ACT
Reginald James Court	Integrated Mapping Technologies	NSW
Joshua Flew	Macquarie University	NSW
Penelope Gillman	Macquarie University	NSW
Andrew John Greenwood	Curtin University	WA
Lucas Heape	GAP Geophysics Australia	WA
Brendan David Howe	Barrick Gold	WA
Glenda Marie Jones	Keele University	UK
James Kells	Macquarie University	NSW
Balakrishnan Kunjan	Australian Worldwide Exploration	NSW
Amie Lucier	Stanford University	USA
David Mackay	Southern Geoscience Consultants	WA
Andreas Pfaffling	Norwegian Geotechnical Institute	Norway
Tim Rawling	University of Melbourne	VIC
Sean Simpson	Curtin University	WA
Peter Strauss	Santos Ltd	SA
Ghassan Sweidan	Integrated Geophysical Solutions	WA
Sean Walter	Aeroquest Ltd	Canada
Liejun Wang	Geoscience Australia	ACT
Benjamin Wilkins	Macquarie University	NSW

[1]Webmaster is not an Executive position but Wayne is listed here because of his new appointment.

Lost Members

The ASEG are looking for the following 'Missing in Action' members. If you are aware of the current contact details for these members, please forward them onto the ASEG Secretariat at aseg@casm.com.au.

Name	Last Known Affiliation
Partha Bhattacharya	FITT
Angus McCoy	Geoimage Pty Ltd
Alan Anderson	Santos Ltd
Christopher Wiles	Newmont Mining Corporation
James Lowe	BHP Billiton
Clarke Petrick	NT Geological Survey
Andrew Winch	Veritas DGC
John Tompson	RPS Energy
Andrew Davids	Woodside Energy
Radim Ciz	CSIRO Petroleum
Claire Grubb	PGS Geophysical
Robert Stuart	Geoinformatics Exploration
Marko Van Der Veen	Woodside Energy Limited

New faces on ASEG FedEx

As reported in the June Preview, Peter Elliot and Troy Herbert joined the ASEG Executive after their elections to the positions of President Elect and Secretary respectively. Here is some more background on the new officers for those who do not know them.

Peter Elliott graduated with a BSc (Hons) in Geology and Geophysics from the University of Melbourne (1976). He was later awarded an MSc from the University of Melbourne in 1984, and a PhD from Macquarie University in 1997. He started his profession as a Cadet Geologist with the Geological Survey of Victoria in 1975. Peter worked as a geologist in Regional Mapping for a couple of years and then as a Geophysicist with the newly formed Geophysics Section in the Dept. of Mines, Victoria (1977–1980). He later joined the Shell Company (Australia) Ltd. in 1981 where he worked as a Regional Geophysicist with the Metals Division (1981–1987). During this time he worked out of Melbourne, Perth, and Adelaide. In 1987, Peter left Shell to set up his own exploration services company. This was the start of the Elliott Geophysics Group of Companies, which now has offices in five countries: Australia, Indonesia, India, Philippines and Papua New Guinea. The EGI Group has completed more than 300 contracts for over 100 client companies, in 14 countries, during the last 20 years.

In addition to setting up a multi-national geophysical contracting firm Peter has given courses in Electrical Geophysics at the University of Adelaide and has published more than 20 scientific papers. He currently holds three patents in the field of airborne electro-magnetics in Canada, USA and Australia.

Peter was founding Secretary of the Victorian Branch of the ASEG in 1977; Treasurer of the Western Australian Branch in 1981; President of the Western Australian Branch in 1982; Business Manager for the ASEG FEDEX in 1984; Secretary (FEDEX) 1985; and First VP FEDEX 1986 and 1987. Since 1987, Peter Elliott became busy studying for an MBA, DBA and PhD, as well as running an international business. Since 2004, he has served on a number of committees for the Western Australian Branch.

Troy Herbert, the new Secretary, has been a member of the ASEG since 1999. He is employed by BHP Billiton, working in the Minerals Exploration team, where he is Project Leader – Southern Domains. In this position he leads a small technical team of geoscientists exploring for nickel sulphides in and around Kambalda in Western Australia. He has worked for BHP Billiton since 2005, and before that with WMC Resources. He started with WMC in 1996 after finishing a degree in geophysics at Curtin University. Troy held various positions in WMC Resources from Field Technician to Project Geophysicist. In that time he provided geophysical support to both Greenfields and Brownfields NiS projects in Western Australia. He also managed Brownfields exploration around the Mt Keith Nickel Operation in Western Australia.

New South Wales – by Mark Lackie

In June, Peter Hatherly gave a presentation on seismic inversion. Peter spoke about his current ACARP research which involves working on seismic reflection surveying for coal mining. Peter took us through the nuts and bolts of inversion of 3D seismic data, utilising borehole data to help derive impedance data from which geotechnical properties can be inferred. Peter highlighted the strengths and pitfalls in the process. The topic was of great interest to the audience with many questions being asked of Peter.

In July, the 2007 NSW Branch Dinner was held. Matters of great geophysical importance were discussed over a few bottles of red. Good time was had by all.

In August, Luke Fredericks from Illawarra Coal spoke about geophysical techniques around the borehole. Luke took us through what geophysical data are acquired from boreholes and what geophysical data are acquired using surface methods and how the knowledge from both avenues is used in understanding geological conditions in the areas to be mined.

In September, Bala Kunjan from AWE spoke about a combined AVO/Tuning model that has been used in predicting oil column height, and hence structure, in the drilling phase of the Tui area field development in New Zealand.

The student evening is planned for October.

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.

South Australia – by Luke Gardiner

Recent events hosted by the SA Branch have included two technical meetings, a social night, and the annual wine tasting night. The first technical meeting was held in June, where Lance Holmes from Santos presented ‘Contribution of Remote Sensing to Exploration Success with examples from Africa & Asia’. This was well received by a large audience, who took home many ideas on how to use readily available remote sensing datasets and appropriate software to assist exploration. A smaller, but no less enthusiastic crowd gathered for Dragan Ivic, who presented ‘Airborne Video – How we use it to monitor seismic lines’, outlining some of the advances in PIRSA’s monitoring of seismic operations for environmental compliance. These talks were both held at the Historian Hotel.

Interspersed with these events were a Social Night and the Annual Wine Tasting Night. During a blind tasting, the panel has selected the wines for this year’s wine offer. The winners were Hardys Nottage Hill 2006 Cabernet Shiraz and Chain of Ponds ‘White Fig’ 2005 Viognier. The details and order form for the wine offer can be found (in this edition of *Preview*, on page ***). An email will be sent out shortly with further details.

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.

Queensland – by Emma Brand

The August Technical Meeting hosted a presentation by Randall Taylor, Chief Geophysicist of Origin Energy, about Origin’s new acreage in Kenya. In 2006, Origin farmed into exploration blocks L8 and L9 in Kenya. These blocks are almost wholly offshore covering approx 12 000 sq km of the Lamu Basin, a passive margin depo-centre formed during the break-up of Gondwanaland. As part of the farmin arrangement Origin agreed to acquire several thousand km of 2D seismic data, which it completed in January 2007. The presentation covered a smorgasbord of operational and technical aspects of the (ad)venture.

If anyone would like to give a presentation at the next technical meeting please contact Emma Brand (emma.brand@originenergy.com.au).

Jennie Carson
jennie.carson@gmail.com

A secure computer in the home

With our hectic work schedules and family demands, more and more people are setting up home offices to cope with the overlapping time requirements of both priorities. People tend to be less diligent with their home computer security due to software costs or a lack of knowledge of where to look for cheap/free programs that can provide basic, up-to-date protection for your private work/life information.

AVG
Anti-Virus System

http://www.grisoft.com/

AVG has a free antivirus software edition which can be downloaded directly from the grisoft site. The software is only available in English and updates must be performed manually by the user on a weekly basis. Downloading of updates is divided into 'Priority' and 'Recommended' and includes the file sizes.

The AVG Free Advisor Web site provides free help resources, including online documentation, FAQ and an AVG Free Forum. For licensing reasons, the AVG Anti-Virus Free Edition is for private, non-commercial, single home computer use only. Use of AVG Free within any organisation or for commercial purposes is strictly prohibited. AVG Anti-Virus Free Edition is absolutely not for use with any type of OEM bundling with software, hardware components, or any service. Commercial versions with more dynamic internet security (e.g. anti-spyware) and professional anti-virus protection are available for a cost of US$30 to $53.

http://antivirusessentials.com/free/download.htm

Norton Security Scan advertises for a limited time that you can get free Anti Virus and Spyware protection in one. Downloading and installation of Norton (similar to Norton Anti Virus and Internet Security) through the Google Pack is free with 'no strings attached'. The download will scan your computer and identify if there are existing viruses, worms, spyware, unwanted adware or Trojans residing on your computer.

A summary of advertised features included are:

- Detects and removes viruses, worms and Trojans;
- Warning you of spyware and unwanted adware that are on your PC;
- Easy-to-use interface that allows the user to run and schedule scans;
- Full System Scan performs a deep scan of the system and hard disc to detect existing viruses, spyware and other threats;
- Scan results summary Informs you of what has been detected, repaired or needs your attention.

http://www.firewallguide.com/freeware.htm

The Firewall Guide gives a listing of the best rated personal firewalls and internet security products that are available for personal use. The software has been sorted in alphabetical order with two to three options of download for each security issue (e.g. bad websites for children, file cleaner, anti-spyware).

A side menu off the main page gives a comprehensive selection of links for the user to a multitude of research options including 'best reviews', 'kid safe', and 'installation' instructions.

eWEEK.COM

http://www.eweek.com

Eweek is an online magazine that provides a multitude of services including the latest blogs, updates on the hardware and software companies and comprehensive articles on all facets of the internet (e.g. programming languages, site changes). For complete access to the site, the user needs to subscribe to the service but for simple peeks into articles users can navigate with relative ease.

The index page is quite long, so remember to scroll down or you may not find what you were looking for. At the bottom of the site there is a 'Topic Center Index' which breaks down the available topics into quick links. There is a Security menu which gives some options that the Firewall guide was lacking in (e.g. vulnerability assessments and wireless security). However, the eguide is not focused on free software so you may have to pay for the software packages recommended though most of them range between free to US$200 depending on the capabilities and guarantees.

DOWNLOAD.com
SAFE, TRUSTED, AND SPYWARE-FREE

http://www.download.com/Best-free-security-and-spyware-software/

Download.com has created their 'Special Collection' of the best free security and spyware software. The article was written in by Peter Butler in 2006 but looking at the recommended software links proved the information is still valid. All the spotlighted software are freeware.

From personal experience on my own laptop with three of these software brands, all of the recommendations are based on their lack of intrusiveness into your average computer usage day and are easy to install and remove from your hard drive.

SOFTPEDIA™

http://www.softpedia.com/

Softpedia is an encyclopaedia of free software downloads which is constantly updated with the most recent upgrades and information. The index page is the most user-friendly of all the websites with iconised links to the information you require.

The latest software available to Windows, Mac, Linux, Webscripts and Mobiles/Handheld systems are listed in menus on the index page. A download basket allows you to keep track of your selections and reviews of your choices are just a click away. If you are unsure of yourself using the previously mentioned sites, Softpedia will put the most basic computer user at ease.

Business Investment in R&D highest ever

Business spending on research and experimental development (R&D) in Australia increased for the seventh year in a row in 2005–06, to a total of $10.1 billion, according to figures released by the Australian Bureau of Statistics (ABS) on 21 August 2007.

Businesses in the mining and manufacturing industries reported the largest growth in R&D expenditure, increasing by $417.2 million (33.0%) and $416.5 million (12.0%) respectively. The major contributors to R&D expenditure were the manufacturing ($3.9 billion or 38.6%), property and business services ($1.7 billion or 17.0%), and mining industries ($1.7 billion or 16.7%).

R&D expenditure in 2005–06 was up 11.8% on the previous year in real terms (and 16.6% in current prices). Between 2004–05 and 2005–06, business expenditure on R&D as a proportion of GDP increased from 0.97% to 1.04%. However, Australia remained below the OECD average of 1.53% (see Figure 1 and Table 1).

While all states and territories reported increased expenditure on R&D, growth since 2004–05 was strongest in Victoria (up $541.7 million) and Western Australia ($392.7 million).

Further information is in *Research and Experimental Development, Businesses, Australia, 2005–06* (cat. no. 8104.0).

Notice the gradual increase in R&D investment in Australia over the last six years. Let's hope this trend continues. At this rate we will soon be overtaking Canada, which has been declining in R&D investment during the last four years.

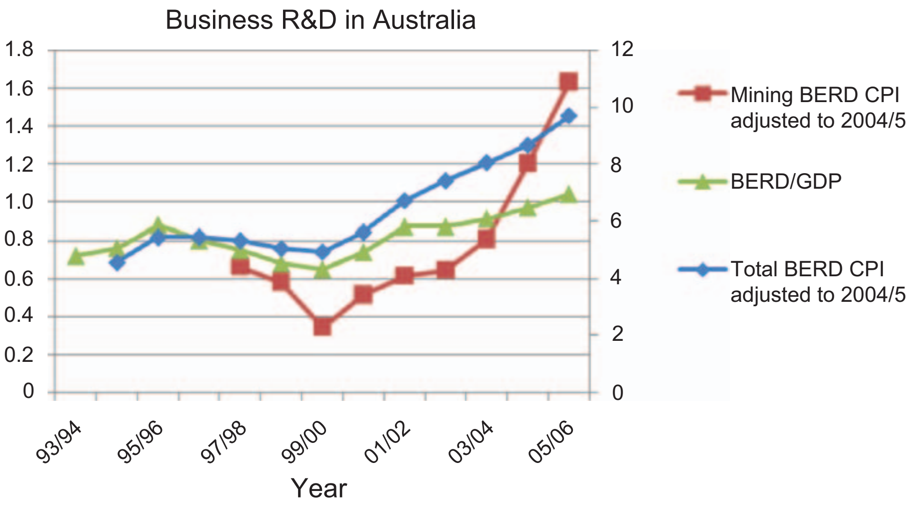

Fig. 1. Right hand axis shows total business R&D expenditure in Australia (BERD) in $billion (blue curve). Left hand axis shows BERD/GDP in % (green curve) and mining (including petroleum) BERD in $billion. All $s are normalised to 2004–05 values. Figures for the mining industry before 1997–98 are not available.

Table 1. BERD/GDP for OECD countries

	2000–01	2001–02	2002–03	2003–04	2004–05	2005–06
Sweden	na	3.28	na	2.93	2.73	2.88
Japan	2.12	2.30	2.36	2.40	2.38	2.54
Finland	2.41	2.35	2.34	2.42	2.42	2.47
Korea	1.96	1.97	1.90	2.00	2.18	2.30
USA	2.04	2.00	1.86	1.84	1.79	1.82
Germany	1.75	1.72	1.72	1.76	1.74	1.71
Denmark	na	1.64	1.73	1.78	1.70	1.67
Austria	na	na	1.42	na	1.51	1.64
Iceland	1.55	1.75	1.71	1.48	na	1.45
Luxembourg				1.48	1.46	1.34
France	1.41	1.39	1.41	1.36	1.34	1.32
Belgium	1.48	1.51	1.37	1.31	1.29	1.24
UK	1.21	1.20	1.19	1.14	1.09	1.10
Canada	1.21	1.29	1.17	1.13	1.12	1.07
Australia	**0.74**	**0.84**	**0.89**	**0.92**	**0.97**	**1.04**
Netherlands	1.10	1.05	0.98	1.01	1.03	1.02
Czech Republic	0.78	0.72	0.73	0.76	0.80	0.92
Ireland	0.82	0.77	0.76	0.80	0.82	0.83
Norway	na	0.95	0.95	0.98	0.87	0.82
Spain	0.50	0.50	0.56	0.57	0.58	0.61
Italy	0.53	0.53	0.54	0.52	0.52	0.55
New Zealand	na	0.42	na	0.49	na	na
Total OECD		**1.57**	**1.51**	**1.51**	**1.49**	**1.53**

na, not available.

Between a rock and a hard place: the science of geosequestration

The House of Representatives Standing Committee on Science and Innovation was asked to inquire into and report on the science and application of geosequestration technology (Carbon Capture and Storage, CCS) in Australia. It had eleven members and was chaired by Liberal MP Petro Georgiou.

One might have expected a sound non-controversial report on this topic, but this was not to be. When it reported to Parliament in August this year, not only did we get a very sound workman-like report from the main committee, but a dissenting report from Dennis Jensen, Jackie Kelly, Danna Vale and David Tollner (three Liberals and one Country Liberal-DT).

The main Committee's report was quite straightforward. It stated that

> *There is now compelling evidence that human activity is changing the global climate. The majority of scientists, and the community at large, agree that global action is needed, otherwise we risk reaching a point where it is too late to reverse the damage.*

Consequently to reduce CO_2 in the atmosphere the Australian Government should encourage CCS. And it went on to make five very non-controversial recommendations.

