Preview

Australian Society of Exploration Geophysicists

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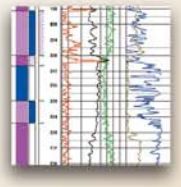

INTRODUCING

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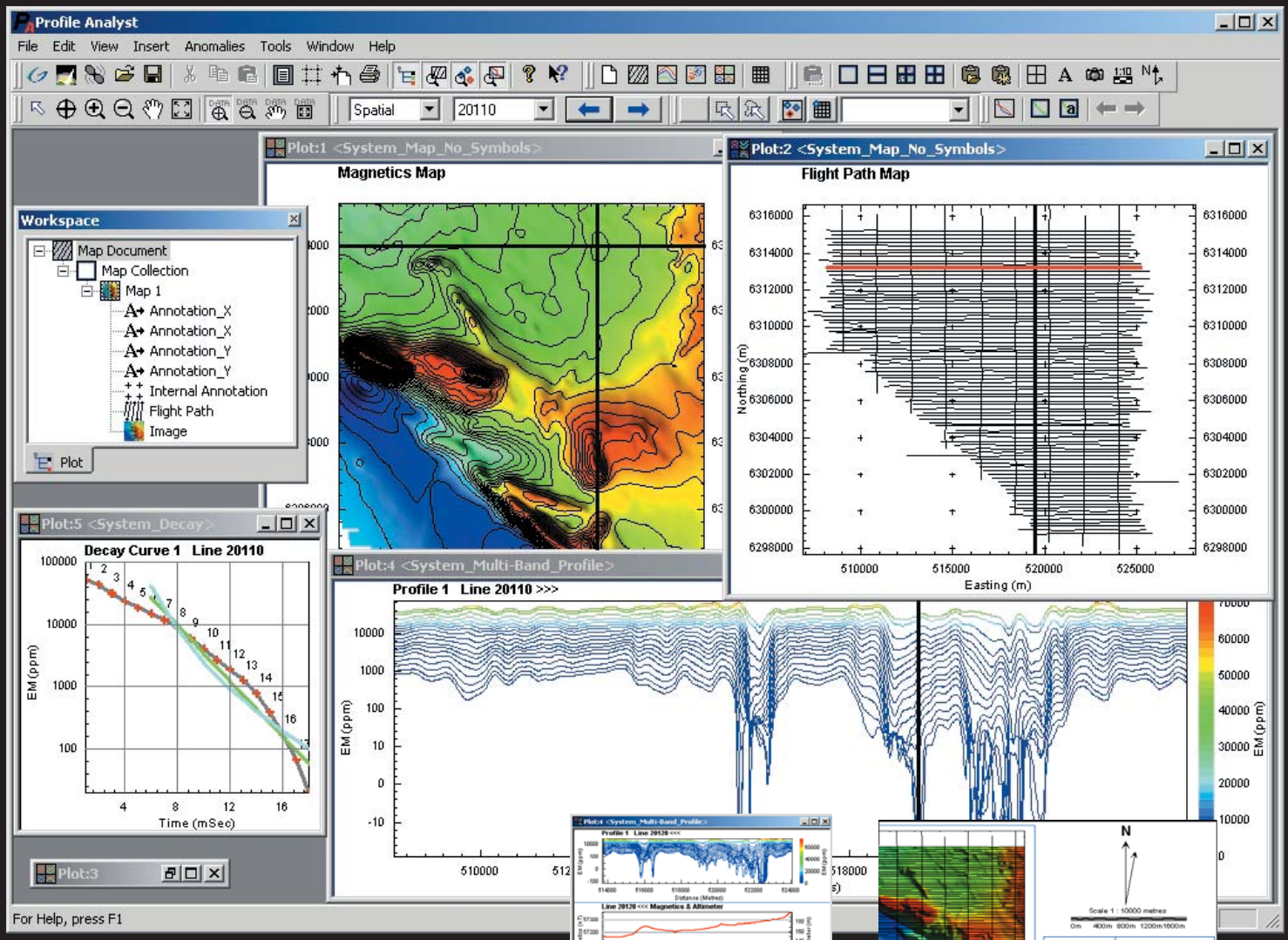

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Editor's Desk

This edition of Preview contains the last of the series of review articles on borehole geophysics. I would like to thank all the authors for providing us with excellent overviews on the state of borehole geophysics through a wide-ranging set of articles. When I was a geophysics student, borehole geophysics was usually tacked on to the end of the core modules on gravity, resistivity, magnetics and seismology, almost as an afterthought. How times have changed. Borehole geophysics is now a mainstream sector of our discipline with applications extending into many new areas of exploration and environmental studies.

We also have the results of the ASEG Membership Survey, which was carried out at the end of last year. The article in this issue by Koya Suto and Brian Spies contains the main findings from this survey. As you will see most members indicated that they were pleased with the way the ASEG has been operating. This is good, however, we must not be complacent. We live in challenging times and need to be able to cope with the changes affecting Australia's resource industries and the catchment areas discipline.

The full report will be placed on the ASEG web site at www.aseg.org.au and I recommend that all members visit the site to read the complete document. As you will see the analysis carried out has been extensive and very thorough; congratulations to Koya and his team. I invite members to comment on the results of the survey through the columns of *Preview*.

We have started a new segment, 'Geophysics in the Surveys' in this issue. The plan is to make information available to members on the main geophysical activities and data releases in the Geological Surveys. We have input from AGSO and the NTGS here and I am planning to include material from the other Surveys in future issues.

The Webwaves feature in this issue has been compiled by Tim Mackey. Natasha Hendrick is finalising her PhD and Tim has been coopted as guest writer. Many thanks to Tim and best wishes to Natasha on a successful submission.

Finally, I would like to remind readers that I still hold on my shelves copies of the following books:

- Numerical Models of Oceans and Oceanic Processes by Kantha & Clayso
- Earthquake Thermodynamics and Phase Transformations in the Earth's Interior by Teisseyre & Majewski.

These are quality hardback publications and will be sent to members on a first come first served basis for reviewing - any takers?

David Denham

Letter to the Editor

Employment Tip

I enjoyed reading Jon Sumner's 'A Corporate Life' in the February issue of *Preview*.

There is a 5th (serious) tip for those geophysicists looking for work. It came to me via early morning radio (you see, I suffer from insomnia). This guy, who was looking for work in the building trade, said the way to go is to form a Company (cost, he said, about $100) and adopt the approach that you are trying to expand, looking for more business...***Never*** admit you are unemployed or you are defeated from the start. He claimed this approach has worked successfully for him.

I'll keep my ear to the radio and advise of any follow-up. Meanwhile, good luck to those of you who have the front to form a company overnight.

Bill Langron
Kiama, NSW

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Contents

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Material published in *Preview* aims to contain new topical advances in geophysical techniques, easy-to-read reviews of interest to our members, opinions of members, and matters of general interest to our membership.

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 $400 per page 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, purchase of multiple hard-copy reprints if required.

Deadlines

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

Therefore, editorial copy deadline for the June 2001 edition is 15th May 2001.

Advertisers

Please contact the publisher, RESolutions Resource and Energy Services, (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 June 2001 edition is the 22nd of May 2001.

New Members

We would like to welcome the following new members to the ASEG. Membership was approved by the Federal Executive at its January and February meetings.

Name	Affiliation	State
Allan Christian Willis	Veba Oil Operations	Canada
Johannes Klaas Koster	Woodside	WA
Peter Shane Nitkewicz	Oil Company of Australia	Qld
Taryn Jane Robbie	Central QLD University	Qld
Yuri Solovyov	Schlumberger	WA
Carlos Alberto Mendonca	University of Sao Paulo	Brazil
Jill Carolyn Lewis	Exploration Data Com Ltd	UK

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Secretary: Guy Holmes,
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Events for 2001/2002

2001

May 8th-10th
SEG-GSH Spring Symposium 2001, Houston, Texas, USA.
Theme: Reservoir Resolution Through Comprehensive Use of Seismic Data Attributes
Call for papers deadline: 17th April, 2001, to seg.papers@texseis.com
Contacts: Mike Graul
Tel: 713-465-3181
Email: symposium.info@texseis.com
or
Tury Taner
Tel: 713-783-5593
Email: mt.taner@rocksolidimages.com.

May 29th-June 2nd
AGU 2001 Spring Meeting, Boston, Mass., U.S.A.
Sponsor: American Geophysical Union (AGU)
Contact: AGU Meetings Department
2000 Florida Avenue, NW, Washington, DC 20009 USA
Tel: +1-202-462-6900;
Email: meetinginfo@agu.org
Web Site: www.agu.org/meetings/

June 11th-15th
63rd EAGE Conference & Technical Exhibition, Amsterdam, The Netherlands
Website: http://www.eage.nl

August 5th-8th
Australian Society of Exploration Geophysicists, 15th International Conference and Exhibition, Brisbane, Qld.
Theme: '2001: A Geophysical Odyssey'
Website: http://www.aseg.org.au
Event Manager: Jacki Mole
Tel: +61 7 3858 5579
Email: aseg2001@im.com.au

September 2nd-6th
7th Environmental & Engineering Geophysical Society European Section, Birmingham, U.K.
Theme: Better and faster solutions
Email: conference@geolsoc.org.wk
Website: www.geolsoc.org.uk/eegs2001/

September 9th-14th
SEG International Exposition & 71st Annual Meeting, San Antonio, Texas, US.
Website: http://www.seg.org

September 24th-28th
4th International Archaean Symposium, University of Western Australia, Perth.
Convenor: Susan Ho
Tel: (08) 9332 7350
Email: susanho@geol.uwa.edu.au

November 25th-28th
Eastern Australasian Basins Symposium 2001 - New Guinea, East Australia, New Zealand.
Theme: A Refocused Energy Perspective for the Future
Melbourne Hilton on the Park, Melbourne,
Contact: Miriam Way, EAB Symposium, AusIMM
PO Box 660, Carlton South Vic 3053
Tel: (03) 9662 3166 Fax: (03) 9662 3662
Email: miriamw@ausimm.com.au
Co-ordinated by the Victoria/Tasmania Branch of Petroleum Exploration Society of Australia

November 26th-27th
New Gen Gold 2001: New Generation Gold Mines Case Histories of Discovery Conference.
Burswood Convention Centre, Perth WA,
Organised by AMF and Keith Yayes & Associates Pty Ltd
Contact: Donna Biddick at the AMF
Tel: (08) 8379 0444,
Email: NewGenGold@amf.com.au
Website: http://www.NewGenGold.com.

December 10th-14th
AGU 2001 Fall Meeting, San Francisco, Calif., USA.
Sponsor: American Geophysical Union (AGU)
Contact: AGU Meetings Department, 2000 Florida Avenue, NW, Washington, DC 20009 USA
Tel: +1-202-462-6900
Fax: +1-202-328-0566
Email: meetings@agu.org;
Web Site: www.agu.org/meetings/

2002

April 22nd-26th
European Geophysical Society (EGS) XXVII General Assembly, Nice, France
Sponsors: EGS, American Geophysical Union (AGU)
Contact: EGS Office, Max-Planck-Str 13, 37191 Katlenburg-Lindau, Germany,
Tel: +49-5556-1440
Fax: +49-5556-4709
Email: egs@copernicus.org
Web Site: www.copernicus.org/EGS/

May 12th-17th
International Association of Hydrogeologists, Australian National Chapter,
International Groundwater Conference, Darwin, Northern Territory, Australia.
Theme: Balancing The Groundwater Budget
Contact: Gary Humphrey
Email: Gary.Humphreys@nt.gov.au

May 27th-30th
64th EAGE Conference & Technical & Exhibition, Florence, Italy
Website: http://www.eage.nl

Western Australia Branch - by Mark Russell

Technical Meetings:
Technical meetings are held on the third Wednesday of each month at the Celtic Club, 48 Ord Street, West Perth.
(5:30pm drinks and food, 6:00pm meeting commences)
ASEG members admission free; Non-members admission $10.00
For information on upcoming meetings/events/agendas, please see our web-site:
http://www.aseg.org.au/wa

2001 Committee
The new committee elected at the December AGM comprises:
President - Kevin Dodds, CSIRO Petroleum
Vice President - Jim Dirstein, Total Depth
Secretary - Guy Holmes, Encom
Treasurer - John Watt, WADME
Membership - Kirsty Beckett, UTS
Petroleum Activity Coordinator - Jim Dirstein, Total Depth
Minerals Activity Coordinator - Mark Russell, Geosoft
General Members: Barry Bourne, Henry Cao, David Howard, Katherine McKenna, and Greg Street.

February Meeting
As a gentle and social start to 2001, we had a wine tasting evening on Wednesday, February 21st. This was a good opportunity for introductions of new and continuing members from the minerals and petroleum communities, as well as a friendly and informal way to start the year! The event was free of charge to members (that was the best part!), and generously sponsored by Hampson-Russell Software Services.

Petroleum Club Golf Day
The Petroleum Club of WA held its Annual Golf Day and Dinner Dance on Friday, February 16th. The golf was at Collier Park and dinner dance at the Hyatt Grand Ball Room.

Other Events being held at time of publication:

1. Hampson-Russel Evening Lecture, Wednesday 14th March - a joint PESA/ASEG event sponsored by Hampson-Russell.
   New Developments in AVO Analysis by Dan Hampson and Brian Russell, from Hampson-Russell Software Services Ltd, Calgary, Alberta.

2. GSA Dinner and Gibb-Maitland Medal Award, Friday, March 16th. The Geological Society of Australia (WA Division) awarded the 2001 Gibb-Maitland Medal to Ms Eve Alexandra Howell of Apache Energy Limited. Ms Howell is recognised as one of the foremost petroleum geoscientists in Western Australia. She has made important contributions to geoscience in Western Australia through her activities in petroleum exploration, development and production. For more details of Eve's achievements go to www.aseg.org.au/misc/howell.html
   The medal was presented at the annual dinner of the WA Division of the GSA, held on Friday, March 16th at the Matilda Bay Restaurant.

For other meetings and plans please check our web-site.

Sponsorship
If your company would like to present a paper and/or sponsor at ASEGWA meetings please contact Kevin Dodds of CSIRO on 08 9464 5005, or Guy Holmes of Encom on 08 9321 1788 about speakers and sponsorship possibilities.

Employment Service
Our employment service is available on the ASEGWA web site. This service is available to WA members to facilitate initial contact between employers and those seeking employment. To see who is currently available, or to register yourself, go to the Employment Section of our website:http://www.aseg.org.au/wa/employment_cont.html.

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Email j.watt@dme.wa.gov.au.

Tasmania Branch - by James Reid

The Tasmanian ASEG has undergone something of a reawakening over the last year. We now have an unprecedented total of 12 members, which is still a few short of the number needed in order to hold regular monthly meetings (not all of our members live in Hobart). However, at an extremely well-attended lunchtime meeting at the University Staff Club on June 2nd, 2000, it was resolved to hold "some sort of meeting" every two months, and we have been reasonably successful in achieving this aim. Since we haven't published a report for some time (years?), I'll use this as an opportunity to catch up on our activities for the last nine months or so...

On June 28th, Marco Nyoni from Anglovaal Minerals gave a presentation entitled: *Geological Concepts driving Geophysical Surveys lead to success at the Nkomati Nickel Mine, South Africa.*

A student's night was held at the University on October 26th, at which the speakers almost outnumbered the rest of the audience. Talks were given by:

Noel Carpenter: *Geophysical evaluation of potential waste disposal sites, Georgetown, Tasmania*;
David Close: *Geophysics of the Cadia Ridgeway porphyry Cu-Au deposit, NSW*;
Jacob Russell: *Geophysics of the Comstock prospect, W Tasmania*; and
Ashley Howlett: *Geophysical characterisation of salinisation at Cape Portland, NE Tasmania.*

This meeting also served as the branch AGM, at which Michael Roach was re-elected president and James Reid became secretary. Examination of the books revealed that one of the three signatories to the ASEG's cheque account had in fact left Tasmania in the mid-eighties - a small oversight which explained why we hadn't managed to spend any money for the last 15 years. In order to rectify this situation, we held a well-attended and well-catered end-of-year BBQ on November 26th.

On November 1st, Jim Macnae from CRC AMET gave a lunchtime presentation entitled: *Seeing the third dimension with AEM.* In late November, student member David Close was awarded both the Tasmanian Rhodes Scholarship, and the University Medal in Geophysics. David will begin a PhD in global seismology at Oxford later in 2001. On March 8th this year, we held a joint meeting with the Tasmanian GSA, at which David gave an updated presentation on the geophysics of the Ridgeway deposit, and a brief slideshow on his plans for Oxford.

Technical meetings are held at the University on a sporadic basis. Whenever possible, visiting geophysicists are prevailed upon to give presentations.

South Australia Branch - by Andrew Shearer

The year in South Australia started off with a new committee being elected. The committee members for 2001/2002 are:
Andrew Shearer - President
Graham Heinson - Secretary
Mark Tingay - Treasurer
Alan Appleton
Iestyen Broomfield
Tim Chapman
David Cockshell
Andrew Davids
Mike Hatch
Richard Hillis
Rod Lovibond
Suzanne Roberts
Stephen Tomlin

Several new faces are present on the committee, and it is hoped that the good work carried out by last year's committee can be maintained. At present we are working on our calendar of technical presentations for the year. I formally invite anyone who is either local or visiting, and would like to speak at our technical meetings to contact me. The strong ties established last year with the local branch of PESA will be strengthened by cross exposure of future events planned.

Northern Territory Branch - by Gary Humphreys

Membership changes

- Kerry Slater left the Alice Springs office of the Department of Mines and Energy (Northern Territory Geological Survey) to move to Sydney.
- Kanglin Lu arrived to work with EWL Sciences P/L as an environmental scientist/geophysicist based in Darwin.
- Ron Matthews,recently arrived to work as Regional Manager for Cameco, based in Darwin.

Recent technical presentations

- Nov 2000: *Water Resource Geophysics; Recent Projects in NT Government*, by Gary Humphreys (Department of Lands, Planning and Environment)
- Dec 2000: Clive Foss from ENCOM came to the NT to present a ModelVision and Automag course for DLPE. We press-ganged him to give a presentation on structural interpretations titled *Mag Depths – How Good Are They?*
- March 2001: *Groundwater Characterisation in Ranger Minesite using Electrical Methods*, by Kanglin Lu (EWL Sciences Pty Ltd).

Queensland Branch - by Troy Peters

The branch Christmas dinner was conducted in late December and, from all accounts, the Turkish coffee house proved to be a great venue.

Howard Bassingthwaighte (Schlumberger) displayed to the Branch the finer points of belly dancing, proving the point that this may have been his profession in a former life.

The focus is still primarily on the Brisbane Conference in August, ***2001: A Geophysical Odyssey***. The technical program is in its final stages of compilation, exhibition space is selling fast and support through sponsorship has exceeded expectations. All indications are that this will be a highly successful meeting.

New South Wales Branch - by Steve Webster

The NSW Branch started the year with the February meeting, attended by more than 30 members. All enjoyed an excellent talk from Peter Hatherly, who discussed the results of seismic monitoring in the coalfields to the south of Sydney.

Tim Pippett will address the March meeting (on the 21st), and the April meeting (on the 18th), will be the Branch Annual General Meeting. The Federal Executive will concurrently hold the national AGM and we look forward to an address by Don Emerson, the details of which can be obtained on the ASEG website.

