Preview

Australian Society of Exploration Geophysicists

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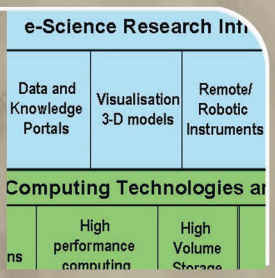

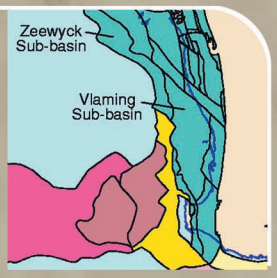

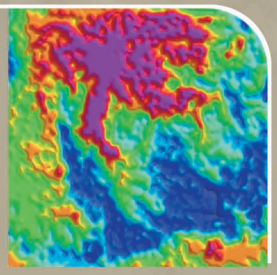

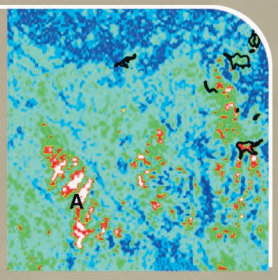

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Editor's Desk

David Denham

Feature articles

I hope you find the feature articles in this issue to be of interest. We have two contributions on how geophysics can be used in the fight against dryland salinity. We also have an article from Geoscience Australia, on where the new activities, which received special funding in the Budget (see *Preview* June 2003), will be taking place. Finally, we have an article on the GRID.

The GRID may be a new idea to some of our members. It offers a new way for doing business more efficiently, with greater computing power and with access to many more data sets. In fact, national and international grids are already operating in the environmental domains such as climate and oceanographic research, and also in astronomy.

Essentially GRID technologies offer more cost effective and accurate ways to integrate, in real time, geographically distributed data sets and hence achieve greater precision for locating and testing potential ore deposits as well as managing other natural resources.

GRID technologies will be built on the existing Internet and World Wide Web facilities and will have the capacity to vastly simplify access to distributed solid earth and environmental science databases. These technologies have become possible because of better data storage, faster computers, better software, and of course broad band access between computers world-wide. Anyway read all about it in *Preview*.

Science and Government

As Science Meets Parliament days approach it is worthwhile pausing to consider the huge number of inquiries that the government has instigated in the last year or so. Many of these relate to the geosciences and a summary of the inquiries and the reports is given below in Table 1.

As can be seen the bureaucrats have been busy writing reports, the stakeholders have been busy preparing submissions and the government has been busy holding more inquiries. We could probably do with a bit more action and a few less reviews, but that's not how the world seems to work these days.

One problem for the government is that the funding for Backing Australia's Ability will soon be coming to an end, and plans have to be in place for the May 2004 Budget, so that there is some certainty in shaping future research programs: hence the hurry.

Another problem is what to do with Higher Education, which is not in good shape right now. On this issue Dr Nelson was hoping to deliver some action, but, unfortunately for the government, the Senate is currently behaving in a hostile manner to his current set of proposals. So you can see why reviews are often favoured over action.

What happens next to his package is anyone's guess at the moment.

Cont'd on page 3

Issue	Investigation started	Report
Higher Education Review	April 2002	Our Universities: Backing Australia's Future; released June 2003 http://www.backingaustraliasfuture.gov.au/
House of Reps Standing Committee on Industry and Resources: Impediments to increasing investment in mineral and petroleum exploration	May 2002	August 2003; see website: http://www.aph.gov.au/house/committee/isr/resexp/contents.htm
National Research Priorities	May 2002	Announced by Prime Minister, December 2002 http://www.dest.gov.au/priorities/docs/overview.pdf
House of Reps Standing Committee	July 2002	Riding the Innovation Wave: The Case for Increasing Business Investment in R&DPublished June 2003 http://www.aph.gov.au/house/committee/scin/randd/report.htm#fullreport
Minerals Exploration Action Agenda	September 2002	July 2003; see website:http://www.isr.gov.au/library/content_library/minerals_aa_finalreport_July2003.pdf
Mapping Australia's Science and Innovation System	January 2003	October 2003
Evaluation of the CRC Program	March 2003, Howard Partners Pty Ltd contracted to do evaluation	228 page report released in August 2003Access on website: https://sciencegrants.dest.gov.au/CRC/HTMLDocuments/Documents/PDF/Report_CRC_Prog_Eval_July2003.pdf
Collaboration between universities and publicly funded research agencies	May 2003	November 2003
National Research Infrastructure Taskforce	July 2003	November? 2003 (see http://www.dest.gov.au/highered/ki_reforms/default.htm)

Table 1.

Halfway through our term is a good time to review how we are coming along with the things we said earlier in the year we were going to do.

First of all, if you want a reminder of what each of the committees is planning to achieve in the short to medium term, you can get it quite easily because the business plan is now available on our web-site. There is also a facility to give immediate feedback on the business plan, so if you see something you really do or don't like you can let us know before your excitement subsides.

The business plan starts with a number of expectations for the Executive Council. On the positive side, we are doing, in my opinion, very well in our interaction with other societies. The procedure manual has also gone live and is distributed. I have confidence that future meetings with the Representative Council will be as successful as the one we had half a year ago. Furthermore, we are planning to have a draft of the new constitution ready for input from the membership by the time you read this.

Realistically, we will adopt the new constitution at the 2004 AGM. However, there are also two areas where we need to improve to achieve our targets. One area is increasing corporate membership, which is falling a bit behind. So far, we are pleased to welcome Santos as a Corporate-Plus Member, but we still need four more companies to make our target. The other area that needs attention is the relationship between the Federal and the State Executive Committees. In the best of times we evidently don't progress beyond an almost total absence of communication. But unfortunately, there were also two instances of some friction. One caused by a misalignment of expectations in organising workshops. The other caused by control over funds. I am convinced that both the Federal and the State Committee involved could have benefited greatly from earlier and more frequent communication on these issues. The Federal Committee is aware that we will have to do better and we are currently discussing ideas on how to achieve this.

Klaas Koster

Some highlights from the other committees are: The Finance and Secretariat Committees have signed contracts for one year to continue services from our current suppliers. We have also put a monitoring system in place to get a better handle on the areas which demand most effort. By doing this we can ensure that these are the same areas that are the most important to our society. If there is a significant mismatch between required effort and its importance then we should reconsider that particular activity. We also made the decision not to hire a professional business manager for the society at this time. It was felt that this would be too large a financial commitment for the anticipated benefits. The Publications Committee has signed an agreement to start scanning Exploration Geophysics articles published before the switch to digital publications. This is an important step towards making all EG articles readily available via the internet. The Membership Committee made a proposal for a new form of membership which was unanimously approved. This 'affiliate' membership will give professionals with some interest in geophysics an opportunity to receive Preview and attend local meetings of the State/Territory Branch. The successes of the Technical Committee were already highlighted in the previous issue of Preview so they will not be repeated here.

To conclude this note, I would like to congratulate Brian Spies on his election as First Vice-President of the SEG. I am convinced that he will ensure that the SEG will pay sufficient attention to our region's interests in their planning.

Klaas Koster

Cont'd from page 2

Christmas wine offer

To end on a brighter note, we have in this issue of *Preview*, the annual notice for the ASEG Christmas wine offer. With great dedication and application, the SA Branch has completed the arduous and demanding job of tasting and ranking a whole plethora of whites and reds from South Australia. I am sure they will be once again great value for money, so get your order in early.

Happy reading.
David Denham

Aims and Scope

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

Contents

The material published in *Preview* is neither the opinions nor the views of the ASEG unless expressly stated. The articles are the opinion of the writers only. The ASEG does not necessarily endorse the information printed. No responsibility is accepted for the accuracy of any of the opinions or information or claims contained in *Preview* and readers should rely on their own enquiries in making decisions affecting their own interests. Material published in *Preview* becomes the copyright of the Australian Society of Exploration Geophysicists.

Contributions

All contributions should be submitted to the Editor via email at denham@atrax.net.au. We reserve the right to edit all submissions; letters must contain your name and a contact address. Editorial style for technical articles should follow the guidelines outlined in *Exploration Geophysics* and on ASEG's website www.aseg.org.au. We encourage the use of colour in *Preview* but authors will be asked in most cases to pay a page charge of $440 per page (including GST for Australian authors) for the printing of colour figures. Reprints will not be provided but authors can obtain, on request, a digital file of their article, and are invited to discuss with the publisher, RESolutions Resource and Energy Services Pty Ltd, purchase of multiple hard-copy reprints if required.

The text of all articles should be transmitted as a Word document. Tables, figures and illustrations should be transmitted as separate files, not embedded in the Word document. Raster images should be supplied as high-resolution (300 dpi) tiff files wherever possible. Vector plots can be supplied using software packages such as Corel Draw or Illustrator. Illustrations produced in any other software packages should be printed to postscript files. Authors are encouraged to contact the publisher, RESolutions, for information to assist in meeting these requirements.

Deadlines

Preview is published bi-monthly, February, April, June, August, October and December. The deadline for submission of all material to the Editor is usually the 15th of the month prior to the issue date.

Advertisers

Please contact the publisher, RESolutions Resource and Energy Services Pty Ltd, (see details elsewhere in this issue) for advertising rates and information. The ASEG reserves the right to reject advertising, which is not in keeping with its publication standards.

Advertising copy deadline is the 22nd of the month prior to issue date. Therefore, the advertising copy deadline for the December 2003 issue will be 15 November 2003. A summary of the deadlines is shown below:

Preview Issue	Text & articles	Advertisements
107 Dec 2003	15 Nov 2003	22 Nov 2003
108 Feb 2004	15 Jan 2004	22 Jan 2004
109 Apr 2004	15 Mar 2004	22 Mar 2004
110 June 2004	15 May 2004	22 May 2004

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Publisher: Brian Wickins
RESolutions Resource & Energy Services Pty Ltd
Tel: (08) 9446 3039
Fax: (08) 9244 3714
Email: brian@oilfield.com.au

Editor: David Denham
7 Landsborough Street, Griffith ACT 2603
Tel: (02) 6295 3014
Email: denham@webone.com.au

Associate Editors:
Petroleum: Mick Micenko
Email: micenko@bigpond.com

Petrophysics: Don Emerson
Email: systems@lisp.com.au

Minerals: Peter Fullagar
Email: p.fullagar@mailbox.uq.edu.au

Engineering, Environmental & Groundwater:
Geoff Pettifer
Email: g.pettifer@geo-eng.com.au

Book Reviews: David Robinson
Email: david.robinson@ga.gov.au

ASEG Head Office & Secretariat: Glenn Loughrey
AMCO Management Pty Ltd
PO Box 42, Everton Park Qld 4053
Tel: (07) 3855 8144
Fax: (07) 3855 8177
Email: secretary@aseg.org.au
Web site: http://www.aseg.org.au

Federal Executive 2003[1]

President: Klaas Koster
Tel: (08) 9348 5762
Email: klaas.koster@woodside.com.au

1st Vice President: Howard Golden
Tel: 08 9479 0576
Email: howard.golden@wmc.com

2nd Vice President: Jenny Bauer
Tel: (07) 3858 0601
Email:
jenny.bauer@upstream.originenergy.com.au

Honorary Treasurer: John Watt
Tel: (08) 9222 3154
Email: john.watt@mpr.wa.gov.au

Honorary Secretary: Lisa Vella
Tel: (08) 9479 8476
Email: lisa.vella@wmc.com

Past President and International Affairs:
Kevin Dodds
Tel: (08) 6436 8727
Email: kevin.dodds@csiro.au

Publications Committee: Terry Crabb
Tel: (02) 6230 1211
Email: tcrabb@sms.com.au

ASEG Research Foundation: Phil Harman
Tel: (03) 9909 7699
Email: phil.harman@mineraldeposits.com.au

Membership Committee: Koya Suto
Tel: (07) 3876 3848
Email: koyasuto@optusnet.com.au

Helen Anderson
Tel: (08) 9273 6400
Email: handerson@fugroairborne.com.au

David Howard
Tel: (08) 9222 3331
Email: david.howard@doir.wa.gov.au

Barry Smith
Tel: (02) 9247 9324
Email: bsmith@mosaicoil.com

ASEG Branches

ACT
President: David Robinson
Tel: (02) 6249 9156
Email: david.robinson@ga.gov.au

Secretary: Ben Bell
Tel: (02) 6249 9828
Email: ben.bell@ga.gov.au

New South Wales
President: Stephen Webster
Tel: (02) 9858 5559
Email: swebster@sneaker.net.au

Secretary: Michael Moore
Tel: (02) 9901 8398
Email: moorem@minerals.nsw.gov.au

Northern Territory
President: Gary Humphreys
Tel (08) 8999 3618
Email: gary.humphreys@nt.gov.au

Secretary: Roger Clifton
Tel: (08) 8999 3853
Email: roger.clifton@nt.gov.au

Queensland
President: Werner Dutler
Tel: (07) 3228 6514
Email: werner.dutler@santos.com

Secretary: Natasha Hui
Tel: (07) 3228 6813
Email: natasha.hui@santos.com.au

South Australia
President: Graham Heinson
Tel: (08) 8303 5377
Email: graham.heinson@adelaide.edu.au

Secretary: Tania Dhu
Tel: (08) 8344 4518
Email: tania.dhu@student.adelaide.edu.au

Tasmania
President: Michael Roach
Tel: (03) 6226 2474
Email: roach@geo.geol.utas.edu.au

Secretary: James Reid
Tel: (03) 6226 2477
Email: james.reid@utas.edu.au.

Victoria
President: James Cull
Tel: (03) 9905 4898
Email: jcull@earth.monash.edu.au

Secretary: Ashley Grant
Tel: (03) 9558 8333.
Email: ashley.grant@nre.vic.gov.au

Western Australia
President: Kirsty Beckett
Tel: 0402 436 663
Email: kirsty.beckett@geophy.curtin.edu.au

Secretary: Megan Evans
Tel: (08) 9382 4307
Email: m.evans@td.iinet.net.au

[1] *Members of the standing and ad hoc committees are listed on the ASEG website*

2003

November 2–5 2003
Annual Meeting of the Geological Society of America (GSA)
Venue: Seattle, Washington, USA
Website: www.geosociety.org/meetings/index.htm

December 8–12 2003
2003 AGU Fall Meeting
Venue: San Francisco, California, USA
Website: www.agu.org/meetings/fm03/

2004

February 8–13
Geological Society of Australia
17th Australian Geological Convention, Hobart, Tasmania
Theme: Dynamic Earth: Past, Present and Future
Website: www.17thagc.gsa.org.au

February 22–26
EEGS Annual Meeting and Exhibition (SAGEEP)
Theme: Geophysics and Global Change—Turning challenges into opportunities
Venue: Colorado Springs, USA
Website: www.sageep.info

March 28–31
APPEA Conference & Exhibition
Venue: National Convention Centre, Canberra
Contact: jhood@appea.com.au
Website: www.appea.com.au/Events/AppeaEvents.asp

March 31–April 4
International Conference and Exposition (SEG Beijing/SPG/SEG) - postponed from 2003
Venue: Beijing, China
Website: www.spgol.org

May 17–21
Joint Meeting: AGU and the Canadian Geophysical Union (CGU)
Sponsors: AGU, CGU
Venue: Montreal, CANADA
Website: www.agu.org/meetings

June 7–11
66th EAGE Conference and Exhibition, Paris, France
Website: www.eage.nl

August 15–19
ASEG, in collaboration with PESA
17th International Conference and Exhibition,
Theme: Integrated Exploration in a Changing World
Venue: Sydney Convention Centre, Sydney NSW
Website: www.aseg-pesa2004.org.au

September 19–22
Pacrim 2004
Theme: Hi Tech and World Competitive - Mineral Success Stories Around the Pacific Rim
Adelaide, SA
Website: www.ausimm.com

September 27–October 1
SEG 2004
Theme: Predictive Mineral Discovery Under Cover
Sponsor: Society of Economic Geologists, Society of Geology Applied to Mineral Deposits and Geoconferences (WA) Inc.
Venue: Perth, WA
Website: www.cgm.uwa.edu.au/geoconferences/seg2004/index.asp

October 10–15
SEG International Exposition & 74th Annual Meeting
Venue: Denver, Colorado, U.S.
Website: www.seg.org

December 13–17
2004 AGU Fall Meeting
Venue: San Francisco, California, U.S.A.
Website: www.agu.org/meetings

Key reports on resource exploration delivered to government

In 2002, The Minister for Industry, Tourism and Resources, Ian Macfarlane, initiated two inquiries into mineral and petroleum exploration in Australia. The first was undertaken by the House of Representatives Standing Committee on Industry and Resources (chaired by Geoff Prosser) into impediments to increasing investment in mineral and petroleum exploration in Australia. The second was prepared by a Strategic Leaders Group for the Mineral Exploration Action Agenda. The reports from these inquiries have now been made public and are available on the web at: http://www.aph.gov.au/house/committee/isr/resexp/contents.htm, and http://www.isr.gov.au/library/content_library/minerals_aa_finalreport_July2003.pdf, respectively.

The Mineral Exploration Action Agenda report contains 12 recommendations covering four main issues: *Access to Land, Finance, Geoscience Information and Human Resources*.

The recommendations are as follows:

1. Develop regional template agreements to resolve native title and heritage issues;
2. Encourage use of the expedited procedure in the *Native Title Act 1993*;
3. Amend the *Aboriginal Land Rights (NT) Act 1976* to facilitate the decision-making process;
4. Develop a coordinated national approach to resolve impediments to land access
5. Introduce a flow-through shares scheme;
6. Introduce a general tax deduction uplift factor for greenfields exploration expenditure;
7. Implement the full deductibility of all costs associated with Native Title requirements;
8. Undertake a major pre-competitive geoscience survey program to achieve national coverage to modern standards of basic geoscience datasets;
9. Develop nation-wide protocols, standards and systems for internet-based access to all exploration related data;
10. Launch a '50 early-career explorer' scheme for new graduates and holders of doctorates;
11. Increase higher education funding for geoscience; and
12. Establish a deep ore discovery research and development program.

The Prosser Inquiry, which covered both petroleum and mineral exploration made 28 recommendations. They covered similar issues:

1. Corporate Structure, Capital Raising and Taxation;
2. Pre-Competitive Geoscience Data Acquisition;
3. Geoscience Research and Education;
4. Titles;
5. Exploration and Native Title;
6. Environmental and Other Approval Regimes; and
7. Resources Exploration and the Community.

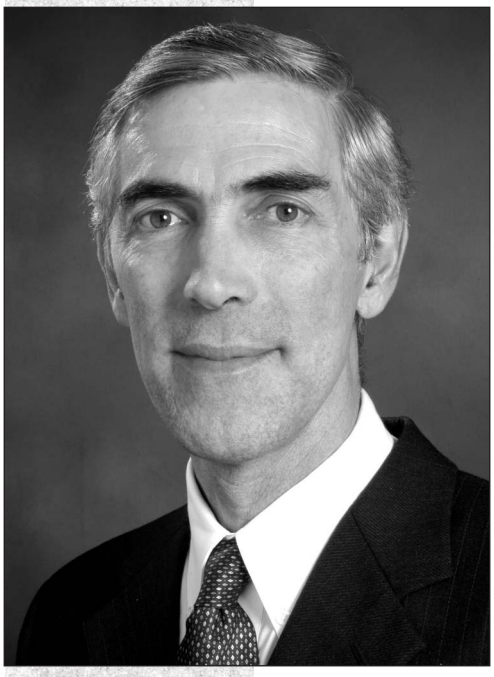
In many respects both reports cover similar ground: incentives to raise capital for exploration, more pre-competitive geoscience information, larger investment in geoscience research and education, nationally consistent exploration title management and simpler procedures for land access. However, there are some interesting recommendations in the Prosser report that deserve a mention. I will just pick out three.

The first calls for additional funds for Geoscience Australia to accelerate onshore pre-competitive data acquisition programs; the second calls for an airborne gravity gradiometry survey of the Australian landmass; and the third calls for an Advisory Board to oversee the GA programs of data acquisition. All matters of interest to the ASEG members.

The recommendations from both reports would make a huge contribution to the wealth of the nation if they are implemented. I recommend that members read both reports and write to government ministers and their MPs urging acceptance and implementation by government of the main recommendations. The difficult work of getting money from the 2004/05 budget to implement the recommendations is only just starting. Minister Macfarlane will have to convince the likes of Peter Costello (The Treasurer) and Nick Minchin (the Minister for Finance) that the funds required to implement the recommendations are important, and in the best interests of the nation. This may not be easy.

Eristicus

Brian Spies elected 1st Vice-President of the SEG



Congratulations to Brian Spies, who has just been elected 1st Vice-President of the SEG for 2003/2004. This is the third time an Australian has been on the SEG Executive (Norm Uren was VP in 1995/96, and Brian was Secretary-Treasurer in 1996/97).

Brian Spies is a Past-President of the ASEG and has 30 years experience in research and management roles in the petroleum and minerals sector in Australia and the USA. Brian holds a BSc from the University of NSW and a PhD from Macquarie. His early contributions to exploration geophysics include the development of the TEM method in the 1970s at the Bureau of Mineral Resources. He later found that physical laws conspired to favour the TEM time range 1 to 10 ms, which penetrates 80 m of regolith at Cobar, 1500 m of basalt in the Columbia Plateau, and 1/2 inch of steel pipeline on Alaska's north slope.

Brian's present activitites at CSIRO Exploration and Mining at North Ryde include work on the Commonwealth government's *Minerals Exploration Action Agenda, and the Review of Salinity Mapping Methods in the Australian Context*, funded by Environment Australia and Agriculture Forestry and Fisheries Australia (AFFA) to evaluate the range of methods available in Australia for mapping the extent and severity of dryland salinity.

Brian recently completed a three-year secondment to the Australian Nuclear Science and Technology Organisation (ANSTO) where, as Director of Physics Division, he coordinated a broad spectrum of interdisciplinary research and services based on nuclear techniques and synchrotron radiation. From 1996-2000, Brian was director of the CRC for Australian Mineral Exploration Technologies which, among other products, developed and commercialised the TEMPEST airborne EM system, and the EM Flow and EM vision software suites.