In summary these were the Australian Government recommendations:

1. Provide funding to the CSIRO to progress research being conducted through the CO_2CRC to assess the storage potential for permanent CO_2 geosequestration in sedimentary basins in New South Wales.
2. Fund one or more large-scale projects which will demonstrate the operation and integration of the CCS – capture, transportation and sequestration and monitoring.
3. Implement a rigorous regulatory environmental risk mitigation framework for CCS.
4. As part of its broader fiscal response to climate change, employ financial incentives, both direct and tax based, in an effort to encourage science and industry to continue developing and testing CCS technology.
5. Consult with industry to develop legislation to define the financial liability and ongoing monitoring responsibilities at a geosequestration site.

Nothing spectacular there you would think. But you would be wrong. The dissenters came out with a rather unusual report saying that they "do not believe the evidence unequivocally supports the hypothesis of anthropogenic global warming (AGW)".

Their arguments are sometimes rather strange. For example:

> *Another problem with the view that it is anthropogenic greenhouse gases that have caused warming is that warming has also been observed on Mars, Jupiter, Triton, Pluto, Neptune and others.*

It seems to me that a few climate change sceptics have helped the dissenters. They acknowledge six people for reviewing the scientific accuracy of this report (that's the dissenting one) but these are all well know climate change sceptics, and several of the references given are from papers written by these experts.

So it's hardly an unbiased scenario. And it reads like they are trawling for evidence to debunk IPCC work and the majority of work carried out throughout the world on climate change. Anyway it's a fun read (if it wasn't so serious) and you can find it at:http://www.aph.gov.au/house/committee/scin/geosequestration/report.htm.

$3M geothermal grant for Torrens Energy in SA

Now for some good news. Torrens Energy Pty Ltd has been offered a $3 million Australian Government grant for its new technology that will help locate geothermal 'hot spots' under the *Renewable Energy Development Initiative (REDI).*

As Senator Minchin said:

> *With more geothermal companies in SA than any other state in Australia, SA is really the centre of excellence for geothermal energy in this country. The software project involves a three-dimensional modelling process that will map where the best geological conditions combine with high temperatures to produce the ideal environment for geothermal energy generation. This will mean more efficient identification of SA's vast geothermal resources.*

And of course, if successful, it will reduce greenhouse gas emissions.

Eristicus

Galvanic surveys – electrode equilibration rates

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Introduction

There are many galvanic methods which rely on high-resolution observations of the electric field at the Earth's surface. Standard galvanic methods include Self Potential, Applied Potential (mise-à-la-masse), Resistivity, Induced Polarisation, and Magnetotelluric surveys. In each case, observations of voltage are required between at least one pair of point-contact electrodes.

Electrodes can be manufactured using a wide range of conductive materials and assembly methods. Perrier *et al*., (1997) have investigated the long-term stability of several common electrode configurations. In general there is a clear distinction between the performance of metal stakes and non-polarising porous-pots containing a variety of electrolytic solutions. However, the details of the manufacturing process may also impact on data quality for long-term observations. Consequently the selection of electrodes may be a critical step in survey quality.

Apart from any impact on noise levels, electrode selection can impact on survey procedures and productivity. Although porous-pots provide low-noise data they are fragile and relatively complex to maintain. Consequently metal stakes are often preferred as a practical solution for routine geo-technical and groundwater surveys. However, the performance of these metals must be more fully explored to avoid errors associated with transient electrochemical effects.

Electrode Drift

Metals placed in soil are subject to corrosion (e.g. Norin and Vinka, 2003). Complex electro-geochemical reactions are involved with *in-situ* voltages commonly exceeding 600 mV for extended periods (2–3 years). Consequently, many geophysical observations may be subject to serious error.

The extent of any galvanic effect will be influenced by, in addition to the usual factors that affect corrosion of a single metal, the potential relationships of the metals involved, their polarisation characteristics, the relative areas of anode and cathode, and the internal and external resistances in the galvanic circuit (e.g. Lichtenstein, 1978). In addition, there may be significant external issues associated with groundwater movements (e.g. Corwin and Hoover, 1979) and geothermal perturbations during any emplacement activity.

In contrast to observations of active corrosion, Sato and Mooney (1960) describe a range of natural conditions associated with self-potential (SP) or *in-situ* voltage. They emphasise the passive nature of any sulphide or other ore body providing for the equilibration of charge carriers in a complex redox cell. Consequently, a steady-state condition may be expected for galvanic surveys, but only following a period of local equilibration of corrosion products some time after electrode emplacement.

In order to obtain useful data for geophysical surveys it is essential to allow adequate time for equilibration of any temporary electrodes. However, a minimum dwell time is required to assure maximum productivity and low cost in any survey. Consequently, new observations have been obtained for typical soils to provide guidelines for electrode emplacement.

Observations

A typical equilibration curve for steel is indicated in Figure 1. Data were obtained with a high impedance multimeter attached to a second stationary electrode *via* a short lead (~5 m). A similar response is obtained for each of two observations with the

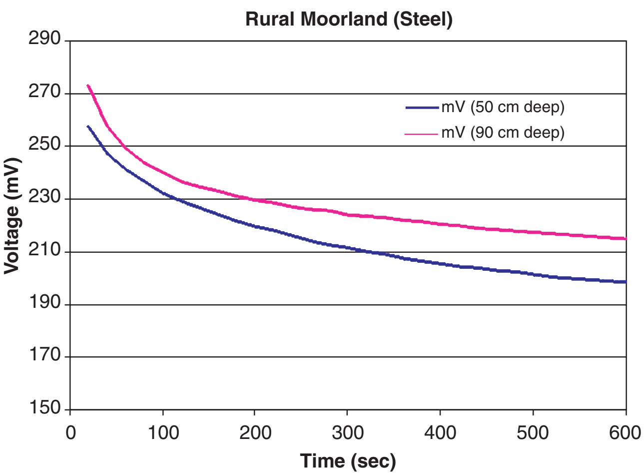

Fig. 1. Equilibration time for stainless steel electrodes inserted into moorland peat (Leeds, UK).

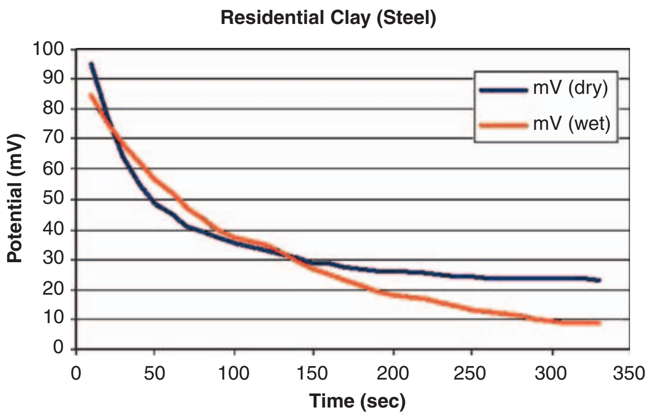

Fig. 2. Equilibration time comparing effects of soil saturation for stainless steel electrodes inserted into high clay content soil in residential area (Leeds, UK).

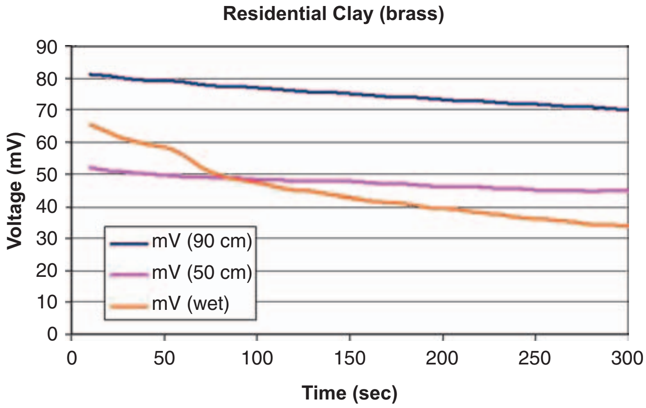

Fig. 3. Equilibration time comparing effects of soil saturation for brass electrodes inserted into high clay content soil in residential area (Leeds, UK).

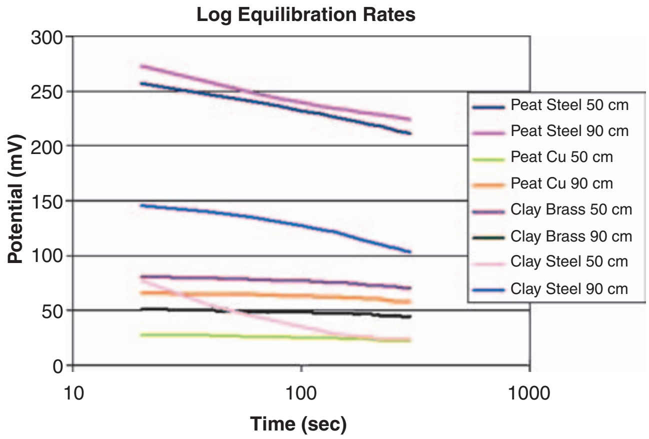

Fig. 4. Variations in equilibration rates and time-constant for a range of soils and electrode materials.

electrode inserted to different depths. The initial variation in amplitude appears to be related to the depth of burial or the total surface exposed to the soil but the rate of equilibration is similar in each case. It is apparent in this instance that reliable values of self potential require equilibration intervals exceeding 10 minutes.

Similar results are obtained for observations in an urban setting (Figure 2). However in this case an additional effect has been introduced by the pouring of water around one electrode (multimeter end) saturating the soil. The resulting decay rate is initially more gradual, but the potential continues to decrease to a lower voltage than previously observed with dry contacts. A streaming potential (e.g. Corwin and Hoover, 1979) would be expected in the region of the wet electrode but an increase in soil conductivity may then assist with better equilibration rates.

This test was repeated using brass electrodes and a similar response was observed as shown in Figure 3. The resulting curves suggest that if the survey site has high water content, then the potential approaches zero quicker than on a dry site. It can be shown that water saturated soil has a higher content of electric charges, and hence less resistivity. Thus with better conductivity between the ground and electrode the potential decays to a smaller value more quickly.

Conclusions

Galvanic surveys rely on the precise determination of a potential difference between two (or more) electrodes. Consequently, survey precision may depend on the selection of suitable non-polarising electrodes to avoid electro-chemical drift (e.g. Perrier *et al*., 1997). For MT and related surveys, electrode stability is essential in order to observe true telluric currents. In contrast, metal stakes are often preferred for more robust resistivity mapping. Low level telluric noise can be ignored since signal amplitude can be readily controlled. However survey productivity relies on the rapid equilibration of the active electrodes and the soil conditions in the survey area.

The present results suggest similar trends in equilibration for a range of electrodes operating in different soils (Figure 4). Significant drift may continue for periods exceeding five minutes setting a limit to productivity in resistivity surveys. However the consolidated data also suggest a systematic trend in the time-constant for each curve. The current data suggest a relationship with clay content and soil moisture. Additional measurements are required to investigate the nature of any charge transfer involving the clay double-layer using soils of known composition.

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World Digital Magnetic Anomaly Map now available

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The recent IUGG (International Union of Geodesy and Geophysics) meeting in Perugia, Italy, was the venue for the public release of the first edition of the World Digital Magnetic Anomaly Map (WDMAM). This map, now released in both hardcopy and digital versions, is the culmination of several years' effort by an Executive Committee of IAGA (International Association of Geomagnetism and Aeronomy), an associated organisation of the IUGG. The map is published by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the Commission for the Geological Map of the World (CGMW).

This map represents crustal magnetic field anomaly data from airborne surveys, shipborne surveys and satellite acquisition merged into a composite grid with a 5 km cell spacing and nominal height above geoid of 5 km. These data have been acquired over more than 50 years of surveying by the many countries whose data are represented in the product (see Figure 3).

The formal map was unveiled on 3 July by Professor Jean-Paul Cadet, the President of the CGMW. The ceremony took place in the Library of the Accademia, the Pietro Vannucci Fine Arts Academy, one of the oldest in Italy. This is located in the rooms of the San Francesco al Prato convent (see Figures 1 and 2).

Map compilation methods were developed within five international teams that prepared six candidate maps, with the final map being a combination of the work of all teams. The authors of the map and the members of the teams are: J. V. Korhonen, J. D. Fairhead, M. Hamoudi, K. Hemant, V. Lesur, M. Mandea, S. Maus, M. Purucker, D. Ravat, T. Sazonova and E. Thébault.

The members of the WDMAM Executive Committee were J. V. Korhonen (Chair), C. Reeves (Chair), M. Ghidella, T. Ishihara, T. Litvinova, M. Mandea, S. Maus, S. McLean, P. Milligan, M. Purucker and D. Ravat.

The second edition of the WDMAM is now under way, with an expanded task force now incorporated into IAGA Working Group V-MOD.

Data were contributed by many countries and organisations, and these are acknowledged on printed versions of the map, and in the metadata for digital versions. The map and DVD are available at http://www.ccgm.org and http://ftp.gtk.fi/WDMAM2007/.

An IAGA symposium (World Magnetic Anomaly Map: anomaly definition and calculation) at the meeting was devoted to the WDMAM. The convenor of the session was D. Ravat with co-convenors E. Thébault and J.V. Korhonen.

On Friday 6 July a related session was devoted to interpretations of geomagnetic anomalies (seismological, geological and tectonic interpretation of geomagnetic anomalies on continents and oceans). This session, sponsored by IAGA in collaboration with IASPEI (International Association of Seismology and Physics of the Earth's Interior), was convened by K. Hemant.

With the release of the WDMAM, research into new geological and tectonic information of the Earth's oceans and continents has been given an added impetus.

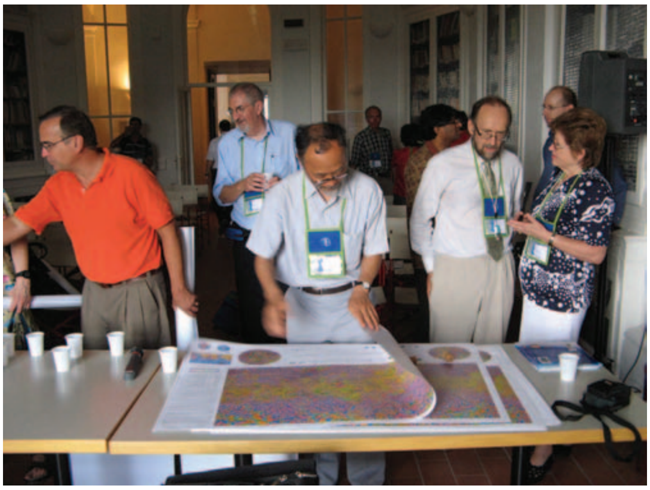

Fig. 1. First distribution of the map during social activities after the formalities. From left to right we have: Mike Purucker from the US (NASA); Colin Reeves (The Netherlands and co-chairman of the WDMAM Executive Committee), he is holding the coffee cup; Takemi Ishihara (NIAST, Japan); Dhananjay (Tiku) Ravat (University of Kentucky, US); Juha Korhonen (Geological Survey of Finland and the other co-chair); Stefan Maus from the US (NOAA) and Tatiana Litvinova (VSEGEI, Russia), who is talking to Juha.

Fig. 2. Delegates at the Perugia launch of the WDMAM, taking their souvenir maps and opening champagne bottles.

[1]Peter Milligan was an external advisor of the WDMAM Executive Committee and attended the IUGG meeting in Perugia.