The Branch is cooperating with the planning of the SMEDG Symposium to be held on April 27th and ASEG members are encouraged to attend. An excellent group of speakers has been assembled and, with the theme of the Symposium being *Exploration Strategies–which work, which don't and why*, some lively discussion is anticipated. Details are available on the SMEDG website

ASEG Membership Survey

Koya Suto and Brian Spies

The ASEG membership survey was distributed to members with the October 2000 issue of *Preview*. Two hundred and thirty-six members (close to 20% of the total membership) responded to the questionnaire, although the last six arrived too late to be included in the analyses. The questionnaire's 66 questions covered most aspects of the Society. The results will assist the present and future Executive Committees plan future directions for the Society.

In this summary report, most of the diagrams are in the form of histograms that show the distribution of the responses. Results are expressed as numbers between 1 (lowest) and 10 (highest).

Who responded the survey?

The age, membership tenure and employment areas of the respondents were similar to those of the total membership of ASEG. Of the 236 respondents, 186 live in Australia (17% of domestic membership), and 30 overseas (11% of overseas members).

The major employment areas are minerals and petroleum, and a sizeable number of members regard themselves as "consultants".

Membership in other Societies

Most respondents belong to other professional societies. More than half (55%) of the respondents are members of the SEG. This is proportionally higher than the SEG members among all the ASEG members. It is interesting to note that there are more PESA (Petroleum Exploration Society of Australia) members (65) than those employed in "Oil and Gas" sector (57). This is perhaps because some respondents employed in the oil and gas industry answered their employment as 'consultant'.

Overall Satisfaction with the Society

Most of the respondents have a high level of satisfaction with the ASEG, and regarded the Society as 'good value for money'.

In general, long-standing members regarded the 'value for money' parameter as the highest, possibly related to income factors. In addition, members with less than five year's tenure also regarded the Society as excellent value for money (one factor here is that many pay the student rate of $20).

Publications

All the three ASEG publications received a high rating for quality:

Publication	Rating		
	Average	Good (>8)	Poor (<3)
Exploration Geophysics	7.5	54.8%	0.4%
Preview	7.4	52.0%	1.8%
Membership Directory	7.8	61.0%	2.8%

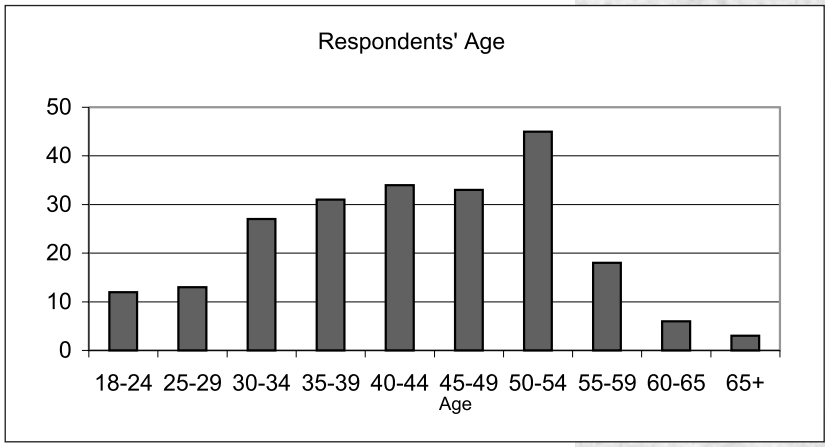


Fig. 1. Distribution by age

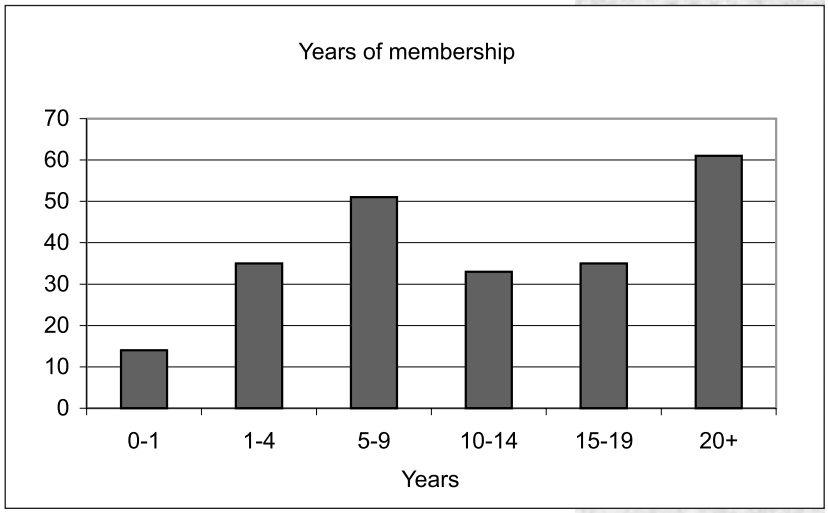


Fig. 2. Distribution by tenure in the ASEG

For *Exploration Geophysics*, several respondents expressed the desire for more petroleum case histories. In general, minerals explorationists rank *Exploration Geophysics* more highly than others. A few people commented the articles were too academic and requested more papers on practical applications. On the other hand, about the same number of respondents thought *Exploration Geophysics* a good practical journal.

Preview is also regarded highly, and respondents commented that they thought it "useful", "interesting", "good general reading", "a good mix of articles of news" and "essential to know what is happening in Australia". Comments for improvement included "more professional issues, employment, etc.", "software companies' technical 'how to' articles" and "more failures and indecisive cases histories".

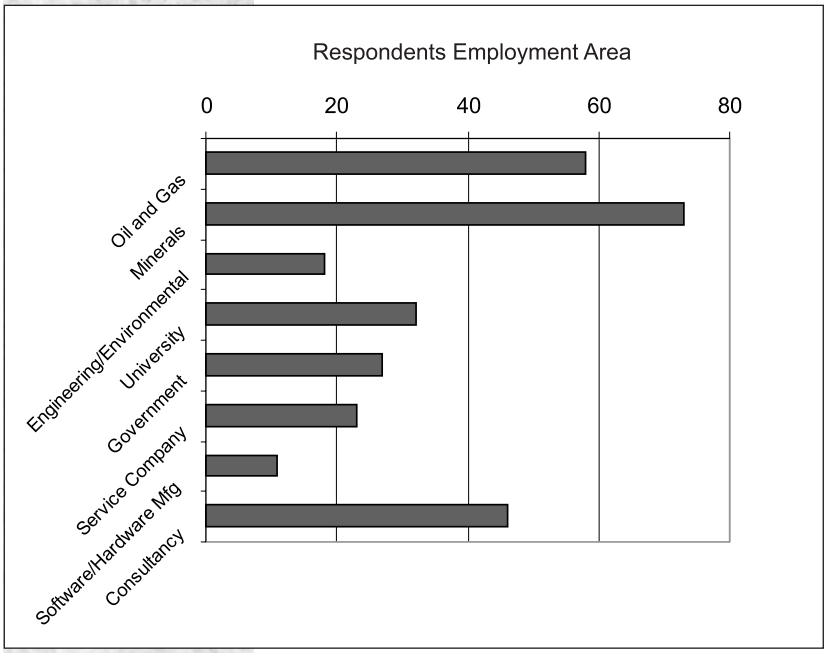


Fig. 3. Employment area of respondents

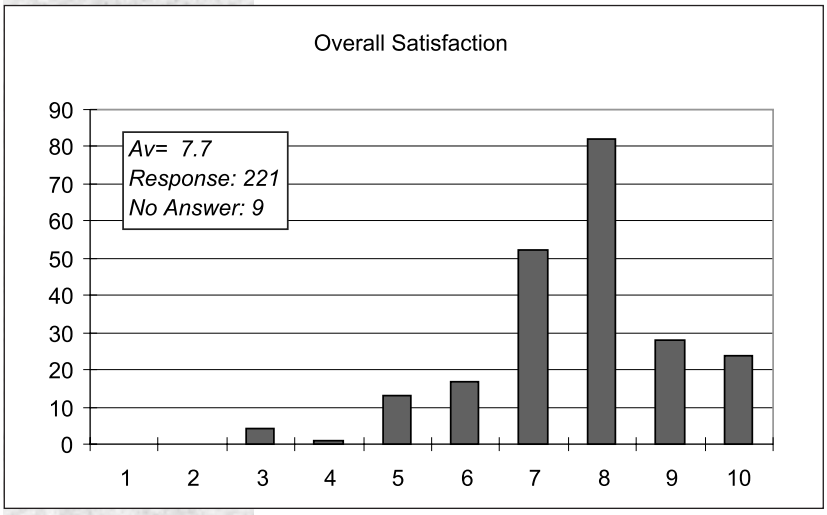


Fig. 4. Respondent's satisfaction with the ASEG

The *Membership Directory* was most frequently rated as 'useful'. As ASEG members move so often, the *Directory* becomes out of date very quickly, and some thought the hard copy "a waste of money". On the other hand some said it was "useful to know whereabouts of friends". Regarding publication frequency, 53% of the respondents preferred current annual publication, while 35% preferred Web-only listing. One respondent, in support of the hardcopy, said, "Many geophysicists in the field have difficulty in accessing the web at times due to lack of infrastructure".

Conferences

Most respondents expressed a high degree of satisfaction with ASEG Conferences. However, the respondents in the petroleum sector were not as satisfied as their minerals counterparts. (The Executive had already noted this trend, and the Conference Organising Committee of this year's Conference in Brisbane is making a considerable effort in technical contents, exhibition and workshops to satisfy the needs of members in the petroleum industry.)

A majority (63%) of respondents preferred the current frequency of 18 months for ASEG Conferences. Respondents commented that "too frequent conferences would drop quality" and "it is hard to make significant contributions at each conference if the frequency is too high". Another respondent noted however, that "resistance to 12 month conferences is superficial. Once implemented, they would be accepted like decimal currency".

Conference fees are paid by employers for 56% of the delegates, while 35% pay their own way. The conference registration fee was rated as slightly high. One member requested, "lower cost of conference dinners, registration and workshops. Keep cost down to suit the self-employed and the unemployed."

Federal Executive

Most respondents were satisfied with the Federal Executives (75% rated 7 and above). However many had comments like, "I have no idea what the Federal Executive actually does". Some expressed the "need to stop Federal Executive based in a single city". (Note, this is gradually taking place; in the coming year elected office bearers will be drawn from three states).

Web Site

More than half the respondents access the ASEG website more than four times a year. The users looked for information on the Conference, links to other sites, membership database, publications, state branch activities and education (in that order). The Web site is accessed by members almost equally, regardless of age profile.

Some of the items desired in the Web page include employment, links to members' CVs, archives of past journals, FAQ for each field, news on geophysical instrumentation and equipment, on-line dues payment, safety issues and forum, and software/freeware/shareware.

Professional Enhancement

The need to broaden the scope of the ASEG activities was a clear message from respondents (71% rated 7 and above). Areas for extra attention included environmental and engineering geophysics, and integration with other disciplines.

Summary and Discussion

What are the most pressing areas for the ASEG to work on? The following table shows the average rating of performance in each activity area (1 for poor performance and 10 for high performance). A low score means the ASEG is not performing well and more emphasis could be given.

Contribution to:	Performance Rating
Education	6.7
Standard	6.3
Advocacy	5.8
Networking	6.6
Certification	5.3

Certification received the lowest rating. This is not surprising, as certification is not a current activity of the ASEG, unlike our sister societies such as AusIMM and AIG. Future Executives should consider whether the Society should be active in this area. Comments included "active member does not mean professional certification", "would like to see serious attempt by the ASEG of professional certification of geophysics" and "registration of professional geophysics is inevitable so ASEG should be involved at the early stage". There is another opinion; "I prefer my AusIMM membership as a professional measure, *i.e.* status, fellow and chartered professional".

Regarding the range of activities, one respondent said, "I appreciate what the ASEG does in technical matters but I see little evidence of ASEG's activity in the wider community". More specific comments are "apart from students' days at conferences, I don't see where the society acts as an advocate for the profession", "our career is our life. ASEG plays an important role in career support, peer group interaction and technical information", "the SEG ran a series of career-related articles recently which the ASEG could/should emulate" and "more support for unemployed members". (A career management seminar at the next conference in Brisbane in August will partly address these requests.)

Community-oriented activities on promotion of geophysics were mentioned by some members who "believe we should get involved as partner aimed at education high school students about geophysics (and geology). Examples included APPEA's 'Petromania' and discovery CDs, working with the National Science Teachers Association to design classroom modules" or "encouraging ASEG to run 1 and 2 day camps/seminars on geophysics".

To Conclude

The survey showed that members were generally satisfied with ASEG activities, and most respondents regard the ASEG as "good value for money". In analysing these results, we should bear in mind that the respondents represent only 20% of the current membership. Potential members, as well as those who have left the Society were not polled, and it is these sections of the population which, to a large extent, need to be understood when considering the needs of the profession and potential growth of the Society.

We expect that the survey results and, in particular, the detailed comments from members, will engage the various Standing Committees and Federal Executives for many years to come. To those that took the time to fill in and return the questionnaire - thank you. For those who did not, your comments are always welcome and valued.

The significant contribution by Sebastian Nixon to this analysis is gratefully acknowledged. A fuller version of the report will be posted on the ASEG website www.aseg.org.au.

WINNER OF THE 'FREE CASE OF WINE' PRIZE

*The winner of the wine draw is **Peter Baillie**, of TGS-Nopec in Western Australia*

Congratulations Peter!

ASEG 2001 ...The year of the Odyssey

Provisional Program Released

Dr Steve Hearn, Chairman of the Technical Papers Committee, has released the provisional program for the upcoming ASEG 2001 Geophysical Conference and Exhibition to be held in Brisbane from August 5th-8th.Over 130 papers have been accepted for oral presentation with additional poster presentations.

Highlights of the program include dual streams for both the petroleum and mineral geophysicists. On Tuesday, one of the mineral streams is dedicated to Australian Case Histories. Keynote Addresses will be given by Dr. Agu Kantsler, Director New Ventures, Woodside Energy Ltd, Mr Vince Gauci, Group Executive - Operations, MIM Holdings Ltd and Professor Ken McCracken, Jellore Technologies.

Workshops

In addition, a comprehensive workshop program has been announced. The workshops have been chosen to appeal to a diverse range of geophysicists and all members should find a course that is suited to their interests.

Career Management Session

A seminar will be held on the Sunday before the conference to bring together policy makers, managers of exploration companies, practicing geoscientists, career counsellors, geophysical consultants, financial advisors, recruiting agents as well as job seekers, students, new graduates and those who are concerned or interested in career management issues. Attendance to this seminar is free of charge.

The ASEG 2001 Conference is proudly sponsored by:

Gold Sponsors

Fugro Airborne Surveys
Woodside Energy

Silver Sponsors

BHP
CSIRO
MIM Exploration
Office of Minerals and Energy Resources SA (formerly PIRSA)
Veritas DGC
WMC

Bronze Sponsors

Anglo American Exploration
Dynamic Satellite Surveys
Green Mountain Geophysics
Origin Energy
NSW Department of Minerals and Resources
Northern Territory Geological Survey
Queensland Department of Mines and Energy
Quantec Geoscience
Velseis Group
Geosoft Australia

ASEG 15th Geophysical Conference & Exhibition
Brisbane Queensland
5 - 8 August 2001
Tel 61 7 3858 5579
Fax 61 7 3858 5510
Email: aseg2001@aseg.org.au
Website: http://www.aseg.org.au

ASEG 2001 Provisional Seismic Petroleum Environmental Geophysics Program					
Monday		Tuesday		Wednesday	
Stream A	Stream B	Stream A	Stream B	Stream A	Stream B
		Environmental EM	PSDM and Depth Conversion		Seismic Case Histories
Quantitative Seismic Interpretation	Coal Geophysics	High Resolution Geophysics	AVO	Seismic Anisotropy & Ray Path Analysis	Seismic Acquisition Methodologies
High Resolution Seismic	Seismic Multiple Attenuation	Petroleum Interpretation Technologies	Seismic Modelling of Near Surface Effects	Regional Geophysics	Seismic Tomography
Land Seismic Acquisition	Seismic Processing and Attribute Analysis	Seismic Migration	Data Management and Risk Reduction in Resource Exploration		

ASEG 2001 Provisional Mineral Geophysics Program					
Monday		Tuesday		Wednesday	
Stream A	Stream B	Stream A	Stream B	Stream A	Stream B
		Case History Day – Australia	Downhole Applications	Regional Perspectives	Inversion
Airborne Processing 1	Petrophysics	Case History Day – Australia	Developments in Processing	Electrical Methods	Magnetic Modelling
Innovative Airborne Geophysics	Tomographic Applications	Case History Day – Australia	EM Interpretation	Electromagnetic Interpretation	Exploring Through Cover
Airborne Processing 2	Applications	Case History Day – Australia	Regional Applications		

Workshop schedule at a glance				
	Minerals	Petroleum	Coal	Environment
4 August	Airborne EM from Start to End. (Part 1: Getting good AEM data) *(J Bishop & J Macnae)*	AVO and Inversion *(B Russell)*	Near Surface Seismology *(D Steeples)*	*See (Bishop & Macnae) & (D Steeples)*
5 August	Airborne EM from Start to End. (Part 2: Making the best use of EM data) *(J Bishop & J Macnae)*	AVO and Inversion *(B Russell)*	Near Surface Seismology *(D Steeples)*	*See (Bishop & Macnae) & (D Steeples)*
5 August	Application of Geophysical Logging to Metalliferous Mining *(Organiser -Fullager)*	Petroleum Geomechanics *(R Hillis)*	Petroleum Geomechanics *(R Hillis)*	
ASEG 200 Conference 6-8 August				
9 August		Stochastic Modelling for Reservoir Characterisation *(R Dimitrakopoulos)*	Stochastic Modelling for Reservoir Characterisation *(R Dimitrakopoulos)*	
9 August	Future Directions in the Analysis of Potential Field Data: Inversion, Signal Processing and Interpretation. *(F Boschetti & M Dentith)*	Seismic Signal Processing for Interpreters *(M Schoenberger)*		
10 August	Future Directions….etc. *(F Boschetti & M Dentith)*	Seismic Signal Processing for Interpreters *(M Schoenberger)*		
11 August	Future Directions….etc. *(F Boschetti & M Dentith)*			
A detailed description of the workshops and biographies of the instructors can be found in the registration brochure and also online at the ASEG web site www.aseg.org.au				

Career Management Seminar at ASEG Conference

ASEG will hold a Career Management Seminar for Geoscientists at the Conference. The seminar will join together policy makers, managers of exploration companies, practising geoscientists, career counsellors, geophysical consultants, financial advisors, recruiting agents as well as job seekers, students, new graduates and those who are concerned or interested in career management issues.

The time and place of the seminar are:
- Sunday August 5th, 2001 at 2pm
- Brisbane Convention and Exhibition Centre

A provisional program of the seminar includes topics on:
- Exploration Outlook: A Government's Perspective (Geoff Dickie, QDME)
- What Employers Seek: An Exploration Manager's View (Nick Sheard, MIM Exploration)
- Starting a Successful Consultancy - Petroleum (Henk van Paridon, Geosolve)
- Running a Consultancy - Minerals (Bob Smith, Greenfields Geophysics)
- Suggestions on Successful Job Search (Ron Morland, Swann Group)
- Suggestions on Career Transition (Paul Kingsley, D&A)
- Financial Advise on Career Management (Noll Moriarty, Professional Investment)

Attendance to this seminar is free of charge. So come to the Conference early and learn your career management opportunities just before the reception cocktail party. There may be an opportunity for members to register with recruiting agents.

Brisbane Welcomes Delegates

Delegates attending the ASEG 2001 Conference can look forward to the subtle treats of the host city...