In the 1980s Brian was based in the USA at research laboratories at Arco Oil and Gas Company and Schlumberger-Doll Research. There he worked in seismic exploration, developed new techniques for non-destructive testing of oil pipelines, and pioneered imaging methods for characterising and monitoring deep petroleum reservoirs.

Brian is an active promoter of the science and profession of geophysics and holds numerous editorial and honorary positions. He was elected a fellow of the Australian Academy of Technological Sciences and Engineering in 1998, and is a recipient of the Centenary Medal. During his upcoming tenure on the SEG Executive, Brian will look at ways that SEG can better serve the profession in this part of the world, and best address the changing demographics and interests of its members.

Brian can be contacted at: brian.spies@csiro.au

New book review editor for Preview

We welcome a new book review editor to Preview, David Robinson.

David is the President of the ACT Branch of the ASEG and works in the Minerals and Geohazards Division at Geoscience Australia. He should be acquiring lots of interesting books to review and those who are interested in helping in the job of reviewing should contact David at david.robinson@ga.gov.au.

Ken McCracken receives Haddon King Medal

Congratulations to Ken McCracken who was awarded the Haddon King medal in August. Ken is Managing Partner of his company, Jellore Technologies, and a senior research associate, University of Maryland, USA. Ken is an Honorary Member of the ASEG of which he has been a member since 1970. He received his BSc and PhD from the University of Tasmania and his DSc from the University of Adelaide. He has won several prestigious awards including the CSIRO Medal in 1988 and he was a joint recipient of the Australia Prize in 1995.

Ken McCracken has made substantial and sustained contributions to the prosperity of Australia through the development of the scientific basis for new technologies for mineral exploration in the highly weathered Australian continent.

Commencing in 1970, he created and led the CSIRO Division of Mineral Physics that provided a new understanding and capability for geophysical exploration - time domain EM; mathematical inversion of geophysical data; satellite remote sensing; and advanced radiometrics to name several.

He made major intellectual contributions to understanding 'time domain EM' and to the development of SIROTEM, which became one of the most used exploration tools, worldwide. Leaving CSIRO in 1989 he subsequently led the development of a new airborne EM exploration system SALTMAP and was instrumental in the identification of military technology that adapted to become the world's first airborne gravity mapping technology in 1999. Two airborne gradiometers are now in operational use by BHP and its exploration partners. The developments from his CSIRO Division and from the period since 1989 were immediately embraced by the exploration community and have contributed in a major way to the scientific and professional capability of Australian geophysics over the past several decades.

The Haddon King Award recognises the contributions of the late Haddon Forrester King to the application of the geological and related sciences to the search for mineral deposits in Australia and elsewhere. Haddon King joined Zinc Corporation as its Chief Geologist in 1946, became Director of Exploration for the merged Conzinc Rio Tinto of Australia (CRA) in 1962 and continued in this capacity until his retirement in 1970. He was a consultant to CRA until 1986. The award is made to a scientist for original and sustained contributions to earth and related sciences of particular relevance to the discovery, evaluation and exploitation of useful mineral deposits, including the hydrocarbons.

Past recipients of the award are:

1993	Frank Rickwood and Roy Woodall
1996	Richard Sillitoe
1998	Richard Stanton, and
2001	John P Hunt

New Members

ASEG welcomes the following new members to the Society. Membership was approved by the Federal Executive at its meetings on 30 July and 27 August 2003

Name	Organisation	State
Triegue Scott Allen	Santos Limited	Qld
Dominic John Howman	Curtin University	WA
Wataru Kato	ECL Australia	WA
Gracjan Plotr Lambert	Curtin University	WA
Duncan Alistair Lockhart	Troy-Ikoda	WA
Amy Elizabeth Lockheed	University of Adelaide	SA
Ramin Nikrovz	University of NSW	NSW
Robert Parums	Geoscience Australia	ACT
JurzaJurza Pavel		WA
Kate Marie Pfeiffer	University of Adelaide	SA
Luke Nicolas Tylkowski	University of Adelaide	SA
Edeltraud Irene von Furt	University of Adelaide	SA

The August Board Meeting held at Australian Technology Park, Eveleigh, provided a chance for Sydney-based representatives of PESA, ASEG, GSA and AIG to hear an address by the President of FASTS, and to participate in a question and answer session. The geoscientists made lively contributions. Dinner afterwards allowed further exchange with FASTS Board members and with a staff member from Brendan Nelson's office. FASTS has offered to assist AGC in promoting the recommendations from the Minerals Exploration Action Agenda.

Next day, the Board reviewed the budget for 2003-04, discussed ways of promoting the role of women in science, and heard of steps to develop the parliamentary science fellows program (see www.fasts.org). Considerable discussion of the recent Nelson reforms to Higher Education, led by two guest speakers, identified the strategy for the response by FASTS, due on 15 August. The AGC has also made a submission.

The current planning for 'Science Meets Parliament' in Canberra during October 14 and 15 focused on the industry dinner ('science and the investor') and on ideas for the key issues for scientists to discuss with MPs. Favourites are higher education and the national research priorities. I suggested the catch phrase "*Australia has the Answers—Sustain our National Research Agencies*" (supported by good news stories from CSIRO, GA, ANSTO etc). This idea is intended as a strong positive statement, provided these agencies are given support, so that Australian researchers are equipped to deliver solutions to critical problems. Interested geophysicists should see the review of SmP 2002 and the timetable for SmP 2003 on www.fasts.org where online registration is also available.

The Board then discussed problems facing CSIRO, including recent staff cuts. Recommendations from the Board sub-committees on communications, structure and policy were debated and approved. The next meeting of the Board is in Canberra on 16 October.

Mike Smith
Geoscience Representative

Conference Website Goes Live

aseg-pesa2004.org.au

The website for the ASEG-PESA 2004 Conference went live on the 29th August. Over the next 12 months it will become the key source of information for the conference, which is to be held at the Sydney Convention and Exhibition Centre, Darling Harbour, from 15-19 August 2004. As the largest technical forum in the Australasian region (with up to 1000 delegates anticipated), the ASEG Conference attracts wide interest in the exploration industry, particularly when it is held in Australia's most populous and alluring city.

The theme of the conference, *Integrated Exploration in a Changing World*, will challenge delegates to optimise their present and future exploration efforts as economic conditions evolve both locally and globally. An initial call for papers was announced as the website went live. The conference edition of *Preview* will contain all abstracts and author biographies/photos. Selected extended abstracts will be published in the ASEG journal *Exploration Geophysics*. The deadline for brief abstracts is 14th November 2003. The Call For Papers Flyer can be downloaded from the website under 'Technical Program'. The full Technical Program will be published on the website early in 2004.

There will be many other upgrades to the website over the next 12 months as further conference information becomes available. A full registration brochure will be available early next year, as will details of workshops and field trips. A number of workshops will be held in conjunction with the conference. To date one has been announced, the Deepwater - SEG Distinguished Instructor One-Day Short Course by Paul Weimar. If you are interested in attending or presenting a workshop go to the 'Workshops' page for further information. The provision of pre or post conference field trips is currently under review. Information regarding these trips will be posted on the 'Field Trips' page.

One of the principal aims of the conference is to attract the participation of genuinely interested high-school teachers and students in Years 10 to 12. Teachers and students will be invited to attend one day at the conference free of charge. The day will include a variety of presentations, which aim to show the wide range of career paths that are possible within our industry, including environmental, groundwater and geotechnical investigations, space exploration, and earthquake monitoring, in addition to the more traditional applications in petroleum and minerals exploration. Further details can be found on the 'Student Day' page of the website.

Veritas has become the first Gold Sponsor for the conference and will be supporting the Conference Welcome Reception. At this early stage many sponsorship opportunities remain, in all five categories (Platinum, Gold, Silver, Bronze and event-specific), although a number of sponsorship packages are close to being taken up. Contact Louise Pitney at Conference Action (louise@conferenceaction.com.au) for further information.

Companies intending to exhibit at the conference will find the particulars they need on the 'Exhibitors' page. The trade exhibition will be open from 5pm Sunday 15th to 6pm Wednesday 18th August 2004. First allocations of booth preference will be made on submissions received by 31st October, 2003. Applications received after this date will be allocated space on an availability basis, so register early to secure a prime position.

Accommodation and travel arrangements are already well under way. Rooms have been secured at five hotels. Pricing details will be available shortly on the 'Accommodation' page. Qantas is supporting the conference by offering up to 40% off the full economy class airfare, with very favourable conditions (tickets can be purchased up to the day of departure, date changes are permitted, tickets are refundable and delegates may travel up to seven days either side of the conference). See the 'Travel' page for details. A number of social activities are being planned. The conference dinner will be a ripper, as will the harbour cruise and golf tournament. Preliminary arrangements are on the 'Social Program' page.

To register your interest in the conference and to receive further conference information as it becomes available, go to the 'Registration' page of the website or email aseg-pesa2004@conferenceaction.com.au.

By Koya Suto

SEGJ 108th Conference: some personal observations

In May this year I attended the 108th Conference of the Society of Exploration Geophysicists of Japan (SEGJ), which was held in the International Congress Centre of Waseda at University in Tokyo.

Conference of Non-Frills

The SEGJ has two conferences each year, in Tokyo during May and at another location in October; hence this is the 108th conference in its 55-year history. The conferences used to be held at a university campus using lecture theatres. As the society grew, the events moved to hotels, commercial conference halls and sometimes in special conference facilities on university campuses. However, the financial and organisational resources of the society and its individual and corporate members could be severely strained because of the frequency of the meetings. Consequently, SEGJ conferences are quite different from the ASEG and the SEG.

The SEGJ does not use a professional conference organiser and the permanent secretariat carries out most of the organisation, with a few committee members assisting on technical matters. This is possible because the scope of the conferences are limited to technical sessions, the Annual General Meeting and associated ceremonies, invited speakers, a reception and a small exhibition. The SEGJ does not collect special sponsorship for the conference, because there are 160 corporate members providing 320 units of sponsorship.

There are no workshops or courses with the conference because the SEGJ organises a number of workshops separate from the conferences. Unlike Australia, Japan is small enough to travel easily and cheaply to a workshop venue. In any case, about 1000 of its 1500 members live in Tokyo or its surroundings. Therefore the conferences are not necessarily a special opportunity to attract large workshop participants.

Presentation of Unfinished Work

The main difference I noticed was the presentations of unfinished work. These presentations typically start like, "This is an interim report at the end of the third year of the five-year project", or "I have just completed the second year of the PhD course, and here I will present my results so far", and there are many of them. It is interesting to hear the many comments from the floor to the presenters, and sometimes the Chairman had to defer the heated discussion to the intermission after the session. This certainly adds new ideas to the projects and is beneficial to the presenters. It also enhances concurrency of the research projects.

If a presentation is limited to completed works, there is no way for the project owners to learn from feedback at the conference and audiences only hear talks on topics that are a few years old.

Target-Based Sessions

The SEGJ adopted a new format for the conference by sorting sessions based on targets rather than technique. For example, the 'Civil Engineering Application I' session included applications of seismic, magnetic electric and electromagnetic methods on various engineering problems. In this way, 'specialists' of one method can learn other methods for similar application.

This format was popular and some sessions attracted an audience larger than the capacity of the session room.

Dominance of Government Projects

I felt there were very many government-led projects. These are mainly geophysical applications to civil engineering and environmental projects. Resource exploration is dominated by private enterprises, as there is an incentive: any discovery becomes property of the company. However,

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The 17th Australian Geological Convention will be held at Wrest Point Casino, Hobart, from February 8th to 13th, 2004. The conference will be the biggest geoscientific meeting in Tasmania since the 1998 ASEG Conference and it is envisaged that there will be a strong geophysical presence. To this end, conference organisers have planned dedicated sessions on regional mineral exploration and environmental geophysics, with emphasis being placed on the interpretation of geophysical data. It is also expected that a number of geophysical papers will be presented in other conference sessions, including 'Exploration for Broken Hill - type Deposits, 'Regolith and Environment' and 'Tectonics and Hydrocarbon Exploration', to name a few. The deadline for the submission of abstracts has now passed, and details of the final program will be available shortly at www.17thagc.gsa.org.au.

The ASEG has supported the geophysical sessions at the conference through advertising in the August issue of *Preview* and an email call for abstracts, distributed to all ASEG members. In particular, Helen Anderson is thanked for her help in organising these and keeping the ball rolling over the last few months.

Speaking of conferences, great progress is being made towards preparations for the ASEG-PESA Conference, to be held in Sydney, in August 2004. Corporate sponsorship is being sought, the call for papers has gone out, exhibitor invitations will be going out shortly, and there has been promotion of the conference in a number of journals. The wheels are in motion for another excellent conference. Watch this space...

Lisa Vella
Honorary Federal Secretary

James Reid
Secretary, Tasmania Branch

Cont'd from page 12

projects such as the construction and maintenance of major highways and railways, monitoring illegal dumping sites, and research on the behaviour of groundwater in landfills have to be done by local or state government. Many of these projects were presented in the conference.

As Japan is poor in natural resources, exploration for resources is an important national priority. It is well known that the government subsidises petroleum exploration by Japanese companies. The government also undertakes exploration programs using local contractors and the data are shared by the exploration companies. This is similar to what BMR/AGSO/GA have been doing over the years, but the Japanese government goes further. It shot two large offshore 3D seismic surveys for methene-hydrate, and followed by drilling several reconnaissance wells. If the exploration permit is offered, exploration companies are ready to drill for resources using only the government's data.

Tea or No Tea Time

The session times of the SEGJ Conference were generally long, and sometimes exceeded two and half-hours before a break. Although I liked hearing the enthusiastic presenters and learning new techniques, my little brain felt saturated after a while.

ASEG conferences always have morning and afternoon tea-time, perhaps from the English tradition. This is essential for out-of-session discussions and browsing the exhibition. If the breaks were short, exhibitors would complain (By the way, there were eight exhibitors in this conference—more than usual). I suggested that the SEGJ should increase tea break times, so that delegates can discuss research and business, and make network contacts in the industry.

In Summary

I thoroughly enjoyed attending this conference. Most of the presentations were in Japanese and many were on civil engineering, environmental monitoring, geothermal exploration and gas hydrate exploration. However, advanced theoretical and modelling studies in each technique applicable to 'traditional' resource exploration were also presented. I also had an opportunity to use the part of my brain, which is not often used in Australia.

Australian Geological Surveys and Departments of Minerals and Petroleum

By Margarita Norvill

Email: margarita@geophy.curtin.edu.au

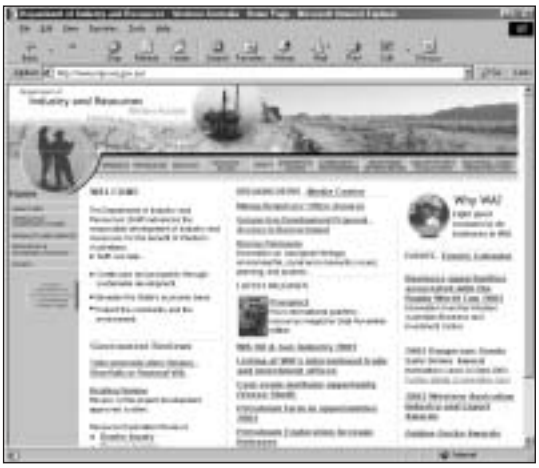
Each State and Territory of Australia has its own department of minerals and petroleum resources (except the ACT). The Geological Surveys are incorporated into these departments. The purpose of the departments is to produce and promote up to date geoscientific information on the state or territory to encourage the mineral and petroleum exploration industries.

These departments are valuable assets for anyone involved in the exploration, mining or petroleum industries. They are responsible for geological and geophysical records, mine safely legislation, exploration licenses and native title.

Departments record and interpret the geology of the state or territory and evaluate mineral and petroleum reserves. They oversee the development and conservation of mineral and petroleum resources and produce a wide range of maps and publications to provide a geoscientific framework for exploration of the state or territory.

The departments receive applications and allocate titles that give legal rights to explore for and mine minerals in their state or territory. They also oversee mine safety and promote safety and health in the industry.

Department of Mineral and Petroleum Resources Western Australia ★★★★

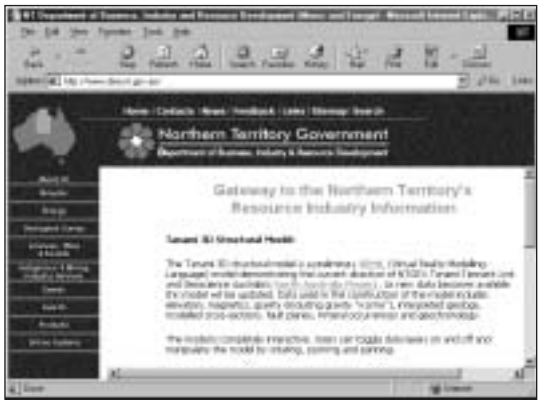


http://www.mpr.wa.gov.au/

The Department of Mineral and Petroleum Resources Western Australia was formed on 1 July 2001 from the amalgamation of the Department of Minerals and Energy and the Department of Resources Development. The website broadcasts a comprehensive calendar of events, both local and international variety, from SEG to caving, geomechanics and world food market conferences.

The Department of Industry and Resources publishes *Prospect* magazine, which is produced quarterly. Each publication contains articles about mineral and petroleum developments, as well as processing projects. Each issue features a map identifying significant resource projects in the State that have been either commissioned or planned. The magazine also contains regular economic and resource indicators, which compare Western Australia's performance with the rest of Australia. The August issue of *Prospect* looks at sustainable development.

Department of Business Industry and Resource Development Northern Territory
http://www.dme.nt.gov.au/ ★★★★½



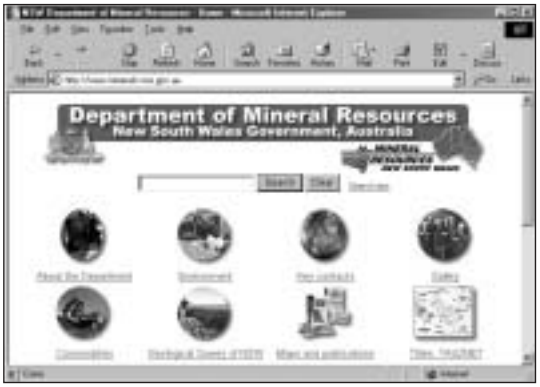
The Department of Business, Industry and Resource Development was established on 13 November 2001. It incorporates the major business, industry and resource development functions of the former departments of Mines and Energy, Primary Industry and Fisheries, Industries and Business and Asian Relations and Trade. The site includes comprehensive write-ups of operational, closed and proposed mine sites. There is an excellent facility for viewing geophysical data sets with the capacity to overlay datasets and vary their transparencies. This site links to the Northern Territory Geological Survey site, (http://www.dme.nt.gov.au/ntgs/index.html) which contains detailed information on regional geoscience and mineral resources programs.

Primary Industry and Resources South Australia
http://www.pir.sa.gov.au/ ★★★

One of the products available for purchase on this website is the 'minerals identification and uses kit'. The kit develops skills in identifying and naming minerals and gives examples of their uses. It contains twelve mineral samples, appropriate identification tools, a laboratory book of instructions and educational examples. A great gift idea for younger friends.

Natural Resources and Mines Queensland
http://www.nrm.qld.gov.au/ ★★★
This website provides information on fossiking areas, inlcuding permits and camping and accomodation information. Information on the occurences and descriptions of native gemstone such as opal and chrysoprase are also avaliable.

Department of Mineral Resources New South Wales
http://www.minerals.nsw.gov.au ★★★★½



The Department of Mineral Resources New South Wales is divided into five Divisions: Geological Survey of New South Wales, Resource Planning and Development Division, Mine Safety and Environment Division, Strategic Planning and Policy Division and a Corporate Services Division.

The site enables airborne geophysical maps to be quickly viewed prior to purchase and provides a dedicated geologist called Bill who will do his best to answer any general questions the public have on geology. The site has an excellent petroleum database of well locations, core cuttings, wireline logs, seismic shot points, seismic sections and tapes. There is also a superb MinView data viewer for petroleum resources.

Department of Primary Industries Minerals and Petroleum Victoria
http:// www.dpi.vic.gov.au ★★★★

Geoscientific data packages covering most of Victoria have been compiled on to CD-ROM and are available free of charge. The data packages are a combination of GIS layers and geoscientific databases. Available on the CD are geology, exploration geochemical data, regolith geology, geological interpretation of geophysics, magnetics, radiometrics, digital terrain, gravity, mineral occurrences and production, exploration and mining title boundaries, roads, towns and map sheets.

The department produces *Discovery* magazine, published quarterly. Each issue contains the latest news concerning Victoria's minerals, oil and gas and extractive industries. Subscription is available free of charge.

Mineral Resources Tasmania
http://www.mrt.tas.gov.au/ ★★★★
Mineral Resources Tasmania is a Division of the Department of Infrastructure, Energy and Resources. There are many reports available on the geology and geophysics of the State. Geophysical data maybe downloaded for free of charge. The site is very clear to navigate and possess ample data and document searches.

Australian Government Geoscience Australia
http://www.agso.gov.au/
★★★★★

The AGSO site is very comprehensive with information on nuclear explosions conducted worldwide, great satellite imagery, and recent earthquake activity. There are free GIS downloads including topographic, thematic, geology, geophysics, satellite imagery, geodetic and GPS data. The site also features a great educational section covering geography, climate change, plate tectonics and geology.

The site houses one of the world's largest collections of petroleum data. Much of this data is open file and available to the public. Data includes digital seismic field and processed data, seismic sections, digital well log data, reports and fluid and gas samples.

Star Rating
The star rating is calculated from estimates of the following parameters:

Content/information available on web pages	2
Navigation friendly	1
Aesthetically Pleasing	1
Currency	1
TOTAL	5

Geoscience Australia

Airborne Gravity Survey - West Arnhem Land, Northern Territory

Geoscience Australia in collaboration with the Northern Territory Geological Survey, Cameco Australia Pty Ltd and Rio Tinto Exploration Pty Ltd, have funded an airborne gravity survey over part of West Arnhem Land in the Northern Territory. See diagram below.