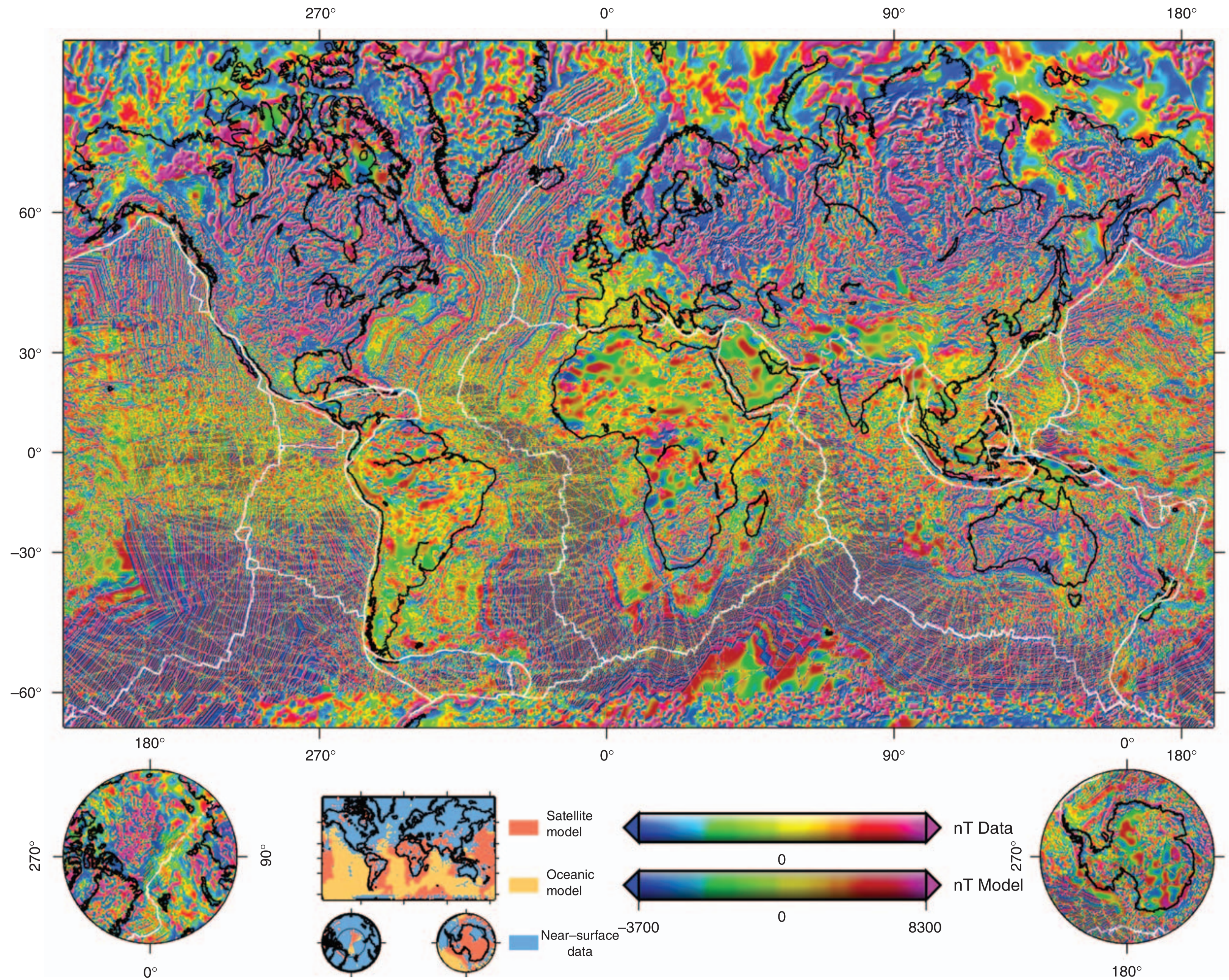

Fig. 3. Magnetic Anomaly Map of the World with Mercator and polar stereographic projections. The anomaly field is shown at an altitude of 5 km above the WGS84 ellipsoid. The near-surface compilations are distinguished from the satellite-based and oceanic-model data by way of shading. The entire dataset is displayed using the natural colour palette (red = high, blue = low) with a shaded relief effect using artificial illumination. The white lines on the map locate undifferentiated tectonic elements and include ridges, fracture zones and trenches. The original map is at a scale of 1 : 50 million.

Activity of magnetic total intensity across continental Australia

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Summary

Geoscience Australia's Geomagnetism Project operates a network of magnetic observatories in the Australian region to produce absolute calibrated long-term secular variation information about the earth's magnetic field. A product of this activity is the availability of high accuracy one-second time resolution vector data that are valuable for many applications. An example is the development of a new method of displaying data from the six permanent Australian continental magnetic observatories in the form of the rate-of-change in magnetic total intensity, dF/dt, contoured over Australia. To examine how well the data from the observatories are able to represent the behaviour of dF/dt over continental Australia, charts produced using data from the observatory sites alone were compared with those produced using data acquired by the Australia Wide Array of Geomagnetic Stations experiment (AWAGS). Although there are limitations brought about by the existence of conductivity anomalies, the information from the permanent observatories provides a useful tool to gauge the activity of the magnetic field over the continent. Near to real-time dF/dt contours are soon to be available on the Geoscience Australia (GA) website.

Introduction

The Geomagnetism Project at GA operates nine permanent magnetic observatories in Australia and Australian Antarctic Territory, six of which are on the Australian continent, one is on Macquarie Island and two on the continent of Antarctica. Vector magnetic field values every one second in time are recorded at all the observatories. The one-second data are filtered to produce one-minute, one-hour, monthly and annual values. Considerable effort is devoted to maintaining accurately calibrated absolute magnetometers and the performance of regular absolute observations at all the observatories. This enables long-term changes in the earth's magnetic field, or secular variation, to be monitored over the lifetimes of observatories, often many decades. To accurately calibrate magnetic observatory variometers it is necessary to monitor changes in the vector magnetic field on as short a time scale as possible. This is to accurately track the constant changes in the earth's magnetic field, primarily driven by current systems in the ionosphere and those subsequently induced in the ground, brought about by the changing position of the sun and its sometimes irregular outbursts of energy. A consequence of the magnetic observatory network's principal operation is that short-term and relative changes in the magnetic field are also available to the geomagnetic community.

Knowledge of changes in the earth's magnetic field is vitally important to many activities such as navigation, communications, mineral exploration and high altitude and space travel. As the data acquired at magnetic observatories are now transmitted to GA in Canberra in near to real-time, it has become possible to make these available on the GA website also in near to real-time. This has been happening for some time already in the form of magnetogram traces of chosen magnetic components (most frequently declination and total intensity) from each of the observatories over a selected period of days. With the intention of efficiently providing useful information in as close to real-time as possible, a new display of geomagnetic information is scheduled to become available on the GA web site by early 2008.

As users of GA's magnetic data often do not require data from a particular observatory, but rather, are interested in the magnetic field or its activity at other locations, the new format will display geomagnetic information in the form of contours over the Australian continent. The display to be initially available will be of the rate-of-change of the magnetic total intensity, dF/dt. Although it would be possible to display the total intensity (or any other component of the earth's magnetic field) in real-time, such a display would appear fairly static and virtually the same as the Australian Geomagnetic Reference Field, AGRF, Total Intensity chart (see Lewis, 2005 and Figure 1), with no perceptible change over brief time intervals. So the real-time nature of the information would lose its value. A view of the rate-of-change of the magnetic element will provide a dynamic display that highlights the activity of the magnetic field at a particular time.

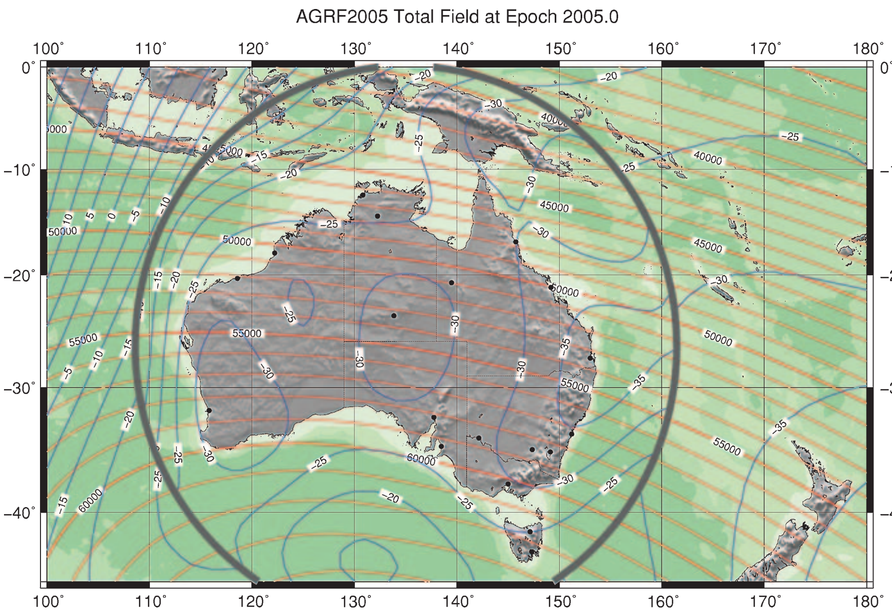

Fig. 1. Australian Geomagnetic Reference Field chart for epoch 2005.0 showing total intensity, F(nT), with red contours and its secular variation, dF/dt (nT/yr), with blue contours. The small black circles indicate the locations of principal population centres. The contours are derived from the AGRF05 model within a 24° spherical cap area, marked on the chart as a circular boundary. Outside this cap area the contours are derived from the IGRF-10 model at epoch 2005.0.

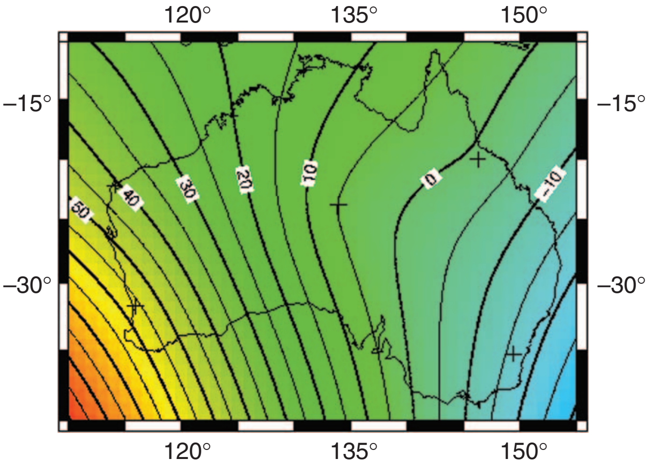

Fig.2. Rate-of-change of magnetic total intensity, dF/dt (nT/hr), over the Australian continent on 23 January 1990 estimated over a 15 minute interval centred on 20:07UT using data from the locations of the 6 permanent magnetic observatories indicated with + symbols.

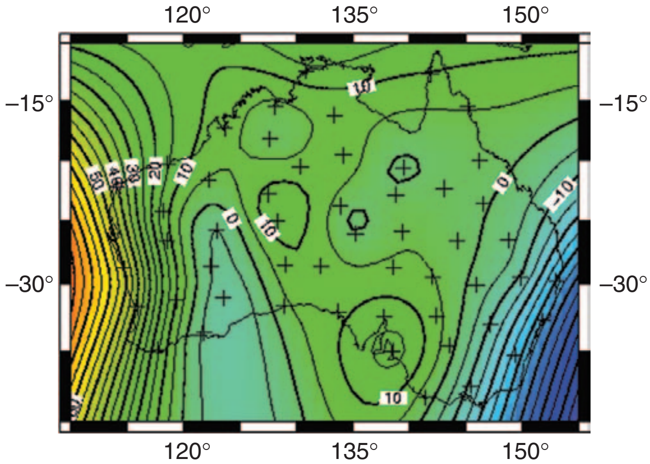

Fig.3. Rate-of-change of magnetic total intensity, dF/dt (nT/hr), over the Australian continent on 23 January 1990 estimated over a 15 minute interval centred on 20:07 UT using data at the 58 AWAGS stations indicated with + symbols.

Description

Figure 2 shows the rate-of-change of the magnetic total intensity, F, or a dF/dt-display, centred at 20:07 UT on 23 January 1990, that can be considered a visual index of activity over the Australian continent. To produce the chart, the rate-of-change of total intensity, dF/dt, was estimated over a 15 minute interval of data at the locations of each of the six magnetic observatories operating in continental Australia, and the values contoured over the area. The units on the contours are in nT/hr.

In the generation of the dF/dt charts a number of choices were required to optimise the usefulness of the data presented. A period of 15 minutes of F data, from which to determine dF/dt, was considered sufficiently long for the changes in F to have a high enough signal-to-noise ratio, yet short enough to be reasonably approximated by a linear trend. (The validity of this assumption reduces with increasing magnetic activity.)

A number of methods to determine the change in F over the 15-minute periods of data were considered. Initially, the raw differences between the F values at the beginning and end of the 15-minute data periods were simply computed, a method suitable for high quality data such as from a magnetic observatory being unlikely to contain noisy or spurious values. To be usable for lower quality data, such as that from the AWAGS experiment, dF/dt was estimated from the average of data in successive 15-minute periods after having a percentage of the highest and lowest values in the periods rejected. The method eventually adopted performed a linear fit to the 15 minutes of data and determined dF/dt from its gradient. There was not a great deal of difference in the displays of the same data using the different analysis methods!

Successive dF/dt determinations can be made at any chosen interval but it should be long enough that the successive displays are appreciably different yet sufficiently frequent to be considered in near to real-time. Once again 15 minutes was selected as an appropriate interval. (Shorter intervals could be used, in which case a 15-minute window of data is incremented by, for example, 5 minutes for successive determinations.) The software developed allowed all the parameters mentioned to be varied should the requirement arise.

Limitations of the maps

To examine how well the data from the six permanent magnetic observatory locations can represent the behaviour of dF/dt over continental Australia, charts produced using the observatory sites alone were compared with those produced using data acquired by the AWAGS, experiment (Welsh and Barton, 1996). In that experiment, an array of 54 portable magnetometers was simultaneously deployed across the Australian continent during the period from late 1989 to mid-1990, with a few stations running to the end of 1990. Data from the four magnetic observatories: Gnangara (GNA), near Perth, WA; Canberra (CNB), ACT; Charters Towers (CTA), north Queensland; and Learmonth (LRM), WA; in existence at the time, supplemented the portable magnetometer data, so the full data set comprised 58 sites. To test how data from the six present-day observatories represented dF/dt variations over the continent compared with how data from the 58 AWAGS experiment sites did, two of the portable magnetometer sites were used as surrogate observatory sites – at Alice Springs (ASP) and Darwin (in place of Kakadu (KDU) observatory) in the NT.

Unfortunately there were some extended gaps in the ‘observatory’ data set during the time that the AWAGS experiment took place that limited the days on which these comparisons could be made. Notable gaps in the 1990 data were: at Gnangara, between days 121 and 181; Alice Springs, between days 042 and 126, and 153 and 217; and at Darwin, between days 084 and 093, 120 and 134 and 162 and 176. Consequently, comparisons could only be made using data acquired in December 1989 and January 1990. Data missing from the non-observatory sites were not so limiting.

Figure 3 shows the dF/dt map at the same time as Figure 2, but produced with data from all 58 of the AWAGS sites in operation at the time.

There is a broad similarity of the contours in Figures 2 and 3, giving support that the six observatories may, at least in some conditions, provide indicative dF/dt over the continent. In the interval 18:00–21:00 UT on 23 January 1990 the k index of geomagnetic activity was 3 at both Canberra and Gnangara, indicating that the magnetic field was moderately disturbed. However, geomagnetic activity is not the only condition that will affect how well data from the observatories alone can represent dF/dt across the whole continent.

At 20:07 UT the local time ranges from 4:07 am on the west coast of Australia to

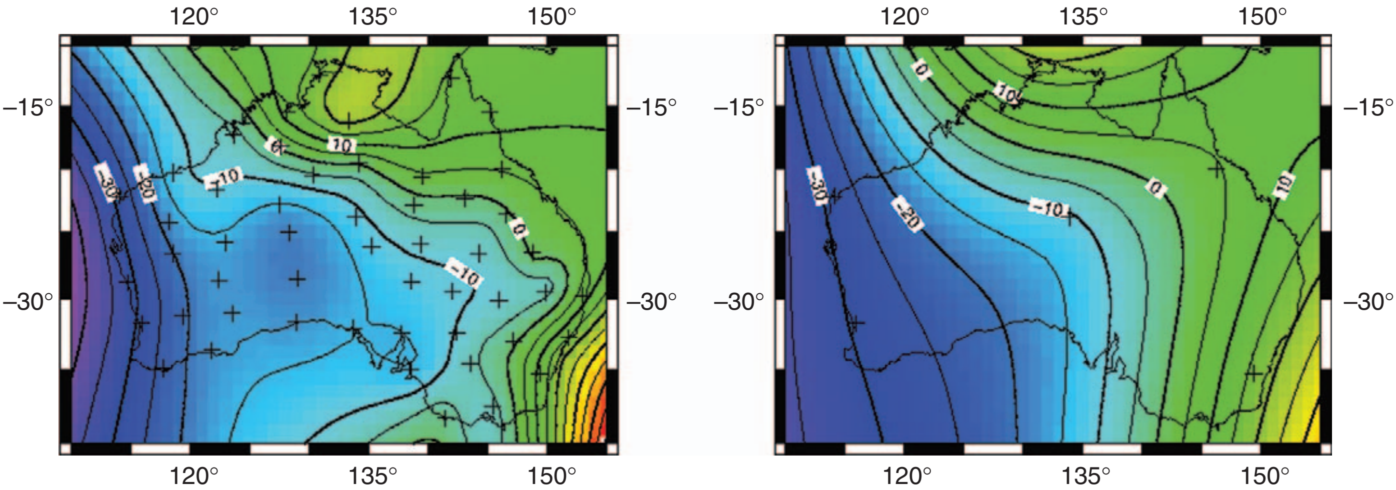

Fig.4. Rate-of-change of magnetic total intensity, dF/dt (nT/hr), over the Australian continent on a magnetically quiet, day 27 January 1990, estimated over a 15 minute interval centred on 00:12 UT (k index = 0) calculated from all AWAGS stations (left) and at the 6 permanent magnetic observatory locations (right).