Brisbane is an idyllic sub-tropical capital city with all the facilities expected in a modern, metropolitan centre, but with the gracious, relaxed lifestyle associated with Queensland. Accordingly, Brisbane can offer a great range of highly diverse activities to cater for all tastes and to keep you entertained during your visit (in addition to the fantastic conference program of course!!).

To begin with, cultural fans will be easily satisfied with the many facilities in the area surrounding the Exhibition and Convention Centre. Just a short stroll from the Centre is the Queensland Museum, host to many permanent and changing exhibitions. One of the permanent exhibitions is 'Objects As Art', displaying traditional Aboriginal and Torres Strait Islander artefacts, including masks, headdresses and weapons. The Queensland Art Gallery is a

Continued on page 14

Continued from page 13

couple of minutes walk from the Museum and, during August, will be displaying its own collection of works.

After absorbing the cultural facets of Brisbane, a meander beside the Brisbane River through the Southbank Parklands provides many opportunities to pause for reflection and admire the city skyline. Activities at Southbank include the IMAX theatre, swimming at Southbank beach or, for the serious gourmet wanderer, being tempted by the many fabulous restaurants in the Parklands. A visit to the Southbank markets is also a must. Southbank is also a port of call for the City Cat Ferries, which ply the Brisbane River from the northeastern suburb of Hamilton to the University of Queensland, St Lucia, on the western reach of the River. Combine a river cruise with a visit to Lone Pine Sanctuary, an icon of Brisbane's faunal history since 1927, and the first and largest Koala Sanctuary in the world.

For the more adventurous delegate, the Conference venue is opposite Kangaroo Point, where they offer abseiling down the picturesque cliffs. If this sounds a little too strenuous, take a stroll through the Botanical Gardens in the City Centre or take a 10 minute taxi ride to visit the Botanical Gardens and Planetarium at Mt Coot-tha. Mt Coot-tha forms the backdrop to the city and provides observers with spectacular views over the City to the islands of Moreton Bay. Ferries take visitors to Moreton and Stradbroke Islands daily, and also on tours around Moreton Bay, providing a fantastic insight into colonial Brisbane.

After the Conference sessions, enjoy a relaxing stroll around Brisbane City; the Brisbane City Council Tourist Office, located in City Hall, provides heritage trail information. Take a self-guided tour of the city and take in such sites as the Commissariat Stores, a convict structure in the City Centre, erected under the direction of Captain Patrick Logan. Should you wish to try your luck at the Brisbane Casino, it is a short walk from the Convention Centre and is located in one of Brisbane's finest representations of Colonial architecture.

Football fans wishing in to take in a game should note that the Brisbane Lions are playing at home on the weekends preceding and following the conference. The Broncos are also home on the weekend preceding the conference

For more information on activities around Brisbane, visit the following websites:

www.brisbanetourism.com.au
www.brisbane.qld.gov.au
www.brisbane-stories.powerup.com.au
www.koala.net
www.Qmuseum.qld.gov.au

We look forward to seeing you here.

ASEG Honours and Awards: Calls for Nominations

During the 15th ASEG Conference to be held in Brisbane in August 2001, up to six categories of honours and awards will be presented to people who merit recognition for distinguished service to the Society and or to Exploration Geophysics. These honours and awards are:

- **ASEG Gold Medal** - for distinguished service to geophysics.
- **Honorary Membership** - for distinguished contributions to the profession of Exploration Geophysics.
- **Grahame Sands Award** - for innovation in Applied Geophysics. It is made to a person or persons who has or have been responsible for a significant practical development of benefit to Australian applied geoscience. This could be in the field of instrumentation, data acquisition, interpretation or theory.
- **The Lindsay Ingall Memorial Award** - For the promotion of geophysics to the wider community. The award is intended for an Australian resident or former resident for the promotion of geophysics, (including but not necessarily limited to applications, technologies or education), within the non-geophysical community, including geologists, geochemists, engineers, managers, politicians, the media or the general public. The candidate need not be a geophysicist, or a member of the ASEG.
- **ASEG Service Medal** - In recognition of outstanding service (over and above normal) to the ASEG over many years, through involvement in and contribution to State Branch or Federal Committees, ASEG Publications or Conferences.
- **ASEG Service Certificate** - In recognition of outstanding service to the ASEG, through involvement in and contribution to State Branch or Federal Committees, ASEG Publications or Conferences.

Nominations are now called for the above awards. Any member of the Society is eligible to nominate applicants. Nominations are to be supported by a seconder and include four copies of all relevant supporting documentation. For the Lindsay Ingall Memorial Award, the nomination should also be supported by letter by at least four other geoscientists who are members of an Australian geoscience body (e.g. GSA, AusIMM, AIG, IAH, ASEG or similar).

Nominations are to be sent to:

Bill Peters
Chairman ASEG
Honours and Awards
Committee,

8 Kearns Crescent
Ardross
WA 6153

bill@sgc.com.au
Tel: 08 9316 2814

Applications will close on May 5th, 2001

Salinity Land Management and New Technology Conference Bendigo, February 19th - 21st, 2001

Greg Street
Conference Chairman

The Salinity Land Management and New Technology Conference held last February in Bendigo, Victoria, was a great success.

Right from the opening address by Wilson Tuckey, talking in medical terms about airborne electromagnetics as the "ultrasound of the Earth" and the saviour for farmers, through to the last talk in which a speaker considered airborne EM a waste of money, delegates were informed and entertained.

The inveterate geophysics conference goers Roger Henderson, Bob Smith, Alan Willocks, Mike Smith, and Tim Pippett found they were in uncharted territory as farming types milled around the booths. The talk was about salinity credits, crop yields, water rights undispersed with a little geophysics.

The aim of the conference was to bring together geophysicists and land managers and to introduce to each group, the problems of the respective disciplines.

Around 200 delegates were registered. The bulk were non-ASEG members and came from the rural parts of Victoria, NSW and SA. Some 12 delegates made the trek from WA and a few from all the other states.

The mix of papers, starting with introductions into geophysics and land management, and followed by case histories and applications of new technologies, kept the meeting room full for almost the entire conference.

Workshop sessions run by Andy Green on the first day ensured a lot of interaction by mixing the geophysicists with land management people and discussing issues.

The afternoon of the second day was out in the paddock at Kamarooka to meet some real farmers and hear their problems and what they hoped they might get from the new technology. Roger and Mike seized the chance to show off some skills in data collection and check the area for mines, large nuggets etc.

Gold sponsors AFFA and NRE-Victoria and silver sponsors Sinclair Knight Merz believed they got value for money out of some excellent exposure. The CRC-AMET provided seed money as the first silver sponsor.

Other sponsors in the booths included UTS, Alpha Geoscience, Tesla 10, ESRI, UNSW, AAM Surveys, Ultimate Poistioning, Fugro, and Geoinstruments.

Unfortunately for ASEG tradition Barry Long did not make it in the white Jacket to MC the dinner but ASEG committee member Kirsty Beckett ably filled in and kept the interaction theme going by making dinner guests change tables between each course.

Roger Henderson and Mike Smith (salty dogs?) measuring conductivities near Kamarooka.

Best paper awards went to:

- Simon Abbott (Dryland Salinity Consultants) for his paper on use of geophysical data for and management in the Kent Catchment WA,
- Carl Daaman of Sinclair Knight Merz for groundwater modelling in Honeysuckle reek Catchment, Victoria, and,
- Alfred Heuperman for use of EM to plan irrigation strategies on Tragowal Plain, Victoria.

Paul Rampant NRE (Victoria) is investigating the preparation of a special ASEG Volume to incorporate papers from the conference.

AGSO Issues: Is the Government Committed to R & D in the Geosciences?

For this issue of *Preview*, rather than commenting on things like the 'Branch Economy' or the Government's response to the Ryan by-election, I thought readers may be interested in an article written by our Editor in his AGC hat, published in the *Canberra Times* in March, and the reply two days later by Warren Entsch.

Eristicus March 26th, 2001

Aftershocks for Geoscience after funding cuts

One of the Howard Government's first decisions when it came to power in 1996 was to approve the construction of a new special purpose building for the Australian Geological Survey Organisation. This cost more than $100 million and, in the 1998 budget, additional money was provided for AGSO to work with the States and NT on joint geoscience programs.

But after the 1998 election the picture changed. The Land and Water sections of AGSO were moved to the Bureau of Rural Sciences, the extra money for joint programs with the States was withdrawn, and the geosciences were hardly mentioned in the Government's recent Innovation Statement.

Why is this so? Why has our national geoscience institution been split up, and why has the Commonwealth reduced its commitment to geoscience research?

It seems rather strange considering that geoscience research is essential for healthy mineral and energy sectors, and for tackling the huge problems of soil degradation and increasing salinity levels. Furthermore, the Australian resource industries are world leaders in the application of new technologies, the largest contributors to our export earnings and national wealth, and need quality R&D investment to remain successful.

The value of our mineral and energy exports is expected to rise from $44 billion in 1999/00 to about $54 billion in 2000/01, slightly more than the combined exports from the farming and the manufacturing sectors.

Healthy resource industries depend on successful mineral and energy exploration programs which, in turn, depend on geoscience research to understand the complex geology of the continent and identify economically prospective areas.

This involves high-tech research to 'see through' non-prospective surface material that covers most of the continent and the development of new concepts and models for mineralisation and petroleum formation. In other words a strong R & D capability is needed.

Australia is a world leader in several new-technology aspects of the geosciences including the commercialising of innovation. Examples include airborne geophysical techniques to 'see through' the surface materials, the geochemistry and age dating of rocks to unravel how and when geological structures were developed, and the skills in computer modelling to interpret the high quality data sets that are now available.

We must continue to lead in the discovery of new deposits to maintain this advantage and it is important that the Commonwealth plays a major role.

The states and the NT have been active in the last ten years in promoting programs to encourage mineral and petroleum exploration. They provided new high-quality geophysical and geological data sets to increase the chances of discovery, and these are now available for use by exploration companies, land managers, educators and researchers.

For example, in New South Wales $65 million will be spent in the period 1994-2007 to provide an enhanced geological and information framework in that State. Similar programs are being carried out in most of the other states, and have been very effective in encouraging exploration and improving our understanding the geology of the continent.

In the decade 1987 to 1996, Australian governments spent a total of about $2 billion on geoscience information/ research, and companies spent about $10 billion.

Industry-funded exploration levels rose after major information releases by governments, and the net increase in Economic Demonstrated Resources of mineral resources alone in that decade was about $355 billion[1].

However, the States and Territories can only work piecemeal within their own boundaries, and most of their programs rely on well-established techniques. They cannot provide by themselves the major research facilities needed to tackle continent-wide problems, which cover state boundaries. This is clearly the Commonwealth's role.

So why has it not identified the geosciences as a key sector for R & D investment?

The rationale for splitting up AGSO has always been difficult to explain. A national geological survey that does not include capabilities on land degradation and ground water is not providing the best value for money for the nation. The surficial material on the Earth is important for both mineral exploration and land degradation. Why not keep the skills base together under one roof?

Flow characteristics through the Earth for ground water and petroleum are the same, and both these valuable fluids are hosted in sediments beneath the Earth's surface. Why not deal with these in one institution? The techniques and data sets used to study ground water and

land degradation are common to many used in the resource sectors. What was the advantage in separation?

Perhaps being listed on the agenda of a powerful Government committee, the Prime Minister's Science, Innovation and Engineering Council, for its next meeting in June is the beginning of a new approach.

We need to maintain our skill-base and our research capacity in the geosciences, and the Commonwealth has a vital role to play on this issue. It is too important to put on the backburner.

David Denham

Dr Denham AM, is President of the Australian Geosciences Council, and Vice-President of the Federation of Australian Scientific and Technological Societies.

[1] Ian Lambert, Sustaining Economic Benefits from Mineral Resources: Government Investment in Geoscience, AusIMM Bulletin, No. 3, 1999, 82-87.

AGSO role logical step

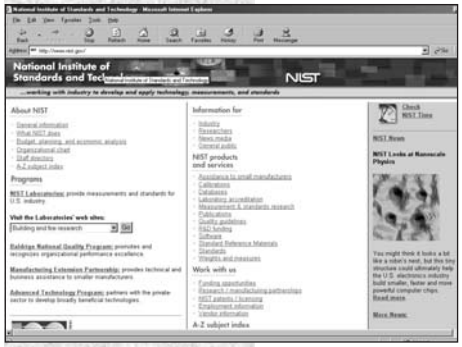
Dr David Denham's article (CT, March 8) concerning government funding of geoscience is misguided. Yes, the government has refocused AGSO's activities towards off-shore oil and gas exploration. But this hardly constitutes an abandonment of geoscience activities in Australia.

Onshore minerals exploration is primarily the responsibility of State and Territory Governments. It would be a waste of limited resources for AGSO, our national geoscience research and information agency, to simply duplicate the geological mapping activities of the states.

With respect to the transfer of the land and water function from AGSO to the Bureau of Rural Sciences, this was done to ensure a co-ordinated approach to dealing with major problems affecting rural and regional Australia.'

WARREN ENTSCH, MP
Parliamentary Secretary to the Minister for Industry, Science and Resources.

Written by:
Tim Mackey
AGSO
Tim.mackey@agso.gov.au



'Tim Mackey has contributed the WebWaves column for this issue. Natasha Hendrick is finalising her PhD thesis this month, and we know what that means. Good luck on the thesis Natasha and thanks for your assistance Tim.' Ed

If you have any favourite sites (not necessarily geophysical) that you would like to share with our members please email Natasha (natasha@geoph.uq.edu.au).
An ASEG Favourites list will be published in the next edition of Preview.

Algorithms, data structures and problems
http://hissa.nist.gov/dads/

Provided by the National Institute of Standards and Technology. This is a dictionary of algorithms, algorithmic techniques, data structures, archetypical problems, and related definitions. Algorithms include common functions, such as sorting, polynomial and matrix operations. Some entries have links to further information and implementations. Index pages list entries by area, for instance, searching or graphs, and by type, for example, algorithms or data structures. A page also lists all implementations.

Basics of exploration seismic experiments and data processing
http://utam.geophys.utah.edu/stanford/node2.html

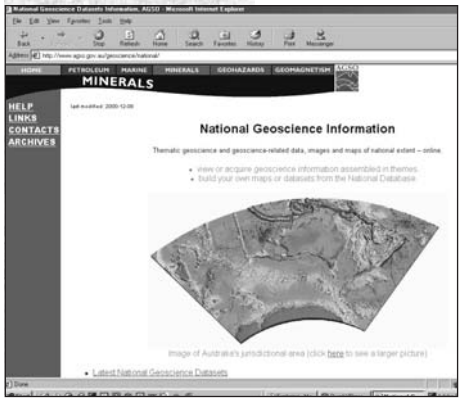
A basic introduction to seismic exploration and data processing provided by the University of Utah, Stanford, mathematical geophysics summer school. Traveltime and waveform tomography are also introduced.

OpenGIS: GML
http://www.opengis.net/gml/01-029/GML2.html

The Geography Markup Language (GML) is an XML encoding for the transport and storage of geographic information, including both the spatial and non-spatial properties of geographic features. This specification defines the XML Schema syntax, mechanisms, and conventions that provide avendor-independent framework for the interchange of geospatial information. Linked geographic application schemas and datasets are therefore possible. This increases the ability of organizations to share geographic application schemas and the information they describe.

Online GIS of Australian geoscience
http://www.agso.gov.au/geoscience/national

This National Maps Online GIS facility is the most comprehensive online visualisation tool for Australian geoscience data on the Internet. The website features over 70 different datasets. It offers users the ability to zoom to selected geological regions, mines and towns, as well as general pan, zoom and query capabilities. The GIS tools available as part of the site enable users to select themes of interest from a large range of geoscience elements to combine them to form tailor made maps. These themes include national scale geophysical images - such as aeromagnetics, gravity and crustal heat flow - these can be overlain with data drawn directly from AGSO's national databases including earthquakes, geochemistry and mineral occurrences.



Free IT courses
http://www.free-ed.net/catalog/itcat01.htm

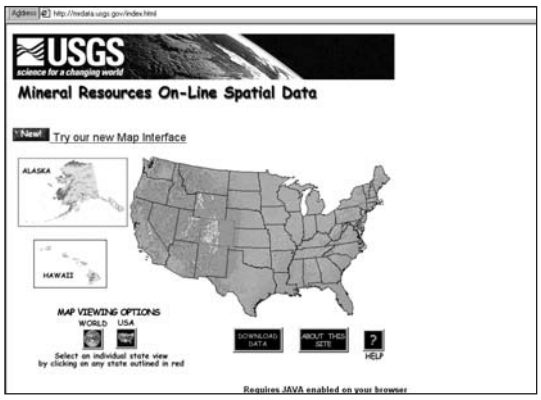
Provides online courses in computer languages, scripts, operating systems, databases, desktop publishing, word processing, spreadsheets, graphics, Internet, PC basics and networks. Courses are free, with no hidden fees or books to buy and are available for over 120 subjects.

Online browsing of scanned maps
http://www.emapsite.com/

eMapSite.com is a new dynamic company dedicated to the provision of online mapping services, using ER Mapper's Image Web Server. It provides users with the only facility to browse, access, view, print, download or link via URL to digital mapping online. The site enables users to roam and zoom around the according to the nature and area of their interest unencumbered by map folds or atlas pages. Users can select maps such as town plans and street maps, aerial photography and satellite pictures.

World mineral resource data online GIS
http://mrdata.usgs.gov/av/wrld1.html

An online GIS provided by the Mineral Resources section of the USGS. Software used is ESRI's Map cafe.



Report on FASTS, February 2001

Mike Smith
Geoscience Representative on FASTS Board.

The Prime Minister's enthusiastic statement of January 29th 2001, has shown that science and technology is moving towards centre stage in debates about Australia's future. Professor Sue Serjeantson, President of the Federation of Australian Scientific and Technological Societies (FASTS), recently said "scientists and technologists have to work more closely with Parliamentarians, to help them construct Australia's future over the next decade. Climate change, public health, genetically-modified food, information technology, salinity, energy, disposal of nuclear waste are all unresolved issues on the public agenda". Many of these issues have a geoscience component.

FASTS' typically takes a broad view of science, stating "Ultimately, science means new industries and new jobs. It's the way forward - an improved environment, better health care, enhanced economic competitiveness, solutions to the problems that drag our society back. Science doesn't have all the answers, but it is always part of the solution". These comments apply equally to geoscience.

FASTS is represented on the Prime Minister's Science, Engineering and Innovation Council and many decisions on national policies originate at PMSEIC. In fact a presentation on the Geosciences is planned for the June 2001 meeting of PMSEIC. During his speech on January 29th, the PM stated "Chairing PMSEIC has been a very stimulating experience, always immensely rewarding, has taught us a great deal, and has assisted government in formulating policy". The Australian Geoscience Council's (AGC) membership of FASTS allows access to the PM for geoscience issues.

The dramatic turnaround in the policy of the current government on funding science and technology is a response to the Labour Party's "Knowledge Nation" position. However, it can be at least partly related to the large number of politicians who spoke to scientists at the "Science meets Parliament" (SMP) Days organised by FASTS and attended by many geoscientists. The SMP encounters provide a new conduit for information, and it is apparent that parliamentarians and scientists find this event both useful and enjoyable."