The survey was carried out between 30 August and 15 September 2003.

Lines were flown in an east-west direction at a line spacing of 2 km, with a constant barometric flying height of 600 m above mean sea level.

Fugro Airborne Surveys Pty Ltd, using a Russian-developed GT1-A airborne gravimeter operated by Canadian Micro Gravity Pty Ltd, flew the survey which comprised a total of 4516 line-km.

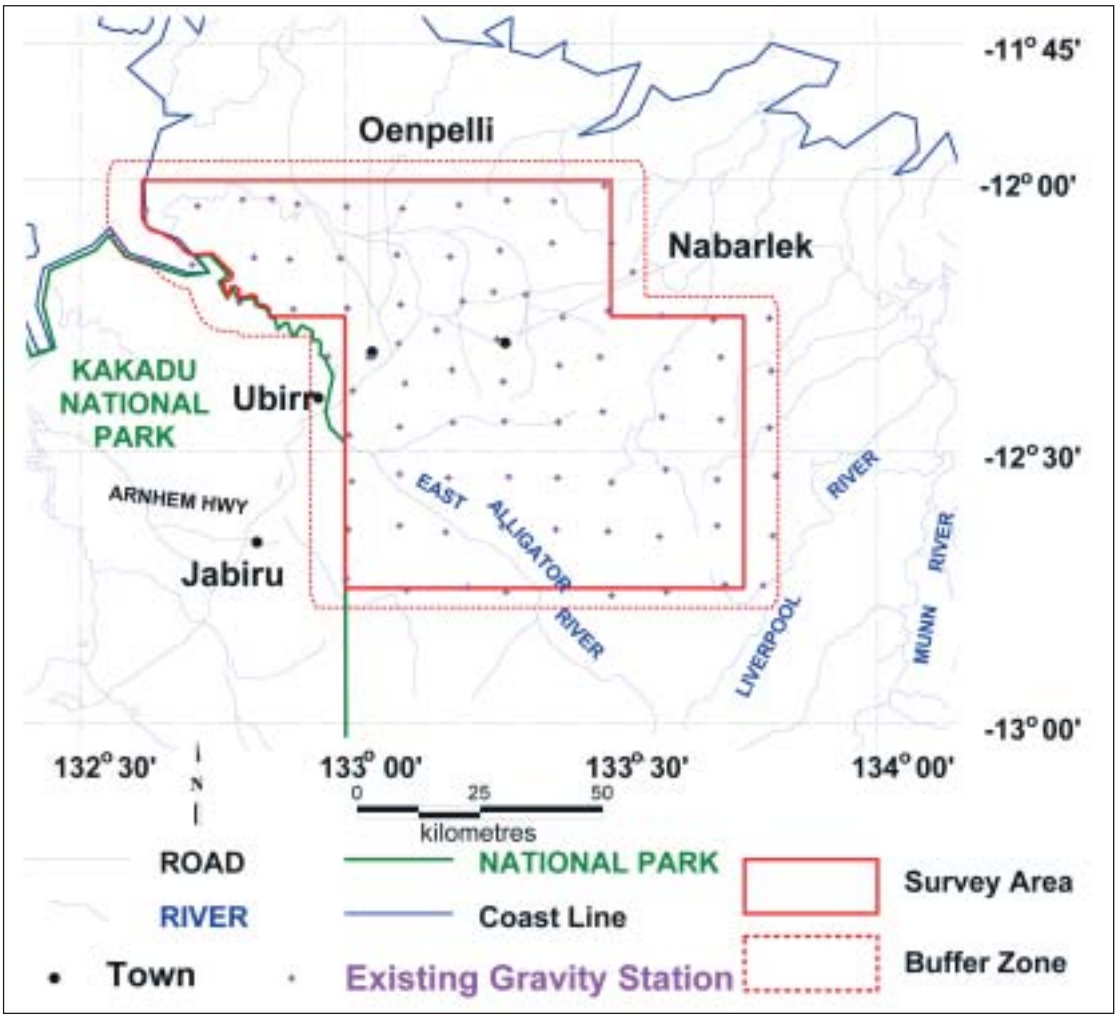


Fig. 1. (Right) Locality diagram for the West Arnhem Land Airborne Gravity Survey.

Fig. 2. (Below) Dr Andy Gabell of Canadian Micro Gravity Pty Ltd demonstrates the operation of the GT1-A airborne gravimeter to Geoff Beckitt (Cameco Australia) and Mario Bacchin (Geoscience Australia) at Jabiru airport.

Preliminary free air data will be available later this year, with final Bouguer and terrain-corrected data available early in 2004. Check http://www.dme.nt.gov.au/ntgs/ or http://www.ga.gov.au for updates.

Robinson Range-Belele Airborne Survey

The Geological Survey of Western Australia (GSWA) and Geoscience Australia (GA) will be contracting out an airborne magnetic, gamma-ray and elevation survey in the Robinson Range and Belele area of Western Australia.

The survey should start in early October 2003.

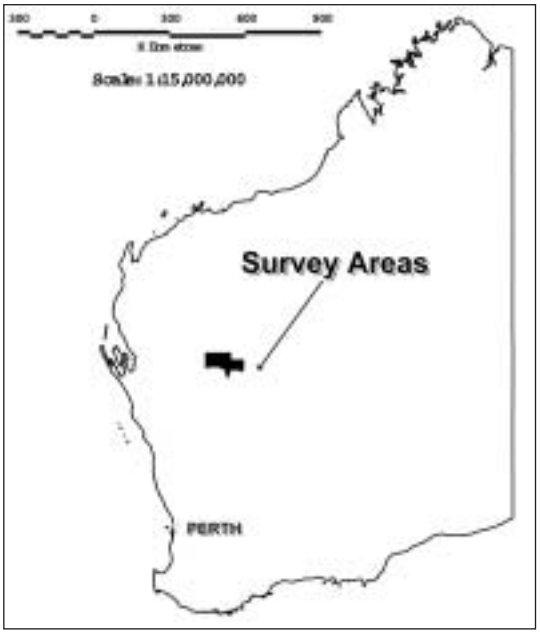


Fig. 3. Robinson Range and Belele survey area.

Information derived from these geophysical data and other complementary data sets will be used extensively to assist in the geological mapping of the Archaean rocks and is aimed at stimulating mineral exploration activity in this prospective region of Australia.

Geoscience Australia will manage the data acquisition and processing components of the initiative. Geoscience Australia will also act as Client Representative for this survey.

The project comprises acquisition, processing and supply of 29,161 line-km of airborne magnetic, gamma-ray and elevation data, and the supply and Joint Ownership of 23,860 line-km of 200 metre-spaced Murchison multi-client airborne magnetic and radiometric data covering part of the Belele and Cue map sheets.

The line spacing for the new survey will be 400 m and the nominal flying height will be 60 m above ground level. The gamma-ray spectrometer downward looking crystal volume is to be 33 litres. Accurate measurements of the Aircraft's height above the ground are required on this project.

GSWA is also purchasing additional modern airborne data to complete the coverage of the Robinson Range and Belele 1:250 000 Sheet areas and a combined dataset will be released subsequent to the flying of the new survey.

Reprocessing Contract — Mt Marshall, Lake Hillman and Goomalling airborne surveys

As part of the Burakin Airborne Survey flown in May 2003, tie lines were flown in order to enable the reprocessing of three newly purchased modern gradiometer airborne magnetic, gamma-ray and elevation data sets.

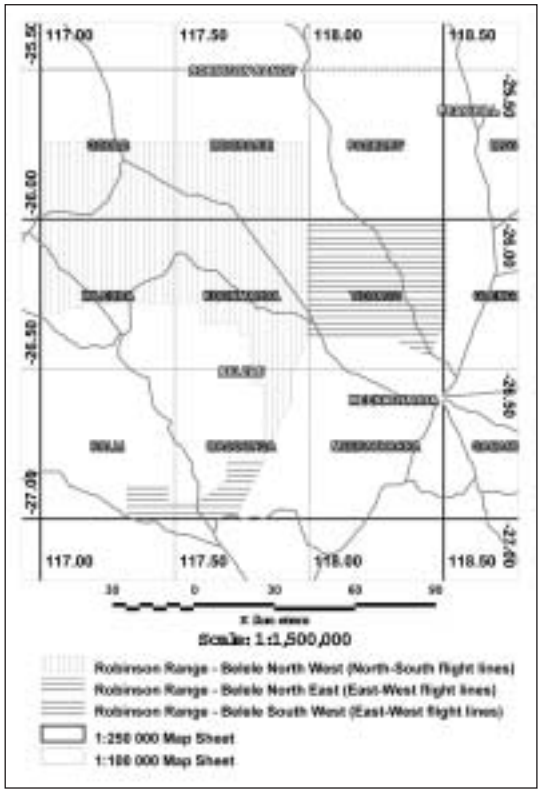


Fig. 4.

Geoscience Australia will be contracting the reprocessing of the Goomalling, Mount Marshall and Lake Hillman (Western Australia) airborne magnetics, gamma-ray and elevation data.

The contract should start in late September 2003 and be completed by early November 2003.

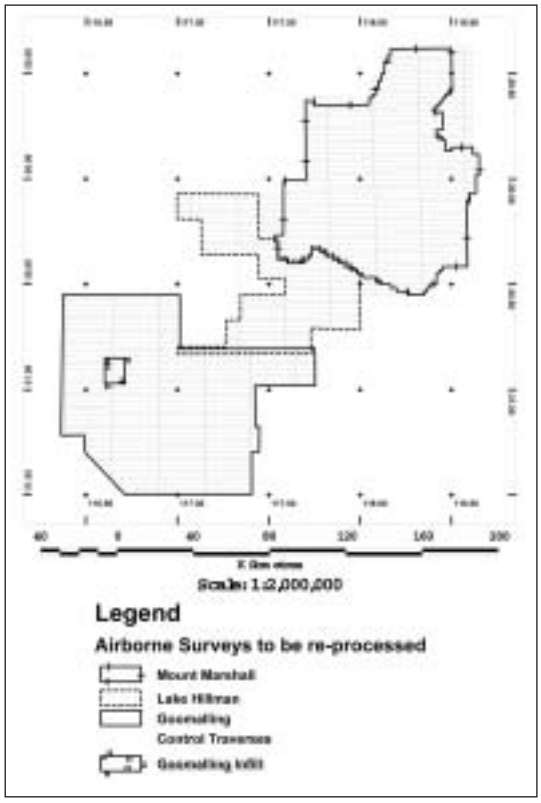


Fig. 5. Mt Marshall, Lake Hillman and Goomalling airborne surveys.

Information derived from these geophysical data and other complementary datasets will be used extensively to assist in geological mapping and is aimed both at stimulating mineral exploration activity in this prospective region of Australia, and in environmental and regolith research studies.

The project comprises reprocessing and supply of approximately 94,160 line-km of airborne magnetic data, gamma-ray and elevation data.

The survey boundaries are indicated in Figure 5.

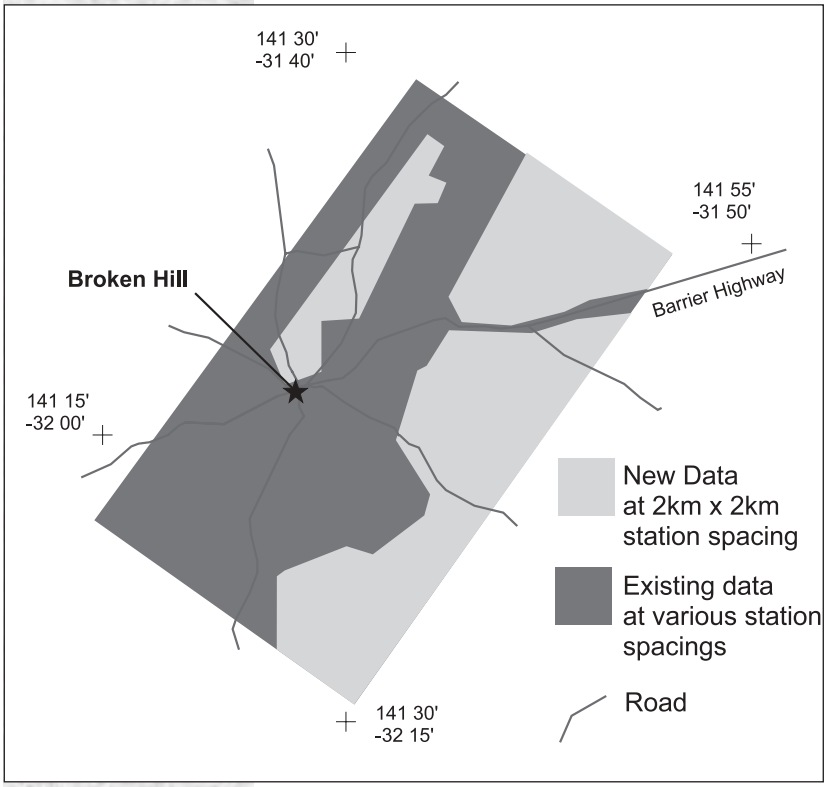


Fig. 6. Broken Hill — Menindee gravity survey.

Broken Hill - Menindee Gravity: release of point-located data

Geoscience Australia has released the Broken Hill - Menindee gravity data set consisting of 182 new gravity stations and 20,514 existing gravity stations. The diagram below shows the distribution of old and new gravity data.

The new data were acquired as part of Geoscience Australia's ongoing program to add to the National Gravity Database. Data from the new and existing stations will assist in the ground truth study of recently acquired airborne gravity data over the same geographic area near Broken Hill.

The new data were acquired in May 2003 at a station spacing of 2 km x 2 km in three separate areas around Broken Hill. As part of the contract, terrain corrections were calculated for the new data as well as for the 20,514 existing gravity stations. This data release includes the terrain corrected gravity values presented as Complete Bouguer Anomaly values for both new and existing data. The existing data sourced from Geoscience Australia, NSW Department of Mineral Resources and industry surveys have previously been released with Simple Bouguer Anomaly values only.

This release of the Broken Hill - Menindee gravity data set is included as an adjunct to the May 2003 release of the National Gravity Database. Purchasers of the 2003 National Gravity Database release will be supplied with this update free of charge on request. Clients may also download the data for free from the Geoscience Australia website at: http://www.ga.gov.au/download/minerals.html#bh

For further information about this and other GA releases contact: Mario Bacchin at Geoscience Australia, Tel: (02) 6249 9308 Email: mario.bacchin@ga.gov.au.

South Australia

The South Australian Government has been undertaking a focused program of geophysical data acquisition to augment industry programs in target regions. The target regions in South Australian include the Gawler Craton, Curnamona Craton and the Musgrave Block. Through the Targeted Exploration Initiative South Australia (TEISA), Minerals and Energy (ME) has provided new, low cost precompetitive exploration data aimed at accelerating the discovery of new resources throughout the State.

Datasets that have been acquired through TEISA include:

- 1,000,000 line-km of magnetics and radiometrics across all three target regions;
- EM Tempest data overarget project areas in the Gawler Craton;
- 12,000 gravity stations over target areas in the Gawler Craton; and
- Orthoimage products over the Musgrave Block and Curnamona province.

These datasets are all open file and available to stakeholders free of charge for use in exploration decision making processes.

All data have been incorporated into State databases to augment existing data and improve the resolution of regional datasets.

Substantial reprocessing of South Australian regional datasets was completed in the 2002/03 financial year to produce a new suite of regional South Australia geophysical datasets which include:

- Total Magnetic Intensity 35 x 35 m mesh,
- First vertical derivative,
- Bouguer Gravity 100x100 m mesh (see Figure 1),

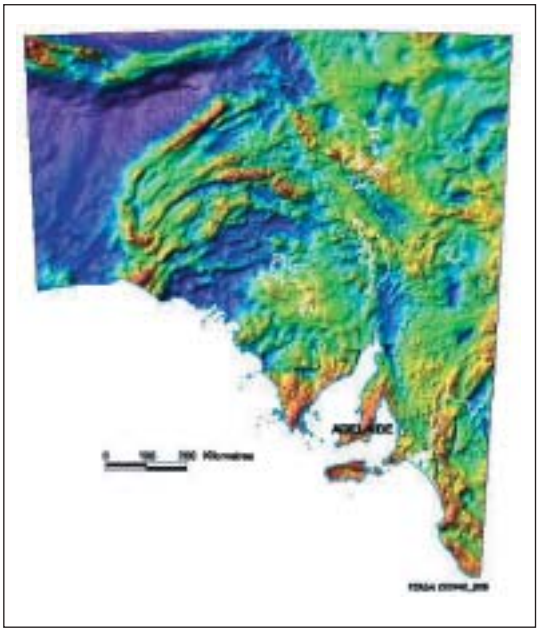


Fig. 1. (above) South Australia Bouguer Gravity map.

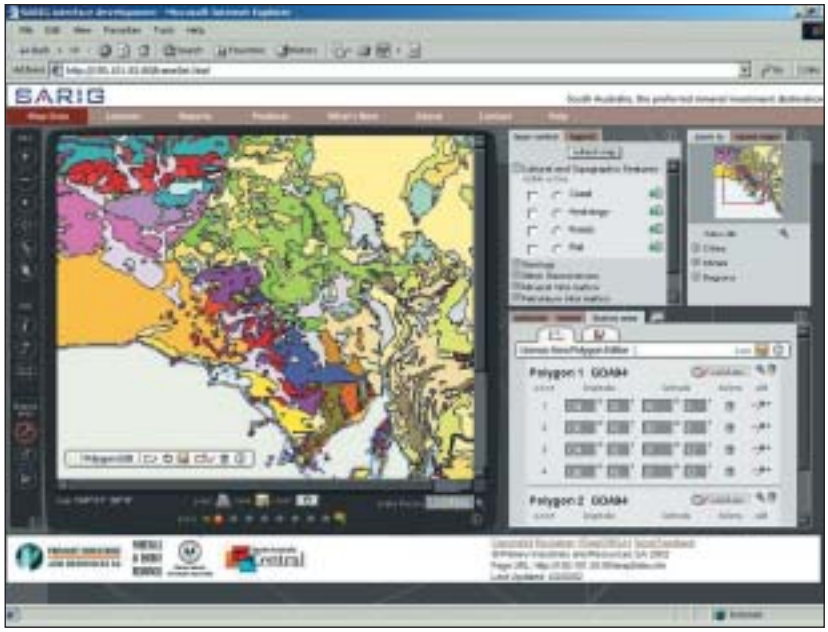
- Depth to magnetic basement,
- First vertical derivative (HIS drape), and
- U, K, Th ternary image

South Australian Resources Information Geoserver (SARIG) South Australia regional geophysical data sets are available for viewing and integration with other Minerals and Energy datasets such as 1:100,000 scale geology, drill hole, mineral occurrence etc. through the online SARIG facility. (www.minerals.pir.sa.gov.au)

Images are also available in a semi-transparent format to enable easy and quick integration with other datasets.

SARIG Mass Data Server

Minerals and Energy has integrated a large volume data server application into SARIG. Through this facility the user can zoom into an area of interest via the spatial interface and select data in either a grided format or as located ASCII data. The data is compiled and compressed on Minerals and Energy servers and an email is then sent to the user with a link to download the data they requested.



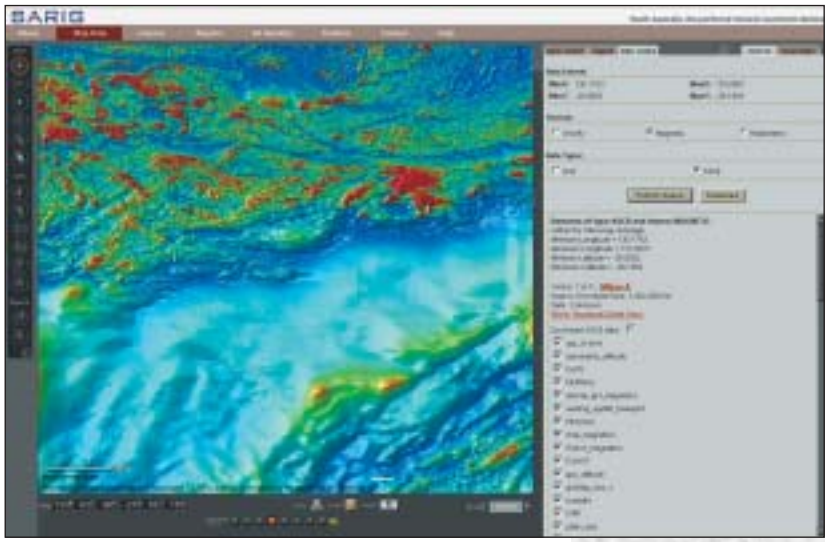


Fig. 2. (Top) The SARIG Map window enables the user to interact with South Australian Geoscience data in a spatial environment through existing WWW browser applications.

Fig. 3. (Above) SARIG - Mass Data Server window where the user can access open file geophysical data for download in either ASCII or grid format.

Upon completion it is estimated that there will be 2TB of data available for users to interrogate and download through the online SARIG facility.

Domenic Calandro
Mineral Resources Group
Minerals & Energy SA
Email: calandro.domenic@saugov.sa.gov.au

New South Wales

New High-Resolution Total Magnetic Intensity of NSW released

In 1991, through the National Geoscience Mapping Accord (NGMA), the NSW Geological Survey and the then Australian Geological Survey Organisation (AGSO, now Geoscience Australia) arranged funding to acquire high resolution aeromagnetic and radiometric data over a number of 1:250,000 map sheets, including Bathurst, Dubbo, Forbes Goulburn and Cootamundra.

From 1994, the NSW Government's Discovery 2000 and Exploration NSW initiatives funded numerous additional high resolution (250 m to 400 m line spacing) airborne aeromagnetic and radiometric surveys. To June 2003, the combination of these total just over 2,000,000 line-km, covering 71% of NSW.