6:07 am on the east coast. This is at the beginning of local dawn when the daily solar quiet component of the field, the *Sq*, changes quite rapidly and will be up to 2 hours out of phase across the continent. This effect is superimposed upon any irregular activity of the magnetic field that will be largely synchronous over Australia, although the amplitudes will vary with location.

The reasonably good representation of dF/dt over the continent using data from the six observatories alone may be explained by the wide distribution of the observatories over longitude (local time) and latitude (distance from the *Sq* focus).

Conductivity and other anomalies

As the continental observatories are mainly situated towards the continental margins, dF/dt data from them may be expected not to be particularly representative of the inland. However the *coast-effect* (Hitchman *et al*., 2000) that enhances the amplitudes of variations, principally in the vertical magnetic intensity, over a period range from a few minutes to a day, diminishes, more strongly with increasing frequency, as the distance from the coast increases. (At daily variation harmonics the *coast-effect* can actually reduce amplitudes through destructive interference (Lilley *et al*., 1999)). Because the rate-of-change of F is being considered, long period variations will not be as dominant in the maps as the shorter ones. As increasingly shorter periods are attenuated more strongly as the distance from the coast increases it follows that the dF/dt data from the Canberra and Charters Towers observatories are not strongly affected by the *coast-effect*, Charters Towers less so than Canberra (Milligan, 1988). Figure 4 shows dF/dt displays at 00:12 hrs on 27 January 1990, during a geomagnetically quiet period.

The sea to the north of Darwin (and the Kakadu observatory) is relatively shallow so the *coast-effect* will have a reduced effect upon data from that site.

The above considerations are not the case for the Gnangara and Learmonth observatories on the coast of Western Australia where the *coast-effect* enhances the amplitude of vertical intensity (and so F) variations that results in them being higher than inland of these sites. This can be seen in Figures 2, 3 and 4 where the magnitude of the contours in Western Australia reduces less rapidly moving away from the coast when only data from the observatory sites are used for the map.

The *coast-effect* will therefore compromise how well dF/dt data at the observatory locations alone can describe the whole continent by either affecting the observatory data themselves or by affecting areas to be characterised using unaffected observatories.

The magnetic observatory at Alice Springs is very valuable as it is virtually free of the *coast-effect* and other conductivity anomalies.

Like the *coast-effect*, other conductivity anomalies, such as that implied by the AWAGS survey in the form of a broad U-shape roughly around the borders of the Northern Territory and those near the Eyre and Yorke Peninsulas (Chamalaun and Barton, 1992) will distort magnetic variations in their vicinity and so reduce the effectiveness of data from the observatories alone to represent the whole continent.

The morphology of undisturbed regular variations in components of the earth's magnetic field, the *Sq*, as a function of latitude and local-time has been well documented (see Hitchman *et al*., 1998). Because of the mathematical relationships between the magnetic elements F, H and Z,

$F = \sqrt{H^2 + Z^2}$ and so

$$dF = \frac{1}{F}(H \cdot dh + Z \cdot dZ),$$

variations in F more closely follow those in H near the equator (where Z is small) and more closely follow those in Z near the poles (where H is small). At any latitude the morphology of the *Sq* is seen to also vary with season. The diurnal curves are indicative behaviour only and are modified in the presence of regional and local induction in conductive structures in the earth and oceans (Chamalaun and Barton, 1992).

A phenomenon called *magnetic amphidromes* is described (Lilley *et al*., 1999) as being locations where short-period fluctuations in F over time are very small to negligible. During geomagnetically active periods *magnetic amphidromes* were found to occur in locations that would have been expected to exhibit appreciable total intensity fluctuations were it not for the proximity of conductive structures. An example was shown to be at Wycheproof in western Victoria. During geomagnetically disturbed conditions, fluctuations in Z and H with periods of an hour or less in the presence of highly conductive structures can vary in a proportion that creates little change

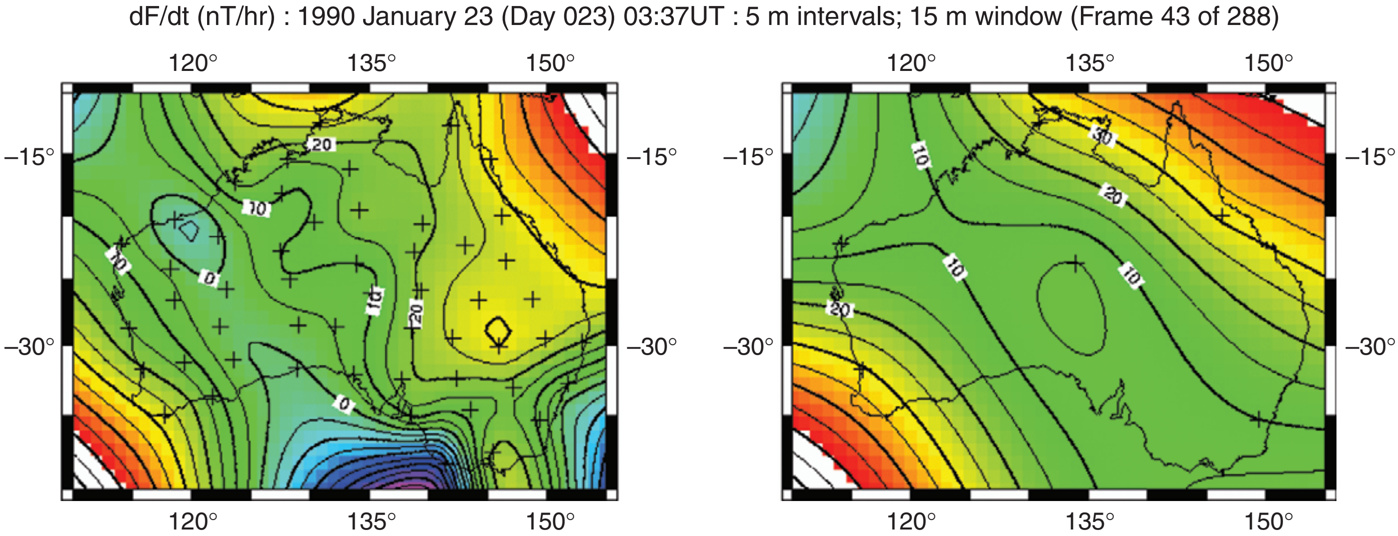

Fig.5. Rate-of-change of magnetic total intensity, dF/dt (nT/hr), over the Australian continent on 23 January 1990, estimated over a 15 minute interval centred on 03:37 UT calculated from all AWAGS stations (left) and at the 6 permanent magnetic observatory locations (right).

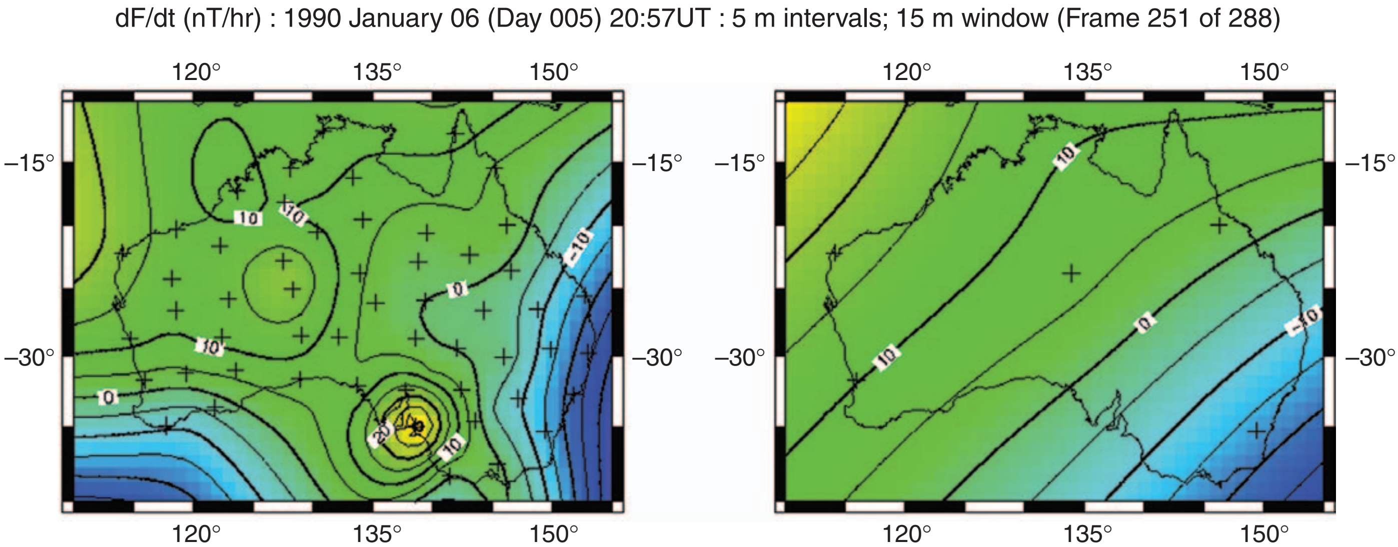

Fig.6. As in Fig. 5 except on 06 January 1990, estimated over a 15 minute interval centred on 20:57 UT.

in F, only in its direction, *i.e.* variations are in the preferred plane, perpendicular to F. Because of the geometry it was pointed out that this was more likely to happen at locations in higher latitudes, both predicting (and observing at some sites) the phenonenon at a number of locations along the southern coast of continental Australia. Like conductivity anomalies, effects of *magnetic amphidromes* cannot be represented by data from the observatories.

Diurnal doldrums were also described (Lilley *et al*., 1999) as a minimum in the quiet diurnal F variations within the 20°–30° geomagnetic north and south latitude bands, potentially affecting how well data from the observatory locations can represent the whole continent. In Australia the *diurnal doldrums* area includes the most northerly region of the continent, from a latitude between that of ASP or LRM and that of CTA and extending to the most northerly regions of the continent. In Australia these regions are equatorward of the *Sq* focus (~35°S geomagnetic latitude) at geographic latitude ~25°S. The maximum amplitude of total field fluctuation was shown (Lilley *et al*., 1999) to occur between geomagnetic 34°S and 44°S in Australia.

As the total-field *diurnal doldrums* is not a localised phenomenon, the observatories within them will be affected to the same extent as other locations at their latitude. Consequently, the variations recorded at those observatories may be expected to be representative of those taking place in this band. The observatories at CTA and KDU are in the affected latitude region.

Animations

In a 15-minute period dF/dt changes appreciably over the Australian continent. On some days it was useful to create 5-minutely or more frequent maps. To observe the changing dF/dt, the periodic displays of the AWAGS data alongside the observatory alone data were combined to create animations over a day at a time. These were valuable in quickly observing over a period of a day, how well data from the observatories alone represented dF/dt over the continent in comparison to all the AWAGS stations.

Figure 5 shows an animation frame at a time when data from the observatory sites produced a chart similar to that produced by all AWAGS stations. Note the spurious

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New data on Capel and Faust Basins

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Introduction

Geoscience Australia has recently completed a seismic survey in the Capel and Faust Basins (Capel–Faust Seismic Survey S302) in an initial appraisal of the hydrocarbon potential of the region. These remote deepwater basins are located 800 km due east of Brisbane in the northern Lord Howe Rise in water depths of 1300–2000 m (Figure 1). The basins have been identified in consultation with the petroleum industry as a potential frontier exploration area. The pre-existing seismic coverage of the area was sparse, consisting of six lines previously acquired during the Shell *RV Petrel* survey in 1971, and the Australian Geological Survey Organisation (AGSO) in 1996 (S177) and 1998 (S206).

The seismic survey was carried out as part of the Australian Government's Big New Oil initiative (2003 to 2007) to provide pre-competitive exploration data to support acreage release in open offshore frontier areas. A follow-up program of potential field, bathymetry and sampling surveys, seismic interpretation and petroleum prospectivity assessment has commenced, as part of the Australian Government's 2007 to 2011 Energy Security initiative.

Seismic survey planning and acquisition

The seismic survey was conducted between 19 November 2006 and 7 January 2007 using the CGG-operated vessel *Pacific Titan*. It resulted in the acquisition of high-quality, industry-standard seismic data as well as magnetic, gravity, and long offset refraction and reflection data. Favourable weather conditions during the survey permitted the collection of 5920 km of two-dimensional (2D) seismic data along 23 lines, with a line spacing of approximately 30 km (Figure 2). The data was collected with an 8 km solid seismic streamer. This produced 12 s of record with a 12.5 m group interval and a 37.5 m shotpoint interval, resulting in 106-fold common

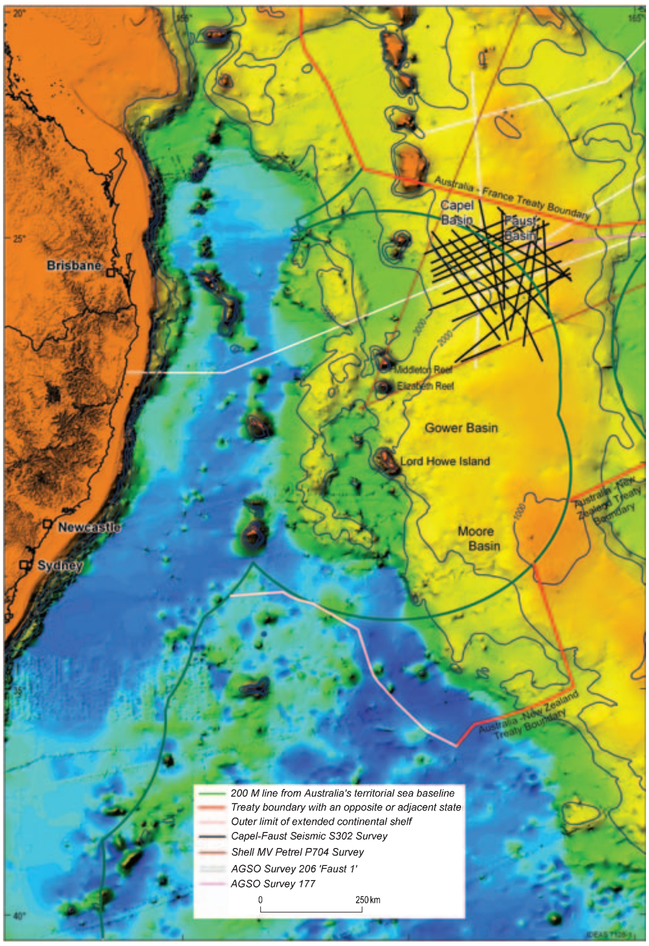

Fig. 1. Location of seismic lines and bathymetry in the Capel–Faust Basin area. Lines marked in black indicate the lines acquired by the recent S302 survey.

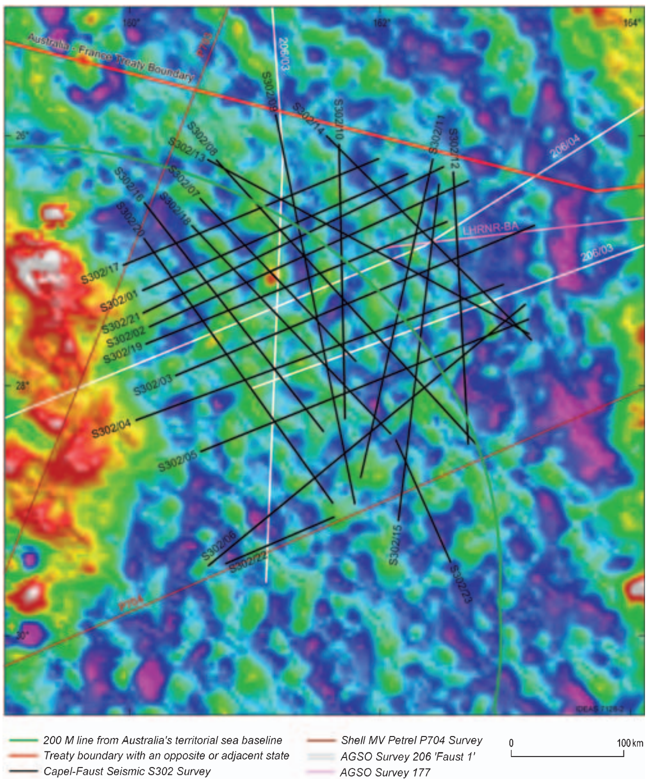

Fig. 2. Seismic lines in the Capel and Faust basins, overlain on satellite gravity data. Note the areas of gravity low (indicated by dark blue to purple colour), which generally correspond to the major depocentres within the region.

mid-points (CMP). The high resolution was intended to provide insights into the deeper structure and the thickness of the depocentres in the Faust and Capel basins.