Members of AGC reasonably ask, "Does AGC get value for the subscription fee of $15 000?" Several achievements in 2000 can be contrasted with results of previous years of involvement, largely as a result of initiatives by AGC President and FASTS Vice-President David Denham. FASTS organised meetings with Warren Entsch in May 2000 (Denham, Cousins, Smith), with Martyn Evans (ALP S&T spokesman) in Nov 2000 (Denham, Smith) and again with Mr. Entsch and his advisors in Nov 2000 (Denham, Smith). We now have a very easy mechanism for meeting with key politicians to present our case on key issues. This opportunity will be used again in 2001, to promote topics that have been identified as important by the AGC. Many other geoscientists participate in Science Meets Parliament each year, and promote issues such as:

- Native title and access to land for exploration,
- CRC support and R&D funding for universities and industry,
- Sustaining a national approach to geoscience,
- Support for AGSO, Returning the management of water back to AGSO,
- Ensuring solutions to the problems of catchment salinisation contain appropriate geoscience content, and
- Maintaining science infrastructure in remote regions.

Gaining value for money from FASTS depends on what we put into the organisation. Mathematicians have done very well in 2000 through the publication of the FASTS Occasional Paper **"Mathematical Sciences in Australia: Looking for a Future"**. Of course FASTS did not fund the writing of the document. The author, Jan Thomas, is the Executive Officer of the Australian Mathematical Society Inc., and also happens to be a Vice-President of FASTS.

The AGC continues to assess what issues need support from FASTS, and these issues are presented by the writer and/or David Denham. Access to land for exploration could be such a topic, as identified at the Canberra AGC planning meeting. Increased involvement in setting of priorities for national geoscience expenditures is another. The AGC has previously nominated the establishment of an Internet portal "National Geoscience Online" to facilitate access to the nation's vast database of geoscientific information by private industry and educational bodies. Strong support for maintaining the science component of ABC programming has been given. The top ten issues identified by the Board of FASTS (listed on the FASTS web site at http://www.FASTS.org), provide one useful mechanism for linking geoscience issues with topics of importance to the broader scientific community.

Geophysics in the Surveys

AGSO

Interpretations of Regional Seismic Data, offshore northern and northwestern Australia

AGSO has released 13 CD ROMs, which contain interpreted horizon and fault data for approximately 35,000 km of regional seismic reflection data. The data was acquired by AGSO between 1990 and 1994 over Australia's continental margin, between North West Cape in the south and the eastern Arafura Sea in the north. The interpretations were mostly undertaken by a Perth-based company, IKODA Pty Ltd, under contract to AGSO.

Although these data have been widely used by industry, they had not been interpreted in a consistent fashion. The products released here provide an open-file, consistent interpretation of horizons and faults through the entire data set.

AGSO's deep-seismic data commonly image features and structures that are deeper than conventional industry seismic data and thus provide a valuable insight into the region's geological evolution. In many places, the deep structures have clearly had a major influence on the development of younger, shallower features that are prospective for hydrocarbons.

The CDs are available from the AGSO Sales Centre for a cost of $2000 each, or $20,000 for the set.

North West Shelf Airborne Laser Fluorosensor Survey Reports

AGSO has released a series of seven reports (AGSO Records 2000/27 - 33) detailing levels of hydrocarbon seepage on the North West Shelf recorded by six airborne laser fluorosensor (ALF) surveys.

The ALF surveys were commissioned by AGSO and flown by World Geoscience Corporation (now Fugro Airborne Surveys) in 1996 and 1998. These data have been reprocessed and re-interpreted to optimise the information gathered on hydrocarbon seepage levels in the Bonaparte and Browse Basins.

Natural petroleum seepage is a direct indication of the generation and leakage of hydrocarbons from thermally mature basins and, in some cases, may help locate significant accumulations. ALF surveys are designed to detect and map hydrocarbon seepage occurring in the marine environment by inducing characteristic fluorescence in the resulting oil films, which form on the sea surface. Such evidence of leakage can be used to identify oil migration pathways and accumulations.

The ALF system uses an aircraft-mounted ultraviolet laser to irradiate the sea surface and induce characteristic light emissions from any surface material. The aircraft flies at 150 m above the sea surface and the ALF system samples a 200 mm^2 area at a rate of 50 times a second which is equivalent to a sample spacing of about 1.5 m under normal flight conditions. It can detect oil films less than 1 mm thick, which are not visible to the eye.

Airborne Geophysical Data

Kidson Sub-basin

AGSO has released 127 535 line-km of data from two areas in the Kidson Sub-basin flown by Kevron Geophysics during 1996. Flight lines were flown north-south at 60 m above ground level and spaced 400 m apart. Magnetic data were sampled every 0.1 seconds (~7 m) and gamma-ray spectrometric data were sampled every 1 second (~70 m). The navigation system utilised the satellite Global Positioning System (GPS) in real time differential mode and were sampled every seconds (~70 m). Final position and elevation data were determined by post flight differential processing of the raw GPS data.

The area covered by the data occupies most of the Joanna Spring, Dummer and Percival 1:250 000 Sheet areas and part of the Sahara and Tabletop Sheet areas. In the southwestern part of the Tabletop Sheet the survey covers the Paterson Orogen, which hosts important gold, copper and uranium deposits.

Gawler Airborne Electromagnetic Surveys

AGSO, Primary Industries and Resources South Australia (PIRSA) and the Co-operative Research Centre for Landscape Evolution and Mineral Exploration (CRC LEME) have released 5845 line-km of TEMPEST airborne electromagnetic, magnetic and elevation data covering three areas and a transect on the Gawler Craton in South Australia. These data were acquired by Fugro Airborne Surveys Pty Ltd in June and July 2000 as part of a collaborative research project funded by AGSO, PIRSA and CRC LEME.

The three areas surveyed include Moonta-Wallaroo (1055 line km), Challenger (1130 line km) and Tunkillia (3215 line km), as well as a transect (445 line km) from Port Pirie to Tarcoola. These surveys were flown at 150 m line spacing with a nominal terrain clearance was 110 m for the transmitter. The three-component dB/dt towed bird receiver was towed 109 m behind and 43 m below the aircraft. The system operates with a bandwidth of 25 Hz to 37.5 kHz.

Northern Territory Geological Survey

West Arnhem Survey

NTGS has released approximately 63 000 line-km of located and gridded magnetic, radiometric and elevation data from the West Arnhem survey, flown on behalf of NTGS during 2000.

The survey was flown at 60 m MTC along 400 m spaced N-S flight lines by UTS Geophysics. The survey is located along the eastern edge of the exposed Pine Creek Orogen, and incorporates the eastern parts of the Cobourg Peninsula, Alligator River, Mount Evelyn and Katherine 1: 250 000 Sheet areas.

An additional feature of all 2000 airborne surveys (including West Arnhem) is that radiometric processing has been undertaken using the Maximum Noise Fraction (MNF) spectral smoothing technique.

Wiso Survey

NTGS has released approximately 113 000 line-km of located and gridded magnetic, radiometric and elevation data from the Wiso survey, flown on behalf of NTGS during 2000.

The Wiso survey was flown at 80 m MTC along 400 m spaced N-S flight lines by Fugro Airborne Surveys. The survey was flown over the central Wiso Basin, between the Tennant Creek and Tanami goldfields, incorporating the Tanami East, Green Swamp Well and SW portion of the Winnecke Creek 1: 250 000 Sheet areas.

Radiometric processing has been undertaken using the Maximum Noise Fraction (MNF) spectral smoothing technique.

Survey location, specifications and located images for the Wiso, West Arnhem and all previous NTGS surveys are available on the NTGS website at:

http://www.dme.nt.gov.au/ntgs/geophysics/air_map/air_geo_map.html

New Image Web Server

The functionality of the NTGS IWS was significant upgraded in December 2000, enabling access to compressed located imagery from 47 semi-regional government airborne geophysical surveys through your web browser.

New upgrades to IWS functionality include the ability to:

- Obtain positional information, in both AMG (or MGA) and lat-long, for any point on the image. Previously, the only positional information available was the top-left and bottom-right corners of the image.
- Overlay any 2 images and vary their transparency - the Transparent Images Link. This function allows assess to the spatial relationship between features on different images.

You can visit the NTGS IWS at http://www.dme.nt.gov.au/ntgs/geophysics/air_map/air_geo_map.html

The Conductivities of Komatiitic Nickel Ores at Kambalda W.A.

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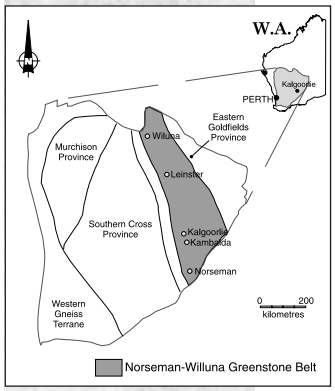
Introduction

The famous komatiite-associated Kambalda nickel sulphide deposits of WMC Resources Ltd lies to the north and south of Kambalda, 60 km south of Kalgoorlie, WA, in the central part of the Norseman-Wiluna Greenstone Belt (Figure 1). Here, fine to medium grained pyrrhotite-pentlandite-pyrite-magnetite ores occur as thin ribbon-like bodies (a few metres thick) at the base of a high Mg ultramafic lava pile. The ores occur as massive, matrix (connected sulphides) and disseminated types, and constitute a pre-mining resource of 67 Mt at 2.9% Ni. These deposits have been discussed by Cowden and Roberts (1990) and Stone and Masterman (1998).

This article describes the results of a mineralogically and chemically controlled, mesoscale laboratory study of the conductivities of blocks and cores of ores from eleven mines: Blair, Carnilya Hill, Foster, Hunt, Mariners, Miitel, Mt. Edwards, Otter-Juan, Schmitz, Victor, and Wannaway. Thirteen massive ores and four matrix ores were studied in the light of XRF, XRD, optical mineralogy and SEM-EDS data provided by WMC Resources.

Fig. 1. Location map showing Kambalda in Western Australia, and also Leinster (discussed in previous Preview paper: Emerson et al., 1999).



The primary texture of Kambalda sulphides varies from the finely banded massive ores to the truly disseminated ores where the individual sulphide grains are not in contact at all. The massive sulphide ores are classified as those having more than 80% sulphide, and they can have up to 20% nickel, which equates to about 60% pentlandite. The disseminated ores contain between 1-2% Ni, and have less than 40% total sulphides. The sulphide texture can be regarded as granular, except in restricted areas where a structural overprint may result in a linear fabric and the reshaping of the sulphide minerals. The matrix ores grade about 4%-5% Ni, and contain between 40%-80% total sulphides.

Table 1. Preliminary data for Kambalda nickel ores - mineralised ultramafics - mean values from 19 mine and drill sites.

ore type	conductivity kS/m	density t/m^3
massive (n=29)	3.06	4.46
matrix (n=17)	2.11	3.51

Previous Work

The results of a 1995 preliminary laboratory study of Kambalda ore conductivities are given in Table 1. The conductivities shown are averages of the maximum-recorded mesoscale values. The conductivities, measured DC galvanically (Emerson, 1969) and electromagnetically (Yang and Emerson, 1997), were found to be sensitive to the orientation of the ore banding i.e. the conductivities can be quite texture dependent with anisotropies of about 2:1.

In contrast to the excellently conducting sulphide continuum of the dense massive ores, the sparsely networked matrix ores had a fair to good conductivity ranging from 50 S/m to 7000 S/m.

Disseminated ores had an average density of about 3 t/m^3 and were usually resistive (hundreds of ohm m) with occasional restricted zones of fair conductivity (few S/m) in favourably textured horizons.

The massive ores manifested a considerable conductivity range: 2.9 kS/m to 135 kS/m. Massive ore conductivities seemed to decrease somewhat as tenor increased from low (~8% Ni) to high (~18% Ni). With a mean conductivity of 30.6 kS/m (std dev, 22.1), the Kambalda massive ores appeared to be less conductive than those at Leinster, 400 km further north on a similar greenstone belt, where good quality, medium to coarse grained, pyrite/magnetite-poor, massive ores have an average conductivity over twice that cited in Table 1 (as reported by Emerson et al., 1999). This disparity was intriguing and it was decided to investigate possible reasons (beyond those of texture) for conductivity variations.

Current Work

Conductivities were measured at mesoscale on cored or shaped sulphides from which material was taken for the chemical and mineralogical determinations. Conductivities cited are the maximum values (parallel to foliation or favourable texture) whether determined by inductive or galvanic (DC) means. Magnetic susceptibilities were measured at low frequency (<1 kHz) in an induction coil; the values cited are averages. Dry bulk densities were also determined and, as porosities are very low, these approximate the composite grain densities. Table 2

Table 2
Data Summary Selected Kambalda Sulphides

	major chemistry (wt %)								ore mineralogy (wt %)					density	cond.	suscept
#	% Ni	% Fe	% S	% SiO_2	% Mg0	Al_2O_3	CaO	Cu %	pn	po	py	cpy	mtt	DBD	σ_{max}	mag k
														t/m^3	S/m	SIx10^{-5}
massive sulphides																
n= 13																
mean	**12.29**	**43.9**	**34.2**	4.3	1.7	0.4	1.1	0.48	**35.8**	**41.8**	**10.9**	1.4	0.9	**4.57**	**54016**	**13894**
s. dev	*3.37*	*6.6*	*3.7*	*5.0*	*2.4*	*0.7*	*1.0*	*0.79*	*9.9*	*19.6*	*9.9*	*2.3*	*1.5*	*0.17*	*39615*	*9461*
matrix sulphides																
n = 4																
mean	**4.78**	**20.3**	**12.5**	25.6	19.3	1.8	1.7	0.19	**14.0**	**17.2**	**2.2**	0.6	2.8	**3.39**	**258**	**10523**
s. dev	*2.61*	*2.4*	*3.0*	*4.4*	*3.1*	*0.3*	*1.6*	*0.09*	*7.6*	*1.6*	*1.2*	*0.2*	*1.4*	*0.19*	*197*	*5122*

summarises the measured data and Figures 2 to 7 display the data in crossplotted perspective.

The fine to medium grained (0.1 mm - 0.5 mm) remobilised sulphides comprised: pentlandite, monoclinic (mainly) and hexagonal pyrrhotite, pyrite, and minor chalcopyrite. Also present were magnetite and chromite (difficult to distinguish in XRD) and gangue minerals including forsterite, talc, serpentine, magnesite, dolomite, calcite, siderite, amphiboles, chlorites, andradite, plagioclase, and quartz.

The stratified ore samples studied were from the basal chill zone of an Archaean volcano-sedimentary sequence that exhibited variation in constituents and properties. The petrophysical data presented here should be regarded as a mesoscale physical snapshot of a suite of materials that is considered to be a reasonable and useful representation of a selected range of ores, but it is by no means a definitive picture of the physical characteristics of Kambalda mineralisation.

Discussion

The mean conductivity value for massive sulphide ore (Table 2) is 54.0 kS/m, which is an average of a considerable spread of data, 4.27 kS/m to 131.8 kS/m. The densities show a tighter grouping. The most conductive massive sulphide with 53% monoclinic pyrrhotite, came from Foster mine, 131.8 kS/m; the least, with 1% pyrrhotite and 40% pyrite, was from Schmitz, 4.27 kS/m. The most pentlandite-rich sample, 55% pentlandite (18.8% Ni), from Victor, with 36% monoclinic pyrrhotite and 8% pyrite, gave a maximum conductivity of 19.9 kS/m. It is interesting to explore the likely controls on such variations. These can be inferred from the crossplots.

Magnetic susceptibility plotted against density in Figure 2 shows three groupings: the matrix ores (with an average of 2.8% mtt and 17% mon po), the massive ores (0.9% mtt, 42% mon po, av.), and two hexagonal pyrrhotite bearing ores from Wannaway (71% hex po and 45% hex po/34% troilite [FeS]).

Conductivity against density in Figure 3 shows a clear trend for those samples containing monoclinic pyrrhotite (as the dominant sulphide). Two hexagonal pyrrhotite-bearing samples and three others, containing significant amounts of the cubic sulphides pentlandite and pyrite, lie off this trend and have diminished conductivities.

Conductivity against % Fe in Figure 4 shows four groupings: the relatively low conductivity matrix ores, the high conductivity monoclinic pyrrhotite ores, the lower conductivity cubic mineral set, and the hexagonal pyrrhotite set.

High concentrations of pervasive, anhedral monoclinic pyrrhotite produce excellent conductivities. When conductivity is plotted against pyrrhotite (and the quite minor chalcopyrite content) a very clear trend emerges for all the massive ores except for two Wannaway hexagonal pyrrhotites which are in high concentration but clearly with conductivity below that of monoclinic pyrrhotite (Figure 5). Ward's (1970) data on synthetic pyrrhotites suggested that hexagonal pyrrhotite's conductivity could be an order of magnitude less than that of the monoclinic variety.

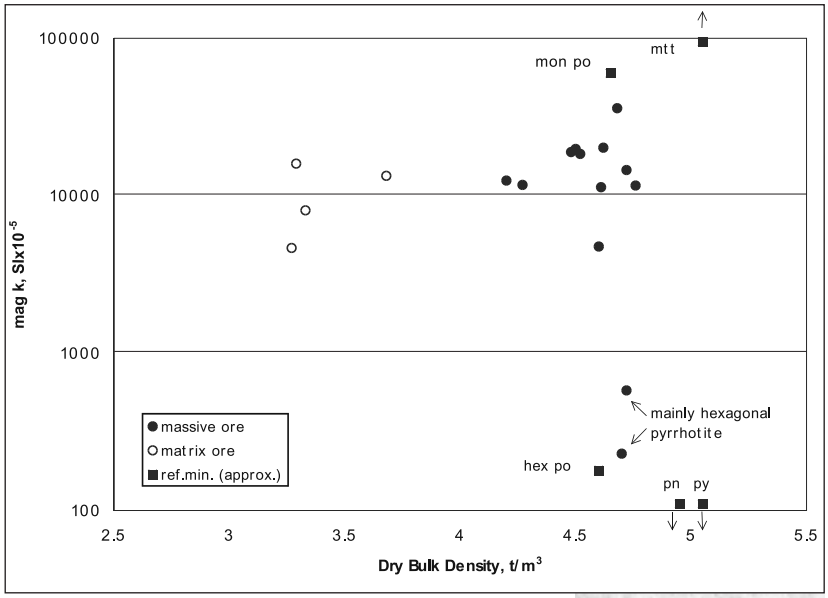


Fig. 2. Magnetic volume susceptibility plotted against dry bulk density depicts the intermediate susceptibilities of the studied Kambalda nickel ores with respect to the approximate values of reference Fe sulphide and oxide minerals (shown); lower density diamagnetic and paramagnetic gangue minerals are not shown. The influence of monoclinic pyrrhotite is clear in several of the massive ores.