The culmination of nearly 40 government funded airborne surveys over the past 12 years is the new High Resolution TMI State Merge. This new state-wide grid brings together the combined work of many skilled geophysicists and

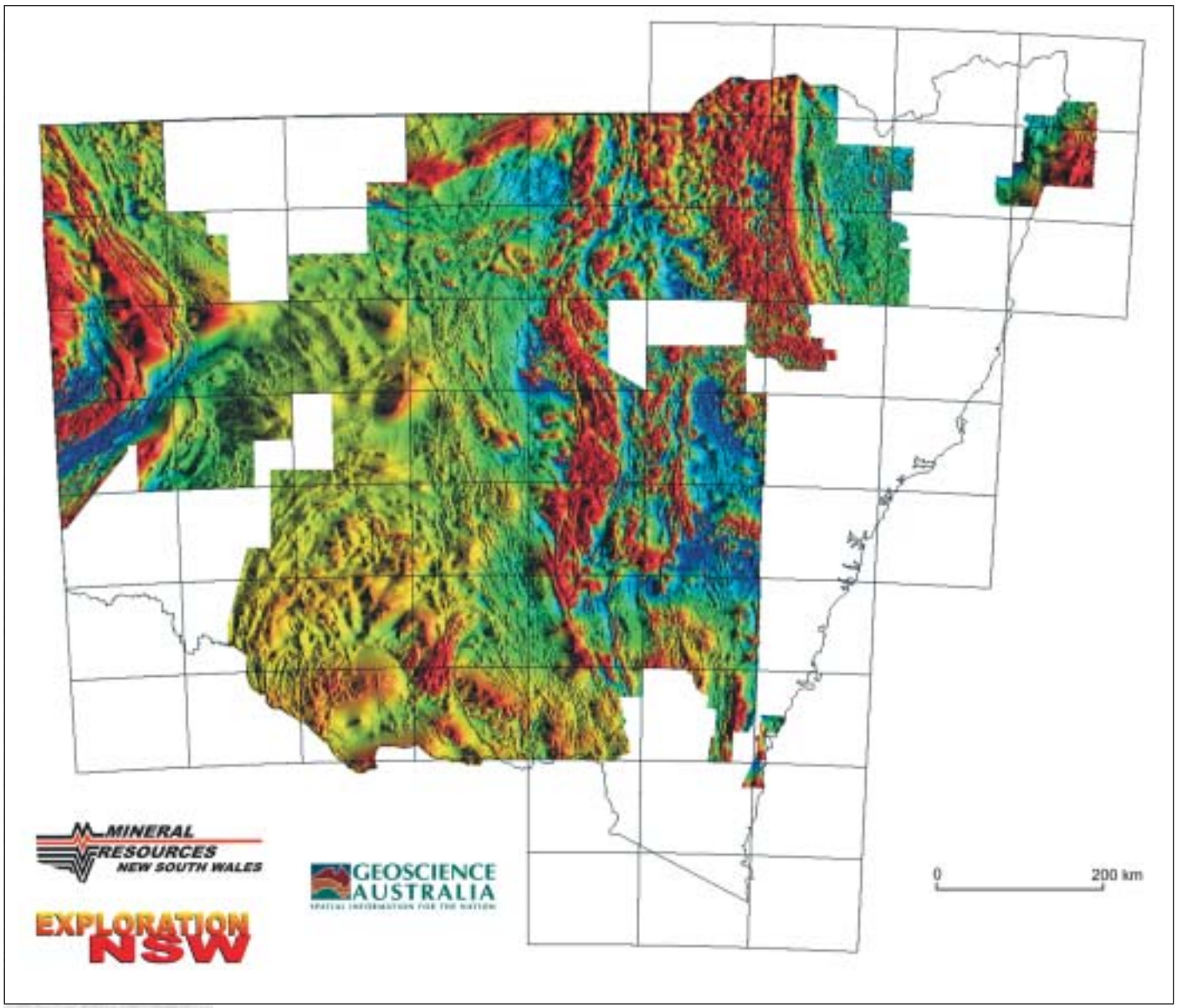


Fig. 1. High Resolution Total Magnetic Intensity Image of NSW (50 m grid cell size).

other staff within the NSW Geological Survey, Geoscience Australia and a number of airborne geophysical survey contractors over many years.

This state-wide merge is only one of a number of current NSW initiatives to upgrade the state geophysical data base and make more of the immense store of geophysical data archived by NSW Geological Survey available to explorers and other government agencies. Other works in progress include a thorough quality control review and reformatting to current standards, of all government flown airborne geophysical survey data and trialling of on-line data delivery technology, designed to provide easier access to the state geophysical datasets and foster resource investment in NSW.

NSW Geological Survey geophysicists completed a significant reworking of the airborne magnetic data, re-gridding the data down to 50 m cell spacing using an Akima Spline and merging together the grids to create a seamless TMI. To avoid oversampling effects, the regional 1500 m spaced data were not included in the merge.

Included in the State-wide grid merge is the recent major Murray/Riverina airborne survey. This survey was released at the Department's NSW Mineral Exploration and Investment Conference in May. It covers more than 60,000 km2 (160,000 line-km) over the Hay and Balranald region forming the largest airborne survey carried out by the Department. The survey program was a joint venture with the NSW Resource and Conservation Assessment Council (RACAC)

Each of the NSW Government airborne geophysical surveys is available individually on DVD at a cost of $110 each. The parameters and outlines of individual surveys can be viewed at:

http://www.minerals.nsw.gov.au/geosurvey/products/geophys/sv_index.htm

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GRID Computing — enabling the next generation of Solid Earth and Environmental Research in Australia.

Lesley A.I. Wyborn[1] and Joan S. Esterle[2]

[1]Geoscience Australia, PO Box 378 Canberra, ACT, 2601
lesley.wyborn@ga.gov.au

[2]CSIRO Division of Exploration and Mining, PO Box 883, Kenmore, QLD, 4069
joan.esterle@csiro.au

Introduction

Earth comprises systems of enormous complexity that sustain all life and control the distribution of our mineral, energy and water resources. Increasingly earth scientists are now moving away from focusing on single domain research on understanding isolated parts of these intricate systems to adopting multidisciplinary, computationally intensive integrated methodologies to model and simulate the real world complexities of earth systems science.

Simultaneously developments in information technology are increasing the capacity of computational systems to credibly simulate complex systems. Real world Solid Earth and Environmental Science data sets are extremely heterogenous, complex and large, and are currently in the order of terabytes (10^{12} bytes). However, the size and complexity of geoscience data sets are also exponentially increasing, as more powerful modern computing systems combine with enhanced engineering capacity to design and build automated instruments to collect more data and new data types. We are rapidly moving into an era when earth scientists will need to have the capacity to analyse petabyte (10^{15} bytes) databases if they are to realistically model and simulate complex earth processes.

Although digital geoscientific data sets are becoming increasingly available over the Internet, current Internet technologies only allow for the downloading of data (if the connection is fast enough): integration, processing and analysis then has to take place locally. As data sets get larger and more complex, then large computational resources are required to effectively process these data. Such resources are increasingly only available to the major industry players, which in turn creates a strong bias against the small to middle enterprises, as well as many university researchers. For those that do not have access to large-scale computing resources, analysis of these voluminous data sets has to be compromised by dividing the data set into smaller units, accepting sub-optimal solutions and/or introducing sub-optimal approximations.

It is clear that if we are to begin grappling with accurate analysis of large-scale geoscientific data sets to enable sustainable management of our mineral, energy and water resources, then current computational infrastructures are no longer viable.

The Enabler of Change — computing in an increasingly exponential world

Varying exponential increases in computing components are producing dramatic changes globally in hardware configurations. Computer speed doubles every 18 months (Moore's Law[1]), but network speed now doubles every nine months, producing an order of magnitude difference every five years (Stix, 2001). To enhance the capacity of the computational resources, the most effective way to increase performance per dollar spent is to invest in networks. This has resulted in the extremely rapid growth of clustered computers, as it is now cheaper to network banks of PCs to increase capacity, than build individual super computers. But beyond these locally sited clusters, computers *per se* are disintegrating into a set of special purpose appliances available across the Internet (Gilder, 2002). Distributed computing or the GRID has now emerged as the next generation of computer infrastructure.

The GRID — a key infrastructure to advance Solid Earth and Environmental Sciences.

The GRID is a new infrastructure, which is built on the Internet and the World Wide Web. As noted by Foster (2003), "by linking digital processors, storage systems and software on a global scale, grid technology is poised to transform computing from an individual and corporate local-scale activity into a globally available general utility."

The GRID offers scalable, secure high performance mechanisms for discovering and negotiating access to computational resources including data, processing packages, networks and hardware. Using GRID technologies, geoscientists anywhere could run applications (software and processing packages) using on line, potentially remote computational resources and data acquired in real time from disparate sources.

[1] *http://info.astrian.net/jargon/terms/m/Moore_s_Law.html*

Cont'd from page 20

The final NSW TMI state-wide merge (ERMapper) grid is 1.3 GB in size and is also available on DVD for $110.

NSW Geological Survey geophysicists are now working to create seamless radioelement grids from the surveys.

For further information on this grid or other geophysical data products from the NSW Department of Mineral Resources, contact Michael Hallett (02) 9901 8371.

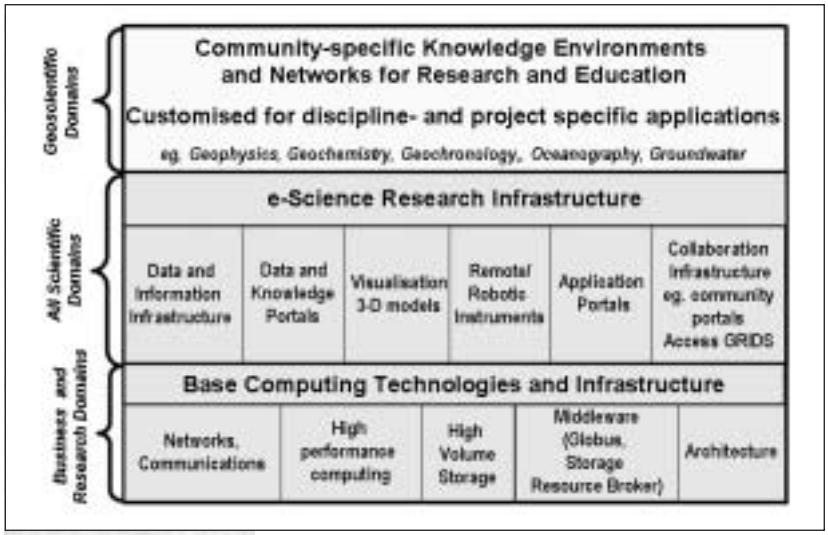

Fig. 1. The 3-layered architecture of the GRID comprising a base computational Infrastructure whose components are common to Science and Business, and overlying Scientific Infrastructure which comprises applications and data and Information infrastructures that are common across many disciplines. The top layer comprises databases and knowledge environments that are specific to individual geoscience domains.

The GRID thus facilitates e-Research as it is enabling resource sharing and coordinated problem solving in dynamic, multi-institutional virtual organisations. New capabilities and organisations will be constructed dynamically and transparently from access to these distributed services.

Commonalities to other Science Disciplines

The analogy of GRID computing with general service utilities such as electricity and water is extremely powerful. Just as a single electricity grid will power a plethora of kitchen appliances, major industrial machinery and light up major building infrastructure, so too will the computational GRID enable a diversity of research problems to be resolved through a shared basic infrastructure. As illustrated in Figure 1, the GRID can be considered to comprise three fundamental layers.

This commonality of much of the infrastructure and functionality means that it will be possible to leverage many developments from other scientific disciplines as well as the commercial world. This is fortunate as geoscientists have been extremely slow to take advantage of what GRID technologies can offer to advance their research. Other research communities such as high energy physics, biology (especially genomics) and astronomy have been developing tools and systems that offer exemplars for the geoscience community of how to combine data from different sources to create value-added knowledge products.

The Status of GRID technologies in Australia overall

While more is required, Commonwealth Government support has positioned Australia with much of the required infrastructure for GRID computing.

1. Network resources

Through initiatives such as AARNET (Australian Academic Research NETwork) and AREN (Australian Research and Education Network) the academic community has access to high-speed bandwidth. Likewise commercial bandwidth facilities are becoming more commonplace. These high-capacity networks allow instruments to be manipulated remotely to improve research productivity and performance, and save on the amount of research dollars that are spent travelling to access these instruments.

2. High performance computing resources

High performance computational resources are not essential for the GRID computing paradigm, but where required, the Australian research community is adequately served with high performance computational resources through the Australian Partnership for Advanced Computing (APAC) and its state partners and the Australian Computational Earth Systems Simulator (ACcESS) Major National Research Facility (MNRF). The Commercial sector is increasingly adopting this modus operandi.

3. Software and programming resources

As the GRID technologies expand, important software or processing programs relevant to the geoscience community will become available either as open source share ware or as (?chargeable) web services, which will remotely process and/or model data. In the geoscience research community is anticipated that the ACcESS MNRF will be developing libraries of down loadable software. Internationally in other research communities, particularly in the US (National Science Foundation – NSF) and the UK (e-Science program) research funding for application development is conditional on developers utilising open-source standards and share ware protocols. These protocols are producing a rich environment of open source shareware applications that are suitable for adaptation to the solid earth and environmental sciences.

4. Data, Information and Knowledge Resources

GRID computing will allow data, information and knowledge resources to be accessed, displayed, and mined by global communities of interest (in addition to those that collected the data) at different locations. However, because data management is at the behest of the individual domains, current data and information infrastructures are clearly the weakest component of GRID computing in Australia.

Accessing our National geoscience information resources for GRID computing

The major factor limiting the application of GRID computing for the solid earth and environmental sciences in Australia is the status of its vast existing information resources. To effectively utilise the opportunities the GRID offers, Australian e-geoscientists must have online access to quality data, information and knowledge that are curated, archived and preserved with sufficient contextual data to permit reuse and combination with relevant resources from other disciplines.

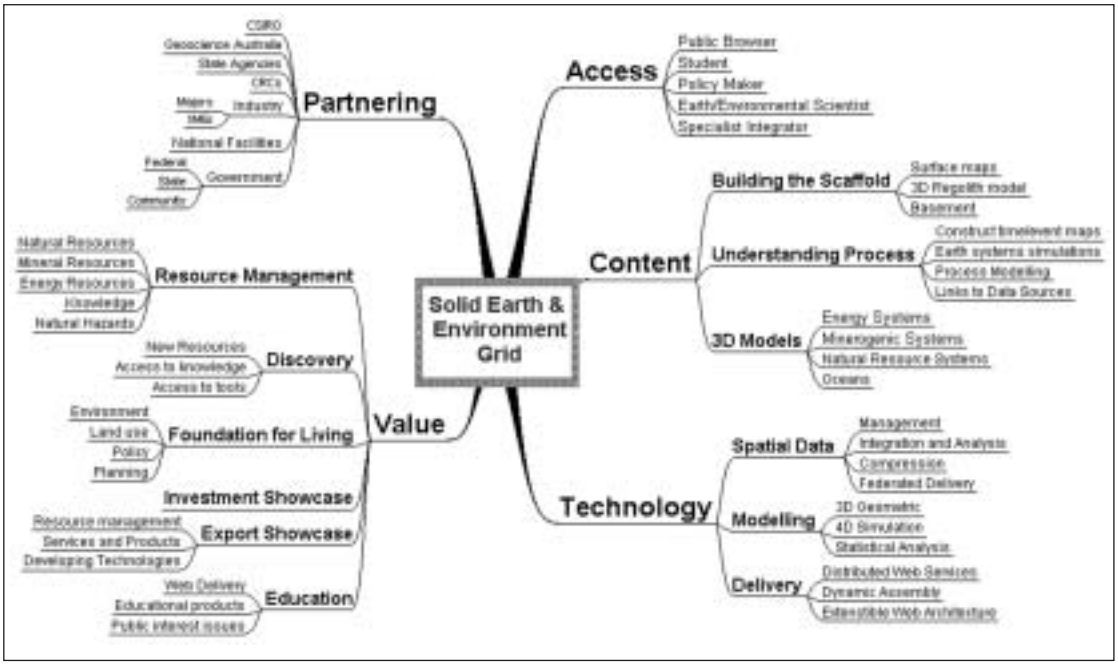

Fig. 2. The components of and linkages between the elements of the proposed Solid Earth and Environmental Sciences GRID.

The effective deployment and uptake of GRID technologies in the geoscience community will require a sound national strategy providing for the curation (including creating, managing, and making accessible), archiving and preservation of geoscientific data, information and knowledge. Each of the Commonwealth and State Government Surveys has made considerable advances in the development of robust databases and knowledge systems. However, the majority of these systems were developed prior to development of the new technologies and international standards that enable interoperability.

Interoperability between geoscience digital data and knowledge resources will require adherence to international standards that allow applications (open source or proprietary software) access to disparate and distributed data sets in real time, thus avoiding the need for scientists to manually download potentially differently formatted data sets from a number of potential data sources. In Australia CSIRO's Division of Exploration and Mining has taken a leading role in collaboration with the various relevant government agencies to make substantial contributions to standards relevant to the geoscience community via the two major international standards agencies the World Wide Web Consortium (W3C) and the Open GIS Consortium (OGC).

It appears that few earth science departments in Australian universities have allocated resources to curate, archive or preserve data, information and knowledge generated from their research. This situation may merely reflect serious shortfalls in university funding, but more probably it reflects the reasonable view that the cost-benefit trade-off from curating department-level data sets may never be attractive. If this is correct, it is important to implement shared facilities, such as those made possible by the Grid, that can capture and curate the valuable data generated by university research, which would otherwise be lost.

The way forward

The relative inaccessibility of major Australian Earth Science Data Repositories has been noted by two recent major government inquiries. Both have made recommendations on this issue.

In July 2003, in a report prepared by the Strategic Leaders Group for the Mineral Exploration Action Agenda 7 July 2003 recommended (Recommendation 9)[2] that "the Commonwealth, the States, Northern Territory and industry cooperatively support the development and implementation of nation-wide protocols, standards and systems that provide for Internet-based access to, and effective storage and archiving of, all exploration-related data, including government-generated pre-competitive geoscience datasets and industry-generated exploration data. Increased expenditure is recommended to accelerate the on-line availability of Commonwealth spatial and other geoscience information, and permit the development of web-based services."

In August 2003, in a report by the House of Representatives Standing Committee on Industry and Resources Exploring: Australia's Future — impediments to increasing investment in minerals and petroleum exploration in Australia Recommendation 17 states[3] that "The Minister for Industry, Tourism and Resources, through

[2] http://www.industry.gov.au/library/content_library/minerals_aa_finalreport_July2003.pdf

[3] http://www.aph.gov.au/house/committee/isr/resexp/contents.htm

the Ministerial Council on Minerals and Petroleum Resources, work with the Northern Territory and State ministers to store all public domain geoscientific data (legacy and pre-competitive) in digital form in a national data repository."

It is clearly a priority to establish nationally accessible, interoperable digital data repositories. Proper curation of geoscience data, information and knowledge will improve the quality of solid earth and environmental science research and extend the life of knowledge derived from these data.

Curation of valuable data may require long-term funding streams for data centres, helping to ensure that there is a strategic approach to data stewardship within the geoscience community which addresses holding information indefinitely, making it widely available and encouraging cross disciplinary usage, including linking to other digital information.

Clearly, the issues to be resolved are not simple. They require linkages with other scientific disciplines as well as careful planning. In July 2003 a national workshop was held in Canberra to develop a strategy for building the 'Solid Earth and Environmental Sciences GRID (SeeGRID). About 180 people from Commonwealth, State and Territory geoscience and environmental agencies, Office of Spatial Data Management, CSRIO, universities, industry and consultancies attended the workshop (SeeGRID, 2003). A key outcome was that participants agreed to work together to upgrade data repositories and to link them through a common, interoperable language. The way forward is not easy, and as Figure 2 illustrates, the linkages will be complex. But it is doable.

Conclusions

The approaching tsunami of data and increased computational capacity for research in the solid earth and environmental sciences will change the way geoscientists discover knowledge about the earth and its environment. It is not just the huge quantity of data that will forge the revolution, but also the large number of data collections that were built by different people that now must operate seamlessly.

The result will be an unparalleled predictive capacity for complex earth systems. The outcome will be confidence in the knowledge that underpins our decisions as stakeholders to keep Australia sustainable.

Acknowledgements

Both authors would like to acknowledge that the vision presented here is also that of colleagues from CSIRO DEM (Peter Hornby, Simon Cox and Rob Woodcock) and present and former staff of Geoscience Australia (Jonathon Root, Ian O'Donnell, Murray Hazell, Tim Mackey, Dmitar Butrovski, Sonja Lenz, Laigee Bell, Stuart Ross, and Stuart Girvan). Part of the work has been undertaken as part of the CSIRO Glass Earth project and in projects in the Predictive Mineral Discovery Cooperative Research Centre (pmd*CRC). The support of Bob Haydon and Mike Etheridge (pmd*CRC) is gratefully acknowledged. Lesley Wyborn publishes with the permission of the Chief Executive Officer of Geoscience Australia.

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Solid Earth and Environmental Sciences Grid (SEEGRID) 2003, Presentations from the workshop: http://www.glassearth.com/news.html

Stix, G., 2001, The triumph of the light: Scientific American, 2001. (http://www.sciam.com/2001/0101issue/0101stix.html)

Urls for further information on the Grid and grid technologies

The 'grid': enabling resource sharing within virtual organisations
http://www.rlg.org/annmtg/foster02.html

USA-NSF Blue Ribbon Report on Revolutionising Science and Engineering through Cyberinfrastructure
http://www.cise.nsf.gov/evnt/reports/toc.htm

USA-NSF: GEON-the cyberinfrastructure for the geosciences
http://www.geongrid.org/

UK-Research Council Core Program for e-Science
http://www.rcuk.ac.uk/escience/

Web Services and the Virtual Observatory
http://arxiv.org/ftp/cs/papers/0208/0208014.pdf
http://bill.cacr.caltech.edu/cfdocs/usvopubs/files/vogrid.pdf

Comparisons between the Grid and the Web
http://www.dante.net/conference/globalsummit2002/4-5gagliardi.ppt.pdf

New Petroleum Program for Geoscience Australia

Heike Struckmeyer
Geoscience Australia
Email:
heike.struckmeyer@gov.au

Summary

Geoscience Australia is embarking on a major program of data acquisition and interpretation to stimulate oil exploration in Australia's offshore jurisdiction. This new initiative, announced by the Australian government in May 2003, has four year funding of $61 million. Of this, $25 million will be used to fund a geophysical and geological acquisition program targeted at frontier offshore basins; also included is the upgrade of more than 300,000 seismic data tapes onto modern storage media. The balance of $36 million is core funding for Geoscience Australia's petroleum research and promotion program. Basic data and information from this new initiative will be made available free or at the marginal cost of transfer.