The orientation and spacing of the seismic lines were determined after consideration of pre-existing seismic data in the area (AGSO S177 and S206) and filtered satellite gravity data coverage (Sandwell and Smith, 1997). The gravity modelling established a correlation between a specific type of gravity anomaly with the occurrence of shallow depocentres evident in the sparse existing seismic coverage. The gravity coverage was then interpreted on the basis of this relationship in order to extrapolate the extent of the depocentres beyond the S177 and S206 seismic lines.

The satellite free-air gravity anomaly data contains two main signals derived from the underlying geology and the water column. To establish a correlation between the gravity and seismic data, it was necessary to remove the water column signal by calculating the Bouguer gravity anomaly. This allowed the geological signal in the Bouguer anomaly to be correlated with the seismic data.

A number of different filter methods, including high-, band- and low-pass residual methods, were applied in an attempt to isolate the gravity signature of the shallow depocentres imaged in the seismic data. The method that produced the most correlatable signal was upward continuation, an established and robust frequency separation technique (Jacobsen, 1987). A residual filter was used, comprising the original Bouguer anomaly minus a 25 km upward continuation of the Bouguer data. This filter has the effect of maintaining the highest frequencies and removing the signal from the underlying deep basement. The Marr–Hildreth edge detection method was applied to the gridded data to enhance the edges of the anomalies (Marr and Hildreth, 1980).

Filtered gravity profiles were then plotted over the existing seismic sections in order to establish the correlation between the two data sets. With the additional assistance of the enhanced gravity imagery, the likely location and extent of the depocentres were mapped, and the line locations and spacing for the recent seismic survey planned.

Data outputs

Geoscience Australia has completed the processing of the newly acquired seismic data and has commenced interpretation. At this preliminary stage, several deep depocentres (up to 4–5 s TWT) have been imaged for the first time (Figures 3a–d). Structures such as half-grabens, possible inversion structures, volcanic edifices and possible hydrothermal fluid flow pathways can be clearly seen. The size of the depocentres suggests that they may be favourable for hydrocarbon generation. Limited stratigraphic control for the seismic grid is provided by DSDP hole 208, which intersected nannofossil chalk of Late Maastrichtian age (594 m below the seafloor).

The seismic data complements basement dredging data, swath mapping, and heat flow measurements previously acquired during the French–Australian *Marion Dufresne* survey in February 2006. This information provides new insights into the nature of the basement and the thermal gradient in the Capel and Faust Basins.

Magnetic, gravity and long offset refraction and reflection data were also collected during the seismic survey. This geophysical dataset complements the seismic grid by providing modelling inputs to constrain the sediment thickness, basement depth and composition.

The dataset from the Capel–Faust Seismic Survey S302 is available in three pre-packaged digital options, including workstation formats, at cost of transfer

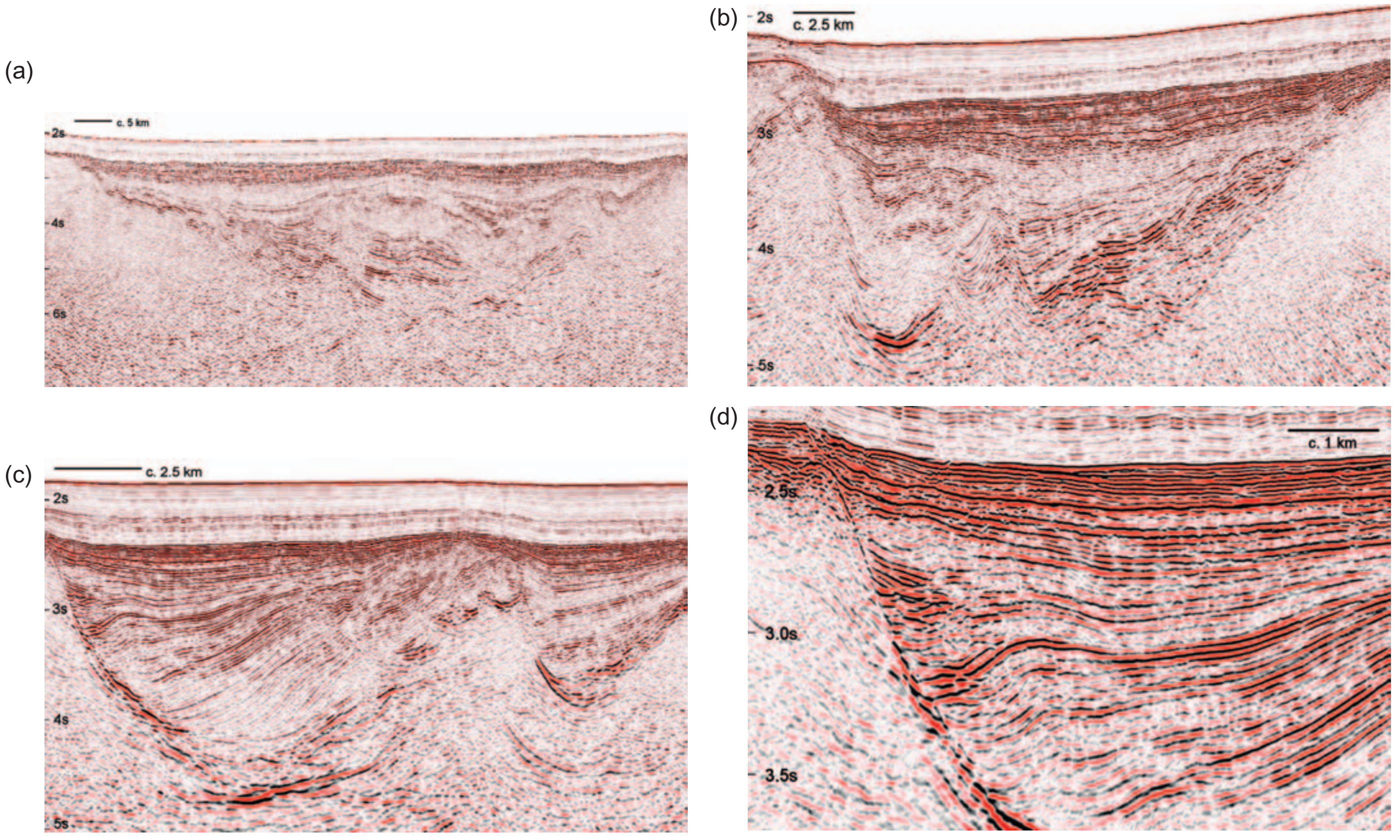

Fig. 3. Portions of seismic profiles acquired by the S302 survey: (a) strike section (line S302-09); (b) dip section across depocentre shown in 3a (line S302-19); (c) a typical half graben (line S302-19); (d) an anticlinal structure within half graben shown in 3c.

from Geoscience Australia. Full pre-STM stacks, near-, middle- and far-angle stacks, velocity and navigation data, and observer's logs from the S302 survey are available, complemented by reprocessed and/or original data from the previous seismic surveys, and processed gravity and magnetic data. Pre-STM CMP gathers and the full survey field data will also be available on request.

Processed datasets will be on display at the 19th International Geophysical Conference and Exhibition to be held in Perth in November 2007. For further information, contact Fred Kroh on +61 2 6249 9183 (fred.kroh@ga.gov.au) or Robert Langford on +61 2 6249 9852 (robert.langford@ga.gov.au).

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anomalies to the south of the continents caused by the contouring software (GMT) extrapolating beyond the data area.

Figure 6 shows an animation frame at a time when features near anomalies apparent with all the AWAGS data were not resolved by the data from only the observatory sites.

A major study of the AWAGS data has been carried out (Whellams, 1996) in which animations were used extensively to interpret the results.

Additional Stations

The value of additional stations acquiring data to contribute to dF/dt maps of Australia will depend on a number of factors. More stations will clearly produce a better estimate to the actual behaviour of the magnetic total intensity over the continent. But the question remains as to where additional stations should be situated to gain the most value.

Placement of more stations in areas where there is most need to know the total intensity behaviour has its attraction, but may be at the expense of a more complete or uniform coverage of the continent. Such locations will be in areas where airborne magnetic surveys are likely to be performed such as in mineral rich provinces.

The best coverage of Australia will be to position stations to complement the permanent observatories in areas where interpolation will otherwise produce spurious results or spatial aliasing. Identification of sites that will be most suitable during all seasons and phases of the solar cycle, various levels of magnetic activity, and taking into account the locations of magnetic anomalies, *amphidromes* and *doldrums*, and the path of the *Sq* focus, is a complex problem. The most likely locations of any new stations, however, may be dictated by convenience and be at sites on which other installations exist, e.g. at magnetic repeat survey sites (typically on airports); permanent field stations of other GA activities such as seismic or gravity; or those of other organisations.

There is also a possibility of creating what could be termed *virtual observatories* by creating models that use the permanent observatory data to generate estimates of magnetic field variations at the sites of some or all of the AWAGS stations or repeat survey stations (see also the magnetic models of NASA, 2007).

Conclusion

Although there are limitations in fine detail when representing the rate-of-change of the earth's magnetic total intensity over the Australian continent using data from the six permanent magnetic observatories operated by Geoscience Australia, an indication of the magnetic activity over the continent can be visualised with the contour charts described. The displays compliment the Aeromagnetic Risk Map of Australia (Barton, 1997).

A display of dF/dt using past data through to near real-time is to become available on the GA website at http://www.ga.gov.au/geomag/.

Acknowledgements

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The Minerals Down Under: National Research Flagship

CSIRO's new Flagship and its exciting plans to help transform Australia's minerals industry[1]

The obvious first question about the new Minerals Down Under National Research Flagship is why do we need more R&D resources focussed on a segment of the Australian economy that, at first glance, is doing very well?

The industry has added hundreds of billions of dollars in export earnings to Australia in the last 25 years and this is increasing at a rate exceeding $100 billion a year. Minerals sector employees are, on a GDP per capita basis, about four times more productive than the national average and 50% more productive than employees in the next best sector. The industry contributes $7 billion in direct and indirect tax contributions to federal and state governments and accounts for at least 19% of Australia's fixed assets and natural capital. New capital expenditure is expected to exceed $30 billion in 2006–07 and exports from mining technology and services are estimated at more than $2.5 billion a year.

That is the good news. But there is also a down side. Many of Australia's major deposits are depleting or experiencing declining grades. And with the rate of new discoveries declining, replacements are not coming on stream fast enough. Very simply, if new deposits are not found and developed, there will be a long-term decline in the size and relative importance of the minerals industry in Australia. Unfortunately, Australia's share of global minerals investment in exploration is also declining.

Minerals Down Under is not simply looking for incremental advances to existing technologies. It is planning to transform the industry with revolutionary new technologies and ideas. Flagship Director, Peter Lilly, said Minerals Down Under "is principally about creating the vision for Australian minerals-sector technology in 2015 to 2030, and helping the industry get there. It's about transformational research, however along the way we expect to deliver outcomes that add value to the sector". Some projects are focussed on producing relatively short-term outcomes, but the majority are aimed at a 10 to 15 year horizon.

[1]The text of this article is adapted from a contribution by Bob Chamberlain of CSIRO. His email contact is bob.chamberlain@csiro.au.

Flagship Director, Peter Lilly

By working with the combined talents of nine CSIRO Divisions, universities, government organisations such as ANSTO, other scientific bodies such as Geoscience Australia and the State and Territory Geological Surveys, Minerals Down Under will create synergies and partnerships that could not have happened without the Flagship. It will be able to mobilise critical mass in a way that has not previously been possible.

Much work is also planned to offer collaboration with industry. Exploration and mining companies are likely to be involved, as are equipment manufacturers, professional service companies and technology companies.

The Chief Executive of Geoscience Australia, Neil Williams, welcomed the new Flagship. He said it will provide scientists from CSIRO, Geoscience Australia and other institutions with "opportunities to work together to achieve complementary beneficial outcomes, particularly in improving mineral discovery rates by overcoming the challenges of searching for new deeply buried mineral deposits".

BHP Billiton's Vice President Technology, Megan Clark, also hailed the Flagship as a major advance. "Science and technology have never been more important for the minerals industry as we face the challenge of meeting the world's growing resource needs and at the same time minimising the impact on the global environment. We welcome the Flagship with its focus on critical issues of how we go deeper, treat low grade ores, and unlock new areas and new ores," she said.

Clearly, the magnitude of the problems beginning to be felt by the industry has been reflected in the level of funding. In its first year of operation, the Flagship will invest about $40 million in its initiatives. Around $24 million of this will come from direct CSIRO funding, with the remainder coming from the private sector, including industry.

We will now look at some of the ways Minerals Down Under intends to transform the viability of the entire minerals value chain: exploration, mining, processing and environmental sustainability.

Exploration

The main aim is to replenish Australia's resource base. In fact, Minerals Down Under intends to facilitate the discovery of $250 billion of new mineral resources in Australia by 2030.

Some of the ways this will be achieved is by:

- Contributing to the doubling of Australia's share of global exploration expenditure by 2020;
- Halving the average cost of discovery in Australia by 2020 relative to the 1996–2006 average; and
- Ensuring that 3D lithological/ mineralogical models at all scales are built and used on a routine basis by all Australian geologists by 2020.

There have been no world-class new ore body discoveries since Olympic Dam in South Australia more than 30 years ago, and still only a fraction of Australia's continent has been explored.

Meanwhile, Australia's share of the global exploration budget has decreased, partly because of a belief that political risk has lessened in many countries.

CSIRO's Anna Littleboy is a senior member of the team responsible for bringing Minerals Down Under to fruition. She says that "We need to find ways of building the technical confidence to operate in unexplored areas of Australia, and keeping operations here in Australia as our higher grade mineral resources are depleted".

Standard practice in the Australian mineral exploration industry today is to analyse data in two dimensions using GIS methods (maps and cross-sections) and identify targets principally by empirical means. To make the necessary increasingly deep discoveries required in the future, mineral exploration practice needs to be transformed so that

Australian geoscientists operate consistently in three dimensions underpinned by a strong process understanding of a fourth dimension – that of ore formation and evolution over geological time.

Major collaborations have already been established to generate hyperspectral data that will provide a fundamentally new perspective on 3D mineral distribution associated with high value ore deposits across the Australian continent. Australia's competitive position will be enhanced through multi-scale simulations of geological processes and 3D mapping technologies. An airborne spectral sensing project has been commissioned by the Queensland Government to develop next generation maps in the Mt Isa region, with a similar project in Tasmania under discussion.

Hyperspectral logging is also a key focus with plans to introduce thermal infrared logging into the system so it can detect non-hydroxyl bearing silicates (e.g. quartz feldspar).

A new National Collaborative Research Infrastructure Strategy (NCRIS) project will see a HyLogging™ facility in every State and Territory, operated by the relevant Survey and associated universities. The end result will be a huge database of easily accessible pre-competitive data. The Mineral Exploration Action Agenda identified the need to manage geoscientific data as a critical path activity in the development of pre-competitive exploration. Through the SEEGrid community, new data languages (GeoSciML) and operability platforms have been successfully tested for the ability to draw together data from six different Surveys in six different countries.

Laser induced breakdown spectroscopy will also be reviewed for its application to downhole logging and its compatibility with hyperspectral scanning technology.

Minerals Down Under will also deploy cutting edge new computational targeting technologies and collaborate closely with a large group of Australian universities to promote transfer if this vital new knowledge.

A smart drill rods program is underway with sponsorship by Boart Longyear and Mitchell Drilling, ACARO and the Queensland Government.

Exploration research within Minerals Down Under will be coordinated by Paul Roberts. Previously, Paul led the 25 person Computational Geoscience for Predictive Discovery research team in the CSIRO Division of Exploration and Mining. The Group was involved with developing and applying a computational system for predictive exploration targeting.

Prior to joining CSIRO in 2002, Paul worked with Pasminco, Metana Minerals, RGC Exploration and the CRA Group. He was responsible for regional exploration programs for a wide variety of commodities in Western Australia, Tasmania and Victoria, detailed feasibility scale evaluation of gold and copper deposits in Western Australia and North Queensland, mine-based exploration for tin and iron ore in Tasmania and Western Australia respectively. In 1985, he played a key role in the discovery of the Henty gold deposit in Western Tasmania.

Within the exploration group, David Gray will manage Mineral System Life Cycles and Targeting. Over 20 years, David's innovative research into the chemistry of weathering, hydrogeochemistry and application of soil extraction analysis for mineral exploration has had significant implications for the exploration industry in Australia.

Warren Potma will hold responsibility for Terrane-scale Technology Applications. Since joining CSIRO in 2002, Warren has been applying his expertise in structural geology to focus on developing predictive numerical modelling methods to solve exploration industry problems.

Mining

The Australian mining industry is facing a number of roadblocks to future growth including declining grades, isolation, limited human resources and difficult mining terrain. In addition, there is a clear need to reduce the impact of mining on the environment and to face the challenge of alternate land uses.