Conductivity of nickel-bearing pentlandite-rich pyrrhotite is seen to diminish as nickel content increases, in Figure 6. This effect is noted too in Figure 7, where conductivity diminishes as metallic cubics (pentlandite, pyrite, magnetite) increase. Despite high crystalline conductivities, the aggregate conductivity of cubic metallics may not be high owing to grain contact impedances and current scattering effects. It is the significant presence of pyrite and spinels (magnetite, and

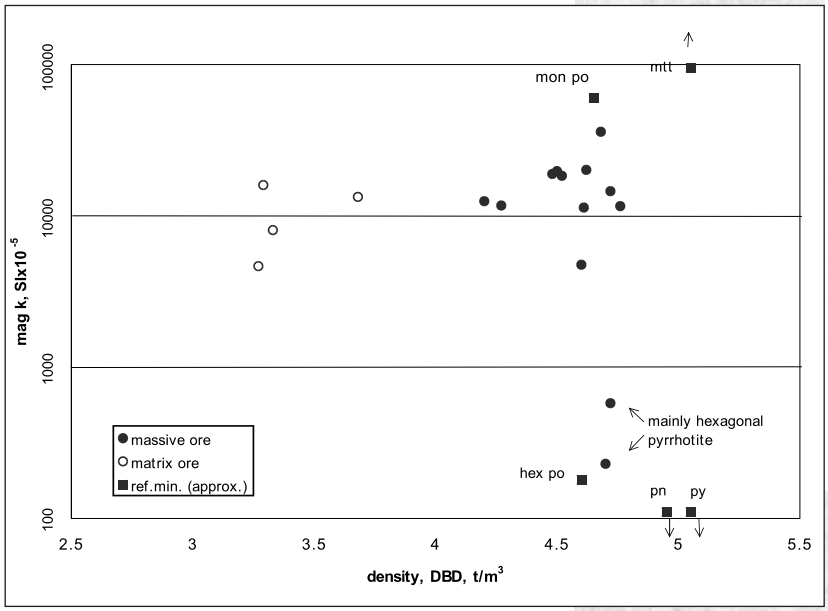
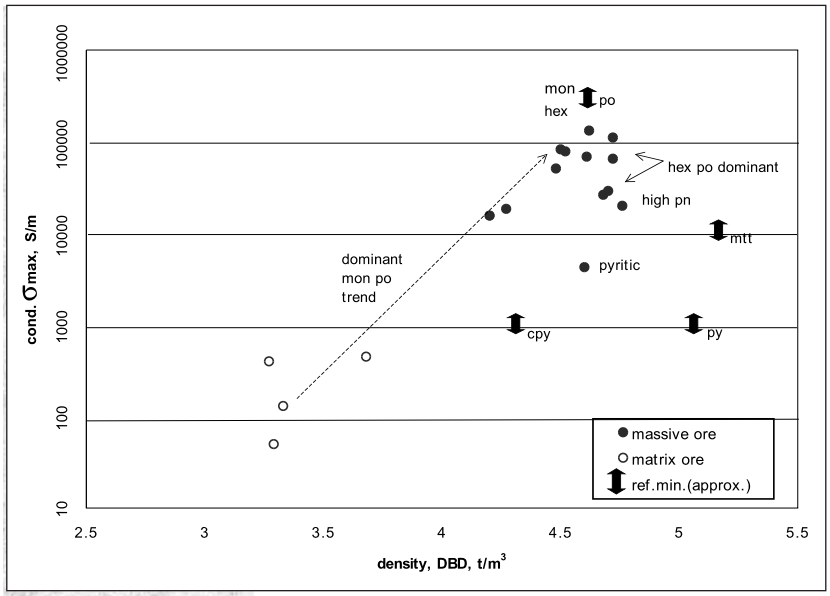
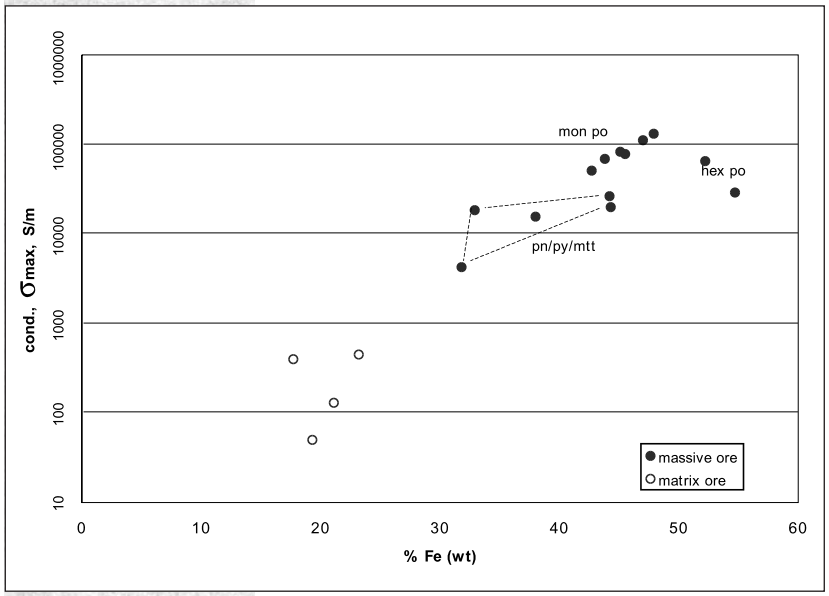
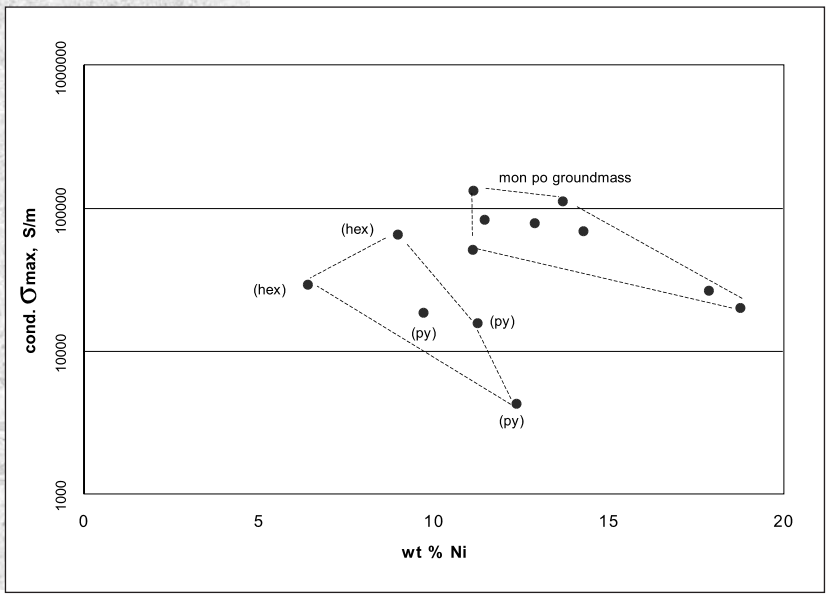


Fig. 3. Maximum ore conductivity plotted against density shows a trend towards the pyrrhotite field for most of the samples. Heavily pyritic and pentlanditic ores and those with hexagonal pyrrhotite (and troilite FeS) show off-trend diminished conductivities. The approximate crystalline conductivities of the main sulphide and metallic oxide minerals are shown. The trend line is visual.







usually minor chromite) that reduces the overall Kambalda conductivities below these of Leinster. Shuey (1975) has documented the conductivities of metallic lustre minerals and discussed such textural effects, generally.

As well as looking at conductivity from the viewpoint of conductors present, it is also instructive to consider the insulators, i.e. the silicates and carbonates present as sediment or country rock impurities caught up in the seafloor environment of the ancient ore forming process. These are represented chemically in Figure 8 , where conductivity can be seen to decrease broadly as gangue content increases.

Conductivity of Hexagonal Pyrrhotite

On the basis of the two samples tested, the conductivity of hexagonal pyrrhotite appears to be distinctly less than that of monoclinic pyrrhotite which, in substantial concentration at Kambalda attains values well in excess of 100 kS/m and could be regarded as having a nominal aggregate conductivity of around 200 kS/m (in a pure Kambalda-textured form). A maximum conductivity value of about 100 kS/m would seem to be indicated for undiluted hexagonal pyrrhotite aggregates at Kambalda. Hexagonal pyrrhotite does not occur in pyritic environments.

Conductivity of Pentlandite

Harvey (1928) tested one sample of pentlandite crystal with a microprobe and obtained a conductivity similar to that of several pyrrhotites. However, crystalline and grain-aggregate conductivities can differ considerably owing to texture, especially in cubic minerals such as pyrite and magnetite (Emerson and Yang, 1994). This effect was noted in the present study where miniprobe galvanic tests on clusters of Kambalda pentlandite grains indicated that their aggregate conductivities were up to an order of magnitude less than the monoclinic pyrrhotite groundmass i.e. around 20 kS/m, in aggregate (i.e. for pn).

Fig. 4. (Top) Maximum ore conductivity plotted against iron content shows a broad trend of increasing s with increasing Fe. Above the 40% Fe level, monoclinic pyrrhotite-rich massive samples have the highest conductivities (as a group); massive ores with significant amounts of cubic metallics (mainly pentlandite with pyrite and/or magnetite) and hexagonal pyrrhotite have lower conductivities. Gangue minerals exert a deleterious effect on conductivity below 40% Fe, for both massive and matrix ores.

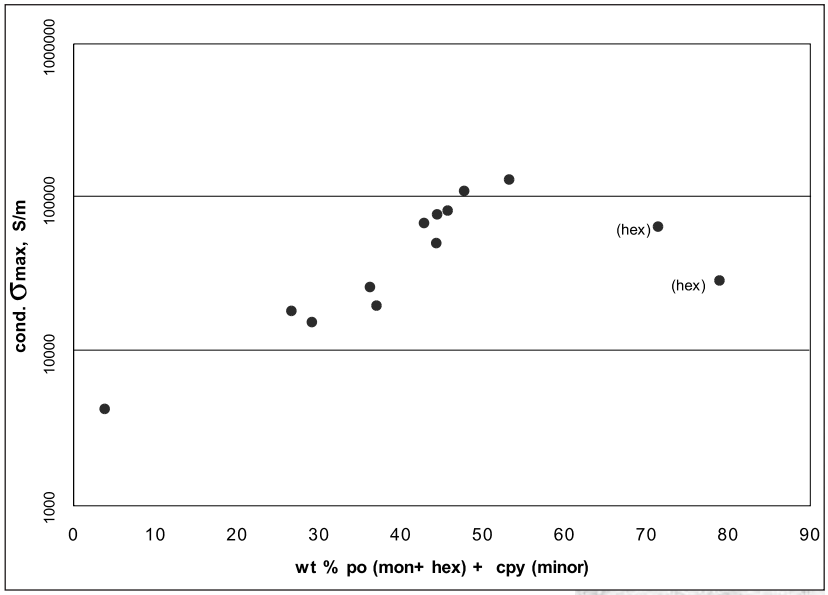
Fig. 5. (Middle) Maximum conductivity plotted against percent pyrrhotite (and quite minor chalcopyrite) shows, for massive ores, a clear trend of conductivity increasing with the amount of monoclinic pyrrhotite. The two off-trend points are for hexagonal pyrrhotite-rich samples of which one, with lower conductivity, has 45% hex po and 34% troilite (FeS).

Fig. 6. (Bottom) Maximum conductivity plotted against percent nickel shows two groupings for massive ores: a higher conductivity monoclinic pyrrhotite group and a lower conductivity hexagonal pyrrhotite and pyritic group. Both groups have trends that suggest diminishing conductivity as nickel content increases.

Conclusions

The electrical conductivities of the Kambalda massive nickel sulphide ores are dominated by pyrrhotite, which in its usual monoclinic aggregate form probably has an undiluted conductivity of around 200 kS/m. In the rarer hexagonal form pyrrhotite's conductivity is probably around 100 kS/m. In massive concentrations this pyrrhotite forms a superb electrical continuum, as would be expected in a low mobility metal (Shuey, 1975) with platy grains and well sutured grain boundaries. However, the addition of the cubic minerals pentlandite, pyrite and magnetite impairs the continuum and diminishes conductivity significantly in massive, low gangue, high-density nickel sulphide ores, and in some cases by over an order of magnitude. Nevertheless, in absolute terms, excellent conductivities are the norm for these ores as shown by the mean value in Table 2, 54.0 kS/m, which is around half the value of the mean maximum value of the Leinster massive sulphides reported by Emerson et al., (1999).

The occurrence of a large volume of silicate gangue and the disruption of the pyrrhotite continuum completely changes the electrical character of the nickel ores. Conductivity is maintained by a sparse network pyrrhotite but at greatly reduced levels, ~260 S/m for the four ores (average density 3.4 t/m^3) in this study and ~2100 S/m for the 17 ores (average density 3.5 t/m^3) in a previous study. For the matrix ores good conductivities may be expected, usually.



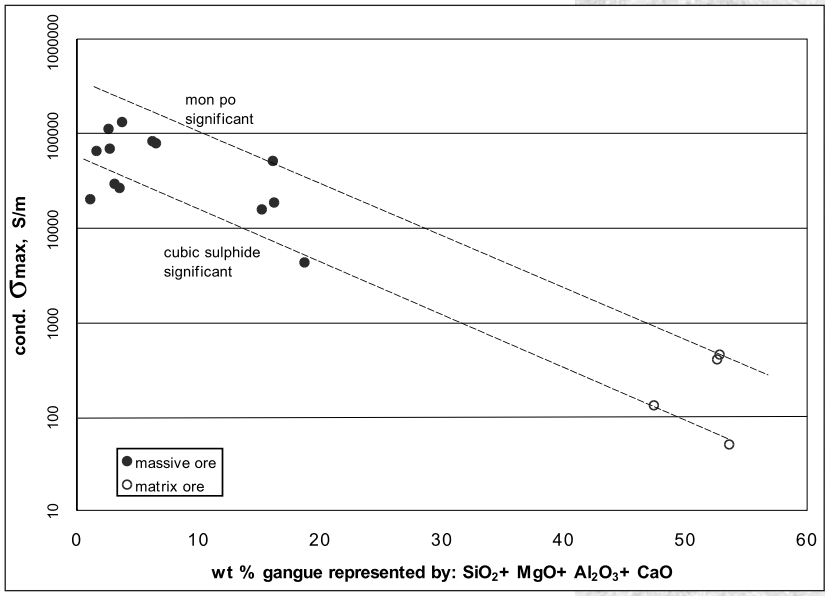


Fig. 7. (Top) Maximum conductivity plotted against metallic cubic mineral content (i.e. pentlandite, pyrite, magnetite), for massive ores, shows a broad decrease in conductivity, for the monoclinic pyrrhotite group, as cubic mineral content increases.

Fig. 8. (Bottom) Maximum ore conductivity plotted against gangue mineral chemistry shows a broad trend of diminishing conductivity as gangue content increases (trend lines are visual).

Acknowledgements

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Short Note on Multi-Coil EM for Diamond Exploration

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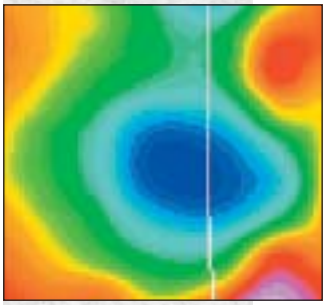
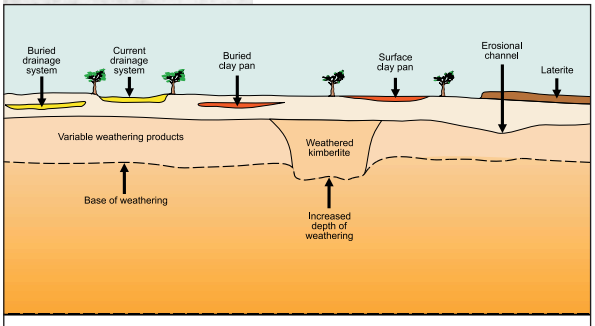
The Task



Diamond exploration using airborne Electromagnetic techniques (EM) aims to map variations in conductivity within the regolith because, the mineral assemblages which make up kimberlite pipes, weather readily to form electrically conductive clay products. Figure 1 shows an image covering 250 m by 230 m of calculated resistivity from a demonstration Hummingbird EM survey flown on N-S lines at 50 m line spacing and 30 m ground clearance over a known diamond pipe in the Merlin Field, Northern Australia. The Hummingbird equipment comprises five coil pairs in a towed bird system, with both horizontal coplanar and vertical coaxial coil configurations and five operating frequencies.



SCHEMATIC DIAGRAM SHOWING VARIABLE CONDUCTIVITY IN THE UPPER PORTION OF THE REGOLITH AND TARGET WEATHERED KIMBERLITE IN THE LOWER PORTION OF THE REGOLITH

The vertical extent of the conductive portion of a kimberlite pipe depends on the depth of weathering in the area. The target typically occupies the lower part of the regolith and often shows an increased depth due to preferential weathering of the more reactive kimberlite material (Figure 2). The task for diamond explorers using EM techniques, is to distinguish common EM responses from the flat lying, transported and often clay rich sediments of the upper part of the regolith, from target responses derived in the lower part of the regolith which reflects the weathered original rock. The thickness of weathered kimberlite material may be very variable, from 10 m to perhaps 80 m. This contrasts with the thickness of conductors within the upper transported portion of the regolith, which might typically vary from half a metre to five metres.

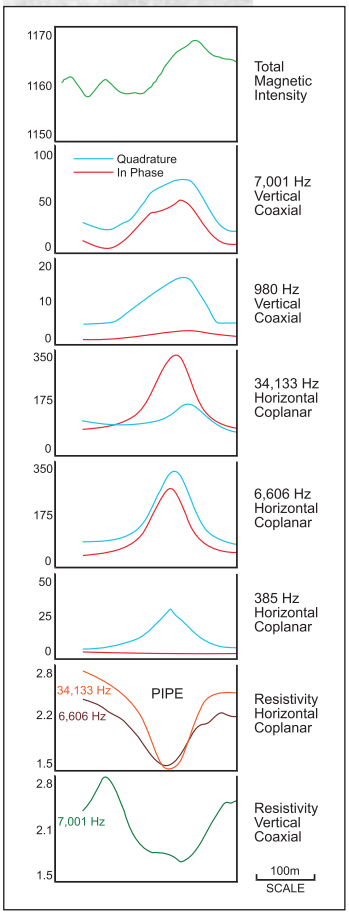


Fig.1. (Top left) Resistivity image over a known weathered kimberlite pipe. Blue corresponds to low resistivity. The area represented by the image is 250 x 230 m, and the flight line spacing is 50 m. The white line is the track of the line shown in Figure 3.

Fig. 2. (Middle left) Schematic diagram showing variable conductivity in the upper part of the regolith, and a weathered kimberlite target in the lower part of the regolith.

Fig. 3. (Left) Vertical coil and horizontal coil EM responses in parts per million over a known kimberlite pipe. A magnetic trace (panel 1 at top) and three calculated resistivity profiles (panels 7 and 8 at base) are also shown.

Fig. 4. (Right) EMFlow inversion of Hummingbird EM profile shown in Figure 3.

The Solution

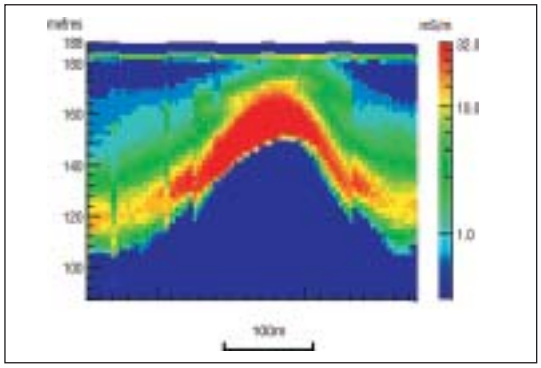
The sides of the weathered kimberlite provide a target for vertical coaxial coils, which give a different and distinctive response to the horizontal coils. Figure 3 shows ten channels of EM data, as well as three calculated resistivity profiles and the TMI profile (south on left, north on right). The second panel from the top contains the vertical coil twin peaked in-phase response (red) and broad-shouldered out-of-phase (blue) response at 7001 Hz. which reflects the disc-shaped geometry of the weathered pipe. This response contrasts with the single peaked response of the horizontal coils at both 34 kHz. (panel 4) and at 6606 Hz. (panel 5). The distinction in response is carried through to the calculated resistivities with the horizontal coil data yielding simple minima ((panel 7) while the vertical coil data give a broad double trough panel 8 at the base of the figure).