Why a new program?

Oil and gas account for over 50% of Australia's current energy fuels, but this level cannot be sustained because Australia's oil reserves are running down. Since the mid-eighties, Australia has been 70–90% self-sufficient in oil and condensate, but the country's reliance on imported oil will increase in the near future if a new oil province is not found. Geoscience Australia's current forecasts (Figure 1) suggest that oil production will fall by 40% over the next 10 years, unless major new discoveries are made. For example, production of oil from Bass Strait fields peaked in 1985 and have declined steadily since then. Industry has been successful in replacing these reserves with production from smaller fields on the North West Shelf and in the Timor Sea, but these small fields have a much shorter production life than those in the Gippsland Basin.

New Program: geographic and conceptual frontiers

The new petroleum program is underpinned by two key objectives:

- To maximise the opportunity to discover a new oil province, and
- To maintain discovery in existing oil and gas provinces.

For frontier basins, basic geophysical and geological information is required to assess the potential source, reservoir, seal, structure and event history necessary for an oil accumulation. To address this Geoscience Australia is planning to acquire up to 10,000 km of regional seismic data over the next four years. This will be complemented by a program of geological sampling and swath bathymetry in selected areas.

For proving up a new oil province it is important to provide tangible evidence of an active petroleum system. This evidence can include natural oil slicks on the sea surface from leaking hydrocarbon accumulations, the presence of thermogenic hydrocarbons in the seabed sediments and, of course, any oil or gas shows intersected in existing wells. A key to this analysis is the integration of geological and geophysical techniques. For example, evidence of leaking hydrocarbons can be detected using remote sensing techniques such as Synthetic Aperture Radar (SAR), hyperspectral methods, seismic indicators through amplitude analyses and other geophysical parameters.

Accordingly, for frontier areas of offshore Australia, Geoscience Australia will implement a program of seismic data acquisition and geological sampling integrated with remote sensing and seabed sampling techniques. In consultation with Industry, a portfolio of potential frontier areas has been identified, and includes the deepwater Perth Basin, Mentelle Basin and Bremer Sub-basin, and the remote Lord Howe Rise region (Figure 2). These depocentres are outside the focus of current exploration and are likely to have sufficient size and sediment thickness to potentially contain large reserves of liquids.

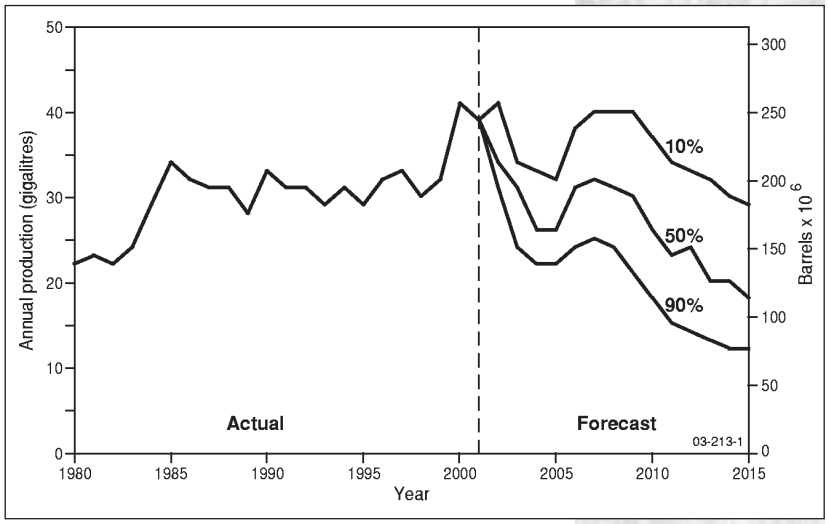
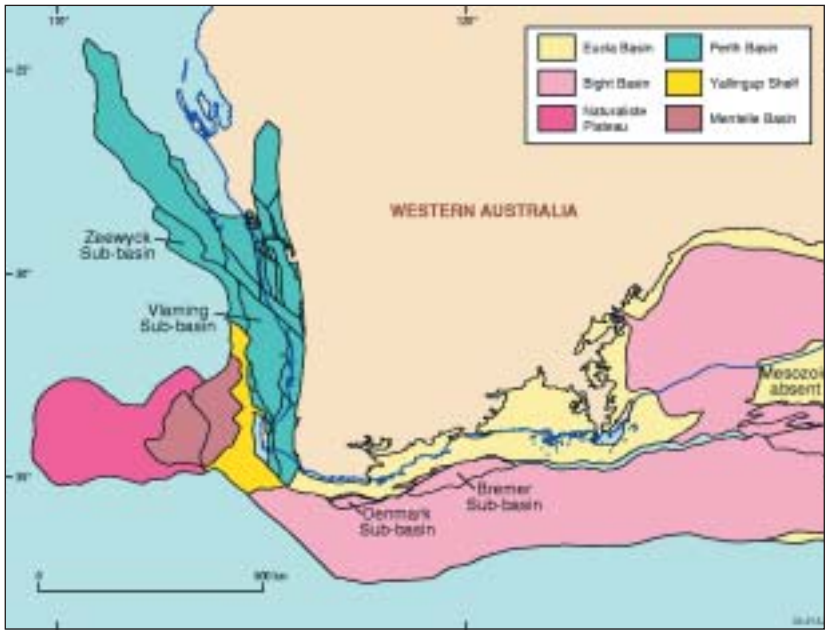


Fig. 1. Australia's annual production of crude oil and condensate, 1980–2015, and forecast annual production at 90%, 50% and 10% cumulative probability, 2002-2015 (source: Oil and Gas Resources of Australia 2001).

Priority has been given to the southwestern offshore area of Australia (Figure 3). The Bremer and Denmark Sub-basins of the Bight Basin and the Mentelle Basin require basic information on the age and nature of the sediment fill to assess their prospectivity. In this area, Geoscience Australia's first work program will be a survey in the Bremer Sub-basin to collect new swath bathymetry, shallow seismic, dredge and core samples for biostratigraphy and hydrocarbon detection.

Within existing exploration areas, new conceptual frontiers include potential new petroleum systems in Ashmore Platform, Rowley Sub-basin and northern



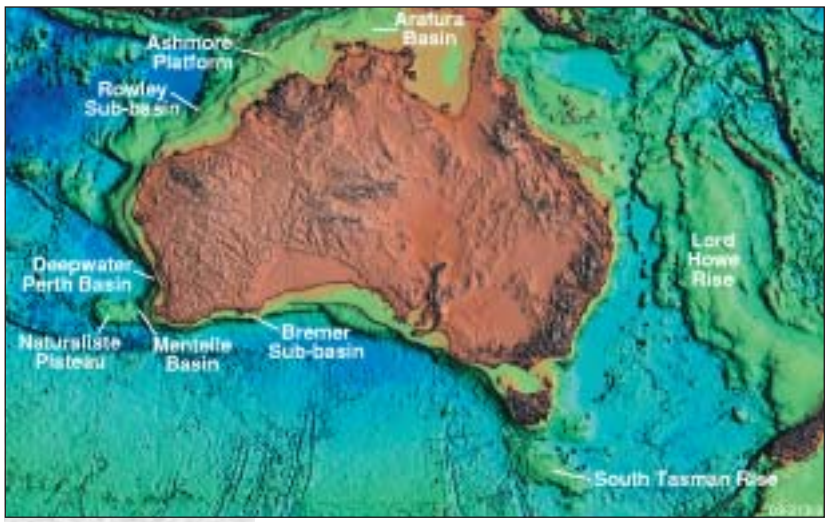


Fig. 2. (Top) Areas for potential acquisition projects.

Fig. 3. (Above) Basins of southwestern offshore Australia.

Arafura Basin (Figure 2). From existing seismic data, it is unlikely that major oil reserves will be found in all these areas, but the development of new concepts may lead to further oil discoveries elsewhere on the North West Shelf. Concepts to be tested include the presence of a potential Triassic to Early Jurassic carbonate source system, untested Palaeozoic petroleum system(s), underfilled Jurassic marine rifts, Triassic-Jurassic shallow marine and delta-plain ponding, and the possibility of oil migration to outboard parts of basins in response to rapid progradation of Late Tertiary carbonates.

Digital Seismic Tape Remastering

The Australian government budget of May 2003 provided funds for the copying and concatenation onto high-density media, of over 300,000 older technology (9 and 21 track) tapes held in the Geoscience Australia data repository. Currently, Geoscience Australia's collection comprises over 570,000 digital magnetic tapes from over 1000 seismic surveys. Additionally, there are associated paper-based data from over 700 seismic surveys. The digital magnetic tapes contain field seismic survey data, well logs, processed seismic and navigation data. The tape media include 21 track tapes, 9 track tapes, 3480 cartridges, 3590 cartridges, DLT cartridges, 8 mm and DAT tapes.

The copying and concatenation of the seismic data will result in more efficient access and lower costs for petroleum companies wanting to use the seismic data for processing and interpretation. Currently, companies are required to borrow the large number of older media associated with a seismic survey and return copies to Geoscience Australia. For example, in the past 12 months, digital data from over 250 seismic surveys and 160 offshore wells have been borrowed by both local and overseas petroleum companies. These data loans have amounted to 5 Terabytes (5000 Gigabytes) of data.

Over the past three years there has been an average of 5 Terabytes, accessed by industry, every year. After copying and concatenation some of the older surveys can be contained completely on a few tape cartridges.

For further information on the new frontiers program contact Heike Struckmeyer, Tel. (02) 6249 9646, Email: Heike.Struckmeyer@ga.gov.au

For further information on the tape-remastering program contact Paula Cronin,
Tel. (02) 6249 9181, Email: Paula.Cronin@ga.gov.au

Calibration of Honeysuckle Creek Conductivity Depth Imaging

Anthony Christensen
Geological Survey of Victoria
Department of Primary Industries
P.O. Box 500
East Melbourne
Victoria 3002 Australia
Email:
anthony.christensen@dpi.vic.gov.au

Introduction

The Honeysuckle Creek airborne electromagnetic survey area lies largely within the triangle formed by the towns of Shepparton, Benalla and Euroa in northeastern Victoria. Flown in mid-2001, previous survey results and interpretations have been reported by Dent *et al.* (2002) and Gibson and Wilford (2002). Near surface conductivity mapping results prior to this work are shown in Figure 1. The extensive areas of high near surface conductivity indicated by initial conductivity depth image (CDI) processing are inconsistent with both the relatively limited extent of mapped surface salinity expressions and the agricultural productivity of the survey area. The poor performance of near surface (0–5 m) conductivity depth imaging methods at distinguishing areas mapped geologically as surface salinity expression was also noted by Dent *et al.* (2002).

As a follow up to the airborne survey program, the Murray Darling Basin Commission and Goulburn-Broken Catchment Authority funded a program of drilling and petrophysical logging. Ten holes were drilled and logged. Three pre-existing monitoring bores were also logged for the same suite of petrophysical parameters (susceptibility, conductivity, total count gamma). The work presented here briefly describes the method and results of the calibration reprocessing undertaken by the Department of Primary Industries - Victoria to refine the processed conductivity-depth imaging products.

Why Calibration?

The most desirable outcome of CDI processing is that calculated conductivities as a function of horizontal location and depth should perfectly predict conductivities values obtained from petrophysical logging. Inevitably differences between the predicted and observed conductivity values are present. Measurement errors and noise aside, differences between predicted and observed conductivities may be considered to result from:

- unaccounted for geological variability, and,
- the processing method.

Geological Variability

Drill hole conductivity logs only investigate the ground within a 2 m radius of the drill hole. However, the TEMPEST x-component footprint upon which the conductivity calculation used in this paper is based has a radius about two orders of magnitude larger. Therefore, errors in the prediction of an individual borehole conductivity log may result from conductivity variations occurring over the scale of the system footprint that are not evident in the recorded drill log. Clearly, the extent to which a single borehole is representative of the entire volume of investigation of the AEM system will vary from site to site.

The utility of conductivity as a salinity-mapping tool also depends upon the degree to which conductivity is a reliable proxy for the salt load of the earth. In the Honeysuckle Creek survey area, statistical analysis of EC1:5 measurements and EM39 logging undertaken by BRS (Dent (ed.), 2002) found a correlation coefficient of ~0.9. Consequently, at Honeysuckle Creek, conductivity may be regarded as an efficient indicator of salt load.

Processing Error

Within the processing algorithm, differences between observed and predicted conductivity values can result from numerous sources including:

- Intrinsic shortcomings of the approximation scheme employed, and
- Inappropriate parameter selection/designation.

Improving intrinsic shortcomings in the solution algorithm is the subject of longer term R&D and is not addressed in this work. Processing parameters on the other hand can be optimised to allow the CDI algorithm to best reproduce observed conductivity profiles. Such a heuristic optimisation or calibration is the primary focus of this work.

Survey Specifications and Initial Processing

The Honeysuckle Creek survey was flown with the TEMPEST system (Lane *et al.*, 2000) and totals some 6082 line-km. Flown along 200 m spaced flight lines, a nominal transmitter terrain clearance of 115 m was used with the receiver 'bird' trailing 115 m behind and 30 m below the survey aircraft. A base frequency of 25 Hz was used. All data processing and positioning, up to the data integration into 15 channels, were completed by Fugro Airborne Service (FAS). As part of the survey arrangements FAS computed earth conductivities utilising the fast approximate method of Macnae at al. (1998).

The Calibration Process

Based upon results from FAS's processing 10 shallow aircore drill holes were planned to allow both verification and calibration of the conductivity maps over a variety of earth responses. Drilling and follow up petrophysical logging in these holes (and three pre-existing monitoring bores) were completed in July-August 2002 by staff from the Bureau of Rural Sciences and the Department of Primary Industries (Victoria).

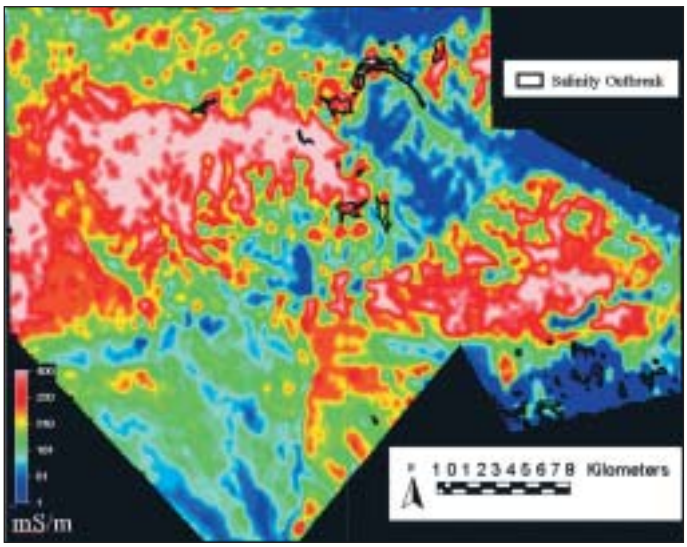


Fig. 1. Initial conductivity map for 0-5 m depth slice. Salinity outbreaks are outlined in black.

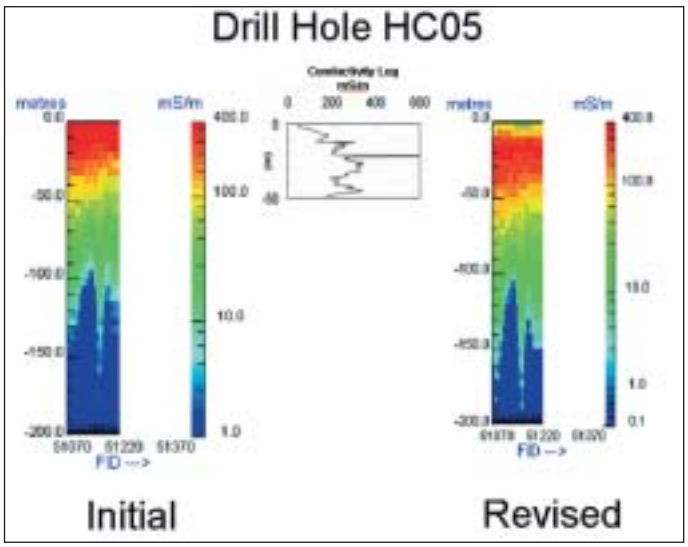


Fig. 2. Initial and recalibrated CDI output from fiducials with response footprint impinging upon drill hole HC05.

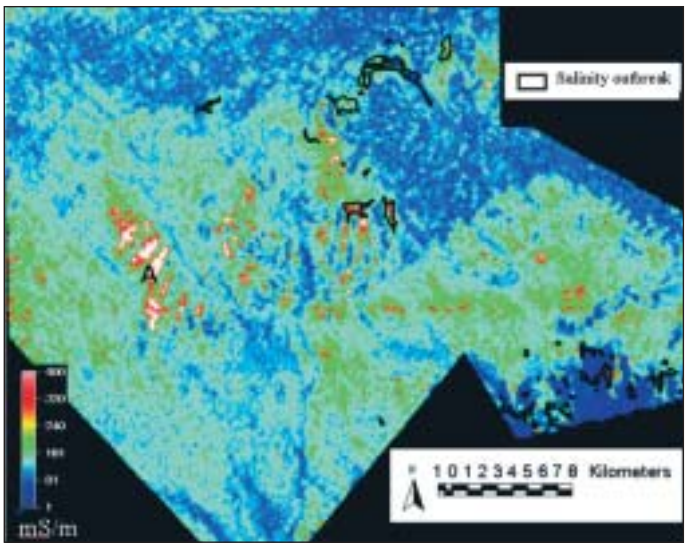


Fig. 3. Calibrated conductivity map 0-5 m depth slice. Mapped salinity outbreaks are outlined in black. (same colour scale as in Figure 1)

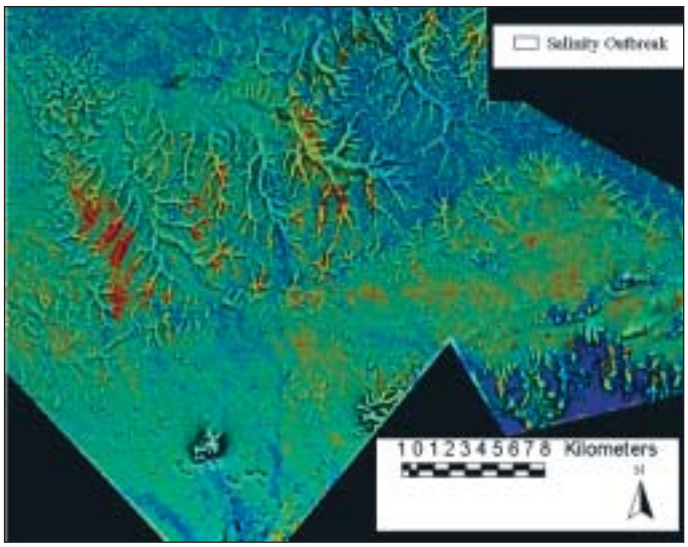


Fig. 4. 0-5 m conductivity draped upon a greyscale first vertical derivative magnetic map.

Process parameter optimisation in this work was completed by an iterative adjustment of EMFLOW parameters followed by qualitative and quantitative assessment of output against calibration logs recorded. In detail, the methodology was:

Log data

Conductivity logs were recorded using the Auslog-Scintrex A034 electromagnetic induction conductivity-logging tool. These logs were recalibrated according the method outlined in Brodie *et al.* (2002).

Logs were edited to remove spikes and the effects of any steel casing present. The logarithm of the recorded conductivity was calculated and averaged over 5 m intervals from the surface to the end of hole.

AEM Data Selection

Only those data points having a response footprint impinging upon a logged drill hole should be included in this calibration process. Consequently an understanding of the AEM system footprint is needed to make an appropriate selection of the data subset to base the calibration upon. Using an inductive limit approximation (Lui and Becker, 1990) a FORTRAN program was written to calculate and analyse the footprint of the TEMPEST system. The analysis showed data points falling within a 400 m x 400 m window centred on each drill hole would be appropriate. Such locations are within the system footprint contributing greater than 90% of the observed response around each drill hole. In practice, a smaller window was used to limit the subset to those points falling on the nearest line. This process resulted in the selection of 284 AEM data points about the 13 drill holes logged.

EMFLOW CDI Processing

All processing undertaken in this paper was completed using EMFLOW v3.2 (Macnae and Lamontagne 1987). Initial

EMFLOW parameters employed were as per FAS's Acquisition and Processing Report (Lawrence *et al.*, 2001). EMFLOW was set to output conductivities at each 5 m interval to a depth of 200 m. Solutions were forced to surface using predicted early time amplitudes.

Based on logging results, the 20 EMFLOW solution conductivities available were defined to be logarithmically distributed between 0.1 mS/m and 400 mS/m. As less than 10% of the recorded conductivities were greater than the upper limit of this range such a range specification was considered appropriate in order to obtain more accurate estimates of conductor thickness. Restricting the range as described limits the tendency of EMFLOW to overestimate the peak conductivity in "bulge" type profiles. The tendency to overestimate peak conductivities results in conductive layers being predicted to be thinner than they in fact are (as the total conductance of the section is preserved).

Statistics

As no single statistic in all circumstances can satisfactorily quantify the quality of the match between the calculated and logged conductivity three statistics were calculated.