Drilling is a massive cost to the industry. It contributes around 20% of exploration costs and 10% of mining costs. However it is an essential technology, used to locate, quantify and determine mineralisation and to place explosives. A revolutionary drill rig will be developed that will be able to be adapted to a wide variety of uses in many environments. This rig is expected to significantly reduce drilling costs, increase rates of exploration, provide more and better data from boreholes and improve control of rock fragmentation.

Processing

Australia's stocks of simple-to-process, high-grade deposits are being rapidly depleted during a time of growing global demand for minerals. For us to maintain and grow our market share, we have to meet a number of challenges head on.

We must learn how to efficiently deal with increasingly complex ores; declining grades and subsequent increasing waste; water limitations near important sites; and growing pressure to reduce the industry's physical and environmental footprint.

The Minerals Down Under Flagship will develop new and transformed processing options suitable for Australian conditions to increase grade, reduce impurities and minimise process volumes for iron ore, nickel, copper, gold, mineral sands and uranium.

Sustainability

At present one assumes the impacts of industrial operations are outweighed by their benefits. As the future unfolds, attitudes may change. Therefore, it is critical to the industry's future that a sustainable balance is maintained and improved.

Minerals Down Under will focus on ways to make deep cuts in the emission of waste, toxic elements and greenhouse gases and in more efficient uses of resources such as water and energy. One of the ultimate aims is a zero waste metalliferous industry. Systems innovation will be used to convert large volume waste streams such as sulphide tailings and toxic residues into valuable and saleable products.

The road ahead

The role of Minerals Down Under is to create new knowledge and technologies for the minerals sector and to ensure there are appropriate pathways for the transfer of that knowledge and technologies to industry to improve Australia's global competitive position.

No one is pretending it will be easy, but the potential benefits to Australia are huge. The Minerals Down Under National Research Flagship will assist the Australian minerals industry to exploit new resources with an *in situ* value of $1 trillion by the year 2030, and more than double the size of the associated services and technology sector to $10 billion per year by 2015.

The next few years promise to be very exciting.

Building the Australian Earth Science Grid, AuScope

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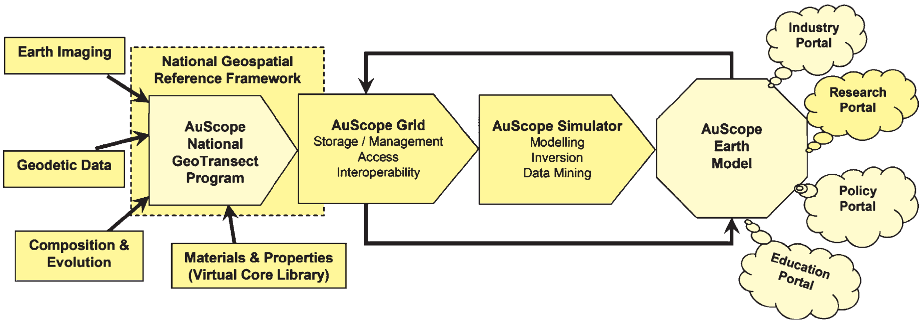

Fig. 1. The AuScope system provides access and interoperability mechanisms to ensure ease of information flow throughout all components of the Auscope infrastructure. Much as Google Earth™ provides a portal for integrating geospatial information, the Auscope research portal will provide a mechanism for integrating scientific data and services for geoscience research .

In 2006, the Australian Government announced a new ~$542 million (over 7 years) funding initiative, the National Collaborative Research Infrastructure Strategy (NCRIS). NCRIS aims to provide Australian researchers from industry, government and academia, with access to major research facilities and supporting infrastructure necessary for world-class research. As a component of this strategy, $42.8 million was allocated to the Australian Earth Science Research community to build an integrated, broadly accessible, national geoscience infrastructure system called AuScope. AuScope is designed to put Australia at the forefront of geoscience research and of geoscience applications for a generation, and thereby enhancing Australia's wealth through improved and sustainable discovery, development and management of its minerals, energy and groundwater assets.

AuScope comprises several components which are linked into a coherent system spanning data acquisition, delivery, simulation, modelling, access to facilities and web publication (Figure 1). Each of these has substantial co-investment from universities, geological surveys, state government agencies, the CSIRO and Geoscience Australia, bringing the total investment to over $100 million (Table 1). Although this investment will allow the core research infrastructure to be built, additional participation and comment from the broader geoscience community is welcomed.

The first four components, Earth Imaging, Composition and Age, Virtual Core Library and Geospatial, are principally about data acquisition to enable an increasingly clear and rich picture of the subsurface to be created. They are linked by a National Geotransects Program (Figure 2) and will result in the acquisition and publication of seismic, magneto-telluric, geochemical, and hyperspectral core logging data and products along the proposed transects. This program is being coordinated with acquisition programs in Geological Surveys and other organizations. All of this data will be underpinned by an enhanced National Geospatial Reference System from the Geospatial component, which will allow for very accurate positioning applications including the monitoring of the deformation of the Australian land mass.

To draw together information from this new national infrastructure and from other existing sources in academia, industry and government, the AuScope funding will also be used to develop a world-leading Geoscience geoinformatics network. This cyber infrastructure (or Grid) network will provide access to data and computing facilities distributed around Australia. The Grid will use open geospatial standards to allow real time access to data, information and knowledge stored in distributed repositories. A key objective for the Grid is that it will be built on 'end-to-end' science principles (aka open access principles) providing access to the highly processed information and knowledge as well as the original raw data and the processing programs used to generate the results. All of this information and the services will be made accessible via the AuScope Research Portal.

The Simulation and Modelling component facilitates quantitative Geoscience analysis by providing an infrastructure and tools for advanced data mining and online computational modeling and simulation. Computationally demanding Geoscience programs, ranging from earthquake and tsunami simulation through to ore formation and block caving, will be made available as services, and distributed across computing and storage resources in a manner that requires only limited knowledge of the physical infrastructure.

There are no obvious technological barriers to what has been proposed in building the AuScope Grid. Nearly all

Continued on p. 31

Table 1. AuScope investment summary over 7 years, NCRIS money is from Australian Government, co-investment money is from AuScope partners

AuScope	NCRIS	Co-investment	Totals
Earth Imaging	$8.37M	$3.53M	$11.90M
Composition & Age	$3.00M	$2.80M	$5.80M
Virtual Core Library	$2.88M	$8.03M	$10.91M
Geospatial	$16.99M	$48.33M	$65.31M
Simulation & Modelling	$8.00M	$11.29M	$19.29M
Cyber Infrastructure	$6.38M	$3.10M	$9.48M
AuScope Administration	$1.00M	$1.50M	$2.50M
Totals	**$46.62M**	**$78.58M**	**$126.20M**

Offshore Canning Basin: new magnetic data

Geoscience Australia has acquired new high-resolution magnetic data across current Commonwealth offshore Acreage Release Areas W07-12 to 15 in the Offshore Canning Basin (Figure 1) under a contract awarded to Fugro Airborne Surveys Pty Ltd. The survey also covers adjacent State Water Acreage Release Areas (T07-1 to 3) and ties to and in-fills existing onshore and offshore magnetic data.

The survey aims to improve the understanding of the geology and petroleum potential of the release areas by identifying structural and basement features, including the delineation of associated Devonian reef trends and Permian intrusive structures. No exploration activities have been undertaken in this offshore area since the 1980s, but several petroleum systems (Permo-Carboniferous, Devonian and Ordovician) are proven to be prospective in the adjacent onshore portion of the basin. Live oil shows were also recorded at multiple levels within the Permian-Devonian section intersected in the offshore Perindi-1 well (1983).

The Survey data covers an area of approximately 31 770 square kilometres and consists of a total of 56 504 line-km, comprising 44 633 line-km new data (flying height of 60 m asl) and 11 871 line-km of previous data. Geoscience Australia will level and merge the new and pre-existing data to achieve a 750 m line spacing and 3000 m tie line spacing grid across the release areas.

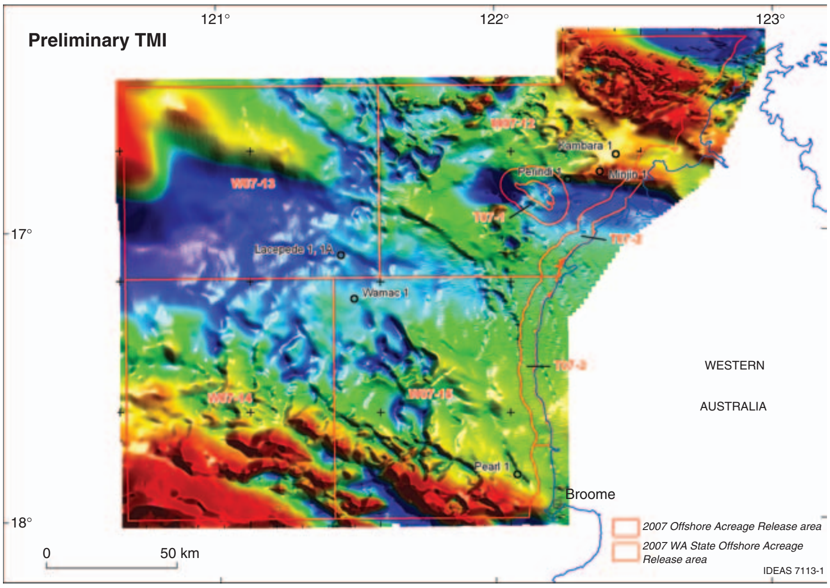

Fig. 1. Preliminary total magnetic intensity map of the newly acquired data in the Offshore Canning Basin, Western Australia, showing Commonwealth and State offshore acreage release areas.

Levelled and merged magnetic data will be released in October 2007 via Geoscience Australia's geophysical online data delivery system (GADDS). Bids for the Commonwealth offshore release areas close on 17 April 2008 (bids for the adjacent State release areas close on 11 October 2007).

For further information, please contact:

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Geological Surveys of Queensland, Western Australia, Northern Territory, Tasmania and Geoscience Australia

Update on Geophysical Survey Progress (information current at 5 September 2007)

Tables 1 and 2 show that the acquisition of new gravity, magnetic and radiometric data

Table 1. Airborne magnetic, radiometric and AEM surveys

Survey Name	Client	Contractor	Start Flying	Line km	Spacing AGL Direction	Area (km²)	End Flying	Final Data to GA	Locality Diagram (Preview)
North-East Tasmania	MRT	GPX	18 March 07	52 000	200 m 90 m E/W	8600	98% complete @ 2 Sep 07	TBA	123 – Aug 06 (p. 39)
East Isa North	GSQ	UTS	3 Apr 07	113 000	400 m 80 m E/W	39 940	Completed 15 Jul 07	TBA	125 – Dec 06 (p. 32)
East Isa South	GSQ	Fugro	10 Mar 07	145 900	400 m 80 m E/W	51 560	Completed 15 Jul 07	TBA	125 – Dec 06 (p. 31)
AWAGS2	GA	UTS	29 Mar 07	145 350	75 km 80 m N/S	7 659 861	70% complete @ 2 Sep 07	TBA	124 – Oct 06 (p. 15)
Croydon	GSQ	UTS	2 Jun 07	100 320	400 m 80 m E/W	335 310	76% complete @ 2 Sep 07	TBA	127 – Apr 07 (p. 27)
Tanumbirini	NTGS	UTS	16 Jul 07	69 463	400 m 80 m E/W	24 047	62% complete @ 2 Sep 07	TBA	126 – Feb 07 (p. 35)

(Continued)

Table 1. (Continued)									
Survey Name	**Client**	**Contractor**	**Start Flying**	**Line km**	**Spacing AGL Direction**	**Area (km²)**	**End Flying**	**Final Data to GA**	**Locality Diagram (Preview)**
Canning Basin Onshore	GA	Fugro	20 Apr 07	102 656	800 m 80 m N/S	70 192	Completed 15 Jul 07	TBA	127 – Apr 07 (p. 26)
South Kimberley	GSWA	GPX	TBA	163 000	400 m 60 m N/S	57 920	TBA	TBA	128 – Jun 07 (p. 26)
Canning Basin Offshore	GA	Fugro	22 Jun 07	44 643	750 m 80 m N/S	32 640	Completed 8 Aug 07	TBA	129 – Aug 07 (p. 33)
Westmore land	GSQ	TBA	2 Sep 07	59 753	400 m 60 m N/S	21 010	TBA	TBA	129 – Aug 07 (p. 33)
Cooper Basin East	GSQ	TBA	TBA	214 352	400 m 60 m N/S	76 980	TBA	TBA	This issue, Fig. 1
Cooper Basin West	GSQ	TBA	TBA	N-S lines 161 088 E-W lines 47 993	400 m 60 m N/S & E/W	N-S lines 57 700 E-W lines 16 710	TBA	TBA	This issue, Fig. 2
Paterson AEM	GA	Fugro	8 Sep 07	29 164	Various: 200 m to 2000 m 120 m (bird) E/W & SW/NE	N: 15 730 S: 11 830 Total 27 560	TBA	TBA	This issue, Fig. 4

TBA: To be advised

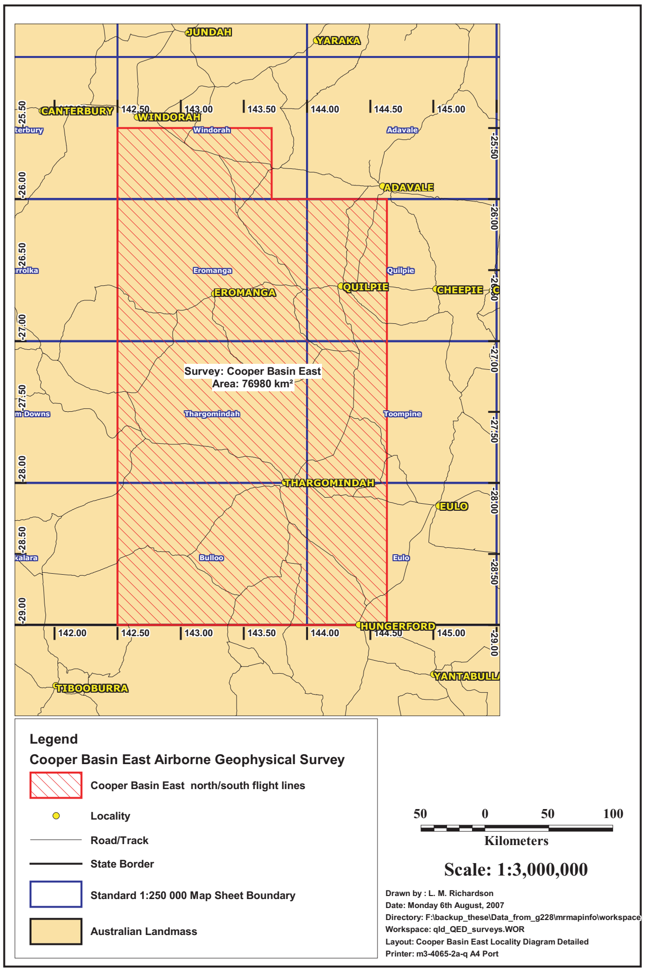

Fig. 2. Location of the 2007 Cooper Basin East airborne magnetic and radiometric survey; line spacing is 400 m ground clearance 60 m; total distance to be flown, 214 352 km.

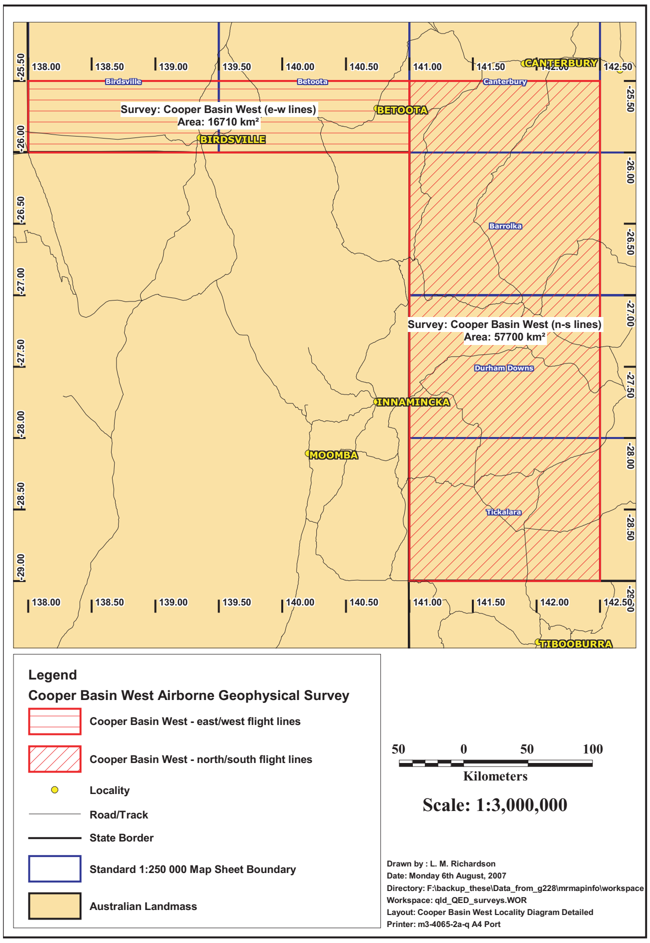

Fig. 3. Location of the 2007 Cooper Basin West airborne magnetic and radiometric survey; line spacing is 400 m ground clearance 60 m; total distance to be flown 209 081 km.