The abundant flat-lying layers of conductive clay within the transported part of the regolith give good electromagnetic responses, which are usually similar to the horizontal coil response of the weathered kimberlite. However, the response obtained from the vertical coil pair clearly identifies the weathered kimberlite. Diamond exploration using multi-coil (vertical and horizontal coils) is recommended for effective discrimination of high priority targets and substantial savings in follow-up ground geophysics. Significant savings may also be anticipated through reducing the amount of drilling directed unproductively at overburden EM responses.

Inversion of the Hummingbird EM profile using EMFLOW (Figure 4) highlights the most conductive portion of the regolith (the weathered kimberlite) beneath a thin veneer of transported sediments. The simple model employed in the inversion is not strictly applicable to the three dimensional disk shape of the conductive portion of the pipe. Nevertheless, the image very clearly highlights the position of the source of the EM anomaly. Subsequent ground geophysics and drilling would readily delineate the target.

Acknowledgements

The writer thanks Bettina Townrow and Keith Jones for discussion of the data and the geological setting of the survey area. The EMFLOW result is presented with acknowledgement to Encom Technology and the CRC AMET.



Large Volume Visualisation and Interpretation

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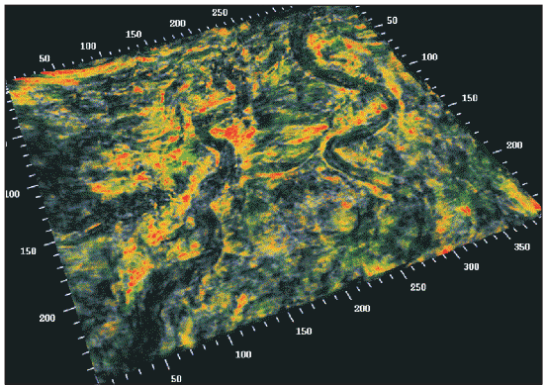
Volume-based visualisation and interpretation has been shown to enhance greatly our understanding of the subsurface image by viewing geological features within seismic data sets in their true 3D stratigraphic and structural position. This understanding is branching into a new sub-discipline in seismic interpretation called seismic geomorphology. Seismic geomorphology is based on the premise that a 3D seismic data set is in essence a 3D geological model. Volume isolation techniques such as windowed, body tracking, or sequence (horizon) sculpting are used to extract and view the buried ancient landforms. The results of the visualisation analysis are then compared with present day analogs.

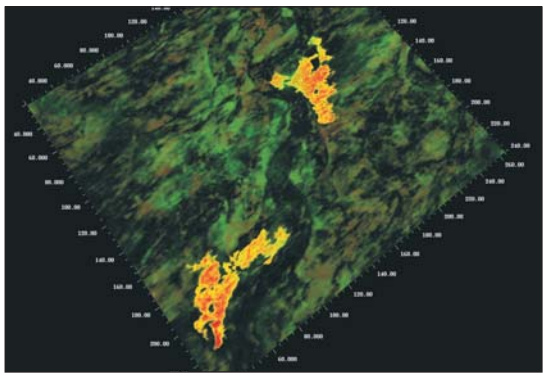
An integral part of volume visualisation is the use of opacity and colour. Colour and opacity are used in conjunction with isolation techniques to focus the visualisation on specific geological features within the seismic volume. Colour consists of two parts, data colour (foreground colour) and background colour. Strong contrast between the two is required for good visualisations. Opacity is a measure of the degree of transparency that can be applied to a range of values in a seismic volume. Once opacity/transparency has been applied, colour is adjusted to enhance the dynamic range of the data being visualised.

In areas of low structure, or in flattened volumes, the windowed visualisation isolation strategy can produce dramatic images of the subsurface. Figure 1 shows such an example. The seismic data within the two meandering channels are characterised by a low amplitude response. By changing the high negative (red-orange) and the high positive (green) amplitude to an opaque setting and changing the intermediate and amplitudes (pale colours) to a semi-transparent and transparent settings we are able to visualise the two channels. Windowed visualisations can provide stratigraphic and structural details that are not typically gained until much later in the interpretation cycle. Analyses/extraction of prospective areas or bodies (geobodies) identified by windowed visualisation are performed using body-tracking techniques, which are based on volume element connectivity (Figure 2). These analyses study the interconnectivity of seismic bodies and also their extent, size, and distribution.

Effective volume visualisation requires the 3D data set to be completely resident in computer RAM. As such, the use of volume visualisation has gone hand in hand with improvements in computer hardware. Desktop visualisation workstations are now typically configured with 2 to 4 gigabytes of RAM. The larger visualisation systems are configured with up to 16 gigabytes of RAM. Today we are seeing 100 gigabyte (8-bit) sized data sets equivalent to areas greater than 10 000km^2. This leaves us with a problem. How can we visualise these larger 3D datasets? One solution has been to reduce volume size through decimation. However, this results in loss of seismic information and resolution, and may result in key visualisation targets being missed or miss-interpreted.

New visualisation methods using volume roaming allows navigation through entire un-decimated 3D dataset by accessing bricks or blocks of data directly from disk and placing the data in cache memory for temporary viewing. Data need to be stored in an efficient format for rapid access by the volume roaming application. Volume roaming speed is comparable to volume visualisation speed in terms of panning through and accessing seismic data sets but with the added benefit of immediate access to the entire un-decimated 3D data set. Areas of interest are identified during volume roaming and are subsequently sub-setted from the main volume so they can fit into system RAM and be analysed using volume-based visualisation techniques.





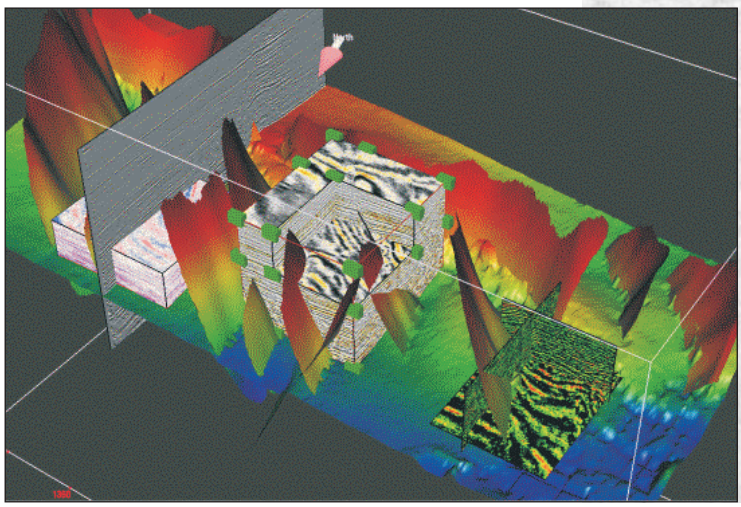


Fig.1. (Top) Windowed Visualisation.

Fig. 2. (Middle) Body Tracking (see text for explanations).

Fig. 3 (Bottom) A 3D scene from a volume roaming application showing several seismic blocks, mapped faults and horizons with time structure. Seismic blocks are moved around the volume graphically using the block handles to find areas of interest in large 3D data sets.

The Barracouta Field Revisited

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Summary

The Barracouta Field is a significant part of Australia's oil and gas history. The Barracouta 'Top of Latrobe' gas in Upper Eocene fluvio-deltaic sands was Australia's first discovered commercial offshore hydrocarbon accumulation and Australia's first offshore well (Gippsland Shelf No.1) in 1965. Production commenced three years later and still continues today. With Barracouta well into its mature stage, focus has switched to increased recovery of existing reserves. In 1999, the first 3D survey was shot over the Barracouta Field with excellent results. Not only did the new 3D survey show the previously observed Direct Hydrocarbon Indicator (DHI), it now imaged what appeared to be a dual contact.

Introduction

The Barracouta Field is located in the Gippsland Basin in southeastern Australia. It is an oil and gas field located 25 km offshore in approximately 46 m of water. The Barracouta structure is an elongate anticlinal dome approximately 4 km by 25 km. Barracouta is the third largest Gippsland gas field after Marlin and Snapper, the three of which together account for more than 80% of the Basin's gas reserves.

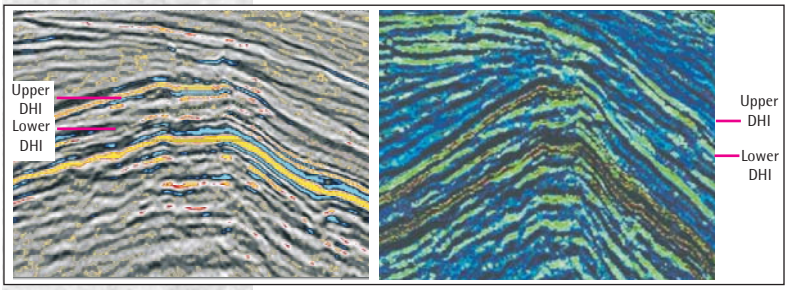

Fig. 1. Double Direct Hydrocarbon Indicator (DHI) present on quadrature phase seismic data (left) and on an optical stack of eight seismic lines (right) from the new 1999 3D survey.

DHI

Various vintages of 2D seismic lines cover the Barracouta Field however, before 1999 there was no 3D survey over the field, all interpretation was 2D based. All vintages of seismic show the presence of a DHI, however, the new 1999 3D survey shows the presence of a double DHI. This can been seen in Figure 1.

ATTRIMOD / GXII Modelling

Modelling was carried out to investigate the validity of the dual contact and what was driving the response. Initial fluid replacement modelling carried out in ATTRIMOD, a proprietary program, showed that the lower DHI was caused by the OGWC (Original Gas Water Contact) and was a velocity contrast between the residual gas and water sands. The second DHI on the other hand was caused by the CGWC (Current Gas Water Contact) and was a response to the density difference between the unproduced and residual gas sands. This second DHI (CGWC) however, was quite a subtle feature on the synthetic sections generated.

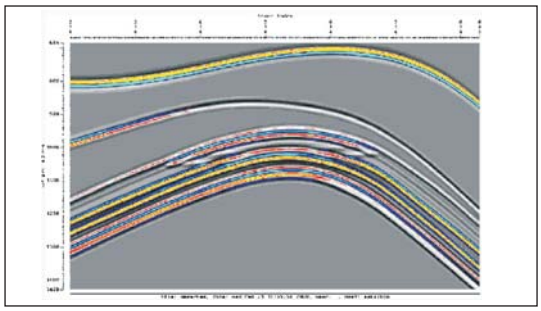

Fig. 2. The GXII model above shows that tuning can be used to help identify the double DHI.

The original seismic sections showed that one of the ways to identify the dual DHI was via 'tuning' effects at the edges of the DHI. To investigate the influence of tuning, more modelling was carried out in GXII.

The GXII modelling illustrated that it was possible to see a dual DHI. Although it was possible to see the double DHI in the ATTRIMOD modelling, the GXII modelling indicated that tuning effects would help identify the edges of each DHI. The GXII modelling also displayed the impact of velocity variations from the high velocity channels above and how these effects tilted the original and current contacts.

After the interpretation of the 1999 3D cube, various attributes were extracted to try and detect the DHI's in map view. The two pictures below (Figure 3) were created from two separate attribute extractions. The one on the left clearly shows the limit of the lower DHI over most of the field while the map on the right shows both the upper and lower DHI visible in the eastern side of the field. Such attribute maps have helped to delineate the extent of the current field.

Conclusions

The 1999 Barracouta seismic survey has provided us with many ways of looking at the field from both a structural and field depletion stand point. Modelling supports the idea that the double DHI is caused by the OGWC and CGWC. Knowing that the second DHI is caused by the CGWC will be of great benefit in planning any future drilling / recompletion plans for the field.

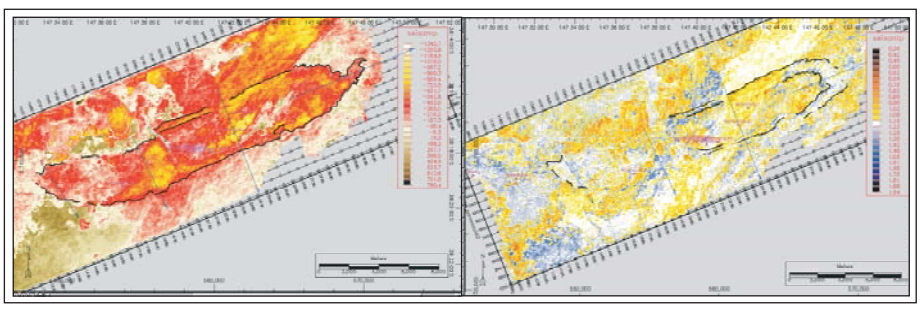

Fig. 3. Attribute maps extracted from the interpretation on the 1999 Barracouta survey.

Application of Geophysical Well Logs in Geotechnical Evaluations of Subsurface Deposits and Geoengineering

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Part 3 - Geophysical well logging for underground tunnelling in carbonate rocks: a case history

Aims: The objectives of geophysical well logging for geotechnical evaluation of carbonate rocks are to determine the:

1. Lithology

2. Rock strength

3. Rock structural features

Well logs: Seven different logging methods have been exploited to achieve these aims:

- Natural gamma ray (GR)
- Gamma-gamma density (Den)
- Multi channel sonic (dt)
- Neutron measurements (Nphi)
- Borehole calliper (CAL)
- Electrical resistivity (Res)
- Acoustic imaging of borehole wall (BHTV)

Lithology: The common lithologies of dolomite and limestone can be well recognised from well logs (Figure 1), cryptalgal and carbonaceous dolomite cannot be distinguished from each other. Therefore, they have been assigned the same symbol or colour to ease the correlation of the core record (core) and the log-derived lithology (loglith). Both cryptalgal and carbonaceous dolomite contain a high amount of carbon, which can be followed from neutron porosity and electrical resistivity logs. In a similar way, belteroporic and calcitic dolomite have been assigned the same symbol, as a high calcite content in both lithologies is expected. Further description of core, such as altering/weathering state and constituents (carbon/calcite), which can be followed from well logs, are emphasised through displaying its symbols in the second and third lithology columns (s2, s3).

The main difference between dolomite and carbonaceous dolomite is due to electrical resistivity. Both have the highest densities, and the lowest P-wave velocities. There are also differences between dolomite and limestone based on density and P-wave velocities.

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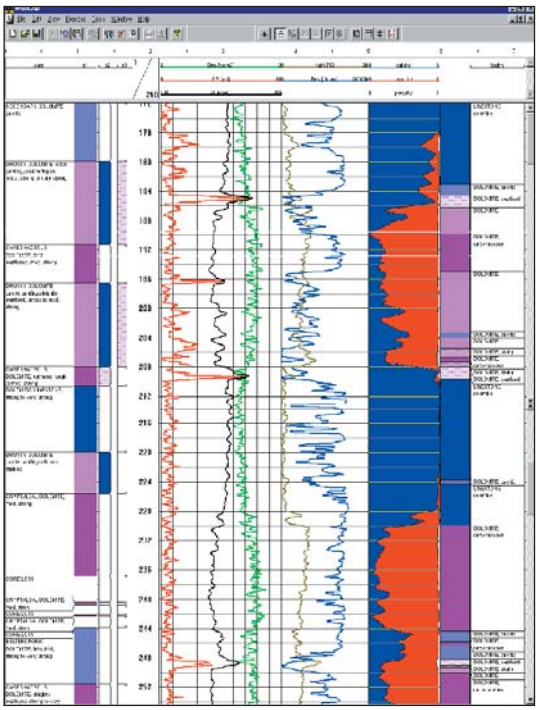
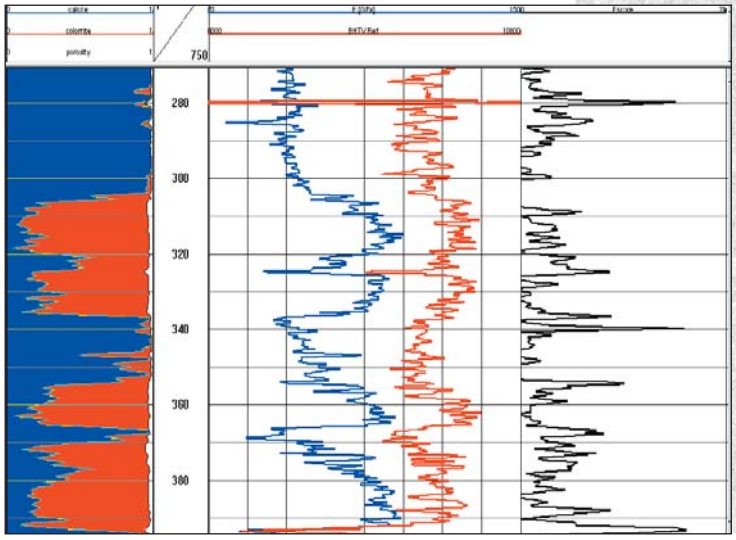


Fig. 1. (Left) Log derived lithology compared to core record.

Fig. 2. (Below) Correlation of rock strength with lithology and structural measure, Fscore.



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An increase of calcite content in dolomite will lead to lower densities and higher P-wave velocities. The dolomitic limestone has a higher calcite content than the calcitic dolomite.

The occurrence of higher gamma ray values and lower electrical resistivities is observed in some dolomite sections. These intercalated beds are interpreted as "shaley" dolomite. Normally an increase in neutron porosity would be also expected, but there is no noticeable increase in neutron porosity values. Another lithological unit is interpreted as "weathered/altered" dolomite, because of its low electrical resistivity and low P-wave velocity. The differentiation between weathered/altered dolomite and dolomitic limestone is based on electrical resistivity.

Rock strength: The stiffness modulus has been calculated and a Poisson's ratio of 0.25 (elastic body) has been assumed to calculate the dynamic E modulus (Figure 2). The calculated E modulus provides a value of ≈114 GPa in the dolomite section, which is similar to the static ones of massive dolomite determined in laboratory. In the limestone section an E modulus average value of 90 GPa is calculated.

Rock structural features: To distinguish between mineralogical and structural influences on rock strength, a structural evaluation of the BHTV amplitude image and volumetric analysis of well logs was carried out.

Structures have been picked from the BHTV amplitude image. The fracture score (Fscore) is then calculated. At depth levels with high fracture score values (280 m, 285 m, 325 m, 354 m, 368 m, 393 m) a noticeable reduction of theE modulus is observed. These decreases are attributed to fracturing.

Volumetric analysis has been carried out based on a limestone-dolomite-water mineralogical model. Measurements of density, P-wave velocities and neutron porosity have been considered in the volumetric analysis. Depth intervals with high dolomite content (red areas) show high E modulus values in comparison to those with high calcite content (blue areas), in spite of its higher porosity (white area). This is caused by the high density and P-wave velocity of dolomite compared to those of limestone.

The derived acoustic reflectivity from the BHTV amplitude image (BHTV Ref) shows a good correlation with the E modulus. Heavy fractured zones are also well identified in BHTV acoustic reflectivity. The dolomite sections have higher BHTV reflectivity in comparison to limestone sections. It is noticeable, that the separation between BHTV reflectivity and E modulus in dolomite sections is lower than in limestone sections. This could be caused by a higher roughness of the borehole wall in dolomite section, which leads to lower acoustic reflectivity.