To quantify how well the AEM derived conductivity predicts the variability in observed in logging, the Pearson correlation coefficient statistic was used. This statistic is referred to as the "R^2 " statistic and is defined as,

$$R^2 = \left(\frac{N\left(\sum_{i=1}^{N} x_i y_i\right) - \left(\sum_{i=1}^{N} x_i\right)\left(\sum_{i=1}^{N} y_i\right)}{\sqrt{\left[N\sum_{i=1}^{N} x_i^2 - \left(\sum_{i=1}^{N} x_i\right)^2\right]\left[N\sum_{i=1}^{N} y_i^2 - \left(\sum_{i=1}^{N} y_i\right)^2\right]}} \right)^2$$

where x_i is the borehole derived observation, y_i is AEM derived conductivity, N is the number of observations and the subscript i represents the *ith* observation.

As other measures of how well the TEMPEST derived observations fit the borehole measured parameters the 'mean misfit' (MM) and 'misfit standard deviation' (MSD) were used. These are defined as:

$$MM = \frac{\sum_{i=1}^{N} y_i - x_i}{N}$$

$$MSD = \sqrt{\frac{\sum_{i=1}^{N} (y_I - MM)^2}{N-1}}$$

These statistics were calculated for:

1. each fiducial selected down each relevant drill hole,
2. averaged statistics for all fiducials within the nominated footprint window about each hole, and
3. all 5 m depth slices across all holes.

The R^2 correlation coefficient is a measure of how well the variations in a dependent variable reflect the variations in the independent variable. It is important to note that this statistic is not always a meaningful measure in circumstances of low absolute conductivities. Where there are only small calculated and logged conductivity, as is the case with several of the boreholes in this study, it is not always possible to achieve a good R^2 statistic. In such cases a small mean misfit and misfit standard deviation value will often more sensibly describe the comparison of the two profiles.

Another important feature of the R^2 statistic is its extreme sensitivity to any vertical offset between the predicted CDI depth profile and the observed conductivity profile. As such, although qualitatively good matches may be attained R^2 (and to lesser extent MM, and MSD) statistics may yield overly disparaging results.

In recognition of such behaviour it was decided that the final or optimal parameter selection would be determined based in part upon a qualitative assessment of the processing product rather than purely upon the absolute largest attainable R^2 value.

Results

On a hole-by-hole basis optimal processing parameters selected produced R^2 values varying between 0.004 (entire hole resistive, MM=-0.061) to 0.72. The initial and recalibrated CDI sections for windowed fiducials about drill hole HC05 are shown in Figure 2. Visually, it is apparent that the recalibrated section (right) better represents the near surface low conductivity region observed in logging data (centre) and better matches the depth at which the peak conductivity is seen. For drill HC05, R^2 statistics were improved from 0.26 for the initial CDI product to 0.56 in the revised or recalibrate CDI product. Averaged over all holes the MM and MSD statistics were improved by the calibration process from 0.14 to 0.11 (20%) and 0.42 to 0.26 (38%) respectively.

Table 1 shows R^2, MM, and MSD statistics calculated for each depth slice to 50 m for the initial and revised CDI products. The tendency of initial processing results to overestimate the near surface conductivity is evidenced by a 0-5 m Mean Misfit of 0.499. In general the calibrated CDI product shows an improvement in all prediction statistics over initial conductivity calculations. Interestingly, in the 0-5 m depth slice, the revised R^2 statistic is slightly worse than that of the initial conductivity calculation. Such behaviour, given the substantial improvement in the MM and MSD statistics in the calibrated CDI for this depth slice is not disconcerting.

Results of the calibration exercise appear subtle when viewed in section; however, the impact of the processing on shallow depth slice maps is much more profound. Figure 3 shows the 0-5 m calibrated conductivity depth slice. In this figure, known salinity outbreaks appear better predicted

	Initial CDI Statistics			Revised CDI Statistics		
DEPTH	R^2	MM	MSD	R^2	MM	MSD
00–05m	0.3952	0.4994	0.5513	0.3271	0.0123	0.2308
05–10m	0.4275	0.3650	0.4188	0.4688	0.1231	0.2170
10–15m	0.2237	0.1547	0.2881	0.3966	0.1070	0.2205
15–20m	0.4458	-0.0426	0.2767	0.5760	-0.0054	0.1694
20–25m	0.6121	-0.1739	0.3359	0.7526	-0.0896	0.2123
25–30m	0.8129	-0.2561	0.3652	0.7848	-0.1704	0.2488
30–35m	0.7207	-0.3447	0.4220	0.6900	-0.2572	0.3608
35–40m	0.6049	-0.4334	0.5245	0.8335	-0.2564	0.3198
40–45m	0.7648	-0.4215	0.4752	0.8741	-0.3403	0.3909
45–50m	0.6936	-0.5321	0.5482	0.6960	-0.3388	0.3934
Average	0.5701	0.3223**	0.4206	0.6400	0.1700**	0.2764
***average of |MM|*						

Table 1. Initial and Revised CDI prediction statistics calculated for each depth slice.

and distinguished in comparison to the initial near surface conductivity maps (Figure 1). Importantly the map better reflects the generally benign near-surface salinity characteristics of the vast majority of the survey area. Additionally, when the reprocessed conductivity results are draped upon first vertical derivative magnetics an extremely strong correlation between palaeo-drainage features and regions of increased near surface conductivity is readily noted. Such observations are clearly insights into landscape and regolith controls on near surface salinity (and are the subject of work in progress). Here the magnetic field data also provide significant independent corroborating evidence that, despite the modest R^2 statistic of the calibrated 0-5 m depth slice, meaningful and interpretable geological signal is being resolved in the calibrated nearest-surface depth slice. For example, the NNE trending conductivity features labelled 'A' (centre left, Figure 3) correlates very well with magnetic palaeo-drainage features (Figure 4). The existence of these conductive features and their northeastern termination in the near surface has been confirmed by subsequent drilling (English, pers com., 2003).

Further results from this calibration work, include a much improved correlation between the 0-5 m conductivity distribution and radiometric signatures of the area has been established. Additionally, the calibration process has helped in the definition of more accurate depth to basement maps. Improved estimations salt store volumes and masses are also the logical result of this improvement. This work is still in progress and will be reported in the near future.

Conclusion

At Honeysuckle Creek, the heuristic calibration process applied improved both the vertical and lateral resolution of salt stores over the initial CDI products. Recalibrated results better relate to other geophysical and geological data sets. Improved insights into regolith and landscape influences upon the near surface distribution of conductivity have resulted.

Regardless of whether similar improvements will ubiquitously result from the application the methodology applied here, petrophysical logging is highly recommended as a follow up to AEM salinity surveys. At a minimum AEM conductivity products will be validated. However, as seen at Honeysuckle Creek, considerably more utility may result.

Acknowledgments

The author wishes to thank Ross Brodie and Richard Lane (Geoscience Australia) for freely passing on the benefit of their experience in AEM ground truthing. Thanks also to Jim Macnae (RMIT) for numerous discussions of AEM acquisition and processing issues.

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Reducing the Acquisition Costs of Airborne Electromagnetics Surveys for Salinity and Groundwater Mapping

Ken Lawrie, Matt Gray, Andrew Fitzpatrick, Paul Wilkes and Richard Lane

The authors are staff of the CRC LEME.

Abstract

Presently, airborne electromagnetic methods (AEM) are viewed as considerably more expensive than other airborne geophysical techniques for salinity and groundwater mapping. However, recent investigations by the Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME) and Geoscience Australia (GA) suggest that substantial cost reductions in acquiring AEM datasets (up to an order of magnitude) may be achieved if the critical landscape elements that control salinity and groundwater in a target area can be identified prior to surveying. Savings can be made if the spatial and geo-electrical characteristics of the elements allow relatively wide line spacings to be used.

Case studies in areas with existing AEM datasets, including the GILMORE, Lower Balonne and Honeysuckle Creek TEMPEST AEM survey areas, suggest that 1 km line-spacing is adequate to map most landscape and salinity elements in these depositional landscapes. Even 2 km line-spaced data provides catchment and sub-catchment scale salt store data, and this may be useful for broad scale planning and national audit purposes. For 1 km and 2 km spacing, this means that significantly larger areas could be flown for the same cost, reducing the cost of AEM data per hectare as follows:

1 km line-spacing <$0.7/ha for acquisition
2 km line-spacing <$0.4/ha for acquisition

This represents a very substantial cost saving, and could make AEM data affordable for many more Natural Resource Management (NRM) applications. The assumptions in the above calculations are that the total number of km from the original surveys are maintained, that the line-km costs are similar to those from recent surveys, and that all other survey mobilisation and operational costs remain similar to the original surveys.

Introduction

The potential of airborne geophysics to dramatically improve the understanding of groundwater and salinity systems at a range of scales has been demonstrated in several NRM and multi-disciplinary project over the last five years (George and Woodgate, 2002). In particular, AEM has been shown to provide tremendous insight into the regolith architecture and distribution of salt stores (Lawrie *et al.*, 2000).

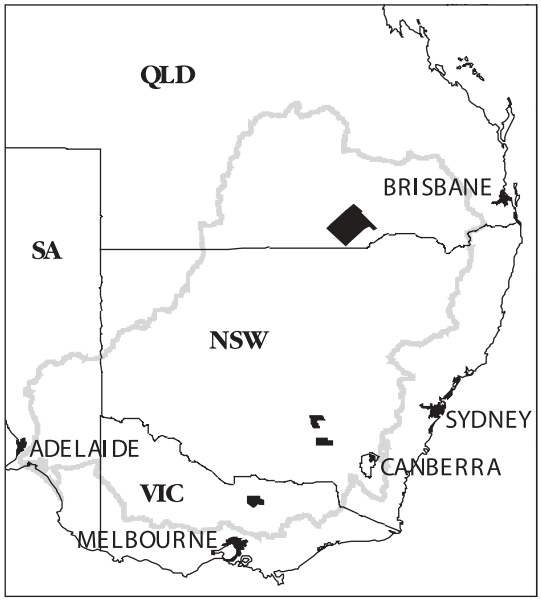

Fig. 1. Map showing the location of the three AEM surveys (solid black areas) considered in this paper (Lower Balonne (Qld), GILMORE (NSW) and Honeysuckle Creek (Vic).

Many of these early surveys had very general exploratory objectives. As knowledge of the subsurface elements of the Australian landscape has improved, airborne geophysical data are now being acquired to address more specific gaps in knowledge in a mature and cost-effective manner (Munday *et al.*, 2001). This requires that greater thought be given to the scale of the landscape and salinity elements to be mapped and opportunities to minimise the costs of acquisition per unit area. There can no longer be a 'one size fits all' approach. For example, in parts of Queensland, where land clearing has occurred relatively recently, catchment-scale datasets have the potential to provide benefits due to the general paucity of data and lack of knowledge on salinity processes and salt store distribution. In contrast, in many of the southern States and in WA, the salinity problems are such that salinity management requires more targeted interventions, and these necessitate the acquisition of sub-catchment scale data (Lawrie *et al.*, 2003).

Examples from three areas are given where the key landscape and salinity elements have been identified (Figure 1). Acquisition and processing reports for the surveys can be found in Lane *et al.*, (1999), Owers *et al.*, (2001) and Lawrence *et al.*, (2001). Previous interpretations of these datasets are given in Dent *et al.*, (2002) and Lawrie *et al.*, (2000). In the present study Lawrie *et al.*, (2003), data for hypothetical surveys employing different line spacings were prepared and interpreted to determine the minimum costs required to map the key elements.

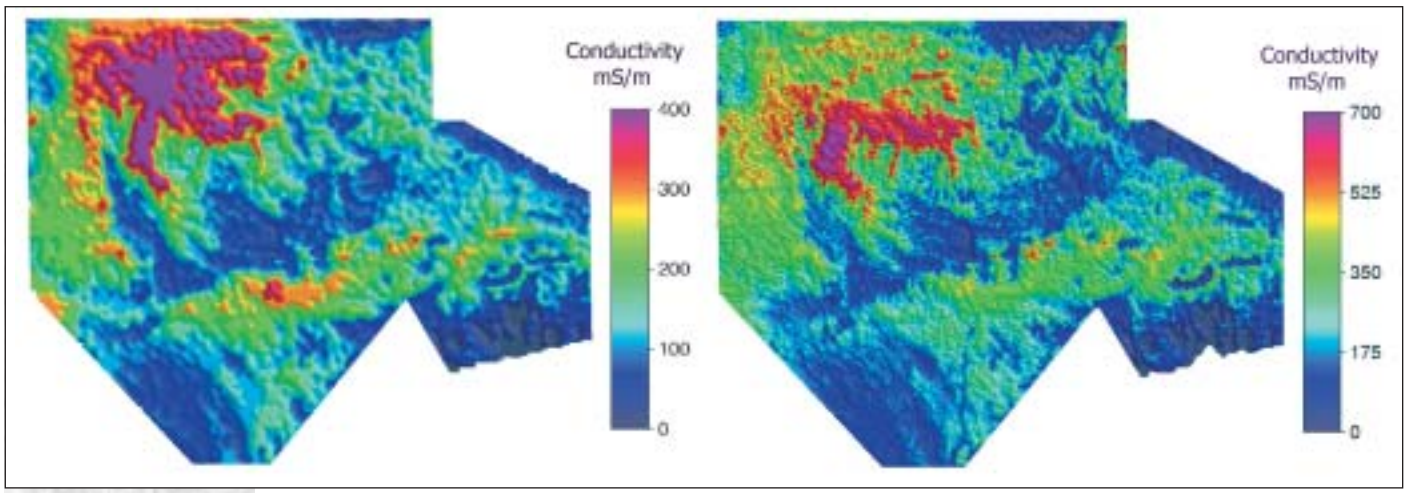

Fig. 2. The Honeysuckle Creek data processed with standard commercially available EMFlow version are illustrated in (Fig. 2a). CDI conductivity data for the study areas (excluding GILMORE) have been reprocessed using EMFLOW version 5.22-3 (Fig. 2b). A significant improvement in resolution is apparent. A correction of + 5 m has been applied to the transmitter height for the re-processed data.

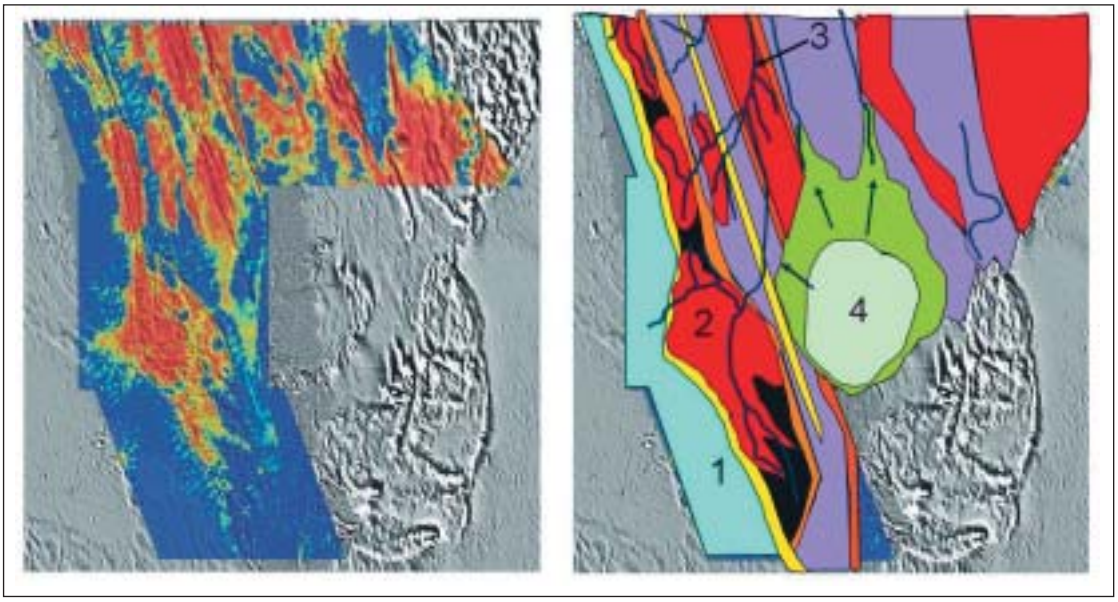

Fig. 3. This figure shows an LEI depth slice (Fig. 3a) with landscape elements interpreted (Fig. 3b). There are broadly four scales of features present:

1. *First order features. At depth (>20 m), bedrock-influenced elements such as variably weathered saprolith, and limited fresh bedrock (resistive silicified ridges). The structural dominance in the bedrock has partitioned the bedrock and its weathered equivalent into NNW-trending landscape elements that are between 1 and 6 km in width, and 10-50 km in strike length;*
2. *Second Order Features. Sedimentary basins developed through preferential erosion of weathered bedrock and subsequent infill. These form discrete basins at depth (15-60 m), and are between 1.5 and 6 km in width, and 3-20 km in length;*
3. *Third Order Features. The sedimentary basins are inter-connected downstream. They are sinuous features that represent palaeo-channel fill materials (not a single channel, but many stacked, small scale channels). They contain higher proportions of sand-sized materials than adjacent sediments, and in general appear to have higher hydraulic conductivities and water yields than adjacent finer grained sediments. These features form palaeo-gorges that cut through linear bedrock ridges that otherwise act as barriers to groundwater flow in this area. The palaeo-channels are generally less than 300 m in width, and can be traced for between 20 km and 2 km in length. It is important to recognize and map these features at sub-catchment scales;*
4. *Fourth Order Features. Small-scale features are evident in the highest resolution AEM datasets. These features mainly comprise narrow (<100 m wide, 500 m long) tributary palaeo-channels. These are probably of some significance at farm scale only.*

Methods and Procedures

Steps involved in determining optimal AEM survey specifications

In order to optimise AEM survey design for salinity and groundwater mapping, an approach has been developed based on maximising the information on 3D regolith architecture and composition, and landscape evolution. Particular emphasis is placed on identifying the key landscape elements that control groundwater and salinity. An example of this is shown in Figure 3. This approach utilises knowledge of sedimentology and geomorphic processes to assist with sub-surface interpretations and predictions of material distribution. Lawrie *et al.*, (2003) provide a more complete explanation of this methodology and a detailed examination of each of the three survey areas. In summary the basic steps are as follows:

- Landscape elements for mapping salinity and groundwater are identified within each survey area. This was done initially through analysis of independent datasets (airborne magnetics, gamma radiometrics and

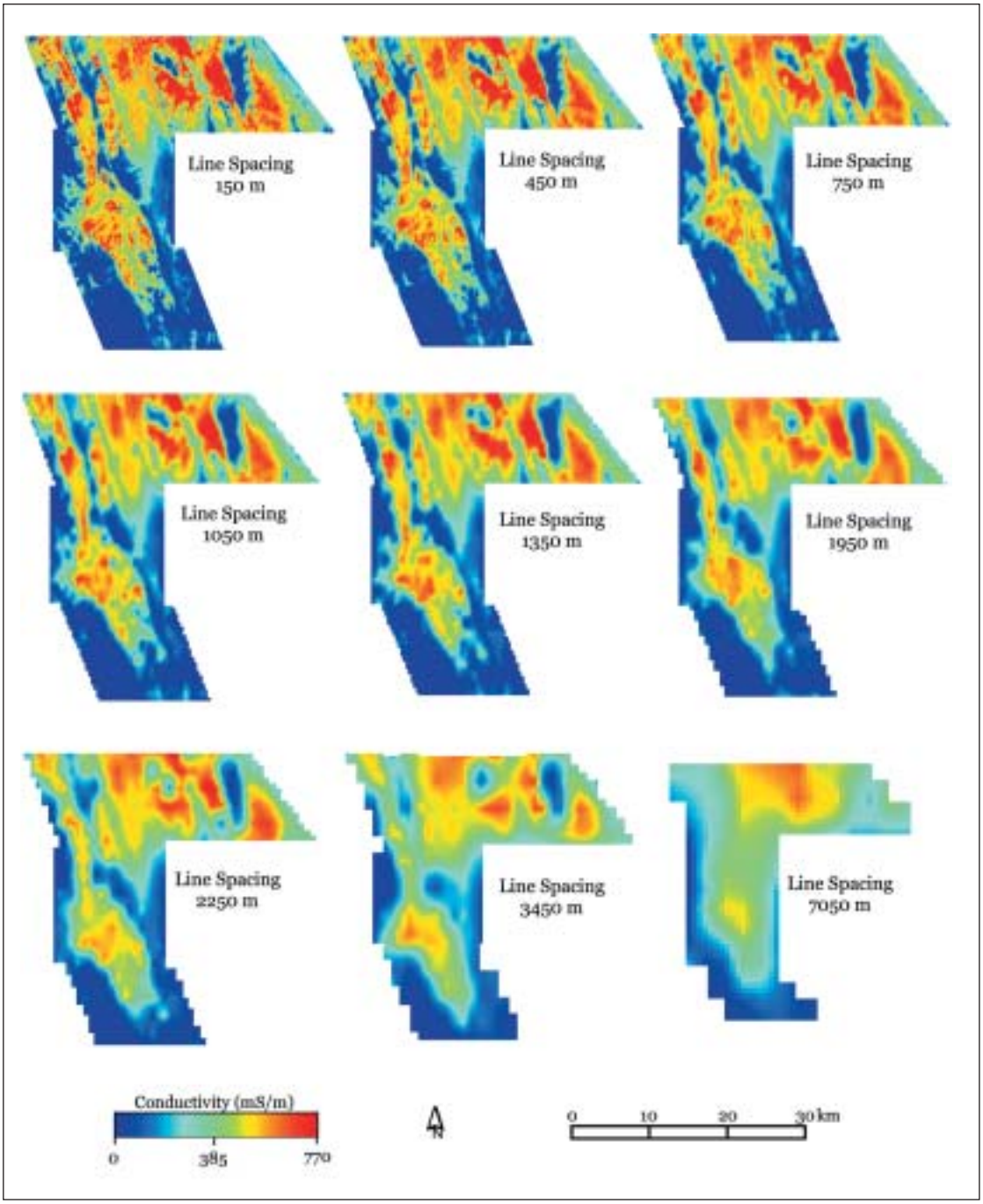

Fig. 4. CDI depth slice 30-32 m, GILMORE Project Area 1. CDI data from flight line profiles were chosen at spacings of 450 m (x3), 750 m (x5), 1050 m (x7), 1350 m (x9), 1650 m (x11), 1950 m (x13), 2250 m (x15), 3450 m (x23) and 7050 m (x47) of the original spacing. A linear colour stretch was used in these images.

drillhole data), and existing regolith, soils and land systems map data and Groundwater Flow System (GFS) conceptual models and frameworks where available.