Table 2. Gravity surveys									
Survey Name	**Client**	**Contractor**	**Start Survey**	**No. of stations**	**Station Spacing (km)**	**Area (km^2)**	**End Survey**	**Final Data to GA**	**Locality Diagram (Preview)**
Tanami	GSWA	TBA	Dependent on land access	3700	2.5 regular	23 000	TBA	TBA	128 – June 07 (p. 27)
Cooper Basin North	GA	Daishsat	TBA	3537	4 regular	56 590	17 Jun 07	Preliminary Data 3 Aug 07	128 – Jun 07 (p. 27)
Charters Towers	GSQ	Fugro	22 Aug 07	15 310	2 and 4 regular	133 950	1.6% complete @ 26 Aug 07	TBA	128 – Jun 07 (p. 26)
Cooper Basin South	GSQ	TBA	TBA	9170	4 regular	146 700	TBA	TBA	This issue, Fig 3

TBA: To be advised

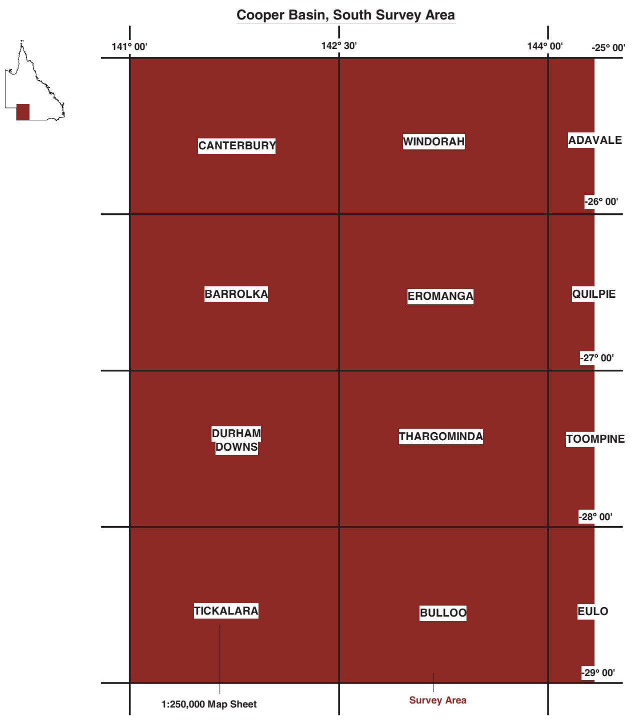

Fig. 4. Location of the 2007 Cooper Basin South gravity survey; 9170 stations at a regular 4 km spacing and covering 146 700 km².

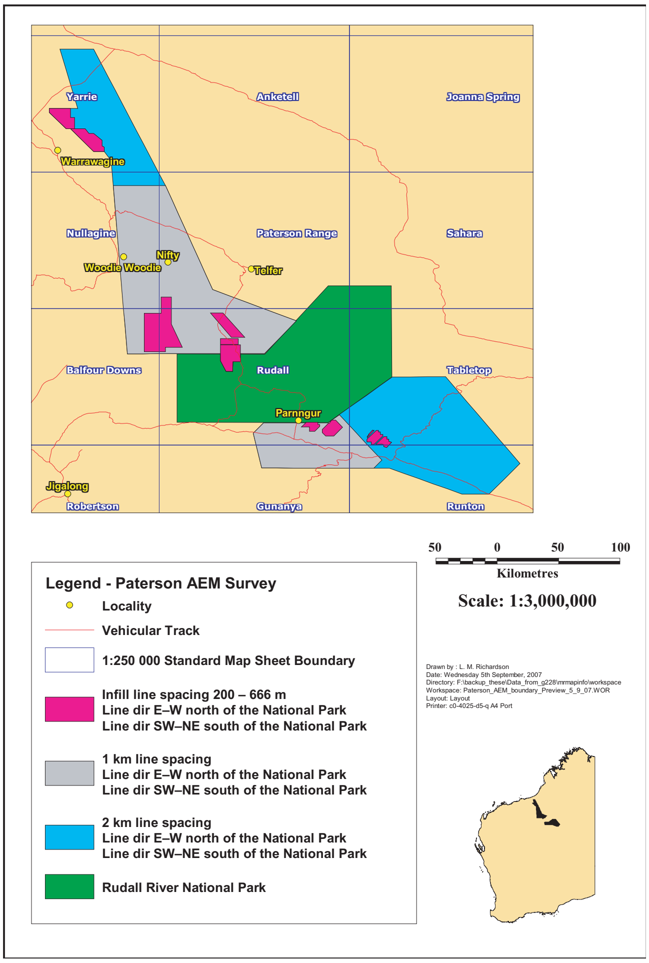

Fig. 5. Location of the Paterson Airborne EM survey, comprising 29 164 line-km at 120 m ground clearance.

over the Australian Continent by the States, the Northern Territory and Geoscience Australia is continuing at great pace. Some very large new surveys are about to start. For example the 423 433 km Cooper Basin surveys in Queensland and the 29 164 km EM survey over the Paterson province in Western Australia. All the surveys in the tables are managed by geosciences Australia. All the releases through the GADDS system will be announced later.

Locality diagrams for the Cooper Basin East and Cooper Basin West surveys are shown in Figures 2 and 3. A locality diagram for the Cooper Basin South gravity survey is shown in Figure 4. A locality diagram for the Paterson AEM survey is shown in Figure 5.

New data from Queensland added to the Australian National Gravity Database

Gravity data from the Geological Survey of Queensland and company surveys in the State have recently been incorporated into the Australian National Gravity Database.

A total of 23 618 stations from 32 surveys are now open file and have been entered into the Australian National Gravity Database. Data were provided to Geoscience Australia by the Geological Survey of Queensland. The surveys centre on the Mt Isa Region and south east Queensland. The surveys mostly date from 1991 to 2002. All data in the Australian National Gravity Database, can be obtained free-of-charge using the Geophysical Archive Data Delivery System 'GADDS'.

Figure 6 shows the locations of the surveys. They are mostly small and detailed, but ~24 000 new stations is a significant addition to the ANGD.

For further information, please email Mario Bacchin; or phone +61 (0)2 6249 9308.

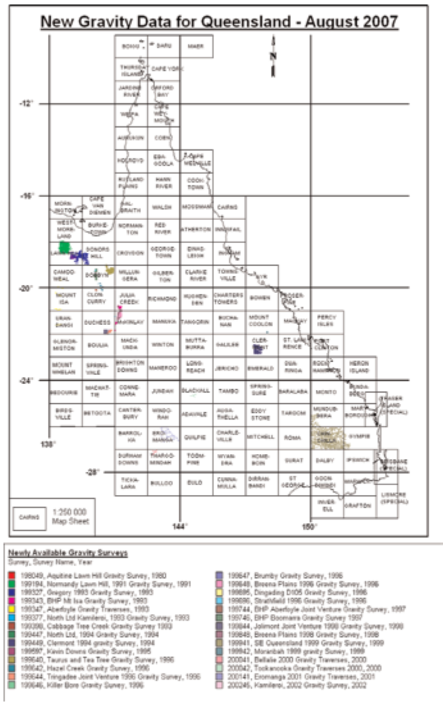

Fig. 6. Location of Queensland gravity data added to the Australian National Gravity Database. The surveys mostly took place from 1991to 2002.

Continued from p. 27

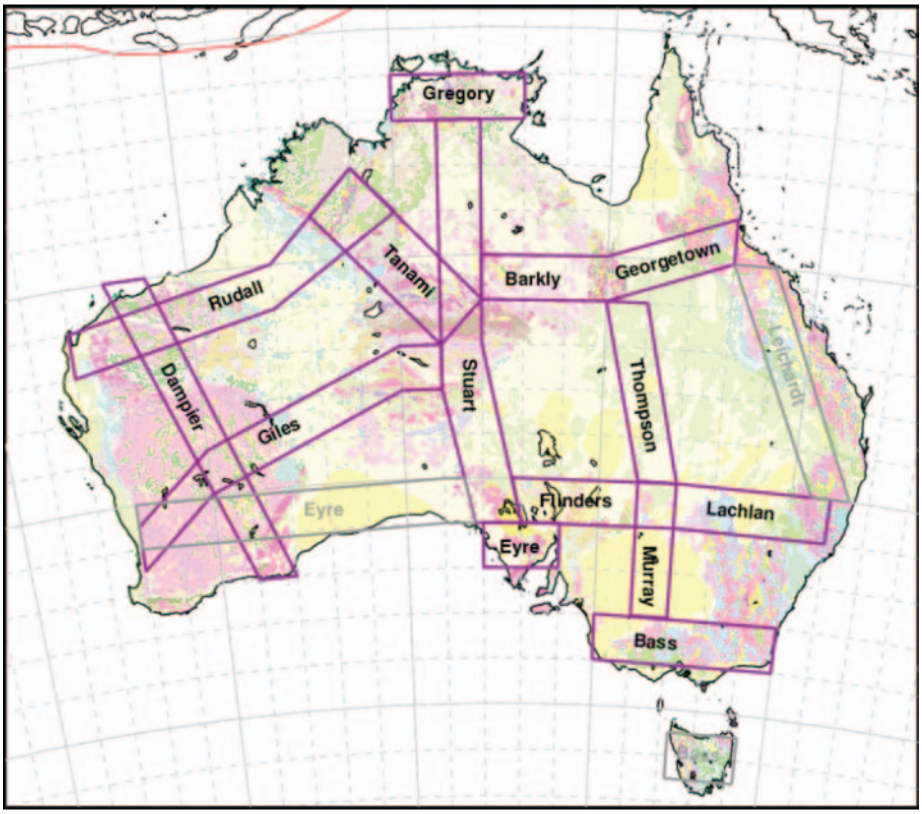

Fig. 2. Possible configuration of the transect corridors. The transect program seeks to coordinate and make accessible both new and existing Seismic, MT, geochemical and drill hole data sets within these priority corridors. The Georgetown seismic survey has already been completed.

technical elements of it have been trialled in recent years in a series of test bed projects (*Preview*, June 2006, 'Towards Service Oriented Geoscience: SEE Grid and APAC Grid'). The principle challenge will be to achieve sufficient participation and open access to enable a thriving community of practice to develop and use the infrastructure, and more importantly, to contribute to our understanding of the structure and evolution of the Australian continent.

Further information on AuScope and its investment plan can be found on the AuScope website at www.auscope.org.au. AuScope Ltd is funded under the National Collaborative Research Infrastructure Strategy (NCRIS) an Australian Commonwealth Government Program.

Geophysicists at War: Mines, Magnetism and Memories Part 2: The Australian Connection

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Introduction

Part 1 of this article discussed the magnetic properties of ships, and the development of magnetic mines that were triggered by the vessels' magnetisation. It also discussed the counter measures devised in 1940 to reduce the magnetic signature of a vessel by a variety of techniques that included degaussing (coiling), wiping, flashing and deperming. This part of the article explores the degaussing work undertaken in Australia in the early years of World War II, and the critical role played by Australian geophysicists in this endeavour.

As described in more detail in Part 1, degaussing uses a series of permanently installed coils whose current is adjusted dynamically to cancel the field of the ship. Deperming and the related techniques of wiping and flashing use temporary coils and large currents to remove the permanent magnetisation of the ship. The process, however, must be repeated every few months as the magnetic field of the Earth and the vibration from the ship's engines slowly restores the permanent magnetisation.

Degaussing operations in Sydney

Degaussing operations commenced in Sydney in early 1940. Geophysicists from the North Australia Survey including Jack Rayner and Lew Richardson played a critical role in the early work together with James Madsen, Professor of Electrical Engineering at Sydney University and chairman of the Radio Physics Board, David Myers head of the Electrotechnology Section of the National Standards Laboratory, CSIR, and Commander Reilly of the RAN. Jack told me that the work that he and Lew had done around Tennant Creek in the mid 1930s, and in particular some of the theoretical modelling used to interpret their results, was of major assistance when they began to investigate the magnetic properties of ships. A note amongst the family photos from 1940 written by my late mother Phyllis Rayner to her grandchildren records that:

> *[These pictures are of] ships assembling to take troops to the Middle East: "Queen Mary", "Queen Elizabeth", "Empress of Britain", "Mauritania", "Aquitania", "Empress of India", hospital ship "Manowai", U.S. cruiser "Chicago", 6 U.S. destroyers. All [of] these ships degaussed for mines by Grandad, Bob Thyer, Lew Richardson. Other ships as well.*

One of the first tasks of the group was to establish whether or not the techniques developed by the British Admiralty for the Northern Hemisphere were applicable to the Southern Hemisphere where the vertical component of the Earth's field is in the opposite direction, and so a series of experiments were undertaken using the tug 'Wattle'. The 'Wattle' was a steam tug built at the Cockatoo Island dock in Sydney Harbour in 1933, and still survives today at the Williamstown Maritime Museum (Figure 9).

Fig. 9. Steam tug 'Wattle' at Williamstown (http://en.wikipedia.org/wiki/steam_tug_wattle).

The vessel had strong permanent magnetisation with its south pole pointing downwards. Successful demagnetisation would therefore require a degaussing (DG) coil with a clockwise current when viewed from above. Three coils were wound around the ship: one just outside the hull, one just inboard of the hull and a third one around only the superstructure.(NAA 1940–41) The outer coil consisted of 9 turns with a maximum current of 43 Amps resulting in about 400 Ampere-turns for the coil, with comparable figures for the other coils. Measurements were made using a 'Grassot' type fluxmeter, designed by Madsen, and a search coil. Most of the measurements were made directly under the vessel along the keel line with a pair of navy divers positioning the search coil as required.

Figure 10, which is reproduced directly from the final report (NAA 1940–41), shows a typical set of results taken along the keel line.

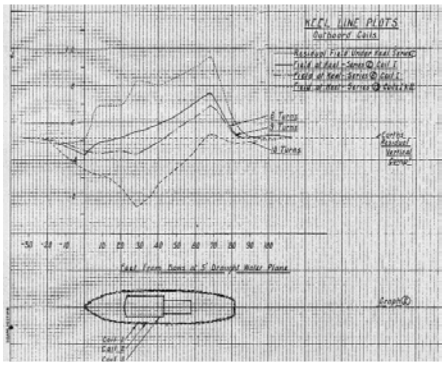

Fig. 10. Graph showing the magnetic field of the 'Wattle' along the keel line before and after degaussing. Note the strong field towards the stern due to the engines (NAA 1940–41).

The vertical component of the earth's field is about 0.52 gauss while the maximum field without DG in the vicinity of the engines is almost 0.9 gauss. With degaussing the field is reduced, significantly but still shows a considerable gradient along the length of the ship indicating that additional F and Q coils were needed. The report also recommended the urgent need to build an open water proving range to speed up the process of assessing ships.

Subsequent to the tests on the 'Wattle', a temporary experimental proving range was established at the Chowder Bay fuelling depot and tested in June 1940 using HMAS 'Bingera', (see Figure 11) a coaster that had been rebuilt for antisubmarine duties. Later the "Bingera" was used by the port commodore, later Rear Admiral, G.C Muirhead Gould at the time of the Japanese midget submarine attack in 1942.

Fig. 11. The coastal vessel 'Bingera' before and after conversion to a submarine hunter (Australian War Memorial negative No. 300409 and 300410).

Figure 12 shows the results for the 'Bingera' to which a Q (Quarterdeck) coil was added later to compensate for the field in the vicinity of the stern.

The first major ship to use the Chowder Bay facility was the heavy cruiser, HMAS 'Canberra' (see Figure 13) which was surveyed on the 20th and 21st June 1940, leading to the results shown in Figure 14.

Degaussing operations increased considerably during the latter half of 1940 including the degaussing of the 'Queen Mary' in December 1940 which was in Sydney where her refitting from a luxury liner to troop carrier was completed. Her degaussing coil running along near the top of the hull is clearly visible in Figure 15.