Conclusions: Geophysical well logs offer a suitable base for geotechnical evaluation of rocks. Lithological, structural and rock mechanic information can be derived from well logs. An integrated, objective analysis of log data with proper statistical tools is required. Two procedures can be distinguished:

1. Direct derivation of petrophysical, structural and elastic parameters from well logs, and,

2. Indirect determination of strength parameters from well logs after a suitable calibration with rock mechanic measurements in laboratory

According to the examples presented, the following information are obtained directly from geophysical borehole measurements:

- Lithology (if geology is previously known!),
- Rock structural features,
- Physical properties,
- Elastic parameters,
- Weakness zones,
- Direction of horizontal stress field

Rock mechanic parameters such as:

- Compressive strength,
- Cohesion,
- Friction angle,
- Static young's modulus

can be derived from well logs after a proper calibration with laboratory tests.

The importance of acoustic methods (imaging and sonic) should be emphasised in geotechnical studies. Acoustic velocity as well as reflectivity of drilled rocks is an important parameter for quantitative structure analysis and quantitative determination of rock strength. The dependency of rock mechanic parameters such as compressive strength and cohesion on seismic velocity follow in general the exponential relationship: $a*V_p^b$. The high scatter of calculated parameters in comparison to measured ones is not satisfactory for the end user. The main reason is caused by heterogeneity of core samples and the limited resolution of the well logs. Other parameters such as lithology and fracturing should be also considered while selecting probes. It is recommended to calibrate with geophysical data individually for homogenous groups of probes. The derived relationships should be also verified in other wells before general application.

Geophysical Logging for Rock Mass Assessment

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Parameters for geotechnical evaluation

Geotechnical investigations into the geomechanical properties of rock units at depth, conventionally rely on the logging and testing of cores. As with geotechnical investigations in the near surface, the overall assessment requires consideration of the properties of the intact rock and the defects within it. Measures of these are often used as input into the empirical Hoek-Brown failure criterion:

$$\sigma_1 = \sigma_3 + \sigma_c \left(m_b \frac{\sigma_3}{\sigma_c} + s \right)^a \qquad (1)$$

which defines the strength of a jointed rock mass under differing loading conditions (Hoek et al., 1998). Here σ_1 and σ_3 are the axial and confining principal stresses (in MPa), σ_c is the uniaxial compressive strength (in MPa), m_b is a constant depending upon the rock type and its texture, and s and a are constants related to the defects (joints etc.) within the rock. The Uniaxial Compressive Strength (UCS) is usually determined in a laboratory. Tables of values for the other variables have been established through extensive testing and experience (Hoek et al., 1998).

As with any investigation requiring the recovery of core, geotechnical investigations are costly when compared to the alternative of open hole drilling and geophysical logging. In this article I discuss the potential for geophysical logging to provide supplementary or even alternative data for geotechnical investigations.

Strength of intact rock

It has long been recognised that seismic velocity has some relationship with rock strength. There have been numerous efforts to quantify this with the nomograms, first put out by Caterpillar in the 1960's relating velocity and rippability by bulldozers, being an early example. In the case of sonic logging, the following empirical relationship between sonic transit time, t, measured in microseconds per foot and UCS, proposed by McNally (1990) is frequently quoted.

$$UCS = 1000e^{-0.035t} \qquad (2)$$

This relationship was established on the basis of UCS test results on 1004 core samples from 40 boreholes in the NSW and Queensland coalfields. Australia's coal industry has extensively used this and other specific relationships established for 'local' rock types and specific sites. However, the need for modified relationships, particularly for low strength materials, hints at a problem with this approach of determining intact rock strength.

One problem in estimating rock strength, is that UCS and seismic velocity are measures respectively of inelastic (static) and elastic properties of a rock mass. As such, exact relationships between velocity (or any other elastic measure) and strength are unlikely, and we must therefore rely upon empirical relationships.

A second issue is that seismic velocity and rock strength are affected differently by variations in the composition of the rock material. This is recognised in McNally (1990) and one explanation can be found in the results of the various petrophysical studies describing relationships between seismic velocity (P- and S-wave) and the porosity, quartz and clay contents of clastic rocks. For example, Han et al. (1986) suggest that for sandstones at 10 MPa confinement:

$$V_p = 5.39 - 7.08\phi - 2.13C \qquad (3)$$

where V_p is the P-wave velocity in km/s, φ is the porosity, C is the clay content and the sum of the porosity, quartz and clay contents is one. A recent Australian example of this type of work can be found in Khaksar and Griffiths (2000).

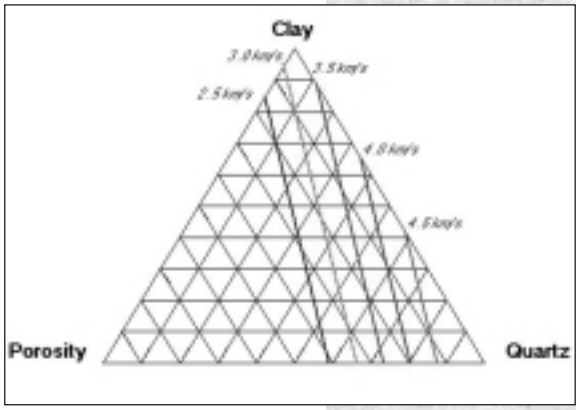

Figure 1. Ternary diagram showing variations of P-wave velocity derived using equation (3) for varying porosity, quartz and clay content for sandstones at 10 MPa confinement.

Equation (3) suggests that P-wave velocity varies in the manner shown in Figure 1 and from this it can be seen that P-wave velocity is not particularly sensitive to changes in clay content. However, the amount of clay present within a rock and the proportion of clay forming the cement and infilling pores does significantly affect its strength. Such considerations are embedded in equation (1), where the value of m varies significantly between different rock types; for example, conglomerates and claystones (Hoek et al., 1998, p. 90).

Figure 1 also shows that velocity is reasonably dependent on porosity. This provides one reason for the observed correlation between neutron log response and rock strength, but as noted by McNally (1990), the correlation between neutron log response and UCS is inferior to that for velocity and UCS.

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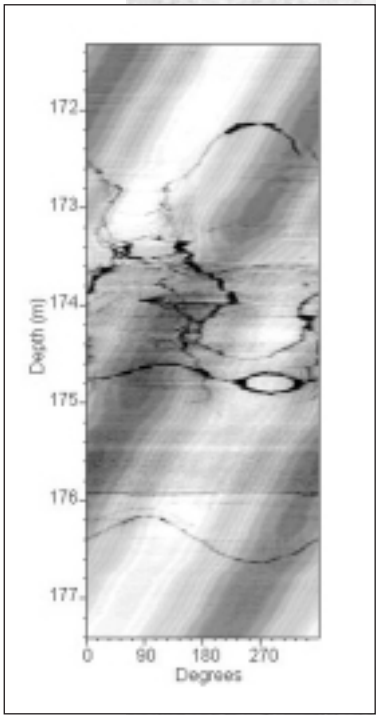

Figure 2. Acoustic scanner image from a section within a borehole through sandstones in the southern coalfield of the Sydney Basin. The sharp dark lines define the fractures around the borehole wall. The broad diagonal stripes are caused by the scanner deviating from the centre of the hole and should be ignored.

Continued from page 31

Defects

The measurement and quantification of the effect of defects on the strength of rock mass is one of the more problematic aspects of geotechnical evaluation. To properly apply equation (1), factors such as the number of joint sets, their orientation, their spacing, the length of the joints, their openness, their infilling, and their surface roughness all need to be considered. Obviously this is difficult with borehole data, even when core are available. One measure, which is often made on core, is the Rock Quality Designation (RQD). This is determined over one-metre intervals by subtracting from 100 (cm), the sum of the lengths of core sticks with lengths less than 10 cm. If the lengths of all the sticks of core from a one-metre interval are all greater than 10 cm, the RQD for that interval is 100. If all the sticks of core have lengths less than 10 cm, the RQD is 0.

Compared to the list of fracture attributes required for their characterisation, the RQD is not a very complete measure of the downhole fracturing. Geophysical logs that can help fill the gap are acoustic scanners (televiewers), optical scanners (for dry holes), dip meters and full waveform sonic logs.

In the case of scanners, an oriented image of the borehole wall is obtained at a resolution of about 5 cm. An example of an acoustic scanner image is shown in Figure 2. There are a number of fractures intersecting the borehole wall which exhibit the characteristic sinusoidal shape. From this the dip and orientation of the fracture can be determined. The photograph of the core from this section of the borehole (see Figure 3) allows the nature of these fractures to be judged. The dipping fracture between 176.2 m and 176.4 m, the horizontal fracture at 175.9 m and the broken zone above 174.8 m are all present on the scanner image and in the core.

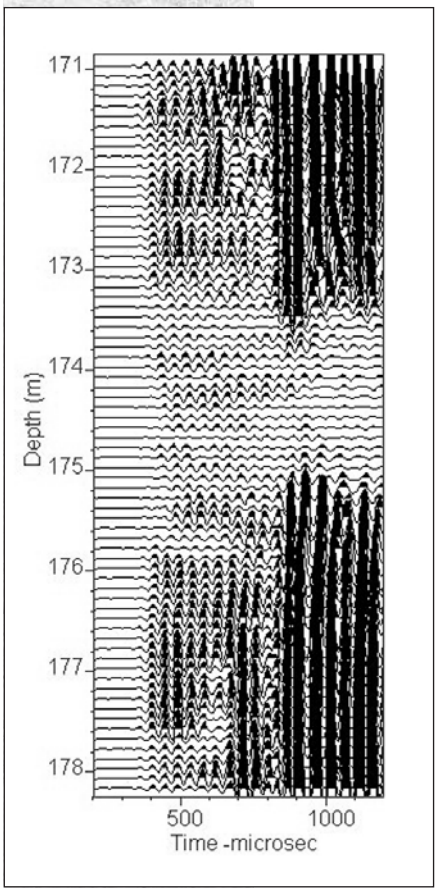

Figure 3. (Top) Photograph of core from the section of the borehole imaged in Figure 2. The depth ranges from 172.85 m (top right) to 177.52 m (bottom left). Approximate metre depths are marked in chalk on the core. Over this interval, all the core is sandstone.

Figure 4. (Bottom) Full waveform sonic log for the section of the hole covered in Figures 2 and 3. Within the fractured zone between 173.5 m and 175 m, the Stoneley wave (arrival time normally about 850 µs) has been completely absorbed. Notice also the reduction in the strength but not necessarily the velocity of the P-wave across this zone. The source to receiver separation is 1.22 m (4 feet).

Acoustic scanner data can also be used to determine the orientation of the maximum and minimum horizontal stress fields. The two-way reflection time to the borehole wall can be used to provide a full hole caliper and if the principal horizontal stress field is sufficiently strong to cause borehole breakout, its direction is perpendicular to the direction of the breakout. If something is known of the strengths of the rocks in which the breakout is occurring, the magnitude of the stress field can also be inferred.

To determine the openness of the fracturing, there is a role for full waveform sonic logs. An example of a full waveform sonic log, which is from the same section of borehole as in Figures 2 and 3, is shown in Figure 4. This log shows the usual P-wave events (approximately 400 µs arrival time) and the Stoneley wave event (approximately 850 µs arrival time). The S-wave event on this log is masked within the P-wave arrivals.

The Stoneley wave is a pressure pulse travelling up through the borehole fluid. Authors such Hardin et al. (1987) and Hornby (1989) describe its use in indicating the presence of fractures through the generation of reflections, and in indicating the permeability of a formation and any fractures, through the degree of absorption that occurs. The mechanism for this loss of energy is by the injection of borehole fluid into the formation and fractures.

In the example of Figure 4, Stoneley wave reflections are not readily evident, but there is a very clear disruption to the Stoneley wave in the main fracture zone between 173.5 m and 175 m. On the other hand, the fracture at 176.3 m, which is evident in the core and on the scanner log, is too tight to cause an observable Stoneley wave anomaly.

In general, Stoneley wave losses are easily observed on full waveform sonic logs from soft and hard rock environments. In Hatherly et al. (1997) there are examples of full waveform sonic logs from hard rock environments, which show a good correlation with RQD measurements. In a similar sense, dipmeter logs can also be used to infer the openness of fractures on the basis of there being a resistivity kick when the pads pass over an open water filled fracture.

Future possibilities

In this article, I have concentrated mainly on giving insights into sonic and scanner log responses as they relate to geotechnical considerations. It is pleasing to note that in the Australian coal mining industry, the use of sonics for rock strength estimation is routine in areas where local relationships between velocity and UCS can be established. Scanners are also being used to determine the presence of fractures intersecting a borehole wall. These applications have been established for a number of years but the use of geophysical techniques has still to be accepted by the geotechnical community at large.

One reason for this is that geotechnical evaluation requires the prediction of the behaviour of a rock mass under certain stress conditions using equation (1) or equivalent. These empirical relationships were established on the basis of extensive rock testing and measurement of physically measurable parameters. Geophysical parameters such as sonic velocity (or derived quartz and clay content) and Stoneley wave attenuation have not been considered in determining equation (1) and therefore cannot provide direct input.

However, there is no doubting the physical basis of geophysical measurements and the sense that the inputs to equation (1) should have a geophysical counterpart. This, plus the attractions of the reduced cost and the *in-situ* aspect of geophysical logging, surely points to the possibility of a much more significant role for geophysical logging in geotechnical engineering. However, for this to happen, a geophysical equivalent to equation (1) must first be found.

Acknowledgements

The views expressed in this article are my own but I express my thanks to Dr Terry Medhurst of Australian Mining Consultants for his assistance in explaining aspects of geotechnical engineering to me. I also thank Greg Poole of BHP Minerals for the providing me the opportunity to examine the very fine geophysical logging data presented here. Constance Conte assisted with the examination of the core samples.

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BHP and Billiton in $57 billion merger

The big news in March was the merger of BHP and Billiton to make the second largest mining/metals company. With an estimated market capitalisation of US$28 billion, it follows the Pittsburgh based Alcoa (US30 billion) and is ahead of Rio Tinto (US$27 billion) and Anglo-American (US$25 billion).

BHP Billiton will have its head office in Melbourne and a dual sharemarket listing in London to provide greater access to foreign capital. However, with the head of the Petroleum Group moving to London, one wonders how long Melbourne will be the centre of the company. After all, if Boeing can move from Seattle, anything is possible.

We probably all know the history of BHP, but Billiton's origins go back to 1860, when it was formed to smelt tin and lead in the Netherlands. In the 1940s it expanded into bauxite mining in Surinam and Indonesia and in 1970 it was acquired by Shell. By 1994 it had expanded as a worldwide business operation and was sold to the South African mining house, Gencor. In 1997 it was 'spun off' from Gencor, and combined its nickel interests with Australia's QNI.

Billiton's core assets include aluminium, copper, manganese, nickel, steel, titanium and coal. At the time of the merger Billiton had a capital value of US$9.7 billion compared to BHP's US$18.5 billion. Paul Anderson, the current CEO of BHP, will head-up the new company, and will be succeeded in 2002 by Brian Gilbertson, the current CEO of Billiton.

Battle for Woodside continues

At the time of writing, the battle for Woodside was still unresolved. Shell's hostile $10 billion bid for Woodside has been with the Foreign Investment Review Board for several months and it has yet to make a recommendation to the Treasurer.

It will be difficult for the government to come up with a win/win outcome on this issue. On the one hand the government is concerned about Australia's reputation as a foreign investment destination if the bid is rejected, and on the other, there will be concern about national interests if an offshore multi-national controls a major Australian strategic resource.

Ironically, while this battle is underway in Australia, Shell has mounted a US$1.8 billion hostile bid for the Denver-based US gas producer Barrett Resources.

For those who have read Daniel Yergin's book, 'The Prize: the epic quest for oil, money and power' it will be clear that behavioural patterns of the petroleum multinational have not changed in the past 100 years. In Shell's case it is noteworthy that its market capitalisation is a huge US$200 billion – larger than most nation's GDP.

Turbulent times for Anaconda Nickel as share price plunges

The share price of Anaconda Nickel fell to $1.14 in March, its lowest value since April 1999, and led to the company requesting the ASX to undertake an investigation into whether there has been manipulation in the price of Anaconda stock.

In July last year, its share price was $2.74, its market capital was over $1 billion, and the company was listed as 97th in the top 150 companies. It has now dropped out of this list.

However, in a statement to the ASX Anaconda confirmed that its Murrin Murrin Nickel Cobalt Operation ('Murrin Murrin') has been operating at 65% of design capacity during March, ahead of schedule, and anticipates that it will operate at 100% of capacity in the first half of next year, as previously reported. It stated that Murrin Murrin, is now operating cash flow positive, and is expected to operate at a rate that will cover operating costs, principal repayment and interest, during the third quarter of this year.

Minerals Exploration Expenditure bounces back and Petroleum continues to increase

Charts provided with permission of the Australian Bureau of Statistics

Minerals rebound

Figures released in March by the Australian Bureau of Statistics showed that for the December 2000 quarter, the expenditure on mineral exploration has finally rebounded from its four years of continuous decline. The ABS estimated a seasonally adjusted expenditure of $177M for that quarter, which is 5% higher than the estimate of $168M for the December 1999 quarter and an increase of 7% ($11M) over the September 2000 quarter.

Figure 1 shows the trends for the last eight years.

The good news is that the rise in total mineral exploration in the December 2000 quarter was mainly due to an 11% ($14M) increase in expenditure reported in 'all other areas' (i.e. other than 'on production leases'). This indicates that companies are exploring more in' Green field' areas and bodes well for new discoveries.

Western Australia accounted for all the increase, with mineral exploration expenditure rising (seasonally adjusted) in that State from $101M to $112M, ensuring that WA continues to dominate mineral exploration in Australia.

Although there were marginal increases in New South Wales, South Australia, Tasmania and the Northern Territory, these were balanced by equivalent decreases in Victoria and Queensland.

For the last three quarters, the estimate for metres drilled has continually risen. The increase between the September 2000 and December 2000 quarters was 7 km (0.5%). The December 2000 quarter figure of 15,000 km was 5% higher than that of the December 1999 quarter.

In the December 2000 quarter, exploration expenditure for nickel and cobalt rose by 40% ($7M) and gold by 5% ($5M). Between the September 2000 and December 2000 quarters, exploration expenditure for base metals (copper, silver-lead-zinc, nickel and cobalt) increased by 24% ($9M) to $48M.

Petroleum Exploration Expenditure continues to rise

Reported expenditure on petroleum exploration in the December 2000 quarter was $253M, 15% ($34M) higher than the September 2000 quarter, and 33% ($62M) higher than the December 1999 quarter.

Total petroleum exploration expenditure for the December 2000 quarter was the highest reported since the December 1998 quarter. This occurred as a result of a 10% ($19M) increase in offshore expenditure, and a 44% ($15M) increase in onshore expenditure.

Figure 2 gives an indication of trends over the past 2 years.

Between the September 2000 and December 2000 quarters, expenditure for petroleum exploration on 'production leases' and 'all other areas' rose 42% ($18M) and 9% ($16M) respectively. More than 65% of the total was spent in WA and Victoria had a big increase from $7M to $13M.