- A hierarchy of landscape elements was established in each area. An example is given in Figure 2, where four scales of landscape elements in the GILMORE Project area are identified.
- These data were then integrated with the closest line-spaced AEM data available, and the landscape elements mapped within selected CDI slices. The scales of the landscape elements essential to mapping salinity were then tabulated for each survey area.
- Progressive broadening of the line spacing in each of the three survey areas was undertaken using both spaced line and swath set mapping approaches to assessing line space broadening.
- Comparisons were made between interpretations of landscape and salinity elements from the closest-spaced AEM surveys (and utilizing all other available data), with interpretations from progressively wider line-spaced datasets. Expert assessments of the quality of the results for landscape and salinity mapping involved CRC LEME staff and colleagues.

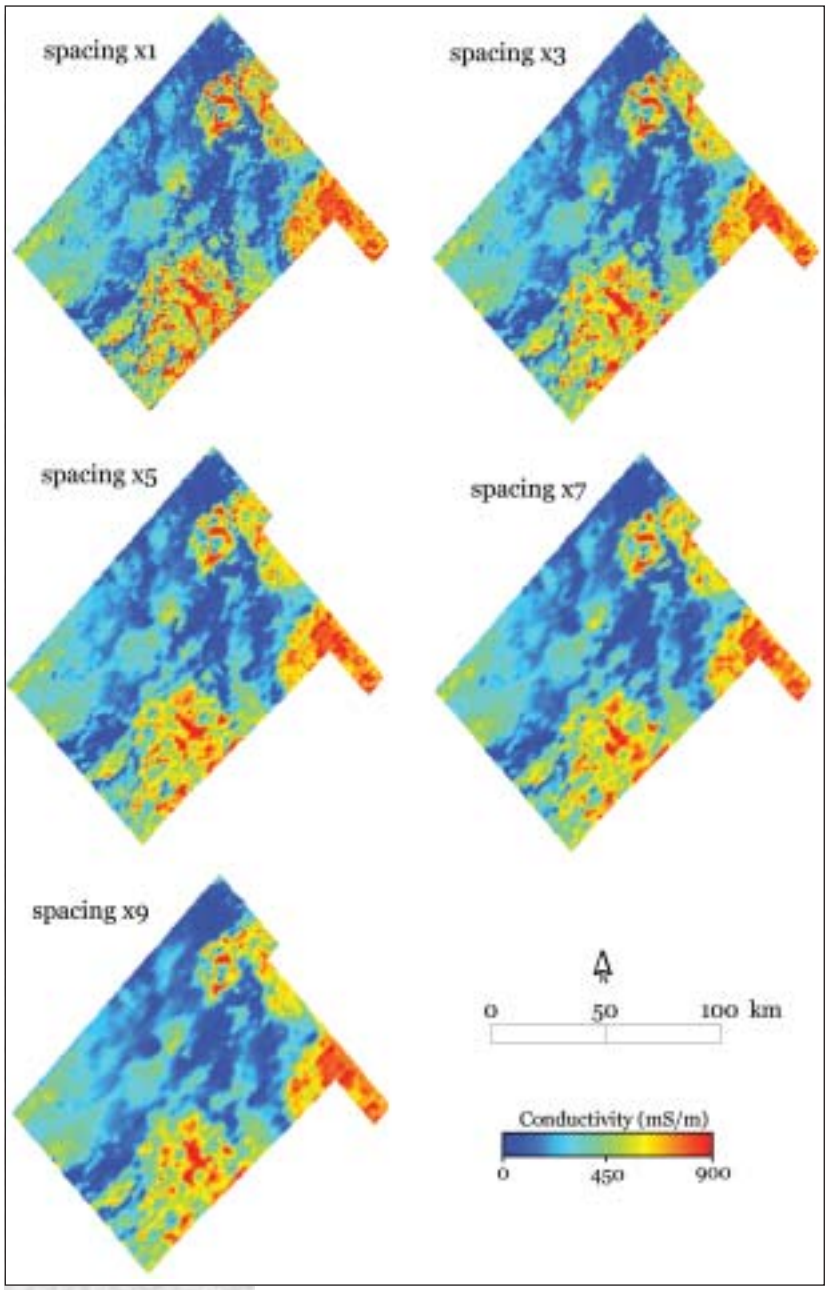

Fig. 5. Lower Balonne survey, CDI depth slice 25–30 m. CDI data from flight line profiles were chosen at spacings x3, x5, x7, x9 of the original survey. A linear colour stretch was used in these images.

- An assessment was then made to determine if any potential cost reductions could now be seen (with the benefit of hindsight).
- A further independent 'blind' test to assess the optimum line spacing for mapping different landscape and salinity elements was carried out by non-CRC LEME geoscientists from GA. The latter had little or no prior knowledge of the study areas, and were given progressively closer line-spaced data and limited additional data for the three project areas.
- The 'optimal' line spacing in each of the survey areas was then determined, and the costs of survey acquisition calculated based on available costings.
- These findings were then compared with previous assessments of survey costs, calculated as a cost per hectare.

AEM data processing

The survey examples all involve data acquired with the TEMPEST AEM system (Lane *et al.*, 2000; Lane *et al.*, 2001). To compare outputs in a consistent manner, AEM data were transformed to conductivity using EMFlow Conductivity Depth Imaging (CDI) software (Macnae and Zonghou, 1998; Macnae *et al.*, 1998; Stolz and Macnae, 1998). With the exception of data from GILMORE, EMFlow version 5.22–3 was utilised. This is a product of the current AMIRA P407b Project sponsored by a consortium that includes CRC LEME and GA. Improvements to the software during this project include the option to output 250 discrete conductivity values rather than the upper limit of 20 discrete values allowed by previous versions. The improvement in the output can be significant (Figure 2 a, b).

Point located CDI conductivity data were sub-sampled by omitting varying numbers of lines to simulate wider line spaced surveys prior to gridding. Odd number spacing factors (eg x3, x5, x7, etc) ensured that adjacent flight lines retained the normal survey convention of opposite flight direction. This practice minimises the directional bias associated with the asymmetrical geometry of the TEMPEST system. The use of swaths (i.e. groups of closely spaced lines separated by wider spacing) was also investigated and is reported in Lawrie *et al.*, (2003).

The sub-sampled point located CDI conductivity data were interpolated to form regular grids that were then imaged to reveal the lateral conductivity variations. Given the large disparity in along-line and cross-line spacing, data were sub-sampled along each line prior to gridding using a triangulation algorithm. Most of the data manipulation and gridding were performed with OASIS MONTAJ (GEOSOFT) version 5.1.7. Alternate forms of display such as profiles and sections that could do justice to the detailed along-line sampling would help to maximise the amount of information that could be extracted from widely spaced lines.

Results

GILMORE Project area (NSW)

The original line spacing in this area was 150 m (Lawrie *et al.*, 2000). The spaced line approach was applied to investigate the line spacings at which key landscape features could be resolved. CDI data from flight line profiles were chosen at various spacings from x3 to x47 the original survey. Some of the results are shown in Figure 4.

The GILMORE survey area is characterised by a high degree of complexity in both bedrock and regolith architecture, with four scales of salinity and landscape elements evident. The re-sampling exercise demonstrates that first order features in the landscape are evident at different CDI depth slices at coarse line spacings (1.8-2.2 km). This suggests some use of this scale of survey approach for identifying catchment scale conductivity (salinity) hot spots, with subsequent infill surveys for finer resolution

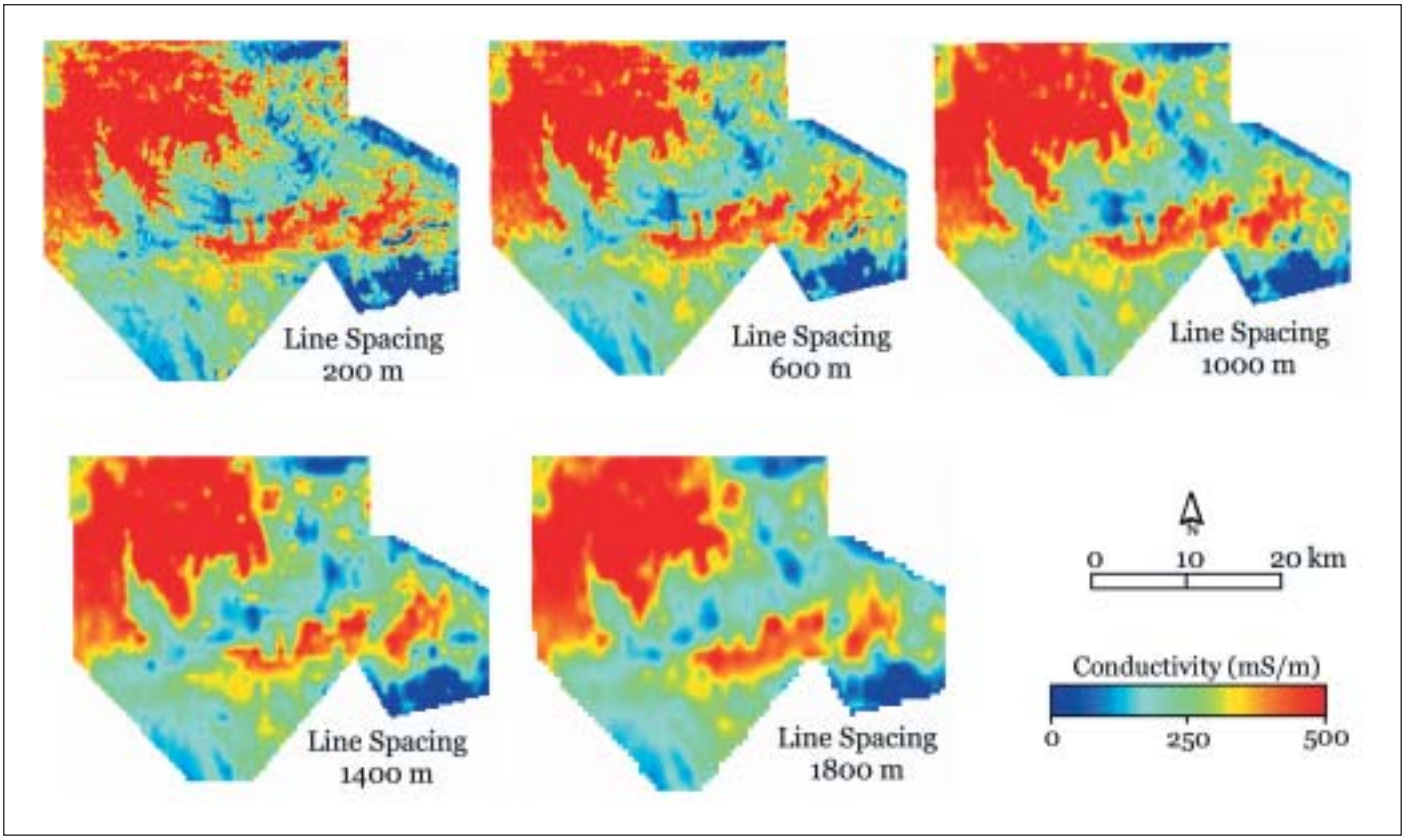

Fig. 6. Honeysuckle Creek Survey, CDI depth slice 15–20 m. CDI data from flight profiles were chosen at spacings x3 (600 m), x5 (1000 m), x7 (1400 m) and x9 (1800 m) of the original spacing. A linear colour stretch was used in these images.

studies. Second order features are also evident at coarse line spacings (resolvable in general terms up to 2 km), with not much increase in resolvability if line spacing closer than 750 m are used. This suggests that second order elements can be resolved for sub-catchment scale mapping purposes with line spacings between 750 m and 1350 m.

Third order features are important for sub-catchment scale mapping of salinity and landscape elements. A spaced line approach using a separation of between 750 m to 1050 m (x5 to x7) would provide adequate information to resolve sub-catchment scale landscape and salt store elements (down to third order). This equates with a km reduction of over 80-90% compared with the original survey. Resolution of the finest scale mapped palaeo-channels (4th order features) is lost between 150 and 450 m, indicating loss of paddock-scale features with line spacing much coarser than the original survey specifications.

Lower Balonne (Qld)

The spaced line method has also been applied to assess the optimal line spacing for mapping landscape elements in the Lower Balonne survey area. The original line spacing for this area was variable (400 m in the central block, and 250 m for the northern and southern blocks). Flight lines at factors x3, x5, x7 and x9 of the original spacing were selected. The results for the 25-30 m CDI depth slice are shown in Figure 5.

These data show that the scale of landscape and salinity elements in the Lower Balonne survey is clearly much larger than in the GILMORE and Honeysuckle Creek surveys. This may be due in part to greater structural complexity in the Lachlan Fold Belt geology of the GILMORE area compared to the Surat Basin geology in the Lower Balonne project area. Such observations may assist with future survey planning. Line spacings in the order of x3 and x5, which translates to a line spacing of between 1 and 1.5 km, would appear to be sufficient to resolve the key landscape elements that control salinity and groundwater flow at sub-catchment scales in the Lower Balonne landscape. Conservatively, this equates to a line separation of 1250 m for St George North and South, and 2000 m for the Central block.

Honeysuckle Creek (Vic)

The spaced line methodology was also applied to the Honeysuckle Creek survey area. The original line spacing for this survey was 200 m, therefore flight lines were chosen at factors x3, x5, x7, and x9 of the original spacing. CDI depth slices of 15-20 m for x3 to x 9. The results for the 15-20m CDI depth slice are shown in Figure 6.

The Honeysuckle Creek study again demonstrates that most of the finer scale landscape and salinity elements are still resolvable at a spacing of x3, and possibly even x5. Some distortion of the palaeo-drainage features is evident in the latter, but this is an inevitable problem associated with

Fig. 7 a, b, c. The original survey areas for GILMORE, Lower Balonne and Honeysuckle Creek respectively, each with a larger box drawn around to illustrate the areas that might have been flown with the same number of line-km as the original surveys but a line spacing of 1 km.

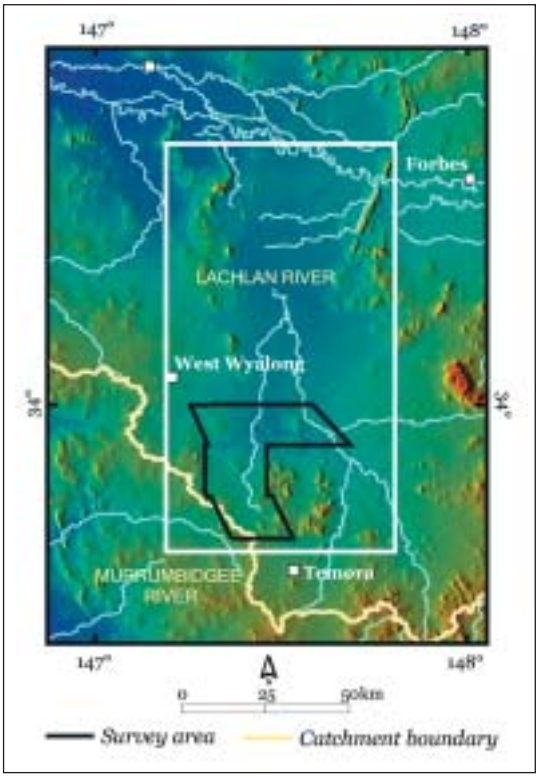

Fig. 7a.

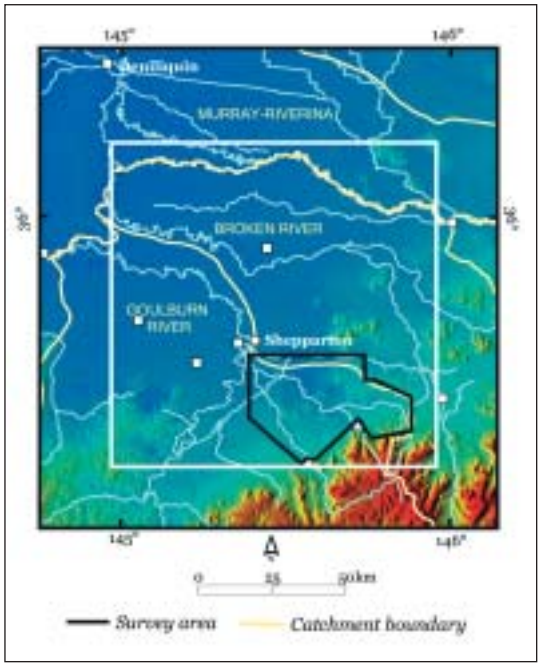

Fig. 7b.

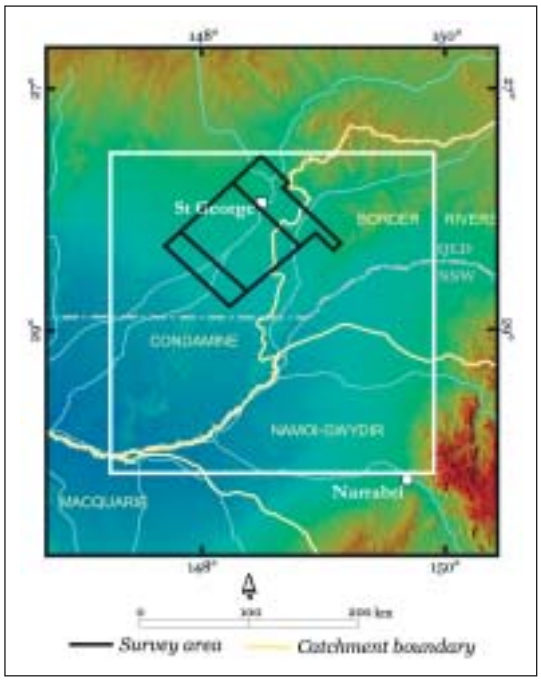

Fig. 7c.

presenting such anomalies in gridded format. It is regarded however that the broad conductivity distribution is still known without significant distortion of the features. Such a representation is still very useful for a salinity investigation.

Cost of acquisition of airborne geophysics datasets
Previous estimates of acquisition costs are listed below:

Previous costings (George *et al.*, 2000)
A Landsat TM and Digital Elevation Model (DEM)
= $0.40 + 0.10 = $0.50/ha
B Magnetics and Radiometrics
= $0.60 + 0.20 = $0.80/ha
C Airborne Electromagnetics and Interpretation
= $4.00 + 1.00 = $5.00/ha

These are essentially based on an analysis of the Toolibin survey in WA, carried out as part of the National Airborne Geophysics Project (NAGP) (George *et al.*, 2000). There are a number of issues embedded in this assessment that need to be revisited. For example, the Toolibin area is characterised local groundwater flow systems in areas of Archaean basement. These systems are simpler than the Cainozoic Intermediate and Regional Flow systems of Eastern and Southern Australia. The analysis of the Toolibin survey also assumed that data with line spacing of 200 m were required in an approach that covered the complete spectrum of scales from paddock to catchment. The proposal to broaden spacing from 200 m to 1 km for example, would necessarily imply that the AEM data were no longer being acquired for direct input into paddock to farm scale interventions. It could be argued that this was an appropriate shift in direction for AEM surveying as the shallow, high resolution subsurface conductivity information required from EM surveys at these detailed levels could be best provided using ground-based methods. The forte of AEM surveys is clearly in the provision of consistent, spatially coherent information at sub-catchment to regional scales.

Employing the wider line spaced approach argued here, significantly larger areas can be flow for the same cost (Figures 7 a, b, c.). New costs for AEM data per hectare can be derived:

New costings for AEM (with assumptions listed previously)
1 km line-spacing <$0.7/ha for acquisition
2 km line-spacing <$0.4/ha for acquisition
Even when benefits are restricted to relatively direct and short term returns, AEM is viewed as positive to marginally economic for salinity/groundwater mapping in many landscapes/farming systems (George and Woodgate, 2002). The work presented here has the potential to make AEM datasets much more affordable across a wide range of landscapes.

Further cost reductions for the delivery of AEM data could be achieved through a number of strategies, including:

- Greater focus and clarity in the objectives of a survey,
- Cost sharing with partners using the data for other applications,
- Discounts from service providers for large and consistent amounts of work,
- Increased focus on maximizing the use of existing data and knowledge of landscapes,
- Incremental and revolutionary improvements to technology, and
- Changes to the acquisition and processing parameters.

On the other side of the cost effectiveness equation to the cost reductions discussed here, the effectiveness of AEM data for NRM can be improved by carefully matching the characteristics of the AEM system to the target through pre-survey model studies and by ensuring that the supporting information required to properly process and interpret the AEM data is available (Munday *et al.*, 2003a, b).

Conclusions

Analysis of existing survey data from three depositional landscapes across Australia has indicated that a line spacing of approximately 1 km (and wider spacings in the Lower Balonne survey area) could have been used to identify and map most of the sub-catchment scale landscape elements. This suggests that order of magnitude cost savings in survey acquisition costs might be achieved for surveys with similar line km totals in adjacent or similar landscapes.

An integrated geoscience approach to assessing the scale of landscape elements that involves consideration of present landforms and buried landscapes can greatly assist with the design of cost-effective surveys for salinity mapping and broader NRM applications. This approach should also utilise GFS conceptual models and frameworks where possible. This will be particularly important in designing appropriate AEM surveys in areas without existing high-resolution geophysical data.

Depending on the scale and geo-electrical characteristics of the landscape and salinity elements, AEM acquisition costs could be reduced by widening the line spacing. Swath mapping could be employed in some instances where localised detail is required to identify features. Cost reductions could still be achieved in cases where portions of the survey area were covered in greater detail leaving other areas more sparsely covered. This style of survey would require careful planning.

An approach involving different levels of survey detail has parallels in mineral exploration where regional surveys may target the broader mineral systems and their surrogate expressions in the regolith whilst more detailed surveys chase individual orebody anomalies.

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ASEG 2003 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 the 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 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. 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.

Tapestry McLaren Vale Cabernet Sauvignon 2001

This wine has a deep dark rich purple colour and a bouquet of lifted berry fruit characters, along with intense violet, mint and subtle vanillin oak.