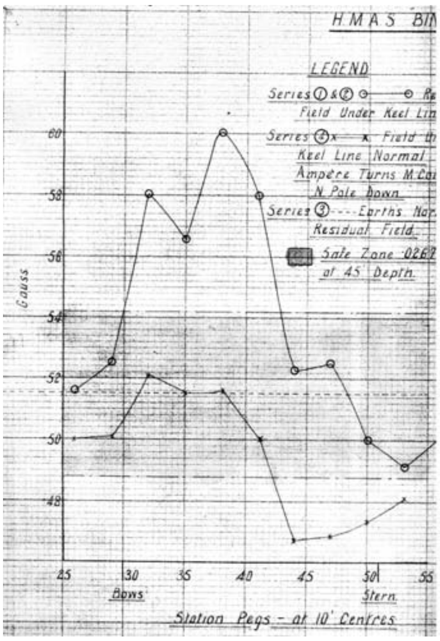

Fig. 12. Graph of the magnetic field of the 'Bingera' along the keel showing the need to install a Q coil. "Safe zone": ± 0.027 gauss for a depth of 45 ft (7$^1/_2$ fathoms) (NAA 1940–41).

Fig. 13. HMAS 'Canberra' 1930, passing under the partially completed Sydney Harbour Bridge (Australian War Memorial negative No.P01869.001).

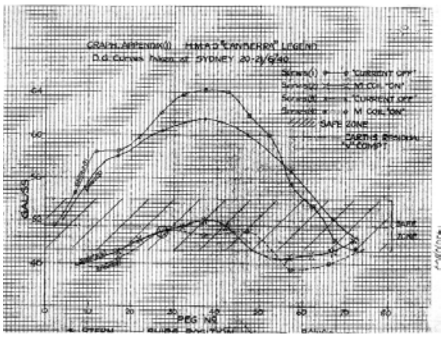

Fig. 14. Graph of the magnetic field of the 'Canberra' along the keel before and after degaussing (NAA 1940–41).

Fig. 15. 'Queen Mary' in 1940 showing the degaussing coil around the top of the hull installed in Sydney (http://troopships.pier90.org/ships/q/queenmary).

Jack used to talk about how nervous he felt as he sat on his back veranda in Mosman watching the convoy of great liners leaving the Harbour packed with Australian troops, praying hard that he and his colleagues had got their sums correct.

The Open Proving Range

As the number of ships requiring degaussing increased it became apparent that an "open proving range" was required that would speed up the process of surveying ships for degaussing purposes. The Minister for the Navy granted approval for the construction of the range on the 6th June 1940. Shark Island in the middle of the Harbour was chosen as the site for a recording station with a deep-water range located between the Island and Bradley's Head and a shallow-water range on the other side between the Island and Nielsen Park, as shown in Figure 16. (NAA 1940–41) The deep-water range consisted of a set of seven coils laid on the floor of the harbour, each of 200 turns and with a diameter of 104 inches (2.56 m), yielding an area-turns product of 1.094 $\times 10^3$ m^2 turns. A recording hut was built on the island, and included a recording room for the fluxmeters and a dark room for processing the long rolls of 5$^1/_2$ inch wide film used for recording results.

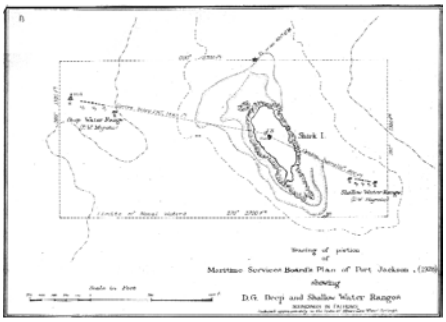

Fig. 16. Map showing the location of the open proving range in Sydney Harbour (NAA 1940–41).

The British Admiralty's degaussing facility at Helensburgh on the banks of the Clyde shipped 18 fluxmeters, 5 cameras and ancillary equipment for recording the signals on board the freighter 'Hertford' in mid October1940. Unfortunately the vessel was mined off the South Australian coast on 7 December 1940 and the equipment was not recovered. However Sydney University working with Myers was able to construct a set of suitable fluxmeters which when used in association with the coils produced an overall sensitivity of 0.845 milligauss per scale division. Given that the 'safe zone' was reckoned to be ±25 milligauss for a mine at a depth of 45 feet (7.5 fathoms), the sensitivity was satisfactory. After some initial problems with the inadequate insulation of the cables between the coils and the shore, the range was declared to be in regular operation by July 1941 (NAA 1940–41). The file also records a long exchange of legal memoranda concerned with having the Harbour around Shark Island declared as an Admiralty exclusion zone.

Beginning in the first half of 1940 with ~8 ships in 3 months the number of ships handled for DG operations in Sydney

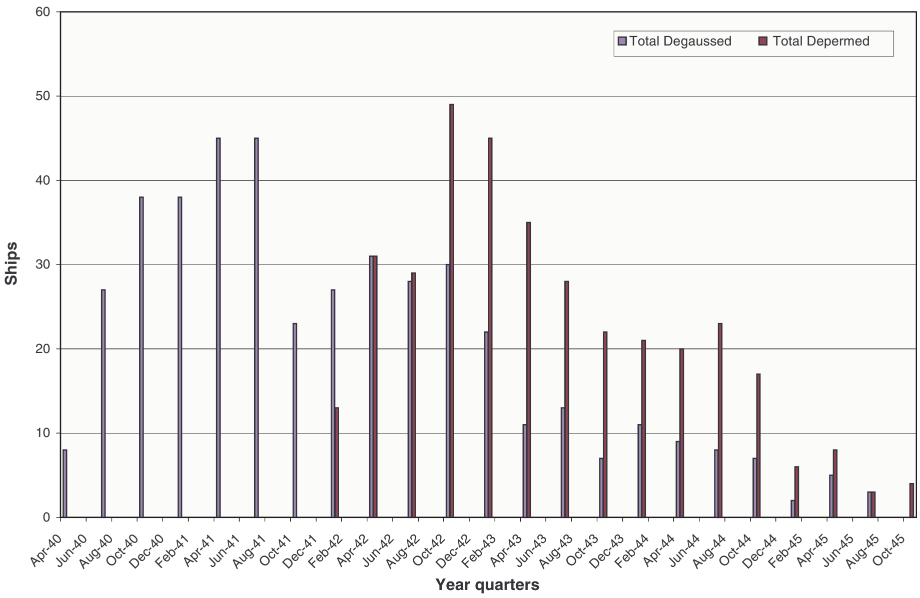

Fig. 17. Bar graph showing the number of vessels degaussed or depermed in Sydney per quarter between 1940 and 1945 (AWM 1940–45).

Fig. 18. Map showing Lew Richardson's magnetic survey of the area around the open range.

escalated very rapidly. The numbers presented in Figure 17 show the number of ships degaussed or depermed each quarter throughout the War. The data were taken from the quarterly reports of the Harbour's Engineering Management Depot (AWM 1940–45). Initially the records were somewhat sketchy but become more detailed and systematic from early 1942 onwards.

The records show that although much of the early effort was directed towards degaussing this declined somewhat from early 1943 as deperming became dominant. At the height of operations in the latter half of 1942 Sydney was handling some 70 to 80 ships per quarter. Throughout the war 130 naval ships and 308 merchantmen were degaussed while 190 naval and 164 merchant ships were depermed. In addition 575 naval and 658 merchant ships were tested on the proving range. From 1944 onwards 'channel ranging' became the dominant assessment method with up to 600 ships per quarter being tested (AWM 1940–45).

Other issues

From early in the War it was critically important to provide magnetic protection for submarines. It was extremely difficult to retrofit degaussing coils to submarines and so most of the attention was directed to devising effective derperming procedures. Initially the main problem was to counter the threat of magnetic mines. Later, however, as airborne fluxgate magnetometers were developed to search for underwater submarines, magnetic quietening of submarines became even more important. For geophysics, of course, the development of fluxgate magnetometers revolutionised aerial magnetic surveys. Early experiments using the new technique commenced in 1944 and were observed by Jack when he visited the USA in mid-1945 (Rayner 2007).

I have not been able to trace direct references to the degaussing work of the geophysicists apart from a report by Lew Richardson in 1944 when he conducted a magnetic survey of the area around the range in order to confirm the reference magnetic field for the site as recorded on the map shown in Figure 18 (Richardson 1944).

For the survey, Lew used the same horizontal and vertical force variometers as he had used for the magnetic work at Tennant Creek, together with an Earth Inductor, No. 18, obtained from the Carnegie Institution of Washington, for the absolute determination of the magnetic elements. The survey found that the mean values of the force components were: Z = 523.0 milligauss and H = 257.2 milligauss with typical fluctuations ~ ±0.2 milligauss over the site. His report also noted that:

> *Particulars of this absolute determination and of another one made on Shark Island are given below. Throughout the area surveyed the transient magnetic disturbances due to tramway and electric railway power circuits were observed to range up to 30 gammas in Z and 10 gammas in H. (100 gammas = 1 milligauss). It is possible that stronger effects would be observed at times of peak traffic in trains and trams.*

Conclusions

This article has attempted to illustrate how a group of scientists trained in one area used their knowledge and ingenuity to solve novel problems in a different field. It has also attempted to recognize the often unsung, but critical role of scientists in a time of national emergency. Jack very seldom spoke about this work, partly because much of it remained classified, and little of it is recorded in formal reports. However, from my conversations with him, it was clear that he was immensely proud of the contributions that he and his fellow geophysicists had made towards the War effort.

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AWM, 1940–45, Australian War Memorial file: AWM 78453/1 "Department of Engineer Managers Depot, War Diary". This file details the activities of the Garden Island/Cockatoo Dockyard 24 June 1940 to 29 Nov 1945. It is a series of quarterly reports which includes the number of ships depermed (DP) and degaussed (DG) for each of the 16 quarters.

NAA, 1940–41, National Archives of Australia file: Series MP1049/5, Item 1924/4/597: This file contains, signals, memoranda and reports concerning early degaussing experiments in Sydney and the development of the open proving range adjacent to Shark Island between June 1940 and August 1941.

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Engineering Geology, Second Edition

F.G. Bell

Publisher: Butterworth-Heinemann/ Elsevier, 2007, 581 pp.

Price: $92.50, ISBN: 0-7506-8077-6

Working with several engineers on earthquake hazard assessment for the past few years has given me a clearer understanding of the types of geological knowledge they require. With this recent experience in mind, I was intrigued to see what types of geological information engineering students and professionals were being armed with in a standard textbook. I trust that this review provides a useful summary of the text regardless of your geological or engineering bent.

The main goal of ***Engineering Geology*** is to provide students and early-career professionals with a fundamental knowledge base in geology as it relates to application in engineering practice. The text achieves this by offering explanations of key processes and commonly encountered conditions, backed up by clear illustrations and examples, along with a comprehensive list of suggested further reading. The broad scope of this book makes it a highly relevant and comprehensible information source.

Chapter 1 presents information on the major rock types, their mineral composition, texture and structure. It introduces key processes in their formation, including volcanism, metamorphism and sedimentation. Importantly, the concepts of stratigraphy and geological time are also presented. Geological structures are then introduced in Chapter 2, with an initial focus on fold and fault types, including explanations of their formation and recognition. Discontinuities (joints, bedding planes, etc.), which influence rock shear strength, receive the most attention in this chapter. Introductory information regarding the identification, description, classification and assessment of structures is provided.

Surface processes, including physical and chemical agents of geomorphic change, are presented in Chapter 3. The impacts of physical, chemical and biological weathering on rock properties are discussed, as is engineering classification of weathered materials. Slope destabilisation and mass movement are explained. Fluvial processes, covering drainage development, basic hydrology and sediment transport are introduced. Karst development is addressed briefly, while glacial landforms are described in more detail. The action of wind in the drier landscapes is introduced, along with a brief mention of surface water erosion in this environment. A concise explanation of wave action leads into a discussion of coastal and shoreline erosion and deposition, followed by a short description of storm surge and tsunami.

Chapter 4 deals with the occurrence, movement and assessment of groundwater. Porosity and permeability in relation to aquifer yield and groundwater flow are explained in some detail. Groundwater exploration is addressed through the assessment of field permeability and flow, discussion of aquifer recharge, yield, and water quality and pollution issues.

The description, properties and behaviour of soils and rocks are dealt with in Chapter 5. It provides an introduction to soil classification for engineering purposes, and describes key characteristics significant in determining soil behaviour. Grain packing, compaction and clay activity, swelling and volume change are specifically addressed. The properties and behaviour of highly weathered tropical soils, dispersive soils, soils of the arid regions and those associated with glacial deposits are covered, as is the influence of frost action and organic matter. The procedure for describing rock masses is outlined and the engineering properties and behaviour of several major rock types are considered.

Chapter 6 explores the properties of building (dimension) stone, armourstone, and roofing and facing materials. Characteristics and applications of industrial materials such as aggregate, sand and gravel, lime cement are described, along with clay deposits, including their suitability for brick-making. Chapter 7 progresses to issues associated with site investigation. Reconnaissance study including the integration of existing soil, geological and remotely sensed data is addressed. Different methods of site exploration are presented, including direct methods such as soil sampling and drilling, and indirect methods such as in situ geotechnical, seismic and other geophysical tests. Map preparation for engineering purposes and the management of data within geographic information systems are also introduced.

The role of geology in planning and development is covered in Chapter 8. With a focus on natural hazard assessment, examples including earthquake, volcanic activity, landslide and coastal erosion are discussed in the context of using geological information for assessment and planning. Mine subsidence, domestic and industrial waste disposal and soil erosion are presented and discussed as examples of human-induced geological hazards. The closing part of this chapter touches on derelict and contaminated land.

The final chapter in this book deals with geology in construction, and brings together several of the concepts outlined earlier in the book. Excavation methods such as ripping, blasting and digging are discussed. Slope control and stabilisation is addressed, with particular credence given to reinforcement and drainage control. Tunnelling issues such as flooding, gas, structural stability and soft ground are presented. A large part of the subsequent section on tunnel excavation is devoted to the assessment of tunnel support and geotechnical criteria used in doing so.

Engineering Geology provides an excellent introduction to the basic geological concepts relevant to engineering practice. It is targeted primarily at undergraduate and post-graduate engineering geology students, but also represents a valuable resource for early-career professionals. I have no hesitation in recommending this book and would encourage lecturers to consider its suitability for undergraduate teaching.

Copies can be purchased direct from Elsevier Australia Customer Service, Tel: 1800 263 951, Fax: (02) 9517 2249 or email: service@elsevier.com

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The Earth's Magnetism: An Introduction for Geologists

by Roberto Lanza and Antonio Meloni

Publisher: Springer, 2006, 278 pp.

Price: $124.95, ISBN: 978-3-540-27979-2

Roberto Lanza and Antonio Meloni are senior Italian geophysicists at the University of Torino and Istituto Nazionale di Geofisica e Vulcanologia, respectively. The dust jacket biographies indicate that Lanza's research interests are palaeomagnetic, particularly in volcanological applications of rock magnetism, palaeosecular geomagnetic variation and archaeomagnetism. Meloni, on the other hand, specialises in observatory geomagnetism and conducts research into short and long-term magnetic-field variations. By and large, the contents of ***The Earth's Magnetism: An Introduction for Geologists*** reflect the authors' backgrounds and interests.

The book is in three parts. The first four chapters give a basic description of geomagnetism fundamentals: Earth's magnetic field, rock magnetism, magnetic prospecting and palaeomagnetism. The second four chapters describe applications of geomagnetism and explain the magnetic fabric of rocks, crustal magnetization, magnetic chronology and environmental geomagnetism. The short third section is a single chapter that traces the historical development of the science of geomagnetism.

The text is written in an uncomplicated style, is well formatted, and nicely supplemented with clear and well-captioned greyscale figures and four colour plates. I liked the structuring of the book into nine well-defined chapters each with its own list of recommended books and articles for further reading. I found the authors' treatment of each topic well pitched for readers who may not have a strong mathematical background or significant familiarity with geomagnetism.

Not unlike the Fiats made in Torino, however, the book has its idiosyncrasies. From time to time the construction of sentences or phrases is a little awkward (though the intended meaning is seldom obscured), there remain occasional spelling errors in the text, and full stops appear to have been intentionally omitted from the final sentence of every figure caption (apparently the publisher's habit). Foibles such as these are only minor detractions from the text.

Where does this book fit into the array of geomagnetic texts? I think it fills a neat niche by specifically tailoring its content to the geological applications and relevance of geomagnetism. I believe that geology students and scientists, whether in exploration, mining, environmental, or other research, will find this text a valuable resource in its own right and a helpful stepping stone to more-detailed treatments of topics in the recommended literature. I expect the book will also prove a useful resource for a wider readership who have broad Earth-science interests and who may not be specifically looking for depth of mathematical treatment.

The authors consider that they will have achieved their goal if their book stimulates readers to follow up on topics of interest in specialist books and the "vast geomagnetic literature". I believe this book will do just that. It is a helpful resource in itself and a valuable springboard for readers who may wish to delve deeper.

Copies can be ordered directly from http://www.springer.com or through your local book store.

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

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