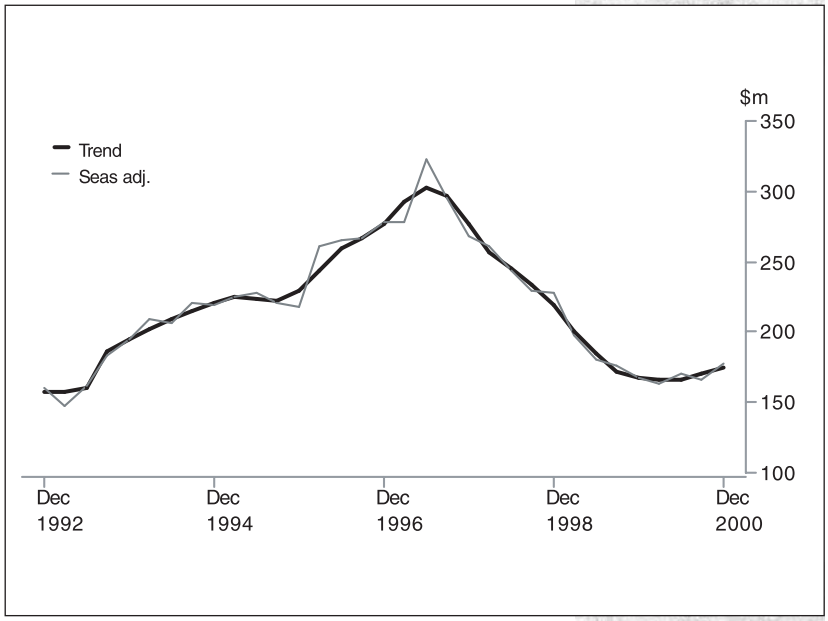


Fig. 1. Mineral exploration expenditure, December 1992 to December 2000.

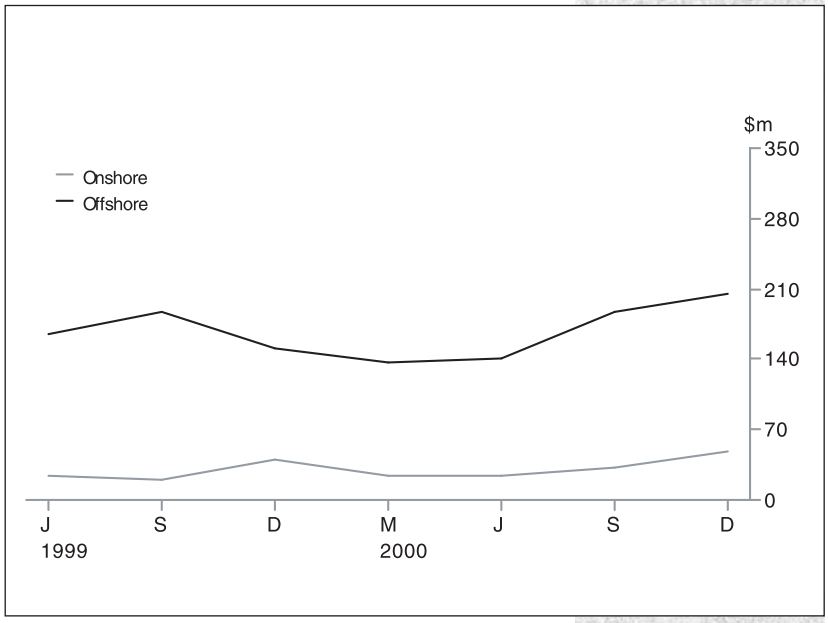
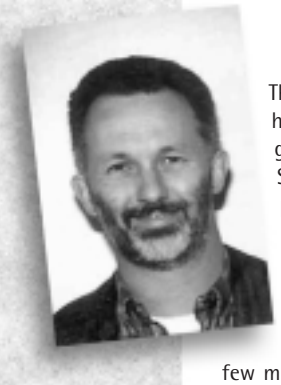


Fig. 2. Petroleum exploration expenditure, June 1999 to December 2000.

AGSO's New Portable Absolute Gravimeter



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The Australian Geological Survey Organisation (AGSO) has recently purchased an A-10 portable absolute gravimeter. This instrument, manufactured by Micro-g Solutions Inc., in Eerie, Colorado, USA, is the only portable outdoor absolute gravimeter in Australia and only the fourth one that Micro-g Solutions have built.

The A-10 can achieve 10μGal (1 μGal = $1x10^{-8}m/s^2$) precision in 10 minutes reading time. It is designed to operate out of a field vehicle and takes only a few minutes to set up for a reading. The instrument uses laser interferometry to measure the acceleration of a falling test mass in an evacuated chamber.

AGSO has purchased the instrument to facilitate the refurbishment of the Australian Fundamental Gravity Network. This network consists of about 800 documented gravity stations at or near about 200 locations throughout Australia. Survey time involved in refurbishing this network will be greatly reduced with the absolute gravimeter as, being an absolute instrument, there is no need for loops, ties and drift corrections so each site will only need to be occupied once.

During the latter half of 2001, AGSO plans to occupy about 50 to 60 Fundamental Gravity Network stations with the absolute gravimeter. This network of absolute stations will be used to adjust the current Fundamental Gravity Network, established by relative gravimeters, to reduce errors and warps introduced by these relative measurements.

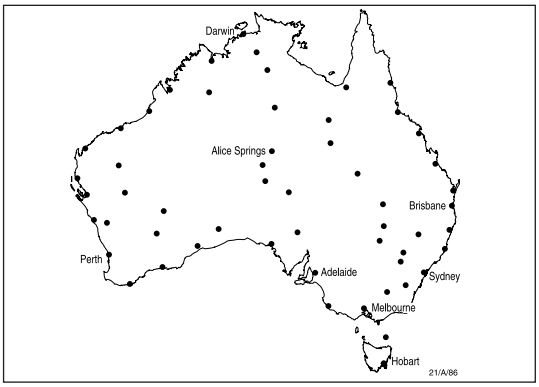

Fig. 1. (Right) Proposed locations of absolute gravity stations.

Fig. 2. (Far Right) The A-10 portable absolute gravimeter operating from a field vehicle.

Fire in the Sea

W.L. Friedrich (translated by A.R. McBirney) Cambridge University Press, 1999, 258pp.

Reviewed by ***Kurt Lambeck*** *Australian National University.*

Santorini or Thera is one of those rare places where everything comes together: geology, Bronze Age history, biology and art. With its eruption in 1866, 'witnessed' by Captain Nero in Jules Verne's 20,000 leagues under the sea, Santorini provided a significant laboratory for volcanological studies at a time when geological thinking was evolving rapidly. But long before that, the island's eruption had provided a source of fascination for early writers, storytellers and philosophers. Occasional playground for Zeus and Paseidon, land mark for Homer's wanderer, the volcanic island captured public imagination again with its renewed association with Plato's Atlantis by Marinatos in 1939. As a consequence of the volcanological studies in the previous century stunning discoveries of a bronze-age civilisation began to appear from beneath the pumice layers displaying an art that maulled and exceeded that found at Knossos on Crete.

Freidrich's 'Fire in the Sea', subtitled 'The Santorini Volcano: Natural History and the History of Atlantis', brings together the various aspects of the island in four parts: (i) the geological framework, (ii) the Minoan eruption and its effects, (iii) the volcano released its secrets, and (iv) the island is changing its appearance. In the first part, the geographic setting is described and its geological history is recounted, not in splendid isolation, but within the context of the eastern Mediterranean tectonics. Major island-shaping volcanic events occurred at intervals throughout Pleistocene time with the last major one occurring about 3,600 years ago. The importance of this last event in that by this time a sea-faring civilization had securely established itself on the island and was trading across the Aegean and at least as far afield as Egypt. The second part describes the eruption from the geological evidence as well as its effects on the population and flora. Again, the eruption is not taken in isolation of other global events: its occurrence is illustrated in the Californian bristle core growth-ring record as well as in the Greenland ice-core record.

The third part describes the archaeological finds revealed not only from beneath the pumice layers of the sixteenth century BC eruption but also from subsequent settlers including from the earlier Cycladean and later Helenic periods. The account leads naturally into the Atlantis story. Without prejudice, evidence is discussed and the reader is left to make a personal decision whether or not this is the Atlantis. The final part discusses recent and present changes on the island: the consequences of the forces of nature and man. The possibility of future eruptions is discussed but, wisely, no conclusions are drawn.

Overall, the book is a measured account of one of nature's displays of strength and beauty, as well as its consequences on man and life in general. The book is beautifully and plentifully illustrated but it is not a mere picture book. It provides insights into geological processes, biology and climate that even those trained broadly in scientific disciplines can learn from. Most of all, it must whet the appetite to visit Santorini or, if one has been fortunate to have done so before, return and look anew at the geology, archaeology and botany of Poseidon's realm.

Continental Shelf Limits
The Scientific and Legal Interface

Edited by ***Peter. J. Cook*** *and* ***Chris M. Carleton***

Oxford University Press, 2000, 364pp, Hardback $160, ISBN 0195117824

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Australia has probably the world's third largest legal continental shelf and was a leading player in the multilateral negotiations from 1973 to 1982 that culminated in the conclusion of the Law of the Sea Convention in 1982. Australia ratified the convention in 1994.

Australia's broad goals at the Third UN Conference on the Law of the Sea were to increase the rights of the coastal state to offshore resources. Thus it supported the extension of the territorial sea to 12 miles, the 200-mile exclusive economic zone and, most importantly, sought a formula to secure shelf rights to the edge of the continental margin.

Australia was one of thirteen countries that formed the 'Margineers' group at the conference, which argued that national limits to the shelf should extend beyond 200 miles. This was really the top priority of Australia over the life of the Law of the Sea Conference. From fairly early on, it looked like the shelf claim would be accepted in the Conference, but Australia took a very hard line on rejecting the concept of sharing revenue in areas beyond 200 miles with the international community. Many wide shelf states felt that revenue sharing was necessary to get the support of the 59 land-locked and geographically disadvantaged states. Australia's opposition did not in the end see the removal of a revenue sharing provision in the final convention.

The problem of finding a satisfactory formula for delimitation of the shelf saw Australia accept a complicated Irish formula on delineation (see below), even though it involved some compromise from Australia's support for the principle of natural prolongation. A number of states, led by the Arab group, were pressing for a limitation of the continental shelf to 200 miles. Australia recognised, along with other 'Margineers', that a Shelf Boundaries Commission might be useful in overcoming fears of those countries that argued that it was not possible to delineate the outer edge of the shelf. Australia's work did not pay off here, as the recommendatory body it had in mind was not reflected in the final text of the convention.

The 21 member Commission on the Limits of the Continental Shelf - Australia is not a member and the next election of members will be mid 2002 - has been established to make recommendations to coastal states on matters related to the outer limits of their shelf. But the limits of the shelf established by a coastal state will be 'on the basis of these recommendations' and 'shall be final and binding'. Part XV of the Law of the Sea Convention also requires that some form of binding settlement resolve disputes over the outer shelf limit. Australia will be among the first group of countries required to submit its boundary limits of its continental shelf beyond 200 miles by November 16th, 2004. This is an enormous challenge for AGSO.

Where the margin extends beyond 200 nautical miles the Law of the Sea convention provides that the limits of its outer edge are defined by either:

- A line delineated by the outer-most fixed points at which the thickness of sedimentary rocks is at least 1% of shortest distance from the foot of the continental slope or

- A line not more than 60 nautical miles from the foot of continental slope.

The legally defined outer edge of the margin is limited by a two-part cut-off formula, to give the outer limits of the legal shelf beyond the EEZ. It consists of:

- A line not exceeding 350 nautical miles from the territorial baselines and

- A line not exceeding 100 nautical miles from the 2500 m isobath.

The book under review explains the scientific issues and explores the legal-scientific interfaces in determining the outer limits of the continental shelf claim of coastal states. It aims to provide information to assist states in their planning of the research programs and surveys necessary to substantiate any claims made. It succeeds extremely well in achieving its aim.

It is very much a practical handbook to enable systematic and state-of-the art delineation to be undertaken that will pass muster by both the lawyers and the scientists. As is pointed out in the book's introduction, over the next 10 years or so, nations will document and lay claim to an area equal to more than half the Earth's land surface-a task of extraordinary magnitude.

The book covers all relevant legal issues and methodologies that will be required in order to submit a technically robust claim to the commission. It provides an excellent glossary of technical terms. It is a superb reference work. The audience for this book deserves to be a wide one - geoscientists, hydrographers, industry executives, academics, and lawyers. The book should provide the basis for understanding the scientific aspects of shelf delimitation and thus facilitate cooperation between coastal states.

AUSTRALIAN SOCIETY OF EXPLORATION GEOPHYSICISTS

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I, _____ (name), agree for the Australian Society of Exploration Geophysicists to make all necessary enquiries concerning my application and suitability to become a Member. By lodging this Application and upon being accepted in my membership, I agree to be bound by the Constitution of the Australian Society of Exploration Geophysicists, including its ethical and professional standards.

Signature:_____ Date:_____

MEMBERSHIP ELIGIBILITY

Active Membership - an applicant must be actively engaged in practising or teaching geophysics or a related scientific field. The applicant's work must have been of a professional nature for not less than eight years and must have been of a responsible nature calling for exercise of independent judgement and the application of geophysical or geologic principles during at least three years of the total eight years' professional experience. An applicant having worked toward a degree in a scientific field from a recognised college or university may count time as a student toward a portion of the required eight years' professional experience, not to exceed the following: Bachelor's degree, four years; Master's degree, five years; Doctor's degree, seven years. Time spent solely as a full-time student, even in pursuit of a doctorate, cannot be counted toward the requirement of at least three years' professional experience of a responsible nature.

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Clause 4 of the Articles of Association of the ASEG states that "Membership of any class shall be contingent upon conformance with the established principles of professional ethics":

1. A member shall conduct all professional work in a spirit of fidelity towards clients and employers, fairness to employees, colleagues and contractors, and devotion to high ideals of personal integrity and professional responsibility.
2. A member shall treat as confidential all knowledge of the business affairs, geophysical or geological information, or technical processes of employers when their interests require secrecy and not disclose such confidential information without the consent of the client or employer.
3. A member shall inform a client or employer of any business connections, conflicts of interest, or affiliations, which might influence the member's judgement or impair the disinterested quality of the member's services.
4. A member shall accept financial or other compensation for a particular service from one source only, except with the full knowledge and consent of all interested parties.
5. A member shall refrain from associating with, or knowingly allow the use of his/her name, by an enterprise of questionable character.
6. A member shall advertise only in a manner consistent with the dignity of the profession, refrain from using any improper or questionable methods of soliciting professional work, and decline to accept compensation for work secured by such improper or questionable methods.
7. A member shall refrain from using unfair means to win professional advancement, and avoid injuring unfairly or maliciously, directly or indirectly, another geophysicist's professional reputation, business or chances of employment.
8. A member shall give appropriate credit to any associate, subordinate or other person, who has contributed to work for which the member is responsible or whose work is subject to review.
9. In any public written or verbal comment, a member shall be careful to indicate whether the statements or assertions made therein represent facts, an opinion or a belief. In all such comments a member shall act only with propriety in criticising the ability, opinion or integrity of another geophysicist, person or organisation.
10. A member will endeavour to work continuously towards the improvement of his/her skills in geophysics and related disciplines, and share such knowledge with fellow geophysicists within the limitation of confidentiality.
11. A member will cooperate in building the geophysical profession by the exchange of knowledge, information and experience with fellow geophysicists and with students, and also by contributions to the goals of professional and learned societies, schools of applied science, and the technical press.
12. A member shall be interested in the welfare and safety of the general public, which may be affected by the work for which the member is responsible, or which may result from decisions or recommendations made by the member, and be ready to apply specialist knowledge, skill and training in the public behalf for the use and benefit of mankind.

For the June 2001 Indonesian Acreage Release

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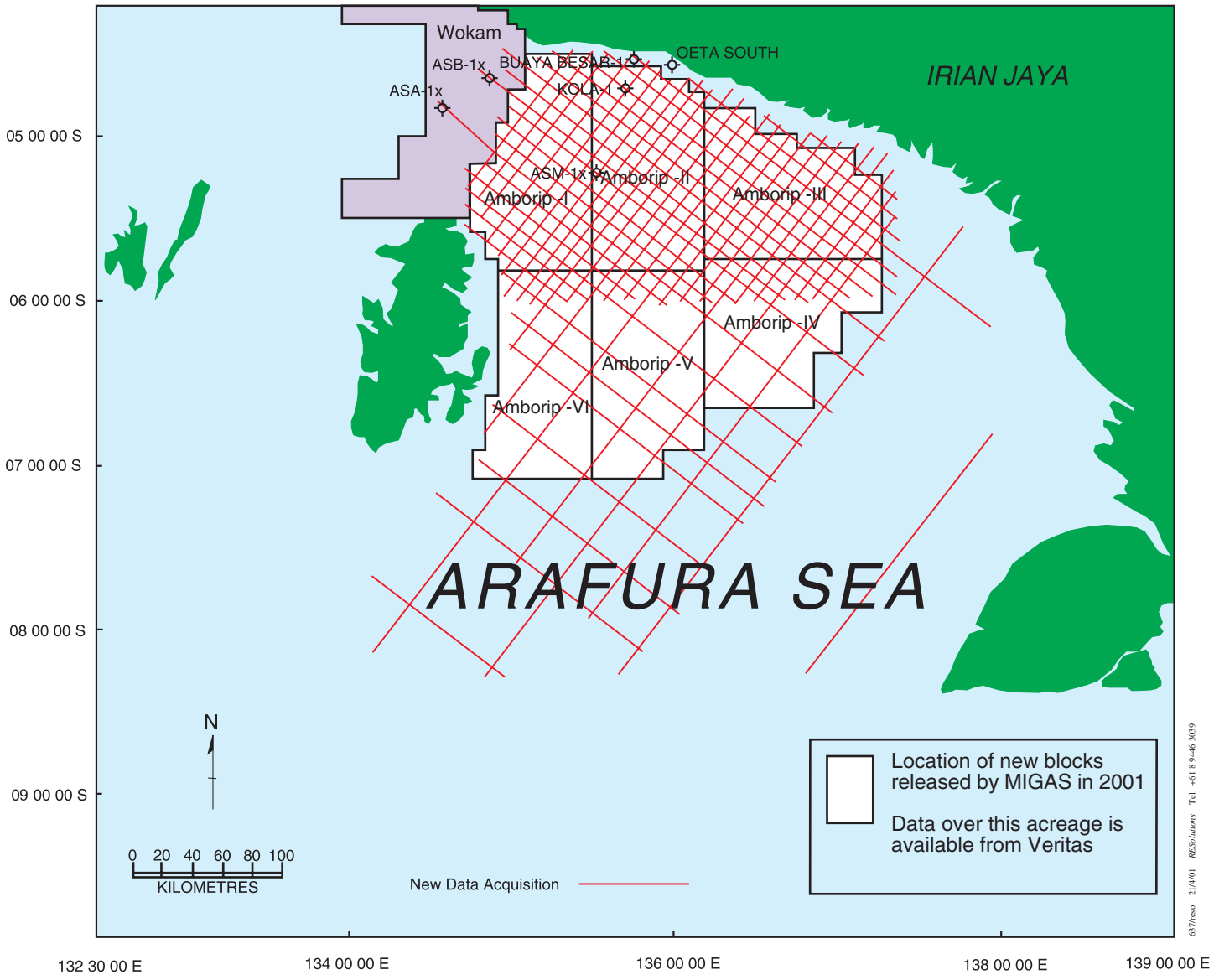

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P.T. Veritas DGC Mega Pratama has acquired 12,480 km of new regional seismic data covering the Arafura Shelf, Southern offshore Irian Jaya, East Indonesia.

This project has been undertaken in co-operation with MIGAS.

The region is now the focus of considerable interest from the petroleum industry and MIGAS will release a number of blocks within two months in the defined area for open PSC tender.

This data is the largest 2D data library seismic survey collected to date in Indonesia and ties to key exploration wells in the area.

VERITAS
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