The palate is rich in fleshy fruit with a balanced, lingering finish. The vanillin characters that are derived from the oak treatment supplement and enhance the concentrated flavours associated with this variety.

This wine is drinking well now, but has excellent cellaring potential and with patience will peak in around 2010.

The wine is complemented by duck, roast beef, roasted capsicum with mushroom and pepper sauces.

Retails at around $240/case

Hamilton Slate Quarry Riesling 2003

The cool conditions of the 2003 vintage produced grapes of elegance and style, with intense flavours and varietal definition.

The bouquet has lovely aromatic characters, with lifted floral notes and limey citrus fruits while the palate has delicate yet intense citrus fruit, finished with refreshing clean acidity.

This wine is ideal as an aperitif, or the perfect accompaniment to delicately flavoured seafood and white meat dishes. Perfect to drink now to enjoy the refreshing acidity, or see further complexity and depth of flavour develop with medium term cellaring.

Like many premium Rieslings, this wine is sealed under a stelvin closure to ensure perfect freshness.

Retails at around $160/case

2003 ASEG WINE OFFER: orders close NOVEMBER 14th 2003

Please supply: Photocopies of this order form are acceptable

Number of dozens	Wine	Cheque price	Credit Card price	Total
	Tapestry Cabernet Sauvignon 2001	$145	$148	
	Hamilton Slate Quarry Riesling 2003	$105	$108	
			TOTAL	

Name: _____ Daytime telephone: (___) _____ Email address _____

Address: _____ Capital city for collection: _____

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

Card Account number: __ __ __ __ __ __ __ __ __ __ __ __ __ __ __ __

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

Enquiries: Stephen Tomlin, Tel: 08 8224 7862, Fax: 08 8224 7578, email: stephen.tomlin@santos.com

Business expenditure on research and development climbs in 2001/02

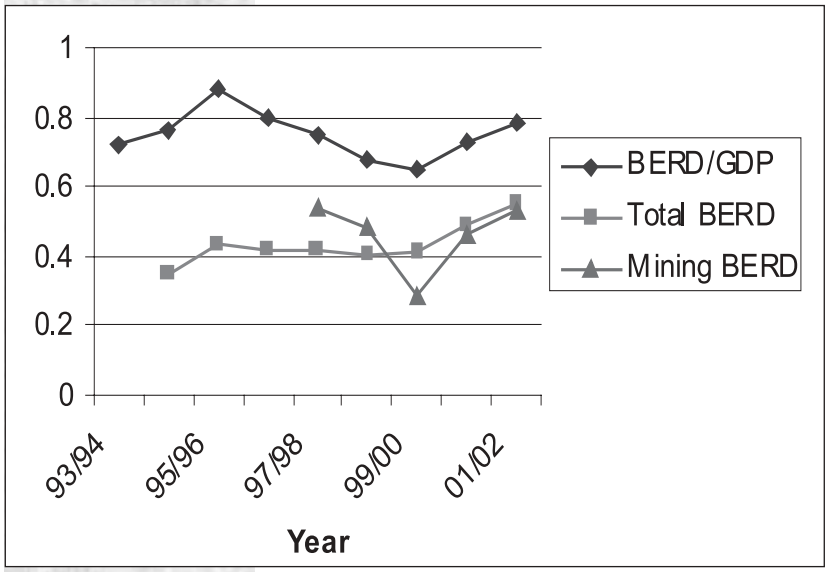

Fig. 1. R&D expenditure in Australia; BERD/GDP in %; Total BERD in $billion/10 (in current $); Mining BERD in $ billion (in current $).

Figures released by the Australian Bureau of Statistics in August this year show that the level of business expenditure on research and development (BERD) has continued to rise over the last two years.

The numbers, relating to the 2001-2002 financial year, show that the mining industry experienced a large increase in R&D investment of almost 16 % to $534M. However, as the figure below shows, this follows the huge (and somewhat anomalous) fall in R&D investment during 1999/2000.

However, the overall picture in terms of BERD/GDP is not so good with this ratio not yet back at the level it was in 1996/97. There is still a long way to go, particularly in comparison with other countries. In 2001/02 Australia was headed by Japan (2.28%), US (2.1%) the UK (1.28%) and at least ten others. So the government should not slacken its efforts to encourage a higher level of BERD.

Mineral exploration expenditure continues to increase in June quarter, but petroleum declines slightly

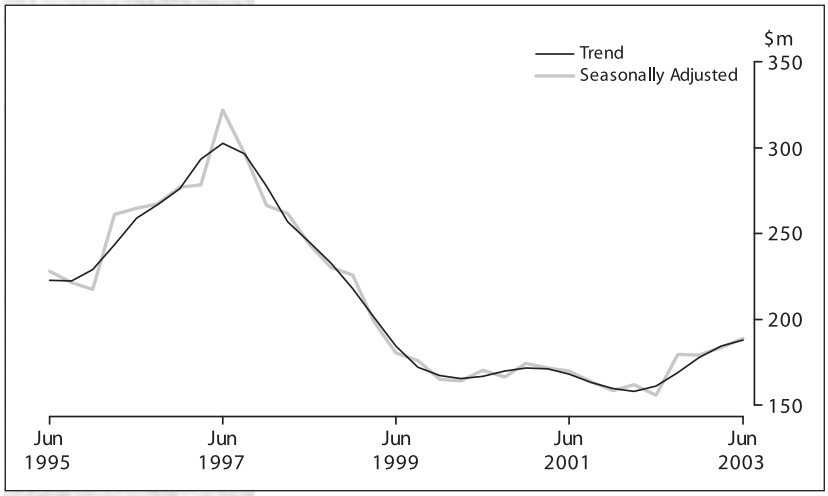

Fig. 2. Trend and seasonally adjusted quarterly mineral exploration expenditure from June 1995 June 2003 (provided by the Australian Bureau of Statistics).

Minerals

Figures released in August by the Australian Bureau of Statistics showed that investment in mineral exploration is continuing to rise from the low point of $158.3M experienced in the March quarter of 2002.

The trend estimate for total mineral exploration expenditure increased by 1.8% to $188M in the June quarter 2003, the fifth consecutive increase in this series. The trend estimate is now 16.5% higher than the corresponding estimate in the June quarter 2002, as shown in the figure below.

The trend estimate for metres drilled increased by 5.8%, the third consecutive quarter of steady growth. In original terms, mineral exploration expenditure increased by $50M (32.6%) in the June quarter 2003 (up 2.8% in seasonally adjusted terms). Expenditure on production leases increased by $19M (58.7%) and expenditure on all other areas increased by $31M (25.6%).

Most states contributed to the overall increase in the June quarter 2003. The largest increase was recorded by Western Australia (up $21m or 22.9%), with exploration for gold, nickel and cobalt driving the increase. As usual, WA dominated the scene with 55% of the total expenditure of $203.4M (original numbers) being spent there.

Petroleum

In the June quarter 2003, expenditure on petroleum exploration fell by $26M or 9.9% to $240M, which is still

33.0% higher than the June quarter 2002. There was a significant increase in exploration on production leases (up $14M or 136.6%) which was more than offset by a decrease in exploration on all other areas (down $40M or 15.7%). While onshore exploration expenditure increased significantly by $11M (36.1%), offshore exploration decreased by $37M (15.7%), with drilling activity contributing strongly to the offshore decrease. Figure 3 indicates the changes in the numbers.

As would be expected, because of the large costs involved in offshore drilling, the graphs are rather lumpy. It only needs a couple of offshore drilling rigs to come or go and the effect on the expenditure is huge.

Western Australia dominates the scene with $151.3M (63%) of the total $240.1M spent in WA.

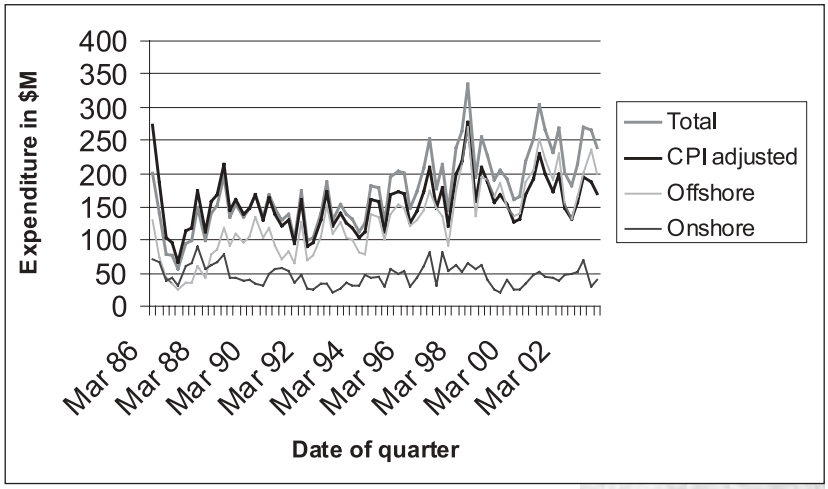

Fig. 3. Quarterly petroleum exploration expenditure from March 1986 through June 2003 for onshore and offshore areas.

Xstrata finally captures MIM and sells its exploration portfolio

After several months of skirmishing between Xstrata and MIM stakeholders, the Swiss based company has finally taken control of MIM and another Australian Resource icon is no more.

Completion of the acquisition of MIM took place on 24 June 2003, at which time Xstrata took control of MIM, and MIM shares were suspended from trading from that date.

Under the terms of the arrangement MIM shareholders will receive $1.72 cash for each MIM share.

Xstrata is a major global diversified mining group, listed on the London and Swiss stock exchanges and based in Switzerland. The group maintains a meaningful position in six

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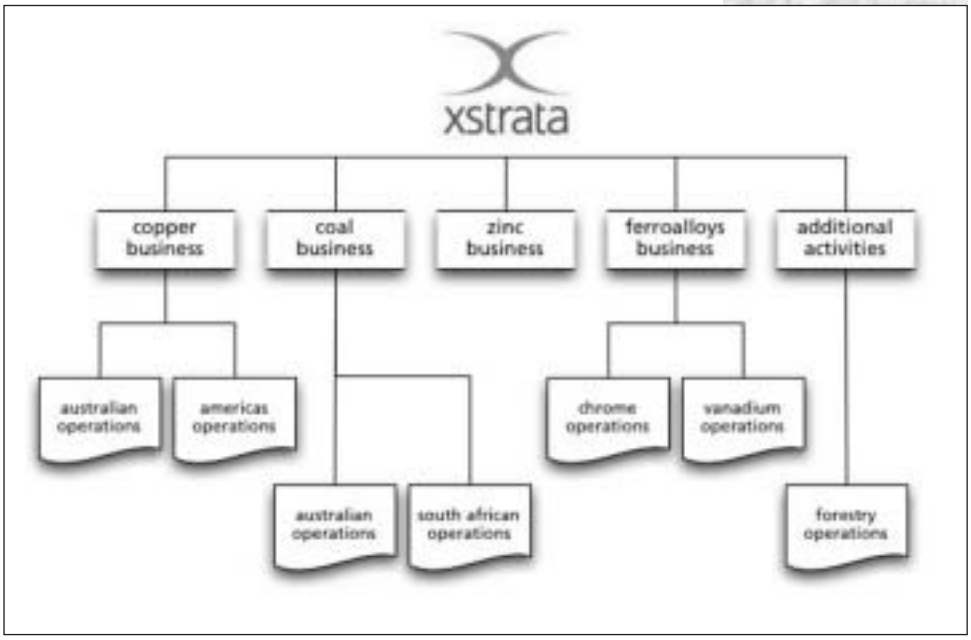

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major international commodity markets: copper, coking coal, thermal coal, ferrochrome, vanadium and zinc, with additional exposures to gold, lead and silver. The group's operations span four continents and six countries: Australia, South Africa, Spain, Germany, Argentina and the UK. Xstrata is headquartered in Zug, Switzerland and has approximately 19,500 employees worldwide. The Xsrata structure is shown to the left.

Details of the new executive appointments can be found on the Xstrata website at: http://www.xstrata.com.

Subsequently, STRAITS Resources acquired the former MIM Holdings' exploration portfolio in Australia.

The coal producer and former copper miner will pay Xstrata cash for the portfolio.

The portfolio includes six 100% held projects in Queensland, New South Wales and South Australia, and features high-grade gold and copper-gold targets.

The joint venture's projects include Snake Well in the Murchison region of Western Australia with Giralia Resources, Quartz Hill in WA (International Goldfields), Buck Pan in the Northern Territory (Newmont Mining), Drew Hill in SA (Polymetals), and Torrens, also in SA, (Argonaut).

Last month Straits said it was considering a salt development in WA. The company sold its Nifty copper mine earlier this year in a deal that netted it $90 million.

Fifteen of the world's largest mining companies give pledge to recognise existing world heritage properties as 'no-go' areas

The announcement was made by the International Council on Mining and Metals (ICMM) whose members include major mining companies such as Alcoa, AngloGold, BHP Billiton, Newmont, Placer Dome and Rio Tinto.

The ICMM Chairman Sir Robert Wilson said in August this year, "We understand that the analysis of all options for land use will sometimes mean that mining projects cannot proceed because unique and sensitive biological or cultural values would be compromised if they did. We need and intend to earn the trust of other participants in the debate so we can contribute to sustainable development."

The announcement results from a dialogue process with IUCN, The World Conservation Union, started earlier this year. IUCN Director, General Achim Steiner, said he welcomed the decision. "Today's announcement by the International Council on Mining and Metals sets an important precedent.

"By making this 'no-go' pledge, 15 leading mining and metal producing companies of the world have now created a threshold for corporate responsibility against which they and, indeed, others in the extractive industry will be assessed.

While many issues and objectives remain to be addressed, this is an important milestone. We hope that such a clear statement by the major mining companies in the world will significantly reduce direct or indirect impacts by mining on World Heritage sites all over the world."

The agreement includes an undertaking not to explore or mine in world heritage properties and a commitment to take all possible steps ensuring company operations are not incompatible with the outstanding universal values of world heritage properties.

It will be of interest to see if the petroleum explorers are prepared to give a similar undertaking.

Drilling program for gold, in Eyre Peninsula

Adelaide Resources announced in June the start of gold exploration drilling activities on the Eyre Peninsula Joint Venture tenements. The formation of the Eyre Peninsula Joint Venture with the Newmont Australia Limited Group, the Australian arm of the world's largest gold producing company, was announced on 27 May 2003. The joint venture is exploring for gold in an area of over 6400 sq. km on the northern Eyre Peninsula of South Australia.

The program will be dominated by about 20 km of RAB/aircore drilling, which will be completed before the end of December 2003. The budget for the overall six-month program is $750,000. The targets to be tested in the current campaign of 8,000 m can be viewed at the website: http://www.adelaideresources.com.au/announcements/ASX%20-%2027-06-03.pdf

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Geodynamics: Second Edition

Donald L. Turcotte, Gerald Schubert
Published By: Cambridge University Press, USA, p 456, 2002
RRP: $90.00

Reviewed By:
David Burbidge, Geoscience Australia
Email:
David.Burbidge@ga.gov.au

The first edition of '*Geodynamics: Applications of Continuum Physics to Geological Problems*' by Turcotte and Schubert has been the classic textbook for geodynamics for the last 20 years. Beginning with fundamental physics of stress and strain it covers most areas of geophysics (with the notable exception of seismology) at the advanced undergraduate level. It has formed the basis of many an undergraduate course in geophysics and can be found on the bookshelves of many researchers in the field. It was therefore with great interest that I read the second edition of Turcotte and Schubert's classic text.

The new edition of Geodynamics is simply titled, '*Geodynamics: Second Edition*' and, like the first, it begins with a chapter discussing plate tectonics at a general level. This was designed to bring up to speed physics and mathematics students with the basics of plate tectonics, although some understanding of geological terms would be necessary to gain the most from this chapter in the book. The first chapter also seems to be one of the most revised in the second edition with additional discussion on mantle plumes and a totally revised section on planetology. The section on planetology takes into consideration what has been learnt about the terrestrial planets in the last 20 years thanks to the latest space missions. As all the figures in the book are in greyscale, many of the photos of the planets lose their impact when compared to the colour versions (particularly those of Io). However, this chapter does successfully motivate the rest of the book.

The next chapters in the second edition are quite similar to the first edition as they cover fundamental physics. The only differences I could find are some additional geological examples in a few of the chapters. Beginning with a discussion of stress and strain in solids, the authors then discuss elastic flexure, heat transfer and gravity anomalies as they apply to the Earth's lithosphere. They then discuss fluid mechanics as it applies to magmas, the mantle and plumes. The next chapters then go on to discuss rock rheology, faulting and flow in porous media. The final chapter is completely new and discusses chemical geodynamics, the use of quantitative measurements of isotope ratios to infer something about physical processes in the Earth (e.g. geochronology). Each chapter also contains exercises, some of which have answers in the back of the book. There is also a very useful table of physical constants related to geodynamics in the back (e.g. densities and thermal conductivities of typical rocks).

As in the first edition, all the derivations are made using nothing more mathematically advanced than algebra, calculus and trigonometry. No use is made of tensors. While this allows the book to be used by students without this mathematical background, it does make many of the derivations fairly long and limited to one or two dimensions. Given the length of the derivations, this is not a textbook for those intimidated by multiple pages of algebra! There is also no in-depth discussion of seismology, although some of the observations derived from seismology are discussed. However, there are many other textbooks, which cover seismology more than adequately, so this isn't a great concern.

I would recommend this book to anyone considering giving a course in geodynamics or simply needing an entry level book on the field of geodynamics that covers the basics. I would have more difficulty recommending this to current owners of the first edition, as most of the chapters have remained the same. However, given the amount of use most versions of the first edition have had, you may want a new one which isn't as worn! As it has a relatively low price ($90) and covers a broad range of the topics, it seems that the second edition of Turcotte and Schubert's '*Geodynamics*' is destined to remain the classic textbook on geodynamics for the next 20 years as well.

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Drilling last quarter discovered gold at White Tank returning intersections including 7 m at 10 g/t gold and 7 m at 3.09 g/t gold. Primary gold mineralisation has also previously been intersected in limited drilling on both the Western and Southern Zones at Barns.

Other prospects to be drilled in later 2003 campaigns include WUD6, WUD2 Central, WUD9 and Yantanabie.

Like Barns, these targets have all returned strong and widespread gold anomalism in first pass drilling completed in previous years. In the 2004 program it is envisaged that, as well as deeper reverse circulation drilling, there will still be a significant component of RAB drilling on new and existing targets.

A concurrent program of calcrete sampling is being conducted to define further gold anomalies for drill testing. This work will boost the Adelaide Resources' drilling program to $2 million a year across its South Australian tenements.

The Dating Game: one man's search for the age of the Earth

By Cherry Lewis

Cambridge University Press
ISBN 0 521 89312 7
$32.92

Reviewed by David Denham
Email:
denham@webone.com.au

The Dating Game is the story of how Arthur Holmes (1890–1965) rose from a poor family, living in the terrace houses of Gateshead, in northern England, at the turn of the 19th Century, to become the most influential and respected geoscientist in Great Britain some fifty years later.

But that is not all. Cherry Collins weaves into her fascinating story, observations on academic life in Great Britain, including the politics and the power plays within academia during the first half of the 20th Century. She also provides an incisive commentary on how the technology needed to estimate the age of the Earth was only advanced from new knowledge obtained outside mainstream geology.

Holmes was lucky in so far as he had a physics training (he never took a degree in geology) and was able to apply the newly discovered properties of radioactivity to determine the age of rocks on Earth. He was also able to do battle with the likes of Lord Kelvin who, without the knowledge of radioactivity in the Earth's crust, gave an estimate of the age as 100 million years, and Harold Jeffreys, who argued that the continents could not move because the Earth was too rigid.

By 1947 Holmes had not only estimated the Earth's age as 3.35 billion years, but had also determined age estimates for each geological period from Cambrian (510 million years in his 1947 paper) through to Pleistocene. These estimates are the same order of magnitude as present day values and were a long way from Archbishop Ussher's estimate of God creating the world in 4004 BC which, apart from being the smallest estimate of the Earth's age, was widely believed until the end of the 19th Century.

Holmes' triumphs did not come easily: for many years he was hampered by a lack of funds and resources, and at one stage almost gave up pursuing his research activities. In 1911 he took a job with Memba Minerals to go to Mozambique and earn some real money, as well as riches for his company. Although he was able to map some of the rocks in the region he contracted blackwater fever and malaria and nearly died as a result. Throughout his life he suffered from bouts of malaria but at least he escaped the battlefields of the First World War because of his health.

After the War, Holmes was still only a demonstrator at Imperial College, despite having published three books and gained a significant reputation for his work on radiometric age dating. The financial pressures were so great that in 1920 he took his first wife Margaret and young son Norman to Burma as Chief Geologist to the Yomah Oil Company. This adventure ended in tragedy, Norman died of dysentery before his fourth birthday and the company owed Holmes a large amount of money for wages not paid. When he returned to Gateshead in 1922 he was worse off than before he went to Burma and was reduced to working in a shop until in 1924, when he finally landed a job at Durham University as a lecturer in Geology.

From then on Holmes' achievements began to be more widely recognised. His career in academia was firmly established and he was eventually promoted to professor and became an inspirational lecturer and communicator. However, there were still a few interesting twists to the story. In 1930 he started a relationship with Doris Reynolds, a petrologist whom he met on a field trip in Scotland, and who became the second Mrs Holmes after his first wife died in 1938. The story of how this affair led to him leaving Durham and moving to Edinburgh sheds interesting light on the way university authorities at the time reacted to Holmes' personal situation. But you will have to read the book to find out what happened.

The Dating Game is an excellent read. It is well researched and well written, and if you still have the *Principles of Physical Geology* on your bookshelves dust it down and see for yourself some of Holmes' great achievements.

Finally a quote from the great man himself in 1964: 'Looking back it is a slight consolation for the disabilities of growing old to notice that the Earth has grown older much more rapidly than I have — from about six thousand years when I was ten, to four or five billion years by the time I reached sixty.'

Highly recommended for everyone with an interest in the geosciences, the history of science and how new knowledge is obtained.